Quarterly Journal of Iranian Distance Education (IDEJ)
Vol. 1, No. 2, Autumn 2018 (P 9-30), Payame Noor University

University Website Quality Improvement Using Intuitionistic Fuzzy Preference Ranking Model

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Received: 2017/07/09 **Accepted:** 2018/01/01

Abstract
Website is the first interaction tool between user and organization in every online business. The basic goal of every website is to provide information through its content. Nowadays, website content is considered to be a strategic issue for online businesses which will contribute to user attraction and retention. In this paper a soft decision making approach is taken towards the website content selection problem. To tackle this problem, a multi criteria decision making algorithm is proposed based on PROMETHEE outranking methodology. To overcome the shortening of this methodology facing the inherent uncertainty in decision problems, a new method is developed, where the characteristics of the alternatives are represented by intuitionistic fuzzy sets. Finally, a numerical example for content selection of Iranian universities' website is given to illustrate application of the intuitionistic fuzzy PROMETHEE method. The outcome shows the effectiveness of intuitionistic fuzzy PROMETHEE in accommodating the imprecise information in comparison with fuzzy PROMETHEE and original PROMETHEE.

Keywords
Website Quality, University Website, Soft Decision Making, PROMETHEE Method, Intuitionistic Fuzzy Sets.

Introduction

Over the past decade, development of internet has changed every aspect of life and its main outcome is the emergence of online organizations offering electronic services. Among the different back end and front end technologies that are needed to deliver electronic services, website serves as a primary interface with users. Therefore, website quality is a critical success factor for online organizations to survive in competitive world of business [3]. The basic goal of every website is to provide user with information [1]. Hence website content is one of the key dimensions of website quality [15][19][21][22][12]. Content involves the information, features and services offered by the online organization [15]. High quality content which satisfies the informational and structural needs of user will help the user find the required information quickly and become enthusiast for the next visit.

On the other hand, to meet the increasing demand for higher education, universities are also questing for new ways of delivering education and as a result, e-learning is being implemented more frequently each day, creating new opportunities for both educational institutions and students [25]. Likewise every online organization, website of an educational institution plays an important role in establishing long term relation with students. Hence this paper focuses on selecting proper content for university website from users' perspective and providing a framework for Iranian university website. In line with multi-dimensional characteristics of website quality, selecting proper content items for a website is a selection problem with different criteria influencing the optimal solution. Therefore multi criteria decision making provides an effective ranking framework to address this selection problem.

Multi Criteria Decision Analysis (MCDA) is a powerful methodology concerned with complex evaluation and ranking problems in management, business, engineering and other areas of science. It formulates the problems by considering several, usually conflicting criteria which can be qualitative or quantitative. Numerous methods have been proposed for multi criteria decision making among which outranking models are developed to make a true ranking of real-life problems [13]. These models benefit from the concept that an alternative outranks others if and only if there is sufficient evidence to support the claim that alternative is superior or at least equal to the others [26]. ELECTRE and PROMETHEE are two main methods of outranking approach [11][17]. ELECTRE approaches [23] use complex comparisons and non-realistic thresholds which make it difficult for the decision maker to understand and use [13]. Besides, PROMETHEE family uses a transparent computational procedure and is quite simple in conception and application for non-specialist users [14][16]. Therefore PROMETHEE method is chosen as decision making tool in this paper.

The main difference between PROMETHEE and other outranking approaches is the use of generalized criterion functions which were introduced to incorporate the inherent uncertainty in decision making problems. Criteria weights and performance values are two main sources of uncertainty in decision analysis. Generalized criterion functions do not take into account the uncertainty in criteria weights. Besides, selecting the suitable function and its associated thresholds for each criterion leads to additional source of uncertainty. Therefore, to overcome the deficiency of this method, an approach to face uncertainty in decision problems should be developed.

Fuzzy sets, proposed by Zadeh (1965)[29], is introduced to model the uncertainty of human judgments. The main characteristic of fuzzy sets is the use of membership function which assigns a membership degree to each element in a universe of discourse and the non-membership degree which equals one minus the membership degree. In fuzzy set theory, the membership degree of an element to a fuzzy set is a single value in interval [0, 1]. But in real-life problems, non-membership degree of an element in a fuzzy set may not be equal to 1 minus the degree of membership. In other words, there may be some hesitation degree where the decision maker is undecided. As a result, intuitionistic fuzzy sets were introduced as a generalization of fuzzy sets by Atanassov in 1986. Since the intuitionistic fuzzy sets provide an extra possibility to represent imperfect knowledge and model real problems in a more adequate way, an extension of PROMETHEE is introduced to utilize the inclusion of uncertainty in original algorithm by using intuitionistic fuzzy sets. In this approach, the need to define generalized criterion functions and their associated thresholds is eliminated. Also, the uncertainty in criteria weights is taken into consideration.

The remainder of this paper is organized as follows: PROMETHEE method is reviewed in section 2. The definition and properties of intuitionistic fuzzy sets are briefly introduced in Section 3. Multi criteria decision-making method based on intuitionistic fuzzy sets is then proposed in section 4. Section 5 comprises a case study on university website to validate the application of the model. Conclusions are drawn in section 6.

PROMETHEE

PROMETHEE (Preference Ranking Organization Method for Enrichment Evaluation) is a multi-attribute decision making method developed by Brans et al in 1986. PROMETHEE method provides a simple and clear algorithm for decision makers and has been applied to various fields such as website evaluation [3], supplier selection [11], environmental assessments [13][14], finance [4] and etc.

PROMETHEE belongs to outranking category of multi criteria decision making and divides the decision making process into two separate phases [18]:

Construction of the outranking relations

The PROMETHEE approach is based on the notion of generalized criterion functions which are used to state the decision maker's preference for an alternative in relation to another with respect to each criterion. To calculate the preference value, the decision maker should choose a preference function Pk for each criterion. Pk(Ai,Aj) is a function of difference between performance values of pair of alternatives and shows the intensity of preference of Ai over Aj with respect to criterion k:

$$p_k(A_i, A_k) = F_j\left(d_j(A_j, A_k)\right) \tag{1}$$

Where:

$$d_j(A_j, A_k) = a_{ji} - a_{jk} \tag{2}$$

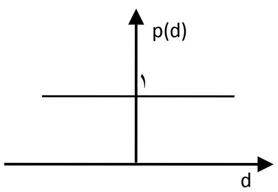
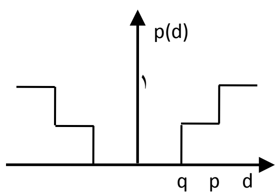
a_{ki} and a_{kj} are performance values of alternative Ai and Ak with respect to criterion j. Also Fj is a set of generalized criterion functions that can be chosen from the predefined functions or decision maker can build a special function to model his preferences. Table 1 shows the six types of predefined functions suggested by Brans and Vincke (1986)[6]. To delimit the indifference and preference area, (q) and (p) are defined as indifference and preference thresholds respectively. Considering two thresholds, for preference function we have:

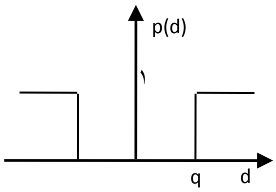
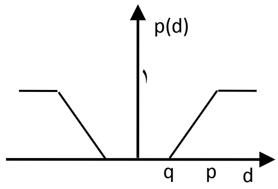
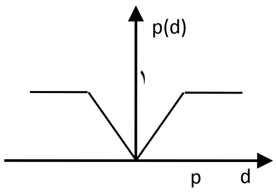
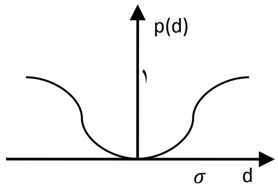
$$a_{ji} - a_{jk} \le q_j \quad => \quad F_j\left(d_j(A_j, A_k)\right) = 0 \tag{3}$$

$$a_{ji} - a_{jk} \ge p_j \quad => \quad F_j\left(d_j(A_j, A_k)\right) = 0 \tag{4}$$

$$q_j \le a_{ji} - a_{jk} \le p_j \quad => \quad 0 < F_j\left(d_j(A_j, A_k)\right) < 1 \tag{5}$$

Table 1. The shape of six basic generalized criterion functions in PROMETHEE algorithm

Type I: Usual criterion		Type IV: Level criterion	
$P(d) = \begin{cases} 0, d = 0 \\ 1, \lvert d \rvert > 0 \end{cases}$		$P(d) = \begin{cases} 0, & \lvert d \rvert \le q \\ \frac{1}{2}, & q < \lvert d \rvert \le p \\ 1 & , \lvert d \rvert > p \end{cases}$	

Type II: Quasi criterion		Type V: Criterion with linear preference and indifference interval	
$P(d) = \begin{cases} 0, & \lvert d \rvert \leq q \\ 1, & \lvert d \rvert > q \end{cases}$		$P(d) = \begin{cases} 0, & \lvert d \rvert \leq q \\ \dfrac{\lvert d \rvert - q}{p - q}, & q < \lvert d \rvert \leq p \\ 1, & \lvert d \rvert > p \end{cases}$	
Type III: Criterion with linear preference		Type VI: Gaussian criterion	
$P(d) = \begin{cases} \dfrac{\lvert d \rvert}{p}, & \lvert d \rvert \leq q \\ 1, & \lvert d \rvert > q \end{cases}$		$P(d) = 1 - e^{-d^2/2\sigma^2}$	

To establish the outranking relation in PROMETHEE approach, preference index, is defined as the weighted average of the preference functions for all the criteria. Preference index shows the intensity of preference of the decision maker for alternative compared to alternative considering all the criteria:

$$\pi(A_i, A_j) = \frac{\sum_j w_j . p_j(A_i, A_k)}{\sum_j w_j} \qquad (6)$$

Where is the weight assigned to criterion j. Preference index, $\pi(A_i, A_j)$, assigns a value in interval [0 , 1] for each pair of the alternatives and validates the credibility of the statement “the alternative Ai outranks the alternative A k[18] and can be represented by an outranking graph (Figure .2).

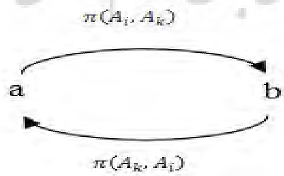


Figure 1. Outranking graph between alternative Ai and Ak

Exploitation of outranking relations rank the alternatives

To obtain the alternative ranking, three new functions on the set of the alternatives are defined, namely inflow(φ^-), outflow(φ^+), and net flow(φ). Inflow for an alternative Ai, is a measure for how much alternative Ai is dominated by others and is calculated by:

$$\varphi^{-}: A \rightarrow [0,1] \tag{7}$$

$$\varphi^{-}(A_i) = \frac{1}{m-1}\sum_{k=1,k\neq i}^{m} \pi_{k,i} = \frac{1}{m-1}\sum_{k=1,k\neq i}^{m} \pi\left(A_k, A_j\right) \quad \forall A_i \in A \tag{8}$$

Outflow for an alternative Ai is a measure of how much alternative Ai dominates others and is calculated by:

$$\varphi^{+}: A \rightarrow [0,1] \tag{9}$$

$$\varphi^{+}(A_i) = \frac{1}{m-1}\sum_{k=1,k\neq i}^{m} \pi_{i,k} = \frac{1}{m-1}\sum_{k=1,k\neq i}^{m} \pi(A_i, A_k) \quad \forall A_i \in A \tag{10}$$

And the net flow is the difference between outflow and inflow:

$$\varphi(A_i) = \varphi^{+}(A_i) - \varphi^{-}(A_i) \quad \forall A_i \in A \tag{11}$$

PROMETHEE I partially ranks the alternative based on the inflow and outflow values. Mathematically speaking, alternative Ai overclassifies Ak if one of the following conditions happens to be true:

$$\varphi^{+}(A_i) > \varphi^{+}(A_k) \wedge \varphi^{-}(A_i) < \varphi^{-}(A_k) \tag{12}$$

$$\varphi^{+}(A_i) > \varphi^{+}(A_k) \wedge \varphi^{-}(A_i) = \varphi^{-}(A_k) \tag{13}$$

$$\varphi^{+}(A_i) = \varphi^{+}(A_k) \wedge \varphi^{-}(A_i) < \varphi^{-}(A_k) \tag{14}$$

Alternative Ai and Ak are incomparable if one of the following conditions happens:

$$\varphi^{+}(A_i) > \varphi^{+}(A_k) \wedge \varphi^{-}(A_i) > \varphi^{-}(A_k) \tag{15}$$

$$\varphi^{+}(A_i) < \varphi^{+}(A_k) \wedge \varphi^{-}(A_i) < \varphi^{-}(A_k) \tag{16}$$

PROMETHEE II provides final ranking of the alternatives based on the net flows. The alternative with higher net flow overclassifies the other with lower net flow:

$\varphi(A_i) \geq \varphi(A_k)$

Figure 2. shows a graphical result of the ranking based on the partial preorder of PROMETHEE I or complete order of PROMETHEE II [13].

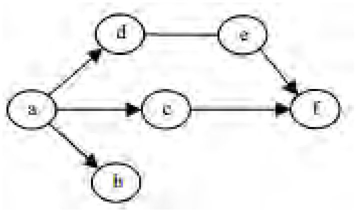


Figure 2. Graphical result of a partial preorder

PROMETHEE methodology can be summarized in the following steps:

Figure 3. PROMETHEE stepwise procedure

Intuitionistic fuzzy sets

Let X be a universe of discourse. Zadeh introduced the concept of fuzzy set as:

$$F = \{(x, \mu_F(x) | x \in X\} \quad (17)$$

The main characteristic of fuzzy sets is that the sum of membership and non-membership degree is equal to one stating that there is no lack of knowledge. But in real applications the knowledge about a certain element of a fuzzy set may be incomplete. In this case, the sum of membership and non-membership degree will be less than one. Ordinary fuzzy sets lack to model this incomplete knowledge. In other words, fuzzy sets cannot model the decision makers thinking when he is undecided. To overcome this problem, [2] added a new degree of freedom to the ordinary fuzzy concept and introduced Intuitionistic fuzzy sets(IFSs). Intuitionistic fuzzy sets are defined as followed:

Definition 1. Intuitionistic fuzzy A, in the universe of discourse X is an object having the following form [2]:

$$A = \{(x, \mu_A(x), \nu_A(x) | x \in X\} \quad (18)$$

Where:

$$\mu_A: X \to [0,1], \qquad x \in X \to \mu_A(x) \in [0,1], \quad (19)$$

$$\nu_A: X \to [0,1], \qquad x \in X \to \nu_A(x) \in [0,1], \quad (20)$$

With the condition:

$$\mu_A(x) + \nu_A(x) \leq 1 \,, \forall x \in X \quad (21)$$

$\mu_A(x)$ and $\nu_A(x)$ denote a degree of membership and a degree of non-membership of x, respectively. For every intuitionistic fuzzy set, we call:

$$\pi_A(x) = 1 - \mu_A(x) - \nu_A(x) \quad (22)$$

the intuitionistic fuzzy index (or hesitation margin) of element x in the IFS A. It is obvious that for every $x \in$X:

$0\leq \pi_A(x) \leq 1$ (23)

If $\pi_A(x) = 0$, then the IFS A is reduced to a fuzzy set.

A good example of intuitionistic fuzzy situation is voting, as human voters may be divided into three groups (Castillo et al. 2007):

People who Vote for a candidate;

People who Vote against a candidate;

People who are undecided or abstain or give invalid votes.

Third group is a proof for the concept of hesitation margin in intuitionistic fuzzy sets. Since the development of intuitionistic fuzzy sets, it has been applied to several multi attribute decision making methods[5][8][9]. In the next section, we propose an extension for PROMETHEE algorithm using intuitionistic fuzzy sets.

Intuitionistic fuzzy PROMETHEE

In this section, PROMETHEE methodology is utilized to encounter the inherent uncertainty in decision making problems. In the proposed approach, criteria weights and alternative performances are considered as two explicit sources of uncertainty and are represented by ordinary fuzzy and intuitionistic fuzzy sets respectively. The need to use generalized criterion functions is omitted. In return, a fuzzy inference engine is designed to determine the preference values based on intuitionistic fuzzy inputs. Similar to the original PROMETHEE, IF PROMETHEE methodology is divided into two phases: Establishing outranking relations and then exploiting relations to obtain the final ranking. We will explain both phases step by step in the following section:

Establishing intuitionistic fuzzy decision matrix

First step in every decision making problem is constructing the decision matrix which represents each alternative's performance with respect to each criteria. Suppose that there exist an alternative set A= {A1, A2, …, Am} which consist of m alternatives and criteria set C= {C1, C2,…,Cn}, which consist of n criterion and decision maker set DM={ DM1,DM2,…,DMl} with l decision makers. λ={ λ_1, λ_2,…, λ_l} is showing the decision maker's relative importance and$\sum_{k=1}^{l} \lambda_k = 1$ Each alternative is going to be assessed on n criteria by l decision makers. Performance of Alternatives (a_{ij}) with respect to criterion C_j is an intuitionistic fuzzy set and this characteristic for alternative A_i is defined as follows:

$$a_{ij}^{k} = (\mu_{ij}^{k}, \nu_{ij}^{k}) \quad i = 1,2, \dots, m \quad j = 1,2, \dots, \mathrm{n} \tag{24}$$

Where μ_{ij} and ν_{ij} are the membership and non-membership degree of alternative Ai with respect to criterion Cj assigned by decision maker k. Here, membership degree shows the degree which alternative Ai satisfies criterion Cj and non-membership degree indicates the degree which alternative Ai does not satisfy criterion Cj. In every group decision making approach, there is a need to aggregate all the individual decision opinions into a group opinion. In order to construct aggregated intuitionistic fuzzy decision, intuitionistic fuzzy weighted average proposed by Xu is used[28]:

$$\begin{aligned} a_{ij} &= \sum_{k=1}^{l} \lambda_k a_{ij}^{k} = \lambda_1 a_{ij}^{1} + \lambda_2 a_{ij}^{2} + \cdots + \lambda_l a_{ij}^{l} \\ &= [1 - \prod_{k=1}^{l} (1 - \mu_{ij}^{k})^{\lambda_k}, (\nu_{ij}^{k})^{\lambda_k}] \end{aligned} \tag{25}$$

With this background, aggregated intuitionistic fuzzy decision matrix will have the following form:

	c1	c2	….	cn
A1	(μ_{11}, ν_{11})	(μ_{12}, ν_{12})	….	(μ_{1n}, ν_{1n})
A2	(μ_{21}, ν_{21})	(μ_{22}, ν_{22})	….	(μ_{2n}, ν_{2n})
A3	(μ_{31}, ν_{31})	(μ_{32}, ν_{32})	….	(μ_{3n}, ν_{3n})
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.

Am	$(\mu_{m1}, \nu_m$	(μ_{m2}, ν_{m2})	....	(μ_{mn}, ν_{mn})

Determination of criteria weights

In multi criteria decision analysis, each criterion has different impact on the objective of the problem. The relative intuitionistic fuzzy importance of a criterion Cj from the criterion set C and assigned by decision maker k is defined as below:

$$w_j^k = (\mu_j^k, \nu_j^k) \tag{26}$$

It is also needed to aggregate decision maker's opinion about the importance of the criteria. To do this, the mentioned aggregator used for alternative performance is used:

$$w_j = \sum_{k=1}^{l} \lambda_k w_j^k = \lambda_1 w_j^1 + \lambda_2 w_j^2 + \cdots + \lambda_l w_j^l = [1 - \prod_{k=1}^{l} (1 - \mu_j^k)^{\lambda_k}, (\nu_j^k)^{\lambda_k}] \tag{27}$$

The aggregated intuitionistic fuzzy decision matrix will have the following form:

$$W = [w_1, w_2, \dots, w_n] \tag{28}$$

Where: $w_j = (\mu_j, \nu_j) \quad j = 1,2, \dots, n.$ (29)

Determination of performance deviations based on pair-wise comparisons

The differences between performances of alternatives with respect to criterion j can be expressed as matrix dj:

$$d^{(j)} = \begin{bmatrix} d^{(j)}(A_1, A_1) & d^{(j)}(A_1, A_2) & \dots & d^{(j)}(A_1, A_m) \\ d^{(j)}(A_2, A_1) & d^{(j)}(A_2, A_2) & \dots & d^{(j)}(A_2, A_m) \\ \vdots & \vdots & \ddots & \vdots \\ d^{(j)}(A_m, A_1) & d^{(j)}(A_m, A_2) & \dots & d^{(j)}(A_m, A_m) \end{bmatrix} \tag{30}$$

Where: $d^{(j)}(A_i, A_k) = \left(d_\mu^{(j)}(A_i, A_k), d_\nu^{(j)}(A_i, A_k)\right) = \left(\mu_{A_i}^{(j)}(x) - \mu_{A_k}^{(j)}(x), \nu_{A_i}^{(j)}(x) - \nu_{A_i}^{(j)}(x)\right)$ (31)

$d^{(j)}(A_i, A_k)$ is a two dimensional matrix with one dimension representing $d_\mu^{(j)}(A_i, A_k)$ and the other $d_\nu^{(j)}(A_i, A_k)$ which denote deviation between alternatives based on their membership and non-membership degree respectively. To calculate the differences between membership and non-membership degrees the concept of hamming distance measure between two fuzzy sets is used [24].

Determination of preference index for each pair of alternatives

To obtain the preference values, a fuzzy system is developed for each criterion. The fuzzy system maps the difference matrix $d^{(j)}$ to the preference indices. The configuration of the system is shown in Figure 4.

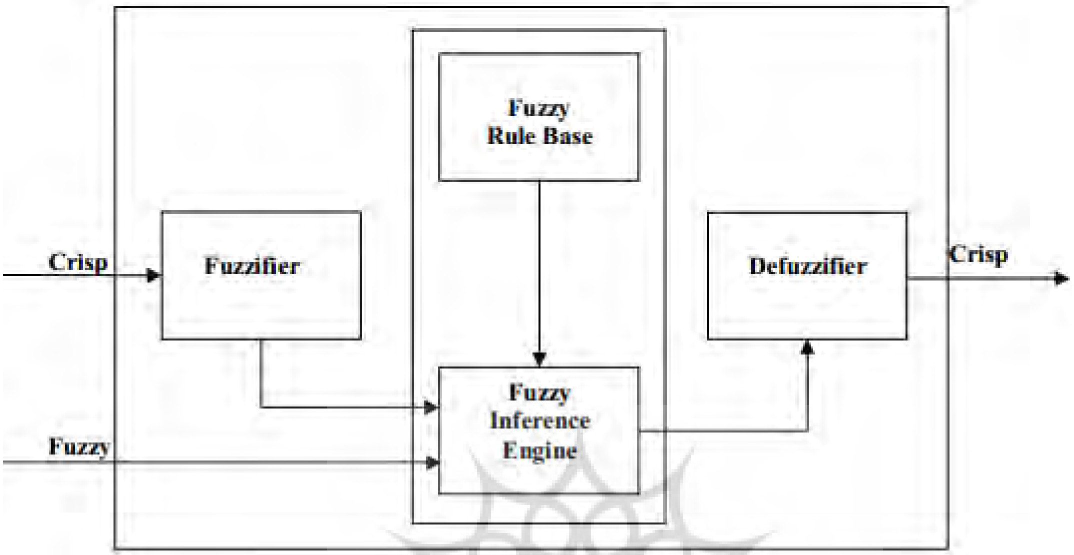
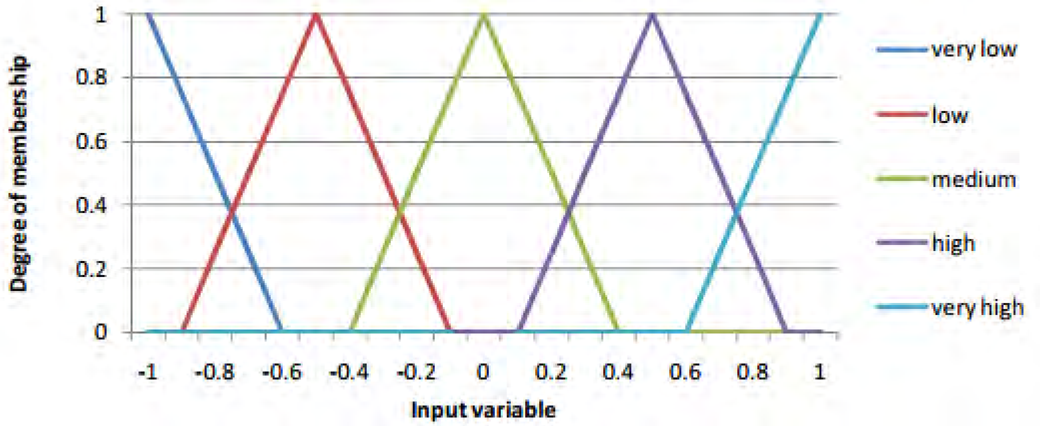


Figure 4. Configuration of the fuzzy system for preference function modeling

The fuzzy system consists of four components: Fuzzifier, fuzzy rule base, fuzzy inference engine and defuzzifier with following roles:

Fuzzifier

Fuzzifier is used to translate the crisp input values to linguistic terms using membership functions. Here, input values are two dimensions of each element of the matrix $d^{(j)}$ (deviation based on



membership and non-membership degree) and fuzzifier maps both dimensions to linguistic terms: very low, low, medium, high and very high. The membership function assigned to each of these linguistic terms is plotted in Figure 5. Triangular membership function is used due to its easiness in calculations.

Figure 5. Membership functions for input variables

Defuzzifier

Defuzzifier is used to map a fuzzy value to a crisp output. Here, the output is the preference indexes. The linguistic terms for preference are defined as: very low, low, medium, high and very high and membership functions similar are assigned for each. Defuzzification is performed by the membership function of the output variable. Here, centroid defuzzifier is applied with the following formula:

$$y^* = \frac{\int y_i \mu_B(y)dy}{\int \mu_B(y)dy} \qquad (32)$$

Fuzzy rule base

Fuzzy rule base is constructed to present decision maker's opinions by means of combination of fuzzy If-Then rules. 21 fuzzy rules are derived based on the values of dimensions of each element:

"IF membership degree deviation is low AND non-membership degree deviation is low THEN preference is low"

"IF membership degree deviation is high AND non-membership degree deviation is low THEN preference is high"

"IF membership degree deviation is very high AND non-membership degree deviation is low THEN preference is very high"

Fuzzy inference engine

The fuzzy inference engine is designed to calculate the preference index of each pair of alternatives. To do so, the engine performs tow tasks: first is to map the input values (elements of matrix $d^{(j)}$) to output values (elements of matrix $p^{(j)}$) using fuzzy rules. The second is weighting the preference matrices by intuitionistic fuzzy weights of criteria. In the first part, to aggregate the rules Mamdani minimum inference engine is applied where the minimum and maximum operators are used for all triangular norm and triangular conorms respectively. Also maximum operator is used for the aggregation of the rules. In the second part, multiplication operator is used to weighting the preference values by criteria weights. The multiplication operator for two IFSs A and B is defined as follows:

$$\mathrm{A} \otimes \mathrm{B} = \{\mu_A(x).\mu_B(x), \nu_A(x) + \nu_B(x) - \nu_A(x).\nu_B(x) \mid x \in X\} \qquad (32)$$

The output of fuzzy inference engine is a crisp preference index of each pair of alternatives which is used to calculate outflow, inflow and net flow of each alternative. Then the complete order of alternatives is obtained. The stepwise procedure is presented in Figure 6.

Figure 6. Stepwise procedure of intuitionistic fuzzy PROMETHEE algorithm

Case Study: university website (content selection)

The algorithm for the soft decision analysis based on intuitionistic fuzzy PROMETHEE is demonstrated with a case study from university website which is used to rank the content items for the homepage of the university to enhance the informational and structural needs of users. In order to make up the decision problem, alternatives and design criteria of the ranking problem relative to a university website with e-learning component should be identified. In this regard, a list of content items is proposed for a university homepage. To classify contents of a university website with e-learning component, the items are divided into two groups: general contents of a university and specific content for e-learning which are located in three different sections: header, main body and footer. Table 1-4 represents the benchmarked items for header, main body and footer of a university homepage. The general items are benchmarked from the top ten universities in Webometrics ranking [10] and specific content from the Online Education Data Base[20].

Table 2. items benchmarked for header of a university homepage

No	Header content Items	No	Header Content Items
1	University Logo	6	Search in Website
2	University Name	7	Content in other Languages
3	University Contacts	8	Content in other Fonts
4	Site Map	9	University Directory
5	Website Index	10	Frequently Asked Questions

Table 3. General items benchmarked for main body a university homepage

No	General main body content Items	No	General main body Content Items
1	About university	9	Higher Degree Education
2	University Chancellor	10	Direction of use
3	Education	11	University Staff
4	Research	12	Alumni
5	Academic Calendar	13	Employment Opportunities
6	University centers	14	Academic Programs
7	University Events	15	Student Affairs
8	University News	16	News Spotlight

Table 4. Specific items benchmarked for main body a university homepage

No	Specific main body content Items	No	Specific main body content Items
1	Learning Management System	8	User Login
2	E-Content Development Center	9	Direction of use
3	Digital Library	10	Electronic news letter
4	Virtual Class	11	Discussion room
5	Online consulting	12	Online chat
6	Educational system	13	Forum
7	University virtual tour	14	Questionnaire

Table 5. Footer items benchmarked for main body a university homepage

No	Footer content Items	No	Footer Content Items
1	University phone number	6	Website Guide
2	University Address	7	Privacy Statement
3	University Webmail	8	Trademark notice
4	Website Admin Email	9	Quick links
5	Last update date	10	Copy right

To define the structural criteria of website design several research papers are reviewed. Then it is tailored for university website by e-learning website designers. These criteria are listed in table 5.

Table 6. decision criteria for university website

Criteria	Explanation
Presentation	Visual appearance or general attractiveness of the site
Usability	Quality of user experience interacting with website
Accessibility	Enabling users with disabilities to interact with website
Navigation	Easy access to website information or service
Security	Making users rely on the website organization

Then a soft decision making algorithm is applied to rank the items with respect to structural needs of the users. With this approach the content will be selected that both satisfy the informational and structural needs of the users. As an example, site map and search engine will convey navigation criterion, privacy statement and copyright will satisfy security criterion and font color and size will affect the accessibility criterion while Programs offered by a university is an informational need of the learner. Now, IF-PROMETHEE algorithm will be applied to rank the benchmarked items according to structural criteria. The first step to run the model is to collect alternative performance and criteria importance data. To do so, an intuitionistic fuzzy questionnaire was designed to obtain the membership and non-membership degree of alternatives performances and criteria importance. In the questionnaire, decision makers are divided into three groups. The details are shown in table 7.

Table 7. Statistical population of the research

Decision maker group	Number
E-learning website designer	20
Virtual university instructor	10
Virtual university student	35

Here, we will run the model for the header contents step by step:

1. Establish group decision matrix based on the aggregated performance values of alternatives: Decision makers' attitude about membership and non-membership degree of alternative performances with respect to defined criteria is obtained from the questionnaire and aggregated by the equation 28. The result is shown in table 8.

Table 8. Aggregated intuitionistic fuzzy decision matrix data

Criteria	Presentation		Usability		Accessibility		Navigation		Security	
Content Items	μ	υ	μ	υ	μ	υ	μ	υ	μ	υ
University Logo	0.67	0.07	0.65	0.16	0.38	0.09	0.44	0.09	0.48	0.11
University Name	0.36	0.19	0.73	0.17	0.26	0.13	0.46	0.10	0.41	0.07
University Contacts	0.14	0.09	0.54	0.21	0.21	0.15	0.64	0.10	0.37	0.14
Site Map	0.29	0.11	0.73	0.12	0.25	0.11	0.70	0.12	0.34	0.14
Website Index	0.22	0.14	0.58	0.17	0.21	0.13	0.72	0.09	0.25	0.14
Search in Website	0.20	0.05	0.76	0.04	0.19	0.11	0.77	0.10	0.25	0.11
Content in other Languages	0.27	0.09	0.42	0.12	0.78	0.04	0.34	0.09	0.35	0.11

Content in other Fonts	0.29	0.13	0.46	0.14	0.78	0.02	0.40	0.09	0.31	0.14
University Directory	0.18	0.09	0.42	0.10	0.21	0.13	0.50	0.07	0.35	0.14
Frequently Asked Questions	0.14	0.13	0.60	0.10	0.23	0.11	0.48	0.06	0.45	0.14

2. Establish group criterion matrix based on the aggregated importance values of criteria:

Fuzzy importance of the criteria is asked from decision makers and the group decision about the weight of criteria is obtain by aggregation of their opinions. Then the aggregated fuzzy weights are defuzzified using center of area concept. The result is shown in table.

Table 9. Decision criteria weights

Criteria	Weight
Presentation	(0.14,0.2)
Usability	(0.35,0.12)
Accessibility	(0. 42,0.16)
Navigation	(0.63,0.08)
Security	(0.52,0.15)

3. Establish two dimensional deviation matrix based on membership and non-membership degrees of alternatives for each criterion: For each criterion, a deviation matrix is established which shows the differences between the performance of alternatives. The deviation matrix for header content is shown in tables 10-14.

4. Apply Fuzzy inference system for determination of preference index of each pair of alternatives: For each criterion, a fuzzy system is developed to map the deviation matrix to preference indices. The fuzzy system is shown in Figure 7, fuzzy rule base in Figure 8. and preference matrix is presented in tables 15-19. The preference index for each pair of alternatives is presented in table 20.

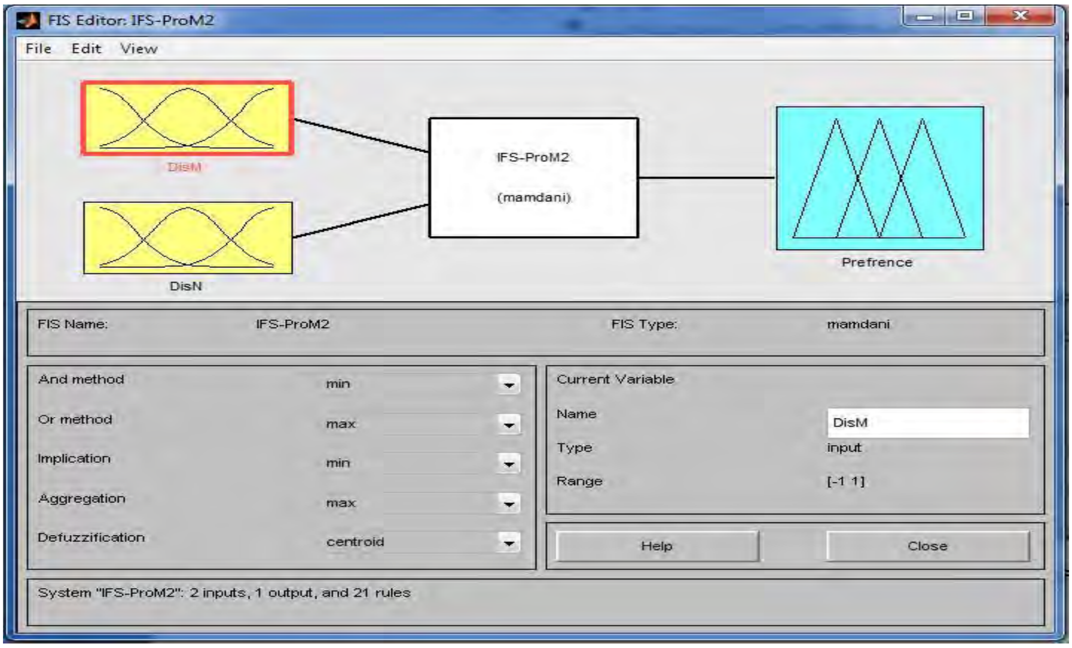


Figure 7. Fuzzy inference engine developed by MATLAB fuzzy toolbox

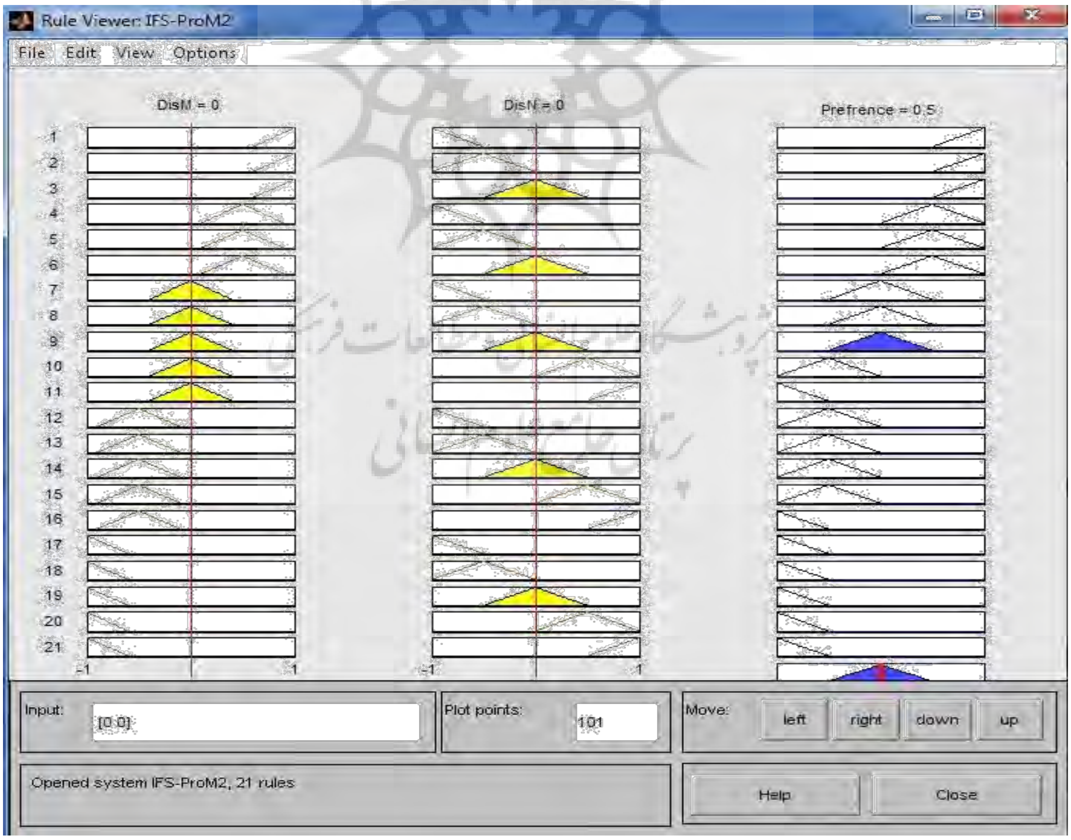


Figure 8. Fuzzy rule base designed by MATLAB fuzzy toolbox

Table 10. Deviation matrix for criterion presentation for header content items

Criteria	Logo		Name		Contact		Map		Index		Search		Languages		Fonts		Directory		FAQ	
Content items	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ
Logo	0.00	0.00	-0.12	0.31	-0.02	0.53	-0.04	0.38	-0.06	0.45	0.03	0.47	-0.02	0.40	-0.05	0.38	-0.02	0.49	-0.05	0.53
Name	0.12	-0.31	0.00	0.00	0.10	0.23	0.08	0.07	0.05	0.14	0.14	0.16	0.10	0.09	0.06	0.07	0.10	0.18	0.06	0.23
Contact	0.02	-0.53	-0.10	-0.23	0.00	0.00	-0.02	-0.15	-0.05	-0.08	0.05	-0.06	0.00	-0.14	-0.04	-0.15	0.00	-0.05	-0.04	0.00
Map	0.04	-0.38	-0.08	-0.07	0.02	0.15	0.00	0.00	-0.03	0.07	0.06	0.09	0.02	0.02	-0.02	0.00	0.02	0.11	-0.02	0.15
Index	0.06	-0.45	-0.05	-0.14	0.05	0.08	0.03	-0.07	0.00	0.00	0.09	0.02	0.05	-0.05	0.01	-0.07	0.05	0.04	0.01	0.08
Search	-0.03	-0.47	-0.14	-0.16	-0.05	0.06	-0.06	-0.09	-0.09	-0.02	0.00	0.00	-0.05	-0.07	-0.08	-0.09	-0.05	0.02	-0.08	0.06
Languages	0.02	-0.40	-0.10	-0.09	0.00	0.14	-0.02	-0.02	-0.05	0.05	0.05	0.07	0.00	0.00	-0.04	-0.02	0.00	0.09	-0.04	0.14
Fonts	0.05	-0.38	-0.06	-0.07	0.04	0.15	0.02	0.00	-0.01	0.07	0.08	0.09	0.04	0.02	0.00	0.00	0.04	0.11	0.00	0.15
Directory	0.02	-0.49	-0.10	-0.18	0.00	0.05	-0.02	-0.11	-0.05	-0.04	0.05	-0.02	0.00	-0.09	-0.04	-0.11	0.00	0.00	-0.04	0.05
FAQ	0.05	-0.53	-0.06	-0.23	0.04	0.00	0.02	-0.15	-0.01	-0.08	0.08	-0.06	0.04	-0.14	0.00	-0.15	0.04	-0.05	0.00	0.00

Table 11. Deviation matrix for criterion usability for header content items

Criteria	Logo		Name		Contact		Map		Index		Search		Languages		Fonts		Directory		FAQ	
Content items	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ
Logo	0	0	0.12	0.31	0.2	0.53	0.4	0.38	0.6	0.45	0.03	0.47	0.2	0.4	0.5	0.38	0.2	0.49	0.5	0.53
Name	0.12	0.31	0	0	0.1	0.23	0.08	0.07	0.05	0.14	0.14	0.16	0.1	0.09	0.06	0.07	0.1	0.18	0.06	0.23

Contact	0.02	0.53	0.1	0.23	0	0	0.2	0.15	0.5	0.8	0.05	0.6	0	0.14	0.4	0.15	0	0.5	0.4	0
Map	0.04	0.38	0.8	0.7	0.02	0.15	0	0	0.3	0.07	0.06	0.09	0.02	0.02	0.2	0	0.02	0.11	0.2	0.15
Index	0.06	0.45	0.5	0.14	0.05	0.08	0.03	0.7	0	0	0.09	0.02	0.05	0.5	0.01	0.7	0.05	0.04	0.01	0.08
Search	0.3	0.47	0.14	0.16	0.5	0.06	0.6	0.9	0.9	0.2	0	0	0.5	0.7	0.8	0.9	0.5	0.02	0.8	0.06
Languages	0.02	0.4	0.1	0.9	0	0.14	0.2	0.2	0.5	0.05	0.05	0.07	0	0	0.4	0.2	0	0.09	0.4	0.14
Fonts	0.05	0.38	0.6	0.7	0.04	0.15	0.02	0	0.1	0.07	0.08	0.09	0.04	0.02	0	0	0.04	0.11	0	0.15
Directory	0.02	0.49	0.1	0.18	0	0.05	0.2	0.11	0.5	0.4	0.05	0.2	0	0.9	0.4	0.11	0	0	0.4	0.05
FAQ	0.05	0.53	0.6	0.23	0.04	0	0.02	0.15	0.1	0.8	0.08	0.6	0.04	0.14	0	0.15	0.04	0.5	0	0

Table 12. Deviation matrix for criterion accessibility for header content items

Criteria	Logo		Name		Contact		Map		Index		Search		Languages		Fonts		Directory		FAQ	
Content items	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ
Logo	0	0	0.4	0.12	0.6	0.17	0.2	0.13	0.4	0.17	0.2	0.19	0.04	0.41	0.06	0.41	0.4	0.17	0.2	0.15
Name	0.04	0.12	0	0	0.2	0.05	0.02	0.01	0	0.05	0.02	0.07	0.09	0.52	0.11	0.52	0	0.05	0.02	0.03
Contact	0.06	0.17	0.02	0.5	0	0	0.04	0.4	0.02	0	0.04	0.02	0.11	0.57	0.13	0.57	0.02	0	0.04	0.2
Map	0.02	0.13	0.2	0.1	0.4	0.04	0	0	0.2	0.04	0	0.06	0.06	0.53	0.09	0.53	0.2	0.04	0	0.02
Index	0.04	0.17	0	0.5	0.2	0	0.02	0.4	0	0	0.02	0.02	0.09	0.57	0.11	0.57	0	0	0.02	0.2
Search	0.02	0.19	0.2	0.7	0.4	0.2	0	0.6	0.2	0.2	0	0	0.06	0.6	0.09	0.6	0.2	0.2	0	0.4
Languages	0.4	0.41	0.9	0.52	0.11	0.57	0.6	0.53	0.9	0.57	0.6	0.6	0	0	0.02	0	0.9	0.57	0.6	0.55
Fonts	0.6	0.41	0.11	0.52	0.13	0.57	0.9	0.53	0.11	0.57	0.9	0.6	0.2	0	0	0	0.11	0.57	0.9	0.55
Directory	0.04	0.17	0	0.5	0.2	0	0.02	0.4	0	0	0.02	0.02	0.09	0.57	0.11	0.57	0	0	0.02	0.2
FAQ	0.02	0.15	0.2	0.3	0.4	0.02	0	0.2	0.2	0.02	0	0.04	0.06	0.55	0.09	0.55	0.2	0.02	0	0

Table 13. Deviation matrix for criterion navigation for header content items

Criteria	Logo		Name		Contact		Map		Index		Search		Languages		Fonts		Directory		FAQ	
Content items	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ
Logo	0	0	0.2	0.2	0.2	0.2	0.3	0.26	0	0.28	0.2	0.33	0	0.1	0	0.04	0.02	0.6	0.03	0.4
Name	0.02	0.02	0	0	0	0.18	0.2	0.24	0.02	0.26	0	0.31	0.02	0.12	0.02	0.06	0.03	0.4	0.04	0.2
Contact	0.02	0.2	0	0.18	0	0	0.2	0.6	0.02	0.8	0	0.14	0.02	0.3	0.02	0.24	0.03	0.14	0.04	0.16
Map	0.03	0.26	0.02	0.24	0.02	0.06	0	0	0.03	0.2	0.02	0.8	0.03	0.36	0.03	0.3	0.05	0.2	0.06	0.22
Index	0	0.28	0.2	0.26	0.2	0.08	0.3	0.02	0	0	0.2	0.6	0	0.38	0	0.32	0.02	0.22	0.03	0.24
Search	0.02	0.33	0	0.31	0	0.14	0.2	0.08	0.02	0.06	0	0	0.02	0.43	0.02	0.37	0.03	0.28	0.04	0.29
Languages	0	0.1	0.2	0.12	0.2	0.3	0.3	0.36	0	0.38	0.2	0.43	0	0	0	0.6	0.02	0.16	0.03	0.14
Fonts	0	0.4	0.2	0.6	0.2	0.24	0.3	0.3	0	0.32	0.2	0.37	0	0.06	0	0	0.02	0.1	0.03	0.8
Directory	0.2	0.06	0.3	0.04	0.3	0.14	0.5	0.2	0.2	0.22	0.3	0.28	0.2	0.16	0.2	0.1	0	0	0.01	0.02
FAQ	0.3	0.04	0.4	0.02	0.4	0.16	0.6	0.22	0.3	0.24	0.4	0.29	0.3	0.14	0.3	0.08	0.1	0.2	0	0

Table 14. Deviation matrix for criterion security for header content items

Criteria	Logo		Name		Contact		Map		Index		Search		Languages		Fonts		Directory		FAQs	
Content items	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ	dμ	dυ
Logo	0.00	0.00	0.05	0.06	0.20	0.10	0.20	0.13	0.20	0.23	0.00	0.23	0.00	0.12	0.20	0.17	0.30	0.12	0.20	0.02
Name	0.50	0.60	0.00	0.00	0.70	0.04	0.70	0.07	0.70	0.17	0.50	0.17	0.50	0.06	0.70	0.10	0.70	0.06	0.70	0.40
Contact	0.02	0.10	0.07	0.40	0.00	0.00	0.00	0.03	0.00	0.12	0.02	0.12	0.02	0.02	0.00	0.06	0.10	0.02	0.00	0.80
Map	0.02	0.13	0.07	0.70	0.00	0.30	0.00	0.00	0.00	0.09	0.02	0.09	0.02	0.10	0.00	0.03	0.10	0.10	0.00	0.11
Index	0.02	0.23	0.07	0.17	0.00	0.12	0.00	0.90	0.00	0.00	0.02	0.00	0.02	0.10	0.00	0.60	0.10	0.10	0.00	0.21
Search	0.00	0.23	0.05	0.17	0.20	0.12	0.20	0.90	0.20	0.00	0.00	0.00	0.00	0.10	0.20	0.60	0.30	0.10	0.20	0.21
Languages	0.00	0.12	0.05	0.60	0.20	0.20	0.20	0.01	0.20	0.10	0.00	0.10	0.00	0.00	0.20	0.04	0.30	0.00	0.20	0.10
Fonts	0.02	0.17	0.07	0.10	0.00	0.60	0.00	0.30	0.00	0.06	0.02	0.06	0.02	0.40	0.00	0.00	0.10	0.40	0.00	0.14
Directory	0.03	0.12	0.07	0.60	0.01	0.20	0.01	0.01	0.01	0.10	0.03	0.10	0.03	0.00	0.01	0.04	0.00	0.00	0.01	0.10
FAQ	0.02	0.20	0.07	0.04	0.00	0.08	0.00	0.11	0.00	0.21	0.02	0.21	0.02	0.10	0.00	0.14	0.10	0.10	0.00	0.00

Table 15. Preference matrix for criterion presentation for header content items

Content items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.75	0.75	0.73	0.75	0.75	0.75	0.73	0.75	0.67	0.5
Name	0.56	0.5	0.46	0.44	0.47	0.5	0.45	0.53	0.5	0.33
Contact	0.5	0.5	0.45	0.46	0.47	0.5	0.45	0.5	0.39	0.25
Map	0.55	0.49	0.5	0.48	0.46	0.5	0.5	0.53	0.5	0.27
Index	0.49	0.47	0.49	0.47	0.45	0.5	0.48	0.47	0.46	0.25
Search	0.5	0.5	0.5	0.47	0.5	0.5	0.5	0.5	0.45	0.25
Languages	0.54	0.5	0.5	0.5	0.47	0.5	0.5	0.54	0.5	0.25
Fonts	0.55	0.48	0.5	0.47	0.45	0.5	0.49	0.51	0.5	0.27
Directory	0.5	0.5	0.49	0.5	0.47	0.5	0.49	0.5	0.43	0.25
FAQ	0.5	0.47	0.45	0.46	0.45	0.5	0.45	0.47	0.39	0.25

Table 16. Preference matrix for criterion usability for header content items

Criteria / Content items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.75	0.25	0.73	0.75	0.75	0.75	0.73	0.75	0.33	0.5
Name	0.56	0.5	0.46	0.44	0.47	0.5	0.45	0.53	0.5	0.33
Contact	0.5	0.5	0.45	0.46	0.47	0.5	0.45	0.5	0.39	0.25
Map	0.55	0.49	0.5	0.49	0.46	0.5	0.5	0.53	0.5	0.27
Index	0.49	0.47	0.49	0.47	0.45	0.5	0.48	0.47	0.46	0.25
Search	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.45	0.25
Languages	0.54	0.5	0.5	0.5	0.47	0.5	0.5	0.54	0.5	0.25
Fonts	0.55	0.49	0.5	0.47	0.45	0.5	0.48	0.51	0.5	0.27
Directory	0.5	0.5	0.49	0.5	0.47	0.5	0.49	0.5	0.08	0.25
FAQ	0.5	0.47	0.45	0.46	0.45	0.5	0.45	0.47	0.08	0.24

Table 17. Preference matrix for criterion accessibility for header content items

Criteria / Content items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.55	0.56	0.25	0.25	0.58	0.56	0.53	0.56	0.52	0.5
Name	0.49	0.5	0.25	0.25	0.48	0.5	0.49	0.5	0.5	0.48
Contact	0.47	0.49	0.25	0.25	0.47	0.49	0.47	0.5	0.49	0.44
Map	0.5	0.5	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.47
Index	0.49	0.5	0.25	0.25	0.49	0.5	0.49	0.5	0.5	0.44
Search	0.5	0.5	0.25	0.25	0.5	0.5	0.5	0.5	0.5	0.42
Languages	0.75	0.75	0.49	0.5	0.75	0.75	0.75	0.75	0.75	0.75
Fonts	0.75	0.75	0.5	0.5	0.75	0.75	0.75	0.75	0.75	0.75
Directory	0.49	0.5	0.25	0.25	0.49	0.5	0.49	0.5	0.5	0.44
FAQ	0.5	0.5	0.25	0.25	0.5	0.5	0.5	0.47	0.5	0.45

Table 18. Preference matrix for criterion navigation for header content items

Criteria / Content items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.48	0.48	0.5	0.5	0.31	0.35	0.37	0.41	0.49	0.5
Name	0.47	0.48	0.48	0.5	0.33	0.37	0.38	0.43	0.5	0.49
Contact	0.52	0.51	0.6	0.64	0.46	0.48	0.5	0.5	0.57	0.57
Map	0.55	0.54	0.63	0.68	0.48	0.48	0.5	0.48	0.6	0.6
Index	0.59	0.58	0.68	0.73	0.5	0.5	0.5	0.5	0.64	0.65
Search	0.62	0.62	0.7	0.75	0.5	0.48	0.5	0.54	0.67	0.67
Languages	0.46	0.45	0.5	0.5	0.25	0.27	0.29	0.34	0.48	0.5
Fonts	0.48	0.48	0.5	0.5	0.28	0.32	0.34	0.38	0.5	0.5

Directory	0.49	0.5	0.5	0.55	0.35	0.4	0.41	0.46	0.5	0.5
FAQ	0.5	0.5	0.5	0.54	0.34	0.38	0.4	0.45	0.5	0.5

Table 19. Preference matrix for criterion security for header content items

Criteria / Content items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.59	0.48	0.56	0.56	0.59	0.59	0.56	0.58	0.47	0.5
Name	0.51	0.5	0.45	0.44	0.46	0.49	0.45	0.49	0.5	0.44
Contact	0.5	0.5	0.47	0.48	0.48	0.5	0.48	0.5	0.46	0.41
Map	0.53	0.51	0.49	0.5	0.48	0.5	0.5	0.51	0.51	0.43
Index	0.49	0.51	0.5	0.5	0.48	0.5	0.49	0.48	0.5	0.41
Search	0.5	0.53	0.51	0.52	0.5	0.5	0.5	0.5	0.5	0.41
Languages	0.54	0.52	0.5	0.5	0.47	0.48	0.49	0.51	0.52	0.44
Fonts	0.54	0.53	0.5	0.49	0.46	0.49	0.49	0.51	0.52	0.44
Directory	0.49	0.5	0.46	0.47	0.45	0.47	0.47	0.49	0.38	0.4
FAQ	0.5	0.49	0.46	0.45	0.47	0.5	0.46	0.47	0.37	0.39

Table 20. Preference index for header content items considering all the criteria

Criteria / Content Items	Logo	Name	Contact	Map	Index	Search	Languages	Fonts	Directory	FAQ
Logo	0.59	0.48	0.56	0.56	0.59	0.59	0.56	0.58	0.47	0.5
Name	0.51	0.5	0.45	0.44	0.46	0.49	0.45	0.49	0.5	0.44
Contact	0.5	0.5	0.47	0.48	0.48	0.5	0.48	0.5	0.46	0.41
Map	0.53	0.51	0.49	0.5	0.48	0.5	0.5	0.51	0.51	0.43
Index	0.49	0.51	0.5	0.5	0.48	0.5	0.49	0.48	0.5	0.41
Search	0.5	0.53	0.51	0.52	0.5	0.5	0.5	0.5	0.5	0.41

Languages	0.54	0.52	0.5	0.5	0.47	0.48	0.49	0.51	0.52	0.44
Fonts	0.54	0.53	0.5	0.49	0.46	0.49	0.49	0.51	0.52	0.44
Directory	0.49	0.5	0.46	0.47	0.45	0.47	0.47	0.49	0.38	0.4
FAQ	0.5	0.49	0.46	0.45	0.47	0.5	0.46	0.47	0.37	0.39

5. Calculate inflow, outflow and net flow for each alternative: inflow, outflow and net flow is calculated using equations 7-9 and the result for header content is presented in table 21.

Table 21. Inflow, outflow and net flow of the header alternatives

Measure Content items	Inflow	Outflow	Net flow
Logo	9.45	7.16	2.29
Name	8.04	8.06	-0.02
Contact	8.14	8.64	-0.50
Map	8.44	8.36	0.08
Index	8.30	8.58	-0.29
Search	8.50	8.22	0.28
Languages	8.50	8.39	0.11
Fonts	8.49	8.37	0.12
Directory	7.75	8.65	-0.90
FAQ	7.74	8.92	-1.18

6. Determine complete ranking of the alternative based on PROMETHEE II: in this paper, the complete ranking of the alternatives is proposed and the header content ranking is presented in table 22.

Table 22. Ranking of the header content items

No	Header content Items	No	Header Content Items

1	University Logo	6	Site map
2	University Name	7	Website Index
3	Search in Website	8	University Contacts
4	Content in other Fonts	9	University Directory
5	Content in other Languages	10	Frequently Asked Questions

Same procedure is taken to rank the content of the other sections of the homepage and the results are presented in tables 23-25.

Table 23. Ranking of the general items of main body

No	General main body content Items	No	General main body Content Items
1	Academic Programs	9	Academic Calendar
2	Admission	10	University Events
3	Education	11	University News
4	Research	12	University centers and services
5	Higher Degree Education	13	Employment Opportunities
6	Student Affairs	14	University Chancellor
7	Academic staff	15	About university
8	Alumni	16	University Staff

Table 24. Ranking of the specific items of main body

No	Specific main body content Items	No	Specific main body content Items
1	Virtual Class	8	Discussion room
2	Learning Management System	9	Forum
3	Educational system	10	Electronic news letter
4	User Login	11	University virtual tour
5	E-Content Development Center	12	Questionnaire
6	Online guide	13	Direction of use
7	Digital Library	14	Online chat

Table 25. Ranking of the footer content items

No	Footer content Items	No	Footer Content Items
1	University phone number	6	Website Guide
2	University Address	7	Privacy Statement
3	University Webmail	8	Trademark notice
4	Website Admin Email	9	Quick links
5	Last update date	10	Copy right

IF- PROMETHEE model validation

To validate the model's result and compare its efficiency, a framework for the homepage of university website is developed based on the ranking results of the model. Then it is evaluated by 50 university users (website designers, instructors and students). The experts' assessment results are shown in table 26.

Table 26. experts' satisfaction rate of university website framework

Criteria / Expert	Presentation (%)	Usability (%)	Accessibility (%)	Navigation (%)	Security (%)
Website designer	92	98	100	100	100
Instructor	95	100	100	100	100
Student	94	100	100	100	100
Average	93.8	99.3	100	100	100

To show the efficiency of using intuitionistic fuzzy data, the research problem is solved with fuzzy PROMETHEE and PROMETHEE algorithm. Then based on the results a framework is designed for both approaches and assessed by the same experts. The result of this comparison is shown in Figure .9.

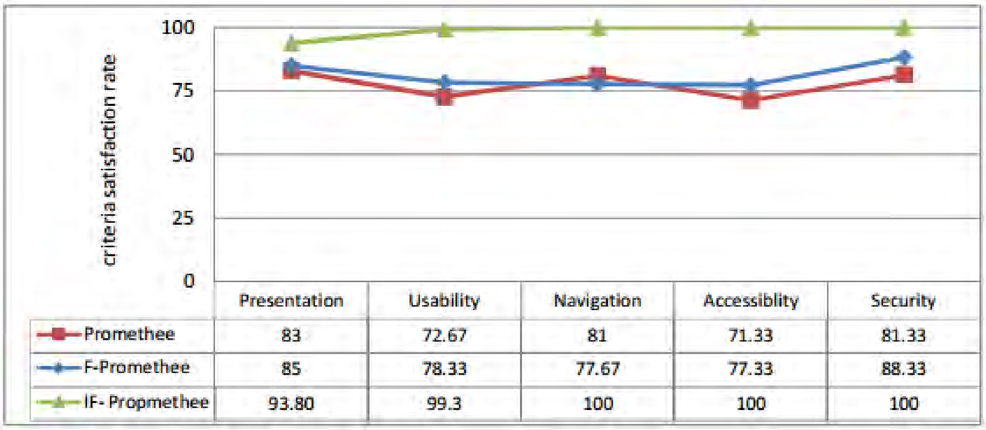


Figure 9. Comparisons on the IF-PROMETHEE with PROMETHEE and F-PROMETHEE

Sensitivity Analysis

To perform the sensitivity analysis, each criterion weight is increased up to 100 percent and net flow of the alternatives is calculated. Figure .10-15 show the changes in the ranking while altering criteria weights of header content items.

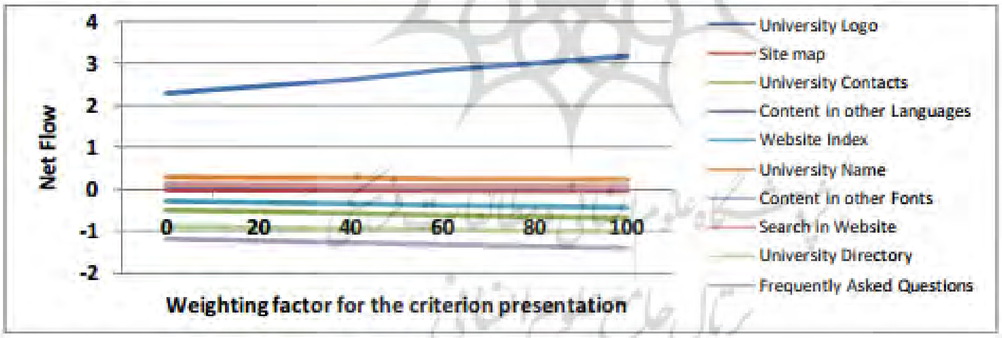


Figure 10. Sensitivity Analysis for header items based on criterion presentation

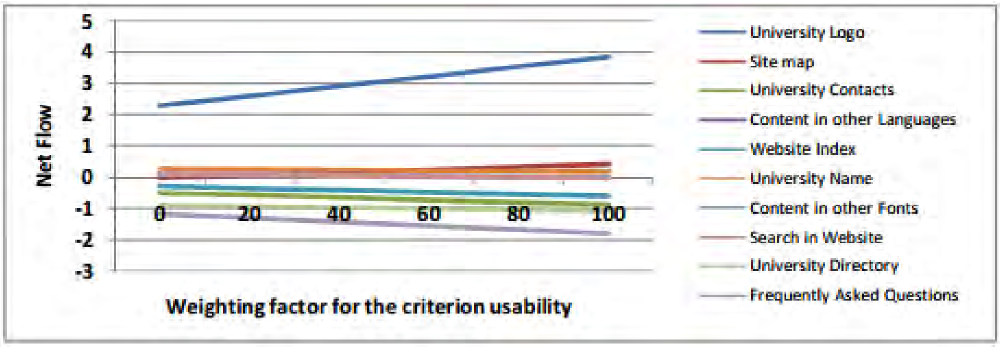


Figure 11. Sensitivity Analysis for header items based on criterion usability

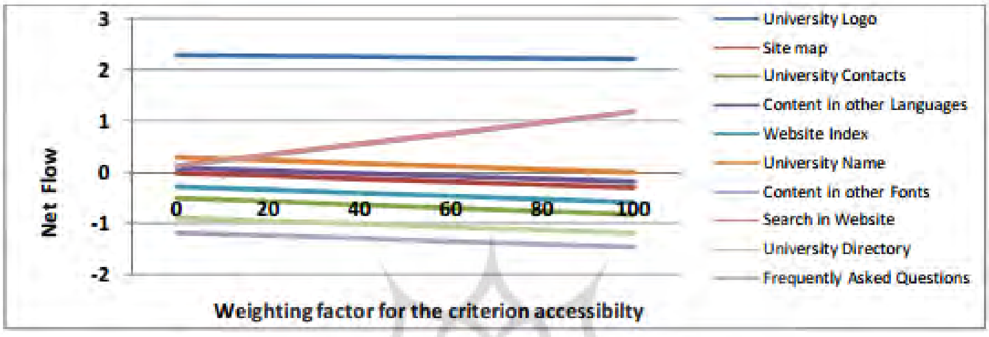


Figure 12. Sensitivity Analysis for header items based on criterion accessibility

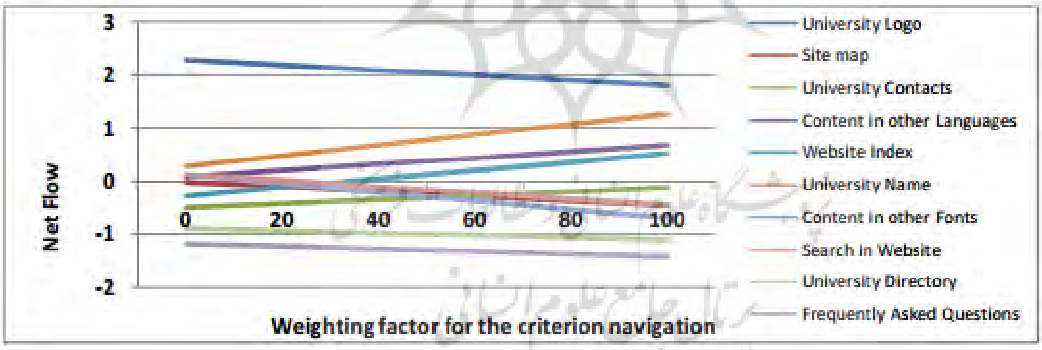


Figure 13. Sensitivity Analysis for header items based on criterion navigation

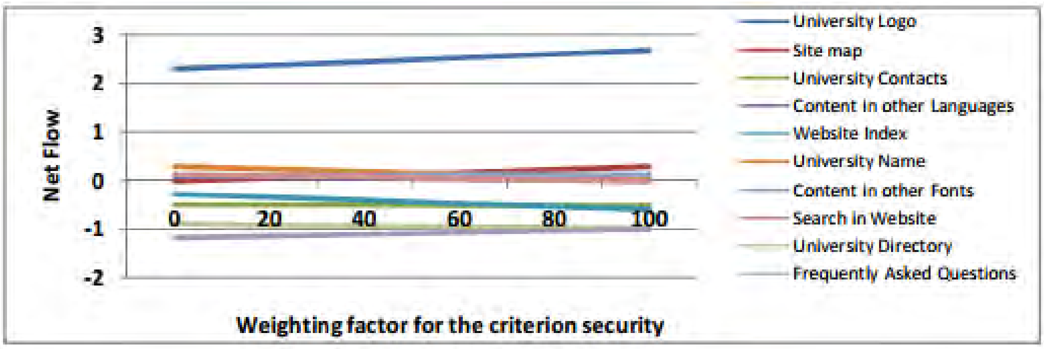


Figure 14. Sensitivity Analysis for header items based on criterion security

Sensitivity analysis shows that easy navigation and feeling are of great importance among the different criteria contributing to website quality. Also it can be concluded that increasing importance of the navigation criteria makes the maximum effect on the final ranking of the header items and is identified as the most critical criteria influencing website quality.

Conclusion

This study proposes content selection for university website with e-learning component. For ranking purpose, a novel soft decision making model is developed based on PROMETHEE method. To overcome the deficiency of PROMETHEE algorithm encountering imprecise information, intuitionistic fuzzy sets are applied to the methodology in which the characteristics of criteria weights and alternative performance are represented by intuitionistic fuzzy sets. The notion of intuitionistic fuzzy sets models decision maker's judgments with more precision considering that the decision maker can be undecided and this results in more realistic ranking of the alternatives. Comparison between the outcomes of the proposed IF-PROMETHEE with original and fuzzy PROMETHEE confirms the efficiency of applying intuitionistic fuzzy concept.

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