



FAHP Approach to Rank Educational Websites on Usability

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Abstract: Website of an educational institute is a platform that gives complete information about the organization. These websites are frequently visited by students, parents aspiring students and their parents, university faculties and other personnel and many other visitors who want to know about the organization. Usability of these websites will have different dimensions for different users. Hence broadly, measuring usability of website is a Multi criteria decision making problem (MCDM). Analytic hierarchy Process (AHP) approach has been considered a common solution to these problems. However, to handle uncertainty of the judgment Fuzzy Analytic Hierarchy Process (FAHP) is used. In this paper, different websites of an educational institute are compared and ranked on their usability criteria using FAHP.

Keywords: Usability, Website, FAHP, MCDM

1. INTRODUCTION

Today website is considered as lifeline of any organization. Website is primarily used as a virtual image and promotional platform of the organization that display all features and facility of the organization. With increasing internet usage websites are becoming an integral part of all business process and usually all business application processes are linked with web portal of organization. The user centric approach if used in developing the website will definitely improve the utility of the website and overall success of the organization. The usability of a website is directly related with the growth of any business organization along with other parameters such as reliability and security of website. Usability of website depends upon wide range of parameters like ease of use, ease of navigation, attractiveness, informative, accessibility, design etc. As different organization have different business requirement and end users hence standardization of usability metrics for all projects based on same criteria is not justifiable. The website usability and design has attracted much attention in the fields of human computer interaction. Designing a website giving more attention to the fact like “who will be the visitors”, “what information is searched” and “how this information is retrieved easily

and timely”, will improve the overall effectiveness of the website.

Usability of website can have both subjective as well as objective measures like user satisfaction, experience, navigation, pattern, download time and accessibility etc. These measurements are done after the launch of the website through feedback or through different tools. For overall increase effectiveness of a website it is required to usability prediction and estimation at each stage of the website design. Thus along with requirement analysis a usability analysis also need to be done in the initial stage of web designing. Keeping in view the users and business need [1] tried to identify the parameters which are most important for given website, depending on the user feedback collected from wide range of user who will possibly visit the website frequently. A rule set should be designed so that the usability of the website can be measured as per the requirement laid. While designing the websites its usability need to be evaluated using user interface models, navigational models, technological platforms, database schemas etc. The prime objective is user satisfaction, as users have wide range of choices and cognitive approach to access the website. Hence user feedback is considered beneficial to provide guidelines and frameworks for making the pleasing user experiences in such systems [2]. The most common usability



measurement approaches concerns the user attitude and view especially towards the interface through which it interacts via the interface and possible outcomes. To obtain this input large variety of questionnaires are being designed, however these techniques are dependent upon the user feedback and the type of users and their experience. Technically experts can provide a better insight about the website and incorporating their opinion and decision making will definitely enhance the usability of website.

As the web usability incorporates both tangible and intangible measures hence it can be regarded as multi criteria decision making (MCDM) problem. As discussed above the usability is not a single property but a combination of several properties and attributes, that is there are many criteria's that influence the usability of the website. These criteria's can be conflicting in nature like if the aesthetics of website need to be improved many images and videos can be incorporated which may in turn increase the download time. To have an effective website it is important to determine the criteria that will influence the website quality and need to be focused most by the website designers [3]. Identifying the most crucial criteria Analytic Hierarchy Approach (AHP) can be used that allow the importance ranking to the criteria's (weights) and alternatives, options can be compared based on the set multilevel criteria. However the AHP approach is often criticized for representing the personal judgments with crisp values. In actual practice the use of fuzzy set helps the decision maker to incorporate the unquantifiable, incomplete and unobtainable information into the decision model. In the case of a website parameters like ease of use and user satisfaction are unquantifiable. Further there is always a chance of uncertainty and incomplete information extraction with such a large number of end users hence fuzzy based approach prove to be more effective solution for assigning the weight to the criteria and evaluating the alternatives.

Like other industries the websites are becoming the key entry point for the aspiring students and their parents to select an educational organization. As the online technologies has become a key source for information retrieval there is need to have a reliable, informative and effective website which can cater the need of wide range of viewers. Further these websites provides many features like online attendance, marks verification etc. which are the integral component of education process. Blending the user's satisfaction and the need of education processes (admission regular monitoring, examination etc.) made the website designing a complex process. Thus measuring the effectiveness of website by merely counting the hits on the pages or only one criterion like ease of navigation etc. is not accurate. Hence there is a need to use an effective usability measurement technique which can suffix MCDM approach for these websites. In

this paper FAHP, a MCDM technique is used to rank some popular educational websites in the National Capital Region (NCR) of India. These websites are associated with technical higher education and hence have a more or less similar type of user and similar environment. In this paper FAHP approach has been applied to study the usability of the educational website and for making a decision that which website is most usable depending on user experience, below steps are performed:

- Identifying and evaluating attributes on which the usability of the website depends.
- Evaluating the alternatives web site and rank them based on the given criteria.

2. LITERATURE REVIEW TO IDENTIFY THE PARAMETERS USE TO MEASURE THE WEBSITE

The concept of usability is widely discussed in various dimensions in software industry [4] [5]. For the web industry great amount of research has been performed for measuring and benchmarking the usability of the website [6] [7]. Different definitions have been proposed based on ISO 9241- 11[8] standard says usability is: "The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use". One of the most widely accepted definition of usability was introduced by Nielsen [9]. According to [9] the components of usability are Learnability, Efficiency, Memorability, few errors, users' satisfaction. Navigation, download speed, content relevance, ease of use, accessibility and availability are some key parameters that affect the usability of the website. Although for tourism industries aesthetics, for e-commerce site security, for stock market and news websites latest information and speed are the prime parameters. Thus different industries have different requirement but certain important parameters need to be identified that prove useful for different range of websites to name a few are given below in Table [1]. It can be easily seen that navigation, content, download time, ease of use and availability are the most important parameters used in literature for measuring usability.

There are various techniques for evaluating the usability which includes [10] [11]

Testing methods

- Think Aloud Protocol-where users think while performing a task
- Performance Measurement-using software tools and obtaining statistics
- Log Analysis- analyzing the usage pattern from the web logs

These techniques are not user friendly and time consuming.



Inspection Methods

- Cognitive Walkthrough-experts examine the user's goal achievement by performing a group of task.
- Heuristic evaluation-finds the usability in user interface
- Perspective based inspection-experts inspects the design perspective and evaluated
- Guideline Review-verify the usability by setting up the guidelines.

In these approaches experts are the evaluators and they evaluate the website on certain set parameters.

Inquiry Methods

- Questionnaires and Interviews-collecting the feedback from the user for measuring the user satisfaction.
- Focus Group-where multiple user participate for evaluation.

The validity of this approach depends upon the collected data as well as user participation.

One of the major challenges in above technique is that often websites have a wide range of visitors few are well versed with the technology and some are novice. Especially the university website is used by both students which are well trained and parents who are still not very comfortable with the technology. For both trained and untrained users setting up usability goals so that designer can meet the user expectation and provide the website with best possible performance is the desired task. Inputs from the expert designers who can critically analyze the whole scenario and compare various parameters as discussed in Table [1] can lead to an effective website. Another major challenge [36] for designing a model to measure the usability of the website is to design questions and measure both objective and subjective usability aspect which includes outcomes effectiveness (interaction process (efficiency), user attitude and experience (user satisfaction)). Selecting the parameters that can measure the effectiveness, efficiency and user satisfaction directly or indirectly and rating importance of these parameters will prove a useful study for measuring the usability of the website.

Hence MCDM approach can be suitably used for measuring web usability. The MCDM problem involves decision making in the presence of multiple, usually conflicting criteria. MCDM problems are common in everyday life. In general, there exist two distinctive types of MCDM problems due to the different problems settings: one type having a finite number of alternative solutions and the other an infinite number of solutions. Normally in problems associated with selection and assessment, the number of alternative solutions is limited.

In problems related to design, an attribute may take any value in a range. Therefore the potential alternative solutions could be infinite. If this is the case, the problem is referred to as multiple objective optimization problems instead of multiple attribute decision problems [12]. In this paper MCDM approach with finite number of solutions is followed. Different approaches like AHP, Compromise Programming, TOPSIS (Technique for Order Preference by Similarity to an Ideal Solution), and PROMETHEE-2 are available to solve such problem. In order to incorporate the importance of human judgment which is always subjective and imprecise the fuzzy theory is incorporated in the AHP (FAHP). In this approach the decision makers evaluate the weights for the criteria depending on the subjective judgment. Further the alternatives can be prioritized depending on the given factors. This approach has been widely used in various domains like irrigation planning [13] Construction project selection [14] Personnel Selection problem [15] location selection problem [16].

In this paper this approach is extended for ranking educational websites. A hierarchical framework for measuring usability in through FAHP technique is proposed for that the four most important criterias that affects the usability most for an educational websites were identified.

3. METHODOLOGY

The AHP proposed by Saaty [17] has been widely used in various kinds of MCDM problems. This approach is extended to FAHP by including fuzzy ratios instead of exact ratios to handle the uncertainty problems in decision making [18]. The fuzziness was introduced by Zadeh [19] in order to deal with uncertainty of human thoughts.

A. Fuzzy Sets

The fuzzy set theory can productively express indefinite information or individual perception using linguistic terms.

B. Linguistic variables

According to Zadeh [20] linguistic variable are variables whose values are represented in words or sentences in a natural or artificial language. Linguistic variable are used in such situation that are complicated and hard to define. The domain of linguistic approach is specifically the humanistic systems like artificial intelligence, pattern recognition, information retrieval and the related areas. As an example, height can be given exact value; also it can be represented as a linguistic variable if its values need to be compared using fuzzy variables like short, very short, tall etc. rather than measuring exactly.



TABLE 1: FACTORS AFFECTING THE USABILITY OF A WEBSITE.

	Ease of use	download speed	navigation	accessibility	personalization	Availability	Content	Security	Aesthetics
Palmer(2002)[6]			√				√		
Agarwal, Venkatesh (2002)[24]	√		√				√		
Tarafdar M. et. al.(2005)[25]		√	√	√	√	√	√	√	
Seethamraju, (2006)[26]		√	√			√			
Pearson J. et.al(2007)[27]	√	√	√	√	√		√		
Pearson & Pearson(2008) [28]		√	√			√	√		
Sindhuja & Dastidar (2009) [29]			√				√		√
Nathan, R & Yeow, P 2009 [30]		√	√						√
Toit M. , Bothma C,2010 [31]			√				√		
Hsiu-Fen Lin(2010)[3]		√	√	√				√	√
Bringula, R. P.(2011) [32]		√	√			√	√		√
Mirfa Manzoor(2012) [2]			√	√					
Nilashi et al.(2012)[33]							√		
Nagpal et.al.2013[1]	√	√	√				√		
Layla Hasan (2014)[34]	√		√				√		
Maristella Matera et.al. [35]	√		√	√			√		

C. Triangular Fuzzy numbers

Linguistic variables simply approximate the individual perception of decision makers; the widely adopted triangular fuzzy number (TFN) approach is used to represent the uncertainty or vagueness of linguistic terms [21]. A TFN can be defined by a triplet low, medium, high (l, m, h) as given below using the membership function:

$$(x) = \begin{cases} \frac{x-l}{m-l} & l \leq x \leq m; \\ \frac{m-x}{h-m} & m \leq x \leq h; \\ 0 & \text{otherwise} \end{cases} \quad (1)$$

The relationship between fuzzy number and corresponding linguistic variable which identify the important weights for each criteria and membership function is given in Table [2].

Table 2 Linguistic variable for importance weight of each criteria [16][22]

Fuzzy number	Linguistic Scales	Membership function
1	Equally Important	1,1,3
3	Weak important	1,3,5
5	Essentially Important	3,5,7
7	Very strongly important	5,7,9
9	Absolutely Important	7,9,9



Various arithmetic operations that can be performed related to fuzzy numbers with triangular membership function are:

If $A = (l1, m1, u1)$ and $B = (l2, m2, u2)$ are two triangular fuzzy numbers then

Addition: $(A + B) = (l1 + l2, m1 + m2, u1 + u2)$

Multiplication: $(A \times B) = (l1l2, m1m2, u1u2)$

Inverse: $A^{-1} = (1/u1, 1/m1, 1/l)$

D. Algorithm

In this paper Deng H. [23] approach is used for solving fuzzy multi criteria analysis where fuzzy pair wise comparison is done for qualitative data resulting in effective decision. The steps of Deng’s extent analysis can be modified as below:

- Formulate the decision problem as a Multi criteria Analysis problem and identify the hierarchical structure of the problem.
- Obtain the Normal paired comparability matrices (NPC) using AHP method and convert it into Fuzzy NPC using Table 2.
- Evaluate the Consistency Ratio (CR) [17] index of the matrices obtained in step (b). It should be less than 10% which shows the judgments are satisfactory.

$$CR = CI/RI \tag{2}$$

Where,

$$Consistency\ Index(CI) = \frac{(\lambda_{max} - N)}{N - 1} \tag{3}$$

λ_{max} = Maximum Eigen value
 N = Number of Criteria’s
 RI = Average Random Index

As in the present discussion the four criteria’s are taken so the value of RI is 0.90 [17].

- Fuzzy extent analysis can be applied to convert the fuzzy NPC to its corresponding criteria weights w_j and alternate Performance ratings p_{ij} of different website can be evaluated as:

$$p_{ij} \text{ or } w_j = \frac{\sum_{n=1}^k C_{xy}}{\sum_{x=1}^k \sum_{y=1}^k C_{xy}} \tag{4}$$

Where $i=1, 2, \dots, u$ and $j=1, \dots, v$, x and $y=1, \dots, k$ and $k=u$ or v relying on the fact whether we are evaluating the performance ratings of the alternatives or the weights of the criteria under study.

$$P \text{ (Decision Matrix)} = \begin{bmatrix} (p_{11l}, p_{11m}, p_{11h}) & \dots & \dots & (p_{1vl}, p_{1vm}, p_{1vh}) \\ \dots & \dots & \dots & \dots \\ (p_{u1l}, p_{u1m}, p_{u1h}) & \dots & \dots & (p_{uvl}, p_{uvm}, p_{uvh}) \end{bmatrix} \tag{5}$$

And

$$WT \text{ (Weighing vector)} = [(wt_1, wt_2, \dots, wt_v)] \tag{6}$$

- Using the fuzzy extent analysis, final fuzzy weighted performance matrix w.r.t. the criteria can be obtained by multiplying the Weighing vector with the decision matrix

$$A = WT * P = \begin{bmatrix} wt_1 p_{11} & wt_2 p_{12} & \dots & wt_v p_{1v} \\ wt_1 p_{21} & wt_2 p_{22} & \dots & wt_v p_{2v} \\ \dots & \dots & \dots & \dots \\ wt_1 p_{u1} & wt_2 p_{u2} & \dots & wt_v p_{uv} \end{bmatrix} \tag{7}$$

- Applying α -cut on Performance matrix obtained in step no. 5, determine the interval performance matrix.

$$\left. \begin{aligned} a_{ijl\alpha} &= [\alpha * (m - l)] + l \\ a_{ijh\alpha} &= h - [\alpha * (h - m)] \end{aligned} \right\} \tag{8}$$

$$i = 1 \dots u \quad j = 1 \dots v$$

α -(Degree of confidence of decision maker) L and R represents the left and right values of the interval.

$$A_\alpha = \begin{bmatrix} [a_{11L}^\alpha, a_{11R}^\alpha] & \dots & \dots & [a_{1vL}^\alpha, a_{1vR}^\alpha] \\ \dots & \dots & \dots & \dots \\ [a_{u1L}^\alpha, a_{u1R}^\alpha] & \dots & \dots & [a_{uvL}^\alpha, a_{uvR}^\alpha] \end{bmatrix} \tag{9}$$

After evaluating the left and right values of the interval, these values need to be changed to their normal values using Lambda Function which reflects the attitude of the decision maker. The attitude of the decision maker can be positive, moderate or negative and accordingly they will have higher, average and less values for their fuzzy assessments. The concept of optimism index λ is used to calculate the normal values.

$$a_{ij\alpha}^{\lambda'} = \lambda a_{ijr}^\alpha + (1 - \lambda) a_{ijl}^\alpha, \lambda \in [0,1] \tag{10}$$

$$A_\alpha^{\lambda'} = \begin{bmatrix} a_{11\alpha}^{\lambda'} & a_{12\alpha}^{\lambda'} & \dots & a_{1v\alpha}^{\lambda'} \\ a_{21\alpha}^{\lambda'} & a_{22\alpha}^{\lambda'} & \dots & a_{2v\alpha}^{\lambda'} \\ \dots & \dots & \dots & \dots \\ a_{u1\alpha}^{\lambda'} & a_{u2\alpha}^{\lambda'} & \dots & a_{uv\alpha}^{\lambda'} \end{bmatrix} \tag{11}$$

- After evaluating the normal values, Normalized Performance matrix can be obtained as:

$$a_{ij\alpha}^\lambda = \frac{a_{ij\alpha}^{\lambda'}}{\sqrt{\sum_{i=1}^u (a_{ij\alpha}^{\lambda'})^2}} \quad (12)$$

$$A_\alpha^\lambda = \begin{bmatrix} a_{11\alpha}^\lambda & a_{12\alpha}^\lambda & \dots & a_{1v\alpha}^\lambda \\ a_{21\alpha}^\lambda & a_{22\alpha}^\lambda & \dots & a_{2v\alpha}^\lambda \\ \dots & \dots & \dots & \dots \\ a_{u1\alpha}^\lambda & a_{u2\alpha}^\lambda & \dots & a_{uv\alpha}^\lambda \end{bmatrix} \quad (13)$$

- For depicting the best and the worst possible solution among the alternatives across all criteria simple fuzzy positive ideal solution $L_i^{\lambda+}$ and fuzzy negative ideal solution $L_i^{\lambda-}$ can be calculated by choosing the extreme value and the lowest value over all alternatives wr.t. criteria as

$$L_i^{\lambda+} = (A_{1\alpha}^{\lambda+}, A_{2\alpha}^{\lambda+} \dots A_{v\alpha}^{\lambda+}) \quad (14)$$

$$L_i^{\lambda-} = (A_{1\alpha}^{\lambda-}, A_{2\alpha}^{\lambda-} \dots A_{v\alpha}^{\lambda-}) \quad (15)$$

Where,

$$A_{1\alpha}^{\lambda+} = \max(a_{ij\alpha}^\lambda, a_{2j\alpha}^\lambda, \dots, a_{uj\alpha}^\lambda) \quad (16)$$

$$A_{1\alpha}^{\lambda-} = \min(a_{ij\alpha}^\lambda, a_{2j\alpha}^\lambda, \dots, a_{uj\alpha}^\lambda) \quad (17)$$

- Degree of Similarity between each alternative and the positive ideal solution and the negative ideal solution can be calculated respectively by:

$$S_{i\alpha}^{\lambda+} = \frac{L_{i\alpha}^\lambda L_{i\alpha}^{\lambda+}}{\max(L_{i\alpha}^\lambda L_{i\alpha}^\lambda, L_{i\alpha}^{\lambda+} L_{i\alpha}^{\lambda+})} \quad (18)$$

$$S_{i\alpha}^{\lambda-} = \frac{L_{i\alpha}^\lambda L_{i\alpha}^{\lambda-}}{\max(L_{i\alpha}^\lambda L_{i\alpha}^\lambda, L_{i\alpha}^{\lambda-} L_{i\alpha}^{\lambda-})} \quad (19)$$

Where,

$L_{i\alpha}^\lambda = (a_{i1\alpha}^\lambda, a_{i2\alpha}^\lambda, \dots, a_{iv\alpha}^\lambda)$ is i^{th} row of overall performance matrix. So, larger value of $S_{i\alpha}^{\lambda+}$ and $S_{i\alpha}^{\lambda-}$ represents higher degree of similarity between each alternative and positive and negative ideal solution respectively.

- The overall usability score (U.S.) of each alternative and rank the alternatives according to their index.

$$U.S. = \frac{S_{i\alpha}^{\lambda+}}{S_{i\alpha}^{\lambda+} + S_{i\alpha}^{\lambda-}} \quad i = 1, 2 \dots, u \quad (20)$$

3. EMPIRICAL STUDY

In this section we present an empirical study of a website selection problem. Selecting the best website from the available websites is a complex decision making approach in which the overall effectiveness of the website needs to be evaluated with respect to the multiple selection criteria. Various selection criteria are involved for evaluating the effectiveness of the website. In the current discussion websites of different educational institutes (W1, W2, W3, and W4) are considered as a case study. Based on comprehensive survey [1] of the relevant educational websites four parameters identified as selection criteria are Response Time (RT), Ease of use (EOU), Ease of Navigation (EON), Informative (INF). The hierarchical structure for evaluating the usability of website is given in Fig.[1]. The four selection criteria's and their corresponding fuzzy NPC matrix are given below:

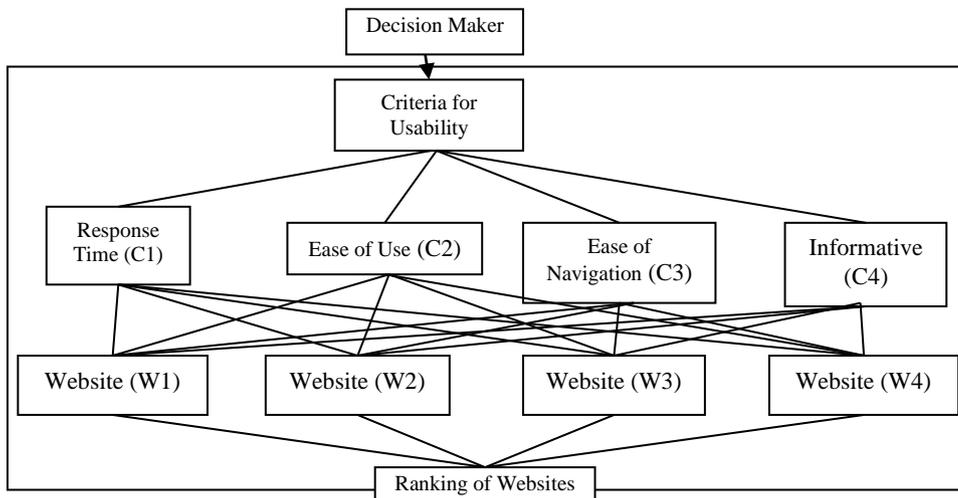


Figure1: Hierarchical Framework for evaluating the usability



A. Response Time (RT)

The response time of the website is related to how quickly a website responds to a request. This response time is depended on various parameters like network bandwidth, download time and query processing time etc. Based on decision maker the comparison of the response time of the websites (W1, W2, W3, and W4) is done and fuzzy NPC matrix for response time (C1) is formulated as:

$$C1 = \begin{bmatrix} (1,1,3) & (1,3,5) & (5^{-1}, 3^{-1}, 1) & (9^{-1}, 7^{-1}, 5^{-1}) \\ (5^{-1}, 3^{-1}, 1) & (1,1,3) & (7^{-1}, 5^{-1}, 3^{-1}) & (9^{-1}, 7^{-1}, 5^{-1}) \\ (1,3,5) & (3,5,7) & (1,1,3) & (7^{-1}, 5^{-1}, 3^{-1}) \\ (5,7,9) & (5,7,9) & (3,5,7) & (1,1,3) \end{bmatrix}$$

The elements of matrix like C1 [0] [0] represents the comparison of W1 with itself and C1 [1] [0] represents the comparison of W2 with W1 on response time and so on.

B. Ease of use (EOU)

Ease of use of a website concerns about how easily or how quickly the visitor is able to access a particular website. For an educational website, EOU is the important criteria for evaluating the effectiveness of a website. Since it is a judgmental factor and depends upon the individual training to use the website. A fuzzy NPC matrix (C2) for determining the ease of use for websites is given below:

$$C2 = \begin{bmatrix} (1,1,3) & (3^{-1}, 5^{-1}, 7^{-1}) & (5^{-1}, 3^{-1}, 1) & (5^{-1}, 7^{-1}, 9^{-1}) \\ (3,5,7) & (1,1,3) & (1,3,5) & (5^{-1}, 3^{-1}, 1) \\ (1,3,5) & (5^{-1}, 3^{-1}, 1) & (1,1,3) & (7^{-1}, 5^{-1}, 3^{-1}) \\ (5,7,9) & (1,3,5) & (3,5,7) & (1,1,3) \end{bmatrix}$$

C. Ease of navigation (EON)

Ease of Navigation concerns about how quickly and how easily user is able to get the required information. It depends on the complexity of the website design and broken links. For this the fuzzy NPC matrix (C3) with respect to the usability of website in regard to this criteria is as follows

$$C3 = \begin{bmatrix} (1,1,3) & (3,5,7) & (7^{-1}, 5^{-1}, 3^{-1}) & (9^{-1}, 7^{-1}, 5^{-1}) \\ (1,3,5) & (1,1,3) & (5^{-1}, 3^{-1}, 1) & (7^{-1}, 5^{-1}, 3^{-1}) \\ (3,5,7) & (1,3,5) & (1,1,3) & (5^{-1}, 3^{-1}, 1) \\ (5,7,9) & (3,5,7) & (1,3,5) & (1,1,3) \end{bmatrix}$$

D. Informative (INF)

Informative Refers to how current, accurate and complete information a particular website is providing. For an educational website information is the significant factor that impacts the effectiveness of a website. The

fuzzy NPC matrix (C4) based on the pairwise comparison process is given below:

$$C4 = \begin{bmatrix} (1,1,3) & (5^{-1}, 3^{-1}, 1) & (7^{-1}, 5^{-1}, 3^{-1}) & (9^{-1}, 7^{-1}, 5^{-1}) \\ (1,3,5) & (1,1,3) & (5^{-1}, 3^{-1}, 1) & (7^{-1}, 5^{-1}, 3^{-1}) \\ (3,5,7) & (1,3,5) & (1,1,3) & (5^{-1}, 3^{-1}, 1) \\ (5,7,9) & (3,5,7) & (1,3,5) & (1,1,3) \end{bmatrix}$$

To determine the relative importance of one criteria over other fuzzy pair wise comparison process is conducted, resulting in a fuzzy reciprocal judgment matrix (Z) as

$$Z = \begin{bmatrix} (1,1,3) & (5^{-1}, 3^{-1}, 1) & (7^{-1}, 5^{-1}, 3^{-1}) & (5^{-1}, 3^{-1}, 1) \\ (1,3,5) & (1,1,3) & (5^{-1}, 3^{-1}, 1) & (5^{-1}, 3^{-1}, 1) \\ (3,5,7) & (1,3,5) & (1,1,3) & (1,3,5) \\ (1,3,5) & (1,3,5) & (5^{-1}, 3^{-1}, 1) & (1,1,3) \end{bmatrix} \quad (21)$$

Using equation (2)-(3) the CR index for criteria 1 is calculated as

$$\lambda_{max} = 4.24039$$

$$CI = \frac{(4.24-4)}{4-1} = 0.08$$

$$CR = \frac{0.08}{0.90} = 0.08 < 10\%$$

CR ratio less than 10% shows that judgments are satisfactory. Similarly the CR is calculated for all the criteria's and the fuzzy reciprocal judgment matrix (Z).

By using the fuzzy extent analysis on these reciprocal matrices (C1, C2, C3, C4), the performance ratings (p_{ij}) of alternative W_i (i=1,2,3,4) w.r.t criteria C_j (j=1,2,3,4) were calculated using Equation 4 and 5 as a result the decision matrix can be determined as (P) in (22). Using Equation (4) and (6) and (21) the weighting vector is calculated as in (23). A fuzzy weighted performance matrix as mentioned in Eq. (7) using fuzzy extent analysis can be obtained as in (24). Applying α-cut analysis from equation (8) to the weighted performance matrix obtained in Eq. (24) for a moderate decision maker (α=0.5) the interval performance matrix can be obtained as in (25). Incorporating the attitude of the decision maker in the interval performance matrix equation (25) (λ=0.5 for moderate decision maker) using Eq. (10) is evaluated as in (26). After obtaining the normal values as in Eq. (26) the normalization process is applied using Eq. (12) and we achieve the following normalized performance matrix as shown in (27)



$$P = \begin{bmatrix} (0.04,0.12,0.40) & (0.03,0.05,0.22) & (0.07,0.16,0.41) & (0.02,0.05,0.23) \\ (0.02,0.04,0.19) & (0.09,0.29,0.83) & (0.23,0.03,0.13) & (0.04,0.14,0.49) \\ (0.09,0.26,0.66) & (0.04,0.14,0.48) & (0.12,0.28,0.66) & (0.09,0.29,0.84) \\ (0.24,0.56,1.22) & (0.18,0.50,1.24) & (0.23,0.50,0.96) & (0.18,0.50,1.26) \end{bmatrix} \quad (22)$$

$$WT = [(0.03,0.07,0.40) (0.04,0.18,0.76) (0.12,0.46,1.52) (0.06,0.28,1.06)] \quad (23)$$

$$A = \begin{bmatrix} (0.0012,0.0008,0.16) & (0.0012,0.0009,0.1672) & (0.0084,0.0736,0.6232) & (0.0012,0.014,0.2438) \\ (0.0006,0.0028,0.076) & (0.0036,0.0522,0.6308) & (0.0027,0.0138,0.1976) & (0.0024,0.0392,0.5194) \\ (0.0027,0.0182,0.264) & (0.0016,0.0252,0.3648) & (0.0144,0.1288,1.0032) & (0.0054,0.0812,0.8904) \\ (0.0072,0.0392,0.488) & (0.0072,0.0900,0.9424) & (0.0276,0.2300,1.4592) & (0.0108,0.1400,1.3356) \end{bmatrix} \quad (24)$$

$$A_{\alpha} = \begin{bmatrix} (0.004,0.084) & (0.001,0.084) & (0.041,0.348) & (0.007,0.128) \\ (0.001,0.039) & (0.027,0.341) & (0.008,0.105) & (0.020,0.279) \\ (0.010,0.141) & (0.013,0.195) & (0.071,0.566) & (0.043,0.485) \\ (0.023,0.263) & (0.048,0.516) & (0.128,0.844) & (0.075,0.737) \end{bmatrix} \quad (25)$$

$$A_{\alpha}^{\lambda'} = \begin{bmatrix} 0.044 & 0.042 & 0.194 & 0.067 \\ 0.02 & 0.184 & 0.056 & 0.149 \\ 0.075 & 0.104 & 0.318 & 0.132 \\ 0.143 & 0.282 & 0.486 & 0.406 \end{bmatrix} \quad (26)$$

$$A_{\alpha}^{\lambda} = \begin{bmatrix} 0.261 & 0.118 & 0.315 & 0.146 \\ 0.119 & 0.519 & 0.091 & 0.326 \\ 0.446 & 0.293 & 0.517 & 0.288 \\ 0.851 & 0.796 & 0.791 & 0.888 \end{bmatrix} \quad (27)$$

Positive and negative ideal solution is evaluated using Eq. (14, 15, 16, and 17) to find the best and worst solution among alternatives.

$$L_{\alpha}^{\lambda+} = (0.851,0.796,0.791,0.888) \quad (28)$$

$$L_{\alpha}^{\lambda-} = (0.119,0.118,0.091,0.146) \quad (29)$$

To choose the best alternative out of the given alternatives among all criteria's in the problem, the concept of positive ideal solution $L_{\alpha}^{\lambda+}$ (to get the desired outcome) and negative solution $L_{\alpha}^{\lambda-}$ (to avoid the worst outcome) can be calculated by choosing the maximum and minimum value across all alternatives w.r.t each criteria

Table 3 Similarity Index and Usability Score

Alternatives	$S_{\alpha}^{\lambda+}$	$S_{\alpha}^{\lambda-}$	U.S.	Rank
W1	0.2506	0.4686	0.3484	4
W2	0.3159	0.00003	0.8999	1
W3	0.4608	0.3834	0.5458	3
W4	1	0.1431	0.8748	2

As per Table (3), Website (W2) is the best alternative among the taken alternatives with 89% usability and Website (W4) is the second best with usability score 87%.

Conclusion:

Website being multiuser software, achieving the desired usability is very critical for its success. The given work examines the group decision making process and proposes the multicriteria framework for ranking the educational websites. Compared to usability evaluation using user feedback FAHP provide faster and better results using domain experts. It provides better decision making, flexibility, and ability to check inconsistency and is able to handle hierarchies of criterias. To deal with the qualitative attribute in subjective judgment, FAHP approach is employed that evaluate the weights of the parameters which are relatively important for the given website. Four selected websites which are designed for similar environment usage (and similar visitor (educational website) are ranked based on the evaluated usability score. The work can be further extended for evaluation of website of any organization by identifying the important parameters that need to be considered for designing given website. A sensitive analysis will help to identify the effectiveness of the website. As each website perform different task, a task based utility function can also be evaluated by selecting the appropriate MCDM approach.



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