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USING FUZZY MULTI CRITERIA DECISION MAKING APPROACH FOR RANKING THE WEB BROWSERS

Meysam Shaverdi [*1], Mahsa Akbari [2], Sajad Emamipour [3]
[*1] *Corresponding author: Yuong researchers club, Ilam branch, Islamic Azad University, Ilam , Iran*
E-mail: Meisam.shaverdi@gmail.com
[2] *Sciences and research branch, Islamic Azad University, Tehran , Iran*
[3] *Yuong researchers club, Ilam branch, Islamic Azad University, Ilam , Iran*

ABSTRACT

Internet users need methods to ascertain web browser performance in a simple manner. The objective of this study was to construct a practical approach based on fuzzy analytical hierarchy process for selecting the best web browsers. In this paper five alternatives and five criteria are considered. These alternatives and criteria, synthesize from experts' knowledge and judgments. Fuzzy AHP has chosen to calculate the relative weights of selecting methods in order to reduce vagueness and ambiguity of information and ranking. It shows that the proposed fuzzy AHP model for selecting the web browsers can be a useful and effective assessment tool.

Keywords: *Fuzzy multiple-criteria decision making (FMCDM), Fuzzy analytic hierarchy process (FAHP), Triangular fuzzy number (TFN), Web browser, Decision making*

1-INTRODUCTION

The domain of e-commerce has provided many documents that discuss its role in the World Wide Web. The increasing number of users using and dealing with e-commerce on the web and the increasing number of applications in its domain have made it an interesting application to study [23]. Great volume of World Wide Web usage is in e-commerce. For instance, the most popular online US auction site eBay had more than 90.1 million active users during the year 2009, who contributed to a gross merchandise volume of more than $48 billion [24]. The World Wide Web has come a long way in its short existence. Without it, many people wouldn't know what to do with their day. And others literally couldn't survive without it. To browse the web we use browser. A web browser provides a user interface for displaying and selecting items from a list of data or from hierarchically organized lists of data such as directory paths. We can tell that browser is the most commonly used client side application. Earlier the choice of the browser was limited but this is no longer the situation now [25]. Following to rapid growth and expansion of Internet around the world and increase its users, public internet usage in various spheres, especially in trade, commerce and public sector, has remarkable growth. Facilitation of Many business and public processes through the Internet has led to the role of web browsers been highlighted. As these reasons, choose of appropriate browser which can provide best performance and minimum the cost and time of internet user becomes a crucial issue. Nowadays, Numbers of options are available making the choice of web browser difficult and confusing. Aim of this paper is selection the best web browser for help web users to reduce their time and cost while they are working at cyber environment.

The analytic hierarchy process (AHP) method is widely used for multiple-criteria decision-making (MCDM) and has successfully been applied to many practical decision-making problems [1-5,9,12,14,18,26]. In spite of its popularity, the method is often criticized for its inability to adequately handle the inherent uncertainty and imprecision associated with the mapping of a decision-maker's perception to crisp numbers. The empirical effectiveness and theoretical validity of the AHP have also been discussed by many authors [11,31] and this discussion has focused on four main areas: the axiomatic foundation, the correct meaning of priorities, the 1–9 measurement scale and the rank reversal problem. However, most of the problems in these areas have been partially resolved, at least for three-level hierarchic structures [18]. However, in many cases the preference model of the human decision maker is uncertain and fuzzy and it is relatively difficult crisp numerical values of the comparison ratios to be provided by subjective perception. The decision maker may be subjective and uncertain about his level of preference due to incomplete information or knowledge, inherent complexity and uncertainty within the decision environment, lack of an appropriate measure or scale [10]. Fuzzy analytic hierarchy process (FAHP) and fuzzy multiple criteria decision-making (FMCDM) analysis have been widely used to deal with decision-making problems involving multiple criteria evaluation/selection of alternatives [1,30,31] have shown advantages in handling unquantifiable/qualitative criteria and obtained quite reliable results. Thus, this research applied fuzzy set theory to the decision-making problems of alternative selection, with the intention of establishing a framework of incorporating FAHP and FMCDM, in order to help web users to select the most appropriate web browser.

Overall, there has been few research and study about the application of fuzzy AHP in selecting optimum web browser and this study is the somehow first attempt and unique research. For this reason, applied approach that proposed here, is a new and comprehensive model that can be a useful and effective assessment tool. The remainder of this paper is organized as follows. In the second section web browsers are introduced. In the third section first the fuzzy set and fuzzy number defined, then the fuzzy AHP explained and the literature review of fuzzy AHP are briefly reviewed and finally the fuzzy AHP methodology are explained. A proposed model and fuzzy AHP calculations are given in section four. Finally in section five, results are presented and suggestions for the future studies are clarified.

2- WEB BROWSERS

In this paper we select five web browsers that have more popularity among web users and Assign the greatest market share of 2010 as described on table 1. As below, we summarized the introduction of each of these five browsers.

Table 1- Global market share of five browsers for December 2010

Browser / Source	Internet Explorer	Firefox	Google Chrome	Safari	Opera	Others
Net Apps	57.08%	22.81%	9.98%	5.89%	2.23%	3.45%
StatCounter	46.94%	30.76%	14.85%	4.79%	2.07%	4.1%
W3Counter	41.3%	30.3%	13.5%	5.9%	2.0%	-
Wikimedia	42.12%	28.82%	11.18%	5.70%	3.67%	6.4%
median	**44.53%**	**29.56%**	**12.34%**	**5.80%**	**2.15%**	**4.10%**

2-1- Google chrome

Chrome the latest browser released in 2008 already had a market share of 3.9% in Jan 2009. Chromium is the open source project behind Google chrome. Salient Features include task manager for websites, visual browser history, super clean contextual menus, search option from the address bar, check memory usage by different browsers, reopen website tabs that you closed by mistake, launch websites from the start menu/quick launch bar and developers claim faster speed, better stability and performance and high security. Architecture of chrome provides insight into its security features. Chromium has two modules in separate protection domain: browser kernel and rendering engine. This architecture helps mitigate high severity attack without compromising the compatibility [25].

2-2- Internet explorer (IE)

Windows internet Explorer (formerly Microsoft internet Explorer; abbreviated MSIE), commonly abbreviated to IE, is a series of graphical web browser developed by Microsoft and included as part of the Microsoft Windows line of operating system starting in 1995. It has been the most widely used web browser since 1999, attaining a peak of about 95%usage during 2002 and 2003 with IE 5 and IE6 and that percentage share has declined since in the face of renewed competition from other web browser developers. Web Explorer uses DOCTYPE sniffing to choose between "quirks mode" (renders similarly to older versions of MSIE) and standard mode (renders closer to W3C's specifications) for HTML and CSS rendering on screen (Web Explorer always uses standards mode for printing). It also provides its own dialect of ECMA Script called Jscript. Web Explorer has been subjected to criticism over its limited support for open web standards [25]. With a market share of 44.53% in 2010 it is the most popular browser [42].

2-3- Mozilla Firefox

Firefox is an open-source project that is managed by the Mozilla Foundation. Each component is divided into sub-modules. Each of these modules is owned by a specific individual that is in charge of managing the development of that that module. It descended from Mozilla Corporation suite and is managed by Mozilla Corporation. Firefox includes tabbed browsing, a spell checker, incremental find, live bookmarking, a download manager, and an integrated search system that uses the user's desired search engine .Functions can be added through add-ons created by third-party developers, which include the NoScript JavaScript disabling utility, Tab Mix Plus customizer, Foxy Tunes media player control toolbar, Ad-block Plus ad blocking utility, StumbleUpon (website discovery), Foxmarks Bookmark Synchronizer (bookmark synchronizer), WOT: Web of Trust security site advisor, download enhancer, and Web Developer toolbar [25].

2-4- Opera

Opera has market share of 2.15%, but the special features of this browser lead to choose it in our comparison chart. Moreover, being a fast and secured browser, it has the following new features in its latest version include content blocking, BitTorrent support, widgets, search engine editor, site preferences, and new installer. one package—30 languages, integrated source viewer, opera: configuration for advanced settings configuration, tab use: thumbnails when you hover the cursor over a tab and widgets in Opera are more like small standalone applications that can interact with the web and live outside the browser, rather than interface elements that can change the basic behavior of the browser, as Firefox's extensions are [25].

2-5- Safari

Safari is a graphical web browser developed by Apple and included as part of the Mac OS X operating system. First released as a public beta on January 7, 2003 on the company's Mac OS X operating system, it became Apple's default browser beginning with Mac OS X v10.3 "Panther". Safari is also the native browser for the OS. A version of Safari for the Microsoft Windows operating system, first released on June 11, 2007, supports Windows XP, Windows Vista, and Windows 7. The latest stable release of the browser is 5.0.3, which is available as a free download for both Mac OS X and Microsoft Windows. As of 2010, Safari is the fourth most widely used browser in the US, following Google Chrome [43].

2-6- Market Share of web browsers

In Continental-scale Internet users, Asia with 825 million and 94 thousand and 396 users is in the first rank, Europe with 475 million and 69 thousand and 448 users is in the second rank, North America with 266 million and 224 thousand and 500 users is the third, Latin America and the Caribbean with 204 million and 689 thousand and 836 users is the fourth, Africa with 110 million and 931 thousand and 700 users is the fifth, the Middle East with 63 million and 240 thousand and 946 users is the sixth and Pacific with 21 million and 263 thousand and 990 users is in the final ranking. Nigeria, Africa with 43 million users, China with 420 million users in Asia, Germany with 65 million users in Europe, Iran with 33 million users in the Middle East, United States of North America with 239 million users, Brazil in Latin America and Australia in the Pacific with 17 million users, are countries and regions of the world that most Internet users has allocated [20]. Worldwide usage share of browsers have been evaluated by different corporations. The global market share of five browsers for December 2010 that have been measured by StatCounter, NetApplications, W3Counter and Wikimedia [42] have shown in table 1. Global market share of five browsers is shown in Tables 1. The last and newest versions of these five web browsers are: Internet Explorer 9, Firefox 3.6, Google Chrome 4 through Chrome 7, Opera 10.50 and Safari 5. Our study is based on the last version of internet browsers.

3- METHODOLOGY

3-1- Fuzzy set and fuzzy number

The fuzzy set theory was introduced by Zadeh [44]. Fuzzy set theory provides a strict mathematical framework in which vague conceptual phenomena can be precisely and rigorously studied [47]. Fuzzy set theory is a proper tool to reinforce the comprehensiveness and correctness of the decision making stages. Fuzzy set theory is a fundamental approach to provide measuring the uncertainly of concepts that are associated with human beings' subjective judgments including linguistic terms, satisfaction level and importance level that are often vague and unclear. A linguistic variable is a variable whose values are not quantitative but phrases in a natural language. The concept of a linguistic variable is very beneficial in dealing with situations, which are too complicated or not well defined to be rationally described in usual quantitative expressions [47]. For instance, lingual expressions, such as satisfied, fair, dissatisfied, are usually regarded as natural representations of preferences or judgments of humans. Herrera and Herrera-Viedma [17] describe that clinguistic terms are intuitively more convenient to use when decision makers express the subjectivity and imprecision of their assessment. For these reasons, the fuzzy set theory is used for selecting the optimum web browser.

Because the linguistic terms generally include uncertainty and vagueness, membership functions are applied to a set for removing it. In the classical set theory, an existence is the member of a set or not. Because uncertainty of an existence in a fuzzy set, membership function that is the cornerstone of the fuzzy sets needs to be defined for each existence in the set. A fuzzy number is a special fuzzy set $\tilde{A} = x \in R \mid \mu_{\tilde{A}}(x)$, where x takes its values on the real line $R_1 : -\infty < x < +\infty$ and its membership function $\mu_{\tilde{A}}(x)$ is a continuous mapping from and to the close interval [0, 1].

The most generally used fuzzy numbers are triangular and trapezoidal fuzzy numbers. Triangular fuzzy numbers (TFNs) are often used in applications for their calculation easiness and features. In this paper, TFNs are used to present the linguistic variables. A TFN can be defined as $\tilde{M} = (l_1, m_1, u_1)$ and its membership function

$\mu_{\tilde{M}}(x) : R \to [0,1]$ is equal to

$$\mu_{\tilde{M}}(x) = \begin{cases} \dfrac{x-l}{m-l} & l \le x \le m \\ \dfrac{x-u}{m-u} & m \le x \le u \\ 0 & otehrwise \end{cases}$$

where l and u stand for the lower and upper value, respectively, of the support of $\tilde{M}$, and m is the mid-value of $\tilde{M}$. The parameters l, m, and u that describe a fuzzy number indicate the smallest possible value, the most promising value, and the largest possible value, respectively. A triangular fuzzy number $\tilde{M}$ is shown in Fig. 1 [34].

If we define, two positive triangular fuzzy numbers $\tilde{A} = (l_1, m_1, u_1)$ and $\tilde{B} = (l_2, m_2, u_2)$ then:

$$\tilde{A} \oplus \tilde{B} = (l_1, m_1, u_1) + (l_2, m_2, u_2) = (l_1 + l_2, m_1 + m_2, u_1 + u_2) \quad (1)$$

$$\tilde{A} \otimes \tilde{B} = (l_1, m_1, u_1) \otimes (l_2, m_2, u_2) = (l_1 \otimes l_2, m_1 \otimes m_2, u_1 \otimes u_2) \quad (2)$$

$$\tilde{A}^{-1} = (l_1, m_1, u_1)^{-1} \approx (1/u_1, 1/m_1, 1/l_1) \quad (3)$$

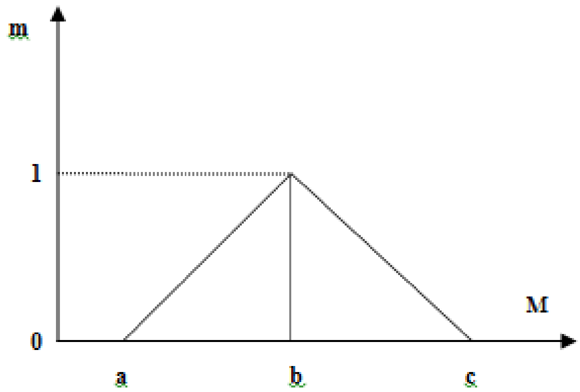

Fig.1- Triangular fuzzy number, $\tilde{M}$

3-2- Fuzzy Analytic Hierarchy Process (FAHP)

Analysis Hierarchical Process (AHP) is a multi-criteria decision making tool that was proposed by Saaty [33] on 1980. Since it was introduced, AHP have been one of the most useful multi-criteria decision making tools available to decision makers and researchers. Although AHP is sophisticated in recording knowledge, the conventional AHP is unable to veritably reflect the way human thinks and judges [22]. Although it uses a precise yardstick to compare the opinions of decision makers, the conventional AHP becomes confusing [41]. AHP is criticized for using lopsided judgmental scales and its inability to properly consider the inherent uncertainty and carelessness of pair comparisons [13]. To overcome these shortcomings, fuzzy AHP is developed to resolve the expanded hierarchical problems. Decision makers understood that distanced judgment is more persuasive than fixed value judgments. The reason is the individual often cannot explicitly express his preferences regarding the fuzzy nature of comparison process [22]. Since the relative importance specified by the AHP decision makers is oral, it is vague and imprecise. Decision makers often prefer to employ oral presentation rather than numerical value. Because of the nature of pair comparisons they cannot explicitly express their opinions about priorities correctly. In such circumstances the useful solution is to make decisions on the basis of multiple conditions and goals to achieve a relatively desirable level of achievement. These issues have caused the nature of decision making to be involved with complexities and ambiguities in most minor and most major cases. Consequently, most decisions are made in a fuzzy environment. Therefore, considering that the fuzzy logic method is applied for decision making in uncertain and ambiguous situations, using this method can decrease ambiguities and increase the effectiveness of decisions made [14].

3-3- Literature review of Fuzzy AHP

Many methods and applications of fuzzy AHP are expressed by numerous researchers. The fuzzy analytic hierarchy process (FAHP) method is used to determine the preference weightings of criteria for decision makers by subjective perception. Van Laarhoven and Pedrcyz [40] suggested the first principles of fuzzy logic employed in AHP. Buckley [6] invented the trapezoidal fuzzy numbers to explain decision makers' evaluation regarding each criterion. Chang [9] introduced a new method of FAHP using triangular fuzzy numbers for pair comparisons. Traintaphyllou and Lin [38] developed the methods of multi-indexed fuzzy decision making. These methods are based on AHP, the weighted sum model, the weighted product model and TOPSIS. Deng [13] presented a fuzzy approach for the qualitative multi-criteria analysis in a simple and clear cut manner. Zhu, Jing, and Chang [46] demonstrated the basic theory of triangular fuzzy numbers and improved the formula of the comparison of fuzzy numbers' size. Upon this, they introduced an actual example of oil discovery. Leung and Cao [29] suggested a compatible fuzzy description while observing the tolerance deflection.

Chou and Liang [12] proposed multi-criteria fuzzy decision making model integrated with the theory of fuzzy collection, AHP, and anthrop for evaluating the performance of sailing companies. Bozdag, Kahraman, and Ruan [5] (2003) presented four multi-purposed fuzzy decision making methods to come up with the best possible solution for the computerized integrated manufacturing system. One of these methods is fuzzy AHP, the others being Yager's weighted goals method, Blin's approach, and fuzzy synthetic evaluation. Chang, Cheng, and Wang [9] demonstrated a methodology of evaluating the performance of airports. They used the gray statistical model for choosing criteria and employed fuzzy AHP for specifying the weight of criteria. They ultimately utilized fuzzy integration and TOPSIS approach to rate the performance of airports. Hsieh, Lu, and Tzeng [18] proposed a multi-criteria fuzzy approach for programming and choosing the options in general buildings of companies. Fuzzy AHP method specifies the weight for assessing criteria among decision makers. Mikhailov and Tsvetinov [32] employed the AHP new fuzzy regulation to assess services. The proposed fuzzy prioritizing method use paired comparisons in relation with the precise numerical value of comparisons and the initial prioritizing issue converts to non-linear programming.

Tang and Beynon [35] used fuzzy AHP method to apply and expand static investment studies. They tried to align the owned machines with hired ones. Bashgil [3] created an analytic tool to choose the best software for achieving the best customer satisfaction. Gu and Zhu [15] devised the symmetrical fuzzy matrix as the area of goal indication. This matrix is created upon the fuzzy decision and fuzzy AHP method using the estimated fuzzy vector. Tuysuz and Kahranman [39] invented an analytic tool to estimate the risk of projects suffering from insufficient and vague information. They used fuzzy AHP to assess the IT project risk of a Turkish company. Ayag and Ozdemir [2] presented an intelligent approach based on fuzzy AHP to assess the tools' options. They first used FAHP under multiple indexes for weight and options and then performed the cost/benefit analysis using FAHP and provisions. Chan and Kumar [7] provided a model to create an organizational framework for a universal provider considering the risk factors. They used fuzzy AHP in selecting the universal provider. Lee, Chen and Chang [27] invented an approach based on fuzzy AHP and Balanced Scorecard (BSC) the IT section of industry in Taiwan. Tang [36] introduced an approach for the budget allocation of an aero space company using fuzzy AHP and Artificial Neurotic Network (ANN). Ertugrul and Karakasuglo [14] employed a model by integrating BSC, fuzzy AHP, and TOPSIS the cement companies of Turkey. Torfi, Farahani, and Rezapour [37] used a multi-criteria decision making approach by employing fuzzy AHP and fuzzy TOPSIS to assess the alternative options for preferred demands of users. Zheng, Ging, Shi, and Zhang [45] developed fuzzy AHP model to assess the energy conservation in China's buildings. Hsu, Lee, and Kreng [19] mixed fuzzy AHP and fuzzy Delphi method to choose the technology for recycling lubricants. Lee [28] applied fuzzy AHP to develop intellectual capital evaluation model for assessing their performance contribution in a university. Hadi-Vencheh and Mohamadghasemi [16] proposed an integrated fuzzy analytic hierarchy process-data envelopment analysis (FAHP-DEA) for multiple criteria ABC inventory classification. Chen et al. [10] described the design of a fuzzy decision support system in multi-criteria analysis approach for selecting the best plan alternatives or strategies in environment watershed.

3-4- Fuzzy AHP methodology

In this research the extent FAHP is utilized, which was originally introduced by Chang (1996). Let $X=\{x_1,x_2,...,x_n\}$ an object set, and $G=\{g_1,g_2,...,g_n\}$ be a goal set. According to the Chang's extent analysis method, each object is taken and extent analysis for each goal is performed respectively. Therefore, *m* extent analysis values for each object can be obtained, with the following signs:

$$M_{g_i}{}^1, M_{g_i}{}^2, ..., M_{g_i}{}^m, i=1,2,...,n$$

Where $M_{g_i}{}^j (j=1,2,...,m)$ all are TFNs. The steps of Chang's extent analysis [8] can be described as following:

Step 1. The value of fuzzy synthetic extent with respect to the *i*th object is defined as:

$$\mathrm{s_k}=\sum_{j=1}^{n} m_{g_i}^j \otimes \left[\sum_{i=1}^{n}\sum_{j=1}^{m} m_{g_i}^j\right]^{-1} \qquad (4)$$

To obtain $\sum_{j=1}^{m} M_{gi}{}^j$, the fuzzy addition operation of m extent analysis values for a particular matrix is performed such as

$$\sum_{j=1}^{m} M_{gi}^j=\left[\sum_{j=1}^{m},\sum_{j=1}^{m} m_j,\sum_{j=1}^{m} u_j\right] \qquad (5)$$

and to obtain $\left[\sum_{j=1}^{m},\sum_{j=1}^{m} m_j,\sum_{j=1}^{m} u_j\right]^{-1}$, the fuzzy addition operation of $M_{g_i}{}^j (j=1,2,...,m)$ values is performed such as:

$$\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}^j=\left(\sum_{i=1}^{n} l_i,\sum_{i=1}^{n} m_i,\sum_{i=1}^{n} u_i\right) \qquad (6)$$

and then the inverse of the vector above is computed, such as:

$$\left[\sum_{i=1}^{n}\sum_{j=1}^{m} M_{gi}{}^j\right]^{-1}=\left(\frac{1}{\sum_{i=1}^{n} u_i},\frac{1}{\sum_{i=1}^{n} m_i},\frac{1}{\sum_{i=1}^{n} l_i}\right) \qquad (7)$$

Step 2. As $M_1=(l_1,m_1,u_1)$ and $M_2=(l_2,m_2,u_2)$ are two triangular fuzzy numbers, the degree of possibility of $M_2=(l_2,m_2,u_2)\geq M_1=(l_1,m_1,u_1)$ is defined as: $V(M_2\geq M_1)=\sup\lfloor \min(\mu_{m_1}(x),\mu_{m_2}(y))\rfloor$ and can be expressed as follows:

$$V(M_2\geq M_1)=hgt(M_1\cap M_2)=\mu_{M_2}(d) \qquad (9)$$

$$= \begin{cases} 1 & m_2 \geq m_1 \\ 0 & l_1 \geq u_2 \\ \dfrac{l_1 - u_2}{(m_2 - u_2) - (m_1 - l_1)} & otherwise \end{cases} \quad (10)$$

Fig. 2 (Chang, 1996) illustrates Eq. (6) where *d* is the ordinate of the highest intersection point D between μ_{M_1} and μ_{M_2}. To compare M1 and M2, we need both the values of $V(M_1 \geq M_2)$ and $V(M_2 \geq M_1)$.

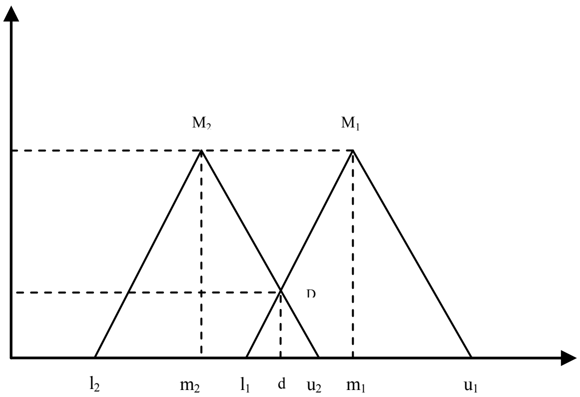

Fig.2 - The relation between M1 and M2.

Step 3 . The degree possibility for a convex fuzzy number to be greater than k convex fuzzy $M_i (i = 1, 2, ..., k)$ numbers can be defined by

$$V(M \geq M_1, M_2, ..., M_k) = V\left[(M \geq M_1) and (M \geq M_2) and ...(M \geq M_k)\right]$$

$$= \min V(M \geq M_i), \ i = 1, 2, 3, ..., k \quad (11)$$

Assume that $d(A_i) = \min V(S_i \geq S_k)$ for $k = 1, 2, ..., n; k \neq i$. Then the weight vector is given

By :

$$W' = (d'(A_1), d'(A_2, ..., d'(A_n)))^T \quad (12)$$

Where $A_i = (i = 1, 2, ..., n)$ are *n* elements.

Step 4. Via normalization, the normalized weight vectors are

$$W = (d(A_1), d(A_2, ..., d(A_n)))^T \quad (13)$$

Where *W* is a non-fuzzy number.

4- APPLICATION

The aim of this paper is to choose optimum web browser based on fuzzy AHP method. In this research, five alternatives and five criteria have been surveyed. Alternatives include Google chrome (A_1), internet explorer (A_2), Mozilla Firefox (A_3), opera (A_4) and safari (A_5). The reason slept behind for choosing these alternatives is the highest global market share of mentioned web browsers. This study criterion includes work comfortableness (C_1), Security (C_2), speed and consistency (C_3), technological support (C_4) and Add-ons (C_5). These criteria through interviews with web and information technology experts has been selected and extracted. Then, the pair-wise comparisons questionnaire following to criteria and alternatives were provided. The importance of these alternatives according to different criteria of questionnaire was evaluated by twelve mentioned experts. Furthermore, the importance of five mentioned criteria was assessed too. Fuzzy AHP approach was applied to weight the criteria and alternatives. Following this method, the best web browser has determined. According to the criteria and alternatives, this research hierarchical structure has shown in Figure 3.

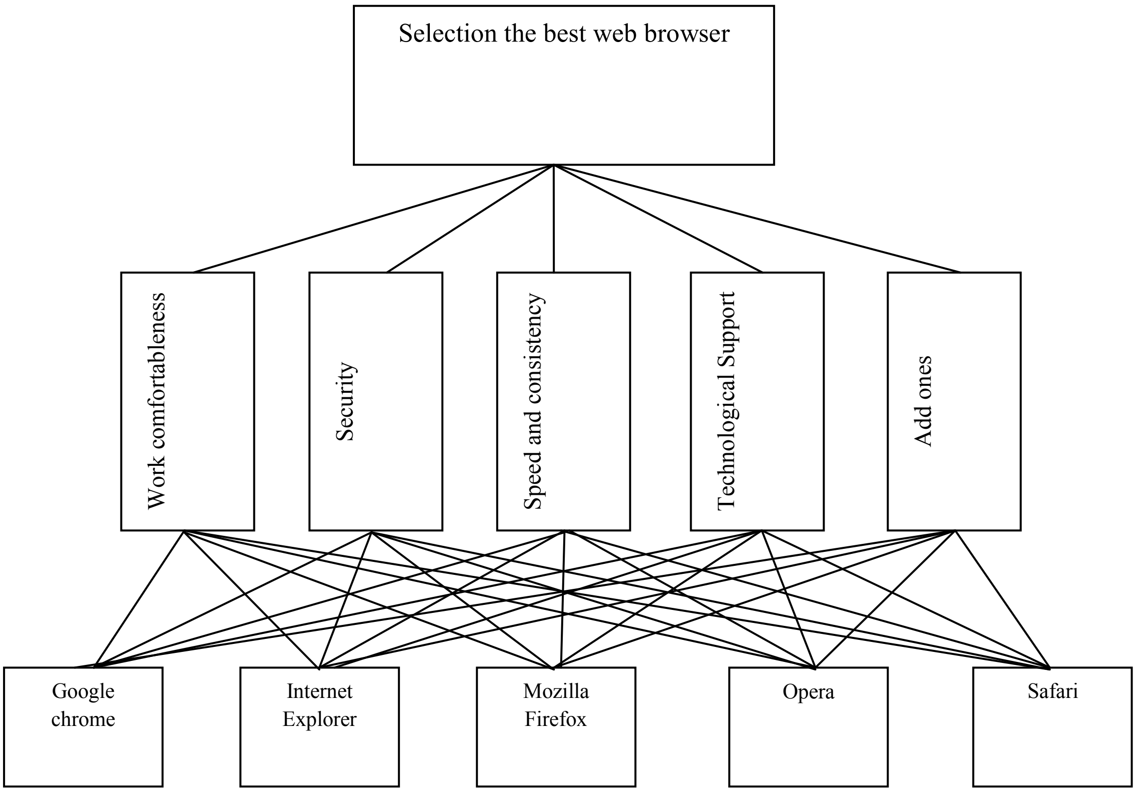

Figure.3 - Research hierarchical structure

As reason of difference between experts' judgments and for reducing uncertainty and ambiguity in decision-making process, a method of group decision making based on fuzzy AHP is suggested. According to table 2 each decision maker individually was using pair-wise comparisons based on Saaty's 1-9 scale [33].

Table 2- Pair-wise comparison scale (Saaty, 1980).

Fuzzy number	1	3	5	7	9	2,4,6,8
Definition	Equally important	Moderately more important	Strongly more important	Very strongly more important	Extremely more important	Intermediate values between the two adjacent judgments

Then, through the Eq. 14 with the integration scores given by the twelve experts, comprehensive matrix of pair-wise comparisons has calculated.

$$(x_{ij}) = (a_{ij}, b_{ij}, c_{ij})$$

$$l_{ij} = \min_k \{a_{ijk}\}, \quad m_{ij} = \frac{1}{k}\sum_{k=1}^{k} b_{ijk}, \quad u_{ij} = \max_k \{d_{ijk}\} \tag{14}$$

Through this step, decision makers' pair-wise comparisons values can become to triangular fuzzy numbers. Fuzzy Pair-wise comparisons matrix has evaluated options according to different criteria. These Fuzzy Pair-wise comparisons matrixes have shown on table 3 to 8. After the formation of fuzzy pair-wise comparisons matrix, criteria and alternatives weights' are determined by fuzzy AHP. According to fuzzy AHP method, combined weights must be calculated first. Referring to tables 3 to 8 and using the related equations, combined value is calculated. The related calculation by each matrix is given as below.

Table 3 - Fuzzy Paired-wise comparisons matrix according to technological supports (C_1)

Technological support (C_1)	Google chrome	IE	Firefox	Opera	Safari
Google chrome	(1,1,1)	(1.02, 2.32, 3.4)	(0.53, 0.91,1.25)	(0.62, 0.9, 1.25)	(0.57, 0.89, 1.64)
IE	(0.29, 0.43, 0.98)	(1,1,1)	(0.34, 0.49, 0.89)	(1.29, 2.08, 2.99)	(1.45, 2.74, 3.41)
Firefox	(0.8, 1.1, 1.89)	(1.12, 2.02, 2.98)	(1,1,1)	(2.21, 3.37, 3.96)	(1.94, 2.75, 3.3)
Opera	(0.8, 1.1, 1.61)	(0.33, 0.48, 0.77)	(0.25, 0.3, 0.45)	(1,1,1)	(0.45, 1.78, 2.97)
Safari	(0.61, 1.12, 1.75)	(0.29, 0.36, 0.7)	(0.3, 0.36, 0.51)	(0.34, 0.56, 2.22)	(1,1,1)

Table 4 - Fuzzy Paired-wise comparisons matrix according to Speed and consistency (C_2)

Speed and consistency(C_2)	Google chrome	IE	Firefox	Opera	Safari
Google chrome	(1,1,1)	(0.38, 0.79, 1.93)	(0.29, 0.43, 0.57)	(2.25, 2.89,4.01)	(1.11, 2.32, 3.51)
IE	(0.52, 1.27, 2.63)	(1,1,1)	(0.32, 0.53, 0.82)	(0.77, 1.82, 2.61)	(2.33, 3, 3.89)
Firefox	(1.75, 2.33, 3.45)	(1.22, 1.89, 3.11)	(1,1,1)	(1.75, 3.12, 3.97)	(2.79, 3.44, 4.26)
Opera	(0.25, 0.35, 0.44)	(0.38, 0.55, 1.3)	(0.25, 0.32, 0.57)	(1,1,1)	(0.55, 1, 1.67)
Safari	(0.28, 0.43, 0.9)	(0.26, 0.33, 0.43)	(0.23, 0.29, 0.36)	(0.6, 1, 1.82)	(1,1,1)

Table 5 - Fuzzy Paired-wise comparisons matrix according to Security (C_3)

Security(C_3)	Google chrome	IE	Firefox	Opera	Safari
Google chrome	(1,1,1)	(0.27, 0.39, 1.06)	(1.25, 2.21, 3.01)	(0.9, 1.67, 2.91)	(2.11, 3.24, 4.25)
IE	(0.94, 2.53, 3.66)	(1,1,1)	(3, 4.33, 4.87)	(2.45, 3.51, 5.76)	(3.25, 4, 6.11)
Firefox	(0.33, 0.45, 0.8)	(0.2, 0.23, 0.33)	(1,1,1)	(1.5, 2.28, 4.07)	(2.01, 3.75, 4.56)
Opera	(0.34, 0.6, 1.1)	(0.17, 0.28, 0.41)	(0.25, 0.44, 0.67)	(1,1,1)	(1.88, 2.64, 3.33)
Safari	(0.23, 0.31, 0.47)	(0.16, 0.25, 0.31)	(0.22, 0.27, 0.5)	(0.33, 0.38, 0.53)	(1,1,1)

Table 6 - Fuzzy Paired-wise comparisons matrix according to work comfortableness (C_4)

Work comfortableness (C_4)	**Google chrome**	**IE**	**Firefox**	**Opera**	**Safari**
Google chrome	(1,1,1)	(0.47, 0.67, 1.41)	(0.29, 0.4, 0.5)	(2, 2.76, 3.11)	(1.29, 2.12, 2.75)
IE	(0.71, 1.49, 2.11)	(1,1,1)	(0.41, 0.63, 1.49)	(2.89, 3.56, 4.33)	(2, 2.67, 3.75)
Firefox	(2, 2.5, 3.47)	(0.67, 1.59, 2.44)	(1,1,1)	(1,1.56, 2.9)	(1.33, 1.89, 3.11)
Opera	(0.32, 0.36, 0.5)	(0.23, 0.28, 0.35)	(0.34, 0.64, 1)	(1,1,1)	(1, 2, 2.52)
Safari	(0.36, 0.47, 0.77)	(0.27, 0.37, 0.5)	(0.32, 0.53, 0.75)	(0.39, 0.5, 1)	(1,1,1)

Table 7 - Fuzzy Paired-wise comparisons matrix according to Add-ons (C_5)

Add-ons(C_5)	**Google chrome**	**IE**	**Firefox**	**Opera**	**Safari**
Google chrome	(1,1,1)	(1, 2.18, 3.01)	(0.32, 0.39, 0.53)	(1.75, 2.64, 3.93)	(2.24, 3.66, 4.5)
IE	(0.33, 0.46, 1)	(1,1,1)	(0.24, 0.33, 0.5)	(0.89, 1.43, 2.67)	(0.75, 1.62, 2.13)
Firefox	(1.88, 2.56, 3.11)	(2, 3.33, 4.21)	(1,1,1)	(2.76, 3.89, 4.95)	(2.01, 3.45, 4.56)
Opera	(0.25, 0.41, 0.57)	(0.37, 0.7, 1.12)	(0.2, 0.26, 0.36)	(1,1,1)	(0.66, 1, 1.33)
Safari	(0.22, 0.27, 0.45)	(0.47, 0.62, 1.33)	(0.22, 0.29, 0.5)	(0.75, 1, 1.51)	(1,1,1)

Table 8 - Fuzzy Paired-wise comparisons of total criteria together

Total criteria	**technological supports**	**Speed and consistency**	**Security**	**work comfortableness**	**Add-ons**
technological supports(C_1)	(1,1,1)	(0.28, 0.37, 0.51)	(0.41, 0.49, 0.78)	(0.36, 0.76, 1)	(0.57, 0.89, 1.46)
Speed and consistency(C_2)	(1.97, 2.69, 3.61)	(1,1,1)	(0.67, 1,06, 1.73)	(2.33, 3, 4.27)	(2.39, 3.74, 4.33)
Security(C_3)	(1.28, 2.05, 2.45)	(0.58, 0.94, 1.49)	(1,1,1)	(1.79, 3.17, 4.01)	(0.66, 1, 1.91)
work comfortableness(C_4)	(1, 1.32, 2.76)	(0.23, 0.33, 0.43)	(0.25, 0.31, 0.56)	(1,1,1)	(1.42, 2.67, 3.03)
Add-ons(C_5)	(0.68, 1.12, 1.75)	(0.23, 0.27, 0.42)	(0.52, 1, 1.51)	(0.33, 0.37, 0.7)	(1,1,1)

4-1 calculation of table 3 (technological support criteria)
From Table 3, synthesis values respect to technological support (C_1) calculated like in Eq. (4):

S_1 = (3.7, 6.2, 8.54) × (0.026, 0.032, 0.049) = (0.096, 0.198, 0.418)

S_2 = (4.37, 6.74, 9.27) × (0.026, 0.032, 0.049) = (0.113, 0.216, 0.454)

S_3 = (7.07, 10.24, 13.13) × (0.026, 0.032, 0.049) = (0.184, 0.328, 0.643)

S_4 = (2.83, 4.66, 6.8) × (0.026, 0.032, 0.049) = (0.074, 0.149, 0.333)

S_5 = (2.54, 3.4, 6.18) × (0.026, 0.032, 0.049) = (0.066, 0.109, 0.303)

Fuzzy values of technological support indicator have compared and computed through Eq. (10):

$S_1 \geq S_2$= 0.94, $S_1 \geq S_3$= 0.44, $S_1 \geq S_4$=1, $S_1 \geq S_5$= 1; $S_2 \geq S_1$=1, $S_2 \geq S_3$= 0.493, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$=1, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$= 0.83, $S_4 \geq S_2$= 0.52, $S_4 \geq S_3$= 0.45, $S_4 \geq S_5$= 1 ; $S_5 \geq S_1$= 0.7, $S_5 \geq S_2$= 0.64, $S_5 \geq S_3$= 0.35, $S_5 \geq S_4$= 0.85

Then, priority weights have calculated through following Eq. (11):

V($S_1 \geq S_2$, S_3, S_4, S_5)= 0.44; V($S_2 \geq S_1$, S_3, S_4, S_5)= 0.49; V($S_3 \geq S_1$, S_2, S_4, S_5)= 1; V($S_4 \geq S_1$, S_2, S_3, S_5)= 0.45; V($S_5 \geq S_1$, S_2, S_3, S_4)= 0.35

Priority weight has shown as $W' = (0.44, 0.49, 1, 0.45, 0.35)$. After the normalization of this values priority weights respect to technological support criteria has computed as $(0.16, 0.18, 0.37, 0.16, 0.13)$.

4-2 calculation of table 4 (Speed and consistency criteria)
From Table 4, synthesis values respect to Speed and consistency (C_2) are calculated like in Eq. (4):

S_1 = (5.03, 7.43, 11.02) × (0.021, 0.03, 0.042) = (0.106, 0.223, 0.463); S_2 = (4.94, 7.62, 10.95) × (0.021, 0.03, 0.042) = (0.104, 0.229, 0.46); S_3 = (8.59, 11.78, 15.79) × (0.021, 0.03, 0.042) = (0.18, 0.353, 0.663); S_4 = (2.53, 3.22, 4.98) × (0.021, 0.03, 0.042) = (0.053, 0.097, 0.209); S_5 = (2.37, 3.06, 4.51) × (0.021, 0.03, 0.042) = (0.05, 0.092, 0.189); Fuzzy values of Speed and consistency indicator have compared and computed through Eq. (10):

$S_1 \geq S_2$=0.98, $S_1 \geq S_3$=0.68, $S_1 \geq S_4$=1, $S_1 \geq S_5$=1; $S_2 \geq S_1$=1, $S_2 \geq S_3$=0.98, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$=1, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$=0.45, $S_4 \geq S_2$= 0.44, $S_4 \geq S_3$= 0.11, $S_4 \geq S_5$= 1; $S_5 \geq S_1$= 0.55, $S_5 \geq S_2$= 0.26, $S_5 \geq S_3$= 0.03, $S_5 \geq S_4$= 0.96

Then, priority weights have calculated through Eq. (11):

V($S_1 \geq S_2$, S_3, S_4, S_5)= 0.68; V($S_2 \geq S_1$, S_3, S_4, S_5)= 0.98; V($S_3 \geq S_1$, S_2, S_4, S_5)= 1; V($S_4 \geq S_1$, S_2, S_3, S_5)= 0.11; V($S_5 \geq S_1$, S_2, S_3, S_4)= 0.03

Priority weight has shown as $W' = (0.68, 0.98, 1, 0.11, 0.3)$. After the normalization of this values priority weights respect to Speed and consistency criteria have computed as $(0.24, 0.35, 0.36, 0.04, 0.01)$.

4-3 calculation of table 5 (Security criteria)
From Table 5, synthesis values respect to Security (C_3) are calculated like in Eq. (4):

S_1 = (3.52, 7.38, 12.23) × (0.019, 0.027, 0.04) = (0.067, 0. 2, 0.49); S_2 = (10.64, 15.37, 21.40) × (0.019, 0.027, 0.04) = (0.202, 0.415, 0.856); S_3 = (5.04, 7.71, 10.76) × (0.019, 0.027, 0.04) = (0.096, 0.208, 0.43); S_4 = (3.64, 4.96, 6.51) × (0.019, 0.027, 0.04) = (0.069, 0.14, 0.26); S_5 = (1.94, 2.21, 2.33) × (0.019, 0.027, 0.04) = (0.037, 0.06, 0.093)

Fuzzy values of security indicator have compared and computed through Eq. (10):

$S_1 \geq S_2$=0.57, $S_1 \geq S_3$=0.98, $S_1 \geq S_4$=1, $S_1 \geq S_5$=1; $S_2 \geq S_1$=1, $S_2 \geq S_3$=1, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$=0.52, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$=0.76, $S_4 \geq S_2$=0.17, $S_4 \geq S_3$=0.28, $S_4 \geq S_5$=1; $S_5 \geq S_1$=0.16, $S_5 \geq S_2$=0, $S_5 \geq S_3$=0, $S_5 \geq S_4$=0.23

Then, priority weights have calculated through Eq. (11):

V ($S_1 \geq S_2$, S_3, S_4, S_5)= 0.57; V ($S_2 \geq S_1$, S_3, S_4, S_5)= 1; V ($S_3 \geq S_1$, S_2, S_4, S_5)= 0.52; V ($S_4 \geq S_1$, S_2, S_3, S_5)= 0.17; V ($S_5 \geq S_1$, S_2, S_3, S_4)= 0

Priority weight has shown as $W' = (0.25, 0.44, 0.23, 0.08, 0)$. After the normalization of this values priority weights respect to security criteria has computed as $(0.25, 0.44, 0.23, 0.08, 0)$.

4-4 calculation of table 6 (Work comfortableness criteria)
From Table 6, synthesis values respect to Work comfortableness (C_4) are calculated like in Eq. (4):

S_1 = (5.05, 6.96, 8.77) × (0.023, 0.031, 0.043) = (0.116, 0.216, 0.377); S_2 = (7.01, 9.35, 12.68) × (0.023, 0.031, 0.043) = (0161, 0.29, 0.545); S_3 = (6, 8.54, 12.92) × (0.023, 0.031, 0.043) = (0.138, 0.265, 0.556); S_4 = (2.99, 4.28, 5.37) × (0.023, 0.031, 0.043) = (0.069, 0.133, 0.231); S_5 = (2.34, 2.87, 4.02) × (0.023, 0.031, 0.043) = (0.054, 0.089, 0.173)

Fuzzy values of work comfortableness indicator have compared and computed through Eq. (10):

$S_1 \geq S_2$= 0.55, $S_1 \geq S_3$= 0.62, $S_1 \geq S_4$=1, $S_1 \geq S_5$=1; $S_2 \geq S_1$=1, $S_2 \geq S_3$=1, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$= 0.96, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$=0.58, $S_4 \geq S_2$=0.31, $S_4 \geq S_3$=0.41, $S_4 \geq S_5$=1; $S_5 \geq S_1$=0.31, $S_5 \geq S_2$=0.06, $S_5 \geq S_3$=0.17, $S_5 \geq S_4$=0.70

Then, priority weights have calculated through Eq. (11):

V ($S_1 \geq S_2$, S_3, S_4, S_5) = 0.55; V ($S_2 \geq S_1$, S_3, S_4, S_5) = 1; V ($S_3 \geq S_1$, S_2, S_4, S_5) = 0.96; V ($S_4 \geq S_1$, S_2, S_3, S_5) = 0.31; V ($S_5 \geq S_1$, S_2, S_3, S_4) = 0.06

Priority weight has shown as $W' = (0.55, 1, 0.96, 0.31, 0.06)$. After the normalization of this values priority weights respect to work comfortableness criteria has computed as $(0.19,\ 0.35,\ 0.33,\ 0.11,\ 0.02)$.

4-5 calculation of table 7 (Add-ons criteria)
From Table 7, synthesis values respect to Add-ons (C_5) are calculated like in Eq. (4):

S_1= (6.31, 9.87, 12.97) × (0.023, 0.028, 0.041) = (0.145, 0.276, 0.532); S_2= (3.21, 4.84, 7.30) × (0.023, 0.028, 0.041) = (0.074, 0.135, 0.299); S_3= (8.87, 14.23, 17.83) × (0.023, 0.028, 0.041) = (0.204, 0.398, 0.731); S_4= (2.48, 3.37, 5.58) × (0.023, 0.028, 0.041) = (0.057, 0.094, 0.229); S_5= (1.66, 3.18, 5.19) × (0.023, 0.028, 0.041) = (0.038, 0.089, 0.213)

Fuzzy values of Add-ons indicator have compared and computed through Eq. (10):

$S_1 \geq S_2$= 1, $S_1 \geq S_3$=0.72, $S_1 \geq S_4$=1, $S_1 \geq S_5$=1; $S_2 \geq S_1$=0.52, $S_2 \geq S_3$=0.26, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$= 1, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$=0.31, $S_4 \geq S_2$=0.77, $S_4 \geq S_3$=0.08, $S_4 \geq S_5$=1; $S_5 \geq S_1$=0.26, $S_5 \geq S_2$=0.73, $S_5 \geq S_3$=0.03, $S_5 \geq S_4$=0.97

Then, priority weights have calculated through Eq. (11):

V ($S_1 \geq S_2$, S_3, S_4, S_5) = 0.72; V ($S_2 \geq S_1$, S_3, S_4, S_5) = 0.26; V ($S_3 \geq S_1$, S_2, S_4, S_5) = 1; V ($S_4 \geq S_1$, S_2, S_3, S_5) = 0.08; V ($S_5 \geq S_1$, S_2, S_3, S_4) = 0.03

Priority weight has shown as $W' = (0.72, 0.26, 1, 0.08, 0.03)$. After the normalization of this values priority weights respect Add-ons criteria has computed as $(0.34,\ 0.13,\ 0.48,\ 0.04,\ 0.01)$.

4-6 calculation of table 8 (Total criteria)
From Table 8, synthesis values respect to Total criteria are calculated like in Eq. (4):

S_1= (2.62, 4.08, 4.75) × (0.024, 0.03, 0.044) = (0.063, 0.122, 0.209); S_2= (8.35, 11.49, 14.94) × (0.024, 0.03, 0.044) = (0.2, 0.358, 0.675); S_3= (5.31, 8.16, 10.86) × (0.024, 0.03, 0.044) = (0.127, 0.245, 0.478); S_4= (3.9, 5.63, 6.17) × (0.024, 0.03, 0.044) = (0.094, 0.169, 0.271); S_5= (2.76, 3.76, 5.38) × (0.024, 0.03, 0.044) = (0.66, 0.113, 0.237)

Fuzzy values of total indicators have compared and computed through Eq. (10).

$S_1 \geq S_2$=0.04, $S_1 \geq S_3$=0.4, $S_1 \geq S_4$=0.71, $S_1 \geq S_5$=1; $S_2 \geq S_1$=1, $S_2 \geq S_3$=1, $S_2 \geq S_4$=1, $S_2 \geq S_5$=1; $S_3 \geq S_1$=1, $S_3 \geq S_2$=0.64, $S_3 \geq S_4$=1, $S_3 \geq S_5$=1; $S_4 \geq S_1$=1, $S_4 \geq S_2$=0.27, $S_4 \geq S_3$=0.65, $S_4 \geq S_5$=1; $S_5 \geq S_1$=0.95, $S_5 \geq S_2$=0.13, $S_5 \geq S_3$=0.45, $S_5 \geq S_4$=0.72

Then, priority weights have calculated through Eq. (11):

$V(S_1 \geq S_2, S_3, S_4, S_5)$= 0.04; $V(S_2 \geq S_1, S_3, S_4, S_5) = 1$; $V(S_3 \geq S_1, S_2, S_4, S_5) = 0.64$; $V(S_4 \geq S_1, S_2, S_3, S_5) = 0.27$; $V(S_5 \geq S_1, S_2, S_3, S_4) = 0.13$

Priority weight has shown as $W' = (0.04, 1, 0.64, 0.27, 0.13)$. After the normalization of this values priority weights respect to total criteria has computed as $(0.02,\ 0.48,\ 0.31,\ 0.13,\ 0.06)$. Referring to above tables and the coefficient of relative importance of each criterion, Internet explorer known as the best browser and it has the first ranking after that Mozilla Firefox has the second ranking (Table 9). The ranking results on each criterion based on five mentioned web browser have shown on Table 10.

Table 9 - Final results of ranking indexes using FAHP

Criteria / Alternatives	**Technological support** 0.02	**Speed and consistency** 0.48	**security** 0.31	**Work comfortableness** 0.13	**Add- ons** 0.06	**Indexes relative importance coefficient**	**Ranking**
Google chrome	0.16	0.24	0.25	0.19	0.34	0.2410	3
IE	0.18	0.35	0.44	0.35	0.13	0.3613*	1
Firefox	0.37	0.36	0.23	0.33	0.48	0.3232	2
Opera	0.16	0.04	0.08	0.11	0.04	0.0639	4
Safari	0.13	0.01	0	0.02	0.01	0.0106	5

Table 10 - Ranking criterion based on five web browsers

Criteria / Alternatives	**Technological support**	**Speed and consistency**	**security**	**Work comfortableness**	**Add- ons**
Google chrome	(3)	(3)	(2)	(3)	(2)
IE	(2)	(2)	(1)	(1)	(3)
Firefox	(1)	(1)	(3)	(2)	(1)
Opera	(3)	(4)	(4)	(4)	(4)
Safari	(5)	(5)	(5)	(5)	(5)

5- CONCLUSION

Nowadays, following to the worldwide expansion of Internet usage and the importance of the Internet in promoting various activities such as governmental, economical, trade, scientific and etc, using appropriate Web browsers to facilitate the Internet operations and reduce time and cost of individuals and organizations has become prominent. The purpose of this article is to identify and select optimum web browsers based on Fuzzy AHP calculations. In this paper, the top five browsers in 2010 according to global market share were selected. For Evaluation and ranking the five criteria of technological support, speed and consistency, security, work comfortableness and Add-ons were considered. AHP method due to its use of unbalanced scale of judgments and its inability to adequately handle the inherent uncertainty and carelessness in the pair-wise comparison process is criticized. To overcome all these shortcomings and respect to ambiguity and complexity of human decision-making process, fuzzy AHP approach is developed.

The research findings can be summarized as following items: Internet explorer with (0.3613) and Mozilla Firefox with (0.3232) have the most priority weights and Safari (0.0106) has the lowest weight. The most important criteria respect to experts' judgments in selecting web browsers are respectively the speed and consistency (0.48), Security (0.31) and work comfortableness (0.13). Table 9 results present that Firefox has the highest ranking in technological support, speed and consistency and Add-on criteria and Internet explorer has the best ranking in security and work comfortableness while Safari has the lowest rating between all the criteria. Future research can be used more comprehensive criteria for evaluating Web browsers. Other browsers which haven't referred in this article, can be cited for more accurate ranking. For subsequent studies, using other multi-criteria decision making methods can be proposed to rank web browsers more properly.

REFERENCES

C.V. Altrock, B. Krause, Multi-criteria decision-making in German automotive industry using fuzzy logic, Fuzzy Sets and Systems 63(3), 1994, pp. 375– 380.

Z. Ayag, R.G. Ozdemir, A fuzzy AHP approach to evaluating machine tool alternatives, Journal of Intelligent Manufacturing 17, 2006, pp. 179–190.

H. Baslgil, The fuzzy analytic hierarchy process for software selection problems, Journal of Engineering and Natural Sciences 3, 2005, pp.24–33.

R.E. Bellmann, L.A. Zadeh, Decision Making in Fuzzy environment, Management Science 17(4), 1970, pp.141-164.

C.E. Bozdag, C. Kahraman, D. Ruan, Fuzzy group decision making for selection among computer integrated manufacturing systems, Computer in Industry 51, 2003, pp.13–29.

J. J. Buckley, Fuzzy hierarchical analysis. Fuzzy Sets and Systems 17,1985, pp. 233–247.

F.T.S. Chan, N. Kumar, Global supplier development considering risk factors using fuzzy extended AHP-based approach, Omega International Journal of Management Science 35, 2007, pp.417–431.

D.Y. Chang, Applications of the extent analysis method on fuzzy AHP, European Journal of Operational Research 95, 1996, pp.649–655.

Y.H. Chang, C.H. Cheng, T.C. Wang, Performance evaluation of international airports in the region of East Asia, Eastern Asia Society for transportation studies. 4, 2003, pp. 213–230.

V.Y.C. Chen, H.P. Lien, C.H. Liu, J.J.H. Liou, G.H. Tzeng, L.S. Yang, Fuzzy MCDM approach for selecting the best environment-watershed plan, Applied Soft Computing 11(1), 2011, pp.265-275.

F.K.T. Cheung, J.L.F. Kuen, M. Skitmore, Multi-criteria evaluation model for the selection of architecture consultants, Construction Management and Economics 20 (7), 2002, pp.569–580.

T.Y. Chou, G.S. Liang, Application of a fuzzy multi-criteria decision making model for shipping company performance evaluation, Maritime Policy & Management 28(4), 2001, pp.375–392.

H. Deng, Multicriteria analysis with fuzzy pair-wise comparison, International Journal of Approximate Reasoning 21, 1999, pp.215–231.

I. Ertugrul, N. Karakasoglu, Performance evaluation of Turkish cement firms with fuzzy analytic hierarchy process and TOPSIS methods, Expert Systems with Applications 36(1), 2009, pp.702–715.

X. Gu, Q. Zhu, Fuzzy multi-attribute decision making method based on eigenvector of fuzzy attribute evaluation space, Decision Support Systems 41, 2006, pp.400–410.

A. Hadi-Vencheh, A. Mohamadghasemi, A fuzzy AHP-DEA approach for multiple criteria ABC inventory classification, Expert System with Applications 38(4), 2011, pp.3346-3352.

F. Herrera, E. Herrera-Viedma, Linguistic decision analysis steps for solving decision problems under linguistic information, Fuzzy Sets and Systems 115(1), 2000, pp.67–82.

T.Y. Hsieh, S.T. Lu, G.H. Tzeng, Fuzzy MCDM approach for planning and design tenders selection in public office buildings, International Journal of Project Management 22, 2004, pp.573–584.

Y,L. Hsu,. C.W. Lee, V.B. Kreng, The application of Fuzzy Delphi Method and Fuzzy AHP in lubricant regenerative technology selection, Expert System with Applications 37, 2010, pp.419-425.

Internet World Stats. http://www.internetworldstats.com.
M.T. Issai,., A. Kanani, M. Tootoonchi, H.R. Afzali, Intelligent timetable evaluation using fuzzy AHP, Expert System with Applications 38(4), 2011, pp.3718-3723.
C. Kahraman, U. Cebeci, Z. Ulukan, Multi-criteria supplier selection using fuzzy AHP, Logistics Information Management 16(6), 2003, pp.382–394.
A. Kayed, E. El-Qawasmeh, Z. Qawaqneh, Ranking web sites using domain ontology concepts, Information & Management 47, 2010, pp.350–355
V.O. Kayhan, J.A. McCart, A. Bhattacherjee, Cross-bidding in simultaneous online auctions: Antecedents and consequences, Information & Management 47, 2010, pp.325–332.
A. Kulkarni, J.S. John, Y.J. Thampi, S. Udaykumar, G. Prasad, V. Halarnkar, Web Browsers Department of computer engineering, National Institute Technology Karnataka Surathkal, 575025:www.isea.nitk.ac.in/ PMISprojects/reports/ WebBrowsersReport.pdf
S. Lai, A preference-based interpretation of AHP, Omega 23, 1995, pp.453– 462.
A.H.I. Lee, W.C. Chen, C.J. Chang, A fuzzy AHP and BSC approach for evaluating performance of IT department in the manufacturing industry in Taiwan, Expert System with Applications 34, 2008, pp.96–107.
S.H. Lee, Using fuzzy AHP to develop intellectual capital evaluation model for assessing their performance contribution in a university, Expert Systems with Applications 37, 2010, pp.4941–4947.
L.C. Leung, D. Cao, On consistency and ranking of alternatives in fuzzy AHP, European Journal of Operational Research 124, 2000, pp.102–113.
S.-P. Li, B.F. Will,(2005). A fuzzy logic system for visual evaluation, Environment and Planning B: Planning and Design 32 (2), 2005, pp.293–304.
C. Mcintyre, M.K. Parfitt, Decision support system for residential land development site selection process, Journal of Architecture Engineering 4(4),1998, pp.125–131
L. Mikhailov, P. Tsvetinov, Evaluation of services using a fuzzy analytic hierarchy process, Applied Soft Computing 5, 2004, pp.23–33.
T.L. Saaty, The analytic hierarchy process, New York, McGraw-Hill, 1980.
N.Y. Seçme, A. Bayrakdaroglu, C. Kahraman, Fuzzy performance evaluation in Turkish Banking Sector using Analytic Hierarchy Process and TOPSIS, Expert Systems with Applications 36, 2009, pp.11699–11709.
Y. Tang, M.J. Beynon, Application and development of a fuzzy analytic hierarchy process within a capital investment study, Journal of Economics and Management 1(2), 2005, pp.207–230.
Y.C. Tang, An approach to budget allocation for an aerospace company—Fuzzy analytic hierarchy process and artificial neural network, Expert System with Applications 72, 2009, pp.3477-3489.
F. Torfi, R.Z. Farahani, S. Rezapour, Fuzzy AHP to determine the relative weights of evaluation criteria and Fuzzy TOPSIS to rank the alternatives, Applied Soft Computing 10(2), 2010, pp.520-528.
E. Triantaphyllou, C.T. Lin, Development and evaluation of five fuzzy multi attribute decision-making methods, International Journal of Approximate Reasoning 14, 1996, pp.281–310.
F. Tuysuz, C. Kahraman, Project risk evaluation using a fuzzy analytic hierarchy process: an application to information technology projects, International Journal of Intelligent Systems 21, 2006, pp.559–584.
P.J.M. Van Laarhoven, W. Pedrcyz, A fuzzy extension of Saaty's priority theory, Fuzzy Sets and Systems 11, 1983, pp.229–241.
T.C. Wang, Y.H. Chen, Applying consistent fuzzy preference relations to partnership selection. Omega: the International Journal of Management Science 35, 2007, pp.384-388.
Wikipedia. http://en.wikipedia.org/wiki/Usage_share_of_web_browsers
Wikipedia. http://en.wikipedia.org/wiki/Safari_%28web_browser%29.
L.A. Zadeh, Fuzzy sets, Information and Control 8, 1965, pp.338–353.
G. Zhen, Y. Jing, H. Huang, G. Shi, X. Zhang, Developing a fuzzy analytic hierarchical process model for building energy conservation assessment, Renewable Energy 35, 2010, pp.78-87.
K. Zhu, Y. Jing, D. Chang, A discussion on extent analysis method and applications of fuzzy AHP, European Journal of Operational Research 116, 1999, pp.450–456.
H.J. Zimmermann, Fuzzy set theory and its applications (2nd Ed.), Boston, Dordrecht, London: Kluwer Academic Publishers, 1991.