International Journal of Innovation and Scientific Research
ISSN 2351-8014 Vol. 9 No. 2 Sep. 2014, pp. 268-284

http://www.ijisr.issr-journals.org/

# Evaluating the Critical Factors for Electronic Medical Record Adoption Using Fuzzy Approaches

*Hossein Ahmadi[1], Mahdi Darvishi[1], Mehrbakhsh Nilashi[1], Alireza Almaee[2], Othman Ibrahim[1], Ali Hossein Zolghadri[3], Mojtaba Alizadeh[4], and Mohammadreza Farahmand[1]*

[1]Faculty of Computing, Universiti Teknologi Malaysia, Johor, Malaysia

[2]Organization of Technical and Vocational Training, Lahijan, Guilan, Iran

[3]Islamic Azad University Qeshm Branch, Qeshm, Iran

[4]Malaysian-Japan International Institute of Technology Universiti Teknologi Malaysia, 54100 Kuala Lumpur, Malaysia



**ABSTRACT:** Using Electronic Medical Records (EMRs) has a great possibility for rising physician's performance in their daily work which improves quality, safety and efficiency in healthcare that are slowly being adopted throughout the world. The adoption of EMRs as a new technology in healthcare system is an important issue which has to be scrutinized as well. In physician practices, the rate of EMRs adoption has been slow and restricted in spite of the cost savings through lower administrative costs and medical errors related to EMR systems. Hence, this research is conducted to identify, categorize, and analyze Meso-level dimension which introduced by [27], for the adoption of EMRs in the healthcare context. To collect data, Likert-based and pairwise questionnaires were designed and distributed among the public experts and physicians healthcare organizations. Fuzzy Technique for Order of Preference by Similarity to Ideal Solution (F-TOPSIS) and Fuzzy Analytic Hierarchy Process (F-AHP) was applied involves in quantitative approach in the ranking and weighting of the factors presented in Meso-level dimension framework. As a result, in this study, we develop a Multi Criteria Decision Making (MCDM) framework for healthcare industry improvement and adoption of EMR. The purpose of ranking and weighting using the F-TOPSIS and F-AHP is to inspect which factors are most imperative in EMRs adoption among primary care physicians. Performing F-TOPSIS and F-AHP is as novelty methods in this study for identifying the critical factors of EMRs adoption to assist healthcare organizations specifically hospitals setting in pursuing their key users' behavior towards accepting of this new technology. We find that seven factors, namely time investment, screen/room, hybrid system, planning, resource training, workflow, and weight, are the most influential criteria and strongest drivers in the adoption of EMR in Malaysia's primary care setting.

**KEYWORDS:** EMRS, Adoption, Fuzzy TOPSIS, Fuzzy AHP, Meso-Level Adoption Factors, HIS.

## 1 INTRODUCTION

Currently, there is a vast investment in Information Technology (IT) by healthcare providers that looked at the development and adoption of Hospital Information System (HIS) for instance Electronic Medical Records (EMRs) [1,2,21,22]. IT is utilized by physicians for billing purposes, but unfortunately the number incorporating IT into their practices for clinical purposes such as EMRs are low [8]. According to [43] "It is estimated that the healthcare industry is at least ten years behind other industries in terms of IT investment". Despite ITs' increasing ubiquity, decreasing costs, and the potential for benefits in the clinical decision-making process, the low rate of adoption occurs among physicians practices specifically in developing countries [16,18,21,47]. Healthcare organizations are dissimilar from organizations operating within other business contexts, especially about individual autonomy and operational independence [17]. EMRs adoption has been attracted by little interest

in the Management Information Systems (MIS) literature [30]. In this research, an EMR explained as a computerized HIS where provider's record detailed encounter information such as patient demographics, encounter summaries, medical history, allergies, intolerances, and lab test histories. Some may support order entry, results management and decision support and some may also contain features or be integrated with software that can schedule appointments, perform billing tasks, and generate reports. The level of primary care in medical area is becoming a core and essential part of healthcare community. The term of "general practice" was considered to refer to the same care setting as the term "primary care". Primary care is defined as the first point of contact a patient has with the health system and usually refers to family practice. This is the point where people receive care for most of their everyday health needs [28].

In this research, the Meso-level factors has been investigated which previous studies indicating its significant effect on adoption of EMRs. The framework of three dimensions consisting of Micro, Meso, and Macro-level for EMR success developed by Lau et al. [27], in systematic review study. Their study described the impact of EMR on physician practices in physicians' office setting [27]. Basically, this study applied the proposed framework in Malaysia as a successful developing country to identify the crucial factors influencing EMR adoption among primary care physicians. In addition, this research seeks to validate the developed framework to foster IT innovation in context of healthcare in increasing the advantages of serving a better and faster service by facilitating and extending such innovation among medical professionals. Therefore, the crucial factors in Meso-level framework are determined to increase the knowledge of hospitals in adopting of EMRs among medical professionals specially physicians as important users of such a technology. In addition, this study provides contextual analyses of the factors by conducting two effective methods to contribute in further understanding of the EMRs adoption.

The remainder of this paper is structured as follows. The Section 2 introduces the proposed research model of this study. In Section 3, the research methodology has been described step by step. Section 4, 5 and 6 allocated to the data collection and background mathematical of F-TOPSIS and F-AHP, respectively. Finally, we present the results of F-TOPSIS, F-AHP and conclusion in Sections 7 and 8, and 9 respectively.

## 2 PROPOSED RESEARCH MODEL

The EMR adoption model of physician in primary care provides a conceptual model to identify the most determinant factors that have a more significant effect on adoption of EMRs. This study will evaluate and extend Clinical Adoption (CA) framework which developed through a systematic review study conducted by Lau et al. [27] which was based on aforementioned dimensions. Their study was based on DeLone and McLean [13] with regard to the IS success model that was followed. Lau's CA framework comprised of Micro, Meso and Macro-level dimensions. Each dimension has its own category and sub-category which would influence physicians in EMRs adoption. In the current research, it has been concentrated on the Meso-level of a particular framework. At Meso-level, the adoption framework of primary care physician explains Clinical Information System Success (CISS) in particular of the EMRs system. In this study, EMR adoption has been examined in practice of physicians in primary care setting through the lens of CA framework. Hence, this study concentrated on Meso-level dimension combining of the relevant criteria that influence an EMR adoption. At the end, the proposed model of physician adoption model in Meso-level dimension developed and showed in Figure 1. At the Meso-level dimension, there are three main factors, including people, organization and implementation. The following described each of the main factors in detail and its sub factors respectively.

People are the integral part of the system success that may adopt or refuse the new technology based on their characteristics, expectations and responsibilities. Factors in the context of people covers personal characteristics and expectations like the prior EMRs experience of the users [45], and their personal time investment in exchange for the benefits expected from the system [29]. Roles/responsibilities included the need for champions and staff participation [5], and a shift in tasks (documentation by staff VS physicians) [28,29]. That could lead to role ambiguity and conflict [11]. Organization factors covered structure/processes and culture that emphasized EMRs adoption/use [11], EMRs-practice fit (hybrid EMRs/paper systems), and EMRs-supported office and workflow design [11] such as the placement of computer screens in consulting rooms. Return-on value concentrated on verified value at the practice level, such as the replacement effect from guideline driven test orders and prescribing, and tangible cost-efficiency gain with larger practice size and patient volume [32]. Factors in the context of implementation covered the area that the introduction of EMRs into the practice was designed and conducted as a priority project with devoted time and resources [42]. The service support provided during implementation was essential [38], since they influenced the disruptions that physicians and office staff had to defeat while learning to use the EMRs and redesign their work routines.

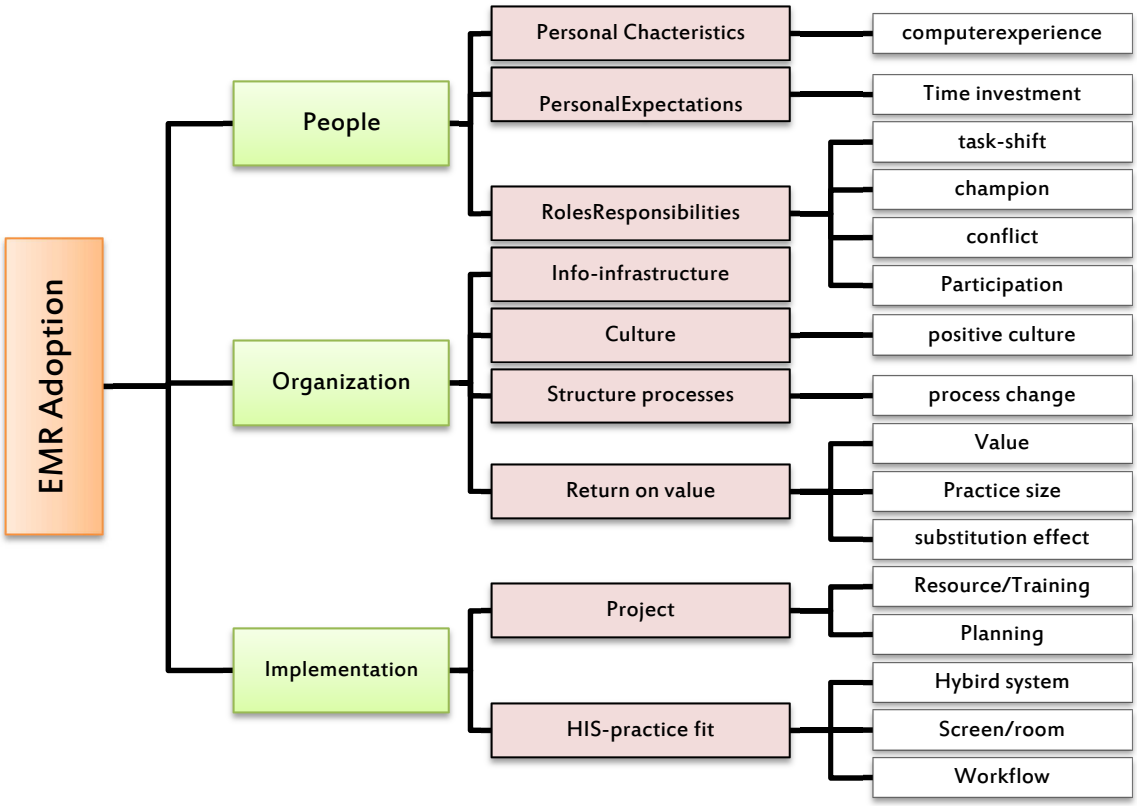


***Fig. 1. Physician EMR Adoption Model in Meso-Level***

## 3 RESEARCH METHODOLOGY

EMR in the study at hand has been considered as a new technology in primary care which has been trying to describe the factors which have the more priority in its adoption. A set of pairwise questionnaire and Likert questionnaire, pertain to the survey-based study was carried out and analyzed to determine and explaining the most influential criteria that have an impact on EMR adoption. Eight Malaysian primary care clinics in various specialties have been chosen to conduct this research. 12 experts with experiencing of EMR system was chosen to fulfill the set of pairwise questionnaire to more validating the findings of this study and the Likert questionnaire survey was emailed in electronic website to 350 physicians who work in office settings in the Malaysia primary care. In overall, 12 experts and 300 physicians fulfilled the questionnaire in this study and the rest did not complete due to their time constrain. The survey contains numbers of questions that were designed to capture information about the constructs in the developed research model. The items that were measured were based on people, organization and implementation dimensions with their relevant sub-factors. F-TOPSIS and F-AHP were used to obtain the ranks and weights of parameters in Meso-level dimension of EMRs adoption. Figure 2, contains a description of each step taken by the present study.

*Table 1. Meso-Level dimension influenced EMRs adoption*

| People | People sub-factors | References |
|---|---|---|
| Individuals-groups | Personal characteristics | [45] |
| | Computer experience | |
| | Personal expectations | [23,28,29,39] |
| | Time investment | |
| | Roles-responsibilities | [23,31,44,5,11] |
| | Task shift | |
| | Champion | |
| | Conflict | |
| | Participation | |
| **Organization** | **Organization Sub-factors** | **References** |
| Strategy | Culture | [4,11,12] |
| | Structure-processes | |
| | Info-infrastructure | [29,32] |
| | Return on value | [32] |
| | Value | |
| | Practice | |
| | Substitution effect | |
| **Implementation** | **Implementation Sub-factors** | **References** |
| Stage | Project | [9,11,38,42,46] |
| | Resource/training | |
| | Planning | |
| | HIS-Practice Fit | |
| | Hybrid system | |
| | Screen/room | |
| | Workflow | |

## 4 DATA COLLECTION

In this study, the primary data was collected through 2 sets of pairwise and Likert questionnaires which delivered to the physicians and experts in using the EMR system. One of the ways in which questionnaire can be administered is the emailed questionnaire; one of the most general approach to collecting information is to send the questionnaire to prospective respondents by email. Obviously, this approach presupposes that should have access to their addresses. In this research, the questionnaires by email applied by researchers as an efficient and effective instrument to collect data from the respondents. For this study, numbers of respondents for first pairwise questionnaire, were 12 (n=12) experts. Numbers of respondents for a second set of Likert questionnaire, were approximately 350 (n=350) physicians. All experts give the feedback in the pairwise questionnaire. But in the second stage of the questionnaire (Likert) almost (85%) of the respondents provided answers to all the questions in the instrument. The first section comprises of information on respondent demographic profile, twelve sections on the independent variable, namely, personal characteristics, personal expectations, roles, responsibilities, strategy, culture, structure-process, info infrastructure, returns on value, stage, project, HIS practice fit. Five options (index) ranked from 1-5 for the raised questions as: 1= very low important 2=low important 3=moderately important 4= high important 5= very high important. Table 2 provides the respondents' demographic profile. About sixty four percent of physicians were male and almost thirty seven percent were female who as medical professionals in primary care office settings were. For the expert respondents, 12 experts in the field of HIS with expertise in one to over ten years of experience in particular with regard to EMRs technology.

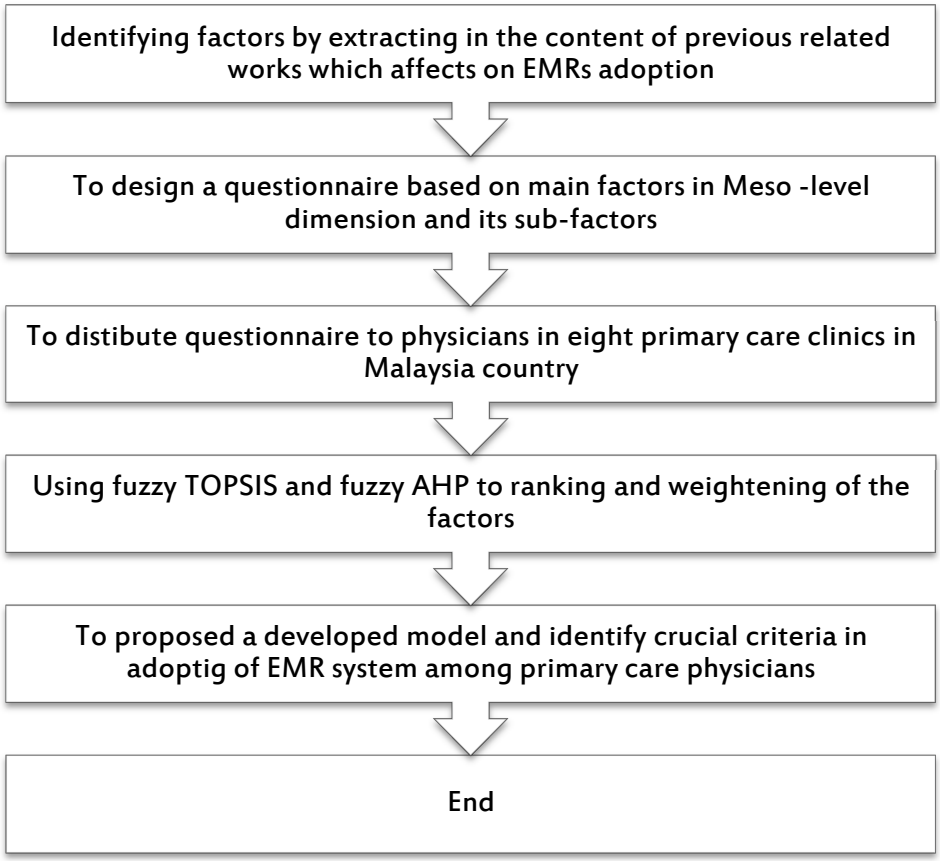


***Fig. 2. Research Methodology***

## 5 BACKGROUND OF FUZZY TOPSIS

TOPSIS, one of the known classical MCDM methods [34], was first developed by Hwang and Yoon [19] that can be used with both normal numbers and fuzzy numbers. In addition, TOPSIS is attractive in that limited subjective input is needed for decision makers. The only subjective input needed is weights. Since the preferred ratings usually refer to the subjective uncertainty, it is natural to extend TOPSIS to consider the situation of fuzzy numbers [3]. F-TOPSIS can be intuitively extended by using the fuzzy arithmetic operations as follows [33,36].

Given a set of alternatives, $A=\{A_i \mid i=1,\cdots,n\}$, and a set of criteria, $C=\{C_j \mid j=1,\cdots,m\}$, where $\tilde{X}=\{\tilde{x}_{ij} \mid i=1,\cdots,n;\ j=1,\cdots m\}$ denotes the set of fuzzy ratings and $\tilde{W}=\{\tilde{w}_j \mid j=1,\cdots,m\}$ is the set of fuzzy weights.

The first step of TOPSIS is to calculate normalized ratings by:

$$\tilde{r}_{ij}(\boldsymbol{x})=\frac{\tilde{x}_{ij}}{\sqrt{\sum_{i=1}^{n}\tilde{x}_{ij}^2}},\quad i=1,\cdots,n;\quad j=1,\cdots,m \tag{1}$$

and then to calculate the weighted normalized ratings by:

$$\tilde{v}_{ij}(\boldsymbol{x})=\tilde{w}_j\tilde{r}_{ij}(\boldsymbol{x}),\quad i=1,\cdots,n;\quad j=1,\cdots,m. \tag{2}$$

***Table 2. The respondents' demographic profile***

| Likert Questionnaire | | | |
|---|---|---|---|
| Aspects | Category | Respondents (n) | Respondents (%) |
| Gender | Male | 190 | 63.33% |
| | Female | 110 | 36.66% |
| Age | 26-33 | 45 | 15% |
| | 34-50 | 90 | 30% |
| | 51-65 | 165 | 55% |
| Medical specialization | Generalist | 178 | 59.33% |
| | Specialist | 122 | 40.66% |
| Pairwise Questionnaire | | | |
| Gender | Male | 3 | 25% |
| | Female | 9 | 75% |
| Age | 30-40 | 4 | 33.33 |
| | 40-45 | 5 | 41.66 |
| | 45-50 | 3 | 25 |
| Years of electronic medical records experience | 1-5 | 4 | 33.33% |
| | 6-10 | 5 | 41.66% |
| | Over 10 | 3 | 25% |

Next the Positive Ideal Point (PIS) and the Negative Ideal Point (NIS) are derived as:

$$PIS = \tilde{\boldsymbol{A}}^{+} = \{\tilde{v}_1^{+}(\boldsymbol{x}), \tilde{v}_2^{+}(\boldsymbol{x}), \cdots, \tilde{v}_j^{+}(\boldsymbol{x}), \cdots, \tilde{v}_m^{+}(\boldsymbol{x})\}$$
$$= \{(\max_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_1), \ (\min_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_2) \mid i = 1, \cdots, n\} \quad (3)$$

$$PIS = \tilde{\boldsymbol{A}}^{-} = \{\tilde{v}_1^{-}(\boldsymbol{x}), \tilde{v}_2^{-}(\boldsymbol{x}), \cdots, \tilde{v}_j^{-}(\boldsymbol{x}), \cdots, \tilde{v}_m^{-}(\boldsymbol{x})\}$$
$$= \{(\min_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_1), \ (\max_i \tilde{v}_{ij}(\boldsymbol{x}) \mid j \in J_2) \mid i = 1, \cdots, n\}. \quad (4)$$

Similar to the crisp situation, the following step is to calculate the separation from the PIS and the NIS between the alternatives. The separation values can also be measured using the Euclidean distance given as:

$$\tilde{S}_i^{+} = \sqrt{\sum_{j=1}^{m} [\tilde{v}_{ij}(\boldsymbol{x}) - \tilde{v}_j^{+}(\boldsymbol{x})]^2}, i = 1, \cdots, n \quad . \quad (5)$$

And

$$\tilde{S}_i^{-} = \sqrt{\sum_{j=1}^{m} [\tilde{v}_{ij}(\boldsymbol{x}) - \tilde{v}_j^{-}(\boldsymbol{x})]^2}, i = 1, \cdots, n. \quad (6)$$

Where

$$\max\{\tilde{v}_{ij}(\boldsymbol{x})\} - \tilde{v}_j^{+}(\boldsymbol{x}) = \min\{\tilde{v}_{ij}(\boldsymbol{x})\} - \tilde{v}_j^{-}(\boldsymbol{x}) = 0. \quad . \quad (7)$$

Then, the defuzzified separation values should be derived using one of defuzzified methods, such as CoA to calculate the similarities to the PIS. Next, the similarities to the PIS is given as:

$$C_i^{*} = D(S_i^{-}) \Big/ [D(S_i^{+}) + D(S_i^{-})] \quad , i = 1, \cdots, n \quad . \quad (8)$$

Where $C_i^{*} \in [0,1] \quad \forall i = 1, \cdots, n$.

Finally, the preferred orders are ranked according to $C_i^*$ in descending order to choose the best alternatives. Fuzzy-TOPSIS method is another type of fuzzification for the TOPSIS method in fuzzy environment that is defined and investigated by credibility measure. In this method, trapezoid-fuzzy numbers are used for ranking all sub-criteria of website quality. Therefore, using fuzzy trapezoid numbers enabled us to change normal TOPSIS into F-TOPSIS which is more precisely as the result shows in the next paragraph. One of the characteristic of fuzzy numbers is fuzzy sets with special consideration for easy calculations. Trapezoid Fuzzy Numbers Let $\tilde{A} = (a, b, c, d)$, a<b<c<d, be a fuzzy set on $R = (-\infty, \infty)$. It is called a trapezoid fuzzy number, if its membership function is:

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-a}{b-a}, \; if \;\; a \le x \le b \\ 1, \qquad if \;\; b \le x \le c \\ \dfrac{d-x}{d-c}, \; if \;\; c \le x \le d \\ 0, \qquad otherwise \end{cases} \tag{9}$$

.

Figure 4 shows the shape of a fuzzy trapezoid number:

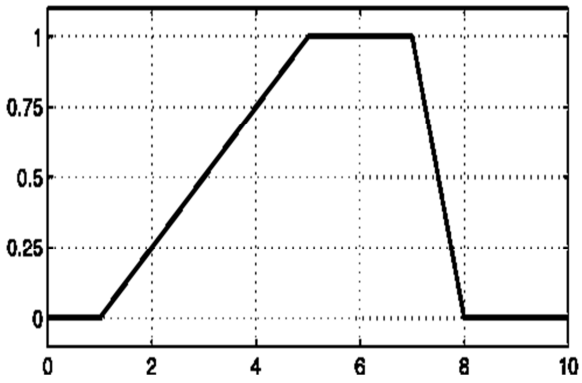


***Fig. 3. Fuzzy trapezoid number***

All process of F-TOPSIS will be calculated upon three of trapezoid numbers that average numbers of experts are shown in Table 3 and Figure 4:

***Table 3. Fuzzy trapezoid number for fuzzy TOPSIS method***

| Linguistic Variable | Range of Fuzzy trapezoid number |
|---|---|
| Non Important | [0.6, 0.8, 1.6, 1.8] |
| Low Important | [1.4, 1.6, 2.5, 2.7] |
| Moderate | [2.3, 2.5, 3.8, 4] |
| Important | [3.6, 3.8, 4.6, 4.8] |
| Very Important | [4.4, 4.6, 5.2, 5.4] |

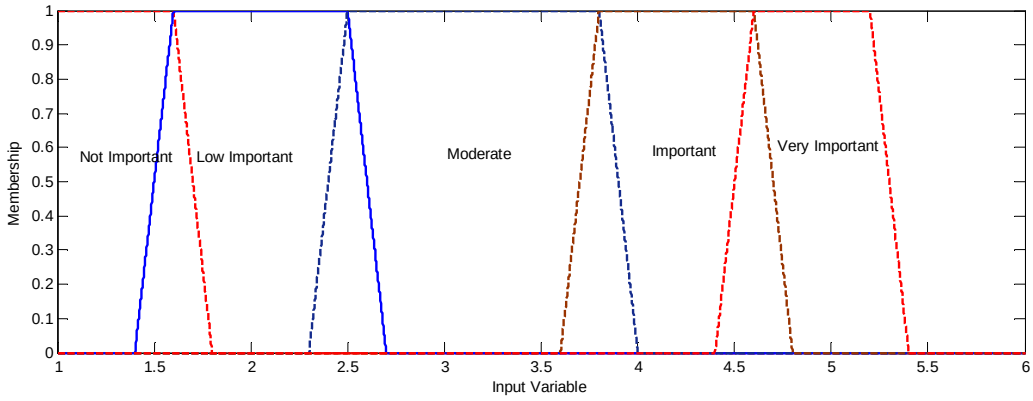


***Fig. 4. Illustrating fuzzy trapezoid number for the fuzzy TOPSIS method***

## 6 FUZZY AHP

The Analytic Hierarchy Process (AHP) method was proposed by [40,41]. Among MCDM techniques, it is a powerful approach to solve complex decision problems [20,35,37]. AHP rank and prioritizes the relative importance of a list of criteria in decision making problems. The elements for ranking can be critical factors and sub-factors which through pairwise comparisons amongst the factors by relevant experts using a nine-point scale are prioritized. Fuzzy Analytic Hierarchy Process (F-AHP) was proposed by Buckley (1985) with incorporating the fuzzy theory into the AHP. Buckley [7], started the F-AHP derives more precisely results rather than AHP for vague and subjective decision making problems. Both quantitative and qualitative can be used in F-AHP. In F-AHP, the uncertain comparison, judgment can be represented by the fuzzy number. There are several types of membership functions for F-AHP where triangular fuzzy number is the special class of the fuzzy number whose membership defined by three real numbers, expressed as (l, m, u). The triangular fuzzy numbers are represented as follows:

$$\mu_{\tilde{A}}(x)=\begin{cases}\dfrac{x-l}{m-l}, if\ \ l\le x\le m\\ \dfrac{u-x}{u-m}, if\ \ m\le x\le u\\ 0, \quad otherwise\end{cases} \tag{11}$$

.

For constructing pairwise comparisons of alternatives under each criterion or about criteria from the experts, similar to the pure AHP, a triangular fuzzy comparison matrix is defined as follows (it can be any type of membership functions):

$$\tilde{A}=(\tilde{a}_{ij})_{n\times n}=\begin{bmatrix}(1,1,1) & (l_{21},m_{12},u_{12}) & (l_{1n},m_{1n},u_{1n})\\ (l_{21},m_{21},u_{21}) & (1,1,1) & (l_{2n},m_{2n},u_{2n})\\ (l_{n1},m_{n1},u_{n1}) & (l_{n2},m_{n2},u_{n2}) & (1,1,1)\end{bmatrix} \tag{12}$$

.

Where $\tilde{a}_{ij}=(l_{ij},m_{ij},u_{ij})=\tilde{a}_{ij}^{-1}=(1/u_{ij},1/m_{ij},1/l_{ij})$

Different methods can be used for total weighs and preferences of alternatives which one of them is Fuzzy Extent Analysis proposed by Chang [10]. The steps of Chang's extensive analysis can be summarized as follows:

First step: In this step we compute the normalized value of row sums (i.e. fuzzy synthetic extent) by fuzzy arithmetic operations presented in Equation 13.

$$\tilde{S}_i = \sum_{j=1}^{n} \tilde{a}_{ij} \otimes \left[ \sum_{k=1}^{n} \sum_{j=1}^{n} \tilde{a}_{kj} \right]^{-1} \quad . \tag{13}$$

In Equation 13, $\otimes$ denotes the extended multiplication of two fuzzy numbers.

**Second step:** In this step, we compute the degree of possibility of $\tilde{S}_i \geq \tilde{S}_j$ by Equation 14:

$$V(\tilde{S}_i \geq \tilde{S}_j) = \sup_{y \geq x} [\min(\tilde{S}_j(x), \tilde{S}_j(y))] \quad . \tag{14}$$

This can be equivalently expressed as,

$$V(\tilde{S}_i \geq \tilde{S}_j) = \begin{cases} 1 & m_i \geq m_j \\ \dfrac{u_i - l_j}{(u_i - m_i) + (m_j + l_j)} & l_j \leq u_i \quad i, j = 1, \ldots, n; j \neq i \\ 0 & otherwise \end{cases} \quad . \tag{15}$$

**Third step:** In this step, using Equation 16, we calculate the degree of possibility of $\tilde{S}_i$ to be greater than all the other (n-1) convex fuzzy numbers $\tilde{S}_j$.

$$V(\tilde{S}_i \geq \tilde{S}_j \mid j = 1, \ldots, n; j \neq i) = \min_{j \in (1, \ldots, n)\, j \neq i} V(\tilde{S}_i \geq \tilde{S}_j),\ i = 1, \ldots, n \quad . \tag{16}$$

**Fourth step:** In this step, using Equation 17, we define the priority vector $W = (w_1, \ldots, w_n)^{\mathrm{T}}$ of the fuzzy comparison matrix $\tilde{A}$ as:

$$w_i = \frac{V(\tilde{S}_i \geq \tilde{S}_j \mid j = 1, \ldots n; j \neq i)}{\sum_{k=1}^{n} V(\tilde{S}_k \geq \tilde{S}_j \mid j = 1, \ldots n; j \neq k)},\ i = 1, \ldots, n \quad . \tag{17}$$

## 7 RANKING PARAMETERS USING FUZZY TOPSIS

For applying F-TOPSIS method after gathering data from the respondents, Table 4 was organized. In Table 4, fuzzy trapezoid numbers have been multiplied to base the fundamental of the F-TOPSIS.

***Table 4. Applying fuzzy number on questionnaire data***

| $R_{ij}$ | Selected Option | Fuzzy Number1 | | | | Selected Option | Fuzzy Number2 | | | | Selected Option | Fuzzy Number3 | | | | Selected Option | Fuzzy Number4 | | | | Selected Option | Fuzzy Number5 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q. No | 1 | 0.6, 0.8, 1.6, 1.8 | | | | 2 | 1.4, 1.6, 2.5, 2.7 | | | | 3 | 2.3, 2.5, 3.8, 4 | | | | 4 | 3.6, 3.8, 4.6, 4.8 | | | | 5 | 4.4, 4.6, 5.2, 5.4 | | | |
| 1 | | 0 | 0 | 0 | 0 | | 28 | 32 | 50 | 54 | | 138 | 150 | 228 | 240 | | 360 | 380 | 460 | 480 | | 528 | 552 | 624 | 648 |
| 2 | | 0.6 | 0.8 | 1.6 | 1.8 | | 14 | 16 | 25 | 27 | | 69 | 75 | 114 | 120 | | 284.4 | 300.2 | 363.4 | 379.2 | | 792 | 828 | 936 | 972 |
| 3 | | 6 | 8 | 16 | 18 | | 28 | 32 | 50 | 54 | | 46 | 50 | 76 | 80 | | 360 | 380 | 460 | 480 | | 660 | 690 | 780 | 810 |
| 4 | | 6 | 8 | 16 | 18 | | 56 | 64 | 100 | 108 | | 115 | 125 | 190 | 200 | | 360 | 380 | 460 | 480 | | 440 | 460 | 520 | 540 |
| 5 | | 36 | 48 | 96 | 108 | | 56 | 64 | 100 | 108 | | 103.5 | 112.5 | 171 | 180 | | 198 | 209 | 253 | 264 | | 440 | 460 | 520 | 540 |
| 6 | | 15 | 20 | 40 | 45 | | 35 | 40 | 62.5 | 67.5 | | 345 | 375 | 570 | 600 | | 360 | 380 | 460 | 480 | | 435.6 | 455.4 | 514.8 | 534.6 |
| 7 | | 1.2 | 1.6 | 3.2 | 3.6 | | 28 | 32 | 50 | 54 | | 184 | 200 | 304 | 320 | | 417.6 | 440.8 | 533.6 | 556.8 | | 360.8 | 377.2 | 426.4 | 442.8 |
| 8 | | 0.6 | 0.8 | 1.6 | 1.8 | | 1.4 | 1.6 | 2.5 | 2.7 | | 110.4 | 120 | 182.4 | 192 | | 540 | 570 | 690 | 720 | | 440 | 460 | 520 | 540 |
| 9 | | 2.4 | 3.2 | 6.4 | 7.2 | | 22.4 | 25.6 | 40 | 43.2 | | 184 | 200 | 304 | 320 | | 288 | 304 | 368 | 384 | | 528 | 552 | 624 | 648 |
| 10 | | 6 | 8 | 16 | 18 | | 28 | 32 | 50 | 54 | | 46 | 50 | 76 | 80 | | 360 | 380 | 460 | 480 | | 660 | 690 | 780 | 810 |
| 11 | | 6 | 8 | 16 | 18 | | 56 | 64 | 100 | 108 | | 115 | 125 | 190 | 200 | | 360 | 380 | 460 | 480 | | 440 | 460 | 520 | 540 |
| 12 | | 3.6 | 4.8 | 9.6 | 10.8 | | 21 | 24 | 37.5 | 40.5 | | 202.4 | 220 | 334.4 | 352 | | 435.6 | 459.8 | 556.6 | 580.8 | | 308 | 322 | 364 | 378 |
| 13 | | 3.6 | 4.8 | 9.6 | 10.8 | | 112 | 128 | 200 | 216 | | 27.6 | 30 | 45.6 | 48 | | 511.2 | 539.6 | 653.2 | 681.6 | | 264 | 276 | 312 | 324 |
| 14 | | 6 | 8 | 16 | 18 | | 30.8 | 35.2 | 55 | 59.4 | | 92 | 100 | 152 | 160 | | 280.8 | 296.4 | 358.8 | 374.4 | | 660 | 690 | 780 | 810 |
| 15 | | 6.6 | 8.8 | 17.6 | 19.8 | | 42 | 48 | 75 | 81 | | 46 | 50 | 76 | 80 | | 320.4 | 338.2 | 409.4 | 427.2 | | 660 | 690 | 780 | 810 |
| 16 | | 20.4 | 27.2 | 54.4 | 61.2 | | 84 | 96 | 150 | 162 | | 207 | 225 | 342 | 360 | | 129.6 | 136.8 | 165.6 | 172.8 | | 352 | 368 | 416 | 432 |

A calculation between two fuzzy trapezoid numbers can be defined as:

$$\begin{matrix} D1 = (a_1, b_1, c_1, d_1) \\ D2 = (a_2, b_2, c_2, d_2) \end{matrix} \Rightarrow D1 + D2 = (a_1 + a_2, b_1 + b_2, c_1 + c_2, d_1 + d_2) \quad . \tag{10}$$

Therefore, Table 5 was calculated from Table 4 by summing of trapezoid numbers. In the next step, each cell of Table 5 will be divided by 300 in order to make the 16 fuzzy numbers for starting F-TOPSIS (see Table 6).

***Table 5. The sum of four trapezoid numbers***

| Sum of Trapezoid Numbers | | | |
|---|---|---|---|
| 1 | 2 | 3 | 4 |
| 1054 | 1114 | 1362 | 1422 |
| 1160 | 1220 | 1440 | 1500 |
| 1100 | 1160 | 1382 | 1442 |
| 977 | 1037 | 1286 | 1346 |
| 833.5 | 893.5 | 1140 | 1200 |
| 1190.6 | 1270.4 | 1647.3 | 1727.1 |
| 991.6 | 1051.6 | 1317.2 | 1377.2 |
| 1092.4 | 1152.4 | 1396.5 | 1456.5 |
| 1024.8 | 1084.8 | 1342.4 | 1402.4 |
| 1100 | 1160 | 1382 | 1442 |
| 977 | 1037 | 1286 | 1346 |
| 970.6 | 1030.6 | 1302.1 | 1362.1 |
| 918.4 | 978.4 | 1220.4 | 1280.4 |
| 1069.6 | 1129.6 | 1361.8 | 1421.8 |
| 1075 | 1135 | 1358 | 1418 |
| 793 | 853 | 1128 | 1188 |

*Table 6. Sixteen fuzzy non trapezoid numbers*

| | $(R_{ij})^2$ | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Q. No | a | L1 | L2 | B | c | d | R1 | R2 |
| 1 | 12.34351 | 0.04 | 1.405333 | 13.78884 | 20.6116 | 22.4676 | 0.04 | -1.896 |
| 2 | 14.95111 | 0.04 | 1.546667 | 16.53778 | 23.04 | 25 | 0.04 | -2 |
| 3 | 13.44444 | 0.04 | 1.466667 | 14.95111 | 21.22138 | 23.10404 | 0.04 | -1.922666667 |
| 4 | 10.60588 | 0.04 | 1.302667 | 11.94854 | 18.37551 | 20.13018 | 0.04 | -1.794666667 |
| 5 | 7.719136 | 0.04 | 1.111333 | 8.870469 | 14.44 | 16 | 0.04 | -1.6 |
| 6 | 15.75032 | 0.070756 | 2.111331 | 17.9324 | 30.15108 | 33.14305 | 0.070756 | -3.062724 |
| 7 | 10.92523 | 0.04 | 1.322133 | 12.28736 | 19.27795 | 21.07422 | 0.04 | -1.836266667 |
| 8 | 13.25931 | 0.04 | 1.456533 | 14.75584 | 21.66903 | 23.57103 | 0.04 | -1.942 |
| 9 | 11.66906 | 0.04 | 1.3664 | 13.07546 | 20.02264 | 21.85251 | 0.04 | -1.869866667 |
| 10 | 13.44444 | 0.04 | 1.466667 | 14.95111 | 21.22138 | 23.10404 | 0.04 | -1.922666667 |
| 11 | 10.60588 | 0.04 | 1.302667 | 11.94854 | 18.37551 | 20.13018 | 0.04 | -1.794666667 |
| 12 | 10.46738 | 0.04 | 1.294133 | 11.80152 | 18.83849 | 20.61463 | 0.04 | -1.816133333 |
| 13 | 9.371762 | 0.04 | 1.224533 | 10.6363 | 16.54862 | 18.21582 | 0.04 | -1.7072 |
| 14 | 12.7116 | 0.04 | 1.426133 | 14.17774 | 20.60555 | 22.46128 | 0.04 | -1.895733333 |
| 15 | 12.84028 | 0.04 | 1.433333 | 14.31361 | 20.49071 | 22.34138 | 0.04 | |
| 16 | 6.987211 | 0.04 | 1.057333 | 8.084544 | 14.1376 | 15.6816 | 0.04 | |
| Sum | 135.7516 | 0.510756 | 16.57253 | 152.8349 | 235.7786 | 258.1897 | 0.510756 | -19.44725733 |
| SQRT | 11.65125 | 0.714672 | 4.070937 | 12.36264 | 15.35508 | 16.06828 | 0.714672 | 0 |
| 1/SQRT | 0.085828 | 1.399243 | 0.245644 | 0.080889 | 0.065125 | 0.062234 | 1.399243 | 0 |

Therefore trapezoid number will be (d, c, b, a) =(0.085828, 0.080889, 0.065125, 0.062234). Afterward, each cell in Table 6 should be multiplied by (0.085828, 0.080889, 0.065125, and 0.062234) that is trapezoid. Table 7 demonstrates result of this multiplication.

*Table 7. The 14 fuzzy trapezoid numbers for fuzzy TOPSIS processes*

| Q.No | $n_{ij}$ | | | | |
|---|---|---|---|---|---|
| | a | b | c | d | Area |
| 1 | 0.768186 | 0.897998 | 1.667252 | 1.928349 | 0.964708 |
| 2 | 0.930467 | 1.077023 | 1.863683 | 2.1457 | 1.000946 |
| 3 | 0.836702 | 0.973691 | 1.716576 | 1.982974 | 0.944579 |
| 4 | 0.660046 | 0.778149 | 1.486377 | 1.727733 | 0.887957 |
| 5 | 0.480393 | 0.577689 | 1.168037 | 1.373248 | 0.741602 |
| 6 | 0.980205 | 1.167848 | 2.438891 | 2.844602 | 1.56772 |
| 7 | 0.679921 | 0.800214 | 1.559374 | 1.808758 | 0.943999 |
| 8 | 0.82518 | 0.960974 | 1.752786 | 2.023054 | 0.994843 |
| 9 | 0.726212 | 0.851539 | 1.619611 | 1.875557 | 0.958709 |
| 10 | 0.836702 | 0.973691 | 1.716576 | 1.982974 | 0.944579 |
| 11 | 0.660046 | 0.778149 | 1.486377 | 1.727733 | 0.887957 |
| 12 | 0.651427 | 0.768574 | 1.523827 | 1.769312 | 0.936569 |
| 13 | 0.583242 | 0.692689 | 1.338602 | 1.563428 | 0.813049 |
| 14 | 0.791094 | 0.923325 | 1.666762 | 1.927807 | 0.940075 |
| 15 | 0.799102 | 0.932174 | 1.657473 | 1.917516 | 0.921857 |
| 16 | 0.434842 | 0.526506 | 1.143576 | 1.34592 | 0.764074 |

In this step, for finding minimum and maximum fuzzy trapezoid number for A+ and A- , was tried to calculate the area under each of the curve. Each curve forms a trapezoid shape. Table 8 shows minimum and maximum trapezoid numbers with their membership functions. Therefore, the maximum and minimum vectors are for question number 6 and 5, respectively.

In Table 9 the square of the distance between the fuzzy number and the Ideal number, $(v_{ij^-} v_{j+})^2$ , has been calculated. In the similar way, the square of distance between minimum point and each point was calculated that has been shown in Table 10. Finally, di+ and di- can be calculated as presented in Table 11.

***Table 8. Maximum and minimum of fuzzy trapezoid numbers for A+ and A-***

| **Max Vi** | | | **No.6** | |
|---|---|---|---|---|
| A+ | 0.980205 | 1.167848 | 2.438891 | 2.844602 |
| **Min Vi** | | | **No.5** | |
| A- | 0.480393 | 0.577689 | 1.168037 | 1.373248 |

***Table 9. The square of distance between maximum point and each point***

| $(v_{ij^-} v_{j+})^2$ | $(v_{ij^-} v_{j+})^2$ | $(v_{ij^-} v_{j+})^2$ | $(v_{ij^-} v_{j+})^2$ |
|---|---|---|---|
| 0.082825 | 0.102598 | 0.249215 | 0.308137 |
| 0.202567 | 0.249334 | 0.483923 | 0.596682 |
| 0.126956 | 0.156817 | 0.300895 | 0.371766 |
| 0.032275 | 0.040184 | 0.10134 | 0.12566 |
| 0 | 0 | 0 | 0 |
| 0.249812 | 0.348287 | 1.615069 | 2.164881 |
| 0.039811 | 0.049517 | 0.153145 | 0.189669 |
| 0.118878 | 0.146907 | 0.341931 | 0.422248 |
| 0.060427 | 0.074994 | 0.203919 | 0.252314 |
| 0.126956 | 0.156817 | 0.300895 | 0.371766 |
| 0.032275 | 0.040184 | 0.10134 | 0.12566 |
| 0.029253 | 0.036437 | 0.126586 | 0.156867 |
| 0.010578 | 0.013225 | 0.029092 | 0.036168 |
| 0.096535 | 0.119464 | 0.248727 | 0.307535 |
| 0.101576 | 0.125659 | 0.239548 | 0.296227 |
| 0.002075 | 0.00262 | 0.000598 | 0.000747 |

***Table 10. The square of distance between minimum point and each point***

| $(v_{ij^-} v_{j-})^2$ | $(v_{ij^-} v_{j-})^2$ | $(v_{ij^-} v_{j-})^2$ | $(v_{ij^-} v_{j-})^2$ |
|---|---|---|---|
| 0.044952 | 0.072819 | 0.595427 | 0.839519 |
| 0.002474 | 0.008249 | 0.330865 | 0.488463 |
| 0.020593 | 0.037697 | 0.521739 | 0.742402 |
| 0.102502 | 0.151865 | 0.907283 | 1.247396 |
| 0.249812 | 0.348287 | 1.615069 | 2.164881 |
| 0 | 0 | 0 | 0 |
| 0.090171 | 0.135154 | 0.773549 | 1.072972 |
| 0.024033 | 0.042797 | 0.47074 | 0.674941 |
| 0.064512 | 0.100051 | 0.671219 | 0.939047 |
| 0.020593 | 0.037697 | 0.521739 | 0.742402 |
| 0.102502 | 0.151865 | 0.907283 | 1.247396 |
| 0.108095 | 0.15942 | 0.837342 | 1.156247 |
| 0.15758 | 0.225776 | 1.210636 | 1.641406 |
| 0.035763 | 0.059791 | 0.596183 | 0.840513 |
| 0.032798 | 0.055542 | 0.610614 | 0.859488 |
| 0.297421 | 0.411319 | 1.67784 | 2.246045 |

***Table 11. The square distance between minimum and maximum for di+ and di-***

| $di+$ | | | | $di-$ | | | |
|---|---|---|---|---|---|---|---|
| 0.082825 | 0.102598 | 0.249215 | 0.308137 | 0.044952 | 0.072819 | 0.595427 | 0.839519 |
| 0.202567 | 0.249334 | 0.483923 | 0.596682 | 0.002474 | 0.008249 | 0.330865 | 0.488463 |
| 0.126956 | 0.156817 | 0.300895 | 0.371766 | 0.020593 | 0.037697 | 0.521739 | 0.742402 |
| 0.032275 | 0.040184 | 0.10134 | 0.12566 | 0.102502 | 0.151865 | 0.907283 | 1.247396 |
| 0 | 0 | 0 | 0 | 0.249812 | 0.348287 | 1.615069 | 2.164881 |
| 0.249812 | 0.348287 | 1.615069 | 2.164881 | 0 | 0 | 0 | 0 |
| 0.039811 | 0.049517 | 0.153145 | 0.189669 | 0.090171 | 0.135154 | 0.773549 | 1.072972 |
| 0.118878 | 0.146907 | 0.341931 | 0.422248 | 0.024033 | 0.042797 | 0.47074 | 0.674941 |
| 0.060427 | 0.074994 | 0.203919 | 0.252314 | 0.064512 | 0.100051 | 0.671219 | 0.939047 |
| 0.126956 | 0.156817 | 0.300895 | 0.371766 | 0.020593 | 0.037697 | 0.521739 | 0.742402 |
| 0.032275 | 0.040184 | 0.10134 | 0.12566 | 0.102502 | 0.151865 | 0.907283 | 1.247396 |
| 0.029253 | 0.036437 | 0.126586 | 0.156867 | 0.108095 | 0.15942 | 0.837342 | 1.156247 |
| 0.010578 | 0.013225 | 0.029092 | 0.036168 | 0.15758 | 0.225776 | 1.210636 | 1.641406 |
| 0.096535 | 0.119464 | 0.248727 | 0.307535 | 0.035763 | 0.059791 | 0.596183 | 0.840513 |
| 0.101576 | 0.125659 | 0.239548 | 0.296227 | 0.032798 | 0.055542 | 0.610614 | 0.859488 |
| 0.002075 | 0.00262 | 0.000598 | 0.000747 | 0.297421 | 0.411319 | 1.67784 | 2.246045 |

As can be seen in Table 12 and Figure 5, first rank goes to the question number 2 with the area under the curve 2.39; the second rank is for question number 15 with the 2.3 area under the curve and so on.

***Table 12. Ranked parameters by fuzzy TOPSIS***

| Parameters ranking by Fuzzy TOPSIS | |
|---|---|
| Area | Question No. |
| 0.178 | 1 |
| 0.2 | 5 |
| 0.34 | 8 |
| 0.4 | 6 |
| 0.45 | 7 |
| 1.09 | 3 |
| 1.24 | 11 |
| 1.28 | 8 |
| 1.3129 | 4 |
| 1.32 | 10 |
| 1.61 | 9 |
| 1.8 | 16 |
| 2.0192 | 12 |
| 2.0643 | 13 |
| 2.1869 | 14 |
| 2.3 | 15 |
| 2.39 | 2 |

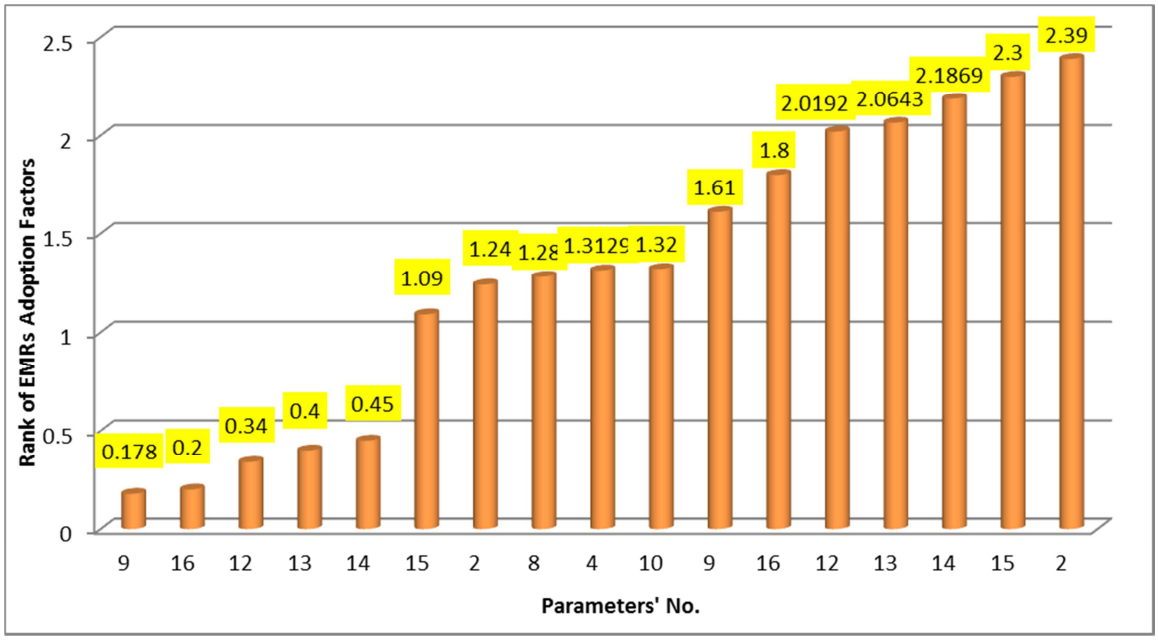


*Fig. 5. Illustrating parameters' rank obtained by fuzzy TOPSIS*

## 8 RESULTS OF FUZZY AHP

After comparing the results of the F-TOPSIS method and ranked the parameters and clarified seven of the most important criteria, it is time to choose them and make a pairwise matrix in order to interview with experts and starting F-AHP. Finally, seven criteria which were the most important ones from F-TOPSIS has obtained, a second questionnaire adjusted just for experts that was a pairwise matrix, then using the matrix data, all analyzed with the F-AHP. At the end weight of eight selected factors was calculated by F-AHP that is shown in Table 13 and Figure 6.

*Table 13. Weights of parameters by fuzzy AHP*

| Parameters ranking by Fuzzy TOPSIS | |
|---|---|
| Parameters | Area |
| 9 | 0.1923 |
| 16 | 0.1945 |
| 12 | 0.2034 |
| 13 | 0.2289 |
| 14 | 0.2193 |
| 15 | 0.3473 |
| 2 | 0.3512 |

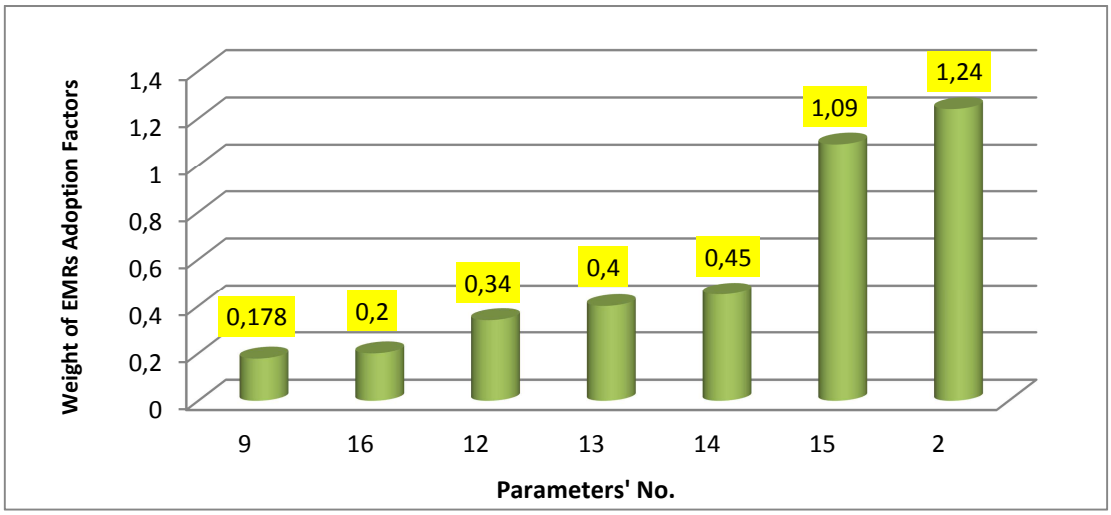


*Fig. 6. Illustrating parameters' weight calculated by fuzzy AHP*

Table 14 shows the most important seven criteria that ranked at first with F-TOPSIS in the left column and in the second time ranked by F-AHP based upon their weight that first rank is Time Investment with the weight 0.3512, the second rank for Screen/Room with approximately weight of 0.3473, Hybrid System with the weight of 0.2193, planning with the weight of 0.2289, resource training with the weight of 0.2034, workflow with weight almost 0.1945 and lastly value with weight of 0.1923.

*Table 14. Parameters ranked by fuzzy AHP and fuzzy TOPSIS*

| Parameters | Rank by TOPSIS | Rank by AHP |
|---|---|---|
| 9 | 7 | 7 |
| 16 | 6 | 6 |
| 12 | 5 | 4 |
| 13 | 4 | 5 |
| 14 | 3 | 3 |
| 15 | 2 | 2 |
| 2 | 1 | 1 |

## 9 CONCLUSION

The present study provided contextual analyses pertain to the Meso-level dimension framework which would contribute in fostering the EMRs adoption within the physician's practices in Malaysian primary care. Thus, it is hoped that this study can add some more knowledge concerning the behavioral science research with regard to the adoption of such a new technology in the healthcare environment. In this study, the criteria in Meso-level dimension based on study of Lau et al. [27] have been examined and focused in purpose of identifying the most influential factors related to primary care physicians EMR adoption. Moreover, the findings of the present study were used to address the adoption of EMRs technology within the physician community in primary care setting. Furthermore, the findings indicated that Physicians tended a positive perception towards some features related to technological adoption success and more importantly emphasized the positive impact of EMR on their HIS practices. In the study at hand, the F-TOPSIS and F-AHP method was applied as a new contribution which is based on MCDM to rank and weighting the critical factors in the adoption of technology innovation. Consequently, this would help IS researchers to apply the aforementioned methods as a new trend with the aim of increasing the prediction power in adopting new technologies. At the end, the physician EMRs adoption model in Meso-level dimension has been developed and the seven most influential factors found out in making sense of EMRs adoption among physicians. Future study can gain more validation through testing of the proposed framework in the current study with regard to developing countries to more fostering the adoption trend of EMR adoption in individual level into the healthcare industry.

## REFERENCES


[1] Ahmadi H, Rad MS, Nilashi M, Ibrahim O, Almaee A: Ranking The Micro Level Critical Factors Of Electronic Medical Records Adoption Using Topsis Method. Health Informatics, 4 (2), 2013.

[2] Ahmadi, H., Rad, M. S., Nazari, M., Nilashi, M., & Ibrahim, O. (2014). Evaluating the Factors Affecting the Implementation of Hospital Information System (HIS) Using AHP Method. Life Science Journal, 11(3).

[3] Bagherifard, K. B., Tafreshi, F. S., Nilashi, M., & Jalalyazdi, M. (2014). Assessing the Critical Factors for E-Learning Systems Using Fuzzy TOPSIS and Fuzzy Logic. International Journal Of Computers & Technology, 12(6), 3546-3561.

[4] Baron, R. J. (2007). "Quality improvement with an electronic health record: achievable, but not automatic." Annals of Internal Medicine 147(8): 549-552.

[5] Bassa, A., et al. (2005). "Impact of a clinical decision support system on the management of patients with hypercholesterolemia in the primary healthcare setting." Disease Management & Health Outcomes 13(1): 65-72.

[6] Boonstra, A. and M. Broekhuis (2010). "Barriers to the acceptance of electronic medical records by physicians from systematic review to taxonomy and interventions." BMC health services research 10(1): 231.

[7] Buckley, J.J., 1985. Fuzzy hierarchical analysis. Fuzzy Sets and Systems 17, 233±247.

[8] Burt, C. W. and E. Hing (2005). "Use of computerized clinical support systems in medical settings: United States, 2001-03." Advance data(353): 1-8.

[9] Cauldwell, M. R., et al. (2007). "The impact of electronic patient records on workflow in general practice." Health informatics journal 13(2): 155-160.

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

[11] Crosson, J. C., et al. (2005). "Implementing an electronic medical record in a family medicine practice: communication, decision making, and conflict." The Annals of Family Medicine 3(4): 307-311.

[12] Crosson, J. C., et al. (2007). "Electronic medical records and diabetes quality of care: results from a sample of family medicine practices." The Annals of Family Medicine 5(3): 209-215.

[13] DeLone, W. H. and E. R. McLean (1992). "Information systems success: the quest for the dependent variable." Information Systems Research 3(1): 60-95.

[14] Endsley, S., et al. (2006). "What family physicians need to know about pay for performance." Family practice management 13(7): 69.

[15] Hennington, A. H. and B. D. Janz (2007). "Information Systems and healthcare XVI: physician adoption of electronic medical records: applying the UTAUT model in a healthcare context." Communications of the Association for Information Systems 19(5): 60-80.

[16] Hsiao, S.-J., Y.-C. Li, et al. (2009). "Critical factors for the adoption of mobile nursing information systems in Taiwan: the nursing department administrators' perspective." Journal of medical systems 33(5): 369-377.

[17] Hu, P. J., et al. (1999). "Examining the technology acceptance model using physician acceptance of telemedicine technology." Journal of management information systems 16(2): 91-112.

[18] Hung, S.-Y., C. C. Chen, et al. (2009). "Moving hospitals toward e-learning adoption: an empirical investigation." Journal of Organizational Change Management 22(3): 239-256.

[19] Hwang, C.L. and K. Yoon, 1981. Multiple Attributes Decision Making Methods and Applications. Springer, Berlin Heidelberg.

[20] Ibrahim, O., Nilashi, M., Bagherifard, K., Hashem, N., Janahmadi, N., & Barisami, M. (2011). Application of AHP and K-Means Clustering for Ranking and Classifying Customer Trust in M-commerce. Australian Journal of Basic & Applied Sciences, 5(12).

[21] Kalogriopoulos, N. A., J. Baran, et al. (2009). Electronic medical record systems for developing countries: review. Engineering in Medicine and Biology Society, 2009. EMBC 2009. Annual International Conference of the IEEE, IEEE.

[22] Kazley, A. S. and Y. A. Ozcan (2007). "Organizational and environmental determinants of hospital EMR adoption: a national study." Journal of medical systems 31(5): 375-384.

[23] Keshavjee, K., et al. (2001). Measuring the success of electronic medical record implementation using electronic and survey data. Proceedings of the AMIA Symposium, American Medical Informatics Association.

[24] Kumar, R. (2005). Research methodology: a step-by-step guide for beginners (2ed.). London: SAGE Publications.

[25] Lau, F., et al. (2006). "A proposed benefits evaluation framework for health information systems in Canada." Healthcare quarterly (Toronto, Ont.) 10(1): 112-116, 118.

[26] Lau, F., et al. (2011). "From benefits evaluation to clinical adoption: making sense of health information system success in Canada." Healthc Q 14(1): 39-45.

[27] Lau, F., Price, M., Boyd, J., Partridge, C., Bell, H., & Raworth, R. (2012). Impact of electronic medical record on physician practice in office settings: a systematic review. BMC medical informatics and decision makin. 12(1), 10.
[28] Ludwick, D. A. and J. Doucette (2009). "Adopting electronic medical records in primary care: lessons learned from health information systems implementation experience in seven countries." International Journal of Medical Informatics 78(1): 22-31.
[29] Ludwick, D. and J. Doucette (2009). "Primary care physicians' experience with electronic medical records: barriers to implementation in a fee-for-service environment." International Journal of Telemedicine and Applications 2009: 2.
[30] Marques, A., T. Oliveira, et al. (2011). "Medical Records System Adoption in European Hospitals." Electronic Journal of Information Systems Evaluation 14(1).
[31] Miller, R. H., et al. (2005). "The value of electronic health records in solo or small group practices." Health Affairs 24(5): 1127-1137.
[32] Mitchell, E., et al. (2003). "Consultation computer use to improve management of chronic disease in general practice: a before and after study." Informatics in primary care 11(2): 61-68.
[33] Nilashi, M., & Ibrahim, O. B. (2014). A Model for Detecting Customer Level Intentions to Purchase in B2C Websites Using TOPSIS and Fuzzy Logic Rule-Based System. Arabian Journal for Science and Engineering, 39(3): 907-1922.
[34] Nilashi, M., Bagherifard, K., Ibrahim, O., Janahmadi, N., & Alizadeh, H. (2012a). A multi-criteria approach to the evaluation of Malaysian government portal. Journal of Theoretical and Applied Information Technology, 40(2), 194-201.
[35] Nilashi, M., Bagherifard, K., Ibrahim, O., Janahmadi, N., & Barisami, M. (2011b). An Application Expert System for Evaluating Effective Factors on Trust in B2C Websites. Engineering, 3(11).
[36] Nilashi, M., Bagherifard, K., Ibrahim, O., Janahmadi, N., & Ebrahimi, L. (2012b) Ranking Parameters on Quality of Online Shopping Websites Using Multi-Criteria Method. Research Journal of Applied Sciences, 4(21): 4380-4396.
[37] Nilashi, M., Ibrahim, O., Barisami, M., Janahmadi, N., & Ithnin, N. (2011a). Developing a Framework for Exploring Factors Affecting on Trust in M-Commerce using Analytic Hierarchy Process. Computer Engineering and Intelligent Systems, 2(8), 59-70.
[38] Randeree, E. (2007). "Exploring physician adoption of EMRs: a multi-case analysis." Journal of medical systems 31(6): 489-496.
[39] Robinson, A. (2003). "Information technology creeps into rural general practice." Australian Health Review 26(1): 131-137.
[40] Saaty, T.L., 1980. The analytic hierarchy process, McGraw- Hill, New York.
[41] Saaty, T.L., 1994. Homogeneity and clustering in AHP ensures the validity of the scale. European Journal of Operational Research 72, 598±601.
[42] Samoutis, G., et al. (2008). "Implementation of an electronic medical record system in previously computer-naïve primary care centres: a pilot study from Cyprus." Informatics in primary care 15(4): 207-216.
[43] Skinner, R. I. (2003). "The value of information technology in healthcare." Frontiers of health services management 19(3): 3.
[44] Tamblyn, R., et al. (2003). "The medical office of the 21st century (MOXXI): effectiveness of computerized decision-making support in reducing inappropriate prescribing in primary care." Canadian Medical Association Journal 169(6): 549-556.
[45] van Wijk, M. A., et al. (2001). "Assessment of Decision Support for Blood Test Ordering in Primary CareA Randomized Trial." Annals of Internal Medicine 134(4): 274-281.
[46] Wager, K. A., et al. (2000). "Impact of an electronic medical record system on community-based primary care practices." The Journal of the American Board of Family Practice 13(5): 338-348.
[47] Yang, Z., A. Kankanhalli, et al. (2013). "Analyzing the enabling factors for the organizational decision to adopt healthcare information systems." Decision Support Systems 55(3): 764-776.