Original Paper

Ranking the Meso Level Critical Factors of Electronic Medical Records Adoption Using Fuzzy Topsis Method

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ABSTRACT. As Electronic Medical Records (EMRs) have a great possibility for rising physician's performance in their daily work which improves quality, safety and efficiency in healthcare, they are implemented throughout the world (Boonstra and Broekhuis, 2010). In physician practices the rate of EMRs adoption has been slow and restricted (around 25%) according to Endsley, Baker, Kershner, and Curtin (2005) in spite of the cost savings through lower administrative costs and medical errors related with EMRs systems. The core objective of this research is to identify, categorize, and analyse meso-level factors introduced by Lau et al, 2012, perceived by physicians to the adoption of EMRs in order to give more knowledge in primary care setting. Finding was extracted through questionnaire which distributed to 350 physicians in primary cares in Malaysia to assess their perception towards EMRs adoption. The findings showed that Physicians had positive perception towards some features related to technology adoption success and emphasized EMRs had helpful impact in their office. The fuzzy TOPSIS physician EMRs adoption model in meso-level developed and its factors and sub-factors discussed in this study which provide making sense of EMRs adoption. The related factors based on meso-level perspective prioritized and ranked by using the fuzzy TOPSIS. The purpose of ranking using these approaches is to inspect which factors are more imperative in EMRs adoption among primary care physicians. The result of performing fuzzy TOPSIS is as a novelty method to identify the critical factors which assist healthcare organizations to inspire their users in accepting of new technology.

KEYWORDS: *EMRs, Adoption, Fuzzy TOPSIS, Meso-Level Adoption Factors, CA*

Introduction

As Electronic Medical Records (EMRs) have a great possibility for rising physician's performance in their daily work which improves quality, safety and efficiency in healthcare, they are implemented throughout the world [1]. In physician practices the rate of EMRs adoption has been slow and restricted (around 25%) according to Endsley, Baker, Kershner, and Curtin [2] in spite of the cost savings through lower administrative costs and medical errors related with EMRs systems [3].

These days, there is a vast investment of Information Technology (IT) by healthcare providers that looked at development and implementation of clinical information systems for instance Electronic Medical Records (EMRs) [4]. IT is utilized by physicians' offices for billing purposes, but unfortunately the number incorporating IT into their practices for clinical purposes such as EMRs are low [4]. "It is estimated that the healthcare industry is at least ten years behind other industries in terms of IT investment" [5]. Despite ITs' increasing ubiquity, decreasing costs, and the potential for benefits in the clinical decision-making process, the low rate of adoption occurs. The reason is, due to the distinctive structure of the healthcare industry. Healthcare organizations are dissimilar from organizations operating within other business contexts, specially, about individual autonomy and operational independence [6]. EMRs adoption has been attracted by little interest in the management information systems (MIS) Literature [7]. In this research, An EMR explained as computerized health information system 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. Primary care is becoming a core part of healthcare community. "The term "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 person 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" [8,9].

In this research, the meso-level factors has been investigated that have more effect on EMRs adoption which has been developed by [10] in his study review of Clinical Adoption (CA) framework according to three dimensions.

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Thus, the purpose of this study is to develop and validate the Meso-level physician EMRs adoption model in the context of primary care units. In addition, this study provides contextual analyses of the factors contributing to the EMRs adoption.

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

Proposed Research Model

The adoption model of physician in primary care provides a conceptual model to identify the factors that have more influence on adoption of EMRs. It extends Clinical Adoption framework by Lau et al [10] in his study review which was based on three dimensions. In his review, DeLone and McLean [11] information system success model was followed. Lau's CA framework comprised of micro, meso and macro-level dimensions. Each dimension has its own factors and sub-factors which could influence physicians in EMRs adoption. In this research it has been concentrated on meso-level factors. At the meso-level, the adoption framework of primary care physician explains clinical information system success include EMRs system. In this study, EMRs adoption has been examined in practice of physician in primary care setting through the lens of clinical adoption framework. EMRs adoption defined based on evaluation measures, related to the factors that rendered to this impact. Hence, this study concentrated on meso-level factors that influence on EMR adoption. At the end the proposed model of fuzzy topsis physician adoption model in meso-level developed and shown in Fig.1. At meso-level, there are three main factors including people, organization and implementation. The following has described each of the main factors in detail and its sub factors respectively.

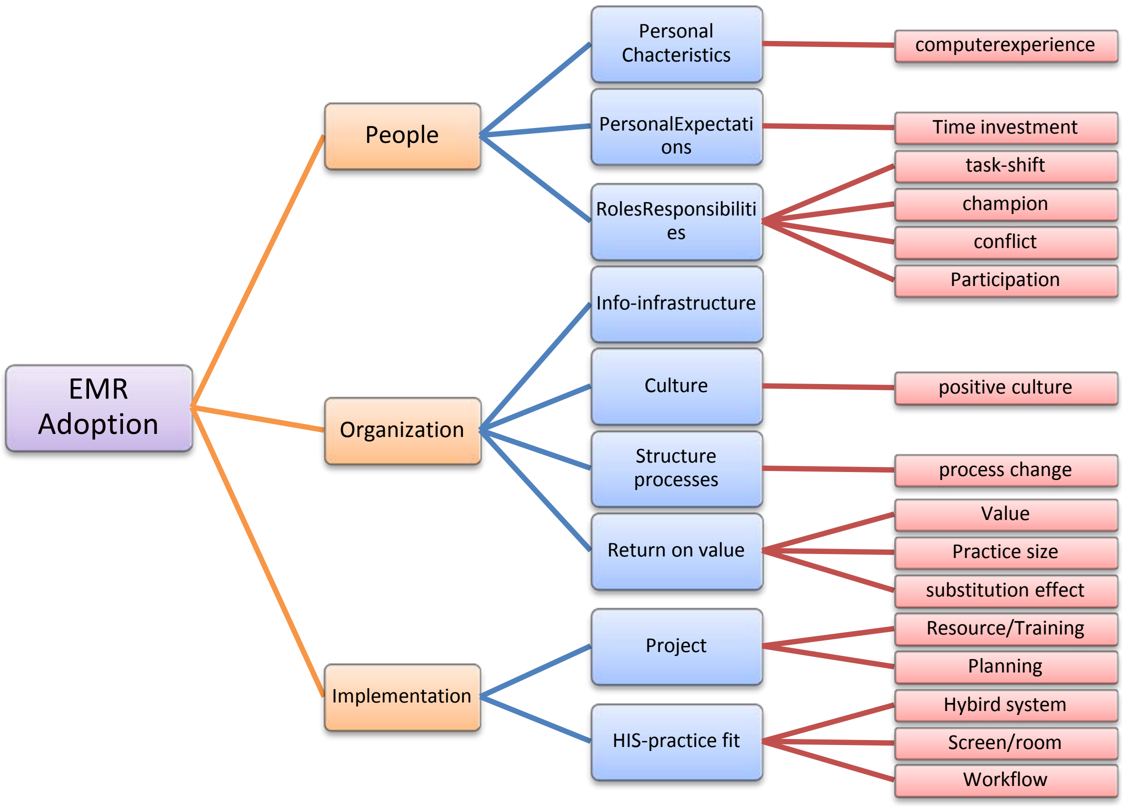

Fig.1. Fuzzy TOPSIS Physician EMRs Adoption Model in Meso-Level

People are the integral part of the system success that may adopt or refuse the new technology based on their characteristics, expectations and responsibilities. People factors covers personal characteristics and expectations like prior EMRs experience of the users [12], and their personal time investment in exchange for the benefits expected from the system [8,9]. Roles/responsibilities included the need for champions and staff participation [13], and shift in tasks (documentation by staff vs. physicians) [5,6]. That could lead to role ambiguity and conflict [14]. Organization factors covered structure/processes and culture that emphasized EMRs adoption/use [14], EMRs-practice fit (hybrid EMRs/paper systems), and EMRs-supported office and workflow design [14] such as the placement of computer screens in consult rooms. Return-on value concentrated on verified value at the practice level such as replacement effect from guideline driven test orders and prescribing, and tangible cost-efficiency gain with larger practice size and patient volume [15]. Implementation factors covered the area that the introduction of EMRs into the practice was designed and conducted as a priority project with devoted time and resources [16]. The service support provided during implementation was essential [17], since they influenced the disruptions that physicians and office staff had to defeat while learning to use the EMRs and redesign their work routines.

Table 1. Meso-Level factors influenced EMRs adoption

People	**People sub-factors**	**References**
Individuals-Groups	Personal characteristics Computer experience	Van Wijk, M. A., et al (2001) [12]
	Personal expectations Time investment	Keshavjee, K., et al. (2001) [18], Ludwick and Doucette (2009) [9], Robinson, A. (2003) [19]
	Roles-responsibilities Task shift Champion Conflict Participation	Keshavjee, K., et al. (2001) [18], Tamblyn,R., et al. (2003) [20], Miller, R. H., et al (2005) [21], Crosson, J. C., et al. (2005) [14], Bassa, A., et al. (2005) [13].
Organization	**Organization Sub-factors**	**References**
Strategy	Culture Structure-processes	Crosson, J. C., et al. (2005) [14], Baron, R. J. (2007) [22],
	Info-infrastructure	Ludwick and Doucette (2009) [8]
	Return on value Value Practice Substitution effect	Mitchell, E., et al. (2003) [15].
Implementation	**Implementation Sub-factors**	**References**
Stage	Project Resource/Training Planning HIS-Practice Fit Hybrid system Screen/room Workflow	Samoutis, G., et al. (2008) [16], Randeree, E. (2007) [17], Wager, K. A., et al. (2000) [23], Cauldwell, M. R., et al. (2007) [24], Crosson, J. C., et al. (2007) [25].

Research Methodology

EMRs in this study have been focused as a new technology in primary care which has been tried to describe the factors which have the more priority in its adoption. A quantitative, survey-based research study was carried out and analyzed to describing the factors that have an impact on EMRs adoption. Eight Malaysia primary care clinics in different specialty have been chosen to conduct this research. Survey was emailed in electronic website to 350 physicians who work in offices in the context of primary care. 300 physicians fulfilled the questionnaire in this study and the rest did not complete. The survey contains number of questions that were design to capture information about the constructs in the research model. The questions that measured were people, organization and implementation besides their sub-factors. Fuzzy TOPSIS was used to obtain the ranks of parameters in meso-level EMRs adoption. Fig.2 contains a description of each step in this study.

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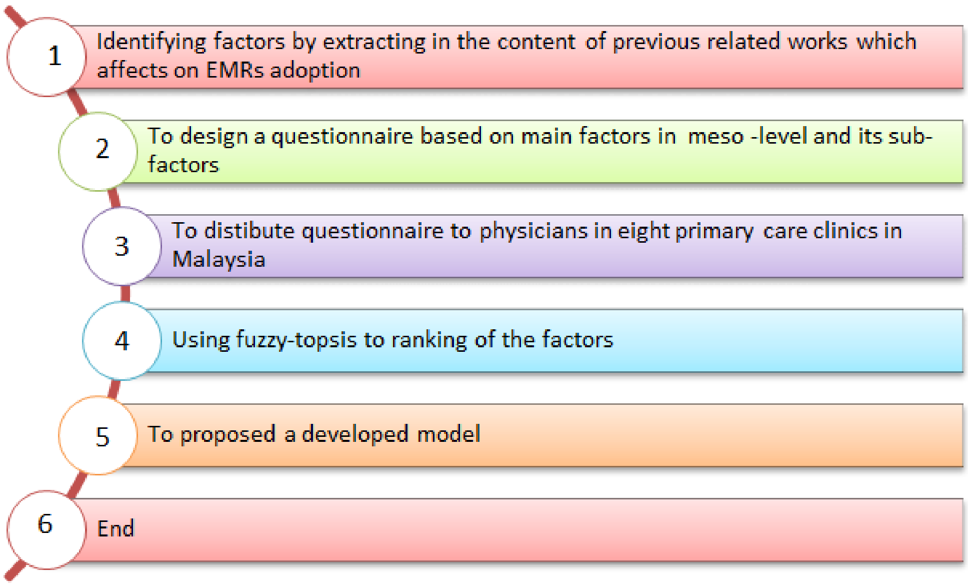

Fig.2. Research Methodology

Data Collection

In this study, the primary data were collected through questionnaire which delivered to the physicians through their email. 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. Kumar [26], in his study justified using of the questionnaire through email based on the criteria of the geographical distribution of the study population in which he said "if potential respondents are scattered over a wide geographical area, you have no choice but to use a questionnaire". Accrodingly, in this research, the questionnaire by email has been used by researcher as an efficient and effective instrument to collect data from the respondents.

For this study, a number of respondents, were approximately 350 (n=350) physicians. Seventy eight (85.71%) 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, individual groups, personal characteristics, personal expectations, roles responsibilities, strategy, culture, structure-process, info infrastructure, return on value, stage, project, HIS practice fit. Five options (index) ranked by 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 five percent of physicians were male and thirty four percent were female, generalist physicians in one to over ten years of experience with EMRs technology.

Table 2. The* r*espondents'* d*emographic* p*rofile

Aspects	Category	Respondents (n)	Respondents (%)
Gender	Male	190	63.33%
	Female	110	36.66%
Age	26-33 34-50 51-65	45 90 165	15% 30% 55%
Years of electronic medical records experience	1-5	128	42.66%
	6-10	116	38.66%
	Over 10	56	18.66%
Medical specialization	Generalist	178	59.33%
	Specialist	122	40.66%

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Background of Fuzzy Topsis

TOPSIS, one of the known classical MCDM methods, was first developed by Hwang and Yoon [27] that can be used with both normal numbers and fuzzy numbers.

In addition, TOPSIS is attractive in that limited subjective input is needed from 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. Fuzzy TOPSIS can be intuitively extended by using the fuzzy arithmetic operations as follows [28].

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

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

Next the positive ideal point (PIS) and the negative ideal point (NIS) are derived as

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

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

.

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:

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

And

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

Where

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

.

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

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

.

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

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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 fuzzy 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

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

.

Fig.3 shows the shape of a fuzzy trapezoid number:

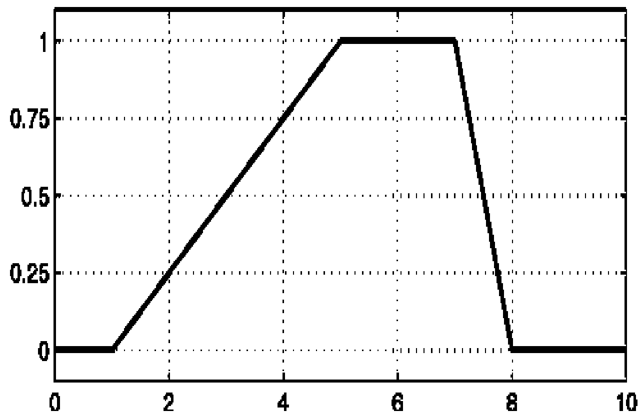

Fig.3. Fuzzy trapezoid number

All process of fuzzy TOPSIS will be calculated upon three of trapezoid numbers that average numbers of experts are shown in Table 3 and Fig.4:

Table 3. Fuzzy trapezoid numbers 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]

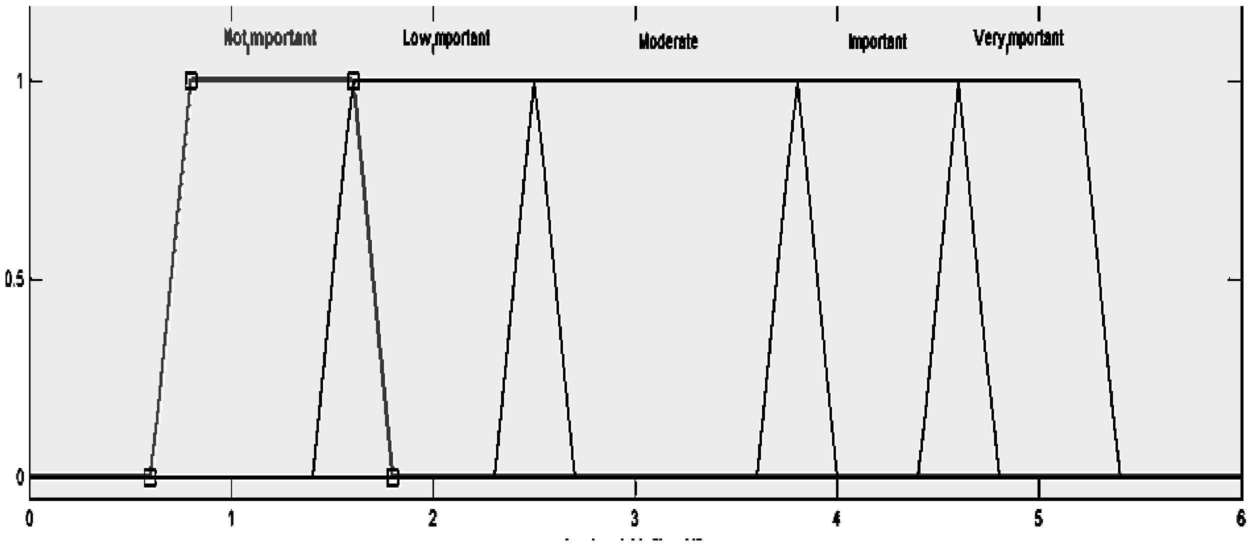

Fig.4. Fuzzy trapezoid numbers for fuzzy TOPSIS method

Ranking Parameters Using Fuzzy Topsis

For applying fuzzy 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 fuzzy 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:

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

Therefore, Table 5 was calculated from Table 4 by summing of four trapezoid numbers.

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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

In the next step, each cell of Table 5 will be divided by 300 in order to make the 16 fuzzy numbers for starting fuzzy TOPSIS.

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 (0.085828,0.080889,0.065125,0.062234) 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.

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

In Table 9 the square of distance between the fuzzy number and the Ideal number, $(v_{ij^-}v_{j+})^2$, has been calculated .

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

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In the similar way, the square of distance between minimum point and each point was calculated that has been shown in Table 10.

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

Therefore, di+ and di- can be as in Table 11:

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, 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.
0.2	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

Conclusion

The present study provides contextual analyses of the meso-level factors contributing to the EMRs adoption. In addition to add knowledge concerning technology adoption within a physician practices through primary care. In this study, meso-level factors have been focused which influenced on EMRs adoption based on Lau et al.[29]. The findings of the present study were used to address the adoption of EMRs technology within the physician community in primary care setting. The findings indicated that Physicians had positive perception towards some features related to technology adoption success and emphasized EMRs had positive impact in their office. The fuzzy TOPSIS physician EMRs adoption model in meso-level has been developed and its factors and sub-factors discussed in this study which provide making sense of EMRs adoption.

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