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Evaluating Success Factors on E-banking Implementation: a Fuzzy MCDM Application

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ABSTRACT

The study proposed a Fuzzy Multiple Criteria Decision Making (FMCDM) approach for success factors on e-banking implementation. This research conducted a performance analysis in five banks at Iran. We present a fuzzy analytic hierarchy process method and utilize crisp judgment matrix to evaluate subjective expert judgments. The Fuzzy Analytic Hierarchy Process (FAHP) method is used to determine the weightings for evaluation criteria. Alternatives selection process is dealt with by using fuzzy numbers for linguistic terms. Additionally, in the application, it is shown that calculation of the criteria weights is important in MCDM method and they could change the ranking. Our proposed framework with FMCDM shows to be a feasible and effective assessment model for e-banking performance evaluation and it can be applied to other institutions as well. We have divided these factors into three categories: technical, strategic and operational. This categorization will help to explain our findings in terms of the nature of success factors in e-banking for Iranian banks.

Key words: E-Banking, MCDM, criteria, success factors, decision making

INTRODUCTION

Generally, when the information technologies combine with functions of banks and financial institutions, it is called electronic banking. Electronic banking technologies have led banks and financial institutions to improve effectiveness of distribution channels through reducing the transaction cost and increasing the speed of service (Ahangar, 2011). The area of e-banking has appeared in information system literature since the mid-1990s (Buhl and Will, 1998; Devlin, 1995; King and Liou, 2004; Liao and Cheung, 2002; Scruggs and Nam, 2002; Yan and Paradi, 1998; Yousafzai *et al.*, 2003). These researchers covered many aspects of e-banking. The importance of e-banking as a financial services delivery channel is growing because of its wider reach and low cost per transaction. The Internet as a channel for services delivery is fundamentally different from other channels, such as branch networks or telephone banking, because of its interactive nature. Therefore, it brings up unique types of challenges and requires novel solutions (King and Liou, 2004; Southard and Siau, 2004; Yousafzai *et al.*, 2003; Haque *et al.*, 2009). Understanding in e-banking is important for banking related because it would help them improve their e-banking adoption process. Whilst there are many examples of empirical work on technical and consumer related issues, limited empirical research related to the success factors in e-banking has been done so far. Some researchers in the field of e-banking have been engaged in quantifying the current provision of electronic services by the banks from an innovation and marketing point of view (Daniel, 1999). Liao and Cheung (2002), Sathye (1999) and Yan and Paradi (1998) have explored the perception of customers about e-banking. King and Liou (2004) and Harden (2002) compared the e-channel with other channels. Tseng (2010) used an Implementation and performance evaluation using the fuzzy network balanced scorecard. Secme *et al*. (2009) proposed a fuzzy multi-criteria decision model to evaluate the performances of Turkish banks by using FAHP.

LITERATURE REVIEW

Strategic factors

Organization flexibility: In terms of re-engineering business processes, pre-plan for potential change to make sure that processes do not inhibit or restrict intervention (Fitzgerald and Siddiqui, 2002).

Established brand name: Having an established brand name was also cited by many informants including their Head of e-Commerce as a critical success factor. The main reason for this given by most informants was that, a household name such as the banks gives customers' added confidence to conduct business online. This view is well supported by the literature reviewed earlier (Yousafzai *et al*., 2003; Yousafzai *et al*., 2005). Other reasons may include their previous positive experiences with the company and the non-substantial nature of the online medium which makes trust in a well-known name even more important than, when more traditional channels are used.

Support from the top management: Support from the top management is widely considered to be a key success factor in technological projects (Turban *et al*., 2000).

Having multiple channels: This factor is also related to the non-substantial nature of the online medium. Customers can use the most desirable channel suitable for the task in hand. For example, a customer may use the internet for checking account balances or transferring money between accounts, but may ring in, to settle a dispute or go to a branch for a face-to-face discussion on complex matters.

Mixed strategy selection of vendors: In information technology projects, choice of vendors is generally an important issue. Some companies go for a single vendor solution to ensure easy integration, whereas others chose best of breed products to find products which meet their requirements better. Therefore, banks used suitable IT products as their first choice. Another reason for this could be easier integration of different components from the same vendor.

Availability of resources: Availability of human and financial resources is critical in all types of projects. In new technology projects such as Internet banking, shortage of readily skilled human resources can be a severe handicap.

Technical factors

Systems and channels integration: Instant delivery requires extensive integration of business processes and information systems. This middleware layer which provided common interface to all existing systems enabled them to add new systems quickly as the interface had to be implemented just once to the middleware rather than to the whole range of different systems. This made the channels interchangeable and allowed the bank to add new channels or services without disrupting core services. The middleware allowed access to all services through all channels. The downside is that if the middleware goes down, it can have quite a big of effect on all channels (Ward, 2001; Shah and Siddiqui, 2006; Amiri *et al.*, 2009c).

Security: Including protection of consumers' personal data and a safe transaction to prevent misuse is paramount for the growth of any sort of online trade, including e-banking. This factor has been cited as very critical by Enos (2001). Security mentioned as a very critical factor by a number of authors (Enos, 2001; Regan and Macaluso, 2000; Shah and Siddiqui, 2006; Turban *et al.*, 2000). Lack of it, or consumers' fears about it, is one of the biggest obstacles in the growth of e-commerce. According to Liu and Arnett (2000) the need for secure transactions are critical to the success of not only internet banking but that of any e-commerce related website (Sudha *et al.*, 2007).

Operational factors

e-channel specific marketing: e-channels have opened up a whole new way of communicating with customers and have a dedicated area within their marketing function that deals with the e-channels. This means that e-commerce has changed the way the marketing department works in order to cope with new ways of marketing.

Rapid delivery of services: E-commerce has raised people's expectations regarding the time it takes to deliver services. Whereas, in the past, people were ready to accept a couple of days delay in funds transfer, now it has come down to real-time. As, they known people move money between their accounts and walk straight to the branch to draw it out. People want other services such as loan or mortgage approval quickly too (Shah and Siddiqui, 2006).

Fast responsive customer service: To meet expectations and requirements, customer support has improved considerably, with all-time availability of customer services and increased choice available for customers to use whichever channel they wish (Mohammaditabar and Teimoury, 2008).

24 h availability of services: This is usually a higher expectation of customer service from the e-channels. Also, to support 24 h e-channels, customer service has to be available 24 h a day, every day of the year too.

RESEARCH METHOD

Building a hierarchical system for multiple criteria decision making: The purpose of this section is to establish a hierarchical structure for tackling the evaluation problem of alternative. The contents include three subsections:

- Building hierarchical structure of evaluation criteria
- Determining the evaluation criteria weights
- Getting the performance value

The criteria to be used in the model were determined by the expert team, Pairwise comparison matrices used to calculate criteria weights were also formed by the same team. Expert team includes a professor of financial management from Tehran University, two managers of bank and two E-business analysts. The five experts responded to the open-ended questions almost similarly. Table 1 presented Demography data of the expert team.

Deal with the problems of success factors assessment is shown in Fig. 1. The key dimensions of the criteria for evaluation and success factors alternatives were derived through comprehensive investigation and consultation with five experts. These individuals were asked to rate the accuracy, adequacy and relevance of the criteria and dimensions and to verify their content validity in terms of building success factors assessment. We selected three dimensions including strategic factors, operational factors and technical factors. From these, 14 evaluation criteria for the hierarchical structure were used in this study.

Table 1: Demography data of the expert team (n = 5)

Variables	Mean
Age (in year)	49.46
Year in experiences	17.14
Education	
Bachelor's	0 (0%)
Master's	3 (60%)
PhDs	2 (40%)
Position	
Professor of assistance	1(20%)
Managers of bank	2 (40%)
Analyst	2 (40%)

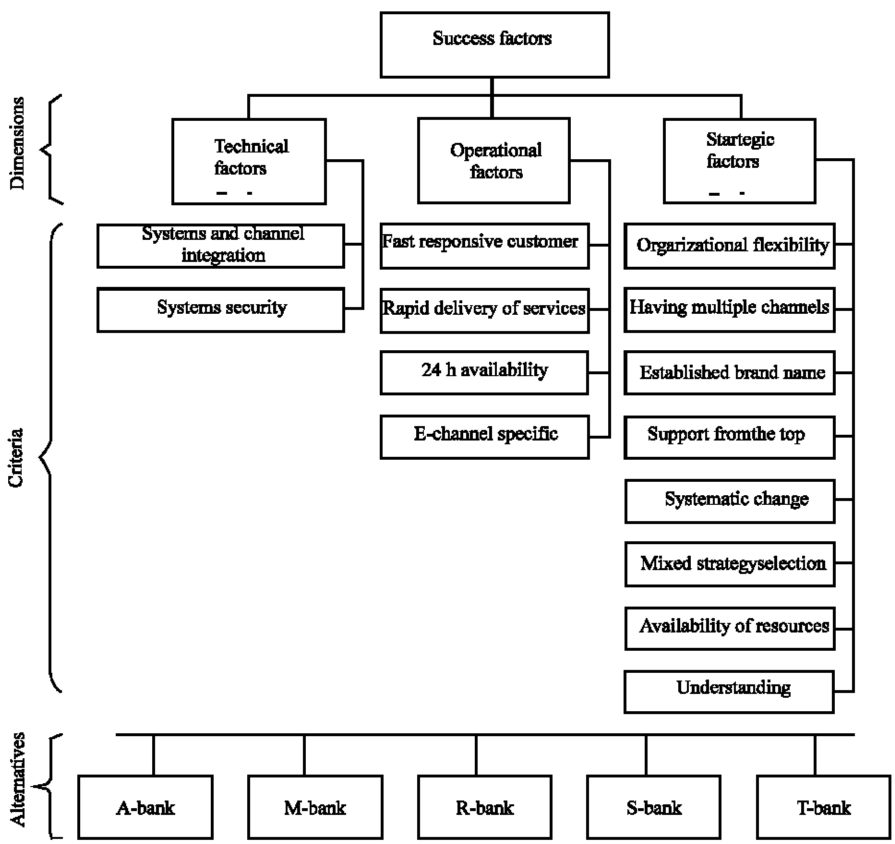

Fig. 1: Success factors dimensions and criteria

The linguistic variable and weights: This study used this kind of expression to compare project selection evaluation criteria by five basic linguistic terms, as (1) absolutely important, (2) very strongly important, (3) essentially important, (4) weakly important and (5) equally important with respect to a fuzzy five level scale (Enos, 2001; Amiri *et al*., 2009a), as shown in Fig. 2.

In this study, the computational technique is based on the following fuzzy numbers defined by Mon *et al*. (1994) in Table 2. This Table 2 has synthesized the linguistic scales defined by Chiou and Tzeng (2001) and fuzzy number scale used in Mon *et al*. (1994). Here each membership function scale of fuzzy number is defined by three parameters of the symmetric triangular fuzzy number, the left point, middle point and right point of the range over which the function is defined (Fitzgerald and Siddiqui, 2002; Harden, 2002; Amiri *et al*., 2009b). Triangular fuzzy number, as shown in Fig. 3.

We used Buckley's method. That expanded Saaty's AHP to the case, where the evaluators are allowed to employ fuzzy ratios in place of exact ratios to handle the difficulty for people to assign exact ratios when comparing two criteria and derive the fuzzy weights of criteria by geometric mean method (Devlin, 1995; Amiri *et al*., 2009a).

FAHP

Step 1: Construct pairwise comparison matrices among all the elements/criteria in the dimensions of the hierarchy system. Assign linguistic terms to the pairwise comparisons by asking which is the more important of each two elements/criteria, such as:

$$\tilde{A} = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ \tilde{a}_{n1} & \tilde{a}_{n2} & \cdots & 1 \end{bmatrix} \Rightarrow = \begin{bmatrix} 1 & \tilde{a}_{12} & \cdots & \tilde{a}_{1n} \\ \tilde{a}_{21} & 1 & \cdots & \tilde{a}_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ 1/\tilde{a}_{n1} & 1/\tilde{a}_{n2} & \cdots & 1 \end{bmatrix} \quad (1)$$

Table 2: Membership function of linguistic scale

Fuzzy number	Linguistic scales	Scale of fuzzy number
$\tilde{1}$	Equally important (Eq)	(1, 1, 3)
$\tilde{3}$	Weakly important (Wk)	(1, 3, 5)
$\tilde{5}$	Essentially important (Es)	(3, 5, 7)
$\tilde{7}$	Very strongly important (Vs)	(5, 7, 9)
$\tilde{9}$	Absolutely important (Ab)	(7, 9, 9)

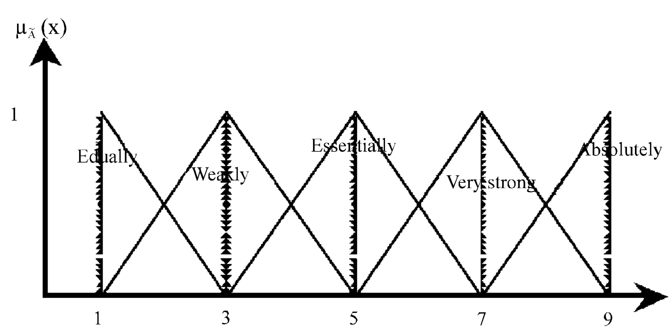

Fig. 2: Memberships function of linguistics variables for comparing two criteria

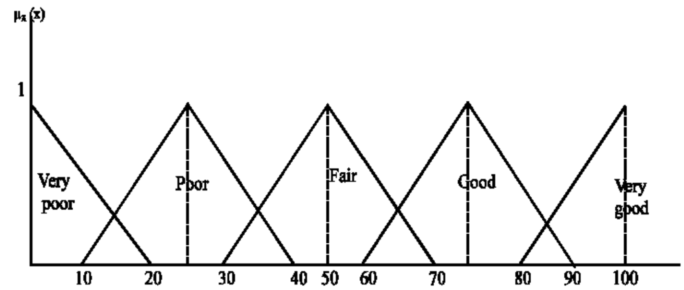

Fig. 3: Membership functions of linguistic variables for measuring the performance value of alternatives

$$\tilde{a}_{ij} = \begin{cases} \tilde{1}, \tilde{3}, \tilde{5}, \tilde{7}, \tilde{9}, & \text{criterion i is relative important to criterion j,} \\ 1, \quad i = j & \\ \tilde{1}^{-1}, \tilde{3}^{-1}, \tilde{5}^{-1}, \tilde{7}^{-1}, \tilde{9}^{-1}, & \text{criterion i is relative less important to criterion j} \end{cases}$$

Step 2: To use geometric mean technique to define the fuzzy geometric mean and fuzzy weights of each criterion by Buckley (1985) as follows:

$$\tilde{r}_i = \left(\tilde{a}_{i1} \otimes \tilde{a}_{i2} \otimes \ldots \otimes \tilde{a}_{in}\right)^{1/n}, \qquad \tilde{w}_i = \tilde{r}_i \otimes \left(\tilde{r}_1 + \ldots + \tilde{r}_n\right)^{-1} \tag{2}$$

Fuzzy MCDM: Bellman and Zadeh (1970) were the first to probe into the problem under a fuzzy environment and they heralded the initiation of FMCDM (King and Liou, 2004; Lan *et al.*, 2007).

Step by step

Step 1: Alternatives measurement: the evaluators are asked for conduct their subjective judgments and each linguistic variable can be indicated by a triangular fuzzy number the scale range 0-100, as shown in Fig. 3. This study uses the notion of average value to integrate the fuzzy judgment values of m evaluators, the LE_{ij}, ME_{ij} and UE_{ij} can be solved by the method put forward by Buckley (1985), that is:

$$\tilde{E}_{ij} = (1/m) \otimes \left(\tilde{E}_{ij}^{1} + \tilde{E}_{ij}^{2} + \ldots + \tilde{E}_{ij}^{m}\right) \tag{3}$$

$$LE_{ij} = \left(\sum_{k=1}^{m} LE_{ij}^{k}\right)/m; \quad ,ME_{ij} = \left(\sum_{k=1}^{m} ME_{ij}^{k}\right)/m; \quad UE_{ij} = \left(\sum_{k=1}^{m} UE_{ij}^{k}\right)/m \tag{4}$$

Step 2: Fuzzy synthetic decision: According to the each criterion weight $\tilde{w}_j$ derived by FAHP, the criteria weight vector $\tilde{w} = (\tilde{w}_1, \ldots\ldots, \tilde{w}_j, \ldots\ldots \tilde{w}_n)^t$ can be obtained, whereas the fuzzy performance matrix $\tilde{E}$ of each of the alternatives can also be obtained from the fuzzy performance value of each alternative under n criteria, that is, $\tilde{E} = (\tilde{E}_{ij})$. From the criteria weight vector $\tilde{W}$ and fuzzy performance matrix $\tilde{E}$, the final fuzzy synthetic decision can be conducted and the derived result will be the fuzzy synthetic decision matrix $\tilde{R}$, LR_i, MR_i, UR_i are the lower, middle and upper synthetic performance values of the alternative i that is:

$$\tilde{R} = \tilde{E} \circ \tilde{W} \tag{5}$$

$$LR_i = \sum_{j=1}^{n} LE_{ij} \times Lw_j;\ MR_i = \sum_{j=1}^{n} ME_{ij} \times Mw_j;\ UR_i = \sum_{j=1}^{n} UE_{ij} \times Uw_j \tag{6}$$

Step 3: Ranking the fuzzy number: We used the "center of area" method to find out the Best Nonfuzzy Performance (BNP) value. The value of the derived BNP for each of the alternatives, the ranking of each of the alternatives can then proceed:

$$BNP = \left[(UR_i - LR_i) + (MR_i - LR_i)\right]/3 + LR_i \qquad \forall_i \tag{7}$$

ANALYSIS OF RESULTS

The pairwise comparison matrices of dimensions will be obtained as follows. According to the interviews with five experts' representatives about the importance of evaluation dimensions:

$$\begin{array}{c}\\ D1\\ D2\\ D3\end{array}\!\!\begin{array}{c}D1\quad D2\quad D3\\ \begin{bmatrix}\tilde{1} & \tilde{3} & \tilde{5}\\ \tilde{3}^{-1} & \tilde{1} & \tilde{3}\\ \tilde{5}^{-1} & \tilde{3}^{-1} & \tilde{1}\end{bmatrix}\\ \text{Expert 1}\end{array}
\begin{array}{c}\\ D1\\ D2\\ D3\end{array}\!\!\begin{array}{c}D1\quad D2\quad D3\\ \begin{bmatrix}\tilde{1} & \tilde{5}^{-1} & \tilde{7}\\ \tilde{5} & \tilde{1} & \tilde{5}^{-1}\\ \tilde{7}^{-1} & \tilde{5} & \tilde{1}\end{bmatrix}\\ \text{Expert 2}\end{array}
\begin{array}{c}\\ D1\\ D2\\ D3\end{array}\!\!\begin{array}{c}D1\quad D2\quad D3\\ \begin{bmatrix}\tilde{1} & 3 & \tilde{5}\\ \tilde{3}^{-1} & \tilde{1} & \tilde{1}\\ \tilde{5}^{-1} & \tilde{1}^{-1} & \tilde{1}\end{bmatrix}\\ \text{Expert 3}\end{array}
\begin{array}{c}\\ D1\\ D2\\ D3\end{array}\!\!\begin{array}{c}D1\quad D2\quad D3\\ \begin{bmatrix}\tilde{1} & \tilde{7} & \tilde{3}\\ \tilde{7}^{-1} & \tilde{1} & \tilde{3}\\ \tilde{3}^{-1} & \tilde{3}^{-1} & \tilde{1}\end{bmatrix}\\ \text{Expert 4}\end{array}
\begin{array}{c}\\ D1\\ D2\\ D3\end{array}\!\!\begin{array}{c}D1\quad D2\quad D3\\ \begin{bmatrix}\tilde{1} & \tilde{5} & \tilde{7}^{-1}\\ \tilde{5}^{-1} & \tilde{1} & \tilde{5}\\ \tilde{7} & \tilde{5}^{-1} & \tilde{1}\end{bmatrix}\\ \text{Expert 5}\end{array}$$

Computing the elements of synthetic pairwise comparison matrix by using the geometric mean method suggested by Buckley (1985):

$$\tilde{a}_{ij} = (\tilde{a}_{ij}^{1} \otimes \tilde{a}_{ij}^{2} \otimes \tilde{a}_{ij}^{3} \otimes \tilde{a}_{ij}^{4} \otimes \tilde{a}_{ij}^{5})^{1/5}$$

$$\text{For } \tilde{a}_{12}: (1, 3, 5) \times (1/7, 1/5, 1/3) \times (5, 7, 9) \times (1, 3, 5) \times (3, 5, 7) = (0, 1.165, 2.290, 3.5)$$

The synthetic pairwise comparison matrices of the five representatives will be constructed as follows:

$$\begin{array}{c|ccc|} & D1 & D2 & D3\\ D1 & \tilde{1} & (1.165, 2.290, 3.50) & (0.801, 1.160, 2.290)\\ D2 & (0.284, 0.433, 0.857) & \tilde{1} & (0.841, 1.552, 2.804)\\ D3 & (0.315, 0.441, 0.723) & (0.442, 0.642, 1.473) & \tilde{1} \end{array}$$

To use Eq. 2 to obtain the fuzzy weights of dimensions for experts and for the weight of each dimension is shown in Table 3 and BNPs in value as shown in Table 4.

This study employed the method of average value to integrate the fuzzy/vague judgment values of different evaluators regarding the same evaluation criteria. The evaluators can define their own individual range for the linguistic variables employed and in this paper according to their subjective judgments within a scale of 0-100 (Table 5) reveals a degree of variation in their definitions of the linguistic variables.

The experts assigned their subjective judgments for alternatives by expressions (VG), (G), (F), (P) and (VP) corresponding to the linguistic variable of Table 4, it can obtain the fuzzy performance matrix to employ Eq. 3 and 4 to obtain the fuzzy performance value of alternatives

Table 3: The weights and BNPs

No.	1	2	3
r_i	(0.977, 1.385, 2.001)	(0.620, 0.876, 1.339)	(0.518, 0.656, 1.021)
$\tilde{W}_i$	(0.224, 0.475, 0.946)	(0.142, 0.300, 0.633)	(0.119, 0.225, 0.483)
BNP	1.030	0.686	0.518

Table 4: (Local and Overall) and BNPs of dimensions and criteria

Dimension and criteria	Overall weights	Local weights	BNP
Strategic factors	-	(0.224, 0.475, 0.946)	1.030
Organizational flexibility	(0.008, 0.027, 0.355)	(0.121, 0.243, 0.754)	0.130
Having multiple channels	(0.004, 0.041, 0.435)	(0.128, 0.454, 0.938)	0.160
Established brand name	(0.005, 0.029, 0.196)	(0.044, 0.135, 0.321)	0.077
Support from the top management	(0.005, 0.019, 0.155)	(0.041, 0.057, 0.152)	0.083
Systematic change management	(0.003, 0.015, 0.109)	(0.191, 0.220, 0.224)	0.042
Mixed strategy selection of vendors	(0.014, 0.041, 0.12)	(0.132, 0.362, 0.952)	0.058
Availability of resources	(0.004, 0.032, 0.165)	(0.092, 0.287, 0.512)	0.163
Understanding customers	(0.002, 0.021, 0.345)	(0.071, 0.211, 0.612)	0.123
Operational factors	-	(0.142, 0.300, 0.633)	0.686
Fast responsive customer service	(0.004, 0.042, 0.155)	(0.071, 0.148, 0.332)	0.067
Rapid delivery of services	(0.003, 0.011, 0.048)	(0.151, 0.335, 1.02)	0.021
24 h availability of services	(0.002, 0.026, 0.044)	(0.096, 0.01, 0.084)	0.024
E-channel specific marketing	(0.011, 0.053, 0.212)	(0.212, 555, 1.055)	0.092
Technical factors	-	(0.119, 0.225, 0.483)	0.518
Systems and channels integration	(0.02, 0.104, 0.564)	(0.235, 0.789, 1.103)	0.229
Systems security	(0.023, 0.049, 0.206)	(0.125, 0.237, 0.398)	0.093

Table 5: The subjective cognition results of evaluators towards the 5 levels of linguistic variables

	Linguistic variables				
Evaluator	Very good	Good	Fair	Poor	Very poor
1	(85,100, 100	(70, 80, 90)	(35, 45, 70)	(20, 30, 40)	(0, 0, 20)
2	(90, 100, 100)	(75, 80, 90)	(45, 60, 75)	(15, 30, 45)	(0, 0, 15)
3	(90, 100, 100)	(80, 85, 90)	(60, 70, 80)	(40, 50, 60)	(0, 0, 40)
4	(88, 100, 100)	(60, 78, 90)	(38, 48, 65)	(15, 27, 48)	(0, 0, 18)
5	(85, 100, 100)	(65, 75, 85)	(30, 50, 70)	(15, 30, 50)	(0, 0, 20)

under criteria that is below (Table 6). From the criteria weights of decision-making group and average obtained by FAHP (Table 4) and the average fuzzy performance values of each criterion of experts for each alternative (Table 6), For example:

A1 under C1: (GFFGVG) = [(70, 80, 90), (45, 60, 75), (60, 70, 80), (60, 78, 90), (85, 100, 100)] =

$$E_{11} = LE_{11} = \left(\sum_{k=1}^{5} LE_{11}^{k}\right)/5;\ ME_{11} = \left(\sum_{k=1}^{5} ME_{11}^{k}\right)/5;\ UE_{ij} = \left(\sum_{k=1}^{5} UE_{11}^{k}\right)/5; = (64, 77.6, 87)$$

After the fuzzy synthetic decision is processed, the nonfuzzy ranking method is then employed and finally the fuzzy numbers are changed into nonfuzzy values. Though, there are methods to rank these fuzzy numbers, this study has employed center of area to determine the Best Nonfuzzy

Table 6: Average fuzzy performance values

	A1	A2	A3	A4	A5
C1	(64, 77.6, 87)	(70.0, 81.6, 90.0)	(37, 51.6, 65)	(55.6, 66.6, 79)	(46.0, 60.6, 77.0)
C2	(63, 72.6, 85)	(28, 38.4, 56.6)	(69.0, 80.60, 89)	(28.0, 41.4, 56.6)	(62, 75.6, 86)
C3	(69.0, 80.60, 89)	(59.0, 73.6, 85.0)	(37, 51.6, 65)	(49.0, 60.6, 76.0)	(17.6, 27.6, 48)
C4	(62.6, 80.6, 89)	(53.6, 64.6, 79.0)	(56.6, 67.6, 80)	(69.0, 82.60, 90.0)	(62, 75.6, 86)
C5	(36.6, 47.6, 64.0)	(22.0, 30.0, 44.6)	(49.6, 61.60, 72.0)	(59.0, 71.6, 84.0)	(57.0, 70.6, 83.0)
C6	(35.6, 45.6, 60.0)	(44.6, 55.6, 71.0)	(53.0, 67.6, 81.0)	(36.6, 47.6, 64.0)	(53.0, 67.6, 81.0)
C7	(49.6, 59.6, 71.0)	(66, 76.6, 87)	(57.0, 70.6, 83.0)	(20.6, 31.6.52.0)	(44.6, 55.6, 71.0)
C8	(47, 61.6, 75)	(21, 31.40, 48.6	(59.0, 71.6, 84.0)	(20.6, 31.6, 52.0)	(55.6, 66.6, 79)
C9	(61.6, 72.6, 83.0)	(22, 31.4, 46.6)	(47, 60.6, 73)	(48.6, 58.6, 71.0)	(45.6, 56.6, 69)
C10	(28.0, 41.4, 56.6)	(64, 77.6, 87)	(64.6, 76.6, 85.0)	(39.0, 50.4, 67.6)	(40.0, 53.4, 68.6)
C11	(70.6, 82.0, 90.0)	(30.6, 41.6, 58)	(30.6, 41.6, 58)	(56.0, 67.60, 82.0)	(62, 75.6, 86)
C12	(43.0, 57.6, 71.0)	(55.6, 63.6, 74.0)	(37.0, 50.4, 68.6)	(55.6, 66.6, 79)	(55.6, 63.6, 74.0)
C13	(37.0, 46.0, 59.6)	(79.6, 88.0,93.0	(62.0, 75.6, 86.0)	(64, 77.6, 87)	(33.0, 46.6, 63.0
C14	(37, 51.6, 65)	(40, 53.60, 67)	(37, 51.6, 65)	(64, 77.6, 87)	(43, 57.6, 71)

Table 7: Ranking by various criteria weightings

	Expert DM	
Alternative	BNP_i	Ranking
A Bank	89.349	2
M Bank	87.650	5
R Bank	94.922	1
S Bank	87.653	4
T Bank	88.344	3

performance value, which is used to rank the evaluation results of each alternative. Finally, details of the results are presented in Table 7. For A1:

$$= ((64\times 0.0080,....,37\times .0.023),(77.6\times 0.027,....,51.6\times 0.049),$$
$$(87.0\times 0.355,...,65\times 0.206)) = (4.858,30.727,232.463)$$

BNP value (Eq. 7) for A1:

$$= (232.463-4.858)+(30.727-4.858)/3+4.858 = 89.349$$

or:

$$= (4.858+30.727+232.463)/3 = 89.349$$

DISCUSSION

The study proposed a Fuzzy Multiple Criteria Decision Making (FMCDM) approach for success factors in e-banking. According to the results of case simulation, the ranking order of weights of criteria, "R. bank" is the best banks considering the weights of this group. The results in Table 7 reflect the common perception that changes in criteria weights may affect the evaluation outcome to a certain degree. Banks also develop new technology to attract new customers. As shown in Table 7, it is evident that "M. Bank" and "S. Bank" have the poorest performance value in the e-banking dimension while this is the most important success factor according to the experts. As far as the evaluation indexes within the e-banking dimension are concerned, S and M Banks has the lowest performance value in the "fast responsive customer service" index. Therefore, in addition to retaining its existing customers, "M. Bank" should also develop new service items and/or provide more and improved e-banking to attract new customers in order to keep up with the other banks.

CONCLUSION

Technological developments particularly in the area of telecommunications and information technology are revolutionizing the banking institutions. In response to the rapid growth of service industries and the increased global competition, particularly for the banking institutions, the need for alternative controls and performance measures has attracted much attention. To deal with the qualitative attributes in subjective judgment, this work employs Fuzzy Analytic Hierarchy Process (FAHP) to determine the weights of decision criteria for expert's representatives. Then the Fuzzy multiple criteria decision making approach is used to synthesize the group decision. This process enables decision makers to formalize and effectively solve the complicated, multicriteria and fuzzy/vague perception problem of most appropriate alternative selection. In the application, it is shown that calculation of the criteria weights is important in FMCDM method and they could change the ranking for the other banks.

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