Optimization
Iranian Journal of Optimization
Volume 8, Issue 1, 2016, 47-58
Research Paper
Online version is available on: www.ijo.iaurasht.ac.ir
Islamic Azad University
Rasht Branch
E-ISSN:2008-5427

An Analysis of Factors Affecting on Customers' Adoption of Internet-banking Services Using the Graph Theory

Ali Sharifi [1] and Mahdi Homayounfar [1*]

[1] Department of Management, Rasht branch, Islamic Azad University, Rasht, Iran

Received: 23 February 2016
Accepted: 26 April 2016

Abstract

The rapid development of Internet and electronic businesses have stimulated the banking sector towards encouraging customers to internet banking (IB), However, the evidence indicates a lack of interest in the use of IB services. Therefore, this paper aims to identify affecting factors on customer adoption from IB and measure the influence of each factor on IB adoption. Based on an explorative literature review, numbers of factors were considered as affecting factors on customer adoption of IB. Then, these factors were sent to a sample of IB customers in form of a questionnaire. Having collected the filled questionnaires and based on a statistical test, the more important factors explored among all. Hence, many of these factors have relationship with each others; a graph theory based technique (DEMATEL) with feedback structure is used to explore the direct and indirect effects of factors on the other factors and the whole system. The results indicate that: responsiveness (effective handling of problems), accessibility to IB services (hardware necessities), speed of network, ease of use and no need to physical attendance in bank branch, respectively, are the most critical factors.

Keywords:
Internet Banking (IB)
Adoption
DEMATEL
Multiple Criteria Decision Making (MCDM)

***Correspondence E-mail**: homayounfar@iaurasht.ac.ir

INTRODUCTION

Trade between people and countries started to change dimensions as well together with the technological developments occurred. Important developments in this respect gained speed with the electronic commerce. Developments at the electronic commerce had also resulted in changes in the banking sector (Kose, 2009). The increased availability of electronically mediated self-service technologies in the banking industry has changed the way banks service their customers. In the 21st century, Internet banking (IB) has experienced exponential growth in many countries around the world and drastically changed traditional banking practice. By offering IB services, traditional banks seek to lower operating costs, improve customer experience, retain/expand customer base, reduce their branch networks, and downsize the number of their service staff. Banking customers today can access, through a variety of different channels, sets of powerful tools which allow them to conduct analyses, make decisions and enact financial transactions, working from their home, office or elsewhere. Following practice, research into the adoption and use of electronic banking channels has grown substantially over the last three decades (Hoehle et al., 2012).

The first self-service technologies in the finance sector emerged in the 1970s (Railton, 1985) when banks installed the first automated teller machines (ATMs) (Dabholkar, 1996). This was followed by telephone banking services in the 1980s (Ahmad and Buttle, 2002), and in the 1990s, with the emergence of the Internet, banks further extended their existing distribution channels by offering web-based banking applications (Tan and Thompson, 2000; Suh and Han, 2002). Over the past decade, the proliferation of mobile technologies such as mobile phones, PDAs, and smart phones have encouraged banks to provide mobile banking applications (Scornavacca et al, 2006; Laukkanen and Lauronen, 2005; Barnes and Corbitt, 2003).

This study aims to investigate the consumer adoption and use of electronic banking channels and their associated transaction- and decision-assistance tools: ATMs, touch-dial telephone banking, Internet banking, and mobile banking in Rasht city, Guilan province, Iran. In light of this study, adoption is understood as the initial use of e-banking whereas use behavior refers to the repeated usage of electronic banking technologies.

A short definition of each electronic banking channel is presented below (Hoehle, et al, 2012): ATM banking includes computerized telecommunication devices that allow customers of financial institutions to directly use a secure method to access cash as well as their bank accounts (Dabholkar, 1996). Telephone banking services are computer-based keypad response or voice recognition technologies allowing customers to perform banking activities over the telephone (Ahmad and Buttle, 2002). Internet banking is a banking channel that allows consumers to perform a wide range of financial and non-financial services through a bank's website (Tan and Thompson, 2000; Bhattacherjee, 2001). Mobile banking is defined as a channel through which customers interact with a bank through non-voice applications such as text- or WAP-based banking services using a mobile device, such as a mobile phone or personal digital assistant (PDA) (Hoehle and Lehmann, 2008).

The paper is organized as follows: firstly it briefly reviews some researches on IB. Third section deals with the technique used for identifying direct and indirect influences of affecting factors explored from literature. Then, the research framework, utilized in the study, is outlined prior to a discussion of the results obtained. The results of research were determined based on the real word data, in section 5. The paper concludes by analyzing the research implications of the findings.

Literature Review

Adoption is the acceptance and continued use of a product, service or idea. According to Rogers and Shoemaker (1971), consumers go through "a process of knowledge, persuasion, decision and confirmation" before they are ready to adopt a product or service.

Some of the major psychological and behavioral factors which affect the adoption of any innovation such as Internet banking include consumer awareness, ease of use, security, accessibility, and technology phobia, in addition to reluctance to change, preference for personalized services and cost of adopting the innovation (Srivastava, 2008).

Four widely used models or theories reviewed and discussed in relation to Internet banking.

They are:

• Technology Acceptance Model (TAM) proposed by Davis (1989) to address why users adopt or decline information technology;

• Theory of Planned Behavior (TPB) developed by Ajzen (1991) by adding a perceived behavioral control construct to TRA;

• Diffusion of Innovation (DOI) proposed by Rogers (2003) which identifies factors that are important in the decision to adopt an innovation and

• Theory of Reasoned Action (TRA) proposed by Azjen (2005) to explain and predict the determinants of intended behavior of individuals;

Hoehle et al. (2012) in their study reviewed 247 peer-reviewed articles from key research outlets on 'consumer adoption and utilization of e-banking channels'. Using a systematic and comprehensive review of 247 peer-reviewed articles from key research outlets, their paper reveals theories and methods used to study adoption of e-banking channel at the individual level. Hence, following we review some studies on IB briefly:

Sathye (1999) dealt with the factors affecting the adoption of IB by Australian consumers and found: security concerns, lack of awareness of the benefits of IB, ease of use, price, resistance to change and accessibility to computers/Internet as more affecting factors. Liao et al. (1999) studied IB adoption through variables such as ease of use, image, comparative advantage, compatibility, willingness, and the opportunity to try it. Polatoglu and Ekin (2001) conducted an exploratory study about consumer acceptance of IB in Turkey based on the examination of consumer-related factors, such as complexity, perceived risk and relative advantages, as well as organizational factor such as marketing effort that affect the adoption of IB. Suh and Han (2002) in their study, introduced trust as another belief that has an impact on the acceptance of IB. Liao et al. (2002) undertaken a survey in Singapore dealt with Consumer attitudes toward the usefulness of and willingness to use Internet e-retail banking. The data showed that expectations of accuracy, security, network speed, user-friendliness, user involvement and convenience were the most important quality attributes underlying perceived usefulness.

Howcroft et al. (2002) studied the principal factors that inhibit online banking adoption. Wang et al. (2003) examined the determinants of user acceptance of IB in Taiwan. The results of their study demonstrated the significant effect of computer self-efficacy, perceived ease of use, perceived usefulness and perceived credibility on the consumers' behavioral intention to adopt IB. Gerrard and Cunningham (2003) used factor analysis to measure the factors relating to the adoption of IB using a sample of Singapore consumers. The results indicated that social desirability, compatibility, convenience, complexity, confidentiality, accessibility, economic benefits and computer proficiency are the influential factors of Internet banking adoption. Sohail and Shanmugham (2003) examined the current trends in the e-commerce revolution in the Malaysian banking sector and studied the customers' preference for e-banking and the influenced factors on adoption of e-banking. Analysis further revealed that accessibility of internet, awareness of e-banking and customers' reluctance to change are the factors that significantly affect the usage of e-banking in Malaysia.

Yousafzai et al. (2003) extended an area of information systems research into the marketing of financial services context by looking into the element of trust and risk in e-banking. They proposed a conceptual model of trust with two main antecedents that influence customer's trust: perceived security and perceived privacy. Rexha et al. (2003) in their study, concluded that trust and satisfaction have an influence on e-banking adoption, although satisfaction moderated by the level of consumer trust. Pikkarainen and Pikkarainen (2004) applied the traditional Technology Acceptance Model (TAM) in Finland and found that perceived usefulness and information on online banking were the main factors influencing customer acceptance. Lai and Li (2005) applied different levels of invariance analysis on the technology acceptance model (TAM) construct in the context of IB acceptance. Jaruwachirathanakul and Fink (2005) identified factors, such as the features on the web site, perceived usefulness, and perceived behavioral control that encourage consumers to use IB services in Thailand. The significant demographic characteristics to Internet adoption were gender, educational level and income. Cheng et al. (2006) developed a theoretical model based on the Technology Ac-

ceptance Model (TAM) with an added construct Perceived Web Security and empirically tested its ability in predicting customers' behavioral intention of adopting IB.

Flavia´n and Guinalı´u (2006) conducted a research which Trust was mentioned as influence factor in adoption of online banking in Spain. Corrocher (2006) in a survey examined the determinants of adoption of IB among Italian retail banks. In particular it investigated the nature of IB in relation to traditional banking activity. Ndubisi and Sinti (2006) examined the determinant structure of customers' attitude system's characteristics on adoption of IB by Malaysian bank customers. The research framework links attitudinal constructs such as importance of IB to customers' banking needs, compatibility, complexity, trialability, and risk to internet banking adoption. Moreover, the impact of IB site design characteristics on adoption was also verified. Synthesizing the existing literature with real-life experience studied the organizational issues involved in adoption of e-banking services of a UK bank, Shah and Siddiquis (2006) found 11 factors as most critical ones for success in e-banking. Lichtenstein and Williamson (2006) reported key findings from an interpretive study of Australian banking consumer experiences with the adoption of IB.

hiemeke et al. (2006) investigated the adoption of IB in Nigeria and finds the main factors that inhibit the adoption of IB are security and inadequate operational facilities including proper telecommunications and power. Padachi et al. (2007) used factor analysis to identify the factors that affect the adoption of IB in Mauritius. The results of their study reveal that the most significant factor is ease of use and the other important factors are trust, cost of computers, Internet accessibility, convenience, and security. Shah et al. (2007) investigated critical organizational factors affecting on success of e-banking. The result found five top factors to be most critical factors for success in e-banking: quick responsive products/services, organizational flexibility, services expansion and systems. Kuisma et al. (2007) in their work studied those characteristics generating resistance to Internet banking and their connections to values of individuals. Eriksson and Nilsson (2007) focused on determinants of the continued use of self-service technology (SST) in IB. Yiu et al. (2007) explored the adoption of IB by retail customers in Hong Kong. Their research developed based on the Technology Acceptance Model (TAM) and incorporated two additional elements of personal innovativeness and perceived risk.

Maenpaa et al. (2008) examined the moderating role of in consumer perceptions of IB. Their survey revealed that level of IB familiarity impacted four out of seven service dimensions explored in the research. Leroux et al. (2008) identified the factors that influence the Internet penetration rate in Latin America. They analyzed correlations between the Internet penetration rate and various economical, educational and infrastructural factors among 18 Latin-American countries. Polasik and Wisniewski (2009) identified five main factors (perceived security, Internet experience, marketing exposure, use of other banking products and demographic characteristics) affect consumers' decisions to adopt IB in Poland. Lee (2009) explored and integrated the various advantages and disadvantage of online banking to form 'perceived benefit' and 'perceived risk'. They integrated TAM and TPB models with perceived risk and perceived benefit to explore the factors influencing the adoption of IB. Nasri and Charfeddine (2009) examined the factors that affect on adoption of IB by Tunisian bank customers. Using the technology acceptance model (TAM) and theory of planned behavior (TPB), their model employed security and privacy, self efficacy, government support, and technology support, in addition to perceived usefulness, perceived ease of use, attitude, social norm, perceived behavior control and intention to use IB.

The major findings of Agarwal et al. (2009) depicted that customers are influenced in their usage of e-banking services by the kind of account they hold, their age and profession, attach highest degree of usefulness to balance enquiry service among e-banking services, consider security & trust most important in affecting their satisfaction level and find slow transaction speed the most frequently faced problem while using e-banking. Polasik et al. (2009) in their study identified empirically the factors underlying the decision to adopt online banking in Poland. Their

findings implied that financial institutions can encourage customers to use this cost-effective distribution channel through carefully-planned actions. Malhotra and Singh (2010) in an analysis of IB offerings and its determinants in India employed multiple regression technique to explore the determinants of the extent of IB services.

Alsajjan and Dennis (2010) in their article proposed a revised technology acceptance model (TAM) to measure consumers' acceptance of IB. Suki (2010) applied multiple regression to analyze factors that influence the IB adoption among Malaysian consumers. The results shows that Hedonic oriented IB sites, followed by the perceived Importance of IB to banking needs and Compatibility all significantly affect the adoption of Internet banking by Malaysian consumers. Gikandi and Bloor (2010) investigated the factors influencing the adoption and effectiveness of e-banking in developing countries, especially Kenya. Tan et al. (2010) investigated the factors influencing adoption of e-banking and mobile banking and to identify customer preferences in choosing either e-banking or m-banking when conducting transactions. The findings indicated that perceived usefulness, perceived ease of use, convenience, computer efficacy, device features and security influence the adoption of e-banking. Chong et al. (2010) empirically examined the factors that affect the adoption of online banking in Vietnam. The results showed that perceived usefulness, trust and government support all positively associated with the intention to use online banking in Vietnam. Contrary to the technology acceptance model, perceived ease of use was found to be not significant in this study. Xue et al. (2011) examined the drivers of adoption of IB and the linkages among adoption drivers and outcomes. They related IB adoption to customer demand for banking services, the availability of alternative channels, customers' efficiency in service co-production and local IB penetration. Nasri (2011) determined those factors that influence the adoption of IB services in Tunisia and employed factor analysis and regression techniques to study the relationship between them.

Eze et al. (2011) investigated the factors that influence the use of IB services among young (18-28 years old) Malaysian adults. Foon et al. (2011) investigated the factors and determinants of IB adoption among Malaysian. The analysis of multiple linear regressions showed that performance expectancy, effort expectancy, social influence, facilitating condition and trust were positively correlated with behavioral intention among respondents.

Results of Kumbhar (2011) research indicated that, perceived value, brand perception, cost effectiveness, easy to use, convenience, problem handling, security/assurance and responsiveness are important factors and contact facilities, system availability, fulfillment, efficiency and compensation are comparatively less important in customers satisfaction in e-banking. Safeena et al. (2011) determined the factors influencing the consumer's adoption of IB in India and hence investigated the influence of perceived usefulness, perceived ease of use and perceived risk on use of IB. Qiu-dan et al. (2011) studied the service quality of the online banking information security product as an important bottleneck of every financial institution to further explore online market and development potential customers. Nasri and Charfeddine (2012) in a paper examined the factors that affect the adoption of IB by Tunisian bank customers. Their base model employs security and privacy, self efficacy, government support, and technology support, in addition to perceived usefulness, perceived ease of use, attitude, social norm, perceived behavior control and intention to use IB. Kesharwani and Singh-Bisht, (2012) extended the technology acceptance model (TAM) in the context of IB adoption in India under security and privacy threat.

DEMATEL method

DEMATEL was first put forward in 1972 to resolve the complicated and intertwined problem group. It's built on the basis of graph theory, enabling analyzes and solves problems by visualization method. This structural modeling approach adopts the form of a directed graph, a causal-effect diagram, to present the interdependence relationships and the values of influential effect between factors. Through analysis of visual relationship of levels among system factors, all elements are divided into causal group and effected group. This can help researchers better understand the structural relationship between system elements, and find ways to solve compli-

cate system problems (Gabus and Fontela, 1972, 1973; Herrera et al., 2000; Wang and Chuu, 2004). DEMATEL has been successfully applied in many situations, such as marketing strategies, e-learning evaluation, control systems and safety problems (Chiu et al., 2006), choose KM strategy (2008), information security (Ou Yang, Shieh, Leu, & Tzeng, 2009), financial stock investment (Lee, Tzeng, Guan, Chien, & Huang, 2009, 2009), and water resources and environment (Chen, Lien, & Tzeng, 2010).

According to Gabus and Fontela (1972, 1973), the steps of DEMATEL method are as follows:

Step 1: Generate the initial direct-relation matrix. Form a committee of experts, and acquire the assessments about direct affect between each pair of elements. Converting the linguistic assessments into crisp values, we obtain the direct-relation matrix A = [a_{ij}], where A is a n×n non-negative matrix, aij indicates the direct impact of factor i on factor j; and when i = j, the diagonal elements aij = 0.

Step 2: Normalize the initial direct-relation matrix. The normalized direct-relation matrix D = [d_{ij}] can be obtained through Eq. (1). All elements in matrix D are complying with , and all principal diagonal elements are equal to 0.

$$D = \frac{1}{\max\limits_{1\le i\le n} \sum_{j=1}^{n} a_{ij}} A \tag{1}$$

Step 3: Acquire the total-relation matrix T using the Eq. (2), in which I is an n × n identity matrix. The element tij indicates the indirect effects that factor i have on factor j, so the matrix T can reflect the total relationship between each pair of system factors.

$$T = D\,(I-D)^{-1} \tag{2}$$

Step 4: Calculate the sum of rows and columns of matrix T. To make the outcome more visible, we compute r_i and c_j through Eqs. (3) and (4), respectively. The sum of row i, which is denoted as r_i, represents all direct and indirect influence given by factor I to all other factors, and so ri can be called the degree of influential impact. Similarly, the sum of column j, which is denoted as c_j can be called as the degree of influenced impact, since c_j summarizes both direct and indirect impact received by factor j from all other factors.

$$r_i = \sum_{1\le j\le n} t_{ij} \tag{3}$$

$$c_j = \sum_{1\le i\le n} t_{ij} \tag{4}$$

So naturally, when i = j, $r_i + c_i$ shows all effects given and received by factor i. That is, $r_i + c_i$ indicates both factor i's impact on the whole system and other system factors' impact on factor i. So, the indicator $r_i + c_i$ can represent the degree of importance that factor i plays in the entire system. On the contrary, the difference of the two, $r_i - c_i$, shows the net effect that factor i has on the system.

Step 5: Construct cause-effect relationship diagram based on $r_i + c_i$ and $r_i - c_i$. A cause-effect diagram can be drawn by mapping the dataset of ($r_i + c_i$, $r_i - c_i$). And the complex interrelationship among factors is visualized through the diagram construction process (Wu, 2012).

Research methodology

In this research, we studied the existing literature on internet banking. The subsequent steps were followed to conduct this research: Reviewing the published papers titled "internet banking" and "electronic banking", 21 factors were identified as affecting factors on adoption of IB. Then, these factors arranged in form of a questionnaire. Next, a questionnaire was designed and asked a randomly selected sample of 390 customers which are already using Internet banking services to fill the questionnaire (385 usable responses were gathered). The raw data was analyzed and the researchers have calculated Cronbach reliability coefficient for all variables by using SPSS 19.0 (greater than 0.7). Then, based on the W Kendall's test, a set of 10 high rank factors distinguished as more important factors. The factors are: Accessibility to IB services (hardware necessities) (x_1), ease of use (x_2), No need to physical attendance No need to physical attendance (x_3), Availability of IB services (technical functioning) (x_4), Bank reputation (x_5), Perceived privacy (x_6), Responsiveness (effective handling of problems) (x_7), Speed of network (x_8), Public training (x_9), Supportive activities

(e.g. electronic password, neat pages in site and etc) (x_{10}). These factors formed a [(m+1)*(m+1)] relationship matrix (Table 1) and then asked the 48 bank experts to determine if, factor cited in row influences the factor cited in column. Merging the relationship matrixes have resulted to a group decision matrix. In the next step, we asked the experts to score the relation cells in proportion to the amount of influence that each raw factor has on each column factor based on a 1-10 scale. Merging the individual matrixes into the group matrix based on the geometric mean, Table 1 resulted as following. Here, you can see how DEMATEL uses this matrix to compute the value of direct, indirect and total effect of each factor on whole system.

Empirical Example

Based on the 10 more important factors resulted from statistical analysis of questionnaire, another surveys were conducted to collect data about relationship among these factors. The degree that factors had direct impacts on each other were asked based on a 1-10 scale and combining the individual direct-relation matrixes into a group matrix, resulted to Table 1.

Next, based on the initial direct-relation matrix 1, the normalized direct-relation matrix (D) was obtained by formula (1). Then, total-relation matrix (Table 2) was acquired by using formula (2).

Using the formula (3) and (4) influential and influenced impacts were determined. Finally, the cause-effect relationship diagram (Fig. 1) is acquired by mapping the dataset of ($r_i + c_i$, $r_i - c_i$).

Fig. 1. The cause-effect relationship diagram

As shown in Fig. 1, the factors are visually divided into two groups according to whether its value of $r_i - c_i$ is positive or negative. So the cause group with positive $r_i - c_i$ value includes X_1, X_4, X_7, X_8, X_9, X_{10} and other factors including X_2, X_3, X_5, X_6 are in the effect group since the $r_i - c_i$ of these factors are negative. There are many other valuable clues that can be resulted from Fig. 1 to facilitate decision making.

Among all factors in cause group, 'Responsiveness (effective handling of problems)" (X_7) has the highest $r_i - c_i$, which means that X_7 dispatches more impact on the whole system than it receives

Table 1: The Direct influence (group) matrix

Factors	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	0	3.959	6.785	5.144	0	0	0	0	2.356	0
X_2	4.502	0	4.619	5.305	3.728	0	0	0	2.416	0
X_3	2.129	3.512	0	2.017	0	0	0	3.245	0	0
X_4	3.859	4.852	7.696	0	3.438	0	3.005	0	4.073	2.605
X_5	2.766	0	0	0	0	6.608	0	0	0	0
X_6	0	0	6.998	0	7.873	0	0	0	4.875	0
X_7	0	5.866	6.470	0	4.891	5.827	0	6.166	0	3.117
X_8	0	0	8.040	0	6.629	0	7.721	0	0	4.169
X_9	0	7.579	5.870	0	0	6.407	0	0	0	0
X_{10}	2.547	0	4.441	0	5.425	0	0	3.320	0	0

Table 2: Total influence matrix T of the factors

Factors	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}
X_1	0.098	0.250	0.381	0.239	0.086	0.051	0.034	0.048	0.136	0.029
X_2	0.229	0.140	0.332	0.244	0.194	0.074	0.033	0.042	0.144	0.028
X_3	0.122	0.173	0.136	0.119	0.077	0.031	0.041	0.125	0.041	0.030
X_4	0.239	0.319	0.484	0.121	0.238	0.110	0.124	0.084	0.199	0.113
X_5	0.107	0.041	0.098	0.030	0.067	0.229	0.005	0.011	0.049	0.004
X_6	0.066	0.095	0.322	0.046	0.294	0.099	0.013	0.036	0.183	0.010
X_7	0.126	0.296	0.470	0.098	0.355	0.283	0.073	0.267	0.086	0.146
X_8	0.099	0.130	0.447	0.065	0.353	0.130	0.272	0.115	0.045	0.175
X_9	0.089	0.318	0.348	0.088	0.118	0.241	0.018	0.040	0.078	0.014
X_{10}	0.131	0.064	0.248	0.047	0.233	0.060	0.037	0.137	0.029	0.025

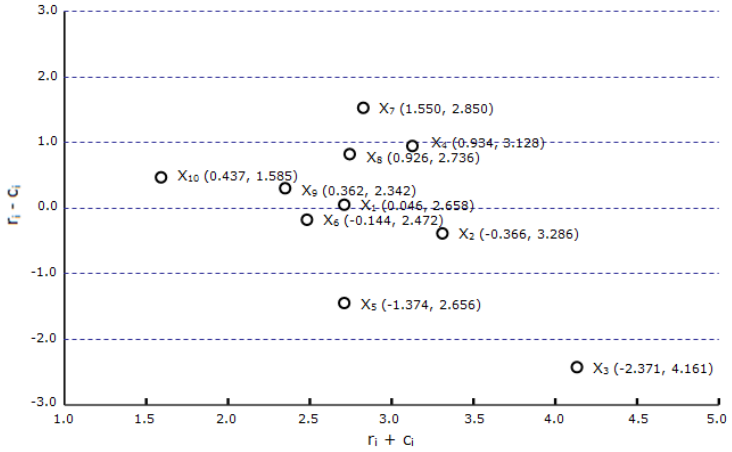

Fig. 1. The cause-effect relationship diagram

Table 3: The scores of each factor and related values for cause and effect groups.

Factors	Description	r_i	c_i	$r_i + c_i$	$r_i - c_i$
X_1	Accessibility to IB services (hardware necessities)	1.352	1.306	2.658	0.046
X_2	Ease of use	1.460	1.826	3.286	-0.366
X_3	No need to physical attendance	0.895	3.266	4.161	-2.371
X_4	Availability of IB services (technical functioning)	2.031	1.097	3.128	0.934
X_5	Bank reputation	0.641	2.015	2.656	-1.374
X_6	Perceived Privacy	1.164	1.308	2.472	-0.144
X_7	Responsiveness (effective handling of problems)	2.200	0.650	2.850	1.550
X_8	Speed of network	1.831	0.905	2.736	0.926
X_9	Public training	1.352	0.990	2.342	0.362
X_{10}	Supportive activities (e.g. electronic password, neat pages in site and etc)	1.011	0.574	1.585	0.437

from other factors. Besides, Table 3 shows that the degree of influential impact of X_7 is 2.200, which ranks first place among all causal factors. It is indicated that X_7 has remarkable impact on other factors, and that improvement of X_7 can lead to the amelioration of the whole system. To sum up, X_7 is a critical factor that worth much more attention in adoption of IB.The factor having the second highest $r_i - c_i$ is factor X_4. We further analyze the indexes in Table 5 and find out the reason for it. According to the ri and ci scores of X_4, its influential impact on others is high and the impact it receives from others is normal, which leads to a high value of ri + ci. Therefore, X_4 can be clustered as a critical factor. X_8 's net effect score $r_i - c_i$ (0.926) has third place among all cause factors, and meanwhile, its influential impact index ri is as high as 1.831. The impacts that X_8 dispatches to the whole system is great, and improvement of X_8 will enhance the effectiveness and efficiency in adoption of IB without doubt. So, evidence suggests X_8 is a critical factor. According to the outcomes derived from DEMATEL method, the impact dispatched from X_{10}, X_9 and X_1 to other factors is greater than the impact they receives. But both the ri and ci scores of them are not high enough. It is obvious that they do not have notable impact on the whole system, X_{10}, X_9 and X_1 are not critical factors.Among all 10 factors, X_3 and X_2 has the highest $r_i + c_i$, showing that they are of the most importance for the adoption of IB. But in Fig. 1 we can see that the ri - ci score of X_3 and X_2 are respectively -2.371 and -0.366. To further illustrate this phenomenon, the degree of influenced impact ci were considered, respectively are 4.161 and 3.286, both the highest among all system factors. This suggests that although they are net receivers, it has an apparent impact on other factors and on the whole system. So considering the important position of them in adoption of IB, we entitle them as critical factors.

CONCLUSION

The procedure presented in this paper provides a relevant model to identify critical factors

among various influencing elements. This proposed DEMATEL method can be also used in the field of manufacturing, organization management, information system and social science. Besides, it is applicable to all systems facing problems that require to segment complex factors and further figure the importance of factors by group decision. This paper also contributes an effective way to Identification and ranking of critical factors affecting on customers adoption of internet banking services as a whole. In this meaning, this study is mainly an analysis at a high macro level. In order to improve, promote, and guarantee the success of IB adoption process, researches about critical factors needs to be coordinated and updated in a continuous way.

REFERENCES

Agarwal, R., Rastogi, S., & Mehrotra, A. (2009). Customers' perspectives regarding e-banking in an emerging economy. *Journal of Retailing and consumer services,* 16(5), 340-351.

Ahmad, R., & Buttle, F. (2002). Retaining telephone banking customers at Frontier Bank. I*nternational Journal of Bank Marketing,* 20(1), 5-16.

Ali, K. Ö. S. E. (2009). Determination of reasons affecting the use of internet banking through logistic regression analysis. *Journal of Global Strategic Management,* 6, 67.

Alsajjan, B., & Dennis, C. (2010). Internet banking acceptance model: Cross-market examination. *Journal of Business Research*, 63(9), 957-963.

Barnes, S. J., & Corbitt, B. (2003). Mobile banking: concept and potential. *International Journal of Mobile Communications*, 1(3), 273-288.

Bhattacherjee, A. (2001). An empirical analysis of the antecedents of electronic commerce service continuance. *Decision support systems*, 32(2), 201-214.

Bhattacherjee, A. (2001). Understanding information systems continuance: an expectation-confirmation model. *MIS quarterly,* 351-370.

Cheng, T. E., Lam, D. Y., & Yeung, A. C. (2006). Adoption of internet banking: an empirical study in Hong Kong. *Decision support systems*, 42(3), 1558-1572.

Chiu, Y. J., Chen, H. C., Tzeng, G. H., & Shyu, J. Z. (2006). Marketing strategy based on customer behaviour for the LCD-TV. *International journal of management and decision making,* 7(2-3), 143-165.

Corrocher, N. (2006). Internet adoption in Italian banks: An empirical investigation. *Research Policy,* 35(4), 533-544.

Currie, W. (2000). The global information society. Chichester: Wiley.

Dabholkar, P. A. (1996). Consumer evaluations of new technology-based self-service options: an investigation of alternative models of service quality. *International Journal of research in Marketing*, 13(1), 29-51.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS quarterly*, 319-340.

Durkin, M., Jennings, D., Mulholland, G., & Worthington, S. (2008). Key influencers and in hibitors on adoption of the internet for banking. *Journal of Retailing and Consumer Services*, 15(5), 348-357.

Eriksson, K., & Nilsson, D. (2007). Determinants of the continued use of self-service technology: The case of Internet banking. *Technovation*, 27(4), 159-167.

Eze, U.C., Manyeki, J.K., Yaw, L.H., & Har, L.C. (2011). Factors Affecting Internet Banking Adoption among Young Adults: Evidence from Malaysia. *International Conference on Social Science and Humanity, Singapore*, 5(1), 377-381.

Flavian, C., & Guinaliu, M. (2006). How bricks-and-mortar attributes Affect online banking adoption. *International Journal of Bank Marketing*, 24 (6), 406-423.

Foon, Y. S., & Fah, B. C. Y. (2011). Internet banking adoption in Kuala Lumpur: an application of UTAUT model. *International Journal of Business and Management*, 6(4), 161-167.

Gabus, A., & Fontela, E. (1972). World problems, an invitation to further thought within the frame work of DEMATEL. *Battelle Geneva Research Center, Geneva, Switzerland*.

Gerrard, P., & Barton Cunningham, J. (2003). The diffusion of internet banking among Singapore consumers. *International journal of bank marketing,* 21(1), 16-28.

Gikandi, J. W., & Bloor, C. (2010). Adoption and effectiveness of electronic banking in Kenya. *Electronic commerce research and applications,* 9(4), 277-282.

Hoehle, H., & Lehmann, H. (2008). Exploring the state-of-the art of mobile banking literature. In *7th Global Mobility Roundtable Conference, Proceedings published by University of Auckland, Auckland, New Zealand.*

Hoehle, H., Scornavacca, E., & Huff, S. (2012). Three decades of research on consumer adoption and utilization of electronic banking channels: A literature analysis. *Decision Support Systems*, 54(1), 122-132.

Howcroft, B., Hamilton, R., & Hewer, P. (2002). Consumer attitude and the usage and adoption of home-based banking in the United Kingdom. *International journal of bank marketing,* 20(3), 111-121.

Huang, C. Y., Shyu, J. Z., & Tzeng, G. H. (2007). Reconfiguring the innovation policy portfolios for Taiwan's SIP Mall industry. *Technovation*, 27(12), 744-765.

Jaruwachirathanakul, B., & Fink, D. (2005). Internet banking adoption strategies for a developing country: the case of Thailand. *Internet research,* 15(3), 295-311.

Kesharwani, A., & Singh Bisht, S. (2012). The impact of trust and perceived risk on internet banking adoption in India: An extension of technology acceptance model. *International Journal of Bank Marketing,* 30(4), 303-322.

Kuisma, T., Laukkanen, T., & Hiltunen, M. (2007). Mapping the reasons for resistance to Internet banking: A means-end approach. *International Journal of Information Management,* 27(2), 75-85.

Kumbhar, V. M. (2011). Factors affecting the customer satisfaction in e-banking: some evidences form Indian banks. *Management Research and practice*, 3(4), 1-14.

Lai, V. S., & Li, H. (2005). Technology acceptance model for internet banking: an invariance analysis. I*nformation & management*, 42(2), 373-386.

Lam, R., & Burton, S. (2005). Bank selection and share of wallet among SMEs: Apparent differences between Hong Kong and Australia. *Journal of Financial Services Marketing,* 9(3), 204-213.

Laukkanen, T., & Lauronen, J. (2005). Consumer value creation in mobile banking services. *International journal of mobile Communications*, 3(4), 325-338.

Lee, M. C. (2009). Factors influencing the adoption of internet banking: An integration of TAM and TPB with perceived risk and perceived benefit. *Electronic commerce research and applications,* 8(3), 130-141.

Leroux, C.G., Zo ,H., & Rho. J.J .(2008). Factors Affecting Internet Adoption in Latin America. *Third International Conference on Convergence and Hybrid Information Technology. ICCIT,* 2, 947-951.

Li, C. W., & Tzeng, G. H. (2009). Identification of a threshold value for the DEMATEL method using the maximum mean de-entropy algorithm to find critical services provided by a semiconductor intellectual property mall. *Expert Systems with Applications*, 36(6), 9891-9898.

Liao, S., Shao, Y. P., Wang, H., & Chen, A. (1999). The adoption of virtual banking: an empirical study. *International journal of information management*, 19(1), 63-74.

Liao, Z., & Cheung, M. T. (2002). Internet-based e-banking and consumer attitudes: an empirical study. *Information & Management*, 39(4), 283-295.

Lichtenstein, S., & Williamson, K. (2006). Understanding consumer adoption of internet banking: an interpretive study in the Australian banking context. *Journal of Electronic Commerce Research,* 7(2), 50.

Lin, C. J., & Wu, W. W. (2008). A causal analytical method for group decision-making under fuzzy environment. *Expert Systems with Applications*, 34(1), 205-213.

Liou, J. J., & Chuang, Y. T. (2010). Developing a hybrid multi-criteria model for selection of outsourcing providers. *Expert Systems with Applications*, 37(5), 3755-3761.

Liou, J. J., & Tzeng, G. H. (2007). A non-additive model for evaluating airline service quality. *Journal of Air Transport Management*, 13(3), 131-138.

Mäenpää, K., Kale, S. H., Kuusela, H., & Mesiranta, N. (2008). Consumer perceptions of Internet banking in Finland: The moderating role of familiarity. *Journal of retailing and consumer services,* 15(4), 266-276.

Malhotra, P., & Singh, B. (2010). An analysis of Internet banking offerings and its determinants in India. *Internet Research*, 20(1), 87-106.

Nasri, W. (2011). Factors influencing the adoption of internet banking in Tunisia. International

Journal of Business and Management, 6(8), 143-160.

Nasri ,W., & Charfeddine, L .(2009). Factors affecting the adoption of Internet banking in Tunisia: An integration theory of acceptance model and theory of planned behavior. *Electronic Commerce Research and Applications*, 8(3), 130-141.

Nasri, W., & Charfeddine, L. (2012). Factors affecting the adoption of Internet banking in Tunisia: An integration theory of acceptance model and theory of planned behavior. *The Journal of High Technology Management Research*, 23(1), 1-14.

Nui Polatoglu, V., & Ekin, S. (2001). An empirical investigation of the Turkish consumers' acceptance of Internet banking services. *International journal of bank marketing,* 19(4), 156-165.

Oly Ndubisi, N., & Sinti, Q. (2006). Consumer attitudes, system's characteristics and internet banking adoption in Malaysia. *Management Research News,* 29(1/2), 16-27.

Padachi, K., Rojid, S., & Seetanah, B. (2007). Analyzing the factors that influence the adoption of internet banking in Mauritius. In *Proceedings of the 2007 Computer Science and IT Education Conference* (pp. 559-574).

Pikkarainen, T., Pikkarainen, K., Karjaluoto, H., & Pahnila, S. (2004). Consumer acceptance of online banking: an extension of the technology acceptance model. *Internet research*, 14(3), 224-235.

Polasik, M., & Piotr Wisniewski, T. (2009). Empirical analysis of internet banking adoption in Poland. *International Journal of Bank Marketing*, 27(1), 32-52.

Qiu-dan, X., Ting, L., & Yunfei, L. (2011). The Study of Influencing Online Banking Information Security Products Service Quality Factors Based on Customer Perception. *Energy Procedia*, 13, 1203-1213.

Railton, J. (1985). Automated teller machines. *Computer Law & Security Review, 1*(4), 12.

Ravi Sankar, N., & Prabhu, B. S. (2001). Modified approach for prioritization of failures in a system failure mode and effects analysis. *International Journal of Quality & Reliability Management*, 18(3), 324-336.

Rexha, N., Kingshott, R. P. J., & Shang Shang Aw, A. (2003). The impact of the relational plan on adoption of electronic banking. *Journal of services marketing,* 17(1), 53-67.

Rogers, E. M., & Shoemaker, F. F. (1971). Communication of Innovations; A Cross-Cultural Approach.

Safeena, R., Date, H., & Kammani, A. (2011). Internet Banking Adoption in an Emerging Economy: Indian Consumer's Perspective. *Int. Arab J. e-Technol., 2*(1), 56-64.

Sanchez-Franco, M. J. (2009). The moderating effects of involvement on the relationships between satisfaction, trust and commitment in e-banking. *Journal of Interactive Marketing*, 23(3), 247-258.

Sathye, M. (1999). Adoption of Internet banking by Australian consumers: an empirical investigation. *International Journal of bank marketing*, 17(7), 324-334.

Scornavacca, E., Barnes, S. J., & Huff, S. L. (2006). Mobile business research published in 2000-2004: emergence, current status, and future opportunities. *Communications of the association for information systems, 17*(1), 28.

Shah, M. H., & Siddiqui, F. A. (2006). Organisational critical success factors in adoption of e-banking at the Woolwich bank. *International Journal of information management*, 26(6), 442-456.

Shah, M. H., Braganza, A., & Morabito, V. (2007). A survey of critical success factors in e-Banking: an organisational perspective. *European Journal of Information Systems,* 16(4), 511-524.

Shih, K. H. (2008). Is e-banking a competitive weapon? A causal analysis. *International Journal of Electronic Finance,* 2(2), 180-196.

Sohail, M. S., & Shanmugham, B. (2003). E-banking and customer preferences in Malaysia: An empirical investigation. *Information sciences*, 150(3), 207-217.

Suh, B., & Han, I. (2003). Effect of trust on customer acceptance of Internet banking. *Electronic Commerce research and applications, 1*(3), 247-263.

Suki, N.M. (2010). An empirical study of factors affecting the Internet banking adoption among Malaysian consumers. *Journal of Internet Banking and Commerce*, 15, 1-11.

Tan, M., & Thompson, S.H.T. (2000). Factors Influencing the Adoption of Internet Banking. *Journal of the Association for Information Systems*, 1, 1-43.

Tan, K. S., Chong, S. C., Loh, P. L., & Lin, B. (2010). An evaluation of e-banking and m-banking adoption factors and preference in Malaysia: a case study. *International Journal of Mobile Communications*, 8(5), 507-527.

Tsai, W. H., Leu, J. D., Liu, J. Y., Lin, S. J., & Shaw, M. J. (2010). A MCDM approach for sourcing strategy mix decision in IT projects. *Expert Systems with Applications*, 37(5), 3870-3886.

Tzeng, G. H., Chiang, C. H., & Li, C. W. (2007). Evaluating intertwined effects in e-learning programs: A novel hybrid MCDM model based on factor analysis and DEMATEL. *Expert systems with Applications,* 32(4), 1028-1044.

Wang, Y. S., Wang, Y. M., Lin, H. H., & Tang, T. I. (2003). Determinants of user acceptance of Internet banking: an empirical study. *International journal of service industry management*, 14(5), 501-519.

Wu, W. W. (2008). Choosing knowledge management strategies by using a combined ANP and DEMATEL approach. *Expert Systems with Applications*, 35(3), 828-835.

Wu, W.W. (2012). Segmenting critical factors for successful knowledge management implementation using the fuzzy DEMATEL method. *Applied Soft Computing*, 12(1), 527-535.

Wu, W.W., & Lee, Y. T. (2007). Developing global managers' competencies using the fuzzy DEMATEL method. *Expert systems with applications*, 32(2), 499-507.

Xue, M., Hitt, L.M.,& Chen, P.Y .(2011). Determinants and Outcomes of Internet Banking Adoption. *Management Science*,57(2), 291-307.

Yee-Loong Chong, A., Ooi, K. B., Lin, B., & Tan, B. I. (2010). Online banking adoption: an empirical analysis. *International Journal of Bank Marketing,* 28(4), 267-287.

Yiu, C. S., Grant, K., & Edgar, D. (2007). Factors affecting the adoption of Internet Banking in Hong Kong-implications for the banking sector. *International Journal of Information Management*, 27(5), 336-351.

Yiu, C. S., Grant, K., & Edgar, D. (2007). Factors affecting the adoption of Internet Banking in Hong Kong-implications for the banking sector. *International Journal of Information Management,* 27(5), 336-351.

Yousafzai, S. Y., Pallister, J. G., & Foxall, G. R. (2003). A proposed model of e-trust for electronic banking. *Technovation*, 23(11), 847-860.

Yousafzai, S. Y., Pallister, J. G., & Foxall, G. R. (2003). A proposed model of e-trust for electronic banking. *Technovation*, 23(11), 847-860.

Zhou, Q., Huang, W., & Zhang, Y. (2011). Identifying critical success factors in emergency management using a fuzzy DEMATEL method. *Safety science,* 49(2), 243-252.