Revenue Structure of Mobile Banking: A System Dynamics Model

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Abstract

Technology advancements during recent years have created new opportunities for offering new banking services which might have great impacts on decreasing banks' costs and increasing their non-interest income earned from the fees of banking services. But, banks have always been wondering if these new services would be adopted or accepted by the customers? Public adoption of a new technology often takes years and depends on its success in the development and continuous use by people. This research intends to employ a system approach to analyzing the dynamics of developing new banking services focusing specifically on mobile banking. Here, a dynamic model is developed and simulated by System Dynamics (SD) approach considering related theories extracted from the literature, identified factors, and influencing feedback for better understanding the existent mechanisms. The simulation results of four scenarios are presented. Results showed that increasing advertisement and R&D budget would not be useful enough for the sustainable growth of mobile banking transactions and their revenue in long term. In fact, improving the set of factors influencing the customers' intention of using the technology can most likely make people accept the technology and increase its use and the revenue earned from banking fees and other charges.

Keywords

E-banking, Technology Acceptance Model, Mobile Banking, System Dynamics, Adoption of New Services

1. Introduction

In today's world economy, we are faced with widespread evolutions in areas of information communication and development of new information and communication technologies. This has made it inevitable for us to employ new methods and guidelines in management and economic activities. Today's management, which is based on new information and communication services, requires a variety of mechanisms and infrastructures that lead to the development of new businesses. The most important infrastructure might be the growth of e-business and accordingly e-banking. Banking systems were actually the first structures to follow the most up-to-date technology of the world based on information technology to attract more customers by facilitating and creating more diversity in their services by making structural changes in receipt and pay systems. This has gone so far that now many believe that e-business's universal achievements are mainly owed to the attention of banks managers to newly developed e-banking structures [1]. E-banking, which is the product of new changes and use of information technology in the banking system, lets customers and other stakeholders communicate with banks directly and indirectly by means of different channels e.g. the internet, smart cell phones, ATMs, telephones, and digital TVs. During recent years, banking systems, like other service providers, have pursued investing on new technologies to control their costs, attract new customers, and satisfy users expectations [2]. In fact, banks have now understood that current services and ordinary activities are not enough alone. That is why traditional methods of serving customers have given up their place to electronic services [3]. Banks benefit from e-banking in several aspects e.g. lower communication costs, twenty-four seven services, higher efficiency in banking processes, better competing against rivals, conserving customers' loyalty, etc. Banks now use technology instead of employees to reduce their costs and tackle their problems in the competing environment against rivals and online banks [4]. Nowadays, the majority of banks are fronted with a highly dynamic environment and all banks have pursued attracting and holding on to business customers considering the rapid changes in competition and market conditions. On the other hand, customers have more chances of comparing services, and their judgment depends on banks' capability to solve their problems and help to develop their business. Security, transaction speed, user-friendly interfaces, ease of use, trust and private life issues are all among the factors influencing customers' choice [5]. Banking services by means of mobile phones cause lower costs, plus ease of access and swiftness in providing services. So, banks are very eager to expand their market through mobile banking [6].

In this research, it is intended to use a structural approach to model the dynamics of developing new banking services. To achieve this, research literature related to acceptance structure (which defines the kinds of new banking technologies that would be accepted by customers) and development of new banking services are reviewed; then, factors influencing the model design are identified. System dynamic model will be developed based on problem's structure, and then, outcomes of applying different policies in form of decision scenarios on the development of banking services are analyzed. In fact, it can be acclaimed that the most important goal of this investigation is to identify the feedback loops and leverage points in adoption and development of new banking services, and also, dynamic and nonlinear analysis of various decision policies which leads to the introduction of a decision support system for banks' managers.

Many investigations have been carried out in the process of adoption of new electronic and mobile banking services. Brown et al. [7] combined *Diffusion of Innovations Theory* and *Decomposed Theory of Planned Behavior (DTPB)* to analyze the factors influencing mobile banking adoption in South Africa. Wang and Liu [8] analyzed the *Technology Acceptance Model* to assess the success of information systems. Kuisma et al. [9] reviewed the root causes of society's resistance to internet banking. Vatanasombut et al. [10] studied the factors influencing internet banking e.g. trust and relationship commitment. Luo et al. [11] analyzed the effects of different aspects of risk and trust on adoption of mobile banking. They showed the different aspects of trust have different effects and the two factors of risk and performance have a direct influence on adoption. Schierz et al. [12] investigated the solutions to increase the use of cell phones for electronic pay in Germany based on *Technology Acceptance Model* and concluded that support for these systems has a great influence on the increase of their use among customers. Dehghan et al. [13] developed a *Technology Acceptance Model* based on *Programmed Behavior Theory* to analyze the adoption of internet banking in Iran. In this paper, several technology adoptions developed models were first discussed, and then, the factors influencing the adoption of internet banking were analyzed. Zanjirchi et al. [14] presented an *Advanced Technology Acceptance Model* for the effectiveness of communication with electronic customers. In this model, some aspects of *Technology Acceptance Model* was combined with *Diffusion of Innovations Theory* for better understanding the problem. Ghafari Ashtiani et al. [15] investigated factors influencing the customers' intention of using mobile banking by means of structural equations modeling (SEM). Teo et al. [16] pointed out the effects of demographic factors on the adoption of mobile banking and its applications. They concluded that education and income have positive relations with perceived usefulness, while gender and education have positive relations with perceived ease of use. Konjkavmonfared and Mirhoseini [1] introduced and analyzed an *Advanced Technology Acceptance Model* for the adoption of mobile banking by customers. They also combined some aspects of *Technology Acceptance Model* with

Diffusion of Innovations Theory for better understanding the behavior of mobile banking users. Hanafizadeh et al. [17] provided a set of factors influencing the use of mobile banking by customers in Iran. This investigation presented a theoretical model to explain the adoption of mobile banking. Mohammadi [18] analyzed the obstacles, the mediating role of capabilities, and moderating effects of personal innovation and subjective norms on users' attitudes towards the use of mobile banking in Iran. He used structural equations modeling. Chuchuen [19] tried to understand the concept of mobile banking adoption depending on factors like trust, security, and behavior in Thailand. This paper presented a conceptual model and also some statements to identify the adoption factors of mobile banking in Thailand at the time of its emergence. Most of the researchers have investigated the factors influencing the adoption of a new technology concentrating on static specific variables, while this issue is affected through time and needs to be analyzed dynamically. Few investigations have been carried out considering system dynamics approach. Intrapairot and Quaddus [20] suggested a model for internet banking in Thailand using system dynamics. Their model analysis showed that training reduces technology's backlog of problems and leads to cooperation between IT men and users, ease of use, and managers' support for the main issues which need to be considered in banks. Additionally, as this technology intends to serve customers, marketing activities e.g. advertisement are necessary for technology's economic life for technology's diffusion to attract the potential market before the technology becomes out-of-date. Intrapairot and Quaddus [21] have also studied *system dynamics modeling of information and communication technologies* in order to holistically present a dynamic model for the adoption of information and communication technologies in a bank in Thailand. By this study, they could identify various political variables influencing the adoption and diffusion of information and communication technologies. Heidarieh et al. [22] carried out a study named *Technology Acceptance Modelling and simulation of Iran's banking* by system dynamics approach for *Refah* bank. In this research, by considering *Technology Acceptance Model*'s initial variables, some new variables e.g. *Habit* and *Customer Awareness* were added to model's structure. Then in order to better identify the influencing variables of the relation, they presented and simulated a dynamic *Technology Acceptance Model* for Iran's banking system. Results specified that the more the customers use the technology, the more they get used to it; so, it causes more desire and conceptual ease of use for them, and finally, they tend to use it even more, and this dynamic cycle goes on through time. Mobile banking has been more welcoming among bankers compared to E-Banking since cell phones are more easily accessible than personal computers. Using cell phones also increase the service quality, as customers are able to manage their finances any place and time. Therefore, using mobile banking is simultaneously beneficial to customers and banks which make a strong relationship between customers and financial institutions. Despite the increasing desire of business holders to use this technology, the number of mobile banking users is less than expectations [17]. Identifying the reasons beyond refraining from using this technology and also the factors influencing the adoption and diffusion of mobile banking is of great importance. Hence, it is necessary to holistically, systemically, and uniformly model the relations and feedback structures of the issue of new banking services adoption and diffusion; so that we would be able to make better decisions by having the insight of system's behavior.

2. Method

Research methodology is based on the overall step of system dynamics approach. The system dynamics was introduced by Jay W. Forrester from Massachusetts Institute of Technology (MIT). System dynamics method has an ability to model various aspects of the issue and is considered as an effective method in the analysis of system and issues through computer simulation and helps to understand complex systems. Different scenarios can be evaluated by the help of this approach through the systemic vision. There are some applications of this methodology in complex problem modeling such as mobile banking adoption simulation [9], Banking Risk Management [10], Banking Paradox[11], Sustainable Development [12], Organizational Demographics[13], brain drain[14], Dust Emission[15], waste management[16], Crisis Management[17], Inflation Rate[18], Housing Cost[19], User Satisfaction in Healthcare services[20], Public Health [21], Clinical Risk Management[22], Occupational Health and Safety Management System Development[23], and Chronic Diseases Costs Management[24]. This approach provides the opportunity for the decision maker to test his proposed solutions in simulation model before application in the actual system and study its consequences in the long term. The problem solution is performed through system dynamics methodology at five stages:

1. Identification and definition of problem
2. Drawing the causal diagrams
3. Construction of mathematical model (Stock and flow)
4. Simulation and validation of model

Definition of different scenarios; evaluation, selection, and implementation of appropriate solution

3. Modeling

3.1. Dynamic Hypothesis and Causal Model

Based on abovementioned studies and theories of research literature, the dynamic hypothesis of this investigation which states the system's structure is as follow.

When first a product or technology is presented to the market, many factors influence its intention of usage. Use intention is actually the result of many positive and negative reactions. Regarding the identified factors from technology adoption and diffusion different theories discussed in the introduction of this paper, here we summarize these factors. Customers' attitude towards using the technology, which is itself influenced by perceived ease of use, usefulness, and consistency with lifestyle, affects customers' behavior. Additionally, users' trust in new technology, which is made of factors e.g. perceived usefulness, security, structural guarantee, and risk, affects users' attitude and their intention of using it. Furthermore, factors e.g. the need for interaction, which demonstrates customers' desire to communicate with bank's employees, or perceived the cost of use, and also perceived risk are all important factors that affect the intention of use negatively and significantly. The influence of risk variable on the intention of use is defined as: "the higher the risk of using a technology is, the less desire would the customers have for using it".

After identifying the set of factors influencing the customers' intention of using the technology and their reactions to each other, a potential population is formed which adopts the new technology. Regarding the Bass Diffusion Model, this potential population needs to be pushed. So, potential adopters may become activated by external information resources e.g. advertisement and marketing. This leads to using technology and creating new customers. In this stage, technology adopters as pioneers, invite their friends, family members, and acquaintances to use the technology and convince some of them to test it. Actually, ones that have adopted the idea or the technology, are in contact with ones that have not and encourage them to become familiar with the new technology. This leads to an incremental feedback which involves more and more people in the new technology and increases the number of adopters. As time goes by and people use the technology more and more, the habit of using the technology gets stronger in the customers and their attitude changes which create a greater desire in them to use the new technology, and finally, it will lead to the continuous use of technology. It should be noted that every new technology that enters the market faces resistance from people which creates a negative attitude and prevents people from using it. Gradually by getting used to E-Banking, this resistance reduces. In other words, this process can continue in form of an incremental cycle and cause more use of technology.

Gradually by the rise in the number of active customers and more use of technology, a backlog of problems would be accumulated; e.g. system malfunction, high response time, unsuccessful transactions, etc. These problems make an uncertainty in minds of some adopters which causes a decline in adoption level, and at the same time by making dissatisfaction in active customers, it encourages some of the users to discard the technology and go back to the potential population. In fact, the backlog of problems, as a restricting factor for the growth of technology, halts the irregular growth of active customers. Additionally, after a while, all technologies become obsolete; especially when they get near to their economic life. Therefore, a number of customers discard the technology as soon as its life period is passed and join the population of potential adopters; so that they would be again impressed by the set of factors influencing the intention of use, as a new technology enters the market. In fact, we could say that the end of economic life is another restricting factor for the growth of technology.

In this system, by the increase in the number of active customers and more use of presented technology, the number of mobile banking transactions goes up. Regarding the fact that various transactions, depending on the nature of the service they provide, differ in fees from each other, each makes some specific revenue. The aggregate value of all revenues is called the bank's non-interest income or fee revenues from mobile banking. In another perspective, transactions have their own costs for the bank which should be subtracted from their revenues to result in a net profit of mobile banking transactions. In order to develop the required infrastructure and describe the dynamics of the business, it is assumed that a part of this profit is invested for Research and Development (R&D) activities. R&D activities intend to create a new version of mobile banking technology with new services by carrying out disparate projects in a specified period of time. Development of newer products is mainly in order to reduce the problems of older versions and to increase the attraction of the product. So that the average number of transactions rises, and product's higher quality make improvements in perceived usefulness and customers' attitude. This will obviously increase the level of satisfaction from the technology. Hence, the updated product or service will again enter the adoption cycle and will follow the set of factors influencing the intentions of use. So, the described processes of adoption and profitability of mobile banking would occur for the newer products, too.

3.2. Causal Model

Causal loop diagram of the whole system consists all the interactions and feedback relations among involved subsystems of the problem and was drawn as figure 1.

Figure 1-Cause and effect diagram of mobile banking development and adoption

3.3. Stock and Flow Model and Scenario Generation

After determining problems, stock and flow structure, and also the information flows, the final stock and flow diagram of the system was provided. Before generating the scenarios, the leverage points of the problem should be identified. In accordance with existent variables in the cause and effect diagram, the leverage points of the model are suggested as follows: 1) Intention of use, 2) Advertisement, 3) Backlog of problems and 4) System quality.

Considering the specified leverage points, following scenarios could be generated to predict the behavior of new banking services development.

1) First scenario: prolonging current situation: This scenario means not to make any changes in the current structure of new banking services development. In this scenario, we can track the behavior of important variables in the time period.

2) Second scenario: increasing advertisement: Here, the advertisement is chosen from all the controllable variables. This scenario tries to enhance the effectiveness of advertisement by increasing its amount and employing novel techniques; so that more potential customers join the active customers and become technology's users.

3) Third scenario: increasing research and development (R&D) budget: In this scenario, a percent of profit which was assigned to R&D is increased from 3% to 6%. It is expected to visit higher transactions levels and profitability as a result of investing more money on R&D and improving the process of product development.

4) Fourth scenario: improving the set of factors influencing the customers' intention of using the technology: This scenario tries to improve the set of controllable factors which influence the customers' intention of using mobile banking technology; e.g. improved ease of access, ease of using the new technology, higher system quality, fewer system errors, and less perceived risk of use which is followed by higher levels of user's trust. Plus, higher quality of service leads to less unsuccessful transactions which prevent some of the customers from leaving the technology. All of these factors have positive effects on users' attitude which forms their behavior. So, they improve their intentions of using the technology.

3.4. Scenarios & Policies Result's Simulation

As the described current system goes on through time, the number of potential adopters would form a normal curve (figure 2.a). Sensibly by the decrease of potential adopters, we would experience an increase in active customers. Also, the number of adopters has formed an s-shaped curve; at first, adopters' population will have an exponential growth, but it is not going to last, as gradually, by the activation of growth restricting loop, this population will converge to about three millions people. As it is noticed in the diagram shown in figure 2.b, costs and revenue would have exponential growth; so, the profit, which is costs subtracted from revenues, would have an exponential growth, too. However, this trend is not favorable as costs are growing with the same trend as revenues. We need to gradually increase the gap between costs and revenues to increase the profit margin.
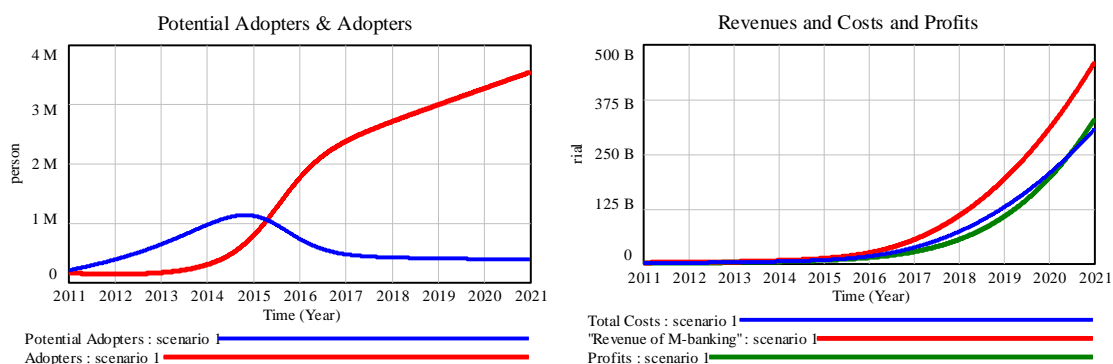

Figure 2-Simulated effects of prolonging current situation on the number of potential adopters and active adopters, revenues, costs, and profits

By applying the second scenario, as it was predictable, the system would face a fall in the population of potential adopters as they will turn into active customers (figure 3.a). As it is shown on figure 3.b, more advertisement would cause an increase in a number of active customers, but it would not be stable in long term.
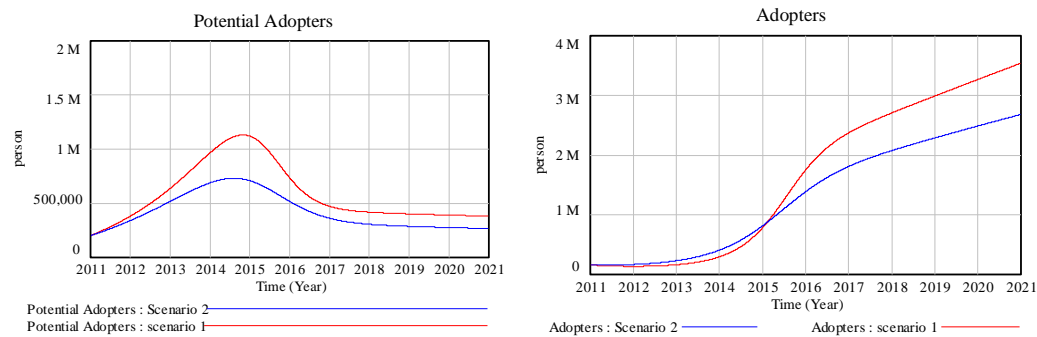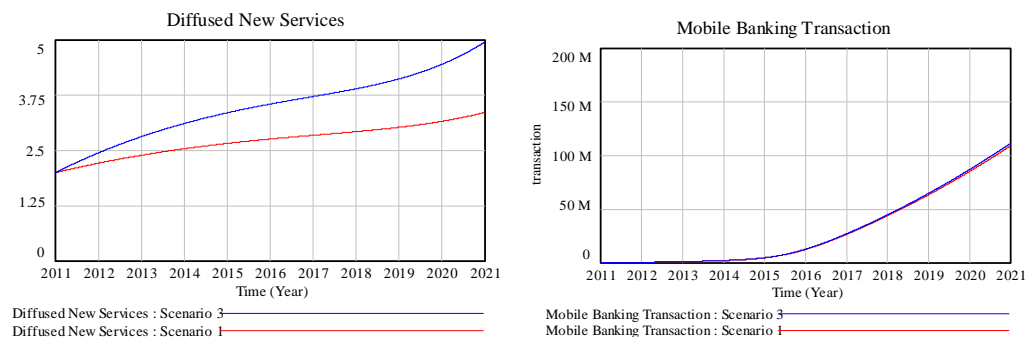

Figure 3-Simulated effects of increasing advertisement on the potential adopters and final adopters

Furthermore, in this scenario, bank's profit reduces unexpectedly (figure 4). The reason beyond this is higher expenses of advertisement compared to the rise in revenue gained from extra transactions in long-term. Therefore, this policy is not a sustainable solution for increasing the bank's profit.
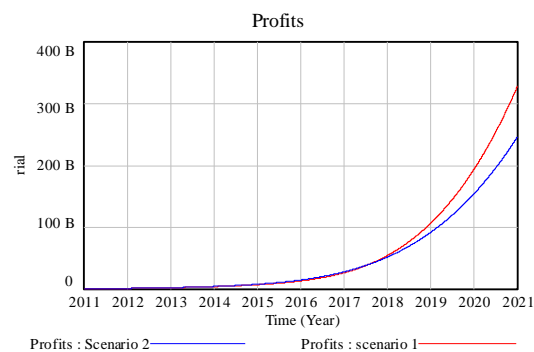

Figure 4-Simulated effects of increasing advertisement on net profit

The third scenario plans to expand the R&D activities which will result in more new services diffused by this sector (figure 5.a). Additionally, in this scenario, we would only experience a rise in the quantity of services, but advertisement and the quality of services remain as before (figure 5.b). Hence, the number of transactions would slightly change. We concluded that only with higher investment on R&D and without improving the quality of product and advertisement for developed services, there would be no significant rise in transactions.


Figure 5-Simulated effects of increasing R&D budget on services development and banking transactions

The fourth scenario tries to target the set of factors influencing the customers' intention of using the technology which leads to an increase in the number of potential adopters (figure 6.a). This behavior is reasonable; because when we strengthen the intentions for using a product, more people will be encouraged to try it. According to figure 6.b, the number of active customers would also go up, since potential adopters act as an input for the population of active customers which will be activated by advertisement.
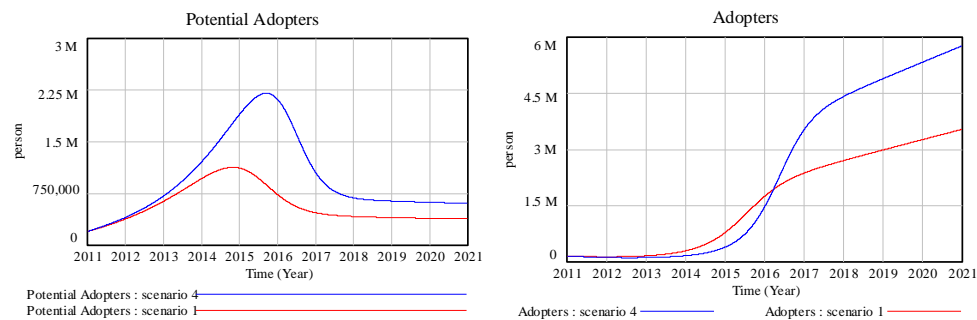
Figure 6-Simulated effects of improving the set of factors influencing the customers' intention of using the technology on the potential adopters and final Adopters
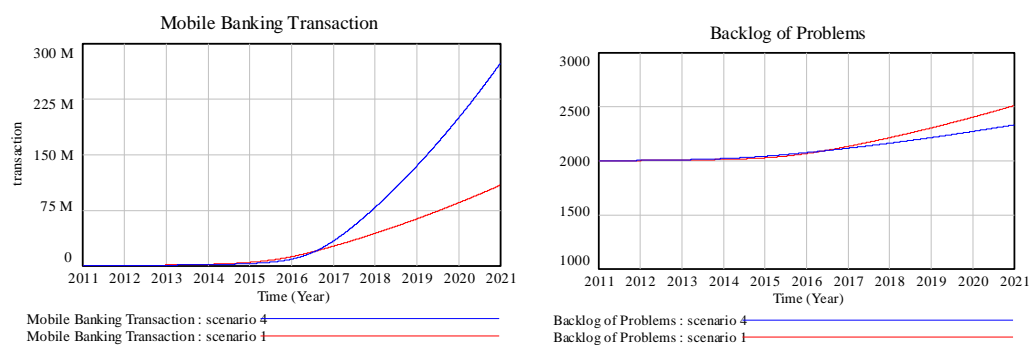
Figure 7-Simulated effects of improving the set of factors influencing the customers' intention of using the technology on banking transactions and backlog of problems

When the population of active customers grows, clearly the number of transactions will increase, too (figure 7). This would result in higher levels of net profit. By applying this scenario accompanied by some improvements in quality and reduction of unsuccessful transactions, system's backlog of problems reduces to some extent. So, it can be concluded that by improving the set of factors holistically and systemically we can achieve a sustainable improvement in the system.

4. Conclusion

In this paper, it was tried to present a dynamic model for the continuous and complicated relations of developing new banking services in order to generate and apply different scenarios and predict their future results, regarding important issues of banking transactions and banks fee revenues. The developed model was used to simulate four different scenarios. The first scenario was employed to simulate the action of prolonging current situation without making any significant changes; it showed no promising results in long term. The second scenario was intended to simulate the results of increasing advertisement; this policy satisfied the short-term requirements of the system, but would not guarantee any stable future and may even cause a decrease in profit. In the third scenario, higher investments in R&D sector was simulated. Unexpectedly, though the quantity of presented services would go up, the number of transactions would barely change. It looks like without advertising and concentrating on service's quality, people would not have

much interest for the new services. For this problem, the fourth scenario would most probably make better improvements, as in this scenario, the set of factors influencing the people's intention of using the technology were improved; e.g. improved ease of use, higher system quality, fewer system errors, and less perceived risk of use. This policy would result in higher satisfaction level, less unsuccessful transactions, and fewer lost customers. Hence, the number of customers or service adopters would increase, and accordingly more transaction fees would lead to a higher profit level.

The suggested dynamic model presented here is capable of demonstrating the dynamic behavior of the real system in developing new banking services. Additionally, the most important feedback loops of its structure were identified; e.g. the loop of adoption caused by interacting with active adopters of the technology and their word of mouth, advertisement and marketing effects loop, loop related to the influence of backlog of problems, and discarding the technology by customers. Also, variables of use intention, advertisement, the backlog of problems, and system quality were recognized as model's leverage points.

This model facilitates the policy making process for banks managers. The key result of this investigation was showing how the set of factors influencing the intention of use are the most important issue that managers need to consider before presenting a new mobile banking technology to the market.

This research was however restricted in some aspects. Above all, the lack of precise and comprehensive information about the existent parameters of the model, made the author define some of the relations in the model based on initial estimations. Regarding the significant role of costs in banking profit and their complex system, it is recommended for the future studies to do a much detailed analysis on costs and their effects on the system. Plus, the relation of banking interest income and the dynamics of developing a new banking service can be investigated much deeply.

References

[1] A. R. Konjkavmonfared, M. Mirhoseini, Factors affecting the adoption of mobile banking customers bank branches export city of Yazd, *Journal of Marketing Management*, 4102. (in Farsi)

[2] N. M. Yaghoubi, R. Shakeri, Internet banking adoption assessment model based on model DTPB developed, *Research Review Management Executive,* Vol. 9, No. 2, 4112. (in Farsi)

[3] P. Ghafari Ashtiani, F. Asadi, The effect in overcoming the resistance of consumers to mobile banking adoption of Melli bank of Iran, *Ninth International Conference on Management,* 4100. (in Farsi)

[4] M.T. Taghavifard, M. Torabi, Factors affecting the use of mobile banking services by customers and rank them (Case study: Bank of Commerce branches in Tehran), *Journal of explorations Business Management,* Vol. 2, No. 3, 4101. (in Farsi)

[5] H. Amadeh, M. Jafarpour, Study of the Barriers and strategies for the development of E-Banking in the country's private banks, *Research Review Management Executive*, Vol. 9, No. 2, 4112. (in Farsi)

[6] M. A. Sarlak, M. Roustaei, M. H. Moghadasan, Factors affecting the mobile banking adoption in Iran, *Fourth International Conference Marketing of banking services. Tehran: Center for Financial Services Marketing,* 4104. (in Farsi)

[7] I. Brown, Z. Cajee, D. Davies, S. Stroebel, Cell phone banking: predictors of adoption in South Africa—an exploratory study. *International Journal of Information Management*, Vol. 23, No.5, pp. 381-394, 2003.

[8] W.T. Wang, C.Y. Liu, The application of the technology acceptance model: A new way to evaluate information system success. *Paper presented at the Proceedings of the 23rd International System Dynamics Conference*, 2005.

[9] T. Kuisma, T. Laukkanen, M. Hiltunen, Mapping the reasons for resistance to Internet banking: A means-end approach. *International Journal of Information Management*, Vol. 27, No. 2, pp. 75-85, 2007.

[10] B. Vatanasombut, M. Igbaria, A.C. Stylianou, W. Rodgers, Information systems continuance intention of web-based applications customers: The case of online banking. Information & Management, Vol. 45, No. 7, pp. 419-428, 2008.

[11] X. Luo, H. Li, J. Zhang, J. Shim, Examining multi-dimensional trust and multi-faceted risk in initial acceptance of emerging technologies: An empirical study of mobile banking services. Decision Support Systems, Vol. 49, No. 2, pp. 222-234, 2010.

[12] P.G. Schierz, O. Schilke, B.W. Wirtz, Understanding consumer acceptance of mobile payment services: An empirical analysis. Electronic Commerce Research and Applications, VOL. 9, No. 3, pp. 209-216, 2010.

[13] A. R. Dehghan, H. Radgohar, SH. Ghasmi, A model based on TAM and TPB to accept internet bank in Iran, Sixth National Conference on Electronic Business and Economy, 4100. (in Farsi)

[14] M. Zanjirchi, A.R. Konjkavmnfared, H. Hataminasab, H. sattarzadeh, Technology Acceptance Model

developed for the effectiveness of electronic customer relationship management (Case Study: Yazd city commercial bank branches), marketing management, Vol. 16, 2012. (in Farsi)

[15] P. Ghafari Ashtiani, M. Panahi Vanani, R. Shabani, Factors affecting adoption mobile banking among customers Parsian Bank city of Arak, Journal of Management, Vol. 10, No. 30, 2013. (in Farsi)

[16] A.C. Teo, G. W. H. Tan, C. M. Cheah, K. B. Ooi, K. T. Yew, Can the demographic and subjective norms influence the adoption of mobile banking? International Journal of Mobile Communications, Vol. 10, No. 6, pp. 578-597, 2012.

[17] P. Hanafizadeh, M. Behboudi, A. A Koshksaray, M. J. S. Tabar, Mobile banking adoption by Iranian bank clients. Telematics and Informatics, Vol. 31, No. 1, pp. 62-78, 2014.

[18] H. Mohammadi, A study of mobile banking loyalty in Iran. Computers in Human Behavior, Vol. 44, pp. 35-47, 2015.

[19] C. Chuchuen, The Perception of Mobile Banking Adoption: The Study of Behavioral, Security, and Trust in Thailand, International Journal of Social Science and Humanity, Vol. 6, No. 7, 2016.

[20] A. Intrapairot, M. Quaddus, A system dynamics approach to the diffusion of Intranet banking: A case study from Thailand. Paper presented at the Proceedings of the 17th International Conference of The System Dynamics Society, 1999.

[21] M. Quaddus, A. Intrapairot, System Dynamics Modelling of Information and Communication Technologies: Policy Studies in the Banking Industry in Thailand. *The 16th international conference of the system dynamics society*, 2008.

[22] A. Heidarieh, M. Seyed Hoseini, A. Shahabi, Simulation model of technology adoption in the banking system dynamics approach (Case Study: Bank Refah), Journal of Technology Management, Vol. 1, 2013. (in Farsi)

[23] Ahmadvand, A., Varandinaderi, A., Bastan, M., & Yahyaei, M. (2014). Analysis of Tehran construction and demolition waste management with System Dynamics Approach. Asian Journal of Research in Business Economics and Management, 4(8), 234-242.

[24] J. D. Sterman, Business dynamics: systems thinking and modeling for a complex world, Vol. 19: Irwin/McGraw-Hill Boston, 2000.

[25] Abbasi, E., Bastan, M., Ahmadvand, A.M. A system dynamics model for mobile banking adoption. *The 12th International Conference on Industrial Engineering (ICIE)*. 2016. IEEE.

[26] Bastan, M., Bagheri Mazrae, M., Ahmadvand, A.M. Dynamics of banking soundness based on CAMELS rating system. *The 34th International Conference of the System Dynamics Society. Delft, Netherlands. 2016.* System Dynamics Society.

[27] Bastan, M., Akbarpour, S., Ahmadvand, A.M. Business Dynamics of Iranian Commercial Banks. *The 34th International Conference of the System Dynamics Society. Delft, Netherlands. 2016.* System Dynamics Society.

[28] Bastan, M., Delshad Sisi, S., Nikoonezhad, Z., Ahmadvand, A.M. Sustainable Development Analysis of Agriculture Using System Dynamics Approach. *The 34th International Conference of the System Dynamics Society. Delft, Netherlands. 2016.* System Dynamics Society.

[29] Bastan, M., Akbarpour, S., Delshad Sisi, S. Organizational Demographic Management: A System Dynamics Model. *The 34th International Conference of the System Dynamics Society. Delft, Netherlands. 2016.* System Dynamics Society.

[30] Kasiralvalad, E., Bastan, M., Abniki, H., Ahmadvand, A.M. Simulation Analysis of Brain Drain in Iran using System Dynamics Approach. *The 34th International Conference of the System Dynamics Society. Delft, Netherlands. 2016.* System Dynamics Society.

[31] Bastan, M., Abdollahi, F., Shokoufi, K. Analysis of Iran's dust emission with system dynamics methodology. *Technical Journal of Engineering and applied sciences,* 2013. 3(24): p. 3515-3524.

[32] Ahmadvand, A., et al., Analysis of Tehran construction and demolition waste management with System Dynamics Approach. *Asian Journal of Research in Business Economics and Management*, 2014. 4(8): p. 234-242.

[33] Khoshneshin, F., Bastan, M. Analysis of dynamics of crisis management in the earthquake and performance Improvement using system dynamics methodology. *The 10th International Conference on Industrial Engineering (in Farsi). 2013*. Tehran University.

[34] Akbarpour, H., et al. Investigation on Short-term Inflation Rate in Iran using Artificial Neural Network. *The First National Conference on Development in Monetary and Banking Management.* 2014.

[35] Bastan, M., Mosaed, M., Kashef, F. Dynamic Analysis of Housing Cost Changes in Tehran. *The 9th International Conference on Industrial Engineering (in Farsi).* 2013. K.N. Toosi University of Technology.

[36] Bastan, M., Soltani Khamsehpour, F. System Analysis of user satisfaction in healthcare services with system

dynamics methodology. *The 1st International Conference on Industrial Engineering, Management and Accounting. 2016.* University of Applied Science and Technology.

[37] Bastan, M., Zadfallah, E. Traffic Impact on Public Health: An Analysis with System Dynamics Approach. *The 1st International Conference on Industrial Engineering, Management and Accounting. 2016.* University of Applied Science and Technology.

[38] Zadfallah, F., Bastan, M., Ahmadvand, A.M. A Qualitative System Dynamics Approach to Clinical Risk Management*. The 13th International Conference on Industrial Engineering. 2017.* Mazandaran University of Science and Technology.

[39] Azizi Baraftabi, L., Bastan, M., Ahmadvand, A.M. Occupational Health and Safety Management System Development: A Qualitative System Dynamics Approach. *The 13th International Conference on Industrial Engineering. 2017.* Mazandaran University of Science and Technology.

[40] Tabarzan, T., Bastan, M., Ahmadvand, A.M. The Model of Chronic Cardiovascular Diseases Growth and Effective Control Costs Management: A qualitative System Dynamics Approach. *The 13th International Conference on Industrial Engineering. 2017.* Mazandaran University of Science and Technology.

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