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Typical presentation to evaluate NFC technology in electronic mobile payments

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ABSTRACT

In recent years, electronic micropayments by cell phones have been possible. Some activities have been done in this field as well. Mobile near field communication (NFC) technology, which is a standard mobile method for connecting electronic devices at near distances, has grabbed a lot of attention in order to pay mobile micropayments and electronic payment services by financial institutions, payment service companies, SIM cards manufacturers and operators. The beneficiary organizations need to meet some requirements such as management preparation. This paper aims to detect different NFC technology uses and study and rank the main factors of success in implementation of this technology in organization by applying analytic hierarchy process. The humanitarian specialists and environmental and technological experts should be considered in order to use NFC technology in mobile payments. Among 81 sub-criteria, security and privacy are the most important factors for implementing NFC technology successfully.

Introduction

Today's world is changing in all aspects particularly in terms of communication and technology development with amazing speed. This change maximizes the speed and simplicity of performances in all aspects. According to the latest data available, more than any other form of technology, mobile devices are used and this issue has brought mobile services into a global commerce revolution in both developed and developing counties (Javdan & Fathian, 2008). Merging the world's most popular mobile device, mobile NFC technology has created various services and commercial opportunities.

One of the basic NFC technology functions in mobile micropayments. Micropayments are used for small amount of money which is transacted between the retailer and customer. The classical method of small payments use a lot of cost and sometimes is time consuming;

therefore, those who offer electronic payment services have presented some solutions for micropayments such as using digit wallet for small amounts of money and also contactless smart cards. The solutions are not over here and the presenters of electronic payment services have introduced this device as the micropayment device considering the number of people who have cell phones and the permanent availability of cell phones. This device by having adopted rigid standards in electronic micropayment system causes the convenience in payment and reduction in expenses. Moreover, it will create a motivation through facilitating the remittance of small amounts leading to an evolution of the micropayment industry. Thus, the dramatic growth in ICT (Information and communication technology) such as computer networking, near communications, radio and computer waves, and mobile payment has become more popular among users and as new payment services, e-commerce has attracted the attention of telecommunication operators, banking institutions, and suppliers of IT services (Zhu et al, 2006).

Regarding the importance, potential benefits, and challenges of applying NFC technology in the field of mobile payments, the aim of this study was to determine the factors that beneficiary organizations and institutions such as banks and host organizations should consider to apply this technology. For this purpose, four categories including organizational, technological, environmental, and human factors were determined after analyzing and mapping the existing literature. Then, different sub-criteria of each factor should be considered for using NFC based technology in electronic payment, security, and privacy of people.

An Overview on NFC Technology

NFC (Near Field Communication) technology consists of combination of standards which are used in Smartphones. NFC is a short-range low-power communications protocol between 2 devices. The device which is an initiator or origin of a communication creates a radio wave field and the target device can identify and access to it. These two devices can transfer small amounts of data wirelessly in less than 4 inches between themselves (Babayi et al, 2013).

NFC is a short-range high frequency wireless communication technology which enables the transfer of data through the device up to a distance of 10 cm with a frequency of 13.56 MHz without a need for user configuration (Ondrus & Pigneur, 2007a). This technology as the basis for mobile payments in a near field communication has applied the similar infrastructures such as existing contactless financial payment cards which are very *convenient* and appropriate to use.

In this technique, mobile phones, based on NFC technology, provide secured storage for the payment, consumer account information, and use the information as virtual card payments by using the combination of small chips. NFC technology in mobile phones with the standard function allows the customers to perform secure contactless transactions, access to digital content, and connect to electronic devices. NFC chip in the mobile works as a card or card reader device or both of them and allows consumers to share information as well as performing quick secured payments. Virtual card payment which functions in NFC-based cell phones requires the cooperation of banks or financial institutions, retailers, service provider

interface, mobile network operators, mobile handset manufacturers, and regulators of required standards for this industry.

NFC Technology Usage

NFC technology is able to use cell phones as card reader devices or the radio waves and this capability would create so many opportunities to provide inventive services. NFC technology is used in different types of applications such as intelligent posters, loyalty scores, availability and accessibility of information, mobile ticket, NFC technology-based devices with internal charge, and usable in daily life. Intelligent posters refer to the advertising posters that can be converted into intelligent ones by using NFC technology. In this situation, an NFC label would be stood on the surface of the poster and people can read or write more information about the advertising products or services by using their NFC-based cell phones. Loyalty scores is an application in which NFC-based technology cell phones are used to store customers' loyalty scores, for example retailers can store loyalty scores of customers on their cells while they go shopping. Availability and accessibility to information while moving is one of the important applications of this technology, for instance while passing the advertising poster on the street, you can have access and manage its information to find the way and the direction and people can be lead through this technology into an unknown environment with the guide of GPRS. Mobile ticket is an application of NFC cell phones which work as electronic tickets, for example through installing NFC-cable terminals in subways or bus stations it would be possible to use it in transportation system with the NFC method (Sixto Ortiz, 2006). Furthermore, sports fan can pay their tickets fee to take part in the match by moving their cell phones next to the card reader device and on their way to their seats; they can receive the picture of their favorite player by approaching to their posters. When the match ends, they can buy the prepared food by using electronic coupons saved on their cell phones. NFC technology-based devices with internal charge work actively without internal battery charge such as smart cards. Through changing the passive device to the active one, the device would be charged and with the increase in the charge, it can communicate and exchange data with other devices. This ability has lead to a difference between NFC technology-based devices and other contactless technologies. Therefore, NFC cell phones can be used to send payment data to the sale terminals or receive data from the advertising signs equipped with this technology. Finally, the last application refers to its usability in daily life. Your cell phone will be easily connected to the printer and wireless headset with NFC. The main purpose of using NFC is to replace cash, credit cards, payment cards, reward cards, coupons, tickets, and passports in transport system into a virtual wallet on the NFC cell phones with different implementations of NFC technology.

The Literature Review

Salminen, Hosio, and Riekki (2006) have presented a model to accept the NFC-based technology through studying other popular acceptable models in technology and in which he has studied the effects of five factors contribute to comparative advantage, trust and security, compatibility, simplicity, and expense for accepting this technology. The concept of NFC technology is new and necessary in the literature. It is the full fledged forms of RFID and

relatively a few studies have been done in this area. Therefore, the studies that provide a classification and prioritization of necessary factors in adaptation and implementation NFC technology have been studied. Joe Kar and Zanozzi (2011, as cited in Tornatzky & Fleischer, 1990) has proposed different factors that influence adoption and application of Radio Frequency Identification (RFID) technology in Iranian Industry and studies three effective aspects of organization, environment, and technology in their model. They considered 12 variables for 3 dimensional models. For technology dimension, factors such as relative advantage, complexity, compatibility, and expenses are considered into account, while for organization dimension factors such as senior management support, company size, technology competence, technical knowledge, and organizational readiness are important. Ultimately, factors like competitive pressure, forcing trading partners, and the urgent need of information are taken into account in environmental dimension. The results showed that except knowledge-based technical variable, other variables affect on the acceptance of RFID technology. Wang, Wang, and Yang (2010) surveyed the key dimensions of factors that determine the consumers' acceptance of RFID technology in Taiwan's industry. They divided the technology acceptance factors into three categories of organization, environment, and technology and considered some variables for each separate category. The organizational variables included senior management support, organization size, and technological competence while environmental variables consisted of competitive pressure, business partner force, and information intensity. Finally, third technology variables refer to the relative advantage, complexity, and compatibility.

A research which investigates the mobile payment acceptance in Nigeria revised the integrated compatibility, relative advantage, complexity, reliability, security, and expense of technology acceptance model (TAM). Perceived usefulness, perceived ease of use (PEU), and behavioral intention approved the acceptance of contactless payment technology in Nigerian consumers.

The results showed that the economic benefits of cash payments via mobile phones were perceived by Nigerians and they are encouraged to use it as well. Its benefits include convenience, ease of use, ease of access, and reduction of each transaction cycle time. However, some factors such as process complexity, the external shape trust in service delivery, agents (retailers), information security and privacy, and valid expenses influence on successful acceptance of mobile payment implementation. The model of TOE consists of technology, organization; environment has effect on usage and perception of effective fundamental factors on applying new information technology in an organization. This framework involves three main factors including organizational, technological, and environmental factors that affect on applying technological innovation (Tornatzky & Fleischer, 1990). According to the research background, *technology-organization-environment* (TOE) framework (Tornatzky & Fleischer, 1990), and organizational human fitness model (Yusof, Papazafeiropoulou, Paul, & Stergioulas, 2008), in this study an integrated model has been used which studied on the required factors to accept and perform NFC technology in four dimensions of organization, technology, environment, and human.

Conceptual Framework of Study

Organizational factor is one of the important items in accepting and using a technology in the organization. All the previous similar researches stated that factors such as the support of senior management, risk taking, and size of the organization are important factors. Organizational factors discuss on the main common characteristics of the organization such as size, degree of concentration, formalization, complexity, management structure, personnel quality, organizational knowledge, and the availability of internal and external resources (Chau & Tam, 1997). Organizational factors, in this study, consist of senior management support, organizational technical knowledge, strategies and objectives, IT infrastructure, financial resources, and finally trust.

Environmental factors which influence on the individuals are often ignored by others. Tornatzky and Fleischer (1990) have defined the environmental factors as the environment in which the organization is in contact with the industry, opponents, government, and customers and each of these areas affects on decisions and commercial policies of the company. In this study, environmental factors include laws and policies, forcing trading partners, competitive pressures, and the role of stakeholders. Technological factors include internal and external technologies that will be effective on new technologies. They encompass the observed characteristics related to a technology (Kuan & Chau, 2001) Technology factors consist of factors such as relative advantage, ease of use, compatibility, and the cost.

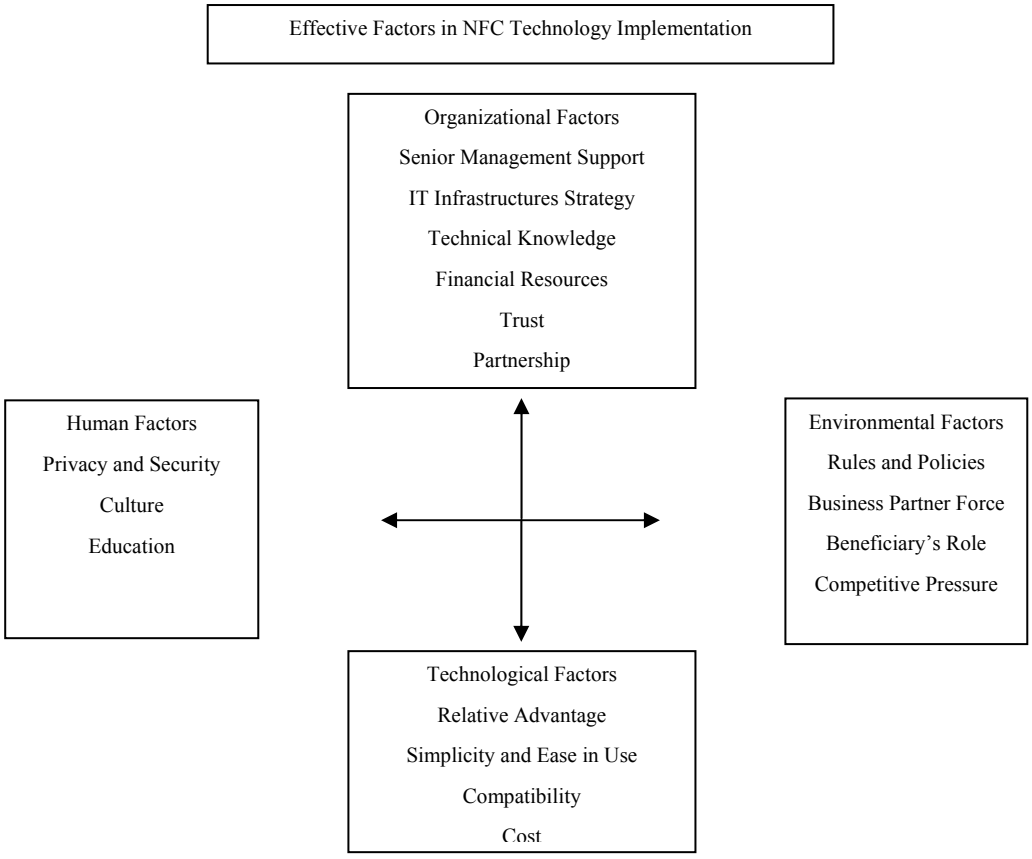

Figure1. The conceptual framework of study

The purpose of creation and development of a new technology is the users' consent and without users' acceptance, all efforts to implement the new technology will be wasted. Human factors in this research include privacy, security, culture, and education. Figure 1 presents the conceptual framework of the study which includes the comprehensive factors that led to the adoption and implementation of NFC technology.

Method

Descriptive research is *used* to describe characteristics of a population or phenomenon being *studied*. The study seeks to identify and rank the organizational factors in the successful implementation of NFC technology. For this purpose, two steps have been taken into account. In the first phase, the factors that may influence adoption of NFC and RFID technology are identified through using library research databases, articles, and researches which have been done in various organizations. In the second phase, the identified factors have been ranked based on the research questions by applying fuzzy analytic hierarchy process (AHP).

Due to the specialized nature of the subject study, the statistical society of this research consists of IT experts of Fanava Company who have cooperation on implementing this successful technology with Shahid Beheshti University professors in information technology field. On the other hand, due to the limited statistical society, the census method has been used.

In order to obtain expert opinions in the parity check matrix the questionnaire was used. Questionnaires were designed in such a way that respondents could determine the value of criteria and sub-criteria by using parity approach. To assess the validity of questionnaire, the ideas of company's IT experts who work on NFC technology and its successful implementation in Iran on its university professors have been used. After collecting the answers of experts in the form of verbal statements, they should be converted into a fuzzy scale.

Data analysis

According to the research on multi-criteria techniques, decision making methods, popularity of *fuzzy analytic hierarchy process* method in previous researches, and necessity of looking at the quality of many indicators which are listed in the survey, it is necessary to conduct the research by using the fuzzy *analytic hierarchy process* method. Moreover to deal with the ambiguity and uncertainty and having a clear picture, fuzzy *analytic hierarchy process* method is preferred in prioritizing the importance of criteria and sub-criteria. In this research, developing analysis method has been used because the steps of this method are relatively simpler than other methods of analytic hierarchy process and it is more similar to the classic *analytic hierarchy process* method. To gather information, two methods consist of library and field research methods have been applied. For codification of theoretical framework and research history, the library evaluation method has been used and to answer the research question and achieve the research goals, the field research method has been applied.

Fuzzy analytic hierarchy process method is the most applicable and famous multiple attribute decision making approach which has been presented by Thomas Saati (1990). The principle of this method lies on the basis of parity comparisons. Chang (1992) has offered a

very simple way to extend the analytic hierarchy process to the fuzzy environment. This method which was based on the arithmetic mean of the experts' opinions and the normalized method is developed by fuzzy triangular numbers and consists of seven steps. The first step represents hierarchical stages in a tree diagram. Through corresponding to the target, criteria, and sub-criteria levels, the decision hierarchical structure would be drawn at this point. The second stage forms the matrix of parity comparisons. In this step, an adaptive decision tree is formed using experts opinions and then the incompatible exchange rate can be calculated according to Gogus and Boucher method (Gogus & Boucher, 1997). In third stage, the arithmetic mean of comments is calculated.

In the next stage, the total elements of line are calculated. The fifth stage refers to the weight of normalized rows. In the sixth stage, *the degree* of variability in the attributes *being measured.* The final stage refers to the normalized matrix and weight vector.

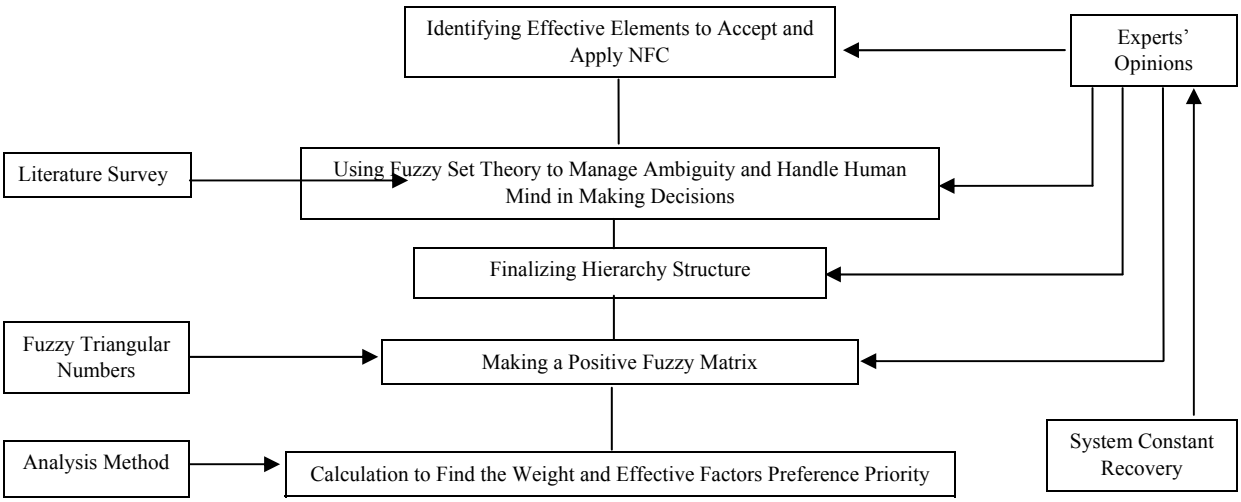

Figure2. The fuzzy hierarchical stream provision based on analytic model

Through using hierarchical structure, applying the steps of fuzzy hierarchy analytic process, and converting the verbal expressions into the fuzzy triangular numbers, the experts have calculated the weights for each criterion on second and third hierarchical levels. The final normalized weight of each element and criteria was calculated using developmental method. Consequently, the results of experts' opinions about necessary factors and criteria are presented in Figure 3 and Figure 4 in order to use NFC-based technology.

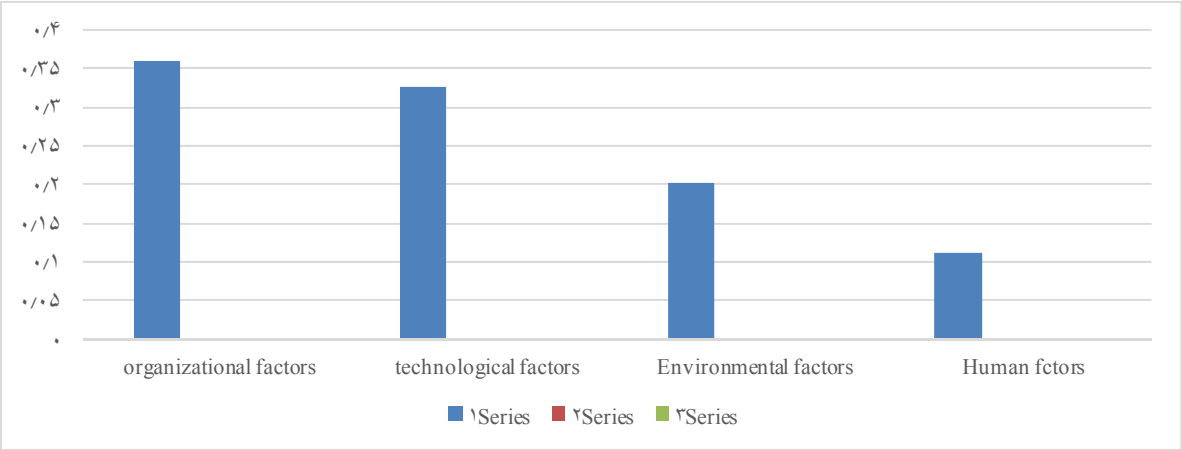

Figure3. The results of experts' opinions about necessary factors

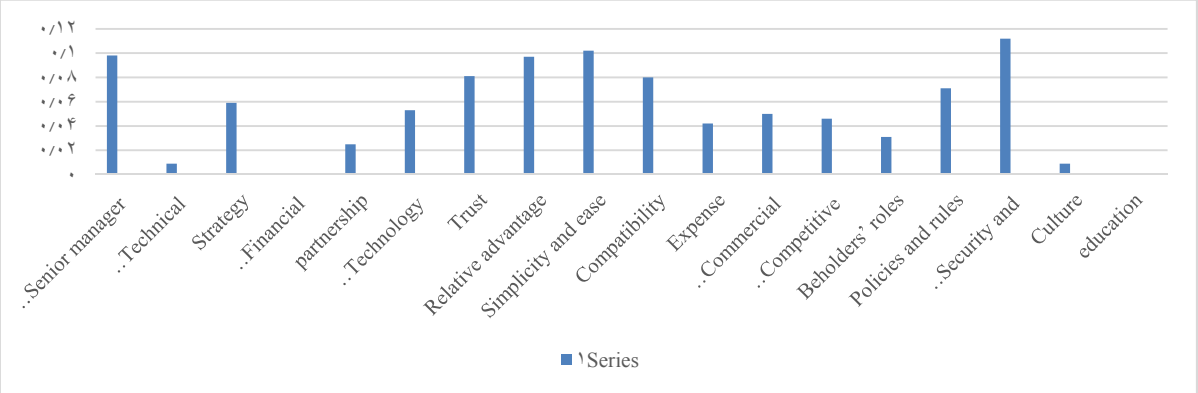

Figure4. The results of experts' opinions about necessary criteria

Discussion and Conclusion

Applying NFC technology, just as any other technologies, needs to take into account the various dimensions and factors. To pay electronically, effective key factors in using NFC technology have been identified and checked in four groups consist of organizational, technological, environmental, and human along with 18 sub-factors and ultimately these factors and sub-factors have been ranked. After analyzing data with fuzzy analytic hierarchy process method, the research results show that from experts' points of view, the criteria for the organizational factors by the weight of 0.35 get the first place for effective factors in applying the NFC technology mobile electronic payment. Respectively, technology factor with the weight of 0.32, environmental factors with the weight of 0.20, and finally human factors with the weight of 0.11 have the lowest level of importance. The final weight matrix of each criterion compared to necessary factors for accepting and applying the NFC technology has been presented in Figure 2. Among sub-criteria, security and privacy have the highest weight in accepting and applying NFC technology in the organizations (with the weight of 0.11). Simplicity of using this modern technology occupies the second rank with weight of 0.10 and one of the reasons that changed it into considerable issue is its ease and simplicity of use. This technology is not complicated and due to its easiness is placed in the second level in order to be used as a modern technology with weight of 0.10.The senior

management support in the organization in accepting and applying NFC technology with the weight of 0.09 allocates the third place to itself. The relative advantage of this technology in comparison with other similar ones is its weight which is 0.09. The extra organizational environmental factors such as competitive pressure as well as the need to gain and maintain a competitive advantage and remain competitive are the factors that managers check as the necessary infrastructure for accepting NFC technology in their organization and take extra steps to use it. The fourth place, trust with the weight of 0.081 is used for adapting priorities, laws, and government policies relating to technology. It is considered as one of the most important issues regarding the use of this technology and the existence of sufficient governmental rules to identify and meet the potential problems. The strategy of the organization is related to the existing organization's IT infrastructure including hardware and software, having a business partner force, competitive pressures, cost, and role of beneficiaries, technical knowledge, and culture and education. Based on the findings, the most important factors are security and privacy of the members. Keeping the formation private and safe is fundamental issue for the growth and development NFC-enabled mobile phones as well as security issues related to mobile security factor or interaction between the operators and various service providers. Therefore, designing transactions and exchanging personal information with limited privacy should be done without compromising the plan security. Secure encryption methods should offer anonymity to users and also tracking encryption users in case of keys disclosure (Ondrus & Pigneur, 2007b). The impact of education in the implementation and application of NFC technology is the least and it is compatible with the nature of this technology in a way that even illiterate people can use it. The results of this research could help the beneficiary organizations in determination of the factors through applying NFC technology and also prioritizing these factors. In other words, organizations that plan to use NFC technology or similar technologies can take advantage of the findings of the study in order to make more effective and better decisions and implement and use NFC. It is suggested that the current research model is used in different organizations and similar sections which accept the modern technology. It is also suggested that the data which was obtained through applying *fuzzy analytic hierarchy process* method can also achieve through applying other types of methods or combinations of these methods such as ELECRE (elimination and choice in translating to reality) or TOPSIS technique for making decisions. Comparing those methods results to those of present study provides a proper ground for further research.

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