

Development of a Research Framework for Analyzing Smart Card Technology Acceptance

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Abstract— Smart Card technology has an outstanding growth and among the fastest growing use of current technologies. In fact smart cards greatly improve the comfort and security of any transaction. It is important to note that consumer acceptance and confidence are vital for the further development of smart card technology or we can say that acceptance has been viewed as a function of user involvement in smart card systems development. Understanding the factors that influence user acceptance of information technology is of interest both to researchers in a variety of fields as well as procurers of technology for large organizations. Adoption of smart card technologies should not be made simply, knowing the customers perception of and behavioral intention to use technology should be key in the decision-making process. The purpose of this study is to develop a model for user adoption of using technology.

Index Terms—Smart card, acceptance, adoption, framework

I. INTRODUCTION

A smart card is a plastic card with an embedded microprocessor chip (usually small gold-colored metal module), capable of storing a significant amount of data and performing basic computing operations. Most smart cards resemble the size of a standard credit card (Rankl and Effing, 2003). The card interacts with a reader through direct physical contact or with a remote contactless radio frequency interface. Without realizing it, these plastic cards have become a very important part of your life.

Smart card has many uses and wide range of applications from phone cards to digital identification of the individuals. This application could be; identity of the customer, library card, e-wallet, to gain physical access to facilities such as buildings, rooms, and gates, and to gain access to computers (through a card reader), and it can be used for digital signature on email and documents.

Smart cards are secure devices that enable positive user identification and they are multi-functional, cost effective devices that can be easily adapted for both physical and logical access. Logical access control concerns such familiar principles as password checking or the more sophisticated cryptographic mechanisms for authentication such as windows logon, VPN access, network authentication, biometric storage and etc. Physical access control relates to ID badges and building access control.

The data is stored and processed within the chip, this data can be value or information or both, either a memory chip or

microprocessor chip. Smart card makes possible sophisticated and portable data processing applications.

It is important to note that consumer acceptance and confidence are crucial for the further development of smart card technology as the underlying issues which demand more control, security, usefulness, flexibility and ease of use (Rankers et al., 2001; Powell, 1999; Argy and Bollen, 1999). Generally, acceptance is defined as an antagonism to the term refusal and it means the positive decision to use an innovation (Simon, 2001). The question about user acceptance is related to all researchers who want to presage which technologies will prove appropriate for an organization (Dillon and Morris, 1996). Several researches developed theories and models to describe and analyze user acceptance and each of these models determines different factors to explain user acceptance. This study combines previous studies and develop a model to investigate the user acceptance about smart card technology.

User acceptance is very significant to the successful implementation of any new technology such as smartcard. Being user-friendly and ease of use are the main factors to achieve the user's acceptance. Smart card implementation must be clear to the users or cardholders, or at least it has minimal impact on them.

An application's features play an important role in determining whether individuals involved in an activity will use it or not (Venkatesh et al, 2003). Technology should be introduced to people and they have to be aware of its characteristics, features, and advantages. Although user awareness is important, educating and supporting the end users is also significant. In addition, culture plays vital role in technology acceptance. Cultural differences that exist between different countries may affect on their understanding and utilization of technology.

In order to be able to investigate and examine the user acceptance of smart card technology, we need to identify the important factors that affect on user acceptance and then having a technology acceptance model.

II. LITERATURE REVIEW

The aim of this section is to provide a review of present literature of some models and theories regarding acceptance or take up of a new technology. User acceptance is defined as the demonstrable willingness within a user group to employ information technology for the tasks it is designed to support. Some of these theories and models which have been used to develop a smart card acceptance model are briefly described in continuation.

Innovation Diffusion Theory is one of the popular and enduring conceptualization of innovation adoption behavior (Masrom and Hussein, 2008). Perhaps the principal theoretical perspective on technology acceptance is innovation diffusion theory, which has been applied at both individual (Rogers, 2003) and organizational levels of analysis. Diffusion theory offers a conceptual framework for discussing acceptance at a global level (Dillon and Morris, 1996). Rogers (1995) argued, diffusion of innovative technology is highly related to communication channels, individuals, organizational members, and social system. According to Rogers (1995) diffusion theory posits five characteristics of innovations that affect their diffusion which are: Relative advantage, Compatibility, Complexity, Trialability, Observability.

The model which was used in a research by Hui Min Lee (2003) is based upon diffusion of innovation theory (Rogers, 1995). It includes eight constructs namely relative advantage, perceived ease of use, compatibility, trialability, visibility, image, result demographic, and voluntariness.

The Technology Acceptance Model (TAM) introduced by Davis (1986) and it is one of the most widely used models of IT adoption. The goal of TAM is to predict information system acceptance and diagnose design problems before users have experience with a system. The model suggests that when users are presented with a new software package, a number of factors influence their decision about how and when they will use it (Masrom and Hussein, 2008). TAM states that an individual's adoption of information technology is depend on their perceived ease of use and perceived usefulness of the technology. Several empirical studies have suggested that TAM could be integrated with other acceptance and diffusion theories, thereby including variables related to both human and social factors and improving its predictive and explanatory power (e.g., Taylor and Todd, 1995; Venkatesh and Davis, 2000).

Extension of Technology Acceptance Model (TAM2) was introduced by Venkatesh and Davis (2000). They suggested that combination of technology acceptance model with other information technology acceptance models or adding other factors could be helpful to improve the specificity and explanatory utility in a specific area. TAM2 extended TAM by including factors namely job relevance, output quality, result demonstrability and two social factors namely subjective norm, and image influence perceived usefulness.

Unified Theory of Acceptance and Use of Technology aims to explain user intentions to use an information system and subsequent usage behavior. It is widely used in the field of information and communication technology acceptance modeling. It consists of four key constructs namely performance expectancy, effort expectancy, social influence, and facilitating conditions which are direct determinants of usage intention and behavior (Venkatesh et. al., 2003). Gender, age, experience, and voluntariness of use are posited to mediate the impact of the four key constructs on usage intention and behavior (Venkatesh et. al., 2003; Masrom and Hussein, 2008).

III. RESEARCH FRAMEWORK

The research framework is developed based on Technology Acceptance Model (TAM) (Davis, 1986), Diffusion of Innovation Theory (Rogers, 1995), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh *et al.*, 2003), Extension of Technology Acceptance Model (TAM2) (Venkatesh and Davis, 2000) and the model which was used in a research by Hui Min Lee *et al.* (2003). Figure 1 depicts a research framework that has been developed for a study

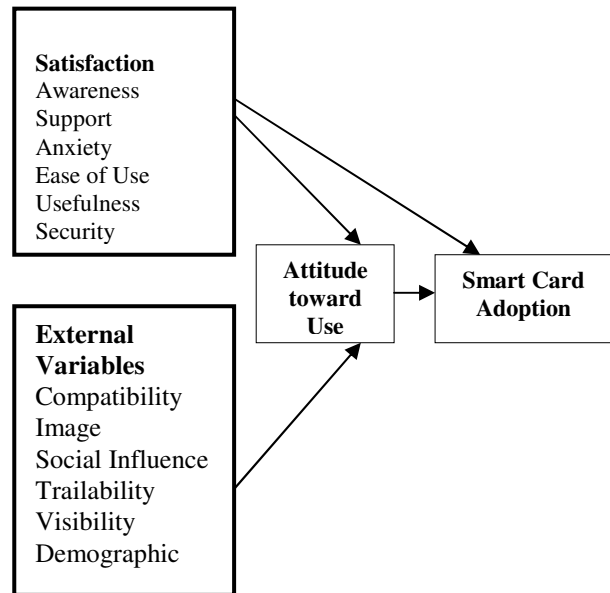


Figure 1. A Research Framework

3.1. Dimensions

3.1.1. Satisfaction

Satisfaction of the computer system will have a direct effect on usage (Igarria and Parasuraman, 1989). Bailey and Pearson (1983) defined satisfaction as “in a given situation, is the sum of one’s feelings or attitudes towards a variety of factors affecting that situation”. The measure of computer satisfaction was developed from the comprehensive tool reported by Bailey and Pearson (1983) (see appendix A). From that list we utilized four factors: Support, Ease of Use, Security, Perceived usefulness. In this list training is included and as we know training will result in awareness, so in this study we are going to add “awareness” as well.

Awareness

It is defined as “the degree to which an individual are aware about the technology” Awareness about technology cause users to look forward to try technology, and at the same time enjoy the various benefits that the system provides (Al-Alawi and Al-Amer, 2006). Having a general knowledge and knowing what features and benefits the smart card technology

has is a significant issue and it can influence on intention to adopt the technology. Awareness refers to the effort in providing knowledge and improving understanding of the smart card.

Support

Vendor support have similar representation to the Facilitating condition of UTAUT model which is defined as “the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system” (Al-Gahtani *et al.*, 2007).

Anxiety

Anxiety related to the computer system will have negative effects on both fun and usefulness (Igbaria. *et al*, 1996). When ask about the major disadvantages of smart card, the most frequently concerns are about privacy, in terms of criminals or unauthorized persons getting access to the information on the card in some manner, illegal and unauthorized using of smart card when it is lost.

Perceived ease of use

Users like and plan to use the system more frequently as the system becomes an easy one to use. Perceived ease of use is “the degree to which a person believes that using a particular system is free of effort” (Saade and Bahli, 2005). A broader view of ease of use includes elements such as ease of learning, ease of control, and understandability (Davis 1989).

Perceived usefulness

Perceived usefulness is defined as “the degree to which a person believes that using a particular system would enhance his or her job performance” (Venkatesh and Davis, 2000). Individuals who believed that using smart card systems could lead to positive outcomes also tended to have a more favorable attitude towards it. In addition, there is an empirical support for the relationship between perceived usefulness and attitude towards use (Agarwal and Prasad, 1999; Moon and Kim, 2001).

Security

Some studies have reported that users’ concern about security has increased and it has been known as one of the most significant factor for technology acceptance. In this study security is defined as “the degree to which a person feels that security is important to them and believes that using smart card is secure” (Vijayasathy, 2004). There are several reasons one requires security in a smart card system. The principles being enforced are:

- Privacy: The act of ensuring the nondisclosure of data between two parties from third party.
- Non-Repudiation: To confirm the origin of data is exchanged in transaction. Certain transaction, that is performed, never could be denied by party.
- Authentication: The process which specifying identity of person .In fact it specifies that someone or something is who or what it is claims to be.

- Integrity: The correctness of message that transmitted from the original to the recipient.
- Verification: Confirming the identity of cardholder is the useful act before using a card.

3.1.2. External Variables

We note that there is no clear pattern with respect to the choice of the external variables considered. Table 1 shows the external variables which are identified in previous studies and this study is going to use them in the propose model.

Table 1: External Variables

Researchers	External Variables
Karahanna <i>et al.</i> (1999)	<ul style="list-style-type: none"> • Compatibility • Visibility
Igbaria <i>et al.</i> (1997)	<ul style="list-style-type: none"> • Training
Agarwal and Prasad (1997, 1999)	<ul style="list-style-type: none"> • Level of Education • Prior Similar Experiences, Participation in Training
Venkatesh and Davis (1996, 2000)	<ul style="list-style-type: none"> • Subjective Norms • Image
Venkatesh and Morris (2000)	<ul style="list-style-type: none"> • Gender • Experience
Taylor and Todd (1995)	<ul style="list-style-type: none"> • Affect of Experience

Compatibility

Compatibility is “the degree to which the innovation is perceived to be consistent with the potential users’ existing values, previous experiences and needs” (Sonnenwald. *et al*, 2001). In other word, it is quality of an innovation that fits easily into the values and routine of an individual. Rogers (2003) discussed the compatibility of the innovation with the values, culture and practices of individuals.

Image

According to Moore and Benbasat (1991), it is defined as “the degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system”. Adoption may be facilitated if the use of the innovation improves the image of the user, so as prestige and other valued attributes to culture in relation to the use of the innovation that are directly related to the adoption rate (Aubert and Hamel 2001).

Social influence

Social influence is defined as “the degree to which an individual perceives that it is important others believe he or she use the new system”. In some studies it is named as “Subjective norm” and it is described as the “person’s perception that most people who are important to him think he should or should not perform the behavior in question” (Ajzen, 1985). In other word, social influence suggests that behavior is

instigated by one’s desire to act as how others act or think one should act (Chun Der Chen. et al, 2003).

Trialability

Trialability is rooted in Diffusion of Innovation Theory and is said to facilitate the adoption. Roger (2003) categorized Trialability among the Characteristics of Innovation. He defines it as “the degree to which an innovation may be experimented with before adoption”.

Visibility

It was originated from the Observability which was created in Diffusion of Innovation Theory by Rogers (2003). Observability was originally defined by Rogers (2003) as “the degree to which the results of an innovation are visible and communicable to others”. Moore and Benbasat stated that “The adoption process can also be facilitated if the technical system proposed is visible in the organization” (Moore and Benbasat 1991).

Demographic

Demography is the available information on any given user or group. Demographic data refers to selected population characteristics which are used to classify people for statistical purposes, such as age, gender, education and so on.

- **Gender**

Women’s and men’s perceptions of technology are different.

- **Age**

Czara et al. (1989) discovered that computer skills were more easily learned by younger person than by older person. Older people have more difficulty generating syntactically complex commands (Egan and Gomez, 1985).

- **Education**

Education level of potential users has a small but significant impact on users’ attitude toward the use of smart card technology. As the education level of users increase, their intention to use smart card systems will increase.

- **Experience**

Previous experience is a determinant of behavior (Ajzen and Fishbein, 1980). We predict that those who have used smart card before have more favorable attitudes towards its use than those who have not used.

3.1.3. Attitude towards use

Attitude towards use involves judgment whether the behavior is good or bad, and whether the user is in favor of or against performing it (Leonard. et al, 2004), and has a direct effect on adoption of smart card systems (Liao. et al, 1999; Davis, 1989). Table 2 shows factors which were used in this study with their definitions and their sources.

Variable (Factor)	Definition	Source(s)
Awareness	<i>The degree to which an individual are aware about the technology.</i>	Al-Alawi and Al-Amer (2006); Bandura (1982)
Support	<i>The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system.</i>	Bailey and Pearson (1983); Al-Gahtani et al. (2007)
Anxiety	<i>The degree to which users are worried about using technology.</i>	Bailey and Pearson (1983); Igbaria et al. (1996)
Ease of Use	<i>The degree to which a person believes that using a particular system is free of effort.</i>	Davis (1989) Bailey; Pearson (1983)
Usefulness	<i>The degree to which a person believes that using a particular system would enhance his or her job performance.</i>	Davis (1989); Venkatesh and Davis (2000); Bailey and Pearson (1983)
Security	<i>The degree to which a person feels that security is important to them and believes that using smart card is secure.</i>	Bailey and Pearson (1983); Vijayasarathy (2004)
Compatibility	<i>The degree to which the innovation is perceived to be consistent with the potential users’ existing values, previous experiences and needs.</i>	Sonnenwald et al. (2001); Rogers (2003); Karahanna et al. (1999)
Image	<i>The degree to which use of an innovation is perceived to enhance one’s image or status in one’s social system.</i>	Moore and Benbasat (1991); Venkatesh and Davis (1996, 2000)
Social Influence	<i>The degree to which an individual perceives that it is important others believe he or she use the new system.</i>	Ajzen (1985); Venkatesh and Davis (1996, 2000)
Traibility	<i>The degree to which an innovation may be experimented with</i>	Roger (1995, 2003)

Table 2: External Variables

	<i>before adoption.</i>	
Visibility	<i>The degree to which the results of an innovation are visible and communicable to others.</i>	Rogers (1995, 2003); Moore and Benbasat (1991); Karahanna <i>et al.</i> (1999)
Demographic	<i>Age, Gender, Education, Experience</i>	Agarwal and Prasad (1997, 1999) Venkatesh and Morris (2000) Taylor and Todd (1995)

2. Organizational competition with the EDP unit
3. Priorities determination
4. Charge-back method of payment for services
5. Relationship with the EDP staff
6. Communication with the EDP staff
7. Technical competence of the EDP staff
8. Attitude of the EDP staff
9. Schedule of products and services
10. Time required for new development
11. Processing of change requests
12. Vendor support
13. Response/turnaround time
14. Means of input/output with EDP centre
15. Convenience of access
16. Accuracy
17. Timeliness
18. Precision
19. Reliability
20. Currency
21. Completeness
22. Format of input
23. Language
24. Volume of output
25. Relevancy
26. Error recovery
27. Security of data
28. Documentation
29. Expectations
30. Understanding of systems
31. Perceived utility
32. Confidence in systems
33. Feeling of participation
34. Feeling of control
35. Degree of training
36. Job effects
37. Organizational position of the EDP function
38. Flexibility of systems
39. Integration of system

IV. DISCUSSION AND CONCLUSION

The purpose of this study was to develop an adoption model of smart card technology and to identify the important factors contributing to increase the user acceptance to design the model.

Both practitioners and researchers have a strong interest in understanding why people accept information technology so that better methods for designing, evaluating, and predicting how users will respond to new technology can be developed (Dillon and Morris, 1996).

Lack of user acceptance is a significant impediment to the success of new information systems. In fact, users are often unwilling to use information systems which, if used, would result in impressive performance gains. Therefore, user acceptance has been viewed as the pivotal factor in determining the success or failure of any information system project (Davis, 1986). Adoption of smart card technologies should not be made simply, knowing the customers perception of and behavioral intention to use technology should be key in the decision-making process. Smart card technology is not well defined in some counties then it is not used in a wide range.

Most of the acceptance model focuses on specific case studies and the literature review revealed no existing model investigating smart card acceptance related. The current literature, which specifically addresses acceptance of smart card technology, and their usage and implementation, is somewhat sketchy. It is the intent of this study to provide important information that will present a backbone for future study into the problems surrounding the acceptance of information technology and specially smart card technology. The proposed model could be used by policy makers and stakeholders to investigate and examine the user acceptance of smart card technology.

APPENDIX

Following are the factors affecting user satisfaction identified by Bailey and Pearson (1983):

1. Top management involvement

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