Kasetsart Journal of Social Sciences 41 (2020) 315–320

Kasetsart Journal of Social Sciences

journal homepage: http://kjss.kasetsart.org

Factors influencing technology adoption of people with visual impairment: Case study of financial transactions through an automatic teller machine (ATM)

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Article Info

Article history:
Received 4 March 2018
Revised 8 May 2018
Accepted 21 July 2018
Available online 7 August 2018

Keywords:
blindness,
financial services,
financial transactions,
technology adoption,
visual impairment

Abstract

The objectives of this study were to identify the factors that influence the technology adoption of financial services through a case study of financial transactions made via an automatic teller machine (ATM). This study adopted both qualitative and quantitative research methods, including experiments, observation, questionnaires, and focus group interviews with 40 observations. The results indicated that the factors influencing technology adoption include cooperation from all related parties, social acceptance, ease of use, usefulness in using existing devices such as mobile phones, transaction safety, and security.

Introduction

For the many years, the only one technology being developed for people with visual impairment or blindness to access financial services by themselves was the automatic teller machine (ATM). However, this technology development does not meet the needs of the blind. The obstacles and problems of making financial transactions via ATMs are due to the complicated transactional process, the difficulty of card insertion, limitations of the ATM menu design for people with visual impairment or blindness, and inappropriate financial evidence. In addition, studies in financial services are limited of technology usage to support people with visual impairment, including total blindness. Hence, this study investigated the behavior of people with visual impairment in adopting financial service technology to make a financial transaction through an automatic teller machine (ATM). The objectives of this study were to identify the factors that influence their technology adoption. These factors will be beneficial in future technology development in the field of financial services for people with visual impairment or blindness.

Literature Review

The development of assistive technology for people with visual impairment or blindness has been adapted from the human activity assistive technology (HAAT) model that demonstrates the relationships among technologies, people, activities, and context (Cook & Polgar, 2002). The study of the relationship between people and technology focuses on identifying the physical design of technology factors, psychological factors of users that are people with visual impairment or blindness, and factors of social context.

Physical Design of Technology Factors

A physical design of the technology refers to a technology design that enhances security, convenience, and user-friendliness in activities for people with visual impairment. A study of shopping system design in

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Peer review under responsibility of Kasetsart University.

https://doi.org/10.1016/j.kjss.2018.07.018
2452-3151/

convenience stores and human robot interaction (HRI) showed the importance of physical design by looking into shopping patterns and obstacles to customers with visual impairment in convenience stores to provide technologies that can increase security, convenience, and user-friendliness in convenience stores (Kulyukin & Gharpure, 2006, pp. 142–149; Kulyukin & Kutiyanawala, 2010). Research regarding different technology access and adoption between those with and without visual impairment indicated that convenience is the main factor that makes a person with visual impairment adopt a new technology (Loiacono, Djamasbi, & Kiryazov, 2013). However, Feingold (2003) found that security and safety are important factors influencing the technology adoption of people with visual impairment. Additionally, a study on model development in access and usage assessment of computer systems by developing a screen which was user-friendly and accessible for people with visual impairment or blindness was divided into two ways. The first way was observation of the behavior of the participants with visual impairment or blindness and the second was observation in controlled environment (Pascual, Ribera, Granollers, & Coiduras, 2014). This study had results that were consistent with research of website design for users with visual impairment or blindness by allowing users to experiment with different websites. The initial website was a dedicated website which had specific functions for users with visual impairment or blindness compared with another website that was not specifically designed with these functions (Ferreira, Silveira, Capra, & Ferreira, 2012). Both studies found that the better website was one that was specifically designed or having specific functions for users with visual impairment or blindness. As a result, the effective performance and positive emotion of the website users with visual impairment or blindness was increased rather than by text-to speech technologies used on the websites. In addition, the study results of smart phones with touch screen technology via application development in terms of general usage and navigation for ease of use by people with visual impairment or blindness pointed out that ease of use, user-friendliness, safety, and convenience are important factors (Lee, Lim, & Kim, 2009; Weiser, 1993). These studies indicate that the physical design of the technology has to take into account the key factors which are security, convenience, and user-friendliness.

Psychological Factors

Psychological factors involve reliability, ease of use, safety, and usefulness. Studies on the technology acceptance of people with visual impairment or blindness have highlighted that attitudes and emotions affect the technology acceptance of these people (Cook & Polgar, 2002; Lindo & Nordholm, 1999). These results are consistent with the study of website accessibility for users with visual impairment or blindness, which included specific websites for users with visual impairment or blindness and general websites (Pascual et al., 2014). The results of this study concluded that satisfaction with website accessibility in terms of reliability, ease of use, safety, and usefulness can affect the technology adoption of people with visual impairment or blindness. In addition, an experiment on the development of maps and brochures using voice synthetic systems that can advise the location and direction for people with visual impairment or blindness discovered problems and obstacles in that there was a lack of reliability or trust in the new technology adoption because the participants in this experiment lacked experience in using technology (Feingold, 2003). Additionally, an experiment on navigation technology design to predict the movement of a person with visual impairment or blindness by designing the environment and the study to ensure for safety and ease of navigation (Nasir, Lim, Nahavandi, & Creighton, 2014) showed that usefulness, reliability, and safety are important factors. Therefore, the design of technologies and the environment has to focus on the psychological effects on people with visual impairment or blindness including the four factors of reliability, ease of use, safety, and usefulness.

Social Context Factors

Social context refers to support from the government, related institutions and the participation of people in society (Abner & Lahm, 2002). Government support is related to legislation and regulations (Ostrowski, 2016). The area designed for the suitability of technologies to support people with visual impairment or blindness has to be implemented (Pick & Azari, 2011) including the establishment and design of public infrastructure (Meerbeek et al., 2014). This can impact on the emotions and attitudes of people with visual impairment or blindness who are a part of society. The experiments consisted of infrared LED technology (Park, Choi, Kim, & Kim, 2014), radio frequency identification (RFID) technology (Alghamdi, Schyndel, & Khalil, 2014) and the design of a public utilities network with wireless sensors (Mpitziopoulos, Konstantopoulos, Gavalas, & Pantziou, 2011; Nasir et al., 2014). Overall, they revealed that the design of technologies, the environment and preparation of some equipment were significant for people with visual impairment or blindness to live with other people in society. These were related to research on travel and navigation using technologies and landmarks to assist people with visual impairment or blindness. Minor modifications of the environment and technologies used that did not impact most people resulted in higher satisfaction for people with visual impairment or blindness (Lewis, Sharples, Chandler, & Worsfold, 2015). Furthermore, studies of the relationship between the design of the working environment and support from the surrounding society (Guerette & Smedema, 2011; Pinquart & Pfeiffer, 2013) discovered that support and cooperation from people in society are key factors in improving the quality of life for people with visual impairment or blindness. Additionally, research on the social interaction of students with visual impairment or blindness in normal schools indicated the importance of social acceptance which creates a positive attitude and pride to students with visual impairment or blindness in the social life (Salleha & Zainalb, 2010). A study on the acceptance of people with visual impairment or blindness using a walking stick in South India found that most people with visual impairment or blindness will refuse to use a walking stick because they feel different

from other people in society (Christy & Nirmalan, 2006). Consequently, social environmental design has to focus on social acceptance and cooperation.

The review of related studies discovered that there are limited studies on the application technology of people with visual impairment or blindness for financial services. Therefore, this research will close the educational gaps by testing the relevant factors and identifying the factors that affect technology adoption of people with visual impairment or blindness in financial transactions.

Methodology

This study adopted both qualitative and quantitative research methods, including experiments, observation, questionnaires, and focus group interviews with 40 observations. The questionnaire had three main parts: physical design factors of technology, psychological factors, and social context factors. The Likert scale was utilized to design this questionnaire. The questionnaire was evaluated in terms of content validity by advisors and experts from this field. Questions from the questionnaire that has an index of item objective congruence (IOC) score over .5 were selected. Furthermore, those questions were tested and the discriminative power per question was determined. The reliability of the questionnaire was tested using Cronbach's alpha coefficient. The reliability of this questionnaire was .903. The degrees of reliability of questions regarding the physical environment design, questions regarding the social environment design, and questions regarding the psychological environment design were .859, .742, and .707, respectively.

Participants

The participants were 40 people who are over 20 years old, with visual impairment, and selected from the Thailand Association of the Blind. They can be categorized into two groups (20 persons per group), namely a group with and a group without experiences in making a financial transaction through an ATM.

Data Collection

All participants are asked to make a financial transaction (a cash withdrawal) through an ATM in a convenience store. The ATM used in the experiment was the only model of a certain bank. During the experiment, all activities were video recorded to identify and analyze problems and obstacles in making a financial transaction at an ATM. After the experiment, all participants were interviewed and asked to fill out the questionnaire. The interview script and the questionnaire were approved by the Thailand Association of the Blind.

Data Analysis

Quantitative data were derived from the results of the questionnaire. The mean ($\overline{X}$) and standard deviation (SD) of the factors influencing the technology adoption were calculated. Moreover, a multiple regression analysis was utilized to forecast the factors influencing the technology adoption. In addition, qualitative data were derived from the results of the interviews and observation.

Results and Discussion

The results of the experiment demonstrated that there are problems in terms of the physical design of technologies, satisfaction of participants in financial transactions via an ATM, and the social context. Regarding the physical design of technologies, first, people with visual impairment had a feeling of insecurity when they made a transaction at an ATM by themselves. Second, inserting an ATM card into a card slot was found to be difficult for persons with visual impairment. Third, the existing financial services on an ATM were very limited; most people with visual impairment can only withdraw money with a shortcut menu that provides a different specific amount of money to be withdrawn. With the provided shortcut menu, people with visual impairment cannot withdraw the exact amount of cash that they want. Furthermore, it is difficult for them to access other financial services such as payment, deposit, and transfer. Lastly, a receipt without braille for a transaction was inappropriate for those with visual impairment. Consequently, individuals could not verify the accuracy of transactions themselves. All these factors highlighted that the current financial service technologies lack security, convenience, and user-friendliness.

In terms of the social context, there were also various serious obstacles for people with visual impairment. First, those with visual impairment had a negative feeling that they were not a part of society because they took longer to complete a transaction at an ATM. As a result, the number of transactions made via an ATM by those with visual impairment has been declining. Second, ATMs lacked a universal design for those with visual impairment. ATM models vary across different financial institutions; therefore, the position of devices equipped with an ATM and financial transaction menus varied greatly among models. Subsequently, people with visual impairment could only make a transaction with a familiar ATM model of a particular financial institution. The results showed that social acceptance and cooperation are key factors in determining the technology adoption of people with visual impairment.

Psychological factors (satisfaction of participants) affected the technology adoption of people with visual impairment making financial transactions via ATMs. The lack of cooperation from governmental and financial institutions to create technologies, regulations, and suitable financial evidence impacted the degree of reliability and confidence of people with visual impairment or blindness in using financial services. The complexity of the ATM transaction process and the shortage of technology development for helping those with visual impairment or blindness impacted on the negative sentiments of using technology in financial transactions via ATMs. Currently, normal people can make financial transactions conveniently and safely through several technologies and devices but the assistive technologies and devices for people with visual impairment or blindness in financial services have

been little developed. This affects the sentiment of inequality by people with visual impairment or blindness.

Finally, it seems that the problems and issues from the physical design of technologies and social context also affect psychological factors.

Table 1 indicates that the participants could make only one type of financial transaction (cash withdrawal) with the shortcut menu of an ATM. This highlights that the technology design and development for financial services does not utilize a universal design for everyone in society. As a result, people with visual impairment or blindness need to use self-adjustment methods to access financial services.

Table 1
Demographic and financial transaction information of participants

Descriptive data	Experiment I (n = 40)	
	n	%
Gender		
Male	30	75.0
Female	10	25.0
Age		
15–22	4	10.0
23–30	6	15.0
31–38	15	37.5
39–46	5	12.5
47–54	5	12.5
Over 54	5	12.5
Education		
Primary education	2	5.0
Secondary education	4	10.0
Diploma	2	5.0
Bachelor's degree	26	65.0
Master's degree	5	12.5
Ph.D.	1	2.5
Occupation		
Freelance	15	37.5
Trader	9	22.5
Own business	6	15.0
Employee of private company	5	12.5
Student	3	7.5
State enterprise officer	1	5.0
Government officer	1	2.5
Income per month (Baht)		
Less than 5,001	1	2.5
5,001–10,000	1	2.5
10,001–15,000	3	7.5
15,001–20,000	3	7.5
20,001–25,000	7	17.5
25,001–30,000	15	37.5
30,001–35,000	6	15.0
35,001–40,000	2	5.0
More than 40,000	2	5.0
Frequency of transactions via an ATM per month (times)		
1-4	34	85.0
5-8	6	15.0
Types of financial transaction		
Withdrawal	40	100.0
Deposit	0	.0
Transfer	0	.0
Payment	0	.0
Amount of money withdrawn per transaction (baht)		
Less than 1,501	4	10.0
1,501–3,000	17	42.5
3,001–5,000	5	12.5
5,001–10,000	8	20.0
10,001–20,000	2	5.0
More than 20,000	4	10.0

Table 2 shows that physical design factors of technology, psychological factors, and social context factors have effects on the technology adoption of people with visual impairment or blindness in financial services. The technology development for financial services to facilitate persons with visual impairment or blindness can be achieved when

Table 2
Mean, standard deviation and interpretation of factors influencing technology adoption of persons with visual impairment in making a financial transaction via an ATM

Activity	Result		
	Mean	Standard deviation	Interpretation
Physical design of technology factors			
1. ATM system security factors	4.76	.43	Highest
• Identity verification before making a transaction	4.78	.42	Highest
• Anti-theft information	4.73	.45	Highest
• Accuracy of a transaction	4.78	.42	Highest
2. Convenience factors	4.68	.46	Highest
• Communication between a user and an ATM	4.63	.48	Highest
• Design of convenient process in making a transaction	4.73	.45	Highest
3. User-friendliness factors	4.56	.45	Highest
• Design of display menu and buttons	4.73	.45	Highest
• Position of devices on an ATM	4.40	.46	Highest
Social context factors			
4. Social acceptance factors	4.88	.33	Highest
• Pride in self-transaction making	4.88	.33	Highest
• Universal design of ATMs	4.88	.33	Highest
5. Cooperation factors	4.88	.33	Highest
• Cooperation between governmental and financial institutions in developing a technology to support those with visual impairment	4.88	.33	Highest
Psychological factors			
6. Reliability factors	4.65	.53	Highest
• User authentication	4.78	.42	Highest
• Financial transaction evidence	4.70	.46	Highest
• Transaction tracking	4.48	.71	High
7. Ease of use factors	4.81	.39	Highest
• Ease of access	4.80	.40	Highest
• Ease of transaction making	4.82	.38	Highest
• 24 h service	4.80	.40	Highest
8. Safety factors	4.80	.44	Highest
• System and procedures for identity verification	4.75	.40	Highest
• Security measures during making a transaction	4.78	.42	Highest
• System and procedures for data verification	4.70	.46	Highest
• Transaction evidence	4.70	.46	Highest
9. Usefulness factors	4.79	.41	Highest
• Time and cost saving in making a transaction	4.78	.42	Highest
• Applications of devices such as a mobile phone, a laptop and other equipment to make a financial transaction	4.80	.40	Highest
Total average	4.76	.43	Highest
In the future, would you be interested in making a financial transaction via an ATM if the ATM had technology to facilitate you with the above factors?	4.65	.44	Highest

Table 3
Results from a stepwise multiple regression analysis

Factors	Unstandardized coefficients		Standardized coefficients	t	Sig.
	b	SE_b	β		
Ease of use	.297	.068	.455	4.392	.000
Cooperation	.314	.075	.474	4.205	.000
Security	.137	.070	.148	1.953	.040
Social acceptance	.302	.077	.506	3.928	.000
Safety	.186	.078	.284	2.380	.023
Usefulness	.192	.085	.252	2.196	.035
(Constant)	2.969	.383		7.748	.000

Note $p < .05$, R = .916, R^2 = .839, SE_{est} = .203, Sig .000*

these technologies can increase reliability, ease of use, safety, and usefulness in their feeling or attitudes by designing technologies which have security, convenience, and user-friendliness through support and cooperation from all sectors of society.

From Table 3, there are six factors, with a statistical significance at .05, that influence the technology adoption of persons with visual impairment in making a transaction through an ATM. These factors are cooperation, security, social acceptance, safety, and usefulness. In the Table, these factors are respectively sorted from the highest level of influence to the lowest level. All six factors can explain the variability of technology adoption at 83.9 percent. The equations in the form of raw scores (Y) and standard scores (Z) are:

$$Y' = 2.969 + .314\text{Cooperation} + .302\text{Social acceptance} + .297\text{Ease of use} + 192\text{Usefulness} + .186\text{Safety} + .137\text{Security}.$$

$$Z'_y = .474\text{Cooperation} + .506\text{Social acceptance} + .068\text{Ease of use} + .085\text{Usefulness} + .078\text{Safety} + .070\text{Security}.$$

The equations highlight that cooperation among government, financial institutions, and people in society is a significant factor in developing a technology to support those with visual impairment in the financial sector. Technology that promotes the acceptance of people in society is the most important key factor. Moreover, the technology must take into account various factors, including ease of use, usefulness, safety in making a transaction, and the security of an ATM system.

From the results of this study, the physical design of technology and psychological factors affected both people with visual impairment and without visual impairment. Nevertheless, this research pointed out that social context factors play a significant role with technology adoption of people with visual impairment or blindness. A universal design of technologies in financial services that can facilitate both people with visual impairment and without visual impairment requires the cooperation of all sectors of society. It should result in successful technology development in financial services for people with visual impairment or blindness.

Conclusion and Recommendation

The equation of behavioral prediction in the technology adoption of persons with visual impairment in making a financial transaction via an ATM consisted of six factors, namely cooperation from all parties in the society, social acceptance, ease of use, usefulness, safety in making a transaction, and security of an ATM system. This means that the development of technologies to motivate those with visual impairment to use financial services should take into account these six factors. Financial institutions can benefit from this research by using the findings in their technology development to facilitate persons with visual impairment. However, future studies should identify additional factors and apply the knowledge of this research to develop practical technologies to promote the use of financial services among persons with visual impairment.

Conflict of interest

There is no conflict of interest.

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