Useful or Easy-to-Use? Knowing What Older People Like about Near Field Communication Technology

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Abstract. The goals of this study are two-fold: (1) To develop a novel concept of a light system with the use of Near Field Communication (NFC)-enabled technology, Bluetooth and Raspberry-PI. This new system is known as NFC Light System (NLS). (2) To set up an experimental design to examine the influence of perceived usefulness and perceived ease of use on older adults' behavioral intention to use the NLS. Our proposed system was empirically tested with 33 older adults in Malaysia. Our findings show that perceived ease of use appears to be the primary factor for the older adults to use the NLS. Interestingly, perceived usefulness was not a significant predictor of older adults' behavioral intention to use the NLS. From the practical viewpoint, this study offers a new insight for gerontechnology manufacturer and developers to focus their design efforts on easy-to-use attribute that are desired by older adults.

Keywords: Technology acceptance model · Experimental design · Gerontechnology · Near field communication · Malaysia

1 Introduction

The demographic profile of the world population has undergone significant transformation over the recent years, with one of the main demographic shifts is population ageing. The proportion of older adults (aged 65 year-old and above) has been increasing and the number is projected to raise from 841 million in 2013 to more than 2 billion in 2050 [24]. It was also reported that 40 percent of the older adults aged 60 years or above live independently [24], and projections indicate that the number of older adults living alone will rise considerably into the future. Given that older adults spend more time in and around their house, duty for care of this older population involves providing them with a safe and healthy home environment, in which they are

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able to function independently. In this vein, gerontechnology is becoming an increasingly important means to support the older adults' vitality and independence.

According to Fozard et al. [10], gerontechnology is a word bearing gerontology (scientific study of aging) and technology (the development and implementation of technological products, services and physical environments). Gerontechnology relates to the use of technology for the benefit of both aging and aged people [5, 9, 25]. Within the scope of gerontechnology, technology is not an end in itself but a means to support the aging people for a better life [2]. Hence, both gerontological and technological studies are closely connected.

The core of gerontechnology focuses on the impact of different technologies within five domains of human activity [9, 25]. The five domains of human activity include: (1) Health and self-esteem (technology supporting physical, cognitive and emotional functioning of older people); (2) Housing and daily living (technology supporting independence, convenience and safety of daily activities among the older people); (3) Mobility and transport (technology supporting personal mobility of older people); (4) Communication and governance (technology supporting societal cohesion, the use of TV, Internet, mobile phone, etc., and remote monitoring of functional status of older people); and (5) Work and leisure (technology supporting older people to continue their work and perform educational and recreational activities). An example of housing and daily living domain includes developing smart technology for controlling lighting and heating that can help to address the limitations in physical function of older adults [10].

The 21st century has witnessed an unprecedented change in the way how technology affects people's daily lives. Today, numerous products and services are available, particularly with the proliferation of near-field communication (NFC)-enabled technology. This study focuses on NFC-enabled assistive technology in the home environment. As light/lamp is an everyday product that older adults use it in their daily lives, interest in NFC-enabled light system is timely and relevant.

In most instances, new technologies have great potential usage in ageing population, but successful implementation of the technology is highly dependent on the user's technology acceptance. Regardless of the extant gerontechnology studies published on electronic government services [19], health-related technology [11], smartphones [28], telecare services [21], there is still room for research that furthers the understanding of factors affecting technology adoption among the older adults. In this study, we draw on Technology Acceptance Model (TAM) to examine the older adults' technology decision.

Taken together, the goals of this study are two-fold: (1) To design an assistive technology for the home environment, we develop a light system with the use of NFC-enabled technology, Bluetooth and Raspberry-PI. This new system is known as NFC Light System (NLS). (2) Building from the lens of TAM, we examine the influence of perceived usefulness and perceived ease of use on older adults' behavioral intention to use the NLS.

In the following sections, we first discuss the design and development of NLS. Thereafter, we draw from TAM to develop our research hypotheses. This is followed by a description of the research method and results. We finally conclude this paper by discussing the findings, research implications, limitations and directions for future research.

2 Literature Review and Research Hypotheses

2.1 NFC Light System (NLS)

In technical research, NFC is known as a wireless technology for data transfer within short-range distance [27]. NFC technology supports two-way data exchange in digital devices [18]. For example, an NFC device can act as a smart key to interact with other NFC-enabled tag/device [18]. Technically, NFC-enabled devices can manage three operation modes, viz., read/write, peer-to-peer and card emulation mode [14].

In this study, we applied the NFC read operation to design and develop the NLS. The design of the NLS uses a set-top-box as a convergence platform, enabling the users to interact with the lamp using a NFC card. In other words, NLS uses the concept of tap-to-connect mechanism where operations are triggered by touching NFC card with a set-top-box. Furthermore, NLS does not require Internet connection for operations. With the use of Bluetooth Low Energy-enabled Raspberry-PI, users are only required to connect NLS with power source to activate the operation. Given that NLS is an assistive technology where users do not need to reach the light switch/lamp to switch on/off the light, our proposed NLS provides a fast and convenient home experience for older adults. The features of NLS include portable, easy-to-use and very low power consumption, thereby augmenting an independence experience for older adults.

2.2 Tam

The theoretical framework for this paper is drawn from TAM, a revised version of Theory of Reasoned Action (TRA) [7]. TAM was introduced in 1986 and has been the robust model to study users' technology acceptance [13, 22]. In the gerontechnology literature, several studies (e.g., [1, 3, 6, 17, 19, 20]) have applied TAM in understanding older adults' technology adoption decision. Within the TAM framework, Davis [7] posits that technology usage is predicted by behavioral intention that is affected by two key variables, namely, perceived ease of use and perceived usefulness.

According to Karahanna et al. [12:788], perceived usefulness is defined as the "instrumental value derived from use of a technology." For example, users are not keen to use the service application if it is not beneficial [15]. Past gerontechnology research has reported that perceived usefulness had a positive effect on older people's Internet use intention [17], intention to use social networking websites [3], and intention to use the electronic governance services [19]. In the context of NLS, we expect a positive usefulness-intention relationship among the older adults. Therefore, we propose:

H1: Perceived usefulness will have a significant positive influence on older adults' behavioral intention to use the NLS.

Davis [7:320] defines perceived ease of use as "the degree to which a person believes that using a particular system would be free of effort." Davis [7] postulates that a user will accept a system that is regarded to be easy-to-use. There have been strong empirical results that support that perceived ease of use has a positive relationship with behavioral intention (see: [17, 19]). In application to our study, perceived ease of use

will have a positive impact on older people's behavioral intention to use the NLS. Therefore, we propose:

H2: Perceived ease of use will have a significant positive influence on older people's behavioral intention to use the NLS.

3 Research Methodology

3.1 Measures

In this study, the survey instrument used to operationalize the three variables were adapted from well-established literature and modified for use in the NLS context. Survey questions of perceived ease of use were adapted from [4, 7, 26]. Three new survey items were developed to measure perceived usefulness. Behavior intention to use the NLS was measured using items adapted from [4, 7, 23, 26]. Respondents were asked to indicate the degree to which they agreed or disagreed with each survey item, on a seven-point Likert scale from 1 (strongly disagree) to 7 (strongly agree).

3.2 Sample

The target sample was older adults in Malaysia. The current sample consists of 33 participants, who are part of a larger on-going study. Voluntary consent was sought and obtained from each participant. All research procedures were performed with the

Table 1. Profile of participants

Variable	Classification	Frequency (n = 33)	Percent (%)
Gender	Male	12	36.4
	Female	21	63.6
Age	55–64	10	30.3
	65–74	12	36.4
	75–84	8	24.2
	Above 85	3	9.1
Highest Education Completed	Informal *(no schooling or self-learning)*	8	24.2
	Primary School *(completed primary 1 to 6 education)*	4	12.1
	High school *(completed form 1 to form 5 education)*	10	30.3
	Diploma	4	12.1
	Bachelor degree/ professional qualification	4	12.1
	Master degree	1	3.0
	PhD degree	2	6.1

approval of university's human ethics review board, and informed consent of all participants.

Our participants included 12 males and 21 females. Table 1 shows our sample demographic profile including gender, age, and the education level.

4 Data Collection

Our experiential product was an in-house developed NLS. There were three components in this system, namely the NFC-enabled card, set-top-box and the lamp. Each participant was requested to switch on/off the lamp by tapping the NFC card on the set-top-box. After the practice session, participants were asked to complete a survey questionnaire about the experiment.

5 Results

5.1 Reliability, Validity and Factor Analyses

IBM SPSS software was used to check the psychometric properties of the survey instrument, and to test our hypothesized model. Reliability of the scales was tested using Cronbach Alpha. As shown in Table 2, all scales were reliable as the values of Cronbach Alpha were greater than 0.70, and met the desirable values suggested by [16]. Both convergent and discriminant validity were assessed using Average Variance Extracted (AVE). As presented in Table 2, convergent validity was confirmed as AVE of all constructs were at least 0.50, meeting the cutoff value suggested by Fornell and Larcker [8]. Discriminant validity was tested through the comparison of square roots of the AVE of construct pairs to the correlation between construct pairs. As shown in Table 2, all the square roots of AVE values were greater than the off-diagonal coefficients of construct pairs, providing an evidence of discriminant validity.

Principal component factor analysis was conducted to check the construct validity. The factor loadings, Kaiser-Meyer-Olkin (KMO), Bartlett test of sphericity, and eigenvalues of our model are shown in Table 3. All variables exhibited good construct validity.

Multiple regression analysis was performed to test the model. Table 4 and Fig. 1 show the results of multiple regression analysis. The predictors explained 52.1 percent of behavioral intention's variance in hypothesized model. Perceived ease of use ($\beta = 0.646$; p-value < 0.001) was the dominant factor predicting older people's behavioral intention. Our results showed non-significant perceived usefulness-intention relationships ($\beta = 0.131$; p-value > 0.05). These results lend support to hypothesis H2 but not H1.

Table 2. Results of reliability and validity

	Perceived usefulness	Perceived ease of use	Behavior intention
Perceived usefulness	*0.893*		
Perceived ease of use	0.512**	*0.829*	
Behavior intention	0.462**	0.713**	*0.943*
Average variance extracted	0.797	0.688	0.889
Cronbach's alpha	0.848	0.844	0.930
Standard deviation	1.275	0.596	1.378
Mean	5.647	6.152	5.434

Note: ** All correlations are significant at the 0.01 level (2-tailed); Italicized values in the diagonal row are square roots of the AVE.

Table 3. Results of factor analysis

Variable	No. of Item	KMO	BTS	EV	Factor Loadings			
					Item 1	Item 2	Item 3	Item 4
PU	3	0.728	46.843***	2.390	0.863	0.907	0.907	Nil
PE	4	0.658	62.472***	2.751	0.872	0.852	0.695	0.885
BI	3	0.758	81.191***	2.669	0.926	0.949	0.954	Nil

Note: *** $p < 0.001$; KMO = Kaiser-Meyer-Olkin; BTS = Barlett's Test of Sphericity; EV = Eigen-values; PU = Perceived usefulness; PE = Perceived ease of use; BI = Behavioral intention

Table 4. Results of Regression Analysis

	Beta Coefficient	Standard Error
(Constant)		
Perceived Usefulness	0.131	0.159
Perceived Ease of Use	0.646***	0.340
R^2	0.722	
Adj. R^2	0.521	
F	16.338	
Sig.	0.000***	

Note: Dependent Variable = Behavioral Intention; *** $p < 0.001$

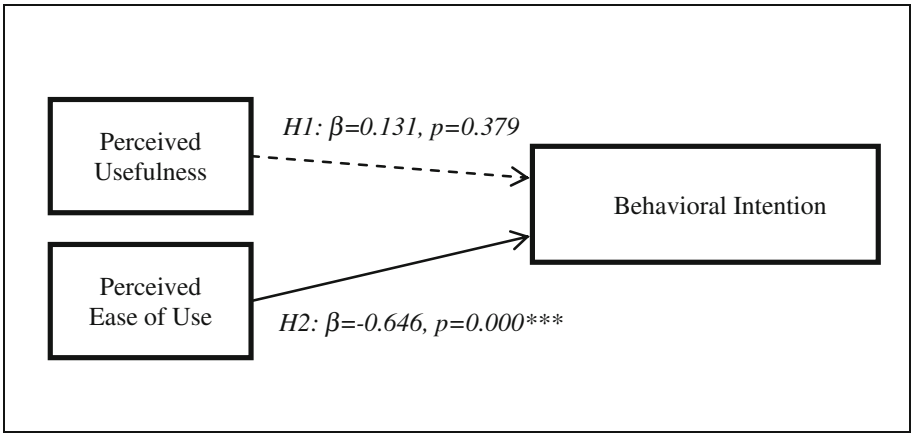

Fig. 1. Results of regression analysis

6 Discussion and Conclusion

Our findings show that perceived ease of use appears to be the primary factor for the older people to use the NLS. This finding is consistent with Pan and Jordan-Marsh [17], where they found a strong effect of perceived ease of use on Internet use intention for older adults. Our result indicates the importance of an easy-to-use technology design in encouraging technology adoption among the older adults. Interestingly, perceived usefulness was not a significant predictor of older people's behavioral intention to use the NLS. One possible explanation for this finding is that older adults do not necessarily adopt new technology even though the technology is a useful practical tool for them. Perception of usefulness/benefits was not the motivational factor for using a new assistive technology for older adults.

From the practical viewpoint, this study offers a new insight for gerontechnology manufacturer and developers to focus their design efforts on easy-to-use attribute that are desired by the older people. In addition, the NLS contributes in itself as a novel gerontechnology design. The proposed NLS is an effective assistive technology for older adults in maintaining their vitality and independence.

This study has two research limitations that should be acknowledged. First, data was collected from Malaysia and future research should be conducted in other countries to improve the generalizability of our findings. Second, we applied TAM as the theoretical basis in this study. Future studies should examine others variables and their relationships by drawing from different theoretical frameworks such as Innovation Diffusion Theory and Unified Theory of Acceptance and Use of Technology (UTAUT).

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