TELKOMNIKA, Vol.17, No.3, June 2019, pp.1128~1135
ISSN: 1693-6930, accredited First Grade by Kemenristekdikti, Decree No: 21/E/KPT/2018
DOI: 10.12928/TELKOMNIKA.v17i3.12212

Healthcare receivers' acceptance of telecardiology in Malaysia

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Abstract

This quantitative study investigates acceptance towards implementation of telecardiology in Malaysia. The purpose of this study is to explore and understand the potential factors that could be the key elements in cultivating positive behaviour towards telecardiology adoption in Malaysia. Data was gathered by using survey method from 149 patients and publics who use internet service in their daily lives. The questionnaire was developed by integrating Technology Readiness Index (TRI), Technology Acceptance Model (TAM) and Theory of Planned Behaviour (TPB) which consists of 42 items. Descriptive statistics, factor analysis and one-way ANOVA were conducted to analyse the data. The analysis reveals that Malaysians generally hold a positive perception towards implementation of telecardiology with some reservations. Besides that, gender and income of the respondents were found to influence the variables in telecardiology readiness, hence suggesting these two variables be taken into considerations in the adoption of telecardiology. It is our hope that the result of this study provides some useful information for the policy makers and implementers to develop effective implementation strategies that could reduce users' resistance and adoption barriers in telecardiology adoption.

Keywords*: telecardiology, technology acceptance, technology readiness, theory of planned behavior*

1. Introduction

Advanced information and communications technologies (ICT) provides opportunities to cater the unmet needs in healthcare industry with different approaches [1]. In the context of cardiology, many developed and developing countries had adopted telecardiology in the healthcare system to improve cardiac care service and reduce the mortality rate of cardiovascular disease. Prior study suggested telecardiology has the potential to save time, money and lives as the technology support general practitioners in decision making for diagnosis and management of cardiovascular diseases. At the same time, telecardiology also allows the patients at risk for more accurate screenings [2]. Thus, telecardiology is viewed as a potential tool to ease the increasing demand of cardiologists in Malaysia. Nevertheless, the implementation of the telecardiology in Malaysia is facing a number of challeges since the degree to which public users, health care providers and the health system in Malaysia are prepared to participate and succeed in telecardiology is not yet clear. Prior study had identified the determinants that would influence future implementation of telemedicine and the determinants are technology, acceptance, financing, organization and policy [3]. The reluctance of users in accepting technology will lead to underutilization phenomenon of ICT across the health sector [4]. Thus, this study attempted to investigate the acceptance and readiness on telecardiology in depth and comprehensively by using a conceptual framework which integrated Technology Acceptance Model (TAM), Technology Readiness Index (TRI) and Theory of Planned Behaviour (TPB).

One of the most significant determinants of technology adoption success is user acceptance [5]. There are many examples of abandonment of telemedicine after adoption due to the failure of integration into the health and business environment [6]. Telemedicine project was launched in Malaysia as one of the national flagship applications in 1997 with the purpose to improve the quality of healthcare as well as enhance the effectiveness of cost saving for

Received January 7, 2018; Revised February 3, 2019; Accepted February 28, 2019

health care institutions [7], but telemedicine was not embraced nationwide due to technological problem, insufficient Information and Communication Technology (ICT) infrastructure and inconsistency of demand [8]. It is significant to understand the readiness of the potential users of telecardiology in Malaysia to prevent the failure and abandonment of the system as introduction of telemedicine required investment of huge amount of money and man power [9].

TAM was adapted from Fishbein and Azjen's Theory of Reasoned Action and designed specifically to explain computer usage behaviour. TAM model is based on two main constructs reflected the belief of users, which are perceived usefulness and perceived ease of use [10]. The attitude of the users and their level of perceived of usefulness of the innovation are considered as significant attributions that led to the formation of one's intention to adopt a technology. Chau and Hu had conducted studies that explaining how physicians accepted and adopted telemedicine in Hong Kong by using TAM model, the results indicated perceived usefulness substantially shapes physicians' acceptance of Health Information Technology systems [11].

Technology readiness refers to the "people's propensity to embrace and use new technologies to accomplish goals in home life and at work" which is measured by a psychometric scale known as Technology Readiness Index (TRI) [12]. Technology readiness comprises of positive and negative technology-related beliefs. The beliefs can be categorized into four dimensions which include optimism, innovativeness, discomfort, and insecurity. Parasuraman also concluded there is a positive relationship between technology readiness scores and technology-related behaviours. An individual's readiness to adopt a new technology is based on the positive or negative evaluations with regard to the technology [13]. A person with the affirmative opinions such as optimism and innovativeness are proned to try new technology whereas discomfort and insecurity are viewed as the inhibitors in technology adoption [14].

The behavioural determinants which assumed to influence the intention of adoption of telecardiology were explored by using TPB. TPB is one of the most established models that has been used extensively to explain the complexity of influences in the behavioural decision-making process by determines the important predictors of individuals' behaviour. It is significant to understand intention and behaviour change. Intentions are assumed to capture the motivational factors that influence behaviour, they are the indicators of to what extent people are willing to try, of how much effort they plan to put forth to perform the behaviour [15]. According to the review of Godin et al., TPB was identified as an appropriate theory to predict behaviour and has been widely used in predicting healthcare systems adoption among healthcare professional [16].

TAM, TRI frequently used with TPB to examine readiness, acceptance and intention of behaviour when an innovation is introduced. Some studies indicated that TAM or TRI are complements of TPB model since TAM and TRI capture the predispositions and beliefs towards the new technology whereas TPB reports on the behavioural factors influence the intention to embrace a behaviour. The purpose of this study is to provide understanding on the potential users' beliefs and attitudes towards telecardiology and its influences on the intention of using telecardiology in future. Besides that, this study also shed lights on the influences of demographic variables (gender, age, level of education and income) on technology acceptance, technology readiness and behavioural factors in telecardiology adoption.

2. Research Method

This quantitative research applied survey method to investigate Malaysian's perceptions of readiness towards telecardiology adoption. Approval to conduct the study was obtained and approved by National Medical Research Register (NMRR). National Institute of Health in Malaysia had required to register undert NMRR as the prerequisite for conducting research in Ministry of Health facilities. The respondents were recruited by convenience sampling method. The instrument used in this study is a questionnaire which consists of four sections: (1) Technology Readiness Index (TRI), (2) Technology Acceptance Model (TAM), (3) Theory of Planned Behaviour (TPB) and (4) demographic information of the respondents. Demographic information of the respondents was collected to understand the influences of demographic variables on the variables in TRI, TAM and TPB. The questionnaire consisted of 42 items and translated into Bahasa Malaysia and Mandarin. Malaysia is a multi-racial country, translated questionnaire would allow respondents to answer the questionnaire with higher reliability.

The questionnaire was distributed to the respondents in three general hospitals in Malaysia through hard copy and online survey method; 176 sets of questionnaires were returned, of which 149 were valid. Data were analysed via descriptive statistics, factor analysis, one-way analysis of variance (ANOVA) and post hoc test by using SPSS version 16.

3. Results and Analysis

3.1. Measurement Validation

Factor analysis shows the interrelationships among the variables and the underlying structure of the data [17]. Principal Component Analysis is one of the statistical procedures to perform factor analysis which aims to transform a set of observations of possibly correlated variables into a linearly uncorrelated set of values [18]. In this study, PCA was run on TRI, TAM and TPB questionnaires to extract the factors that represents the structure of the variables in telecardiology adoption. The questionnaire was originally consisted of 68 items and was reduced to 42 items after inappropriate items were removed. Based on the suggestions of Hair et al., there are three considerations which are important in determining the factors to be extracted or rotated, which included: (1) a minimal cut point of 0.4 and no significant cross loading criteria; (2) scree plot test, and (3) eigen value should be larger than 1 [17]. Principal Component Analysis of TRI, TAM and TPB is presented in Table 1.

Based on the analysis for TRI, there are six components with eigenvalue more than one. The fifth and sixth components were not retained after inspection of scree plot. The four components retained explained 19.43%, 16.47%, 9.00% and 7.74% of total variance, respectively. The interpretation of the data in Rotated Structure Matrix was consistent with the dimensions attributes the questionnaire which was designed to measure with strong loadings of insecurity items on Component 1, innovativeness items on Component 2, optimism items on Component 3 and discomfort items on Component 4. A few items which could raise confusion and might irrelevant to the respondents were removed after adopted suggestions from educational psychology expert.

For TAM, there are two components with eigenvalue more than one according to the analysis. This two-component solution provides 81.14% of the total variance. From the Rotated Structure Matrix, the retained and rotated components load on each variable was shown. The interpretation of the data was consistent with the dimensions attributes the Technology Acceptance Model (TAM) was designed to measure with strong loadings of perceived usefulness items on Component 1 and perceived ease of use items on Component 2. The analysis obtained was aligned with the result shown in the scree plot.

Forced factor extraction was conducted for items extraction in TPB to define the number of components to be retained. All four components make up of 88.92% of total variance. From the Rotated Structure Matrix, the retained and rotated components load on each variable was shown. The interpretation of the data was consistent with the dimensions attributes the Theory of Planned Behaviour (TPB) was designed to measure with strong loadings of Attitude items on Component 1, Intention items on Component 2, Perceived Behavioural Control on Component 3 and Subjective Norm on Component 4.

Reliability refers to the consistency of measurement or the stability of the measurement to obtain similar results over a variety of contexts [19]. Cronbach's alpha is the most widely used objective measurement of an instrument's reliability [20]. Based on the analysis, the Cronbach's alpha value for all constructs were above .75, except for the construct that measured discomfort with the Cronbach's alpha of 0.64. Cronbach's alpha score above .75 reflects the scale is highly reliable whereas a score of .50 to .75 represents the scale is with moderate reliability which suggested that the measurement used in this study is highly reliable [21].

3.2. Analysis of Variance for Telecardiology Readiness

Analysis of variance (ANOVA) is applied in this study to investigate the mean differences of technology readiness based on the demographic differences. For optimism dimension, gender ($F=4.701$, $p=0.032$) and age ($F=2.88$, $p=0.025$) demonstrated significant difference based on the analysis. According to the analysis, only gender ($F=5.913$, $p=0.016$) demonstrated significant difference with innovativeness dimension. The result showed that male had higher level of innovativeness ($M=4.20$, $SD=0.57$) than female ($M=3.40$, $SD=0.72$). Monthly income ($F=3.581$, $p=0.008$) is the only variable that showed significant difference with insecurity

dimension of TRI. Overall, Malaysian has a considerably high level of optimism (M=3.93, SD=0.05) and insecurity (M=3.82, SD=0.69), whereas moderate level of innovativeness (M=3.23, SD=0.63) and discomfort (M=3.47, SD=0.51) towards adoption of innovation. One-way ANOVAs of TRI, TAM, and TPB are shown in Tables 2-4 respectively.

Table 1. Principal Component Analysis of TRI, TAM and TPB

Items	Factor									
	TRI				TAM		TPB			
	1	2	3	4	1	2	1	2	3	4
Optimism										
Optimism 1			.786							
Optimism 2			.806							
Optimism 6			.690							
Optimism 8			.651							
Optimism 9			.642							
Optimism 10			.602							
Innovativeness										
Innovativeness 1		.682								
Innovativeness 3		.771								
Innovativeness 4		.761								
Innovativeness 5		.539								
Innovativeness 6		.748								
Innovativeness 7		.742								
Discomfort										
Discomfort 1				.674						
Discomfort 3				.685						
Discomfort 4				.683						
Discomfort 5				.577						
Discomfort 6				.580						
Insecurity										
Insecurity 1	.766									
Insecurity 2	.778									
Insecurity 3	.757									
Insecurity 6	.733									
Insecurity 7	.689									
Insecurity 8	.637									
Insecurity 9	.634									
Perceived Usefulness										
PU 1					.896					
PU 2					.911					
PU 3					.873					
PU 4					.930					
PU 6					.900					
Perceived Ease of Use										
PEOU 1						.887				
PEOU 2						.890				
PEOU 5						.850				
PEOU 6						.780				
Attitude										
Attitude 1							.917			
Attitude 3							.904			
Attitude 4							.923			
Attitude 5							.912			
Attitude 6							.918			
Intention										
Intention 1								.761		
Intention 2								.872		
Intention 3								.810		
Subjective Norm										
SN 4										.774
SN 6										.725
Perceived Behavioural Control										
PBC 1								.	.733	
PBC 2									.776	
PBC 3									.865	
Cronbach's Alpha	0.819	0.793	0.817	0.644	0.950	0.891	0.979	0.913	0.799	0.907
Eigen Value	4.666	3.952	2.616	1.857	5.00	2.30	7.851	2.206	0.859	0.645
Variance Explained	19.44	16.47	9.06	7.74	55.57	25.57	60.39	16.97	6.61	4.86

Table 2. One-way ANOVA of TRI

Variables	Demographic	N	Optimism		Innovativeness		Discomfort		Insecurity	
			Mean	F value	Mean	F value	Mean	F value	Mean	F value
Gender	Male	35	4.21	4.701*	3.73	5.913*	3.30	1.847	3.97	0.690
	Female	113	3.93		3.40		3.13		3.91	
Age	18 – 25	47	3.77	2.880*	3.43	1.251	3.25	0.636	3.89	1.712
	26 – 35	53	3.97		3.36		3.06		3.77	
	36 – 45	21	4.20		3.70		3.18		4.17	
	46 – 55	14	4.30		3.59		3.19		4.06	
	Above 55	14	4.14		3.48		3.29		4.08	
Education	Primary School	3	4.40	0.672	4.00	1.625	3.00	0.112	4.28	0.413
	Secondary School	35	4.01		3.58		3.19		3.90	
	College/ University	109	3.96		3.42		3.17		3.91	
Monthly Income	Below 2000	56	3.90	1.135	3.45	0.913	3.18	0.886	4.14	3.581**
	2000 – 4000	52	3.92		3.40		3.18		3.68	
	4001 – 6000	24	4.18		3.61		3.08		3.96	
	6001 – 8000	6	4.17		3.87		2.77		3.58	
	Above 8000	8	4.20		3.40		3.38		3.98	

*p < .05 and **p < .01

There are two constructs were measured in TAM, namely perceived usefulness (PU) and perceived ease of use (PEOU). From the analysis, gender (F=4.45, p=0.037) is the only variable that illustrated the significant difference with perceived usefulness in technology acceptance. The result showed that male demonstrated higher level of perceived usefulness (M=4.03, SD=0.57) than female (M=3.74, SD=0.74). As Table 4 illustrated, no significant difference was found among the demographical variables when compared to the perceived ease of use in TAM. As a whole, Malaysian has high level of perceived usefulness (M=3.79, SD=0.72) and moderate level of perceived ease of use (M=3.32, SD=0.54) towards the implementation of telecardiology in Malaysia.

Theory of planned behaviour was applied in this study to measure the intention, attitude, subjective norm and perceived behaviour control towards telecardiology adoption among Malaysians. According to the analysis, gender was the only variable that displayed significance difference with all the TPB dimensions which included attitude, intention, subjective norm and perceived behavioural control. The result showed that male had more positive attitude ($M_{attitude}$=5.81, SD=1.03), greater intention ($M_{intention}$=5.32, SD=1.18), higher level of subjective norm (M_{SN}=5.46, SD=1.01) and perceived behavioural control (M_{PBC}=5.69, SD=1.05) towards telecardiology adoption when compared to that in female ($M_{attitude}$=5.35, SD=1.14; $M_{intention}$=4.71, SD=1.39; M_{SN}, SD=1.12; M_{PBC}=4.77, SD=1.21). In general, Malaysian has a positive attitude (M=5.45, SD=1.14), moderately high level in subjective norm (M=4.95, SD=1.12) and perceived behaviour control (M=4.98, SD=1.23), and a moderate level of intention (M=4.85, SD=1.37) towards telecardiology adoption in Malaysia.

Table 3. One-way ANOVA of TAM

Variables	Demographic	N	Perceived Usefulness		Perceived Ease of Use	
			Mean	F value	Mean	F value
Gender	Male	35	4.03	4.449*	3.49	1.657
	Female	113	3.74		3.32	
Age	18 – 25	47	3.60	2.182	3.38	2.024
	26 – 35	53	3.77		3.37	
	36 – 45	21	3.97		3.57	
	46 – 55	14	4.03		3.34	
	Above 55	14	4.09		2.95	
Education	Primary School	3	4.47	2.245	2.67	2.639
	Secondary School	35	3.93		3.24	
	College/ University	109	3.74		3.41	
Monthly Income	Below 2000	56	3.73	1.101	3.21	2.054
	2000 – 4000	52	3.72		3.35	
	4001 – 6000	24	3.98		3.58	
	6001 – 8000	6	3.93		3.29	
	Above 8000	8	4.13		3.69	

*p < .05 and **p < .01

Table 4. One-way ANOVA of TPB

Variables	Demographic	N	Attitude		Intention		Subjective Norm		Perceived Behavioural Control	
			Mean	F value	Mean	F value	Mean	F value	Mean	F value
Gender	Male	35	5.81	4.442*	5.32	5.567*	5.46	9.749**	5.69	16.407**
	Female	113	5.35		4.71		4.80		4.77	
Age	18 – 25	47	5.27	0.967	4.70	0.550	4.81	0.528	4.79	0.389
	26 – 35	53	5.45		5.00		5.10		5.08	
	36 – 45	21	5.56		4.67		4.81		5.05	
	46 – 55	14	5.40		5.13		5.03		5.07	
	Above 55	14	5.93		4.83		4.93		4.98	
Education	Primary School	3	6.33	1.293	5.56	0.401	5.50	0.392	5.89	2.107
	Secondary School	35	5.57		4.83		4.91		5.23	
	College/ University	109	5.38		4.84		4.92		4.85	
Monthly Income	Below 2000	56	5.40	1.021	4.86	0.770	4.87	0.378	5.01	0.153
	2000 – 4000	52	5.39		4.96		5.10		5.01	
	4001 – 6000	24	5.38		5.03		4.94		5.01	
	6001 – 8000	6	5.40		4.72		5.00		4.89	
	Above 8000	8	6.23		4.13		4.81		4.67	

*p < .05 and **p < .01

4. Discussion

The respondents participated in this study had a high level of optimism and insecurity, moderate level of innovativeness and discomfort towards the use of telecardiology in Malaysia. Based on the description, most of the respondents shared the optimism and innovative beliefs of explorers, however at the same time, they felt some discomfort and insecurity. They desired the benefits of technology but more practical about the challenges and difficulties. Technology acceptance is regarded as one of the most important research areas in the information system. Users' intention to embrace new technology is determined by two key beliefs, namely, perceived usefulness and perceived ease of use. Physicians have greater potential to adopt new technology due to its ease of use [22]. Most respondents perceived telecardiology positively and viewed it as a beneficial technology in monitoring health condition which they believed will enhance their efficiency or performance during health monitoring routine. However, respondents hesitated about the effort of telecardiology operation as medical technologies are often highly complex and respondents did not have hands-on experience with them.

The theory of planned behaviour is commonly used in explaining and predicting human health behaviour. It explains the intention of a person to engage in a particular behaviour and suggests that several salient beliefs, namely attitude, subjective norm and perceived behavioural control are the determinants of the intention. The attitude toward the behaviour reflects the behavioural beliefs which are a favourable or unfavourable evaluation of the behaviour [15]. In this study, the respondents were having a positive attitude towards telecardiology. As mentioned above, the positive attitude can be originated from the positive evaluation of telecardiology adoption or the potential advantages of employment of telecardiology in health monitoring routine. The high level of subjective norm in the findings can be resulted by important others generally approve desirable behaviours (telecardiology adoption) and disapprove of undesirable behaviours [15]. In accordance with the findings, the perceived behavioural control of respondent were at high level. Most of the respondents involved in this study were graduated from university or college, therefore, they perceived themselves were equipped with the necessary knowledge and skills to perform the operation of telecardiology in health monitoring routine. As a general rule, Ajzen proposed that the more favourable the attitude and subjective norm, and the greater of perceived behavioural control, the stronger should be the person's intention to perform the behaviour, in the context of this study, which is the telecardiology adoption. In this study, respondents were having a moderate level of intention to adopt telecardiology. As almost all the respondents were new to telecardiology, Lee and Rho suggested that the perception of users and non-users towards mobile health monitoring systems was quite diverse. The users have a more positive perception towards mobile health monitoring system compared to non-users [23].

In this study, demographic characteristics of the respondents and its bearing on telecardiology readiness were examined. Based on the results, gender was revealed to have a significant influence on most of the telecardiology acceptance variables. The result was supported by previous study conducted by Hoque indicated that gender was strongly associated with the adoption and the use of mHealth in developing country like Bangladesh [24]. Many previous research had discovered that gender differences existed in new technology acceptance. Whitley suggested that male generally has more positive attitudes and less anxious towards technology innovations which is similar to the findings in this study [25]. This may due to the gender stereotyping which often exhibits that male are better in computer or computer-related tasks as compared to female [26]. Besides that, some research indicated that male's perception of usefulness was more significantly compared to female in the adoption of technology innovation [27]. Men focus more on the function and productivity of new technology when considering technology adoption. Venkatesh and his colleagues highlighted that there are salient gender differences in various factors determining an individual's technology adoption decisions. In their study, they pointed out that attitude is the crucial determinants of technology adoption and usage behaviour in men whereas women were strongly influenced by subjective norm and perceived behavioural control [28]. Past research provided preliminary evidence that different age groups may have different thinking and decision making when comes to new technology adoption. Older adults have lower self-efficacy and higher technology anxiety, they considered themselves not as skilful as younger people in operating new technology. However, age was not identified as significant demographic variable in determining respondents' telecardiology readiness. No significant relationship was found between respondents' education level with telecardiology readiness. This finding is similar to the result of Demirci and Ersoy that suggested a level of education has no loading on technology acceptance of the respondents [29]. From the analysis, the income of the respondents was found significantly influence the level of insecurity of technology readiness. This finding could due to the respondents are worried that they could not afford the telemedicine service as medical service usually expensive and not affordable by those from lower socioeconomic background. Rogers also stated that late adopters of innovations tend to be of lower social status [30].

5. Conclusion

This study was designed to examine telecardiology readiness of the respondents in Malaysia to provide some important insight for the implementers and policymakers. Based on the result, Malaysian generally hold a positive view towards telecardiology use, at the meanwhile, Malaysian hold some reservations in adopting the innovations. The findings indicated that Malaysian are desire about the beneficial outcomes that could be brought by telecardiology, but they also worry about the practicality and effort of telecardiology operations. Besides that, the findings also showed that gender is a significant moderator that influences telecardiology readiness. Therefore, implementors could take gender into account during the implementation of telecardiology in Malaysia. There are several limitations in this study which should be noted. First, majority of the respondents in this study are female and with high educational background which may affect the result for new technology exposure. Thus, the respondents in this study may have slightly higher telecardiology readiness profile compared to other level of the socioeconomic groups. Future research can be focus on a more diversified sample in order to generate a more detailed insight into the telecardiology readiness among Malaysia. Second, this current study examined the perspectives of healthcare receivers and health care providers as a whole. This might not representative as the nature of professionalism and cognitive capability are quite distinctive between these groups. Therefore, the researcher recommended future study can be conducted in order to compare the differences of perspectives towards telecardiology acceptance between these two groups.

Acknowledgement

This work was supported by grant from the Ministry of Higher Education (MOHE), Transdisciplinary Research Grant Scheme (TRGS): PY/ 2016/ 06027 cost centre: R.J 130000.7831.4L848.

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