Acceptability and Use of Mobile Health Applications in Health Information Systems: A Case of eIDSR and DHIS2 Touch Mobile Applications in Tanzania

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Abstract. The use of modern information and communication technology plays a significant role in healthcare services improvement. In the recent years, various mobile application systems have been deployed in the health sectors of different developing countries to facilitate remote data collection and transmission so as to improve its quality and availability. Consequently, understanding the factors contributing to mobile technology acceptance is imperative. The purpose of this study was to adopt a modified UTAUT theoretical model to understand the factors influence acceptance and use of mobile health applications by health workers at health facilities in Tanzania. Questionnaires were used to collect data from health facilities workers. Out of 150 health facilities workers, only 108 return, a 72% return rate whose data was statistically analyzed using SPSS tool. The findings show that effort expectancy and facilitating conditions significantly influence the users located in the urban area on behavioral intention to use mobile health applications. Furthermore, the study shows that the constructs such as social influence, training adequacy, and voluntariness of use do not have a significant influence on the use of mobile health applications.

Keywords: Acceptability · Mobile health applications · Health information systems · UTAUT

1 Introduction

Public healthcare services can be improved significantly by use of reliable and timely routine health data for making decision. Due to the advancement of the information and communication technologies (ICT), various studies show that ICT can play a significant role in providing a timely, effective and efficient healthcare services improving a routine data reporting [1]. Through ICT technologies, different systems such as health mobile applications and web-based systems have been developed and implemented in different countries [2]. These systems have the potential to provide and promote quality information on routine health data for decision making and planning.

Published by Springer Nature Switzerland AG 2019
P. Nielsen and H. C. Kimaro (Eds.): ICT4D 2019, IFIP AICT 551, pp. 579–592, 2019.
https://doi.org/10.1007/978-3-030-18400-1_48

In the recent years, different mobile health applications such as electronic Integrated Diseases Surveillance and Response System (eIDSR) and DHIS2 Touch have been adopted and integrated into DHIS2 (a web-based system) [3] for improving routine data reporting. These applications use mobile phone with the help of the internet to communicate with DHIS2 server. Despite the adoption of these mobile applications, users may jeopardize the efficient and effective interaction of the mobile systems and thus lead to a delay in routine data reporting. Delays on routine reporting of data can endanger the information availability and quality. Various studies have shown that the anticipated goals for developed and implemented a system might not be achieved or not well adopted [4]. Acceptability problems might be among of the main reasons for these deficits and therefore recommended to evaluate the acceptability and use of the systems in order to be able to identify and solve or handle these [5]. Lack of acceptability can lead to delay in routine data and increase the poor quality of information and user's dissatisfaction [6].

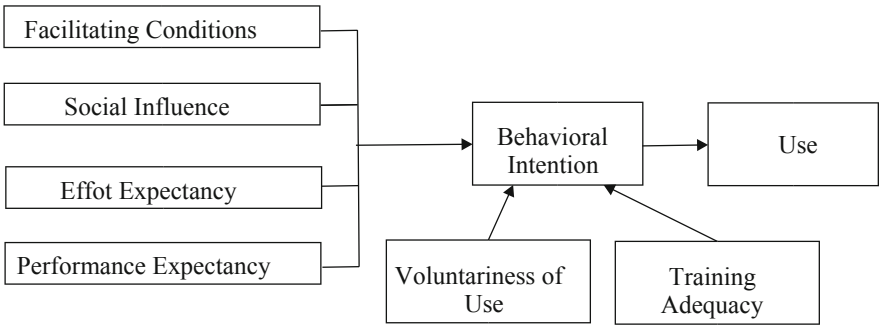


Fig. 1. The study model for mobile health applications user acceptance. (Modified from Venkatesh et al. [7])

Due to the importance of eIDSR and DHIS2 Touch as mobile health applications in the health management information system, in this study, we examine the acceptability and use of mobile health applications using key constructs in an extended unified theory of acceptance and use of technology (UTAUT) [7] to describe acceptance of eIDSR and DHIS2 Touch systems in Tanzania setting as a developing country. This study extends the validity and empirical applicability of UTAUT theoretical model by examining it within the context of the national health management information system. This follows to the adoption of the UTAUT model to include voluntariness of use as a predictor as behavioral intention and training adequacy as a direct factor of behavioral intention as depicted in Fig. 1. This study will inform the system developers and

implementers on interventions against the potential problems that can enable them to have successfully design and deployment of health mobile applications in developing countries.

2 Related Works

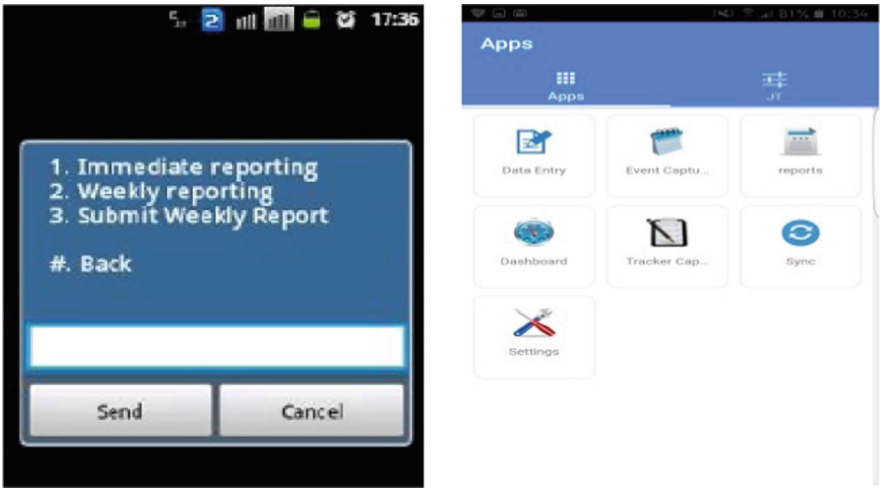
Both researchers have an interest in understanding the factors contributes to the technology acceptance and use. Venkatesh et al. proposed a theoretical model called UTAUT [7] as an acceptance model after comprehensive research. The model defines four constructs which are performance expectancy (PE), effort expectancy (EE), social influence (SI) and facilitating conditions (FC) as elements of behavior intention and use behavior.

Despite the growing adoption and use of the health mobile systems in the developing countries, there are a few studies that have focused on investigating the acceptance and use of mobile health applications in health care context. Most of the studies are in mobile banking [9], learning and teaching [10], etc. to determine the factors that are influencing the adoption and use of mobile applications in organizations. Miltgen et al. [11] studied the user acceptance on biometric and they focused on the social influences and facilitating factors affecting user acceptance. Oliveira et al. [12] worked on user adoption for mobile banking. This study mainly focused on the effects of UTAUT and regulating factors of gender and age. The intention to use of e-learning systems in the workplace was conducted by Yoo et al. [13] and they used performance expectancy, social influences and facilitating conditions as extrinsic motivation components and effort expectancy as intrinsic component motivation. Moreover, Akter et al. [14] investigated the adopted and acceptance problems of mobile health from the quality of service perspectives.

3 Methods

3.1 Mobile Health Applications

This study was conducted based on the mobile health applications namely, eIDSR and DHIS2 Touch which are integrated with the DHIS2 software. The eIDSR is a USSD based application used in Temeke district to report immediate and weekly reportable diseases or events of public health importance while DHIS2 Touch is an android application implemented in Wangingombe district which is used to collect and stores routine data. Both mobile applications are used as tools to collect routine health data within respective districts. About 200 users interact with these mobile health applications. The two mobile applications are independent and run separately. The illustration of the user interfaces is shown in Fig. 2.



(a) **(b)**

Fig. 2. Mobile interfaces of mobile health applications. (a) eIDSR (b) DHIS2 Touch

3.2 Studying Setting

The main purpose of this study was to adopt the modified UTAUT model in order to understand the factors that caused the user to accept and use mobile health applications. The key six constructs are performance expectancy, effort expectancy, social influence, facilitating conditions, training adequacy and voluntariness of use as depicted in Fig. 1. This study was carried out on respective districts (Wangingombe located in the rural area and Temeke located in an urban area) and involved health facilities workers as mobile apps users. A structured questionnaire was administered to them. The questionnaire contained the set of questions adapted from [7] to suit the context of this study.

3.3 Research Hypothesis

Performance Expectancy (PE) is a degree to which user trust that using ICT application will provide him or her to achieve a performance gain in a job [7]. Previous researches, the performance expectancy is regularly a robust intention predictor [12]. The importance of performance expectancy to health has been shown in various studies [13, 14] and thus we hypothesized that:

H1: Performance expectancy will positively influence the users at health facilities to use mobile health application.

Effort Expectancy (EE) is a degree of ease associated with ICT application use was found that it is an important intention predictor in the UTAUT theoretical model [7]. Previous studies show that the effort expectancy has the influence on behavioral intention when a new technology introduced to users [13, 15]. This research supports

UTAUT and hypothesized that effort expectancy will play a vital role in user acceptance of mobile health application.

H2: Effort expectancy will positively influence the behavior intentions to use mobile health application.

Social influence is the degree to which users perceive that vital others influence them to use a certain technology. Social influence has direct effect on the intention to use a particular technology [7]. Friends, supervisors, and peers of the health facilities workers can influence their behavioral intention to use ICT application provided for health. The author in [16] show that social influence is one of the significant factors influencing adoption of the mobile phone and use in South Africa, and therefore we hypothesized that:

H3: Social influence will positively influence health workers intention to use mobile health application.

Training Adequacy (TA) is an extent to which user believes that the training acquired is enough for her or him to use a mobile health application effectively. In this study, we identified TA as a key factor which influences the intention of targeted users to use mobile health application. Since mobile health application are used at the health facilities level, it is expected that users perceived training received is adequate. This study hypothesized that:

H4: Training adequacy will have a positive influence on health facilities workers intention to use mobile health application.

Voluntariness of Use (VO) is an extent to which user perceives that the user has a choice or not to use health ICT and also it is a significant concept influence intention to use information and communication technology. Voluntariness to use was treated as a compulsory variable in the original UTAUT theoretical model. Voluntariness is a key factor on the acceptance and use of a particular technology. We anticipated that the more voluntariness of use, the more users will have a positive attitude on eIDSR or DHIS2 Touch and thus the more intention to use mobile applications. Therefore, we hypothesized:

H5: Voluntariness of use will have significant influence on behavioral intention to use mobile health application.

According to [11, 13, 14], facilitating conditions have a positive influence on the use of certain technology. Facilitating conditions prediction on behavioral intention is non-important [7]. The influence on intention to use a particular technology will be important if the user believes that support from an organization for technology use is unpredictable. However, when the support is predictable and consistency; we expected that the facilitating conditions will influence behavior intention. Therefore, it is anticipated that use behavior will be predicted by behavioral intention.

H6: Facilitating conditions will positively influence the health workers intention to use mobile health application.

H7: Behavioral intention will have a positive influence on health workers usage behavior of mobile health application.

3.4 Data Collection and Analysis

A structured questionnaire was used as a main data collection tool for this study. The questionnaire was printed and self-administered to 108 respondents. The confidentiality was guaranteed to all respondents and filling a name field was considered as an option.

The questionnaire contained the set of questions adapted from [7] which were formulated to capture information for each construct in the modified theoretical model. Formulated indicators for the new constructs which are not included in the UTAUT model was learnt by comprehensive literature review. The 5-point Likert scale from 1 (Strongly Disagree) to 5 (Strongly Agree) used to measure the constructs. Descriptive analysis of the collected data was analyzed using Statistical Packages for Social Science (SPSS) statistical tool for the goal of getting frequencies, means, standard deviation, skewness and kurtosis.

4 Results

4.1 Descriptive Statistics

Acceptability and use evaluation of health mobile applications namely eIDSR and DHIS2 Touch was conducted on respective districts, Temeke and Wangingombe. Total of 108 respondents (54 in Temeke district and 54 Wangingombe district) in this study were health facilities workers which represent the daily users of the mobile health applications. Table 1 shows the descriptive statistics of all 26 indicators measured in this study and used to evaluate the acceptability and use of the mobile health applications through the modified UTAUT conceptional model. The majority of statistical analysis procedures are based on assumption that data are normally distributed. The observations for the normalized data is normally equally and symmetrically about the mean. Skewness and kurtosis are statistical measures which are used to establish sample distribution shape. Symmetry is measured by skewness and peakedness of the distribution is measured by kurtosis.

The values for asymmetry (Skewness) lies between −2 and +2. The values between that range are considered acceptable in order to prove normal univariate distribution. If the value is negative it means that distribution skewed left otherwise skewed right. For zero value, it means that the skewness is perfect normal distribution [8].

Kurtosis values between −2 and +2 are considered acceptable for proving a normal univariate distribution. The value outside mentioned range shows that that the distribution is non-normal. The higher kurtosis value means that the high peak near the mean and the lower kurtosis value means that flat top around the mean [8].

Table 1. Measures to determine the reliability and validity of the model

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
PE1: I find mobile health application more useful in my job	4.07	4.11	.843	.462	.325	.325	.639	.639	Performance Expectancy (PE) is a degree to which user trust that using mobile health application will provide him or her to achieve a performance gain in a job
PE2: Using mobile health application helps me to report routine data quickly	4.24	4.09	.823	.597	.325	.327	.639	.644	
PE3: Using mobile health application increases my productivity	3.91	4.00	.917	.752	.325	.325	.639	.639	
EE1: My interaction with mobile health application is understandable and clear	3.94	3.89	.969	.776	.327	.327	.644	.644	Effort Expectancy (EE) is a degree of ease associated with the mobile health application use
EE2: Learning on using mobile health application is easy for me	4.07	3.94	.843	.738	.325	.325	.639	.639	
EE3: it is easy for me to become skillful at using mobile health application	4.06	4.06	.899	.534	.325	.327	.639	.644	
EE4: In general, I find mobile health application easy to use	4.06	3.84	.763	.946	.325	.333	.639	.656	
SI1: People who are important to me think that I should use mobile health application	3.96	3.66	.776	.854	.325	.327	.639	.644	Social Influence (SI) is the extent to which user believe perceives that her or his colleagues and

(*continued*)

Table 1. (*continued*)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
SI2: My coworkers think that I should use mobile health application	4.07	3.87	.843	.595	.325	.330	.639	.650	supervisors believe she or he should use a mobile health application
SI3: The CHMT has been supportive in the use of mobile health application at my health facility	4.00	4.11	.929	.670	.330	.327	.650	.644	
SI4: Overall, the use of mobile health application has been supportive and encouraged at my health facility	4.11	4.02	.861	.598	.325	.325	.639	.639	
FC1: I have resources. (e.g. mobile phone, computer, reporting forms, internet) to use mobile health application	3.92	3.96	1.089	.706	.327	.327	.644	.644	Facilitating Conditions (FC) is refer to user perceptions of the technical infrastructure or resources available to support the use of mobile health applications
FC2: I have the knowledge necessary to use mobile health application	4.02	3.92	.866	.781	.327	.327	.644	.644	
FC3: Mobile health application experts are available at any time for assistance with mobile health application difficulties	3.83	3.58	.944	.848	.330	.330	.650	.650	

(*continued*)

Table 1. (*continued*)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
FC4: I have knowledge sources (e.g. manuals, documents) to support my use of mobile health application	4.07	3.31	.968	1.076	.325	.330	.639	.650	
TA1: The training on using mobile health application is very helpful in my use of the mobile system	4.02	4.13	1.055	.627	.325	.330	.639	.650	Training Adequacy (TA) is an extent to which user believes that the training acquired is enough for her or him to use a mobile health application effectively
TA2: I have a training document as a reference material that I can consult it during the use of mobile health application	3.81	3.17	1.011	1.122	.325	.327	.639	.644	
TA3: I feel training received is adequate for my efficient use of mobile health application	3.55	3.51	1.048	1.012	.327	.327	.644	.644	
TA4: I need another training on mobile health application to enable me use the system efficiently	4.19	4.34	1.065	.706	.325	.327	.639	.644	
TA5: The mobile health application training was well organized and easy to follow	3.91	4.04	.966	.619	.327	.327	.644	.644	

(*continued*)

Table 1. (*continued*)

Measurement indicators	Mean		Standard deviation		Skewness standard error		Kurtosis standard error		Definition of construct
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	
VO1: Although it might be very helpful, using mobile health application is not obligatory in my work	3.34	3.12	1.018	.968	.327	.365	.644	.717	Voluntariness of Use (VO) is an extent to which user believes that he or she is voluntary using mobile health applications
VO2: My use of mobile health application would be for mandatory routine reporting	4.06	3.87	.811	.625	.325	.354	.639	.695	
VO3: My use of mobile health application would be for voluntary analysis of the health facility data for informed decision making	3.70	3.52	1.093	.969	.325	.365	.639	.717	
BI1: I intend to continue using mobile health application in the future	4.17	4.04	.818	.582	.325	.325	.639	.639	Behavioral Intention (BI): is an extent to which user intends to use mobile health application
BI2: I will continue using mobile health application in my daily work life	4.20	4.00	.833	.679	.325	.327	.639	.644	
BI3: I plan to continue using mobile health application frequently	4.13	4.08	.870	.646	.325	.327	.639	.644	

Mean value shows either majority of respondents agree or disagree with a particular issue and standard deviation shows how respondents differ from a correct issue. Similarities of response in the same issue. Acceptable standard deviation is less than 3.

According to the description of the skewness and kurtosis, it is seeming that the data distribution for variable data is normal. According to the description of the skewness and kurtosis, it is seeming that the data distribution for variable data is normal.

4.2 Reliability Measurement

The PLS-SEM used to evaluate the reliability of the instrument's measurement using SPSS. Table 2 presents the results of the indicator with loadings, composite reliability, Cronbach's Alpha and average variance extracted (AVE). Since some of the factor loadings exceeded 0.5 and some of the construct reliability values exceeded the recommended level of 0.7, the results show that the internal reliability and convergent validity existed. However, some values are below the recommended values. This might be due to the presence of high variability within questionnaire items.

Table 2. Measures to determine the reliability and validity of the model

Construct	Indicator	Factor loadings		CR		Cronbach's Alpha		AVE	
		eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
Performance Expectancy (PE)	PE1	−0.084	0.718	0.023	0.407	0.852	0.44	0.028	0.240
	PE2	0.077	0.091						
	PE3	0.269	0.443						
Effort Expectancy (EE)	EE1	0.031	0.458	0.009	0.745	0.908	0.832	0.005	0.441
	EE2	0.075	0.882						
	EE3	−0.021	0.738						
	EE4	0.109	0.48						
Social Influence (SI)	SI1	−0.135	0.75	0.008	0.481	0.913	0.72	0.041	0.238
	SI2	−0.158	0.458						
	SI3	0.308	0.052						
	SI4	0.165	0.422						
Facilitating Conditions (FC)	FC1	−0.034	−0.084	0.001	0.442	0.797	0.564	0.008	0.245
	FC2	0.123	0.365						
	FC3	−0.019	0.773						
	FC4	−0.122	0.493						
Training Adequacy (TA)	TA1	−0.118	0.309	0.229	0.041	0.786	0.571	0.091	0.030
	TA2	0.289	0.033						
	TA3	0.374	−0.026						
	TA4	0.191	0.214						
	TA5	0.427	−0.073						
Voluntariness of Use (VO)	VO1	0.332	0.874	0.312	0.712	0.552	0.639	0.158	0.497
	VO2	0.158	0.242						
	VO3	0.581	0.817						
Behavioral Intention	BI1	0.906	0.924	0.903	0.933	0.966	0.943	0.756	0.822
	BI2	0.872	0.904						
	BI3	0.828	0.892						

4.3 Research Model Summary

Six factors were introduced to linear regression to measure the success of the model and predict the causal relationship between the factors and behavioral intention. The factors are facilitating condition, social influence, effort expectancy, performance expectancy, voluntariness of use and training adequacy. Based on the results obtained, the model variance with adjusted R values for eIDSR and DHIS2 Touch are 0.722 and 0.128, indicating that the model explains 72.2% (eIDSR) and 12.8% (DHIS2 Touch) toward the acceptance and use of the mobile health applications in health information systems.

Table 3 present the predictive factors (Beta coefficients) for each hypothesis obtained from the linear regression analysis. The results of DHIS2 Touch show that all six factors did not have a significant influence on behavioral intention to accept and use of mobile health application and the results of eIDSR show that performance expectancy, social influence, training adequacy and voluntariness of use did not have significant influence on behavioral intention to accept and use of mobile health application in health information systems.

The two factors in the eIDSR application, effort expectancy and facilitating conditions have shown positively influence the behavior intentions to accept and use mobile health applications. The beta coefficients are presented in Table 3.

Table 3. Unstandardized and standardize coefficients and significance levels of constructs in the model

Construct	B		SE		β		p	
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
PE	−.158	0.79	0.098	.188	−.158	.079	.114	.676
EE	.610	−.042	.114	.194	.610	−.042	0.000	.831
SI	.215	.236	.107	.201	.215	.236	.052	.250
FC	0.550	.091	.100	.167	.550	.091	.000	.588
TA	−.233	.296	.126	.204	−.233	.296	.072	.157
VO	.185	.136	.102	.164	.185	.136	.079	0.413

Table 4 present results of the hypothesis testing.

Table 4. Summary of hypothesis testing

Hypothesis	Results		Conclusion	
	eIDSR	DHIS2 touch	eIDSR	DHIS2 touch
H1	$\beta < -.158$, $p < .114$	$\beta < .079$, $p < .676$	Not supported	Not supported
H2	$\beta < .610$, $p < .000$	$\beta < -.042$, $p < .831$	Supported	Not supported
H3	$\beta < .215$, $p < .052$	$\beta < .236$, $p < .250$	Not supported	Not supported
H4	$\beta < -.233$, $p < .072$	$\beta < .296$, $p < .157$	Not supported	Not supported
H5	$\beta < .185$, $p < .079$	$\beta < .136$, $p < .413$	Not supported	Not supported
H6	$\beta < .550$, $p < .000$	$\beta < .091$, $p < .588$	Supported	Not supported

5 Discussions

This study aimed to understand the factors that influence the acceptance and usage of mobile health application in Tanzania using modified UTAUT research model. Previous studies have shown that the acceptance and use of mobile health technologies can improve the quality of health services [16, 17].

Based on the results in Table 1, the study did not find any significant relationship between performance expectancy and behavior intention to accept and use mobile health applications. However, the interviews showed that the users agreed the applications improve their productivity, save time and send a report to the higher level immediately.

The study shows that the effort expectancy of eIDSR has positive influence ($\beta = .610$) compared with DHIS2 Touch. This implies that the users in an urban area feeling comfortable and easy to use mobile health technologies than in rural area.

Furthermore, the study shows that the constructs such as social influence, training adequacy, and voluntariness of use do not have an influence on the acceptance and use of mobile health applications in health information systems. This finding is attributed to the fact that during the time of this study, users may not have complete support, enough training of the mobile health applications and it is not voluntary to use the applications. This finding may appear contrary to the previous studies [7, 16, 17] which confirm that social influence, training adequacy, and voluntariness of use have a significant relationship with behavioral intention in mobile health applications adoption.

Another finding from this study was that the results of eIDSR showed that the facilitating conditions significantly influence ($\beta = .550$) the acceptance and usage of mobile health technologies in an urban area rather than rural area (DHIS Touch). This means that the users in urban area had resources to use mobile applications including necessary knowledge.

6 Conclusion

The purpose of this study was to adopt a modified UTAUT theoretical model to understand the factors influence acceptance and use of mobile health applications by health workers at health facilities in Tanzania. The study shows that effort expectancy and facilitating conditions significantly influence the users located in the urban area on behavioral intention to use mobile health applications. These findings of the study inform the implementers to develop strategies for the successfully design and deployment of mobile health applications in developing countries.

Moreover, future studies may involve further analysis using structural equation modelling to determine construct validity and other factors surrounding the acceptance and use of mobile health applications.

These will enable to identify other problems hindering behavioral intention to accept and use mobile applications.

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