
Immunisation-notification adoption model: strategies for implementing mobile electronic notification of mothers in Uganda

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Abstract: Mobile e-health systems play a significant role in information delivery by enhancing efficiency, cost effectiveness and mobility. In Uganda, mobile e-health has been predominantly adopted to facilitate information sharing between Ministry of Health and district health offices despite the availability of mobile phones in the community. This study sought to develop an immunisation-notification adoption model to support the use of mobile technology for creating citizen awareness. It focused on the adoption of mobile technology for notifying and reminding mothers of immunisation schedules. The objective was achieved by extending technology acceptance model to predict user satisfaction with the new system. Descriptive survey design was employed using questionnaire for data collection. The study implemented in Northern Uganda targeted 51 health workers and mothers in Gulu referral and Gulu independent hospitals. The model has the dimensions of knowledge, accessibility, support, content, trust, funding, awareness, knowledge sharing, skills and ease of use. Perceived usefulness was considered the key driver for the system adoption.

Keywords: immunisation; immunisation notification; IMUNOT; immunisation coverage and mobile e-health.

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1 Introduction

The growth of information and communication technology (ICT) has greatly enhanced health service delivery worldwide [Ministry of Health (MOH), 2013; Kumar and Kumar, 2013]. However, mobile e-health usage to support healthcare delivery is still limited in most developing countries despite its known benefits (Alam et al., 2010). Mobile e-health refers to the use of mobile devices such as mobile phones to share information or collect patient data. The benefits of mobile e-health include: expansion of access to communications, transmission of voice and data at precise time and providing citizens with access to healthcare information anywhere and anytime. In Uganda, mobile e-health has specifically enhanced efficient communication about medical healthcare services between MOH and districts through phone calls, emails and short messaging services (SMS) (MOH, 2011). There is still no explanation on why the beneficial mobile technology cannot be adopted in hospitals to mobilise mothers for immunisation despite the increasing number of mobile phones (52.1 lines/100 people) (UBOS, 2012). Technology adoption refers to individual's voluntary or intentional use of a technology for the tasks it is designed to support (Yarbrough and Smith, 2007; Davis et al., 1989). Meanwhile Immunisation is a process a mother/child is made resistant to an infectious disease such as polio, measles and tetanus by administration of vaccine (WHO, 2014). The weakness of the existing information systems, few staff and distant health facilities hamper the efficient mobilisation of mothers (Mbondji et al., 2014; Nguyen et al., 2008). Although, the village health teams (VHTs) are used to accompany traditional paper-based health cards for mobilisation, they face challenges of poor facilitations, inconsistent follow-ups, unavailability of outreach programs and insensitive staff attitudes (MOH, 2011; Bazos et al., 2015; Ssemaluulu et al., 2010). All these have impacted negatively on the maternal-child health. Maternal-Child health carries 20.4% of the total disease burden in Uganda as reported by Health Sector Strategic and Investment Plan (HSSIP, 2010). Uganda has 160 deaths of children per 1,000 live births linked to vaccine preventable diseases such as tuberculosis, polio and measles due to poor mobilisation of mothers (Bhutta et al., 2010; Bonny, 2010).

1.1 *e-Health systems in Uganda*

In Uganda, several e-health applications are in use to enhance efficient service delivery, reduce response time and operational costs (Foster, 2012; Nsubuga et al., 2010). These e-health applications include Management Information System and Integrated Diseases Surveillance and Response System (IDSR), Vital Registration Management Information System (VSR-MIS) and Health Management Information System (HMIS). However, for

the purposes of reaching the rural community and improving users' mobility and flexibility, mobile e-health systems have also been introduced in Uganda. These include SMS system, MobileVRS and mTRAC.

Mobile-based SMS system initiated by United Nations International Children's Emergency Fund (UNICEF) Uganda and used for polio campaign in 37 districts contributed to 10% improvement in community awareness (UNICEF, 2015). In a related development, Uganda government with support from UNICEF partnering Uganda Telecom developed a mobile application known as MobileVRS for easy birth registration of children in addition to mHealth for reporting disease out-break, medication stock-outs and malnutrition (MOH, 2013). Similarly, MOH with support from UNICEF Uganda launched another mobile application called mTRAC for monitoring essential medicine supply such as anti-malarial drugs and vaccines (MOH, 2013). mTRAC allows health workers in the facility to send reports using SMS with real-time data to map facility stocks. The overall purpose of this is to avoid unnecessary stock-outs and ensure transparency and accountability for the drugs. Mobile text messages were also used in Lira district to educate and expand the use of human immune virus (HIV) testing and counselling services at the AIDS information center (AIC) (Bonny, 2010). This increased the number of participants by 7,000 and most of the participants valued the approach and agreed to have got the required knowledge. The discussed e-health related systems have improved service delivery in terms of accessibility, efficiency, reduced response time and operational costs, mobility and flexibility. Despite these enormous benefits, the e-health systems have not been able to spread nationwide (Woodward et al., 2014; Isabalija et al., 2011). It is also noted that the success of piloting a system doesn't guarantee its nationwide adoption due to human and technology-based factors that require a holistic guiding framework (Bouchard et al., 2012).

This paper sought to present a model for mobile e-health system adoption in Uganda as underpinned by the extension of TAM using the identified e-health implementation factors from the field study. The e-health implementation factors identified include: e-health knowledge, accessibility, support, content, trust, funding, awareness, knowledge sharing and ICT skills. The model contributes to the extension of the existing e-health adoption models and can be applied to other developing countries. Therefore, the main objective of this study was to develop a mobile-based immunisation notification (IMUNOT) adoption model to implement mobile electronic notification of mothers in Uganda. The purpose of the study was achieved by determining the factors for successful adoption of IMUNOT system and designing the model that best supports its adoption in Uganda. It is envisaged that timely notification is likely to improve the mother's participation and understanding of the importance of vaccination in Uganda.

2 Literature review

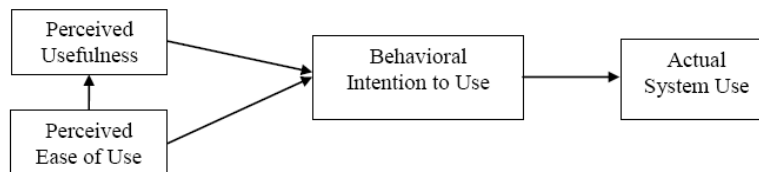
2.1 Underlying theoretical models

In this section, three information technology adoption models relevant to the study are discussed and compared. These models include: technology acceptance model (TAM) (Davis, 1989; Venkatesh et al., 2003), Unified Theory of Acceptance and use of Technology (UTAUT) by Venkatesh et al. (2003) and Health Metrics Network (HMN) model by WHO (2007).

2.1.1 Technology acceptance model

The research was based on the well-known TAM (Davis, 1989; Venkatesh et al., 2003). The most popular TAM examines factors leading to information system acceptance through rigorous research based on previously related work for the purpose of maintaining consistency (Paul et al., 2003). TAM also provides an initial point for numerous extensions and associates positively to challenging models of user acceptance through providing a stream of research papers to aid and grow knowledge about technology acceptance (Paul et al., 2003). TAM has strengthened the information system field by its research rigor and serves where theories are scarce. TAM has been used for describing individual's acceptance of information systems underpinned on perceived usefulness and perceived ease of use (PEOU) to explain user behaviour of a system as an extension of theory of reasoned action (TRA) (Ajzen and Fishbein, 1980). TRA explains why a user accepts or rejects an information technology. User satisfaction is predicted as a major factor that influences the adoption of technology and its continued usage. TAM consists of two dependent constructs that influence user satisfaction. The major dependent constructs of TAM are Perceived usefulness and PEOU (Figure 1).

Figure 1 The TAM



Source: Davis (1989) and Venkatesh et al. (2003)

Perceived Usefulness (PU) shows the level of belief by a person that a particular use of a system will enhance the performance of his work and thus improving productivity. The performance expectancy may involve speeding up the business process, client satisfaction, improved service efficiency and enhancing accessibility and communication with the clients (Phichitchaisopa and Naenna, 2013). *PEOU* indicates the degree of spending little effort in using the system and it is associated with content and technical issues (McGinn et al., 2011). The parameters associated with effort expectancy may include: ability of technology to be used easily, facilitating ones service, ease of fixing error/fault and that the system is user friendly and up-to-date (McGinn et al., 2011). Therefore, the easier a technology is to use, the more useful it can be (Loria, 2010). *Behavioural intention to use* demonstrates the attitude towards the use of the system. According to TAM, the behavioural intention to use the system is influenced by *PEOU* and the *perceived usefulness* of the system and in turn affects the *actual system usage*. *PEOU* affects both *perceived usefulness* and *behavioural intention to use* the system.

TAM has not accounted for other human and technological factors, yet a system can be abandoned if all the user needs are not met. Although TAM claims usefulness and ease of use as the key factors to technology acceptance, it does not clearly explain what constitutes its usefulness and ease of use (Loria, 2010). Another setback of TAM is that it is designed to be implemented in developed countries, thereby need for modification because each country has its own challenges in the system adoption (Henry, 2007).

2.1.2 *Unified theory of acceptance and use of technology*

UTAUT by Venkatesh et al. (2003) also agrees with TAM on perceived usefulness (performance expectancy) and PEOU (effort expectancy). UTAUT extends TAM further to include social influence and facilitating conditions. Social influence refers to the perception by others that a particular system should be used. Facilitating condition refers to a belief that the existence of organisational and technical infrastructures supports the information system acceptance. However, UTAUT still lacks an in-depth analysis of what constitutes social influence and facilitating conditions.

2.1.3 *HMN model*

Another theoretical adoption model that seems to be vital though not commonly used in many existing researches is HMN model by WHO (2007). HMN comprises six constructs of health information system that are categorised into inputs, processes and outputs. These resources include leadership, coordination, training, vision, processes, funding and legal issues. HMN highlights that the success of a health information system depends entirely on the commitment and dedication of those involved in the leadership because of the crucial part they play in decision making. HMN has emphasised on the vital role of broad-based coordination in linking relevant ministries to provide technical advice, guidance and disseminate progress report to all the stakeholders. HMN also highlights on the role of training the users purposely for overseeing data quality and appropriate analysis. Vision propels the users to focus on how the information system will benefit them, lead to a better performance and ultimately improve public health in order to establish the strategic goals for implementing the system. Defining information system processes involves stages or procedures required to make sure a system is successfully implemented. These include leadership, coordination, and assessment, priority-setting and planning. HMN describes funding as one of the vital indicators for a successful implementation of a system in terms of carrying out regular activities such as training, and expert recruitment. HMN advocates for suitable legal policies to provide enabling environment in order to ensure data availability, exchange, quality and sharing. In addition to unpopular use of HMN by researchers, HMN is still silent on technology-based constructs of TAM such as PEOU and behavioural intention to use a system.

The models presented in this section do not describe what constitutes contextual, process and content factors that influence the adoption of information systems as discussed below.

2.1.4 *e-Health implementation factors*

There are various factors that affect integration and adoption of information technology into health sector worldwide (WHO, 2007; Mugo and Nzuki, 2014). However, e-health innovation acceptance in post-conflict context requires keen attention in terms of research to discover more insights. The post-conflict context especially in Northern Uganda has agonising effects on the community and healthcare (Woodward et al., 2014). The discussed critical e-health implementation factors from the existing knowledge base are categorised into interactive contextual, process and content factors.

2.1.4.1 Contextual factors

The contextual factors portray individual and social aspects. Individual and societal variables determine population characteristics in terms of accessibility, skills, trust and attitude (Hage et al., 2013; Isabalija et al., 2011). These variables include a need for e-health, isolation, digital divide and post-conflict effects. Northern Uganda is characterised by the impacts of the 20 years Lord's Resistance Army (LRA) insurgency in terms of impassable roads, poverty, inaccessibility to healthcare and education (Atri and Cusimano, 2013; Justine, 2005; Roberts et al., 2008). The population living in such an environment anxiously demands for accessibility to the required information (Hage et al., 2013). It is also noted that users may resist a new system if they feel comfortable with the routine practice (Anwar et al., 2011). The persons who possess basic ICT skills acquired through training, education and experience are liable to accept a new system (Woodward et al., 2014). A need for e-health may also arise through comparing the performance of the existing and new technologies. If the previous system of supplying information is slow, it is likely that users may adopt the new system as an alternative. A system can easily be adopted if the information it provides is accessible without hindering the workflow (Hasan et al., 2013). Accessibility involves availability of computers, internet, training, user support, software, wired and wireless communication channels and skilled personnel. A strong ICT infrastructure allows room for improving the existing system in relation to planning and introducing new healthcare interventions (Anwar et al., 2011). ICT infrastructure requires adequate funding to acquire expensive hardware and software tools in addition to the operational costs incurred for sufficient training of the users. Internet availability contributes greatly in information access, work collaboration and core business transactions. Therefore, poor, unreliable and unaffordable internet is a potential barrier to e-health adoption. Other contextual factors include perceived usefulness and PEOU of the system. Perceived usefulness is the level of belief by a person that a particular use of a system will enhance the performance of his/her work thereby, improving his/her productivity (Davis, 1989; Venkatesh et al., 2003). The performance expectancy may involve speeding up the business process, client satisfaction, improved service efficiency and enhancing accessibility and communication with the clients (Phichitchaisopa and Naenna, 2013). PEOU indicates the degree of spending little effort in using the system and it is associated with content and technical issues (McGinn et al., 2011). The parameters associated with effort expectancy constitutes the ability to use a technology easily, facilitating ones service, ease of fixing fault and the user friendliness of the system (Phichitchaisopa and Naenna, 2013; McGinn et al., 2011).

2.1.4.2 Process factors

The e-health implementation involves adjusting the e-health context, process and content through a set of participative strategies by management in relation to leadership, knowledge sharing (social structure), awareness, and training, imparting trust, workload, funding and recruitment. Leadership is a critical factor that determines the success of e-health adoption (Silow-Carroll et al., 2012). A good leadership promotes communication to diverse groups through collective learning, evaluation meetings and strong collaborations with different supporting partners (Hage et al., 2013). Adoption of a

new technology is not driven single handedly by a leader based on his political position but rather a collective effort of users who play a complementary role (Denis et al., 2001). Knowledge sharing or social structure refers to the exchange of knowledge such as information, skills, or expertise among people, friends, families, communities or organisations (Huang and Liu, 2004). Achieving social structure requires positive perception and attitude towards ICT adoption by the top management. Top management plays a central role in the daily running of the activities and future planning of an organisation. The decisions and openness of the top management influences all the organisational activities either positively or negatively. Awareness about the scope and benefits of e-health is another significant factor for technology adoption. Most people understand e-health as the use of ICT without specifically focusing on the e-health inventions and hence need for e-health knowledge through training and sensitisation (Woodward et al., 2014). e-Health knowledge depicts the degree of knowledge acquired through training or education in order to note the signs of trust and e-health adoption. Training is a factor that instils comfort in users for successful technology implementation other than frustration and demotivation (Singh and Muthuswamy, 2013). However, in most developing countries, healthcare facilities are faced with the challenge of Workload where physicians tend to associate decrease in productivity to spending more time on training (Singh and Muthuswamy, 2013; McGinn et al., 2011). There is need for management to plan and restructure the training schedules in such a way that specific components of training are given to specific people who use that particular component in their work (McGinn et al., 2011). Trust is a belief by users that the information provided can be misused or the information is insecure (Mohamad, 2012; Luo et al., 2010). A technology may compromise information security or confidentiality within or outside the organisation through loss of privacy or data exposure (McGinn et al., 2011). The technical capacity of an organisation to conceptualise an invention requires appropriate expertise and skills to make it viable. Adequate funding is required for operational expenses, and frequent upgrades including recruitment or hiring of experts. e-health systems are expensive to implement and maintain due to lack of resources (Singh and Muthuswamy, 2013; McGinn et al., 2011).

2.1.4.3 Content factors

The e-health content consists of design and sustainability issues. The design focuses on the user needs associated with interoperability and compatibility (Hage et al., 2013; Viitanen et al., 2011). Interoperability relates to the exchange of data involving more than one system or organisation. The shortfall of a technology to interface with other systems or organisations is an obstacle to its adoption (McGinn et al., 2011). Technology compatibility influences the life style of users in terms of their daily job responsibilities, values and beliefs which in turn impacts on the system adoption (Hill et al., 2007). For example, a busy working mother may appreciate the adoption of a mobile-based technology due to its operational convenience anywhere and anytime. Therefore, the discussed e-health implementation factors (summarised in Table 1) were used as a benchmark to determine the factors for successful adoption of IMUNOT through analysis of the findings.

Table 1 Summary of e-health implementation factors

<i>Interactive categorised elements</i>	<i>Constructs</i>
Contextual	ICT skills of health workers. E-Health knowledge of health workers. Perceived usefulness or benefits for adopting the e-health. Perceived ease of use. Trust in the e-health. Attitude towards the e-health.
Implementation process	ICT utilisation level in hospitals. Awareness about the e-health services. Support (Government or private sector) for the e-health. Social structure (knowledge sharing). Accessibility (power supply, internet, mobile devices, user support, training and skilled human resource). Availability of adequate funding for the e-health adoption.
Content	Compatibility, interoperability and language.

3 Research methods, sampling and data collection

Descriptive field survey approach was used to carry out the study in Northern Uganda using 30 and 21 health workers and mothers (system implementers and consumers) from Gulu Referral and Gulu Independent hospitals respectively. Northern Uganda consists of high infant mortality rate (64.82/1,000 live births) from vaccine preventable diseases due to poor participation of mothers in immunisation (Atri and Cusimano, 2013). Descriptive survey design was employed to provide answers to 'why', 'what' and 'how' questions in addition to giving room for generalisation (De Vaus and de Vaus, 2001). Purposive sampling technique was used to make the sample representative of the purpose for the study (Krejcie and Morgan, 1970). The relevance of the purposive sampling is geared towards its flexibility in meeting the needs of the researcher and selecting the sample based on the purpose and knowledge of the target population (Tongco, 2007; Black, 1999). The respondents comprised doctors, nurses, clinical officers and mothers.

Structured questionnaire was used for collecting data during the study. A questionnaire is objective and quick to administer in addition to providing valuable information on attitudes and beliefs of the participants (Bird, 2009). However, semi-structured interviews were also administered to the hospital administrators for the purpose of getting more opinions or insights (Kajornboon, 2005). Questionnaire validation was done to ensure consistency in what the researcher expected to measure (Parsian and Dunning, 2009). This was accomplished through expert reviews, pre-tests and assessments using item scale correlation and coefficient alpha with the help of windows statistical package for social sciences (SPSS). Prior to data collection, ethical consideration to build trust and confidence in respondents was achieved by availing them with introduction letters to explain the purpose of the study. Two field assistants were trained and closely supervised by the researcher to ensure accuracy and timeliness in data collection. The data collected was compiled, tested and analysed using SPSS 16.0 by

employing descriptive statistics involving frequencies, percentage distributions, cross-tabulations and correlations.

The identified constructs were then used to extend TAM including discussing the influence and interrelationships of the model constructs consistent with the existing literature. Finally, the IMUNOT adoption model was communicated with its utility, rigor of its design and its effectiveness to researchers and audience. This was done to provide opportunity for implementation and further validation of the model.

4 Results and analysis

4.1 Reliability of the questionnaire

The questionnaire was pre-tested using thirty (30) respondents and checked by determining the Cronbach's alpha coefficient. All constructs had depicted a Cronbach's alpha coefficient of greater than 0.7 (see Table 2), which according to Cronbach (1951) implies that the questionnaire was reliable.

Table 2 Summary of reliability of scales measures

<i>Construct</i>	<i>Cronbach's alpha</i>
e-Health knowledge	.738
Intention to adopt IMUNOT	.880
Perceived usefulness of IMUNOT	.916
Factors affecting IMUNOT adoption in Uganda	.899

Table 3 Principal component analysis and variance on factors for IMUNOT adoption

<i>Component</i>	<i>Initial eigen values</i>			<i>Extraction sums of squared loadings</i>			<i>Rotation sums of squared loadings</i>		
	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>	<i>Total</i>	<i>% of variance</i>	<i>Cumulative %</i>
1	4.436	24.647	24.467	4.436	24.467	24.467	3.735	20.751	20.751
2	2.608	14.489	39.136	2.608	14.489	39.136	2.151	11.951	32.703
3	2.160	12.000	51.136	2.160	12.000	51.136	2.059	11.438	44.140
4	1.678	9.320	60.455	1.678	9.530	60.455	1.943	10.794	54.935
5	1.222	6.790	67.246	1.222	6.790	67.246	1.932	10.732	65.666
6	1.026	5.702	72.948	1.026	5.702	72.968	1.311	7.282	72.948

Note: Extraction method: principal component analysis.

4.2 Validity of the questionnaire

Statistical factor analysis was used to determine correlation among the variables using principal component analysis with Varimax rotation to consider all the variances. Convergent validity is the degree to which items measuring the same construct are correlated and discriminant validity indicates how distinct and uncorrelated these items are.

In Table 3, six components with Eigenvalue >1.0 were extracted and Table 4 shows how the items loaded on their components as a measure of convergent and discriminant validity.

Table 4 Component factor loading on factors for IMUNOT adoption in Uganda

<i>Construct</i>	<i>Component</i>					
	<i>1</i>	<i>2</i>	<i>3</i>	<i>4</i>	<i>5</i>	<i>6</i>
<i>Factors for IMUNOT adoption in Uganda</i>						
ICT skills					.812	
e-Health knowledge		.783				
Perceived usefulness		.714				
Perceived ease of use				.820		
Awareness			.758			
Funding						.933
Reliable internet access					.584	
Reliable power supply	.691					
Access to mobile device access	.630					
Government support	.854					
Private sector support	.794					
Management support	.909					
Trust for IMUNOT			.568*	.527		
Attitude towards IMUNOT		.670				
Knowledge sharing	.544					
Compatibility			.590			

Notes: Extraction method: principal component analysis.

Rotation method: Varimax with Kaiser normalisation.

Table 5 Demographic profile of the survey respondents

<i>Variable Category Frequency</i>			<i>Response (%)</i>							
			<i>ICT skills</i>				<i>e-Health knowledge</i>			
			<i>Disagree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Total</i>	<i>Disagree</i>	<i>Agree</i>	<i>Not sure</i>	<i>Total</i>
Gender	Male	24	5.9	41.1	0.0	47	13.7	23.5	9.8	47
	Female	27	13.7	37.3	1.9	53	23.4	19.6	9.8	53
Total		51	19.6	78.4	1.9	100	37.1	43.1	19.6	100
Age	20–29	20	9.9	29.4	0.0	39	15.7	15.7	7.8	39
	30–39	23	5.9	37.3	1.9	45	17.6	21.6	5.9	45
	40–49	05	1.9	7.8	0.0	10	3.8	3.9	2.0	10
	≥50	03	1.9	3.9	0.0	6	0.0	1.9	3.9	6
Total		51	19.6	78.4	1.9	100	37.1	43.1	19.6	100

In Table 5, six components with Eigenvalues greater than 1.0 were extracted. Most of the factors after extraction loaded higher than 0.50 with exception of factor 11, thereby

showing significant discriminant validity. Factors 9, 15, 16, 17 and 18 had cross loading thus a significant convergent validity. The factor analysis reliably explains the variation in the opinions of the respondents by about 73% as indicated in the cumulative percentage of the initial Eigen values.

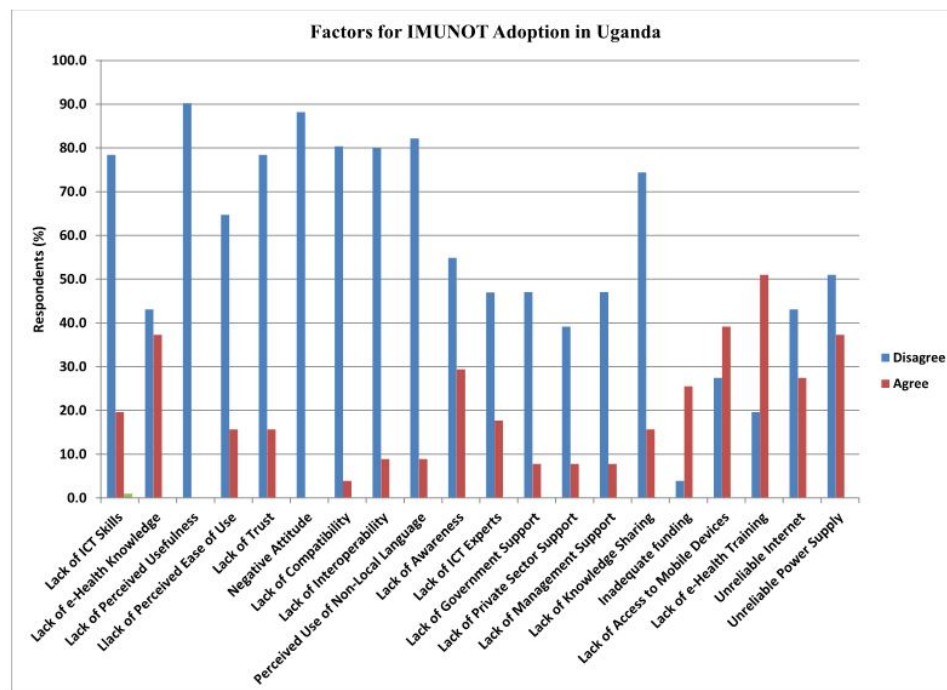
4.3 Demographics

The sample comprised 51 respondents, 24 (47%) males and 27 (53%) females (Table 5). Gulu Referral and Gulu Independent hospitals had 30 (58.8%) and 21 (41.2%) respondents respectively. The findings show that 41.1% were males, while 37.3% females had ICT skills. 23.5% males and 19.6% females had e-health knowledge. However in general, 78.4% and 43.1% of the respondents had ICT skills and e-health knowledge respectively thus enhancing the IMUNOT adoption (Hage et al., 2013). Most of the health workers (45%) were between the age of 30 and 39 with exception of 6% for 50 and above.

4.4 Determination of factors for IMUNOT adoption in hospitals

Figures 2 shows the average percentages of the participants who indicated their opinions through questionnaires availed to them in Gulu Referral and Gulu Independent hospitals. The issues tested include e-health implementation factors categorised into context, process and content.

Figure 2 Factors for IMUNOT adoption in Uganda (see online version for colours)



4.4.1 Contextual factors

The bar graph (Figure 2) shows that all contextual factors as defined in Table 1 were promoting factors for IMUNOT adoption. The respondents agreed that lack of ICT skills (78%), e-health knowledge (43.1%), perceived usefulness (90.2%), PEOU (64.7%); trust (78.4) and positive attitude (88.2%) were not the factors limiting IMUNOT adoption in the hospitals. Although e-health knowledge was found to be a promoting factor, its penetration into the hospitals is still low as portrayed by 43.1% (below average) of the respondents.

4.4.2 Content factors

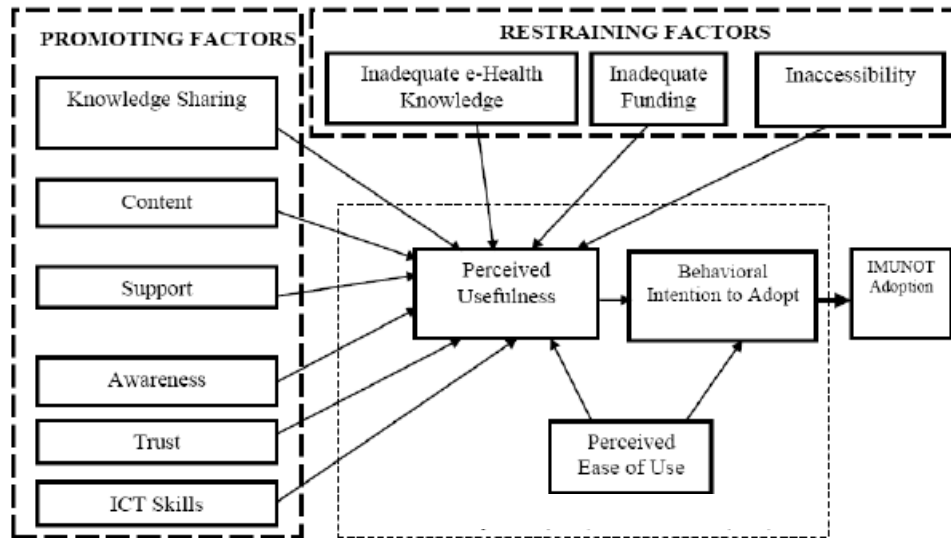
The content factors focused on the perceived opinion regarding IMUNOT compatibility with users' job responsibilities, values and beliefs, use of non-local language and interoperability. Bar graph 4 also shows that compatibility (80.4%), interoperability (80%) and use of non-local language (82.2%) constituting the content factors were found to be the promoting factors for IMUNOT adoption. The respondents disagreed on the three as being the limiting factors for adopting IMUNOT.

4.4.3 Process factors

The process factors focused on the set of strategies by the hospitals, government, private sector and other agencies in alleviating the challenges of adopting IMUNOT. Overall, the findings show that the two hospitals are challenged by inadequate funding (25.5%), inaccessibility to mobile devices (39.2%) and inadequate support for e-health training (51%). It was further established that the implementation process factors had the most restraint on IMUNOT adoption with exception of e-health knowledge (contextual).

Table 6 Summary result factors for IMUNOT adoption in hospitals

<i>Promoting factors</i>	
1	ICT skills
2	Knowledge sharing
3	Perceived usefulness
4	Perceived ease of use
5	Trust
6	Support (from government, private sector and management)
7	Content
8	Positive attitude
9	Awareness
<i>Restraining factors</i>	
1	Inaccessibility to mobile devices, internet and power supply
2	Inadequate funding
3	Inadequate e-health knowledge

Figure 3 Mobile-based IMUNOT adoption model (extension of TAM)

Source: TAM by Davis (1989) and Venkatesh et al. (2003)

5 Model design and discussion

The proposed model (IMUNOT adoption model) in Figure 3 extends the TAM using the nine new requirements. The new requirements include: ICT skills; awareness; support; trust; e-health knowledge; funding; accessibility; knowledge sharing and content in addition to PEOU and perceived usefulness from TAM.

The nine new requirements impact on the intention to adopt IMUNOT in hospitals through perceived usefulness.

- *ICT skills*: the users may use a system easily if they are imparted with the appropriate skills through training programs including their involvement in the implementation process (Hage et al., 2013). However, most of the developing countries are constrained with limited funds to enhance e-health implementation programs (Omary et al., 2010). There is need to involve government, private sector and other agencies for support.
- *Accessibility*: ICT infrastructure is the backbone of e-health and thus needs adequate budget allocation, support from the government, private sector and other agencies (Omary et al., 2010). Access to ICT infrastructure such as reliable internet and power supply, mobile devices and e-health training is very fundamental for the technology adoption.
- *e-Health knowledge* depicts the degree of knowledge acquired through training or education in order to note the signs of e-health adoption. Training as one of the factors of technology adoption instils comfort in the users for successful technology implementation other than frustration and demotivation (Singh and Muthuswamy, 2013). Training is also one of the ways of laying strategies of involving users in the

e-health implementation (Hage et al., 2013). Studies have demonstrated that users who have the e-health knowledge are more likely to recognise the usefulness of an e-health system than those who do not have (Hofstede et al., 2014). Therefore, involvement of government and other supporting agencies is appropriate to support the dissemination of e-health knowledge with incorporation of e-health in the curriculum.

- *Trust* is an expectation that alleviates fear in users in relation to misuse of information. Improving the security of communication through awareness and sensitisation or information sharing and user involvement is vital. Content of a system in relation to users' job responsibilities, values and responsibilities involves the perceived technical and user features to be implemented. It is important to develop skills and trainings consistent with the local cultures, languages and the design of the system for users to realise the benefits of the e-health.
- *Content* of a system consists of design and sustainability issues such as interoperability and compatibility. The design focuses on the needs of the users and usability, funding and costs, availability and accessibility and technical features (Hage et al., 2013; Viitanen et al., 2011). The content factors cannot be isolated from process factors as they are interactive e-health implementation factors. Interoperability refers to the ability of the e-health to exchange data involving more than one system or organisation. The shortfall of a technology to interface with other systems or organisations is perceived as an obstacle to its adoption (McGinn et al., 2011). For example, the gap between the new e-health system and the old paper-based system does not need to be wide.
- *Compatibility and awareness*: compatibility reflects on how the life style of users in relation to their daily job responsibilities, values and beliefs impacts on the system adoption (Hill et al., 2007). For example, a busy working mother would appreciate the adoption of a mobile-based technology due to its operational convenience anywhere and anytime. Studies also indicate that users who possess basic ICT skills and experience in using similar technologies have high ability to adopt e-health services and such skills can be acquired through training and education (Woodward et al., 2014). However, ignoring health informatics as a basis for ICT skills in curriculum for undergraduates' professional education in most of the developing countries has also made it hard to transform the existing paper-based health system into computerised information system (Anwar et al., 2011). Education is any act or experience that has a formative effect on the mind, character or physical ability of an individual. There is need for awareness of the internet; understanding of the internet and users who are educated and literate have tendency of adopting e-health. Awareness about the scope and benefits of e-health is a significant factor for adoption process to be successful. Most people understand e-health as the use of ICTs to accomplish their tasks without focusing much on the e-health innovations (Woodward et al., 2014).
- Knowledge sharing (social structure) is another factor that plays a greater role in system acceptance. Knowledge sharing refers to the interaction between the organisational members (Huang and Liu, 2004). Achieving social structure requires perception and attitude towards technology adoption by top management. Top management plays a central role in the daily running of the activities and future

planning of an organisation. This implies that decisions and openness of the top management influence all the organisational activities.

- Funding is a critical factor for technology adoption that influences a number of parameters in relation to cost of adoption. E-health systems are expensive to implement and maintain due to lack of resources coupled with difficulty of predicting the cost benefits from its implementation (Singh and Muthuswamy, 2013; McGinn et al., 2011). The costs incurred may be linked to activities such as change management, workflow improvement, training, user support, system ownership, personnel, hardware and software and maintenance (Henry, 2007). The high cost slows down the ability to easily adopt such kind of technology and thus Government and supporting agencies need to get involved. Supportive leadership is a critical factor that determines the success of e-health adoption by understanding challenges of technology adoption, setting realistic and open expectations (Silow-Carroll et al., 2012). The good e-health leadership is that communicates to diverse groups in order to promote collective learning, cross-cutting inter-professional evaluation meetings and strong collaborations with different supporting partners (Hage et al., 2013). A change for adopting e-health does not need to be driven by the effects of leaders actions on their political positions rather in a collective fashion where users play complementary roles (Denis et al., 2001).

The findings show factors that promote and restrain IMONOT adoption in Uganda. This is also true with the findings from previous study on “implementation factors and their effect on e-health service adoption in rural communities” (Hage et al., 2013). The contextual and content factors are influenced by the behavioural capabilities of the individuals in terms of their experience and education (Hage et al., 2013; Woodward et al., 2014). The availability of private mobile phones by the individuals in the health institutions adds to their experience or skills to build confidence in them in order to understand the benefits and ease of use of the system. The inadequacy of e-health knowledge reflects lack of e-health content in the education curriculum of the health workers. Attention is therefore needed from government, private sector and agencies to continuously support e-health training for the health workers who are already in the field. It will also be significant to introduce e-health in the education curriculum of the health workers. However, results also reveal that most of the process factors such as inadequate funding, inaccessibility and e-health training hamper IMONOT adoption in Uganda. This demonstrates inadequacy in implementing supportive policies and strategies by both government and other stakeholders. This is in line with the underlying challenges of e-health adoption in Tanzania contrary to the expected unique findings resulting from the post-conflict effects on system adoption (Lazaro and Geoffrey, 2013).

6 Conclusions and future research

Venkatesh et al. (2003) presents ‘perceived usefulness’ and ‘PEOU’ as the basic dependent factors of system adoption. However, what constitutes system usefulness is not clearly explained. This study highlights the key facilitators that impact on intention to adopt IMNOT through ‘perceived usefulness’. These include e-health knowledge, PEOU, accessibility, support, trust, content, knowledge sharing, ICT skills and awareness. The

research further provides a number of directions for future research regarding the adoption and implementation of IMUNOT.

The study makes significant contributions from the developed model containing the requirements such as ICT skills, e-health knowledge, content, trust, support, accessibility, awareness, funding and knowledge sharing. The research has highlighted the significant role of perceived usefulness in IMUNOT adoption. However, more research in addition to the model evaluation to determine its applicability is still needed for IMUNOT in different context. Although few variables are related to IMUNOT adoption, extra variables may be explored in future to improve the analytical capability of the model. The investigation of the impact of user trust in mobile service providers and mobile technology might be reasonable for future research in this field. The proposed model measures perceptions and intention to adopt IMUNOT and yet perceptions are liable to change due to the experience and demands of the users. Therefore, a dynamic model that would predict IMUNOT adoption overtime may be vital for future research.

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