
Factors affecting mobile immunisation notification system adoption in Uganda

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Abstract: *Objective:* The aim of this study was to assess factors that affect the adoption of mobile immunisation notification system in Uganda. *Methods:* Descriptive survey design and structured questionnaires were employed for the study that was carried out in Northern part of Uganda. A total of 51 health workers and mothers were purposively sampled from Gulu Referral and Independent hospitals. Statistical package for social sciences was used to evaluate the impact of the identified factors on the adoption of the proposed system. *Results:* The findings showed that e-health knowledge; trust; ICT skills; accessibility; support; awareness; knowledge sharing and compatibility affect the adoption of the proposed system. *Conclusions:* The study provides informative directions to adopt the proposed system. Government needs to improve ICT infrastructure and support user training on e-health to promote the adoption of the system.

Keywords: mobile; e-health; immunisation; infrastructure; process; contextual and content

Reference to this paper should be made as follows: Abandu, J. and Kivunike, F.N. (2018) 'Factors affecting mobile immunisation notification system adoption in Uganda', *Int. J. Electronic Healthcare*, Vol. 10, No. 3, pp.176–189.

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1 Introduction

In general, there is a decline in the death rates of mothers and children worldwide (United Nation, 2016). However, the death rates are still high in Uganda (Nurmatov et al., 2014). 215 children out of 1000 live births die from diseases such as polio, measles and tetanus of which they can be immunised against (WHO, 2014). Immunisation is a process a mother or a child is made resistant to an infectious disease by the administration of a vaccine at the right time (WHO, 2014). The Northern part of Uganda that is still faced with the post conflict effects of the 20 year-long Lord's Resistance Army revolt impacts negatively on the outcome of immunisation (Mugenyi et al., 2009; Roberts et al., 2008). The roads that are blocked due to lack of maintenance limit mothers to have access to information about immunisation from the facilities at the right time (Justine, 2005; Roberts et al., 2008; Mugenyi et al., 2009; Mbondji et al., 2014; Nguyen et al., 2008). Yet the number of users with mobile phones continues to rise in Uganda (Uganda Bureau of Statistics (UBOS, 2012)). Radical improvements are needed to reduce the death rates of mothers and children. One way of reducing the death rates is to provide access to information through e-health innovations such as m-health (WHO, 2014). E-Health is the use of Information and Communication Technology (ICT) to: treat patients; research; educate workforce; track diseases and monitor the health of public (Blaya et al., 2010). M-health is the use of mobile devices such as cell-phones, smartphones and tablets to share or collect health information (Qiang et al., 2011). M-health helps to reduce costs and offers services that are flexible and efficient (Zhang et al., 2014; Amoakoh-coleman et al., 2016). M-health allows symptoms to be caught early for users to avoid health problems before they become crises.

E-health such as m-health serves as an effective healthcare approach in developing countries (Blaya et al., 2010; Bwalya and Panos, 2004). Some developing countries such as South Sudan use e-health to manage the process of immunisation (Gargar and McWhorter, 2012). The Government of South Sudan deployed a cloud based information system in the central and state stores to manage vaccines (Gargar and McWhorter, 2012). The approach improved efficiency of work and reduces the time of responses. In Uganda, similar systems have been used but in a scanty manner (Woodward et al., 2014; Isabaliya et al., 2011). A mobile based system that was used for polio drive by sending short messaging services (SMS) to the clients improved awareness in 30 districts by 10% (UNICEF, 2015). A mobile system called MTRAC was launched and used to avoid stock outs in addition to mobileVRS that was used to ease birth registration of children (MOH, 2013). Mobile messaging used in Lira district helped to educate and expand the use of HIV testing and counselling services for the participants and most of them agreed to have got the required knowledge (Bonny, 2010).

Most of the mobile systems were used to monitor and manage vaccines but not to mobilise mothers (Abandu and Kivunike, 2017). Yet the ability of mothers to consume the vaccines supplied is still low. This study advocates for the adoption of a mobile system that may help in the mobilisation of mothers. It is noted that deploying a system does not imply that the system can be adopted due to factors that may be human and technical in nature (Bouchard et al., 2012; Yusif and Jeffrey, 2014). Based on this fact, we sought to assess factors that affect the adoption of mobile immunisation notification system (IMUNOT) in Uganda.

2 Literature review

2.1 Underlying theoretical models

The unified theory of acceptance (UTAUT); health metrics network (HMN) and technology acceptance (TAM) models have supported the adoption of the proposed system. TAM was used to emphasise the acceptance of the system. TAM explains why a user accepts or rejects a system (Vankatesh et al., 2003). PU is a belief by a person that a system may be of benefit only if it can satisfy and speed up his business processes (Phichitchaisopa and Naenna, 2013; Abandu and Kivunike, 2017). PEOU shows the degree of spending little effort to use a system (Johnston et al., 2015; McGinn et al., 2011). The intention to use a system demonstrates the attitude towards the system use and this is influenced by PEOU and PU of the system. TAM does not account for other context, process and content based factors, yet a system can be abandoned if all the user needs are not met. UTAUT adds to TAM facilitating conditions (FC) and social influence as new constructs. FC and SI are the beliefs by others that a system should be used and improved infrastructures support the acceptance of a system respectively. But UTAUT still lacks an in-depth analysis of the compositions of the SI and FC.

HMN by WHO (2007) comprises leadership, training and funding. HMN associates the success of an information system to the commitment of the leadership because of its vital role in decision making process. User training improves data quality and analysis. Funding facilitates regular activities such as training and expert recruitment.

2.2 Factors affecting adoption of e-Health systems

Hage et al. (2013) noted that execution of e-health is influenced by contextual, process and content factors. Context based factors may arise from the abilities of individuals to use e-health in that institution. Process factors are driven by the politics and leadership style of an institution in terms of openness, support and allocation of resources. Content looks at the compatibility of a system to interoperate with the existing ones while focusing on the duties and needs of users.

2.2.1 Contextual factors

Contextual factors such as trust; e-health knowledge and ICT skills do influence the adoption of a new technology.

Trust is the belief by users that information provided can be misused or changed by the system (Luo et al., 2010). It is noted that an insecure system often has low rate of adoption by the users due to its incompleteness (EU Health Programme, 2014; McGinn et al., 2011). A system with complexity of sharing data in cyber space is perceived to have lost privacy of patients and hence low *trust* in such a system (Pradesh, 2015). Users of a system need to be assured of the measures to combat such kind of security weaknesses with the help of techniques such as encryption key and password (Memon and Mustafa, 2015).

E-health Knowledge is the degree of knowledge that can be acquired with the help of training to note the signs of adoption of the e-health. Training provides an opportunity for the users to build comfort in themselves so that they adopt the new system without any worries (Hage et al., 2013). *E-health knowledge* helps users to engage with the system and easily accept future changes because they are able to share good practices and learn from the past mistakes (WHO, 2013).

ICT skills are fundamental for users to perform searches and navigate a system as most of the systems are not designed to test the ability of a beginner (WHO, 1994). Users who have basic skills of *ICT skills* that may be attained from training or education have high ability to adopt e-health services (Hage et al., 2013; Woodward et al., 2014).

2.2.2 Process factors

The management of an institution plays a great role in the diffusion of inventions in terms of decision making processes (Enz, 2012). The success of an invention such as e-health is achieved by a manager who understands its challenges and sets intervention measures (Hage et al., 2013). This implies that the decisions of the management may impact on the activities of an institution (Nguyen et al., 2012). The processes that require intervention of the management to adopt a technology may include: sharing of knowledge; awareness; support; access and funding.

Knowledge sharing consists of all the processes of exchanging skills and experiences amongst the researchers, policy makers and providers of service (Tsui et al., 2006). Knowledge sharing ensures that practice and policy are based on evidence to promote inventive ideas in an organisation that uses bottom up approach (Huang and Liu, 2004). Knowledge sharing builds confidence in users of the upcoming inventions (Jungmann, 2015).

Awareness is the degree of understanding an invention by the users in terms of its benefits and limitations (Liang, 2016). For example, most health workers are not aware of e-health and they understand it as the use of ICT to accomplish their tasks (Woodward et al., 2014). Users need to be aware of the conditions under which a technology such as e-health works best for it to be easily adopted (Ziemba, 2016).

Support consists of policies and actions that are either universal or state based to enhance the operation of programs such as inventions. European Union enhances the operation of e-health in its member states by giving financial support to them (Kalra et al., 2015). The autonomy of an individual member state to act on a policy may impact on the adoption of e-health due to differences in priorities and levels of budget (ICT Applications and Cybersecurity Division, 2008). The support of a state is needed for training or educating users about e-health so that they are motivated to use the system (Wong and Lam, 2016).

Accessibility is the degree to which information is availed to the users with the help of computers, internet and electric power supply (Hordern et al., 2011). A good ICT infrastructure allows room to improve an existing system (Qureshi and Shah, 2013). A system that provides access to information without hindering the workflow is likely to be adopted (Hasan et al., 2013). Internet is tool that supports a business in terms of collaborations and core transactions (Juma et al., 2012). Internet helps to bridge digital divide in communities through access to healthcare information (Hage et al., 2013). Unreliable Internet is a barrier to e-health and hence need for collaborative effort with health partners (Woodward et al., 2014). Inconsistent supply of power needed to run the devices that provide access to information may affect the adoption of e-health (Busagala and Kawono, 2013). Availability of computing devices on which the application runs plays a great role in influencing the adoption of e-health. It is noted that users who own computing devices such as mobile phones are likely to adopt mobile e-health easier than those who do not have due to the experience and skills they acquire in using them (Kumar et al., 2015).

Funding is required for operations and frequent upgrades. Access to ICT infrastructure is faced with high costs of operations and purchase of hardware and software (Isabalija et al., 2011). Funding provides the basis for the recruitment of experts and acquisition of hardware and software. E-Health systems are costly in terms of implementation and maintenance of hardware, software, training and management of changes (McGinn et al., 2011; Henry, 2007). This reduces the rate of adoption of e-health.

2.2.3 Content factors

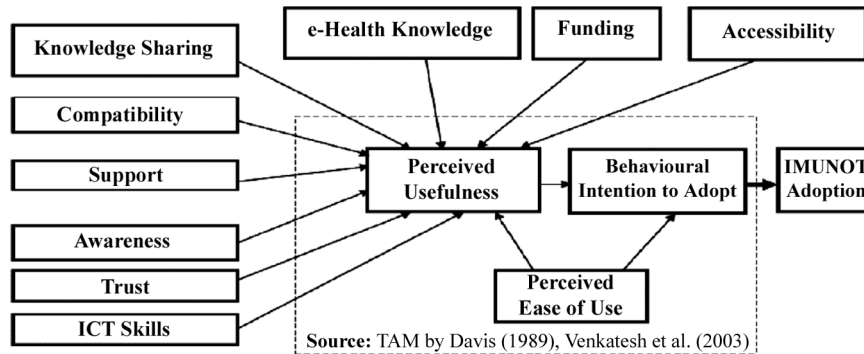
The shortfall of a technology to interface with other systems is perceived as an obstacle to its adoption (McGinn et al., 2011). E-health content focuses on the design and user needs that are affected by the compatibility issues of the system (Hage et al., 2013; Viitanen et al., 2011). The compatibility of a system with the job duties or practices of health workers also needs to be assessed (Ross et al., 2016). The patient-doctor interaction may influence the adoption of e-health in terms of schedules and pressure of work (WHO, 2012). A system that is flexible and does not succumb to the pressure of work can easily be accepted by the users of the system. It is noted that a mobile system creates an environment of flexibility where it can be used anywhere and anytime at the convenience of the user (Hill and Troshani, 2007). Compatibility also looks at the interoperability of the current and the proposed systems regarding how they communicate to each other. A system that is capable of providing healthcare within and across the boundaries of organisations of the same domain may be favoured by the users of the system (Akinde et al., 2013). The context, process and content based factors are summarised as shown in Table 1.

2.3 Research model and hypotheses

We hypothesised that ‘perceived usefulness’ is influenced by the context, process and content based factors (see summary Table 1). The relationships between ‘perceived usefulness’ and the e-health factors summarised in Table 1 are shown in the conceptual framework (Figure 1).

Table 1 Summary of e-Health implementation factors

Categories	Constructs	Source
Contextual	ICT skills	Hage et al. (2013), Woodward et al. (2014) and WHO (1994)
	E-health knowledge	Hage et al. (2013) and WHO (2013)
	Trust	Luo et al. (2010), EU Health Programme (2014), McGinn et al. (2011), Pradesh (2015), and Memon and Mustafa (2015)
Process	Awareness	Liang (2016), Woodward et al. (2014) and Ziemba (2016)
	Support	Kalra et al. (2015), ICT Applications and Cybersecurity Division (2008), and Wong and Lam (2016)
	Knowledge sharing	Tsui et al. (2006), Huang and Liu (2004), Adebayo et al. (2013) and Jungmann (2015)
	Access	Hordern et al. (2011), Anwar et al. (2011), Hasan et al. (2013), Juma et al. (2012), Hage et al. (2013), Woodward et al. (2014), Busagala and Kawono (2013) and Kumar et al. (2015)
	Funding	Henry (2007), McGinn et al. (2011) and Isabaliya et al. (2011)
Content	Compatibility	McGinn et al. (2011), Hage et al. (2013), Viitanen et al. (2011), Ross et al. (2016), WHO (2012), Hill and Troshani (2007) and Akinde et al. (2013)

Figure 1 Conceptual framework

Hypotheses:

- access has a substantial relationship with ‘perceived usefulness’
- funding has a substantial relationship with ‘perceived usefulness’
- E-health knowledge has a substantial relationship with ‘perceived usefulness’
- ICT skill has a substantial relationship with ‘perceived usefulness’
- trust has a substantial relationship with ‘perceived usefulness’
- awareness has a substantial relationship with ‘perceived usefulness’
- support has a substantial relationship with ‘perceived usefulness’
- compatibility has a substantial relationship with ‘perceived usefulness’
- knowledge sharing has a substantial relationship with ‘perceived usefulness’.

3 Methods, sampling and data collection

A descriptive study design was used so that both qualitative and quantitative data were sought and analysed (Plano Clark et al., 2008). The design enabled information to be sought from the health personnel and mothers of the two hospitals (Gulu Referral and Gulu Independent). The sample consisted of 51 health personnel and mothers. A purposive sampling method that makes the sample representative of the aim was then applied in the study (Etikan et al., 2016). Questionnaires that are structured in nature were used to collect data because they are objective and quick to manage (Gravetter and Forzano, 2003). The reliability of the questionnaire was achieved by expert reviews and pre-tests. All the constructs showed Cronbach's alpha coefficient of 0.7 and this justifies the reliability of the questionnaire. Factor analysis was used to find the correlation among the variables. Ethical consideration was done to guard tarnishing the image of the individuals and organisation. The respondents were availed with introduction letters to explain the purpose of the study.

4 Results and analysis

4.1 Demographics

The sample comprised 47% males and 53% females. Although most of the respondents (78.4%) have the basic ICT skills, majority of them (43.1%) lack e-health knowledge. Most of the health respondents were young (20–39 years) and within the working age (Table 2).

Table 2 Demographics of survey respondents

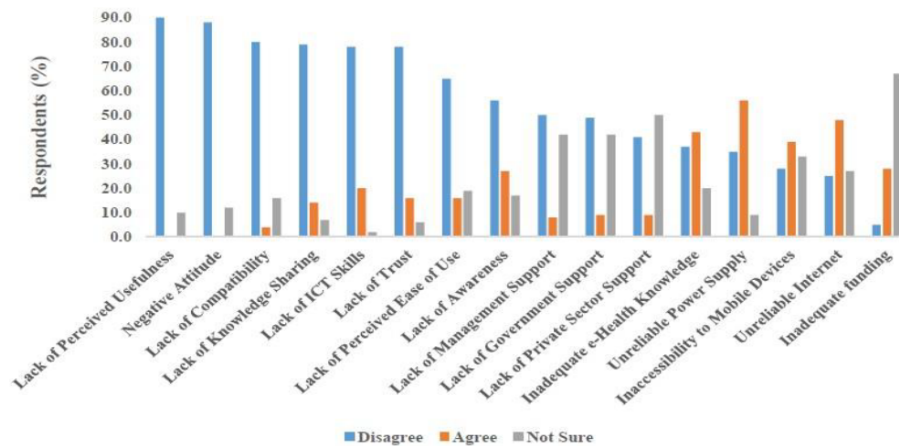
Variable	Category	Frequency	Response (%)							
			ICT skills				e-Health knowledge			
			Disagree	Agree	Not sure	Total	Disagree	Agree	Not sure	Total
Gender	Male	24	5.9	41.1	0.0	47	13.7	23.5	9.8	47
	Female	27	13.7	37.3	1.9	53	23.4	19.6	9.8	53
Total		51	19.6	78.4	1.9	100	37.1	43.1	19.6	100
Age	20–29	20	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

4.2 Perceptions on factors affecting IMUNOT adoption in hospitals

The findings show that all the contextual and content factors are promoting factors for IMUNOT adoption except e-health knowledge (Figure 2). The factors include: ICT skills; perceived usefulness; perceived ease of use; trust; positive attitude and compatibility. All the process factors are restraining factors. The restraining factors include: funding;

mobile devices; power supply and internet. The factors were then evaluated to establish their influence on the intention to adopt the proposed system using regression analysis.

Figure 2 Perceptions on factors affecting IMUNOT adoption in hospitals (see online version for colours)



4.3 Regression analysis

In the evaluation, 51 health workers and mothers were given validation questionnaire and all of them were returned valid. The independent variables that were found include: e-Health knowledge; funding; accessibility; ICT skills; awareness; support; trust; knowledge sharing and content.

Table 2 demonstrates the variability of the response around the mean by 87.8%. This justifies the data fit for the study. Eight antecedents also justify the fitness of the model as indicated by their respective *p*-values (see Table 3).

Table 3 Model summary

Model	R	R Square (R^2)	Adjusted R Square	Std. error of the estimate
1	0.937	0.878	0.644	0.380

Predictors: Support, Trust, Content, e-Health knowledge and Accessibility.

Each independent variable has a substantial effect on the dependent variable when its *p*-value is less or equal to 0.05. The unstandardised B coefficient was used to show the weighting of an independent variable relative to others on the intention to adopt the system. The most critical factors that affect the intention to adopt IMUNOT at the level of $***P \leq 0.01$ are: support; knowledge sharing; compatibility; trust and ICT skills. Factors that affect the intention to adopt IMUNOT at the level of $**P \leq 0.05$ are: accessibility; e-health knowledge and awareness. Funding does not affect the intention to adopt IMUNOT because $P > 0.05$. E-health knowledge, trust, compatibility and ICT skills are the contextual factors that affect the adoption of IMUNOT. Accessibility; support; awareness and knowledge sharing are the process and content factors that affect the adoption of IMUNOT 0.5.

Table 4 Summary of the multiple regression analysis

<i>Variables</i>	<i>Unstandardised coefficients</i>		<i>Standardised coefficients</i>	<i>t</i>	<i>Sig (P)</i>
	<i>B</i>	<i>Standard error</i>	<i>Beta</i>		
ICT skills	0.682	0.241	0.512	2.832	0.008
e-Health knowledge	0.326	0.139	0.399	2.337	0.025
Awareness	0.539	0.242	0.463	2.225	0.034
Funding	0.316	0.241	0.230	1.310	0.197
Access	0.342	0.170	0.350	2.007	0.050
Support	0.677	0.131	0.629	5.161	0.000
Trust	0.457	0.138	0.469	3.325	0.002
Knowledge sharing	0.696	0.147	0.780	4.745	0.000
Compatibility	0.518	0.159	0.498	3.262	0.002

R-Square (R^2) = 0.878. Dependent Variable: Behavioural intention to adopt IMUNOT system.

5 Discussion

The findings show the effect of the process, contextual and content factors on the adoption of IMUNOT in Northern Uganda. The factors include: e-health knowledge; trust; compatibility; ICT skills; accessibility; support; awareness; knowledge sharing; compatibility and funding. Regression showed that all the process, contextual and content factors affect the adoption of IMUNOT except funding. This is in line with the factors that affect the adoption of ehealth in rural a rural setting (Hage et al., 2013). The insignificant effect of funding on the adoption of IMUNOT may be linked to lack of involvement of the staff in the budgeting process. Although funding showed no significant impact on the adoption of IMUNOT, the respondents alleged that its inadequacy restrained the acceptance of the system. The finding is in agreement with the views of other researchers that the high cost of e-health (such as IMUNOT) implementation in relation to change management, user support and purchase of hardware and software negates the adoption of e-health (McGinn et al., 2011; Henry, 2007). The significant impact of ICT skills on the adoption of IMUNOT is linked to the growth of mobile phones that has improved the skills and trust of the staff to use the system (UBOS, 2012). Health workers who have the ICT skills can easily adopt IMUNOT as they will be able to understand its content; diagnose and solve technical problems they face with the system. The findings also indicate that knowledge sharing affects the adoption of IMUNOT as agreed by most of the respondents. Hage et al. (2013) noted that lack of knowledge sharing in the healthcare shows the inability to share project ownership and openness to promote and execute inventions such as IMUNOT. Lack of e-health knowledge and accessibility were found to restrain the intention to adopt IMUNOT in Uganda. E-Health knowledge depicts the degree of knowledge acquired through education to note the signs of IMUNOT adoption. Users who do not have e-health knowledge are more likely to reject e-health such as IMUNOT more than those who have as noted by Hofstede et al. (2014). Lack of access to ICT infrastructure such as internet; power supply and mobile devices negate the adoption of IMUNOT because they

are needed for improving and planning healthcare interventions. Internet availability contributes to information access; work collaboration and business transactions to bridge the digital divide communities (Hage et al., 2013). Power supply is the most restraining factor that influence the intention to adopt IMUNOT.

6 Conclusion and future research

TAM shows that 'perceived usefulness' of a system is a basic dependent factor without an account of what constitutes the 'perceived usefulness'. This study highlights some of the key facilitators of 'perceived usefulness' that impact on the adoption of IMUNOT. The facilitators consist of: knowledge of e-health; access; support; trust; ICT skills; awareness; sharing of knowledge and compatibility with exception of funding. Regression used in the study creates confidence in the results and it echoes the vital role of 'perceived usefulness' for the adoption of IMUNOT. The research further provides a number of implications for research and practice.

The study presents a framework that was validated with the help of regressions on the findings of the study. The outcome of the validation can be used as a point of reference for future related studies. Future research can explore more of the context, process and content based factors in which 'perceived usefulness' becomes a vital dependent variable. The study shows an ample case for IMUNOT adoption that extends the literature on m-health. This will increase the interest of researchers in the implementation of m-health. The high variability (87.8%) of facilitators with the 'perceived usefulness' shows that they can be used for the adoption of IMUNOT. The literature of this study gives the insights of the eight facilitators of 'perceived usefulness' for the adoption of IMUNOT. The list of the facilitators can be extended in future through their in-depth analysis. By assessing the features of the facilitators of 'perceived usefulness', the role of users for the adoption of IMUNOT is highlighted. The study measures perceptions that are liable to change with the user needs. A dynamic approach that will predict the adoption of IMUNOT overtime may be useful.

This study has implications for the users of IMUNOT, practitioners and system designers. The study highlights perceived usefulness as the key driver for the adoption of IMUNOT systems. This may encourage practitioners and designers of the system to consider 'perceived usefulness' as a vital need of users for the adoption of IMUNOT. For IMUNOT services that involve private or confidential information of the patients in cyber space, trust that has significant impact on 'perceived usefulness' plays a major role by building confidence in users. Not only trust that builds confidence in users but also the knowledge of e-health. The model shows that 'perceived usefulness' is dependent on: e-health knowledge; accessibility; support; compatibility; sharing of knowledge; awareness; ICT skills and trust. This means that when a user has e-health knowledge and finds the system trustworthy, accessible, supportive, compatible, the usefulness will increase.

Therefore, attention is needed from government, private sector and other agencies to have adequate support for e-health training for all the health workers. It may be vital to introduce e-health in the curriculum as a mandatory course for the health workers to impart adequate e-health knowledge before they join job market. ICT infrastructure such as internet, power supply, access to mobile devices and adequate funding should be improved in all the healthcare by the Government. It is vital to have reliable providers of

internet that are capable of reducing risks linked with e-health. A safe mobile exchange of information setting can be provided by putting in place user controlled access which remains anonymous. The hospitals should practice bottom-up approach of involving all the departments while budgeting so that realistic allocations are done to meet the needs of e-health.

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