User Acceptance of Health Information Technology (HIT) in Developing Countries: A Conceptual Model

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Abstract

Health Information Technology (HIT) has the potential to improve the quality, efficiency, outcomes, patient safety and reduce the cost of healthcare. But HIT systems are not widely available, and even if available are not properly utilized. This paper reviewed some available HIT systems in order to have an idea on their availability. Also works on acceptance of HIT systems were reviewed so as to understand the level of research done in the area. The problems identified from this work include lack of availability of these systems especially in developing countries, insufficient works on user acceptance of HIT systems, etc. These limitations can be overcome when researchers study the factors that will affect the user acceptance of these systems, and then consider the factors while developing the systems. Finally, a conceptual model of HIT acceptance in developing countries is proposed.

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Keywords: Health Information Technology; User Acceptance; Clinical Decision Support System; Perception; Technology Acceptance Model

1. Introduction

The world population is growing at a rattling rate, while at the same time the healthcare delivery is not good enough to cater for the populace. There is need for bringing other ways of improving the healthcare delivery in order to allow people especially in the rural area to have access to healthcare easily and timely. Meanwhile, healthcare

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delivery can be improved by using various Information Technology (IT) infrastructures; such application of IT in healthcare is termed as Health Information Technology (HIT). HIT can be implemented in the form of Electronic Health Record (EHR), Electronic Medical Record (EMR), Computerized Physician Order Entry (CPOE), Clinical Decision Support System (CDSS), etc. or in some cases combination of two or more of the above.

Unfortunately, in most of the countries particularly in developing economies people do not have access to healthcare facilities due to factors like shortage of healthcare professionals, inadequate hospitals or clinics, high cost of medical consultation, etc [1]. For instance in Ethiopia only about half of the country’s population have access to healthcare services [2]. Hence, Health Information Technology (HIT) systems like Electronic Health Record (EHR) or Electronic Medical Record (EMR) can be developed in order to serve people that have limited access to healthcare services. EMR transforms the management of information in healthcare settings, by providing efficient and cost effective clinical management, reminders for drug prescription, warning on cases like drug incompatibility or abnormal lab result [3-6].

Despite all the challenges in developing world, some countries are trying to use their limited resources to create and implement EMR systems due to their myriad benefits. Some of the existing EMR systems include Computerised System for the Control of Drug Logistics (SICLOM) in Brazil, Lilongwe EMR in Malawi, Highly Active Antiretroviral Therapy (HAART) in Botswana, Partners in Health (PH) EMR in Peru, HIV-EMR in Haiti, PEPFAR project in Tanzania, Mosoriot Medical Record System (MMRS) in Kenya, and Careware system in Uganda [3-5].

However, the acceptance of HIT systems specifically in developing countries is very low, so studying the perception of the intended users about the system before the development or implementation is a wise decision; as it is believed to positively affect the actualization of the real system [7-11]. There are theories that describe user behaviours and attitudes towards using a new technology, and these theories also show how this technology can be accepted and spread. The theories include Theory of Reasoned Action (TRA), Diffusion of Innovation (DOI), Unified Technology Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), etc.

2. Health Information Technology (HIT) for Patient Monitoring

Health Information Technology is an area that combines Information Systems, Computer Science and Healthcare. This area is gaining attention globally as a result of advancement in technology and challenges regarding healthcare delivery. Systems developed in this field are sometimes called Health Information Systems (HIS), Health Informatics, etc.

There are several HIT systems available for patients monitoring which can be within a clinical setting, or from outside usually from home (remote). Various patients monitoring systems utilized sensor network technology in order to collect physiological data of a patient suffering from different diseases like cardiovascular [12] and other diseases [13-17]. The general features of the above projects include using sensor technology, sending alert to caregiver or medical personnel. They also have distinctive features like CodeBlue has GPS integrated into the system for tracking the actual location of patients as well as doctors [16]. While Tura et al. [15] create their system for managing home care activities in brain-injured children; MPHASIS [12] is for cardiovascular disease; WAITER [17], UbiMon [14], and MobiHealth [13] do not specify a disease.

There are also systems that are developed for management of a particular disease like diabetes. For instance, a project presented on treatment of diabetic patients with foot ulcers [18, 19]. Larsen [18] design his system in such a way that the patient and a nurse (home care nurse) will be at home while communicating with the expert at the hospital. This project was carried out at the Computer Science Department in University of Aarhus and Aarhus University Hospital. The Centre for Pervasive Healthcare is also associated with the project group. The patient will have a bandage wrap around the area affected with ulcer, the bandage has built-in sensors that continuously monitor biomedical data concerning the ulcer like: bacteria flora, skin temperature, moisture level, and blood pressure.

Similarly, SiSPED 2.0 [19] is an extension of SiSPED (“a monitoring system for diabetic patients with the possibility of developing diabetic foot”), but in this case the monitoring is not remote, rather the system serves as a repository where patients information are stored. Likewise, a two-tier pervasive healthcare architecture was presented [20]. The client (patient’s PDA) and the server communicate via wireless network. Artificial Neural Network (ANN) model were implemented for diagnosing diabetes. The ANN model for diagnosing diabetes runs locally on the client’s PDA.
There are also systems developed to monitor physiological data related to diabetes, these systems manage diabetic patients generally without considering any complication that might arise. For instance, Jog Falls [21] a diabetes management system using sensor devices (for collecting physiological and activity data) that monitors patient’s physical activities, food intake, sets some goals and monitor progress towards these goals. Related to this is a system called DI@L-Log, which is a project in collaboration between Ulster Hospital and researchers at the University of Ulster. Weight, blood sugar, and blood pressure are the elements that the patients will be measuring to monitor their status. The system allows the patients to use speech to input and record their measurement [22]. Similar works include a system of monitoring and management of Type 1 diabetic patient using mobile phone [23]; a diet management system that provides patient with information related to his/her diet record, exercise and medication [24]; and a web-based medical diagnosis and prediction model that uses neural network to predict patients condition based on the previous similar cases [25].

3. Health Information Technology (HIT) Systems and Clinical Decision Support Systems

Making decision by healthcare professionals regarding their patients sometimes consumes extra time and resources than expected, hence the need for incorporating decision making component into HIT systems. This decision making capability help doctors and other medical experts to manage their patients with ease. These systems are called Clinical Decision Support Systems (CDSS). CDSS is defined as “software applications that integrate patient data with a knowledge-base and an inference mechanism to produce patient specific output in the form of care recommendations, assessments, alerts and reminders to actively support practitioners in clinical decision-making” [26]. A well designed and implemented CDSS has the potential to improve healthcare quality, increase efficiency, and reduce healthcare costs [27].

Some of the works related to CDSS include a proposal for CDSS which uses data mining techniques to build cooperative knowledge bases from domain experts’ knowledge bases, clinical databases, and most recent academic researchers. The data mining engine is connected to the EHR and clinical databases to continuously mine the very recent knowledge and adds it to local knowledge base, specialized knowledge bases from other institutions can also be consulted for relevant knowledge [28].

A model of a cost effective healthcare system for patients residing in remote areas of Pakistan was presented [29]. The complete architecture of the system consists of wearable medical sensor module, data gathering module, PDA, remote server with CDSS and EMR capability, and web enabled remote terminal for accessing services provided by web server. The remote server after processing the data then call CDSS for analysis of the data and finally the EMR will record the data against the patient’s profile. After analysing the data by the CDSS a feedback is sent to the doctor for approval, and then sent to the PDA after approval. The CDSS software analyses the patient’s physiological data like ECG, blood pressure, temperature, etc. for possible sign of abnormality. The software can project the health status based on the received data and also can make decision based on the health situation. A combination of model-driven and knowledge driven decision support systems were used. The model-driven makes decision based on the statistical model of the patient’s data, while the knowledge driven use facts, rules, procedures, etc. to make decision. For diagnosis, a cooperative system is employed in which the decision and action is first send to the consultant for confirmation before sending to the PDA. The EMR store the patient’s data and serve as a source for data to CDSS.

Additionally, a DSS was presented that will help surgeons and hospital managers to schedule patients as well as allocate resources. Web service was used for integrating DSS with HIS; a third party integration agent called AIDA was used as a communication layer of the HIS. Enterprise oriented architecture was used to divide the software into four layers: data access; business logic; web service; and presentation layers. To synchronise DSS and HIS, an update service calls a web service in AIDA for a request to synchronise data warehouse with recent data in HIS. Then the update service request the shared database to update the DSS database [30]. However, another work discuss about creating web-based DSS using Web services. The main components of their DSS are database, user interface, and DSS software system. Three layer design, Rich Internet Applications (RIA) and web services are the core elements that made up the web based DSS. The layers are data, business logic, and view [31].
4. Perception and Acceptance of HIT Systems

The advantage or otherwise of any system can only be known when the users of the system accept and use it. However, in spite of all the potential benefits of providing high quality care, reducing costs, and assuring patient safety; more than half of medical information systems are not in use. This is due to factors like extra time needed for entering patient record and reviewing the decisions provided by the system, interoperability, and user and staff resistance [7, 11]. Therefore, there are studies that identify factors that will facilitate the adoption and use of HIT system. One of such study was conducted which identified using cheaper and faster technology, offering incentive for CDSS deployment as some factors that can help to improve CDSS adoption [27]. The summary of some of the works reviewed is presented in Table 1.

Technology Acceptance Model (TAM) is among the popular theory for studying the perception and factors that contribute to the acceptance of a new technology. TAM as developed by Davis in 1986 is designed for modelling user acceptance of Information Systems. The central idea behind it is to increase the use of IT by promoting its acceptance. The acceptance can only be promoted if the factors that influence it are known; this can be done by examining the perception of the users concerning the use of the technology [32, 33]. TAM is an extension of TRA which was developed as a model for predicting human behaviour [34].

TAM focuses on factors that determine the users’ behavioural intentions towards accepting a new technology. The model shows that certain factors influence the decision of users when they are presented with a new technology on how and why they will use it. Particularly, the factors are: perceived usefulness and perceived ease of use. Davis [35] hypothesized perceived usefulness and perceived ease of use as the major factors that determines user acceptance. TAM also hypothesized that the intention to use the system is influenced by individual’s attitude towards using the system. Perceived usefulness is also hypothesized to affect behavioural intention directly as shown in Fig. 1.

A great deal of research has been conducted using TAM as a framework, and new models such as TAM2 and TAM3 were developed from it. While TAM2 focused on identifying determinants of perceived usefulness and moderating variables, TAM3 centred on interventions that can affect the acceptance and use of IT in an organization [36, 37]. TAM is also used by various researchers to find the behaviour or intention of users regarding the use of new information system in healthcare. These works include the application of TAM in examining physicians’ decisions toward accepting telemedicine technology. In this work the data was analysed from 421 respondents out of 1,728 distributed questionnaires sent to selected physicians from public tertiary hospitals in Hong Kong. They found that perceived usefulness to be significant determinant of attitude and intention while perceived ease of use was not [38]. A study was conducted with the aim of carrying out a comprehensive review of works on TAM related to health IT, in an effort to know the suitability of TAM as a theory for health IT acceptance and use, and also propose ways of improving its effectiveness by modifying it. Works reviewed include those that: quantitatively test relationships between TAM specified variables, use TAM as a theoretical framework, the end users of the health IT healthcare professionals were published on or before July 2008, etc. This study shows that TAM predicts a substantial portion of the use or acceptance of health IT, but the theory can be modified for better prediction. The study proves TAM as a good theory that explains healthcare providers’ reaction to health IT. In addition, it shows a
significant relationship between perceived usefulness and intention to use with actual use of health IT. Hence, promoting use and acceptance of health IT greatly depend on user perceiving it as useful [33].

A research was conducted in order to find the factors that affect the acceptance of integrated Personal Health Records (PHRs) for self-care management. A non-experimental descriptive, cross-sectional survey was used to get response from 78 diabetes patients in Howard University Hospital. The result shows that the users perceive the ease of use for the PHR, and they believe is useful for self-managing their care and diabetes. In addition, PHR adoption rate can be increased by promoting it by staff [39]. In another similar study, online diabetes self-management intervention participated by African American Type II diabetic patients of the Howard University Hospital (HUH) Diabetes Treatment Centre (DTC) was presented. Out of the 47 participants 26 were randomly assigned to treatment while 21 were assigned to control conditions. The participants were surveyed at the beginning and end of the intervention. Home visit was organized as part of the practice for the intervention group, in which the participants will be trained by a nurse on accessing the web-enabled patient application. The patients will send their health data and accessed patient education materials through this application. The study showed a significant association between participation in the intervention and achieving glycaemic control; a significant positive relationship between the participation in the intervention and achieving a healthy BMI; and above all the treatment group testify that the intervention increased their diabetes knowledge and improve their adherence to better diabetes management practices [40].

UPMC HealthTrack is a PHR implemented in University of Pittsburgh Medical Centre (UPMC) for self-management of diabetes. The impact of the system was assessed by analysing the patients’ reaction to HealthTrack with five pre and five post implementation focus groups. The focus group participants felt that the system would enhance communication with the centre and they envisage the reminder system as beneficial. The participants also reported their bad feeling when test results were not released and messages were not answered [41]. An exploratory descriptive study using in-depth interviews and focus groups was conducted in an effort to learn how patients with inflammatory bowel disease value access to Internet-based patient records. University Health Network’s tertiary centre in Toronto was the study area with 12 participating members. Four themes related to patient perceived usefulness were identified, these are sense of illness ownership, patient-driven communication, personalized support, and mutual trust between patients and their providers [42]. Another group of researchers conducted an online survey of 1,421 respondents of the Geisinger Health System, to evaluate patients’ values and perceptions regarding web-based access to their record. One-on-one interview with 10 clinicians and focus groups with 25 patients were also used to supplement the survey. The result of the study shows a positive patient’s attitudes towards the use of Web messaging and online access to their EHR as dominant. Also patients described their medical information as complete and accurate when using the system. Some patients expressed their concern about the confidentiality and privacy of their information. On the other hand, clinicians prefer other types of communication like letters than electronic communication [43].

Three theoretical models of IT acceptance were studied to investigate the acceptance of e-health from patients that registered for e-health. An online questionnaire was used to test five hypothesized antecedents from subjects who registered for e-health in Midwestern United States. The five antecedents are: satisfaction with medical care, health-care knowledge, Internet dependence, information-seeking preference, and health-care need. The findings showed that all tested acceptance models predict patient’s intention to use e-health very well [44]. Information and Communication Technology Acceptance Model (ICTAM) is a new model developed from TAM2 which is an extended version of TAM. The aim of the study is to predict and show consumer’s health information and services usage behaviour on the Internet. The independent variables that serve as antecedents of perceived usefulness were adopted from TAM2 into ICTAM with the exception of job relevance. The model is simply TAM with additional constructs as perceived playfulness from TAM2, compatibility, and Web site loyalty. The explanatory and predictive power of TAM and TAM2 was improved in ICTAM, with 52-66.1% of the variance in perceived usefulness and 47.6~74% in behavioural intention to use [45]. INTOcare is a Pervasive Intelligent Decision Support System (PIDSS) developed to assist the Intensive Care Unit (ICU) professionals in making their decision. The system was evaluated by 14 users, who are nursing staff of the ICU of Centro Hospitalar do Porto. The instrument used was a questionnaire based on TAM3. This study revealed that the users are comfortable with the system since the constructs Perceived Usefulness, Perceived Ease of Use, Behavioural Intention and Usage Behaviour received higher positive response. But then they want the systems to perform faster [46].
TAM was used to observe people’s readiness and attitude towards accepting self-service technology specifically self-diagnosis system as a means to reduce cost and improve quality in healthcare setting. A total of 160 participants were chosen randomly from outside the capital of Norway. Among them 132 filled the paper version of the survey, and 28 completed the survey online. Trust was added to the model proposed in this work as another factor that determines attitude and the variable usefulness is replaced by convenience. The result showed that expected usefulness is positively influenced by expected ease of use; there are also statistically significant and positive relationships between trust of service and expected usefulness and expected ease of use [47]. Another study from the perspective of end users was conducted to identify the health consumers’ behavioural intention of using HIT. TAM was extended with additional variables from Health belief model, theory of planned behaviour. The questionnaire was developed based on the proposed model with additional antecedent and mediating variables on top of the three theories. The participants were 728 members from three Internet health portals in Korea. Web based survey were used to collect the data using structured self-administered questionnaire. The study shows that perceived threat, perceived usefulness, and perceived ease of use significantly affect health consumers’ attitude and behavioural intention. Also health status, health belief and concerns, subjective norm, HIT characteristics, and HIT self-efficacy had a strong indirect impact on attitude and behavioural intention through mediators of perceived threat, perceived usefulness, and perceived ease of use [48].

Gagnon studied the factors that could influence the healthcare professionals to use a telemonitoring system. Response from 93 was used out of 234 questionnaire based on TAM were distributed among nurses and doctors of cardiology, pulmonary, and internal medicine department of Donostia University Hospital in Spain. The results of this study described TAM as a good predictive model of healthcare professionals’ intention to use telemonitoring systems. The factor that greatly influences nurses’ and physicians’ intention to use this new technology is perception of facilitators [49]. Another work is presented to examine the factors that influence medical professional’s behavioural patterns during the introduction of a new CDSS. The study uses 15 medical professionals as sample for the empirical study. The study found that social influence had no impact on the medical professionals’ adoptions of the CDSS. TAM and UTAUT were used together with Decision-Making Trial and Evaluation Laboratory (DEMATEL) for finding the relationship between UTAUT variables. The variables are: performance expectancy, effort expectancy, social influence, attitude towards the use of CDSS, and behaviour intention of using CDSS. DEMATEL analysis result showed that performance expectancy and effort expectancy have high impact on attitude; also the level of the impact is higher in attitude than behaviour. The result also shows insignificant relationships on social influence to attitude and social influence to behaviour towards the use of CDSS, and positive relationship between attitude and behaviour towards the use of CDSS [50]. A cross-sectional study was carried out to measure beliefs and acceptance of HIT systems from 133 sample health professionals. Structured questionnaire was designed using modified TAM. Multiple linear regression analysis was used to evaluate the predictors of HIT usage intentions. The result revealed that perceived ease of use, relevance and subjective norms directly predicted usage intentions [51].

Additionally, a study was conducted to determine the physicians’ attitude towards the use of CDSS, and whether their prolonged utilization has a positive effect on their intention to adopt them in the future. A questionnaire based on TAM was administered to 8 volunteered paediatricians who used a CDSS (e-GuidesMed) for a period of 3 months. It was found that their attitude towards the CDSS is good. Also compatibility and habit variables show that the participants perceive possible difficulty to integrate e-GuidesMed into their daily routine. The facilitators variable shows highest correlation with the intention to use [52]. In another study to explore the willingness and acceptance of CDSS by dentists’, questionnaire was distributed for the cross-sectional study in the dental department of Riyadh Military Hospital. The response rate was 30% out of 100 distributed questionnaires. Finding correlation between the factors in the UTAUT model and the intention to use the system and further the user behaviour was the tested hypothesis. The result of the study shows that performance expectancy had no significant correlation with behaviour intention in contrast to other studies that report strong effect of performance expectancy on behaviour intention. Also social influence shows no significant correlation while effort expectancy shows significant positive correlation [53].
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<td>Hu et al., 1999</td>
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<td>TAM variables</td>
<td>PU as significant determinant of attitude &amp; intention while PEOU was not</td>
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Another similar study investigates if physician’s perceived professional autonomy, involvement in the decision to implement CDSS and the belief that CDSS will improve job performance increase the intention to adopt CDSS. A survey was conducted in seven public and five private hospitals in Kuala Lumpur, Malaysia from different
specialties. A total of 450 physicians were randomly selected and given questionnaire out of which 335 were returned and 309 were used. The hypotheses were tested using SEM and the result shows that Physicians’ perceived threat to professional autonomy lowers the intention to use CDSS; Physicians involvement in the planning, design and implementation increases their intention to use CDSS; Physicians belief that the new CDSS will improve his/her job performance increases their intention to use CDSS [8]. In addition, a study was conducted using Unified Technology Acceptance and Use of Technology (UTAUT) theory to examine the factors influencing HIT services. A structured questionnaire was used to collect data from 400 employees (physicians, nurse, hospital staff members) in Thailand. The model was tested using SEM and the result shows that performance expectancy, effort expectancy, and facilitating conditions are the factors that have significant effect. Also they were found to have significant impact on behavioural intention. They suggested based on their findings that healthcare staffs’ behavioural intention and facilitating conditions need to be improved by healthcare organizational management in order to increase the adoption and use of HIT by the staff [54].

5. Proposed Model of HIT Acceptance in Developing Countries

The model proposed in this study is an extension of TAM, with additional constructs output quality adopted from TAM2 (an extension of TAM) [36] and perceived cost-effectiveness as depicted in Fig 2. Our aim is to examine the factors that can influence acceptance of CDSS by diabetes patients in developing countries. TAM has variables that can determine the users’ acceptance of IT, but the variables are not enough to satisfactorily explain users’ behaviour towards accepting CDSS for improving quality and reducing cost of diabetes care. Based on the literatures reviewed we find it necessary to define additional variables that can influence the patients attitude towards using the technology.

The construct perceived cost-effectiveness is the additional variable that is intended to measure the perception of the users regarding cost-effectiveness of the system. This is hypothesized to directly affect attitude toward using the proposed system. Output quality as proposed in TAM2 as an antecedent of perceived usefulness will be adopted in
this study but with different constituent, and as an antecedent of perceived usefulness and perceived cost effectiveness. This is also assumed to directly influence perceived usefulness and perceived cost-effectiveness.

6. Conclusion

Application of Information Technology in healthcare presents potential benefits to improve healthcare service delivery. Nevertheless, in developing countries very few HIT systems are implemented and used. In this review we found out that there are very limited studies on the users' perception and adoption of HIT systems generally, and the available works do not usually look at the cost aspect of it from perspective of the users. Besides, the developing countries are mostly not considered in the available related researches. Therefore, we propose a conceptual model for HIT acceptance in developing countries.

7. Future Direction

More research should be done on users' perception and adoption of HIT systems as this can help to understand the users need prior to having the actual system. Also, technologies that will improve the quality and reduce the cost associated with HIT systems should be used when developing and implementing the systems. Emphasis should be put on developing countries so as to reduce the suffering of less fortunate people. There is also need for conducting a study using the proposed model in order to identify additional variables and validate the model.

References


