Full Length Research Article

AN INVESTIGATION INTO THE RELEVANCE OF A MOBILE MEDICAL EXPERT SYSTEM AS A PROVIDER OF MEDICAL ADVICE AND DIAGNOSIS TO PATIENTS IN ZIMBABWE

Kitso Dube and *Judith Mwenje

National University of Science and Technology, Zimbabwe

ABSTRACT

Zimbabwe's public health industry continues to be plagued with diminishing national budget allocations, the brain drain of medical professionals and a growing population that depends on this sector that is so under-resourced. This means the industry has to do more with fewer resources which is very arduous and Zimbabwe's Healthcare system is currently in a crisis. It is clear, that the medical professionals who left Zimbabwe for greener pastures are unlikely to return The health professionals that have remained in the country have to work twice or thrice as hard to provide the same quality services in information, diagnoses and treatments to patients. It then becomes a major concern as to what then happens to the average citizens who cannot afford private healthcare, who must be in queues at odd hours of the morning hoping to get a medical professional's opinion on their sickness (considering how over-worked and de-motivated some of the professionals are). The research focuses on ascertaining the relevance of introducing a mobile Medical Expert System (mMES) to help solve part of the under-staffing problem that public hospitals and clinics face, which affects the quality of health services delivered. An mMES is a computer program that is given all the information that a medical professional has. Having considered the types of Management Information Systems, the researcher chose to focus on expert systems (ES).. The study investigates the relevance of mobile medical expert systems (mMES) as providers of medical advice and diagnoses to the ordinary citizens of Zimbabwe. The study was conducted to provide a possible solution towards addressing the labour shortage of medical professionals in the country... Though medical professionals are in short supply, mobile devices such as cell phones are available even in remote areas and they can provide information that can help save lives as patients wait for doctors for long periods even days or months in the case of some rural or remote areas. In some cases people have to travel long distances to get to clinics or hospitals. The findings from the chapter were that there is no mMES in Zimbabwe, the mMES would be a useful tool for patients in Bulawayo, the prevalent diseases in the city are HIV related infections, Diarrhea and Malnutrition, It is clear that the mMES is a groundbreaking technology that could help address part of the labour shortage challenge in the health industry.

INTRODUCTION

Considering the brain drain Africa continues to face with its medical professionals who leave for greener pastures; diseases that require giving patients simple advice and simple diagnosis kill people unnecessarily. There is need to leverage on technology to help solve some of the challenges that plague Africa's public health sector, thus the relevance of this study on mobile medical expert systems.

Corresponding author: **Judith Mwenje**
National University of Science and Technology, Zimbabwe

World Vision further reported to the International Development Committee (2010:91) that a large number of health professionals had left Zimbabwe due to political and economic factors. This had resulted in the "critical shortage of human resources", especially in rural areas. Many rural clinics were no longer functioning and even in larger urban areas health care has suffered.. According to previous research, expert systems are useful in areas where there aren't enough human experts, which is the case in Zimbabwe's health industry. According to a publication released by the Zimbabwe's Ministry of Health and Child Welfare (2013), some of the challenges faced in the health sector were the massive exodus of skilled and experienced health personnel, as

well as low salaries for health staff in the public sector and lack of incentives to work in remote areas.

LITERATURE REVIEW

A Management Information System is an information system that provides output to a manager and it provides support for tactical and strategic decisions (van der Heijden, 2009:3). The focus is on summarizing and analyzing transaction data, for the benefit of effective managerial decision-making. According to van der Heijden (2009), a system provides information to support managerial functions like planning, organizing, staffing, directing and controlling, collects information in a systematic and routine manner which is in accordance with a well-defined set of rules and includes files, hardware, and software and operations research models of processing, storing, retrieving and transmitting information to the users. Turban & Aronson (2001) as cited by Burstein and Holsapple (2008:513) define an expert system as a system that uses human knowledge captured in a computer to solve problems that ordinarily require human expertise. An Expert System offers the opportunity to make decisions that exceed the manager's capabilities. It also explains its line of reasoning in reaching to a particular solution. Very often, the explanation of how the solution was reached is more valuable than the solution itself, because both patients and medical professionals (MPs) would want to understand how it arrived at its diagnosis. Heathcote (2002:228) chose to define it as a computer program that attempts to replicate the performance of a human expert at some specialized reasoning task.

According to Wai, Rahman, Zaiyadi and Aziz (2005) expert systems are used for a number of purposes in medicine. First to generate alerts and reminders whereby an expert system attached to a monitor can warn of changes in a patient's condition. In less acute circumstances, it might scan laboratory test results or drug orders and send reminders or warnings through an e-mail system. The other purpose is for diagnostic assistance where a patient's case is complex, rare or the person making the diagnosis is simply inexperienced, an expert system can help come up with likely diagnoses based on patient data. Expert systems are also used for therapy critiquing and planning by identifying inconsistencies, errors and omissions in an existing treatment plan, or can be used to formulate a treatment based upon a patient's specific condition and accepted treatment guidelines. They also act as agents for information retrieval which can be sent to search for and retrieve information. The agent contains knowledge about its user's preferences and needs, and may also need to have medical knowledge to be able to assess the importance and utility of what it finds. Expert systems are also used for image recognition and interpretation where medical images can be automatically interpreted, from plane X-rays through to more complex images like angiograms, Computerized Tomography (CT scans) and Magnetic Resonance Imaging (MRI) scans and is of is of value in mass-screenings. A mobile Medical Expert System (mMES) uses mobile devices and computing technology so that medical doctors can speed up diagnosis, confirm their own diagnosis and provide advice on certain diseases when diagnosing a patient (International Journal of Science and Technology, 2012). Mateo and Lee (2008), support the development of expert systems but cautions that in

the domain of healthcare, it is important that the system is accurate in diagnosing because it deals with a life of a person where a slight error of treatments or diagnosis can cause death which cannot be changed.

mHealth

mHealth encompasses any use of mobile technology to address healthcare challenges such as access, quality, affordability, matching of resources and behavioural norms (through) the exchange of information (Qiang et al, 2012). However there are a number of challenges faced in nHealth which were highlighted in the World BankReport (2012) as follows:

- **Insufficient financial resources** – if no payment structures have been established, it is unclear who should cover the costs for mHealth in private healthcare (consumers, Governments or Insurance companies?).
- **Lack of sustainable business models** – besides a lack of public and private investments in developing such products and services, low-income countries often lack human resources and purchasing power on the demand side. Thus business models cannot simply be adapted from the developed world, but must be designed to match the scarcity of resources both on the demand and supply side.
- **Difficult coordination of stakeholders** – orchestrating diverse private, public and development sector interests for mHealth can be challenging. Clear roles have yet to be identified and role models are lacking. The different stakeholders have different goals and strategies that often overlap and conflict, leading to frictions and inefficiencies.
- **Limited potential of mHealth commercialization** - according to Qiang et al (2012), due to the diversity of mHealth applications and the limited potential of mHealth commercialization, however, the larger economic or development impact of mHealth is difficult to assess, and there is lack of systematic data for the developing world that would justify higher level investment.

Organizations Leveraging on Mobile Technology in Africa

Africa is one of the continents that need more medical professionals than most continents because of the growing population, increased poverty levels and a continuing continental brain drain of health professionals. It therefore seems reasonable that Africa should be using more of mobile technology considering that the continent has a growing mobile penetration rate from 1% in the year 2000 to 54% in 2012 and is expected to be at 75% by 2016, according to Sub-Saharan Africa Mobile Observatory (2012:9). The growth in mobile penetration could be used to address part of the labour shortage effects on communities.

However, there are very few organizations that are known across the continent that are involved in addressing the issue. They are the following:

- Kgonafalo allows for remote diagnosis of health ailments. A pilot project served 6 areas but is ready to expand to 25. Handsets have been replaced with Android tablets.

Table 1. Reasons for Not Recommending the Usage of Mmes by patients when searching for information concerning their health

Reasons
There is no authenticity as to the qualifications of the "supposed" professional at the other end of the line, thereby, subjecting the patient to a misdiagnosis and probable worsening of the condition if there is failure to visit a health center physically.
Some diagnoses need laboratory confirmation before treatment. Also some conditions need support from health specialists
People who use the internet are giving themselves diagnoses which are wrong and end up stressed and taking wrong medications. So using the cell phone would be worse. It is only good when used for teaching.
Through the network or phone, people tend to run out of network and cash in the phone to explain fully about his or her condition
People would be bound to use wrong dose, wrong treatment due to assumption and wrong interpretation of information.
It would encourage patients to go around seeking medications that are not prescribed because they will think they know what they are suffering from
Patients should just go and see a doctors who are experts and are able to interpret the meaning of medical terms which an ordinary patient may not be able to. Related to that it reduces pressure and anxiety on the patient who is likely to be stressed up already.

Source: Primary Data

Table 2. Responses from Patients

Patient	Reason
P1	I will need to know the source of diagnosis so that I can validate and verify it.
P2	Need counseling or meet the doctor face to face
P3	If it is from a medical doctor
P4	I would seek a second opinion from the medical doctor physically
P5	References of the research
P6	The platform must allow me to probe it for clarity
P7	It must refer me to a specific doctor with that regard because it's pointless getting information with nowhere to take it to
P8	Assurance from the doctor
P9	Links to other sites to further complement my understanding of the diagnosis given and just to compare notes
P10	If I know where it's coming from and an endorsement from the Ministry of Health and Publicity about it
P11	If answers are from my G.P. who I know very well
P12	I will need to go for different tests every month
P13	Dealing with doctors is just the best

- MEDAfrica, launched in November 2011, integrates a pioneering a viable business model into a single platform, which has attracted worldwide media and investor attention.
- RapidSMS saves costs by using SMS aggregation to send text messages to multiple recipients for a single cost.
- Cell-Life works with over 50 organizations to notify patients to take medication.
- Health eVillages aims to deliver medical education via mobile devices to clinicians on some of the most underserved parts of Africa
- M-Pedigree – a mobile app, helps users determine the authenticity of medication

Source: www.oafrica.com

MATERIALS AND METHODS

The researcher chose the exploratory study to find out how grave the situation in the health sector has become and how the general public and medical professionals view this technology. The exploratory research design is important in this study so as discover new ideas, gain insight and ultimately formulate a problem for further investigation. The mMES is a new phenomenon and currently the country does not have such a medical expert system; thus the use of the exploratory research study in the beginning. The researcher then carried out the rest of the study using the descriptive research design using both qualitative and quantitative data According to Kothari (2004), in a descriptive study, the first step is to specify the objectives with sufficient precision to ensure that the data collected are relevant. The researcher took note of the statement as preparations were made to collect data. To obtain the information, the researcher used a survey method to review the opinions and perceptions of the medical professionals and patients at Mpilo Central Hospital.on the relevance of a mobile medical expert system that diagnoses illnesses. This method was chosen for this study because according to Neuman (2005), it allows the researcher to seek answers from the respondents on questions in several different categories including: opinions, characteristics, expectations, self-classification, and knowledge in a way that is convenient for them to participate. In addition, this method also allows many respondents to be included in the study.

RESULTS AND DISCUSSION

Prevalent diseases affecting the citizens of Bulawayo

The researcher wanted to understand what the prevalent diseases were so that if the system is to be created, it could start off by addressing the prevalent diseases. HIV related infections like Tuberclosis, Diarrhea and Malaria, malnutrition are the prevalent diseases.. It is clear that HIV/AIDS is still a major problem in the country. Other mentioned diseases were chronic illnesses such as diabetes, obesity and cancer which in the in-depth interview with IMP2, it was said that chronic illnesses are what the MMES should address first as they have certain symptoms which cannot be linked to other illnesses. Some of the given reasons were the poor water supply and sanitation, economic hardship and the continuous change of weather. These diseases were mostly reported in the Out

Patient's Department of the major hospitals in Zimbabwe such as Mpilo Central Hospital. Neonatal Sepsis as defined by Mathur (2010:3) is a clinical syndrome characterized by systematic signs of infection and accompanied by *bacteremia* (the presence of bacteria in blood) in the first month of life. The Diarrhoea mentioned had been broken down to two types of diseases, namely Gastroenteritis (which is a diarrhoeal disease) and Rotavirus (which is a viral infection of the gut which causes Gastroenteritis) which are severe in children under five years. Older children can suffer from the condition but it does not lead to death and with adults they can limit the condition so that it is not a threat to them.

mMES in Zimbabwe

95% of the medical professionals said there was no mMES in the country, however, 1 respondent said there is and it is called iTriage. Itriage is actually an American based company and people from all over the world can access it via Apple's and Android's application stores. Its content is customized for Americans, and will therefore be disregarded for the purposes of this study. On further investigations a number of participants were not aware of it which makes this research relevant. If there was any existing Mobile Medical Expert System (mMES) in Zimbabwe, the researcher may have investigated its effectiveness instead.

Relevance of the mMES to the citizens of Zimbabwe

The question focused on medical professionals, their students and the patients who represented the citizens of Zimbabwe. 63% of medical professionals pointed out that they would recommend the innovation system to their patients to use and would also encourage their medical students to make reference to it as they learn how to effectively diagnose a patient. 87% of the patients representing the citizens of Bulawayo welcomed the idea of using the mMES and went on to specify what other features they would need to be entirely satisfied like endorsements from the Ministry of Health and Child Welfare and knowing the source of the diagnosis.

Usage of mMES by medical students when verifying a diagnosis?

63% of the medical professionals agreed to the usage of mMES by students when verifying a diagnosi. Most of the respondents supported themselves by saying that the mMES is a useful technology in Zimbabwe because on a day-to-day basis medical students find themselves all alone in the clinical area and they need to verify some challenging issues. However 37% of the respondents did not agree mentioning risks associated with such a move and also a number of them indicated that the mMSE should be used by a qualified person not students.

Patients' usage of mMSE when searching for information concerning their health?

65% of the medical professionals would recommend mMES to their patients to use it when searching for information concerning their health.. 35% said they would not and some of the major reasons are tabulated below:

The variety in their responses helped the researcher understand and consider other possible weaknesses of the system. Other respondents addressed the issue on accuracy by saying that the mMES should probe the users, for example, if a user puts a headache as a symptom, the mMES should ask the patient if the headache is associated with this or that symptom so as to narrow down the probable causes and give an accurate diagnosis because patients may leave out other symptoms think they are not important when they are.

It was further indicated that the mMESwould refer patients for further laboratory tests where the need arises to do so.from the findings that diagnosis that need laboratory confirmation before treatment. For the patients that need the support of health specialists the mMES can also recommend suitable specialists just like any General Practitioner (GP) would.

The need for physical examination assumes that there will always be resources to access healthcare, whereas an introduction of the mMES seeks to address the likely scarcity of such resources, for example, proximity to health centers, financial constraints and adequacy of staff in health centers to attend to the patients. , meaning to say for example, if a patient has a wound, it must be physically examined to assess the magnitude of injury or seriousness of the matter. However, not all patients will have access to this examination, by virtue of resource constraints as already indicated where MPs may not be available in close proximity, or funding to access the health center or even distance to the health center. It was said that medical jargon may confuse people and literacy levels are too low. However, rural areas have primary schools, high schools, vocational training center facilities and adult learning programs to improve the literacy levels there. In addition, Zimbabwe has the highest literacy levels on the continent, according to *Ranking African countries by literacy rate* (2013). The elderly also live with their children and grandchildren who are literate. Through the rapid penetration of technology in rural areas through government support and other development actors (like Non Governmental Organizations), it should not be inconceivable that some people in the most remote areas of the country can use this technology.

Areas of health that patients would be interested in getting information about from an mMES

This question was answered by the patients as the ones who face challenges of accessing information about their health due to the related costs at health centers. Their responses are tabulated below

Do medical professionals support the Use of the mMES technology in rural areas?

Considering that rural areas have fewer medical professionals than urban areas, the researcher wanted to find out what medical professionals thought about the mMES in rural areas. The majority of the medical professionals, 53% indicated that the mMES would not be useful in rural areas citing the need for physical examination. They went on to say that people may misuse the facility and that there's no point in diagnosing when treatment cannot be offered. They also highlighted the

fact that literacy levels are low in rural areas and medical jargon may confuse people. They were concerned about network challenges in the rural areas and the network service providers are too expensive for rural areas.. Finally they had fears that self-diagnosis may worsen the case without the support of proper counseling. The remaining 47% said the mMES would be useful in rural areas considering that there are few qualified health professionals in rural areas and most patients in rural areas live far from hospitals. It would also assist in diagnosis of simple conditions and it relatively cheaper. It also encourages patients to seek medical attention earlier than later. when they have an idea of the problem. The two MPs who were interviewed supported.

The best way of educating people about the mMES

55% preferred social media, followed by health talks and demonstrations. Other platforms suggested were road shows. The widely held opinion from the patients was that social media is the best way of raising awareness. This was primarily because of the benefits of similar platforms, like Facebook and Whatsapp which allow users and the business to interact.

Conclusion

The main objective of this study was to find out how relevant a mMES would be to the citizens of Zimbabwe. The results indicated that the mMES is a relevant tool to the citizens of Zimbabwe considering how expensive healthcare is and the short supply of medical professionals in the city and country at large. The most prevalent disease in Bulawayo, are HIV related infections, Diarrhoea and malnutrition. The MMES can assist in diagnosing the chronic illness which cannot be cured but managed as well as weight control and pregnancy/maternal health whose symptoms and diagnoses are less complex. From the results it becomes apparent that the majority of both medical professionals and patients agree that the mMES would be a useful tool for patients. There is certainly enough scope for the assimilation of this technology given the positive

response it already has from both medical professionals and patients. Since the mMES is a diagnostic tool, it will have to be tailor-made to be simple and detailed enough to assist patients to understand the information given by such technology. The major concern about the mMES is on accuracy of the diagnosis, lack of physical examination and issues of validity and reliability.

REFERENCES

Asabere, N. 2012. mMES: A Mobile Medical Expert System for Health Institutions in Ghana. *International Journal of Science and Technology*, 2 (6), p333.

Burstein, F. and Holsapple, C. W. 2008. Handbook on Decision Support Systems 1: Basic Themes. . Berlin: Springer.

Heathcote,P.M.2002. 'A2' ICT, 3rd Edition, Malta: Gutenberg Press

House of Commons, International Development Committee, DFID's Assistance to Zimbabwe, English Report of Session 2009-10, Volume 1. Pp3-48.

Kothari. N. B. 2010. Research Methodology, New Delhi, New *Age International.*

Mateo, R. and Lee, J. 2008. Exploiting Patterns and Tool Support for Reusable and Automate Change Support for Software Architectures. *International Journal of Software Engineering and its Application*, 2(1), pp 35-58.

Mathur, C. R. 2004. Neonatal Sepsis. New Delhi. Elsevier

Qiang, C. Z., Yamamichi. M., Hausman. V., Miller. R. and Altman. D. 2012. Mobile Applications for the Health Sector. ICT Sector Unit, World Bank, Washington DC.

Sub-Saharan Africa Mobile Observatory. 2012. Retrieved on 28 December 2014 from http://www.gsma.com/spectrum/sub-saharan-africa-mobile-observatory-2012/

The National Health Strategy for Zimbabwe 2009 – 2013. Equity and Quality in Health: A People's Right, MOHCW

Wai, K., Rahman, A., Zaiyadi, M. and Aziz, M. 2005. 'Expert Systems in Real World Applications', generation5. Retrieved 26 December 2014 from http:// www.generation5.org/ content/2005/Expert_System.asp

****