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Mobile Technology for Healthcare Information Dissemination to Low Resource Areas of Namibia

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Abstract: ***The current method of disseminating health-related information to the communities in Namibia is a manual system, which is not efficient and effective. Access to general disease information is difficult due to the sparsely distributed population of Namibia, which not only makes it difficult to provide health services, but also adds additional transport costs to those who want to access general disease information from hospitals and clinics. In addition, Namibia is divided into 14 autonomous regions, which in turn makes it difficult for the Centre for Disease Control (CDC) and the Ministry of Health and Social Services (MoHSS) to coordinate the dissemination of general disease information to the communities. Extension workers from the CDC and MoHSS who are usually sent to different regions across the country to educate people about common local diseases that cause deaths only visit the regions quarterly. Mobile devices have become the most powerful tool to disseminate information across communities in today's world. This study therefore sought to identify an efficient and effective way to disseminate health information to the Namibian population through mobile technologies. Two hospitals, the MoHSS, the CDC and members of the community participated in a study to identify the requirements for a mobile application that is customised to the Namibian environment. The first phase of the study was qualitative, applying an interpretive approach and a qualitative multi-case study research design. Face-to-face interviews, focus groups interviews, questionnaires and document sampling were used as data collection methods from health administrators, health personnel, technical staff and community members. Through laboratory experimentation, the second phase of the study led to the development of a prototype mobile application that would enable anyone to install the application on their cell phones in order to access general disease information. For evaluation of the application developed, expert reviews were sought. The findings of the first phase of the research concluded that a large number of Namibians own cellphones hence a mobile application would suffice. The most prevalent diseases from the research sample are malaria, diabetes, cancer and HIV/AIDS; hence the initial application concentrates on information dissemination for such. The mobile application content covers the most common diseases in Namibia, their definition, the causes of the disease, the symptoms of the disease, how to prevent the disease and whom to contact for information on the disease. From the research, the majority of the population is literate, hence the application can support text-based information in addition to graphics. The research also found that a large number of people visit clinics and hospitals hence the mobile application will benefit even those who visit clinics and hospitals as well, provided there is access in the clinics or hospitals.***

Keywords: mobile systems, health information systems, community-based information systems, health information dissemination

1. Introduction

According to (The World Fact Book), Namibia is a country in South West Africa with a population of 2,436,469 people. 55% of the Namibians live in rural areas. While literacy stands at 81.9%, life expectancy at birth is 63.6 years. With a total of 824,292 square kilometres of land, and the existence of the large arid Namib Desert, Namibia is one of the least densely populated countries in the world. The population density is 2.9 people per square kilometre. The ethnic groupings of Namibia are 87.5% blacks, 6% white and 6.5% mixed. 55% of Namibia's population is rural. Namibia has 13 recognised languages. Namibia's economy is dependent on agriculture, tourism and mining. Its GDP per capita is $11,800. While subscription to mobile cellular phones per 100 inhabitants is 110, internet users constitute only 22.3% of the population.

The Ministry of Health and Social Services (MoHSS) is the main actor in the provision of healthcare services to the communities in Namibia. These healthcare services include but are not limited to pregnancy and antenatal care, family planning, immunisation, child wellness monitoring, voluntary counselling and testing for HIV, diagnosis and treatment of communicable diseases, chronic disease management, information, education and communication on all relevant health matters. The healthcare services are also provided by private organisations (Obeid, 2001). Both public and private organizations experience the same challenges in providing these services.

Namibia, like most developing countries is not producing enough health experts to satisfy its market, thereby compromising the quality of healthcare. In order to improve healthcare in Namibia, effort should be made to increase access to expertise for those in the under-resourced areas of the country. A large part of the rural areas of Namibia is under-resourced. Out of 114 countries in the UN Development Index of life expectancy, adult literacy and GDP per capita, Namibia ranks 70*(Morse, 2003)*. Namibia is identified by WHO as one of the countries that has a critical shortage of health care providers. There is a huge gap between urban and rural healthcare, and the private and public healthcare. During the 2007/2008 financial year, Namibia had an HR capacity ratio in the public health sector of 1:9,633 doctors, 1;42,598 pharmacists, 1:140,795 dentists, 1:59,043 radiographers, 1:91,516 physiotherapists, 1:24,083 social workers, 1:53833 health inspectors, 1:1,830,330 dieticians and 1:915,165 clinical psychologists *(Amakali, 2013)*. These statistics show a dire situation in terms of shortages of health experts to service the Namibian communities holistically. The health experts are concentrated in major cities, meaning the remote and under-resourced areas have little or no access to health experts. This has a negative impact on the quality of health services and also on the access to health services, particularly to the under-privileged. There are a number of definitions of under-resourced areas in literature including low-income areas *(Lafleur, et al., 2013)*, *(Dowrick, et al., 2001)*, areas serving economically poor communities with heightened social and economic problems*(Tatet, 1999)*,*(Parker &*

Jelsma, 2010), areas manned by inadequate human resources*(Hutchinson & Purcell)* and areas with an inadequate investment in infrastructure *(Meddings, 2002), (Tatet, 1999).*

One of the main challenges faced by Namibia is the communities' access to healthcare information on one hand, and the dissemination of health information to the communities by the Centre for Disease Control (CDC) on the other hand. The population directly affected by the lack of basic health care information is the predominantly the poor families from under-resourced areas. Basic health information dissemination to the population could help to educate communities on health resources or services available to them, diseases or conditions that are preventable including warnings on specific epidemics in the area and could provide helpful basic tips on what to do or not do when certain symptoms occur. The problem of information dissemination can therefore be broken down into two parts which are: (i) providing information to the communities, and (ii) utilising the information.

The current technologies used to disseminate health related information to the communities in Namibia are a manual system which is not efficient and effective in the delivery of health information to the communities. There is also the issue of language barriers. Namibia has 13 recognised languages. The CDC has to come up with materials to cater for the myriad of Namibian languages if ever any campaign is to be effective. This requires a lot of resources, be it financial and human, which is in short supply. The department of information education and communication in the CDC has a shortage of staff to undertake this manual dissemination of information. Space has to be made available for the staff to disseminate information from as well.

The health information dissemination methods available at the moment in the Namibian health environment are as follows:

- Information is distributed to the communities through health campaigns such as immunisation campaigns, polio campaigns, HIV/AIDS campaigns, etc. through the media such as radios, newspapers and television
- Other platforms that can be made use of include noticeboards but this doesn't reach the remote communities
- Through vaccination points, flyers, etc.

The challenges that are normally encountered with the current manual system that distributes health information to the communities are that(Angula, 2014):

- It does not reach remote areas
- It only targets a few age groups
- It does not cover the whole population
- Language is a barrier to communication as some people might not understand the language used.

The lack of human resources is a challenge to disseminating healthcare information. However, providing information to the communities can be resolved through a number of channels that include, for example, SMS to mobile phones, mobile cinemas, posters displayed in prominent areas and the radio. The use of mobile phones is so widespread across rural areas, hence adopting mobile technologies in health information dissemination would not entail large amounts of human capital, but coordination of information dissemination. Mobile phone users are not normally charged for incoming messages. However, lack of electricity or funds to charge the mobile phones at community-charging locations can pose a challenge.

The Namibian government is aware of the challengeof the communities' access to healthcare information on one hand, and the dissemination of health information to the communities; hence it recognizes it in the National Development Plan 4 (Fourth National Development Plan 2012/2013 - 2016/2017, 2017). The challenge can only get worse if it is not addressed. The implication affects and impacts how healthcare services are provided to the general public, specifically to the communities. This study aims at providing a solution to healthcare information dissemination by addressing this challenge, through the adoption of mobile applications for information dissemination.

Mobile applications are gaining momentum worldwide in providing healthcare services to communities. The increasing penetration of smartphones as well as 3G and 4G networks provides a significant boost to the use of the mobile applications for healthcare services provision to communities as a result of an improvement in healthcare information dissemination, amongst other uses(Nawal, 2012). This benefits the communities since they do not have to travel long distances to access healthcare related information. They can always use their mobile phones to access healthcare information. The healthcare service providers also benefit due to the fact that transport costs due to Community Health Workers / Health Extension Workers visiting the various communities for health information dissemination are reduced when health information is disseminated to the regions via mobile technologies. It also follows that health service provision costs are directly impacted by a reduction in transport costs.

The use of mobile health teams supports and enables the Ministry of Health and Social Services (MoHSS) and healthcare service providers in Namibia to disseminate healthcare information to the communities and the society at large(MoHSS, 2014 Annual Report of the Namibian Department of Health, 2014). This study is centred on the development of a mobile application for health information sharing. Mobile communication is reaching most corners of Namibia and most Namibians now access information through mobile technologies instead of listening to the radio(Ndiwakalunga, 2015). In other words, only elders are likely to listen to the radio nowadays while the majority of the youths use mobile technologies to access information.

The mobile-based health application developed in this research can help caregivers, communities and societies to reach each other through a mobile healthcare application platform by accessing healthcare information and services wherever they happen to be. The mobile application will allow communities, to access via a mobile-based application, healthcare information. This will reduce the incidence of the MoHSS or health service providers sending

health officials to the regions in Namibia to disseminate healthcare information. Mobile healthcare applications are important, because they provide better access to healthcare information to the communities and as a result the involved parties will benefit greatly.

(Tossy, 2014)states that to achieve the health for all goals, various developing countries like Namibia should adopt mobile applications that can allow the general public to access health information wherever they happen to be. While some countries are managing, some like Namibia are still struggling to use mobile applications to distribute health information to the communities. It has proven difficult to fully utilize mobile applications to disseminate and access health information to the communities and reap its benefits. Regardless of different efforts going on and different donors such as the Global Fund, United Nations agencies, the World Bank, etc. to put emphasis on the importance of mobile applications, little has been done so far in Namibia. The Ministry of Health and Social Services has been struggling to adopt mobile healthcare applications without much success. Most of the contemporary research in mobile healthcare development in Namibia focuses on the challenges of achieving adoption and yet the real challenge lies in the development of the mobile healthcare applications for the Namibian healthcare sector.

The MoHSS does not have a mobile application platform that can be accessed by the community members to receive general health information. Therefore, the only method available currently is the health workers being deployed to all the 14 regions in Namibia to ensure that community members receive general health information. It takes more than a week for the community members to receive the information when flyers are being used to distribute general health information due to the sparse populace of the country. However, this may affect the community members who need the information urgently. Apart from health workers being sent to the regions, another alternative in place currently is that medical officers at the ministry sit and determine how urgent the information is needed by the community members, look at the budget, and consider the vendors and suppliers who are responsible for broadcasting general health information to the communities in all the 14 regions of the country. The only technology platform the CDC has available at the moment is through direct interface when patients visit the hospital or clinic and the current method available currently is through pamphlets which come through other patients that come for treatment. At the ministry level, radio, newspapers, flyers and HIV/AIDS awareness campaigns are the modes of information dissemination. The current technology used to disseminate health information is too costly and some people in the communities might not receive the information due to the remoteness of areas. Flyers that are posted in certain areas are frequently destroyed by natural disasters such as rainfall, winds, snow etc. before communities have access to the information.

The exchange and distribution of information within the environment can significantly address the challenge of access to health information services highlighted in the National Development Plan 4 (NDP4). This study therefore investigated this further and recommended a mobile healthcare application as a solution to address the challenge. The study is expected to improve the way the MoHSS disseminates health information to the communities in Namibia through the development of a mobile application. This study was undertaken because this would allow members of the communities to access health related information from anywhere, anytime, without physically visiting the hospitals or health centres.The aim of this research was to investigate the mode of accessing and disseminating health related information to Namibian communities and propose a solution, which is a mobile-based technology.

2. Problem Statement

The challenge faced by the Namibian government is that of raising awareness about diseases by making health information available and accessible to the population (MoHSS, Annual Report 2012/2013, 2013). Therefore this challenge limits access of the communities to government health information services. This access is made difficult due to the sparsely distributed population of Namibia, which makes it difficult to not only provide health services, but it also adds additional transport costs to those who want to access the services that are available in centralized locations such as hospitals and clinics. Currently, each health facility is the custodian of its health information, that is, information is centralized within any particular centre and is inaccessible to other centres (Khan & Edwards, 2012). It is estimated that only 1.2 million people in Namibia live within 20km of a public health facility (MoHSS, Public Private partnerships framework: Discussion paper 31 March 2014, 2014). However, there are still challenges with the equitable distribution of health services across the country as a sizeable population still lives outside the reach of health services. Furthermore, health facilities remain under pressure to respond to the country's growing health needs, while the human resource base continues to lag behind.

The 2014 Annual Report of the Namibian Department of Health (MoHSS, 2014 Annual Report of the Namibian Department of Health, 2014), states that at independence in 1990, Namibia inherited a fragmented health system based on racial segregation. The health system's financial, physical and human resources were ill-distributed geographically, by level and by type of service provision resulting in a concentration of infrastructure and services in the urban areas. This created inequalities in access to health care services. These services were more of a curative nature and were managed by the Second Tier Authorities that were running parallel programmes. The Government consolidated these Second Tier Authorities into the Ministry of Health and Social Services (MoHSS) thus aiming at using all available resources more efficiently.

3. Methodology

The aim of this research was to investigate the mode of accessing and disseminating health related information to Namibian communities and propose a solution, which is a mobile-based technology.

The main question of this research is, "How can a mobile application be designed to raise health information awareness within low resource areas of Namibia?"

The above question is broken into four sub-questions listed below:

1) How is healthcare information currently being shared between the services providers and the communities in Namibia, i.e. the health information dissemination channels and technologies?
2) What are the challenges faced by communities in receiving health information services?
3) How can information relating to healthcare be distributed and accessed by the sparse populace of Namibia through adopting mobile technologies?
4) How will health information system access and dissemination be enhanced by this mobile ICT-enabled communication and dissemination mechanism?

The main objective is to design a mobile application to disseminate health information. The sub objectives of the study therefore are to:

1) Examine how healthcare information is currently exchanged / shared between the service provider and the communities in Namibia.
2) Identify health related challenges facing people in low resource communities.
3) Identify the benefits of adopting mobile technologies in health information access and dissemination.
4) Design a mobile application prototype for health information sharing.

Two hospitals in the Khomas region of Namibia, the MoHSS, the CDC and members of the Khomas community participated in this study. The first phase of the study was qualitative, applying an interpretive approach and a qualitative multi-case study research design. Face-to-face and focus group interviews and questionnaires with health administrators, IT technicians in health, doctors and nurses, and questionnaires with the members of the communities and in addition, document sampling were used as data collection methods to identify the requirements for a mobile application. The questionnaires were developed from a critical analysis of literature which identified gaps in the current information dissemination systems and the usage of mobile applications in information dissemination.

Two experts were consulted, one from the MoHSS and the other from the Prime Minister's Office to evaluate the prototype with a view to defining further research on the refinement of the prototype.

3.1 Data Gathering

Data gathering is a process of collecting data from all the participants that are engaged in the study with the purpose of answering the research questions and achieve the research objectives in order to draw a conclusion on the findings. The purpose of the semi-structured interviews was to get a better understanding on how general information reaches the communities in Namibia and which technology platform is used to disseminate health related information currently. The study also used questionnaires with a sample of selected community members who are residing in the Windhoek area to complete a questionnaire and also to give their opinions on how they prefer to access and receive general disease health awareness information as a community and also what type of healthcare information they would want to receive as well as how long it takes them as a community to receive general health awareness information. However, before the survey, the questionnaire was piloted. Two participants were selected for the purpose of testing whether the questionnaires set up can be understood by the participants and whether the questionnaires provided the answers to the study research questions.To come up with the questions for both the questionnaires and the structured interviews, a critical analysis of related literature was conducted. This critical analysis is what identified gaps in the literature on current health information dissemination. It is from these gaps that questions were identified. The interviews and questionnaires were in English. These interviews were recorded using an audio recording device and the recorded interviews were transcribed.Document sampling is when you choose documents for analysis from the long list of documents collected for the issue histories(doMbos, 2012). For the purpose of comparability, documents selected had to be similar in topic and type. The review of a variety of existing sources (e.g., documents, reports data files, and other written artefacts) is done with the intention of collecting independently verifiable data and information.

3.2 Selecting Participants

Three categories of participants were selected. Group one consisted of health personnel, who are the doctors, nurses and health participants. The second group of articipants consisted of health technicians, while the third group was the Winhoek communities. Semi-structured interviews were designed with the purpose to acquire general disease information from three groups of participants from the first lot. Each group was interviewed using the same semi-structured interview questionnaire. Each interview took an average of 45 minutes. The interviews were conducted in the English language. These interviews were recorded using an audio recording device and the recorded interviews were transcribed. Group one had 10 doctors; group two had 12 nurses and group three had 15 health assistants, all from the CDC.In the second group, the study also interviewed Windhoek communities. In total, 93 questionnaires were distributed and completed in four different areas representing deep rural areas, peri-urban areas, urban areas and informal settlements. The total number of participants from deep rural areas who participated in the survey was 34, from urban areas they were 18, from peri-urban areas they were 25 and from informal settlements they were 16 participants respectively.

The Office of the Medical Superintendent was approached in order to grant the study permission to engage IT personnel due to the sensitivity of healthcare facilities. Thus, a total of six (6) IT personnel were interviewed individually at the Centre for Disease Control. Two (2) computer technicians, one (1) acting chief computer technician, one (1) system administrator, one (1) registry office and one (1) Chief system administrator as shown in Table 1. Each semi-interview conducted at the hospital lasted for 45 minutes.

Table 1: IT personnel interviewed

Computer technician	Acting computer technician	System administrator	Registry office	Chief administrator
2	1	1	1	1

3.3 Data Analysis

Data analysis entails examining, categorizing and summarizing information in order to establish meaning and maintain evidence (Schoenbach, 2014). Schoenbach (2014) further states that the analysis process is managed by organising, summarising and interpreting data. The interpretive technique was employed to analyse qualitative data. This approach was selected because it is a research standardized approach that comprises of steps on how the data collected should be analysed.Step one is data reduction which means an analytic process through which the qualitative data that the researcher gathered are reduced, rearranged, and integrated to form theory.Step two is data display which involves the researchers taking reduced data and displaying them in an organised, condensed manner.Step three is drawing conclusions - at this point the research questions are answered by determining what identified themes stand for, by thinking about explanations for observed patterns and relationships, or by making contrasts and comparisons.An interpretive technique was used to analyse data from the CDC. The information from the CDC that was analysed was on current information technologies to disseminate health information, critical success factors to deployment of technologies, challenges with the manual system of health information dissemination, role players in health information dissemination, and the impact of fragmented HIS on health information dissemination. A software tool (i.e. SPSS) was used to analyse quantitative data from the communities to obtain the percentages. The information collected was on the distribution of cell phone ownership, channels of health information dissemination, prevalence of disease, literacy levels and frequency of visits to health facilities.

3.4 Case Study Approach

The study adopted a case study as the main approach. According to (Babbie & Mouton, 2001), a case study is defined as "an intensive/ in-depth investigation of a single unit." Since the study is dealing with different healthcare facilities, the primary research method is the case study. The only stakeholder in the dissemination of information is the Centre for Disease Control and prevention (CDC). The other stakeholders are the recipients who are the community. So there are two case studies: one, in which the CDC disseminates information and the second in which the communities access the information. The case study was selected in this study because it focuses on collecting information about a specific object, event or activity such as a particular business unit or organisation. The case study examines the real-life situation from various angles and perspectives. A multiple case study is defined as studying and comparing cases in their totality (holistic), and studying various units within identifiable cases (embedded). A multiple case study enables the researcher to explore differences within and between cases (Sekaran, 2013). While a holistic case study with embedded units only allows the researcher to understand one unique/extreme/critical case, in a multiple case study, we are examining several cases to understand the similarities and differences between the cases.

3.5 Laboratory experimentation

The prototype of the system is developed in a laboratory setup. Different stages of the life development life cycle were employed during the porotype development to ensure that the porotype suites the end user.

4. Related work

Healthcare information systems are also referred to as relationships between people, processes and technology to support operations and management in delivering quality healthcare services (Tossy, 2014). Tossy (2014) adds that a healthcare information system is a set of components and procedures organized with the objective of generating information which will improve health care management decisions at all levels of a health system. They are used in healthcare to devise, execute, and measure health interventions which have reliable data and performance of different parts of the health system. WHO (2004), defines a health information system(HIS) as a system that integrates data collection, processing, reporting, and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services. According to (Hua & Herstein, 2003), a health information system is a system that integrates data collection, processing, reporting and use of the information necessary for improving health service effectiveness and efficiency through better management at all levels of health services. Despite the credible use of HIS for evidence-based decision making, countries with the highest burden of ill health and the most in need of accurate and timely data have the weakest HIS and the vast majority are the world's poorest countries.

According to (Omona & Ikoja-Odongo, 2006), poor economic performance accompanied by a sharp reduction in the amount of resources available to support health information services has resulted in health information poverty which continues to remain a substantial impediment to better healthcare services in the whole of the sub-Saharan region. Health information is fragmented, inconsistent, redundant and lacking for the effective management of health through the provision of systematic and analytical information for continuous assessment of the situation, determination of priorities, improvement in management and evaluation of undertakings. Across Africa, there is a lack of access not only to medical care, but to healthcare information that in and of itself could save lives if the two challenges of i) providing information to communities and ii) utilizing the information are met (Team-42784, 2016). Basic information disseminated to the population could help to educate communities on resources or services available to them, diseases or conditions that are preventable including warnings on specific epidemics in the area. General health information access and dissemination systems are rapidly transforming social and economic conditions across the globe (Ogunsola, 2005). The adoption of general health

information access and dissemination has increased the quality and quantity of data for general health services research, including medical effectiveness research. Healthcare organisations in recent decades have adopted general health information access and dissemination systems as a strategy for health information dissemination and access with communities involving technology to organize, automate, and coordinate business processes. In addition, general health information access and dissemination systems can help healthcare organisations to improve and promote better healthcare to communities (Ogunsola, 2005).

Tossy (2014) states that to achieve the health for all goals, various developing countries like Namibia should adopt mobile applications that can allow the general public to access health information wherever they happen to be. While some countries are managing, some like Namibia are still struggling to use mobile applications to distribute health information to the. It has proven difficult to fully utilize the mobile applications to access health information to the communities and reap its benefits. Regardless of different efforts going on and different donors such as Global Fund, United Nations agencies, the World Bank, etc. to put emphasis on the importance of mobile applications, little has been done so far in Namibia. The Ministry of Health and Social Services has been struggling to adopt mobile healthcare applications without much success. Most of the contemporary research in mobile healthcare development in Namibia focuses on the challenges of achieving adoption and yet the real challenge lies in the development of the mobile healthcare applications for the Namibian healthcare sector.

Furthermore, the purpose of the study conducted by(Murthy, 2006)) was to identify the status of mobile device-based health care management systems in the world, particularly in India. The project began by conducting several field surveys in the implementation area of Sukabumi, West Java. The target area covered about 4,248 square kilometres and it has a population of about 2.3 million people. The findings were that the Primary Health Care strategy seems to be a right intervention in terms of basic preventive methods but it needs to be supported by other strategies as well to close the gaps. The literature reports of an SMS interface for receiving/sending SMSes to a 2G mobile system, which receives the SMS, converts the SMS into a query and executes the query. The results are then sent as an SMS reply when a community member requests for health related information and therefore responses will then be provided from the central server based at MoHSS or CDC.

(Omona & Ikoja-Odongo, 2006)conducted a study and the purpose of the study included the use of ICT in healthcare information dissemination, accessing information, user profiles, ICT literacy and quality of series and telemedicine. Literature reviews and interviews are applicable in this study as sources of data. Interviews and questionnaires were used to collect data gathered for the study. The study was conducted in Uganda and it assessed the application of information and communication technologies (ICT) in health information access and dissemination in Uganda. The study acknowledged the applications used to disseminate health information. The study built a mobile application because most studies done prior had excluded communities' access to health related information. Literature reported the use and application of ICT in health information access and dissemination in Uganda, and drew the attention of all the stakeholders in the health sector to the need to support and promote ICT as the most effective tool for health information access and dissemination.

5. Findings

Three fundamental objectives drove the collection of the data and the subsequent data analysis. Those objectives were to understand how healthcare information are currently exchanged/shared between the service provider and the communities in Namibia; to examine how information relating to healthcare can be distributed and accessed through mobile technologies; and to design and develop a mobile application for health information sharing. The questionnaires were analysed using SPSS and the semi-structured and focus group interviews analysed with an interpretive technique. Therefore as a build up to developing the mobile application, the research identified issues that will feed into the architecture of the mobile application. These issues include the levels of access to cell phones in the population, the preferred channels of dissemination of information, the prevalence of diseases to determine what information to disseminate, literacy levels to determine if the communities will be able to use the application, and access to clinics and hospitals for those who have no mobile applications and can access the application from such institutions.

The analysis of the questionnaires and interviews resulted in a number of findings. There is significant ownership of cell phones among the Namibian communities, with 69% of the sample population being cell phone owners of which 82% of these were smartphones. Therefore mobile phones stand a chance of being adopted as a means of dissemination of health information. In informal settlements the 18-25 year olds are more likely to have cell phones as compared to other age groups, while in peri-urban areas the 36-45 year olds and in deep rural areas the over 45 years of age are likely to own cell phones. In urban areas on the other hand, there is an equal distribution of cell phones among different age groups.

There are many different ways of how health information is presented to communities currently including mobile phones, flyers, health extension workers' word of mouth, radio and television. The majority of the population prefer to receive health information through mobile phones, flyers, health extension workers and radio though, in descending order. To get a picture of what disease information should be disseminated, the research found that the most prevalent diseases among the community members are diabetes, HIV/AIDS, cancer and malaria in descending order. Most of the respondents indicated that they are literate and they can operate and use cell phones. Literacy here refers to the basic ability to read and write.

The response to the frequency of hospital/clinic visits was as follows: frequently-30%, often-33% and never-37%.The results symbolised that most people visit clinics and

hospitals, and they can obtain health-related information from there as well.

The study discovered that CDC does not have a technology platform to disseminate general disease health information. The only platform available at the moment is through direct interface when patients visit the hospital or clinic and pamphlets which come through other patients that come for treatment. At the ministry level, radio, newspapers, flyers and HIV/AIDS awareness campaigns are the modes of information dissemination.The current technologies used to disseminate health related information to the communities in Namibia are a manual system which is not efficient and effective in the delivery of health information to the communities. There is also the issue of language barriers. The CDC has to come up with materials to cater for the myriad of Namibian languages if ever any campaign is to be effective. This requires a lot of resources, be it financial and human, which is in short supply. The department of information education and communication in the CDC has a shortage of staff to undertake this manual dissemination of information. Space has to be made available for the staff to disseminate information from.A huge investment in manpower is needed in the manual system that is being used at the moment and a lack of staff is the barrier. Lack of space is also a problem and so is the lack of materials for information dissemination. There is also a shortage of extension workers specifically in the department of information education and communication of the CDC.The study found out thatthe fragmented health information dissemination system will not enable the MoHSS and CDC on one hand and communities on the other to share information with one another since the systems available at the moment are manual based systems and they are not integrated.

6. Features of the Prototype

A prototype was designed and developed for proof of concept. The following sections describe the prototype.

6.1 Features of the analysis that are integrated into the mobile application

A number of the features of the analysis were factored into the prototype that was developed. A large number of people own cell phones as evidenced from the four different areas in which the research was conducted, hence the development of a mobile application for a cell phone. Also, consideration was put that the majority of the sample population indicated that they would prefer to receive health information through mobile phones as a first priority. The most prevalent diseases in the sample are diabetes, HIV/AIDS, cancer and malaria in descending order, hence the initial application concentrates on such. Literacy among the population sample stands at 100% hence the communities can operate and use cell phones. It is assumed that since the communities are literate the application will be in English for a start with a view to expanding it to the 13 official languages with time. The applicationis both text and graphics based.

The critical success factors to the deployment of any application including this mobile application is that the developed application should be user friendly so that whoever will use the application will not struggle to do so. In other words, the application is not be complex to use. The frequency of visits to the hospitals and clinics is even across frequently, often or never hence the application will benefit even those who visit hospitals and clinics, provided the clinics and hospitals provide access to a cell phone infrastructure for such access. The implications encountered in the software deployment stage were considered to ensure error free installation. Provided the users have smart phones, it will not be difficult for them to install the application. If the application is sent to their Gmail or Yahoo they can install it directly onto their smartphones. The challenges that will be encountered will be rectified as soon as they occur should they be experienced during the deployment of the application installation or launching. The benefits this application can offer is of significance in the development and implementation of the mobile application developed in terms of making general disease information available to the communities timeously. The IS and dissemination models for the mobile application are not available in the Namibian health sector, therefore the application will concentrate on documenting the application developed so that end users will be in a position to follow through on how to use the application.

6.2 Network architecture

The database at the CDC stores information on diseases. A copy of the application that disseminates information is also stored on the same database. Users can register with the database for access to the application. They can download a copy of the application onto their cell phone by making a request to the server. Alternatively, where the users have smartphones, the server sends the copy of the application to their Gmail and Yahoo accounts. Once the application resides on a user's cell phone, any server updates on disease information can be easily broadcast to the communities.

Figure 1 is the network architecture diagram for the mobile application. The user either uses a cell phone via USSD/ internet to access health related information from the file server at the CDC/MoHSS or the user can request information via USSD through a network antenna. The key components of the architecture of the system are as follows:

- The Unstructured Supplementary Service Data (USSD) is a Global System for Mobile (GSM) communication technology that is used to send texts between a mobile phone and an application program in the network. Applications may include prepaid roaming or mobile chatting.
- The Network Antenna is a specialized transducer that converts radio-frequency (RF) fields into alternating current (AC) or vice-versa. There are two basic types: the receiving antenna, which intercepts RF energy and delivers AC to electronic equipment, and the transmitting antenna, which is fed with AC from electronic equipment and generates an RF field.
- A data package is a coherent collection of data and possibly other assets in a single package. It provides the basis for convenient delivery, installation and management of datasets.

- The file server is a computer responsible for the central storage and management of data files so that other computers on the same network can access the files in a client/server model. A file server allows users to share information over a network without having to physically transfer files by some other external storage device.
- A cellphone is a portable telephone that can make and receive calls over a radio frequency carrier while the user is moving within a telephone service area. The radio frequency link establishes a connection to the switching systems of a mobile phone operator, which provides access to the public switched telephone network (PSTN).
- The Internet is the global system of interconnected computer networks that use the internet protocol suite (TCP/IP) to link billions of devices worldwide. It is a network of networks that consists of millions of private, public, academic, business, and government networks of local to global scope, linked by a broad array of electronic, wireless, and optical networking technologies.
- The CDC is an organisation established in 2002 that manages the prevention, care, and treatment programs for various diseases in Namibia.

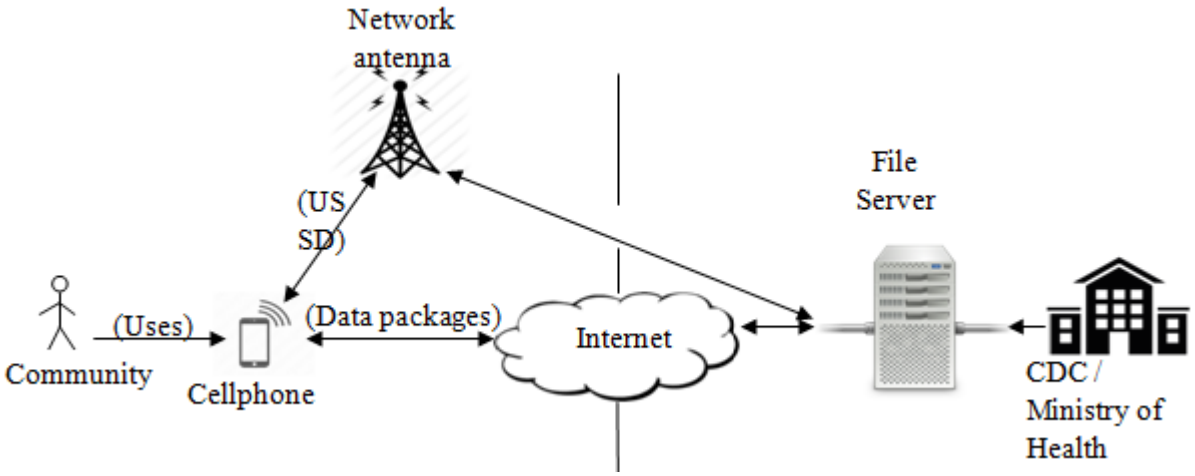

Figure 1: Mobile health information sharing network architecture diagram

The mobile application allows members of the community to access general disease information anytime and anywhere, without physically visiting the hospitals or clinics using mobile smartphones that support an Android Operating System (OS). Therefore the application was developed with the purpose to reach the general public in Namibia that is unable to access health related information anywhere and at any time without visiting health centres, the CDC or MoHSS. The mobile application content covers the common diseases in Namibia, their definition, the causes of the disease**,** the symptoms of the disease, how to prevent the disease and whom to contact.

6.3 The Development Environment

Android Studio was used to develop the mobile application. This is regarded as an integrated development environment that provides the fastest tools for building applications on every type of Android device. Therefore Android Studio is classified as a world-class code editing, debugging, and performance tool. A flexible build system and an instant build/deploy system all allow one to focus on building unique and high quality applications. This implies that only mobile phones with Android Operating System can use the application. The study opted to develop a mobile application that supports the Android Operating System because Android has the largest installed base of all operating systems of any kind. Another reason is that because Android has been the best-selling OS on tablets since 2013, and on smartphones it is dominant by any metrics.

This developed mobile application is compatible with the Android Operating system which is developed by Google, based on the Linux kernel and designed primarily for touchscreen mobile devices such as smartphones and tablets. Android's user interface is mainly based on direct manipulation, using touch gestures that loosely correspond to real-world actions, such as swiping, tapping and pinching, to manipulate on-screen objects, along with a virtual keyboard for text input.

The mobile healthcare application consists of a home page (Figure 2), which is the introduction to the purpose of the application. The application is in English text because from the research conducted, a large percentage of the population is literate as well as proficient in English.

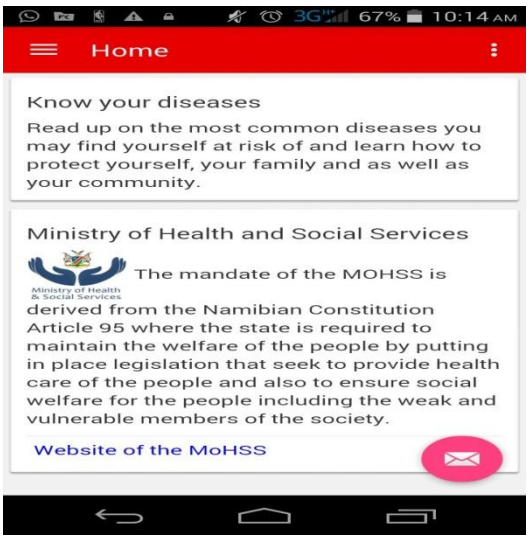

Figure 2: Home

Figure 3shows the user interface that consists of the contents covered by the application, which include 10 diseases such as malaria, obesity, cholera, diabetes, tuberculosis, leprosy, coronary heart disease, cancer and HIV/AIDS. The page has a number of buttons each representing a particular disease. For example, when you click on the malaria button you can find general information on what malaria is all about, what causes malaria to spread, what are the common symptoms of malaria, how malaria can be prevented and whom to be conducted should you be infected by malaria, etc. The other buttons are for diseases such as cholera, diabetes, tuberculosis, leprosy, coronary heart disease, cancer, HIV/AIDS and Ebola respectively.

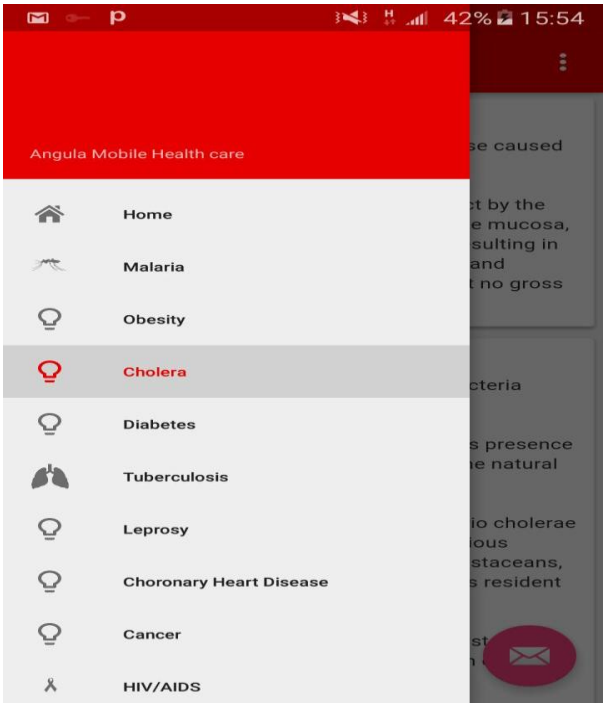

Figure 3: Disease selection

6.4 The benefits of the developed application

The mobile healthcare application can operate effectively in rural and remote areas to provide health related information to an otherwise hard-to- reach population. The benefits of the developed application to the communities are as follows:

- It will enable anyone to access general diseases information using mobile phones.
- It will enhance the accessibility of general diseases information to the communities in Namibia.
- It will eliminate the risks of lack of disease awareness information among the communities.
- It will indirectly enhance health in Namibia if implemented.
- It will supplement health extension workers in the field.
- It will provide a common platform for everyone with a mobile phone to get general diseases information.
- It will add to innovation in existing knowledge in the fields of health and IT.
- It will enhance IT proficiency among the public since it involves the use of a digital communication device.

6.5 An expert review of the mobile application

The framework for approval of new HIS lies with the office of the Prime Minister in Namibia. The framework has guidelines to be followed. These are the guidelines that the experts were responding to when they were evaluating the developed mobile application system. Usability, efficiency, user satisfaction, feedback time, speed and adaptability are some of the criteria. The experts also compared the new system features with the HIS that are on the ground and suggested additional features to be added to the system. Two experts were consulted, one from the MoHSS and the other from the Prime Minister's Office.

In the opinions of the experts, the developer should in the future consider aspects that are not included in the application. An expert review from the MoHSS suggested that the application should integrate help facilities such as contact details of ambulances, health centres/ hospital / clinics, regional fire brigades, first aid centres and pharmacies. In addition, the same health expert suggested that the application should consider the type of users if there will be a possibility of them to use the application: for example, users can be semi-literate, illiterate and physically impaired people. Another expert from the Office of the Prime Minister suggested that the application should integrate all the health centres, hospitals, clinics and also a possibility of the application to include features that would allow patients to visit clinics/hospitals without a health passport card. An expert from the United Nations suggested that the application should include features that would remind patients to take their medication after a prescription from the hospital or clinic.

a) Usability

The application is developed in a way that it is user friendly, which means that users with Android devices can easily, with no guidance at all download the application and install the application on their phones. Once the application is successfully installed, users will be able to view various general diseases information and can read up on the overview of common diseases that affect or cause deaths. The diseases to be viewed are malaria, diabetes, HIV/AIDS, and cancer just to mention a few. Users can also post health related information and receive feedback from the central server based at the CDC or MoHSS.

b) Efficiency

The application is effective for the CDC and this is attributed to the current way that the CDC disseminates information. The application will improve the current process of disseminating general diseases information to the communities in Namibia. For example, instead of CDC storing piles of flyers or pamphlets, general diseases information will be digitalized and accessed via mobile phones. Efficiency in the mobile application refers to the way the application will work in terms of effectiveness and delivery of health related information to the communities on time in comparison to the manual system used by CDC currently to disseminate general diseases information to the communities, which is not cost-effective and experiences delays in the delivery of health related information to the communities in Namibia.

c) User satisfaction

The users were satisfied with the prototype due to the fact that the application can be accessed via their mobile phones and a majority of them use their smartphones on a regular basis. The users were satisfied with the application because most of them have smartphones and they are literate, which means that they will use the application to read up on most diseases affecting them and also learn on how to protect themselves from these diseases. In addition, users demonstrated that the application will improve the current process used to disseminate general diseases information which is time consuming, not cost-ineffective and ineffective in the delivery of health information to the communities in Namibia.

d) Accessibility

The application can be accessed anytime and anywhere without the user physically visiting the CDC, using a smartphone that supports an Android operating system. The application can also be used as a platform to communicate directly to the CDC and receive feedback timely. In terms of response time, the application is faster compared to the manual system in place at the moment. A community member can request health related information in real-time and receive immediate feedback compared to the manual system which needs manpower and it takes time to reach members of the community.

e) Speed

The application is effective and efficient due to the fact that as soon the user clicks on the application menu, the user will be able to access or view general disease information or post any question related to health information. In terms of speed, the developed application is faster than the manual system in place at the moment because a member of the community can request health related information anytime from anywhere, without physically visiting the clinics, hospitals or CDC. The application is more efficient compared to nurses/doctors who can travel to educate members of the communities across all the 14 regions in Namibia.

f) Adaptability

The application can be adapted on the Android environment to work offline or online, which means that members of the community will be able to view general disease information whether they are offline or online and on the other hand they can also post health related information online. The application can adapt to the Android machine configurations environment for it to be executed efficiently. The users with Android devices will be able to download the application and install the application successfully on their Android devices.

7. Conclusion

With the MoHSS as the main actor in the provision of healthcare services, centralisation of decision-making in health information dissemination lies with the MoHSS to ensure information is disseminated country wide. This can be overburdening the MoHSS as opposed to decentralisation of information dissemination to the districts considering that their human resource capacity and financial capacity are low. Access to healthcare information currently is therefore a challenge. Unfortunately the challenge has class connotations, with the under-resourced areas being the most affected. This challenge also impacts on disease prevalence. When communities are not informed on time on disease prevalence epidemics can spread quickly. A manual system of dissemination requires both financial and human resources, and yet a technology solution switches the costs from the MoHSS to the consumer at the end of the day. They pay for the telecommunications costs and the gadgets as well. It is hoped that the study sample is representative of the Namibian population since it covers rural, urban, peri-urban and informal settlements and since the participants are health personnel, IT staff and communities

The mobile application is customised to the Namibian environment. It falls in the category of low-cost, locally-developed appropriate technologies. Instead of purchasing off-the-shelf products, this research contributes to local innovation. Therefore language barriers are likely to be taken care of, considering that there are 13 recognised languages in Namibia. This would reduce the burden of lack of reach to remote areas, non-coverage of whole populations and a system that is not targetted at all age groups. Also it cuts down on the burden of covering long distances to access and disseminate healthcare-related information. The application will supplement the face-to-face contact which occurs between health practitioners and communities.

With mobile applications gaining momentum worldwide, Namibia cannot afford to be left behind. The challenge of health information dissemination is recognised in Namibian policy, as in the NDP4. That shows that Namibia is making an effort towards improving health services delivery. Health information poverty is as a result of poor economic performance that results in a sharp reduction in resources to support health information services. This is a problem that is prevalent in the whole of sub-Sharan Africa and not Namibia alone. Namibia has the advantage of significant cell phone ownership, and that of its acceptability by communities. The communities prefer mobile technology to the other modes of information dissemination.

The mobile application developed will contribute or improve on how CDC and MOHSS disseminate diseases general information to the communities in Namibia. The mobile application allows access to information anytime, and anywhere, increases awareness and indirectly enhances health service delivery. Therefore people with smartphone will install the application in their smartphone and be able to get common general disease information in Namibia that cause death in most the Namibian communities. In addition, if diseases general information is made available to the communities, this will enable the communities to be aware of how to protect themselves from these diseases, the causes of these various diseases, symptoms of these diseases, general background of this particular diseases as well as who to contact should they get affected by these diseases. Usability, efficiency, user satisfaction, accessibility, speed and adaptability are some of the attributes of the mobile application. The way forward to refining the application will come from the expert reviews.

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