Adoption and adaptation of e-health systems for developing nations: The case of Botswana

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Abstract

Due to limited resources in developing nations, limited access to quality health delivery systems is a challenge. Botswana has a high cost of access to medical facilities in certain areas. The sparsely populated nation lacks medical facilities; patients travel 400 km on average to receive medical treatment from referral hospitals. Although hospital facilities exist in major cities, they are not fully equipped. There is a shortage of certain skilled personnel, a condition that forces local patients to seek treatment in other countries, hence raising the cost of access to medical facilities.

It is against this background that appropriate solutions are sought to improve the access and capability of the health delivery systems. The research revealed that many countries are now using information-based services to assist in the administration and delivery of medical services via telecommunication infrastructures. Technological developments have ushered the development and implementation of telemedicine as a complementary health delivery system. Several developed nations now have advanced telemedicine initiatives that have resulted in improved access to medical facilities. However, only a few developing nations have explored the value of telemedicine initiatives.

Interviews and a literature review were used to determine the development of telemedicine in Botswana. The results indicate the infancy of telemedicine and the potential benefits due to widespread telecommunications services. However, the local language poses a great barrier to the implementation of telemedicine. Adoption and adaptation of telemedicine technologies would improve the delivery of health services.
Keywords: Botswana; medical treatment; telemedicine; ICT

Introduction

It is generally argued that emerging economies face healthcare problems and some health delivery systems are on the verge of collapse. Furthermore, a significant proportion of health funds are derived from donor funds. Due to scarce resources, medical health deliverance is, in a way, rationed. Ultimately, the remote rural population receives inadequate healthcare. The problem is further exacerbated by the fact that rural health professionals already have a heavy workload and have very little, if any, access to healthcare information. This has a negative bearing on their professional careers. Therefore, few professionals are willing to work in these remote areas. Thus, the quality of healthcare delivery is declining. Constitutionally, everybody has a right to have access to a sound healthcare system. Therefore, each government has a mandate to provide a basic health system that is resourced and manned by government doctors.

Costs, access, and quality are the major challenges facing healthcare delivery systems. The sector is characterised by an expanding knowledge base, increased uncertainty, and significant time and cost constraints as well as distance limitations. Therefore, governments need to consider new technologies that could be used as enablers in health practices. However, the extent to which e-health would be effective is not yet fully determined. This complexity causes great challenges for governments in terms of decisions to implement e-health systems. Without concrete information, the policy-

This document has been produced by DiploFoundation with the financial assistance of the European Union. The contents of this document are the sole responsibility of the author and can under no circumstances be regarded as reflecting the position of the European Union or DiploFoundation.

maker cannot easily embark on the technological innovations that may benefit the nations.

Telemedicine is the use of electronic information and communication technologies to provide and support health care when distance separates the participants (Institute of Medicine, 1996a, p.1).

Therefore telemedicine, a kind of information technology, is required to address these challenges.

The health care industry has barely begun even to grasp information technology's possibilities …. Perhaps the clearest example of a medical technology whose time ought to have come but hasn't is telemedicine (The Economist, 1998).

Although the definition was presented fifteen years ago, to date it is still valid since health informatics centres are rarely established to assist in awareness campaigns. The rapid development of technology and the widening digital divide provides us with the trajectory of the way health delivery systems are lagging behind technological advancements. The statement from *The Economist* highlights the critical point that medical information systems are lagging behind the technologies that assist practitioners in enhancing their practices. Drawing from these points, it is clear that telemedicine is a subset of e-health services. Therefore, it can be inferred that e-health services in some developing countries, due to the digital divide, are still in their infancy and would need bold decisions for medical professionals to embark on e-health initiatives and activities. In the case of Botswana, a few telemedicine pilot projects are currently in progress. The initiative is in line with the Botswana 2016 vision pillars of being a prosperous, productive, and innovative society. A clear policy direction is therefore necessary for the adoption and adaptation of appropriate technologies. Since medical practices are no exception to globalisation, there is no positive justification why national health professionals should desist from using e-health facilities. However, it is of paramount importance that health professionals and society as a whole accept the technology. This calls for virtual collaboration amongst the key informants: health professionals (doctors, nurses, assistant nurses, health decision-makers, information technology managers, and telecommunications network operators.

Background

A telemedicine medical service is a service initiated by a physician or provided by a health professional under physician delegation, for the purpose of diagnosis, consultation by a physician, treatment, or transfer of data, using interactive audio or video, still image capture, or any other technology that facilitates access of health care services or medical specialty expertise (Texas Department of Health, 2001).

Literature suggests that many developed countries using this technology have drastically reduced their national budgets. Even South Africa has now embarked on a telemedicine pilot project. This is clear evidence that there is a solution in the form of technology applications. It is the phenomenal benefit that motivates developing countries to also embark on telemedicine initiatives as a way to improve their constrained health budgets. However, it must be pointed out that the success or failure of the system depends very much on the key players. The literature review elucidates this point. The Institute of Medicine identified five concerns that prevent and slow down the growth of telemedicine (Simonson and Sparks, 2001): professional licensure, malpractice liability, privacy, confidentiality and security, payment policies, and regulation of medical devices. However, some of these issues may not apply to the Botswana context. The issues that have slowed the growth of e-health are critical and should be addressed.

Limited research is reported on the medical effectiveness and cost effectiveness of telemedicine (Grigsby, 1995). Current research seems to support the conclusion that telemedicine is effective when practiced correctly, but that additional evaluation and assessment activities need to be conducted (Institute of Medicine, 1996b).

Telemedicine – the concept

Telemedicine has become an accepted concept in healthcare worldwide. But the definition of the concept may differ from location to location. According to the World Health Organisation (WHO) Global Observatory for eHealth definition telemedicine includes 'the practice of health

care using interactive audio, visual and data communication. This includes health care delivery, diagnosis, consultation and treatment, as well as education and transfer of medical data (WHO Global Observatory for eHealth, 2010)

In principle, telemedicine involves the use of communication networks to deliver medical services where there is distance between healthcare providers and their patients. Telemedicine is not limited to a specific area of application – diffuse technology. Therefore, applications such as teleradiology, teleconsultation, and tele-education are used to highlight the area of selected telemedicine applications. The advancement in both computer and telecommunications technologies are key enablers in telemedicine. The advent of Internet and mobile communications convergence has greatly improved the flexibility of e-health. Mobile communications imply access to medical services from anywhere at any time. Thus telemedicine has the potential of reshaping the healthcare organisational structures. This is a new concept in Botswana, and has potential to improve and complement the existing health delivery system.

Conceptually, telemedicine is roughly the same shape. No agreed upon framework for or definition of telemedicine exists (Institute of Medicine, 1996a; Office of Rural Health Policy, 1997; USGAO, 1997).

Different definitions may result in different data types being collected, thus impairing data analysis. Data collected from different sources can hardly be compared due to lack of compatibility. This has contributed to the slow development of e-health applications. Software developers and telecommunications providers and clinical practitioners need to work together to develop e-health standards.

Major characteristics of e-health

According to the ITU (International Telecommunication Union) telemedicine framework, the major characteristics of e-health include:

1. Universal access to the medical services irrespective of distance.
2. Use of communications and computer systems to gain access to information.
3. Virtual collaboration by key participants.
4. Relief of secondary and tertiary care hospitals from overloads due to poor referrals.
5. Quick flow of clinical information between clinics and hospitals.

Research benefits and potential applications

E-health is a relatively new concept in developing countries. The major challenges encountered in African healthcare delivery systems are access, quality, and costs. Conceptualising e-health from a virtual collaboration perspective has a number of significant research benefits for developing nations. All stakeholders involved in the development of an e-health system enjoy some benefits. From the patient's perspective, e-health means access to medical facilities that otherwise could not be accessed through the traditional health delivery system. A typical example is where patients in a flooded Okavango Delta are remotely located such that the terrain does not permit the safe transfer of the patients to Gaborone major hospitals. Without technology, it is extremely difficult to meet this kind of demand. However, e-health rapidly disseminates the information that is required for the treatment of the patient. The patient also avoids unnecessary cost in terms of accommodation and transport. In many cases, patients are sent unnecessarily to the referral centres. Culturally, Africans live in communities and enjoy closeness to their people. Elderly people would prefer to be treated while they are at their own homes in proximity to their clan. This point should never be under estimated in such social settings.

Remotely located medical practitioners suffer professional isolation. In the Botswana context, remote healthcare centres lack medical literature and professionals cannot manage to advance their skills while they are in their working environment. The advent of e-health allows professionals to be knowledgeable practitioners with global access to information. The practitioners have specialists at their disposal; complex cases can be quickly resolved through virtual collaboration. Global assistance is easily avail-

able through telemedicine technology typically tele-education and teleconsultation. Such developments tend to improve the quality of healthcare services, hence benefiting the target market.

The government is the greatest beneficiary; this could drastically reduce the health budget levels. Limited resources, such as doctors, can be effectively and efficiently allocated for the benefit of the entire nation. The doctor-to-patient ratio would be improved so as to improve the quality of health delivery services. The government then becomes so credible and attracts many potential investors into the country. Local healthcare providers create job opportunities for local people since local institutions would retain the revenues generated from the local patients. The employment generated implies a contribution to the government tax base. With rapid information dissemination, it becomes easy to detect and contain disease outbreaks. Since prevention is better than cure, fewer cost would be incurred through use of telemedicine. E-health can be a quick solution that can supplement the traditional health delivery system. The precondition of such a setup is the presence of a telecommunication service. With the advent of high telecommunications penetration rate, the infrastructure is now readily available to offer e-health services in a sparsely populated country like Botswana.

E-health increases the demand levels of the telecommunication services. Telecommunications operators and Internet service providers (ISPs) would generate additional revenue streams due to telemedicine applications being transmitted through telecommunications networks. New business models would be established between the health and telecommunications sectors. More jobs would be created in the process of e-health deployment. The technology can also be applied in prisons, so that the public is not exposed to dangerous prisoners. It is costly to transport prisoners to the health centres. The chances of escape are increased while the prisoner is in transit. This risk can be minimised through use of e-health services.

It is hoped that, in the long term, the research would have a positive impact on the national budget, through a direct cost reduction within the Ministry of Health. With healthcare systems in Africa on the brink of collapse, the continent can use e-health to have certain diseases treated locally without patients having to spend large sums of money seeking treatment abroad.

Statement of the problem

Costs, access, and quality are the major challenges facing the healthcare delivery system. The sector is characterised by an expanding knowledge base, increased uncertainty, and significant time and cost constraints. Therefore, e-health, a kind of information technology, is required to address these challenges.

Major research objectives

The major objectives of the research are:

1. To identify the needs and priorities for the introduction of e-health in Botswana.
2. To determine the major barriers to e-health in Botswana.
3. To identify key players capable of championing the implementation of telemedicine in Botswana.
4. To create the demand for e-health/creating awareness for e-health services.
5. To demonstrate the potential benefit of e-health in Botswana and developing nations in general.
6. To develop a working guideline/model for a successful implementation of e-health system.

Literature review

Introduction

Literature about e-health in general and telemedicine applications in particular was reviewed. The literature covered some of the major issues that include benefits to society, barriers for e-health, technology, as well as the doctor-patient relationship. Proper funding structures are required to successfully implement e-health projects. The majority of the reviewed telemedicine projects originated in the USA, the UK, Australia, Norway, Canada, Finland, and Sweden. Within

the region, telemedicine projects were carried out in South Africa, Senegal, and Mozambique. There was scant literature regarding the telemedicine initiatives at the time of the research. According to national press articles, the Ministry of Health in collaboration with Orange Botswana, Click Diagnostics and Botswana University of Pennsylvania initiated the first telemedicine pilot project in 2009. The project established a telemedicine link between the Scottish Livingstone Hospital in Molepolole with the government hospital, Princess Marina in Gaborone. Some links were established for Tshabong, Maun, Serowe, Kasane to link to Goborone. The consulting doctors and other medical specialists were based in the USA and the UK. The assessment results were not yet established. All investigations were relatively recent. The findings from each study were used as the framework to conceptualise telemedicine in Botswana. The research methodologies that were used in these initiatives were redefined to suit the Botswana context. Approximately 90% of the abstracted findings favoured e-health deployments. A thorough needs assessment should be used to enhance the validity of the findings. With telemedicine, generalisation is limited to specific issues. Therefore, there is a need to adopt the technology, but adapt it to suit the environment. In the case of Botswana, real-time video conferencing might sound fantastic but the limited bandwidth infrastructure may not effectively support such a service. Therefore only those areas with digital/ADSL networks could adopt this technology. Market segmentation and targeting becomes very critical under such circumstances. Prior to any e-health implementation, infrastructure auditing becomes vital.

Telemedicine overview

The literature suggests that many countries have long recognised the need for innovative and alternative healthcare delivery systems in order to meet the healthcare needs of the diverse population and geographic areas. In the USA, the State of Texas has a legislature that seeks to promote the telemedicine advancement. In 1998, telemedicine services were recognised in this state. Texas Department of Health, in its document, *Telemedicine Pilot Project*, defines telemedicine in the following manner:

A telemedicine medical service is a service initiated by a physician or provided by a health professional under physician delegation, for the purpose of diagnosis, consultation by a physician, treatment, or transfer of data, using interactive audio or video, still image capture, or any other technology that facilitates access to health care services or medical specialty expertise (Texas Department of Health, 2001)

Telemedicine, telehealth, e-health, and telematics are some of the terms used interchangeably when describing the use of information technology in health. There is abundant literature with similar definitions regarding each these terms, especially telemedicine and e-health. For the purposes of this research these two terms are one and the same.

Australian New Zealand Telehealth Committee (ANZTC, 1996, p.2) defined telehealth/e-health as: *'a health delivery system which provides health related activities at a distance between two or more locations using technology assisted communications'*.

The literature reviewed revealed that telemedicine has become common in the medical literature during the last decade. However, developing countries have recently started telemedicine initiatives. In a White Paper, Dr Michael Simonson gives credit to Kenneth Byrd who, with several others, formed a video microwave network in 1968 from Massachusetts General Hospital to Boston's Logan Airport (Simonson and Sparks, 2001).

However, there were other projects at the same time but this effort is considered as the modern launching of the concept of e-health. But other countries still claim that they had their own pioneer telemedicine initiatives. As a result, the origins of e-health are blurred.

It seems developing countries are lagging behind in terms of technology innovations. Ironically such countries are the ones that have major health problems which could be mitigated through the use of e-health technology. In developed countries and in South Africa for instance, federal and state governments and private institutions are funding e-health projects.

This approach highlights the Systems Approach Theory that calls for collaboration. However, the funding issue appears to be different in most African countries. In Botswana, there is a hierarchical structure within the health sector, and the private sector seems to pursue its private initiatives. Without government incentives, the private players preferred to have their own initiatives. Because of this fragmented approach, duplication of efforts resulted in inefficient allocation of resources. Therefore, the end-users found it very difficult to have universal access to health services. But the current government policy appears to favour the collaboration platform. If this approach is maintained then there are high chances that patients will benefit from this collaborative effort. In America, this approach has enhanced the telemedicine adoption rate. It is hoped that the same model will accelerate the e-health adoption rate in Botswana.

Common telemedicine applications

Kvedar *et al.* (1998) list four major applications for e-health: remote consultation, remote monitoring, remote education, and telemonitoring. Amongst all these applications remote consultation has become synonymous with telemedicine.

Consistent with the ANZTC definition, e-health includes:

- Direct consultation
- Case conferences
- Educational activities
- Medical images and data transfers
- Passive information dissemination (e.g. through websites)

The review revealed that telemedicine technology is used in a variety of clinical areas including psychiatry, emergence medicine, dermatology, cardiology, surgery, pathology, clinical education, oncology, radiology, ophthalmology, and renal medicine. The list offers a wide selection of applications that e-health can provide. However, the exact applications are customer driven. The needs assessment programme must be initiated to determine which applications to start with. For example, in Botswana and neighbouring countries, there is a critical shortage of pathologists; therefore it is justified to start with the pathology application. It might not be advisable to start with surgery applications since these are complex and require high-speed transmission links to connect the participating sites. The challenges of power disruptions within the SADC region pose a major barrier for the adoption of telesurgery applications. The issue is that prioritisation is fundamental. In general, to date, dominating telehealth applications are telepsychiatry, teleradiology, and renal telemedicine. The later was more pronounced in Australia than elsewhere. Telemedicine application names are derived from the clinical area of interest. The clinical area of interest is prefixed by the term 'tele'. For example in radiology the application name is teleradiology.

It is therefore a multimedia tool that can be utilised to improve the state of the heathcare delivery systems in developing nations. In this case, technology is one of the fundamental enablers required in the implementation of e-health. It was apparently clear that the success of such a system is centred on the Systems Approach Theory. A total integrative approach is critical to the sustainable implementation of telemedicine in any nation. The approach recognises the interplay of the interdependent key stakeholders. Such an integrated approach also recognises the interaction and interdependences of several crucial elements of success, i.e. people, technology, process, training, programme management, cost optimisation, and community involvement. Therefore, a taskforce consisting of the key stakeholders should drive telemedicine/e-health initiatives. Proper identification of such members is critical and necessary. The generic task force consists of health agencies, telecommunications operators, medical professionals, legal and telecommunications regulators, and patients. Many pilot projects used this generic model with some kind of adaptations to suit the country of interest.

Different telemedicine activities and information technology configurations

A telemedicine project involves both human and technology interactions. As a result decision-makers need to understand the effects of such interactions.

Getting the human components-both individuals and organizations-to work well together and with complex and changing technologies is a never-ending challenge. By illuminating when and why these components are not performing as intended, evaluators can help program managers decide whether to continue, discontinue, or redesign operations and can also suggests to vendors and designers how their technologies might be better designed to accommodate human characteristics (Institute of Medicine, 1996a, p.73).

Therefore, it is of paramount importance that the available technologies are adapted to suit the needs in question. Due to such issues, it was critical to administer a questionnaire to allow users to bring forth their attitudes and opinions about telemedicine projects.

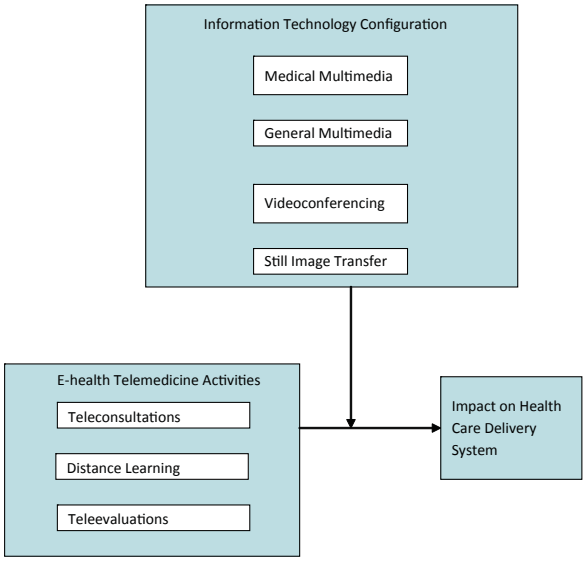

Figure 1. The impact of different telemedicine activities and different information technology configurations (Paul, 2000).

Different information technology configurations

Information technology is viewed as a mediating interaction, and the quality of technology determines the quality of this interaction (Schrage, 1995). Figure 1 represents the telemedicine model in greater detail, relative to the information technology configurations. Basically the information technology is divided into four categories:

1. **Still image transfer** involves an asynchronous transfer of graphical images files such as the digitized x-rays from one terminal to the other. It normally includes a digitizer, which enables x-ray films to be converted into digital images.
2. **Videoconferencing** involves the transfer of real-time audio and video from one location to another, enabling the parties at both locations to see and interact with the other parties in a collaborated manner. It normally includes a document camera that can be used to transmit documents and x-ray images. In terms of the transmission capacity or bandwidth a minimum transmission rate of 128kbps is required to link the two videoconferencing centres
3. **General multimedia** includes video conferencing capabilities and the real-time transfer, viewing and manipulation of data files.
4. **Medical multimedia** includes general multimedia and high powered light sources to which medical devices can be attached, enabling both parties to see, for example, a patient's ear. It may also include an electronic stethoscope, which enables the other party to hear the patient's heartbeat and breathing. In complex facilities the terminal equipment sometimes includes some kind of robotics that allows telesurgery activities to be carried out remotely.

The use of different information technology configurations is a function of the needs to be addressed. Ultimately the needs assessment determines the selection of the appropriate technology to be applied. In the Zimbabwean context, it appears that the dominant technologies could be the first three categories. However, the ideal situation is to have the medical multimedia system that will allow delivery of many e-health applications.

Telemedicine/e-health technology

From a technology standpoint, telemedicine is the application of telecommunications and computer technology that are already in use in other industries (USGAO, 1997). The technology includes the hardware, software, and communication links of the telemedicine project. Telemedicine, like any other advanced ICT depends on complex techni-

cal and human infrastructures. Such infrastructures operate both within discrete institutions and across organisational and geographic boundaries. Therefore, there are many proprietary telemedicine technologies available from different equipment vendors. Such a wide range raises the issue of standards and compatibility. As a result, the ITU has developed an open system standard that allows connectivity of different telemedicine equipment. Therefore, all telemedicine initiatives that include the ITU as one of the key stakeholders are using the standardised terminal equipment.

The technology infrastructure is a telecommunications network with input and output devices at each connected location. Although there is no commonly recognised definition or set of devices that constitute telemedicine, a generic telemedicine constituency will include the following those listed in Table 1.

The health situation in Botswana

Many developing countries are faced with many challenges that affect health delivery systems. These challenges include limited health budgets, shortage of medical specialist, long distances to the nearest health centre, and the emigration of medical professionals. Poor working conditions also motivate staff to leave health institutions. As such, Botswana is also facing similar challenges.

Botswana is a sparsely populated country; hence many patients are forced to travel on average 400 km to the referral centres. Poor patients cannot afford transport costs caused by such distances. The prevalent diseases are HIV/AIDS, hypertension, diabetes, pulmonary tuberculosis (TB) and pneumonia. These diseases are threatening the traditional health delivery system. The shortage of medical specialists, such as neurosurgeons, plastic surgeons, maxillofacial surgeons, nephrologists, and vascular surgeons aggravates the situation.

These skills shortages have forced the government to engage foreign doctors, which puts a further burden to pay more in order to attract and retain critical staff. Foreign medical professionals in the government sector account for 30% of the medical staff in Botswana. The working conditions for some doctors has been made worse by the poor patient/doctor per day ratio (70–100/1). This is a heavy load for the doctor to bear. This situation

Table 1. *The impact of different telemedicine activities and different information technology configurations (Paul, 2000).*

Type of media used	Telecommunications Services Available
Copper telephone lines Fibre Optic Lines Satellite Microwave Coaxial Cables	Switched ISDN 64K Leased Lines Frame Relay Dedicated E1 (2 Mbps)
Peripherals	Real-Time Videoconferencing
Endoscope Electronic Stethoscope Otoscope Ophthalmoscope Dermascope Microscope X-Ray Scanner Document Camera Remote Monitoring Equipment	Studio Videoconferencing Desktop Videoconferencing Full-Motion Uncompressed Video Full-Motion Compressed Video Analogue Transmission Digital Transmission
Data/Image Transfer	Types of cameras available
Real Time *Full motion interactive video* *Still images with two-way audio* *Video clips with two-way audio* Store and Forward Still images for later review *Video clips for later review* Text Electronic Mail	1-chip CCD Camera 3-chip CCD Camera Analogue Video Camera Digitizing Still image Camera Document Camera Macro lens Camera with peripheral scope Laser Scanner

might have been accelerated due to the fact that Botswana did not have a medical school for a long time. The University of Botswana Medical School has only been open for three years.

Assessment in Botswana (findings)

The backbone of telemedicine is centred on the telecommunications infrastructure that provides the necessary links. The dominant national telecommunications operator that provides fixed telephone connections is Botswana Telecommunications Corporation (BTC). Prior to the opening up of the telecommunications sector, BTC enjoyed a monopoly for providing basic telephone services. But this monopoly has derailed the development of the telecommunications infrastructure. Therefore, some areas still have no telecommunications services. Such situations present some technological barriers to telemedicine. Major cities are connected on high-speed networks which are capable of transmitting video signals.

There are now three mobile telecommunications operators in Botswana: be-Mobile, Mascom, and Orange Botswana. be-Mobile is a sister company to BTC while Mascom and Orange Botswana are privately owned companies. These companies have different capital structures and controlling bodies. The government has opened up the telecommunications sector; hence there is a series of VANS licenses which mainly provide Internet services.

Using the PESTLEG model on Botswana, it was determined that the political environment is mature and stable, hence supportive of clear policies. It would be relative easy to convince the government to consider implementing an e-health policy that will assist in rolling out e-health services on a wider scale. The economy is stable with a projected growth rate of over 4% GDP; this means that new innovation projects might have room for implementation as the government, with a little help from donors, would be able to execute the pilot projects. However, the economy is highly dependent on diamonds, so there are some challenges in diversity. Telemedicine services with their multiplier effect apparently present an opportunity to diversify into the service industry. The society is a closed society that strives on strong business relationships and is highly dependent of government services and values the Setswana language. This condition of dependency causes a threat to the delivery of services since the burden of payment would be deemed to rest on the government. Strong business relationships would be desirable to establish new business partnerships for rolling out the e-health services. Due to the strong cultural values, the applications for e-services would need to be translated into the local language in order for e-health to succeed and be owned by the citizens.

Botswana's legal structures exist and are credible. It has the capability to define the legal laws and issue data protection and confidentiality for the patients, as this data is opened up for transfer through ICT infrastructures. BTA regulates the provision of telecommunications services and has the power to control the pricing of services, hence it has the influence to ensure that e-health services are rolled out countrywide and at affordable rates.

The use of computer systems supports the green environmental movement. Green computing means reduced use of paper, thus preserving the environment. E-health service delivery will also have a positive impact on the environmentally friendly strategies since it is paperless and minimises transportation emissions by limiting hospital visits and distances travelled.

With the globalisation movement, Botswana has become a global village; hence the need to interconnect with other entities for remotely accessing any information-based services independent of physical distance. The e-health platform allows the delivery of health services through a networked platform that reaches out to a consulting specialist located anywhere in the world.

Regional telemedicine assessment

Although there were several regional telemedicine initiatives, there was scant information that was drawn from the pilot projects that were being rolled out. According to Giorgio Parentela, the Senior Strategy Officer at the Directorate of

Telecommunications and Integrated Applications based in Paris there were no current telemedicine initiatives in the SADC region; only a recently started project demonstration in two sub-Saharan countries, Senegal and Kenya. The European Space Agency in cooperation with the European Commission and the Telemedicine Task Force (TTF) recently established an 18-month initiative to support the extension of sustainable e-health services in Africa using satellite-based technology as the telecommunications infrastructure to reach remotely located rural patients. It was anticipated that the needs assessments for this project would last for six months. This was an indication that such projects need more time to access and to correctly determine the priorities of the e-health applications based on the findings. Although the satellite communication might reach out to remote locations, the expensive cost of the satellite space segment may affect the deployment of the telemedicine services.

Issues and challenges for telemedicine

Despite the attention that telemedicine has received, information about ongoing telemedicine projects and investments is both scant and unreliable. This has made telemedicine evaluations very difficult to implement. From such perspectives, it was difficult to replicate pilot projects in other areas. It appears it is very difficult to determine the exact levels of government spending on telemedicine. Most of the projects are mere claims that are not substantiated. For example, a study sponsored by the Office of the Rural Health Policy (1997) in the USA noted that while close to 600 rural health facilities claimed to have onsite operational telemedicine projects, over 20% of these projects were not operational by the second time these facilities were re-contacted, roughly eight months after they were initially contacted. This statement indicates that telemedicine implementers should not take the benefits at face value. A detailed situation analysis is required before engaging in such technology initiatives. An iterative process should be adopted when developing telemedicine projects so that true intrinsic values are determined. A simple replication approach may be disastrous and costly. A proper monitoring and evaluation process should be put in place and effectively executed to enable the success of such projects.

Conceptually, telemedicine is roughly the same shape. No agreed-upon framework for, or definition of telemedicine exists (Institute of Medicine, 1996a; Office of Rural Health Policy, 1997; USGAO, 1997). Therefore different definitions may result in different data analysis. However, even though there are such disparities, telemedicine continues to be explored by various developed countries. The initial champions of telemedicine include Sweden, the USA, Australia, Greece, Norway and most of the western European countries. These and other early telemedicine projects were perceived positively from a clinical perspective, but technologically these projects were quite complex. Due to such complexities, they became expensive to operate. As a result, the rate of technology adoption was very low. Only enthusiasts and early adopters were involved in these projects. Because of such market segmentation, some areas benefited earlier than others. A strong character of enthusiasm and early adoption is a fundamental requirement for the success of telemedicine initiatives. Research indicated that few emerging economies participated in telemedicine initiatives. Of all the articles reviewed, telemedicine initiatives involved universities, health agencies, telecommunications operators, telecommunications and legal regulators, medical professionals, and research institutions. Therefore a strong research team is required to execute the telemedicine initiative. All the collaborators contributed mainly in terms of funding and human effort. This is also a critical prerequisite for a successful initiative. The following statement indicates how critical government participation and commitment to the project is.

Technological considerations and reduction in government funding for telemedicine spelled the end for the first wave of telemedicine projects. By, 1986 only one of these early telemedicine projects had survived (Institute of Medicine 1995b; USGAO, 1995).

Despite this information morass, telemedicine is rapidly expanding. Governments and the ITU have taken the lead. This has made a positive impact in developing countries where the ITU works with the local government to assist them

in setting up telemedicine pilot projects. South Africa and Mozambique were involved in ITU-initiated telemedicine pilot projects. Normally these projects have central sites that are connected via high-speed links to provincial hospitals. These pilot projects have shown positive impacts on the respective healthcare delivery systems. Therefore there is a need to alert policy-makers to be aware of the potential benefit of telemedicine. Disseminated information would reinforce the government position (Vision, 2016). The review indicated that telemedicine projects are mainly driven by government agencies. For example, in the USA, *'at least 35 federal agencies were involved in telemedicine projects between 1994–1996, federal investment in telemedicine has been at least 600 million dollars'* (USGAO, 1997).

The emphasis on telemedicine is expected to continue, resulting in government authorities enacting Acts of Parliament that allow the setting up of relevant infrastructures such as telecommunications and electricity. *'The Telecommunications Act of 1996 directed the Federal Communications Commission to explore actions that would provide telecommunications services to all rural areas and further required telecommunications companies to provide discounts to health providers in rural areas'* (USGAO, 1997).

Reference was made to Telecommunications Authority Act 1996 for the establishment of BTA to regulate the provision of services to, from, and within Botswana. The telecommunications market is fairly liberal and now there is talk of privatising the state Botswana Telecommunications Corporation (BTC) by the end of 2011. Currently there are three public telecommunications operators (PTOs), namely BTC, Mascom Pty Ltd. and Orange Botswana Pty Ltd. BTA (2010) reported that there are 43 Value Added Network Services (VANS) that provide data and Internet services. In addition to these licensed operators are 15 private network operators (PNOs) that operate private networks to carry data and voices services. PNOs are for the sole use of the licensed entity and may not be linked to the public network operators. This open market has led to a rise in mobile telecommunications penetration of 105% by March 2009 premised on a population of 1 776 494. Most of these mobile subscribers are pre-paid services. All the operators are now migrating to 3G services, hence improving the geographical spread of data services that are fundamental to the success of e-health services. The access to East African Submarine System (EASSy) and West African Cable System (WACS) could boost the international Internet bandwidth that will further bring down the costs of Internet services. Although the market is competitive, the data service costs are still high, since an ADSL line of 256kbps costs about USD$80. This is still a major barrier to Internet access. Another challenge is the high cost of computers and low computer literacy rate within the country.

The increased performance and dramatic reductions in cost in computer and telecommunications hardware and software in the 1980s paved the way for the resurgence of telemedicine, and the wave of telemedicine activity began early this decade (Paul, 2000).

Therefore, it is a duty of the government to ensure that an enabling environment and infrastructure are in place and ready to provide links for telemedicine applications. Without such items it would be difficult to fully develop telemedicine activities.

Several countries have reported successful implementation of telemedicine pilot projects. In 2003, an American surgeon (in the USA) directed an operation on a French lady (in France) remotely over a telemedicine system known as telesurgery. In this case France Telecom provided the high-speed fibre link that was used for video conferencing. All this evidence suggested that the future of the medical fraternity would be anchored in modern technology. However, in Botswana and some other African nations, the issue of telemedicine has just unfolded. The Ministry of Health has established a few telemedicine initiatives that connect some remote district hospitals to the Gaborone referral hospital. Also Gaborone is connected to Francistown. Private hospitals like Bokomoso also have their own private telemedicine projects. The links are mainly used to exchange patient information and some x-ray images. It must be pointed out that these services *per se* do not constitute a telemedicine interactive video consultation. The current telemedicine systems are still proprietary,

and fail to meet the minimum ITU standards. Therefore, there is still a window of opportunity to develop and implement telemedicine systems that adhere to the ITU's open standard specifications. With such systems, interoperability with other countries' telemedicine systems is guaranteed. Compatibility is a requirement for the globalisation of medical activities. This condition results in the availability of medical health services to many patients whilst the medical specialist can be located anywhere in the world.

A review of the Botswana health delivery system suggests that Botswana is a typical nation that has a tremendous challenge to overcome in the health industry. This is a sector that requires substantive resources both human and financial. With the high death rates of skilled personnel and the scourge of HIV/AIDS in Botswana, the standards of the health delivery system continue to deteriorate. It was on record that many social workers, for example, doctors, pharmacists, and nurses, are leaving the country for greener pastures and better standards of living. This is an undesirable position as the majority of those professionals were educated and trained by the government institutions and used public funds. The Government trained those professionals with the hope that they would plough back the benefits into the society as a whole. Unfortunately, most of them continue to emigrate resulting in a position whereby the government has to depend on foreign specialists and the associated challenge of attracting and retaining these foreign professionals. Such challenges demand high levels of innovation in the form of telemedicine applications.

Although technology was a key enabler, there was little focus on that area. It was apparently clear that many technological initiatives had proven to be robust. Therefore, the focus was on the utilisation of the available technology to enhance the health delivery system. The research also highlighted the critical success factors as well as the barriers that could render the telemedicine initiative difficult to implement. The areas of concern involved information confidentiality, and security of both the information and the transmission media. The legislation that governed the medical practitioners needs to be reviewed to find out what legal issues could affect telemedicine implementation.

Bashur (1998) stated that: *'There is concern about the wisdom of rapid deployment of telehealth systems before we have developed appropriate organizational structures, uniform technical standards, and effective clinical protocols for the proper implementation of telemedicine. Most importantly, we are yet to understand and demonstrate fully how telemedicine can effectively deal with the nation's persistent problems of cost, quality and access to health care.'*

Prior to developing technological systems, a thorough needs assessment and evaluation is essential. Such needs are specific and should be correctly prioritised to have an effective system. There appears to be claims that technology assessment can be used to speed up adoption of technology that improves the efficiencies of the e-healthcare system. Furthermore, possible telemedicine barriers would be revealed and addressed well on time.

Anticipated consequences of using telemedicine/ potential benefits and barriers

The many issues, consequences, benefits and drawbacks of telemedicine highlighted by the literature are often anecdotal in nature. It is argued that the lack of adequate data, especially economic data, hinders the outcome of evaluation (Lobley, 1997). Benefits and barriers can be both quantitative and qualitative. The nature of the benefits and barriers make it extremely difficult to evaluate the effectiveness of the system. Intangible benefits could not be easily explained by those people with a bias towards quantitative analyses.

Almost every telemedicine article reviewed described the benefits of telemedicine. Some authors argue that bias exists due to a 'novelty effect', whereby new technology is usually viewed in a favourable light. In practice, this statement can be challenged. A case in point is the comparison between telecommunications analogue and digital systems. Digital systems represent new technology while analogue systems represent old technology. Digital systems are more reliable, robust, high speed, and carry several kinds of information signals. Therefore, the new technology provides greater benefits.

Lobley (1997) suggests that telehealth has the potential to introduce a cheaper way of delivering services, but can also increase costs through additional capital expenditure and the expansion of treatment into areas where it is currently not available. The availability of telehealth might increase demand for services such that a multiplier effect is realised amongst the key players. Therefore all the key players are likely to derive some benefits from telemedicine initiatives. Typically the network operators may use the initiatives as a marketing strategy that delivers long-term benefits. Orange Botswana has taken a similar view by being engaged in telemedicine pilot project with the Ministry of Health.

Lobley (1997) identified other, non-financial benefits which have been widely publicised but are difficult to quantify: They include:

- Qualitative improvement in patient care through improved treatment.
- Faster and more accurate diagnosis.
- Reduced need for patient referral due to remote consultation.
- Improvement in patient referral through better knowledge and preparation.
- Improved training and education.
- Reduced patient disruption due to reduced travel.
- Improved training due to knowledge transfer from the specialist to the remote site.
- The reducing need for specialist consultation as a result of knowledge transfer.

On the other hand, the Emergence Care Research Institute (1999) reported that the benefits of telehealth include:

- The ability to bring care services closer to patients, rather that converse.
- Providing under-served and isolated areas with health care virtually equal in quality to that delivered to heavily populated area.
- Improving the continuity of care that patients receive.
- Helping clinicians to improve their own skills, by facilitating continuing medical education.

Previous studies indicated that benefits can be perceived from different angles. All the key stakeholders derived some benefits from the telemedicine initiatives. In totality, the benefits are worth trying the telemedicine projects. The biggest challenge in implementing telemedicine projects involves the economic evaluation of such initiatives. Most economic evaluations have failed to capture those intangible benefits, such as reduced professional isolation. Therefore project evaluations must be clear on what benefits should be derived from telemedicine initiatives.

However, past studies also identified common barriers for telemedicine that need to be dealt with. Using Kurt Lewin Force Field analysis, the telemedicine task force should ensure that the supporting forces are reinforced while the restraining forces are removed or minimized. The classical barriers encountered in telemedicine are:

- Initial capital costs
- Doctor and patient acceptance
- Resistance to change
- Regulatory issues
- Data security
- Medical licensing
- Professional liability
- Hospital credentials
- Poor infrastructure

The interesting point is that most of these barriers can be handled using the existing norms and rules. But, in order to assure a complete integration of healthcare activities and the information society, extensive legislative work should be done. This was noted mostly in the American society, where various laws were enacted so that an enabling environment was created. The review indicated that Botswana has a positive attitude towards the creation of such an environment since it has a sound legal framework that supports business entities and protects the interests of the people. The integrity and confidentiality of the patient information should continue to be observed and respected regardless of the manner in which services are provided through the use of e-health technologies.

Conclusion

Existing telemedicine programmes demonstrate that technology can be made operational, but most of the studies assessing the efficacy of costs are insufficient to permit definitive statements about the evidence supporting or disputing the use of telemedicine. Since situations are unique from country to country, it is the duty of the task team to assess and determine the exact requirements of its nation. The critical challenge is to have technology acceptance within specific social settings. This is related to the history of the country or its religion, its economy, geography, and culture. Once that has been dealt with, technology is then applied as an overlay to the structure and organisational environment. The Botswana people are very culturally centred and proud of their language, hence the telemedicine deployment must be culturally centred as well. The developed systems must be in a Setswana language for easy adoption. Therefore, the technology should not be viewed as a new system to replace the traditional health delivery system but as a complimentary service delivery system that cuts across all facets of medical practices.

Research methods

There are many ways to get information that relates to specific problems. However, the most common research methods are literature searches, talking to target groups, focus groups, personal interviews, telephony surveys, mail surveys, e-mail surveys, and Internet surveys.

Literature research

A literature search involves reviewing all readily available materials. Such materials can include internal organisation information, relevant trade publications, journals, magazines, annual reports, company profile, online databases, strategic business plans, and any other published materials. This method is otherwise known as secondary research. It is a very expensive method of gathering information, although it often does not yield timely and accurate information. Literature searches over the web are the fastest, while traditional library searches can take several weeks. Information that is obtained from the web is normally recent and reliable as opposed to that obtained from the traditional libraries. However, time must be spent on qualifying the credibility and validity of the information.

Talking to people is a good way to obtain information during the early stages of the research. It assists in building up the foundation of the research. It can be used to gather information that is not publicly available at the time of the research or too new to be found in the literature. Examples might include meetings with prospective players, customers, suppliers, and other types of business conversation at trade fairs, seminars, and association meetings. The biggest drawback of this approach is its validity. Although often valuable, the information has questionable validity because it is highly subjective and might not be representative of the population.

Focus group

A focus group is used as a preliminary research technique to explore people's ideas and attitudes. It is often used to test new approaches and to discover customer concerns. A group of about 6 to 20 people meets in a conference-room-like set-up and the moderator leads the group discussion and keeps the focus on the area to be explored. It is relatively cheap and can be conducted within a couple of weeks. Its disadvantage is that the sample size is small and may not be representative of the population.

Personal interview

Personal interviews are a way to get in-depth and comprehensive information from the target group. The interview involves one person interviewing another person for personal or detailed information relating to the subject of interest. Personal interviews are very expensive because of the one-to-one nature of the interview. Typically an interviewer will ask questions from a written questionnaire and record the responses verbatim. Sometimes the questionnaire is a simple list of topics that the researcher wants to discuss with the industry experts. Since personal interviews are expensive, they are gen-

erally used only when the subjects are not likely to respond to other survey methods.

Telephone surveys

Telephone surveys are the fastest method of gathering information from a relatively large sample size. The interviewer applies a prepared script that is essentially the same as a written questionnaire. However, unlike a mail survey, the telephone survey provides an opportunity for opinion probing. Telephone surveys generally last less than ten minutes. The costs are relatively low and the survey duration could be a couple of days.

Mail surveys

Mail surveys are a cost effective method of gathering information. They are ideal for large samples that cover a wide geographic area. They cost a little less than the telephone surveys but take more time to complete. Because there is no interviewer, the possibility of interviewer bias is eliminated. The main disadvantage is the inability to probe respondents for more detailed information.

E-mail and Internet surveys

E-mail and Internet surveys are relatively new and little is known about the effect of sampling bias in Internet surveys. While it is probably the most cost effective and fastest method of distributing a survey, the demographic profile of the Internet user does not represent the general population, although this may be changing at a slow rate. Before doing an e-mail or Internet survey, the researcher must carefully consider the effect that this bias might have on the responses obtained.

Advantages of written questionnaires

- Cost effective in comparison with face-to-face interviews.
- Easy to analyse with software packages.
- Familiar to most people.
- The researcher's opinion does not influence the respondents.
- Less intrusive than telephone or face-to-face surveys.
- Potentially information can be collected from a large portion of a group.

Disadvantages of written questionnaires

- Possibility of low response rates leading to low confidence in the results.
- Inability to probe responses since they are structured instruments without flexibility.
- Gestures and other visual cues are not available with written questionnaires.
- Questionnaires may be completed by subjects who do not belong to the target group.
- Questionnaires may not be suited for some people, for example illiterate people.
- Open-ended questions can generate large amounts of data that can take a long time to process and analyse.
- Subjects may not be willing to answer the questions.

Research methodology

The methodology that was used to collect data for the study included both a quantitative and a qualitative approach. However, due to the time constraint of the study, the predominant research methodology was secondary research through extensive literature review. The study was conducted using structured interviews by the researcher over the period February to March 2011. The study involved sample surveys and discussions with key participants in both telecommunications and medical sectors. Data were collected through interviewing key people in different health service providers, for example, managers, administrators, physicians, telecommunications operators, general public (patients), and nurses. The survey included individual interviews with administration and care providers who were the most likely adopters of the potential telemedicine initiatives. It was vital to target such a population since early adopters are enthusiasts and innovators in nature. A high level of innovative thinking was a requirement for the telemedicine projects. The purpose of the survey was to determine the specific telemedicine needs of the particular community, telecommunications operators, healthcare professionals,

and other the attitude of other key participants towards potential telemedicine initiatives and the potential impact on the health structures. The needs assessment surveys were important because of costs involved in telemedicine projects. Central to the needs assessment was the requirement for risk management through a proper selection of key partners in the project.

Strict adherence to confidentiality standards was maintained in the study. The key informants were purposely selected based on their interest in developing telemedicine activities. The identified key informants were asked to provide names of other participants who were likely to be involved in telemedicine initiatives. In some instances the interviewee identified corporate bodies as stakeholders. The researcher then looked for the appropriate person within that organisation. The interviewer telephoned the key informant to schedule an interview at a future date.

Issue-focused, structured interviews of key informants were used in order to provide thick and richly textured data needed (Sackman, 1991; Orlikowski, 1993). All interviews were conducted by the researcher and on a face-to-face basis or through telephone surveys. Face-to-face interviews eliminated the problem of item non-response, which plagued earlier telemedicine studies (Office of Rural Health Policy, 1997). However, the weakness of this method rests on the time constraint of the researcher. A two-month period was not sufficient to effectively collect all the necessary data. Construct validity and reliability were enhanced by triangulated data collection (Eisenhardt, 1989; Yin, 1994). This could not be fully achieved as it required more time to interview multiple key informants from different functional groups. Reliability and construct validity were only enhanced through the use of additional data sources other than interviews. Due to the serious time constraints, few respondents were considered. Therefore, most of the findings were derived from secondary research using secondary data sources. This included heavy desk research and review of telemedicine articles, government policy documents, and some sector acts of parliament.

Research limitations

There were critical research limitations that negatively affected the results. Key informants were sometimes busy with strict schedules. In some cases the researcher had to re-schedule the interviews. This was prevalent mainly amongst the medical professionals with busy schedules. Therefore there was a need to focus on very critical issues so as to minimise the interview periods. Such limitations could have influenced the results since the issue of key questions became subjective and few interviews were conducted. The complexity of the health structure also had a negative bearing on the data collection process.

Due to the widespread locations of health institutions, the study was restricted to areas around Gaborone. Therefore the samples were drawn from public hospitals around Gaborone. However the results were considered to be representative since the majority of the medical professionals were operating within the Greater Gaborone region.

Despite all these limitations, the measures taken to minimise the influence on the results are considered to be robust. Consistent with the objectives of the project, surveys contained questions from the following themes:

- Access to healthcare facilities.
- Cost savings via telemedicine activities.
- Collaboration amongst the key participants.
- Possible barriers of telemedicine.
- Needs assessment on telemedicine applications.

In addition, well-designed research methodology when executed over a proper period of time should yield the desirable results. Therefore the time domain limitation factor may be addressed through a proper research schedule time.

Analysis and results (mix findings and analysis/discussion)

Research findings: Ministry of Health

It was established that the Ministry of Health has bought into the concept of telemedicine to the extent that it has set up some pilot projects for monitoring and evaluating to spearhead the development of telemedicine initiatives. However, the rate of such development is minimal and quite recent. At the time of research, almost two years had elapsed without any concrete published progress reports in line with the telemedicine initiatives. It appeared that only verbal press statements on telemedicine have been issued. The work is barely at its early developmental phase and few members appear to know what telemedicine is all about. It might be too early at this stage to give conclusive comments on the initiatives. But it is hoped that the research findings of this study will further enlighten key decision-makers within the Ministry of Health to speed up the deployment process. Presumably the research document would serve as the source of literature and reference to the telemedicine implementers in Botswana.

The top five causes of admissions in Botswana hospitals are HIV/AIDS, hypertension, diabetes, pulmonary tuberculosis, and pneumonia. Although the list is not exhaustive, the indication of the prevalent diseases is significant. The indicated statistical information is critical for the determination of implementation priorities. Some medical professionals suggested that the first three diseases would be suitable for telemedicine; other conditions which are not diseases could also be included, especially emergencies like trauma, surgical conditions needing urgent attention, and being in remote areas where specialists are unavailable. Therefore, only specific diseases can be addressed through appropriate telemedicine applications.

The secondary data reveals that other initiatives involved the partnering of the newly established University of Botswana Medical School and the National Library of Medicine of America to implement SMS-based medical guidelines to remote heathcare providers. In addition, the running pilot projects are focusing on treating skin diseases, HIV/AIDS, and cervical pre-cancer diseases. The key finding was that telemedicine would allow remote access to health facilities that would otherwise be impossible without telemedicine initiatives.

The respondents indicated that telemedicine would reduce the costs to the patients and speed up the recovery process, as patients will get early diagnosis and treatment. Hence studies indicated that telemedicine can reduce the burden of the taxpayer. If implemented, telemedicine would cut substantive costs since in some instances, it may not be necessary to hospitalise the patient. Also, early treatment in remote areas could avoid acute cases that call for hospitalisation. In the long run, the initiative would allow the government to substantively cut the budget on health activities.

Telemedicine applications can provide real-time information that would be representative of the situation. However, there could be some time lag on the information provided, but still, the information would be accurate enough to allow policymakers to make informed decisions at strategic levels.

The level of telecommunications coverage was found to be the backbone of the telemedicine initiative. Hence the limited bandwidth capacity presents a major barrier to rolling out telemedicine services.

Summary of the benefits and barriers identified by all the key players

Benefits that were pointed out by key player representatives were:

- Connection to remote areas, for example Maun medical officers.
- Improved communications between health centres.
- Provision of basic infrastructure to schools and clinics.
- Registered nurses could be able to assist patients in life threatening situations.
- Knowledge exchange among specialists.
- Supporting social services.
- Appropriate use of resources that already exists.
- Links with international communities.
- Links to other regional countries to exchange information.

Barriers to telemedicine were also pointed out:

- Lack of telecommunications infrastructure.
- Lack of appropriate policy with regard to telemedicine developments.
- Fragmentation of similar projects.
- Lack of partnership between the government and the private sector.
- Incorrect perception that the government alone must develop such initiatives.
- Specialists are in the commercial sector and need to be committed or patriotic to return what the government had put in them.
- Payment problems, i.e. who should pay for the service.
- Funding for both health terminal equipment and telecommunications equipment.
- Public and private relationship on the medical field.

Project teams

All the identified key players in the process of implementing telemedicine projects indicated that such projects require collaborated effort amongst the players. The constituents of the project team should include:

- Ministry of Health and Ministry of Communications and Science and Technology to drive the project (Public Sector).
- Private sector health institutions.
- Businesses in the telecommunications sector.
- Software developing companies.
- ICT businesses.
- Civil society/non-governmental organisations working at grassroots level to create awareness.

Summary of other major findings

'The lack of access, particularly to primary care can be a double-edged sword. It is usually much cheaper to practice preventive medicine and to treat illnesses at an early stage that it is to treat illnesses at a later stage' (Institute of Medicine, 1996b). At the same time people who lack medical access to primary care tend to seek treatment only when their condition becomes an emergency. Such people tend to ignore the early symptoms hoping that they will go away in an effort to avoid the cost or inconvenience of seeking treatment. Only when the pain becomes acute do they seek treatment. 'Treatment at this later stage is almost always complicated and much more expensive than preventive or early stage care' (Institute of Medicine, 1996b). In accordance with previous research studies, the research findings indicated that telemedicine would improve access to medical facilities. Once medical facilities were improved, the quality of health delivery system would also be improved.

From the study, it was evident that the government incurs huge costs for hospitalisation of patients. Technology was considered as a mean of reducing these hospitalisation costs. Empirical evidence suggests that telemedicine can effectively reduce the associated treatment costs. '*The cost of such treatment is usually a financial burden not only to the patient and his/her family, but to the taxpayers as well*' (IOM, 1996b). Patients without access to care are often unable to pay for their treatment. In the end, the government would have to assist in one way or another, for example the social safety nets to cover for the basic health costs for the disadvantaged class of people.

Telemedicine impact

- The project is likely to provide a positive impact to the population in terms of:
- More access to better information.
- Minimising the problem of skills emigration in the long term.
- Economic benefit to the health sector that translate efficient system to patients.
- Instantaneous handling of patients.
- Breaking the barrier of distance to zero.
- Providing updated medical databases; the Ministry of Health would instantaneously know the status of the disease outbreaks, for example, Malaria.

Conclusions and recommendations

Summary of key issues

The research study revealed that the quality of health delivery systems in Botswana is slowly degenerating. It is now prohibitively expensive to

gain access to private health institutions. The less privileged still find it expensive to access public health institutions. Furthermore, remote areas are characterised by a critical shortage of health personnel, transport, and limited medical information for medical staff. These factors are hindering the delivery of quality health care services in such areas. In some cases a medical professional is required to visit several health points at a given time. But due to resource constraints it is not possible for one to effectively execute these duties. Therefore, some form of improvement within the health sector is required. The research findings suggest that telemedicine, if properly implemented, would somehow improve the health delivery system in Botswana. However, technological issues that involve telemedicine uncertainties require decisions that can be supported on scientific as well as social grounds. Therefore, researchers and scientists should communicate technical information clearly and the government organs should inform people about the confidentiality and safety regulations. Ultimately the citizens of Botswana will decide to what extent they are willing to accept the innovation in relation to the health delivery system. It is important that information is disseminated to the target market to create positive attitudes towards telemedicine.

The research findings indicate that the current health delivery system could be improved through the use of telemedicine. The major impact of telemedicine on the current health delivery system relates to costs savings and unnecessary travelling, improved quality of health services, improved access to health services, and increased collaborative effort. Both patients and medical professionals agreed that telemedicine has potential benefits that will improve the standard of health in Botswana. Telemedicine as a tool would allow medical professionals to pursue their further education without being isolated, even though they would be operating from remote stations. In terms of improved quality of health, early diagnosis and treatment before complications would have a positive impact on the health delivery system. Because telemedicine is independent of distance, patients would be treated in their comfort zones within their local community. Furthermore, the benefits accrued from telemedicine would be extended to the region and Africa in general. As a collaborative process, telemedicine cannot be implemented in a disintegrated manner. An integrative approach is necessary to achieve the intended telemedicine benefits. The use of the ITU telemedicine project models would allow for effective execution of the project. The framework has been tested and provides experiences in dealing with telemedicine initiatives.

However, telemedicine implementations are faced with numerous challenges and barriers. The research revealed that telemedicine barriers take several forms. In Botswana, the major barriers are considered to be the initial costs of the terminal equipment, low level of computer literacy, high cost of computers, and disintegrated health system, i.e. lack of collaboration between the private and public sectors. However, trust among participants is key to the success of telemedicine collaborative activities. In order to reap the benefits of telemedicine, these barriers should be minimised or removed completely.

Despite the major barriers, the research findings reveal that telemedicine would benefit Botswana as a whole. Therefore, it would be prudent for Botswana to improve and develop further the current telemedicine initiatives.

Achievements of objectives

The intended specific objectives were as follows:

- Identify the needs and priorities for the introduction of telemedicine in Botswana.
- Determine the major barriers to telemedicine in Botswana.
- Identify key players capable of championing the implementation of telemedicine in Botswana.
- Create the demand for telemedicine / creating awareness for telemedicine services.
- Study the opinions of key individuals in Botswana health services concerning the future of telemedicine, the potential of this technology and the incentives that exist and need to be developed.
- Demonstrate the potential benefit of telemedicine in Botswana and developing countries in general.
- Develop a working guideline/model for a successful implementation of telemedicine.

The survey established that both patients and medical professionals perceived telemedicine as a tool that would improve the quality of health delivery systems. However, this could be perceived as the respondents' subjective perception of telemedicine. The analysis in support of the previous research findings found that successful telemedicine initiatives were built on the strength of collaboration. Therefore, it is of paramount importance that relevant teams are established prior to telemedicine implementation. The survey indicated that telemedicine applications could be rolled out on a case-by-case approach.

Although there are many benefits associated with telemedicine, the research findings reveal that telemedicine barriers must be appropriately addressed before any meaningful telemedicine initiatives can be implemented. The most crucial barriers are:

- Lack of telecommunications infrastructure in some remote areas that has great need for telemedicine.
- Lack of appropriate policy in regards to telemedicine developments limit the rate of rolling out telemedicine initiatives.
- Fragmentation of similar projects instead of consolidated programmes.
- Lack of partnership between the government and the private sector.
- Incorrect perception that the government alone must develop such initiatives.
- Specialist in the commercial sector mainly interested in projects with high return on investment.
- Payment problems i.e. who should pay for the service, and limitations of the national electronic payment systems.
- Funding for both health terminal equipment and telecommunications equipment to link the remote with the central site.
- Public and private relationships in the medical field.
- Little access to computers (computers are very expensive in Botswana).
- Low level of computer literacy in the country.

The research findings indicate that telemedicine barriers appear to be generic in nature. However, there are some barriers that are specific to specific environmental settings. Unlike in the USA where legal and licensure issues were barriers to telemedicine, these issues were considered to be non-barriers to telemedicine in Botswana.

In accordance with literature review, the research findings indicate that telemedicine initiatives require an integrative approach. In order to achieve the intended goals, it is imperative that appropriate teams are set up to spearhead the initiatives. All the identified key players in the process of implementing telemedicine projects indicated that such projects require collaborative effort amongst the players. The stakeholders of the project team should include:

- Ministry of Health and Ministry of Communications and Science and Technology to drive the project (Public Sector).
- Private sector health institutions.
- Businesses in the telecommunications sector.
- Software developing companies.
- ICT businesses.
- Civil society/NGOs working at grassroots level to create awareness.

The research information will help policymakers to make informed decisions that are related to telemedicine initiatives. Experience tells us that people and cultural issues are important in information technology developments. Therefore, it is crucial that the market be woken up to the impact of innovative technological initiatives like telemedicine. The research attempted to improve telemedicine awareness in Botswana. Although the research was predominantly secondary research, it is hoped that at least the medical professionals are aware of the existence of telemedicine. The results highlight the importance of giving early emphasis to patient and medical professionals' involvement and marketing communication strategies. On the other hand, it may be difficult to reach out to all potential telemedicine end-users.

The research results highlight the major potential benefits that could be derived from telemedicine initiatives. From the analysis, it is apparent that the major benefits of telemedicine are:

- Connection to remote areas, for example Maun medical officers.

- Improved communications between health centres.
- Provision of basic infrastructure to clinics.
- Registered nurses to assist patients in life-threatening situations.
- Knowledge exchange among specialists.
- Supporting social services.
- Appropriate use of resources that already exists.
- Links with international communities.
- Links to other regional or international countries to exchange information.

On the other hand, telemedicine benefits are associated with telemedicine barriers. In order to enjoy telemedicine benefits, telemedicine barriers should be minimised or removed. Another way of minimising such barriers involves the introduction of telemedicine incentives. One of the network operators in the region indicated that the government could try to implement policies that allow the network operators to import equipment at a very low customs duty rate so that they could be subsidised in the roll-out process. Another approach would be the use of the universal service fund by those operators that provide infrastructure to remote areas. The government of Botswana has established this fund under the authority of BTA. Although the fund has not yet been utilised, it is hoped that it would have a positive impact on the telemedicine developments.

The concept of virtual collaboration highlights the importance of globalisation. In a global health delivery system, all participants work in collaboration to share limited resources. Telemedicine allows sparsely distributed medical professionals to assist patients in a global village. The fact that patients could, through telemedicine, access remote medical facilities that otherwise they could not access is a huge benefit to the patient. At the same time, medical professionals would improve their working conditions.

Managerial recommendations

In order to implement telemedicine initiatives, it is critical that certain aspects are properly addressed. The research findings indicate that telemedicine had a very positive impact on the access and quality of health care in Botswana. From the research findings the following recommendations were drawn up:

- Network operators should establish good working relations so that they can effectively collaborate in the development of telemedicine initiatives.
- The regulatory telecommunications body should provide incentives to the operators so that telecommunications infrastructure development is speeded up. Otherwise it could be very difficult for the operator to volunteer to move into remote areas.
- Access to computers is a barrier to telemedicine; therefore, telecentres/telecottages should be established in rural schools, police stations, and clinics to provide access to the community. The ideal situation is to have these centres within a 5-km radius of walking distance to minimize of transport costs.
- In terms of funding, a health levy should be introduced so that the proceeds are used to purchase the terminal equipment.
- The government must take the lead in the whole exercise and introduce telemedicine incentives.
- Proper hospital facilities must be put in place before any meaningful telemedicine is implemented. Therefore, telemedicine should be selectively deployed on a case-by-case basis. The initial focus must be on the provider level and where there are appropriate traditional healthcare facilities. From this perspective, major hospitals should be connected first and the telemedicine adoption rate monitored. Once the uptake reaches a certain defined threshold, then the project can be rolled out to the next lower level in the health hierarchical structure. The process should follow an iterative approach. Ultimately the individual patients can have their own private connections to the telemedicine backbone network.
- The regulatory authorities, prior to telemedicine deployment, should address legal and payment issues.
- In areas where telecommunications infrastructure is not available, collaborated effort is required to build up the needed shared infrastructure. The banking sector could be asked to contribute towards a common com-

munity service fund. Financial institutions are renowned for sponsoring community project. This could be another area where financial institutions could depict their corporate citizenship.

- Both private sector and public sector medical professionals should develop the spirit of collaboration.
- Appropriate business models should be developed and must clearly state the obligations of all the partners in the telemedicine initiatives. The investment for telemedicine technology should be appropriately discounted and must exhibit the value added due to telemedicine deployment.
- Medical professionals and information technology administrators should be appropriately trained so that they can use and manage the telemedicine system.
- Patients must be trained so that the telemedicine adoption rate is improved.
- New business in telecommunications could be established to provide new technologies. There is a big opportunity for broadband radio technology as a national investment.
- Telemedicine applications can be prioritised according to end-user needs. Research findings indicated that TB is one of the most prevalent diseases in Botswana. Furthermore, access to medical information by isolated medical professionals is problematic. Therefore telemedicine applications could start by relaying TB information and tele-education activities. The critical thing is that the end-users of telemedicine dictate the pace of implementing telemedicine projects.
- The project team should involve all the key players identified in the research study.
- The government should develop a telemedicine policy to ensure that telemedicine pilot projects were executed to completion and evaluation results extensively publicized. It is from such projects that the inherent benefits are clearly spelled out to the beneficiaries.

Research recommendations

Since the research study was specifically focused on the limited sphere of influence and confined to a certain area of interest, it is vital that more robust research methods are used to enhance the generalisation of the research results. Therefore recommended future research areas include the following:

- An extended focus on the entire health delivery system, so that external validity is improved.
- Focus on the clinical applications based Knowledge Discovery in Data (KDD).
- Conduct state-wide audits of telemedicine activities and broadband telecommunication access throughout the country.
- Determine the patients' satisfaction and cost-effectiveness of services provided by telemedicine technologies.
- Define appropriate telemedicine services evaluation methods.
- Apply telemedicine costs benefit analysis techniques.

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