Communications of the Association for Information Systems

Volume 18 Article 30

11-30-2006

Global Diffusion of the Internet X: The Diffusion of Telemedicine in Ethiopia: Potential Benefits, Present Challenges, and Potential Factors

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GLOBAL DIFFUSION OF THE INTERNET X: THE DIFFUSION OF TELEMEDICINE IN ETHIOPIA: POTENTIAL BENEFITS, PRESENT CHALLENGES, AND POTENTIAL FACTORS

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ABSTRACT

Delivery of healthcare services presents many challenges for governments in most developing countries. Some of these challenges include financial and human resources issues that might affect governments' ability to manage and transform scarce resources to meet healthcare needs. Telemedicine, a healthcare delivery technology where physicians examine patients from distant locations using information technologies, is reported to be increasingly helpful in meeting the needs of the healthcare sector in developing nations such as those in sub-Saharan Africa. This conceptual study reports on the sectoral adoption of telemedicine in Ethiopia, a sub-Saharan African country. We examine the potential benefits of telemedicine diffusion in Ethiopia, addressing the country's healthcare needs, and discussing the obstacles and challenges. Based on previous literature, as well as experiences drawn from other developing nations, we address three potential factors that could influence the diffusion of telemedicine in Ethiopia: *active participation of institutions of higher education, Ethiopian foreign alliances, and government involvement*. Although the initial successes are relatively small and involve isolated projects, they have been promising and have set the stage for researchers to investigate prevailing projects so as to gain better understanding of the aforementioned factors. Our study does not claim that telemedicine can solve all of Ethiopia's medical challenges; however, we contend that it is a starting point to reach Africans that live in areas with limited medical facilities and personnel. Hence, our study could have far reaching implications as the world looks to help this country, and by extension, other developing countries, to overcome their medical challenges and join the information society.

KEYWORDS: Telemedicine, Ethiopia, Developing Countries, Information and Communication Technology, Healthcare

I. INTRODUCTION

The sub-Saharan African region has, on average, fewer than ten doctors per 100,000 people, and some of these countries do not have a single radiologist (Fraser and McGrath, 2000). Ethiopia, a sub-Saharan African country, with a population of over 70 million people, has less than 38 radiologists in the entire country. The shortage of radiologists in the country is further complicated by the concentrated locale of the radiologists. For instance, 30 of the 38 radiologists are located in the country's capital city, Addis Ababa (Ethiopia Ministry of Health, 2001). Given that 85% of Ethiopia's population lives in remote, rural areas, transportation (or the lack thereof) is an issue of concern.

Ethiopia's inadequate transportation infrastructure makes it even more difficult to provide healthcare services in remote, rural areas. The infrastructure also makes it difficult for those needing healthcare services to travel to urban areas where the healthcare providers are heavily concentrated. Even where clinics and hospitals do exist in remote, rural areas, the facilities are often poorly equipped and fall below healthcare delivery standards set by the World Health Organization (WHO, 2002). Additionally, due to extended droughts, famine, civil war, and overall low socio-economic conditions, the state of Ethiopia has continued to deteriorate. Traditional media such as radio, as well as new and emerging information and communication technologies (ICT), could address some of the challenges of the delivery of healthcare services in rural Ethiopia. Ethiopia could benefit extensively from the diffusion of ICTs, such as telemedicine, as a possible step towards addressing the acute poor state of healthcare delivery in rural areas (Mbarika, 2004). Given the decreasing costs and increasing capabilities of computers and imaging systems, thus making ICT more accessible, it is plausible that such technologies could help to diffuse telemedicine in Ethiopia.

The first well-known implementation of telemedicine began during space flights (Perednia and Allen, 1995b); since that time, significant developments and improvements in telemedicine have come about through the use of digital communications and the Internet. In most cases, telemedicine is practiced in rural and urban centers in an attempt to improve the quality of healthcare delivery, as well as offering such services in a cost- effective manner (Mitchell, 2000; Kifle et al., 2006a).

Prevailing cases and instances of telemedicine in sub-Saharan Africa seem to portray the technology as one of several plausible panacea to the region's medical challenges (Kifle et al., 2004; Mbarika, 2004). In their studies, Kifle et al. (2004) and Mbarika (2004) clearly demonstrate how telemedicine technologies are making inroads in the sub-Saharan Africa region with concrete examples of individual countries adopting this technology, which constitutes important "Sectoral Absorption" as reported in the Global Diffusion of the Internet (GDI) framework by Wolcott et al. (2001). Sectoral Absorption captures the commitment to Internet use (as measured by leased lines and Internet servers) in the four major sectors of academia, commerce, healthcare, and government. Whereas the Internet is used to some degree in all four sectors of sub-Saharan Africa, fewer than 5% of those with Internet connections have speeds beyond dial-up. In this conceptual study, we focus on telemedicine as a healthcare delivery modality in Ethiopia, to address the following research questions:

- *What is the current state of telemedicine diffusion in Ethiopia?*
- *What are some potential factors that could impact telemedicine diffusion in Ethiopia?*

To address these questions, we pull together threads from varying case studies, review of existing literature and interviews with 22 personnel from functional and administrative areas including doctors, hospital department heads, ICT staff, and government officials (policy makers). In one way or another, these policy makers and health professionals are all involved with telemedicine implementation in Ethiopia.

This paper is organized into six sections. Following this introduction, Section 2 discusses telemedicine as a means to deliver better healthcare services. Section 3 provides details of our research methodology and data sources. Section 4 outlines our findings, and includes a discussion of those findings. Section 5 details the implications of our findings for practice as well as suggestions for future research, followed by the conclusion in Section 6.

II. TELEMEDICINE FOR HEALTHCARE SERVICE DEVELIVERY

From the use of letters and the telephone (for communication between healthcare provider and patient) in the 19th century to the use of the radio and radio signals to transmit medical information in the 20th century, the implementation and utilization of ICTs in healthcare has been an ongoing process for over a century. For example, in the 1950's, radiographs were transmitted via satellites between Nebraska and the National Aeronautic and Space Administration (NASA) (Amenta and Rizzo, 1999). In 1986, some 30 years later, the sub-Saharan African experience with ICTs in the healthcare sector started with satellite-based interactive video conferencing that enabled formal medical education and lectures, telemedicine and international medical collaboration and research between medical facilities in Canada, Kenya, and Uganda (Crag, 1999; House et al., 1987).

Since its inception, telemedicine has been found to reduce costs and provide optimal utilization of the healthcare system in developed and developing countries (Moore, 1995; Whitten et al., 2003; Malasanoset et al., 2005; Kennedy, 2005; Taylor et al., 2003). In a recent publication highlighting the cost saving role of telemedicine in Ethiopia's healthcare sector, Kifle et al. (2006a) demonstrate how telemedicine has helped reduce travel cost of Ethiopian cardiac patients (mostly middle to upper class in this case) seeking treatment abroad. Using a multi-method case study research approach, Kifle et al. (2006a) analyzed the costs and benefits of introducing tele-cardiology[1] services in Ethiopia. Their findings clearly show that "tele-cardiology is clinically more feasible and more cost effective compared to patients traveling abroad for treatment". Other potential benefits of telemedicine to Ethiopia (and other developing countries) can be summarized as follows:

- To reduce direct and indirect costs to the healthcare sector, patients, and providers (Bashsuru, 1995; Della Mea, 1999; Whitten et al., 2000).
- To enhance citizens' equality in the availability of specialized medical services (Doolittle and Cook, 1999; Hatch, 1997; Sane et al., 1992).
- To improve cooperation between specialized care and primary healthcare centers (Elise and Mark, 2001; Fishman, 1997).
- To promote the proficiency of physicians and other healthcare personnel by means of teleconsultation and video conference-based training (Geddes, 1999; Perednia and Allen, 1995a)

In short, a main objective of telemedicine systems in developing countries is to facilitate cost-effective delivery of primary healthcare services to the majority of the population in rural and urban areas (Braa, 1997; Wootton, 2001). Attempting to understand the current state of telemedicine in Ethiopia as well as challenges the country faces with regards to the diffusion of telemedicine, this study seeks to provide greater insight to information systems (IS) researchers with regards to areas of telemedicine diffusion that might warrant further research. The insights and opportunities for future research should provide a valuable platform for lessons learned that could benefit other sub-Saharan Africa countries and by extension, other developing countries. It will also provide practitioners such as telemedicine service providers in the developed world with

[1] Tele-cardiology is simply telemedicine used within the context of treating heart diseases.

new opportunities to explore how to extend their practices to this often "forgotten" region of the world. In the next section, we discuss the research methodology used in this study.

III. RESEARCH METHODS AND DATA SOURCES

PRIMARY DATA COLLECTION

We conducted semi-structured interviews with open-ended questions to collect the primary data used in this study. Given the large number of possible different measures for telemedicine diffusion in Ethiopia, this study did not focus on specific clinical applications or criteria. Instead, in designing our interview questions, we borrowed from one of the most quoted telemedicine assessment studies titled *"Telemedicine: A Guide to Assessing Telecommunications in Health Care."* This study by the Institute of Medicine (IOM) [Field, 1996] points to pertinent issues that must be addressed for successful implementation of telemedicine and has been used by policy makers worldwide as they seek to improve the state of telemedicine in their countries. The IOM study suggests three domains in need of assessment, quality, access, and cost; along with two criteria, satisfaction and integration with the overall healthcare system that are important when evaluating telemedicine (Field, 1996). The IOM study presents questions to facilitate the evaluation of telemedicine. Since, our goal was to uncover the likely problems and potential consequences due to telemedicine diffusion, the questionnaire presented in IOM, seemed to cover most of our requirements. The three elements (i.e., domains in need of assessment) of the IOM study encompass the areas we were interested in studying as part of determining the problems and potential consequences of telemedicine diffusion.

In addition, a study by the World Health Organization's (WHO) Collaborating Centre for Telemedicine-Norway prescribes guidelines for a country feasibility study on telemedicine implementation (Sorensen, 2003). We used this WHO study to frame the elements of the IOM study, namely quality, access, and cost, by adapting some of the questions from the WHO study to include these three elements from the IOM study. The modified questions can be grouped into four categories that have been identified in prior studies on ICT diffusion in developing countries: policy-related issues (Mbarika et al., 2005; Tan et al., 2005), organizational and human capacity issues (Tan et al., 2005; Kifle et al., 2005), financial issues (Kifle et al., 2006a), and technical issues (Tan et al., 2005). The combination of the elements of the IOM study with WHO's guidelines for a country feasibility study on telemedicine implementation provided a more comprehensive and theory-driven approach to conduct interviews about the diffusion of telemedicine in Ethiopia.

The questions that were used in the semi-structured interviews, and the source of the interview questions, are listed in Table 1. The first draft was presented to two experts on ICT in healthcare at Addis Ababa University. The refined draft was then presented to three experts in Ethiopia from different specialty areas. The experts were comprised of an individual who is an expert on the use of ICT for healthcare from the Ethiopian Telecommunication Cooperation (ETC), a physician policy maker from Ethiopia's Ministry of Health (MOH), and a telemedicine expert from Addis Ababa University's Faculty of Medicine (FOM). The experts provided comments and feedback that helped us refine the questions used in the study. In the next section, we discuss the research participants and explain the nature of the interview process.

Table 1. Interview Questions

Questions	Source
Policy-Related Issues	
1. In terms of access, quality and cost, what are the main challenges in the country's health care system?	Field, 1996

Table 1. Interview Questions

Questions	Source
2. In terms of access, quality, and cost, which of these could be successfully addressed by telemedicine?	Sorensen, 2003
3. What are the current or planned health care programs or activities in the country that could benefit (e.g. by increasing access, decreasing cost, improving quality) from the application of health telemedicine? In which way?	
4. Have any strategies or policies for implementing health telemedicine been developed in the country previously?	Sorensen, 2003
Organizational and Human Capacity Issues	
1. In terms of access (by primary, secondary, or tertiary hospitals), which are the geographical areas, local institutions, and/or focal points that would be involved in a telemedicine project or service?	Field, 1996 Sorensen, 2003
2. Why would these areas or institutions be recommended?	Sorensen, 2003
3. In terms of quality and access, what kinds of human resources are available?	Field, 1996 Sorensen, 2003
4. What is the computer literacy level among key personnel?	Sorensen, 2003
5. How is the issue of medical responsibility within the country's health care system in relation to health telemedicine?	
6. Is there any existing legislation on confidentiality, security and privacy, which could apply to health telemedicine services?	
Financial Issues	
1. How will the health telemedicine project or service be funded with regard to investments and running costs?	Field, 1996 Sorensen, 2003
2. How will the health telemedicine service be paid for (e.g. reimbursement, out of pocket, taxes)?	Sorensen, 2003
3. What is the level of communication (Internet and telephone) costs, quality, and access in the country?	Field, 1996 Sorensen, 2003
4. Who will provide training and maintenance?	Sorensen, 2003
Technical Issues	
1. In terms of distribution and costs, explain your view of telecommunication infrastructure in the country. How can this infrastructure improve the quality of health care?	Field, 1996 Sorensen, 2003
2. What type of communication technology is used, ground based or satellite?	Sorensen, 2003
3. Is the telecommunication infrastructure reliable?	Field, 1996 Sorensen, 2003
4. Are there any government plans to improve access, reduce cost, and improve the quality of health care as it relates to the current telecommunication infrastructure?	

Table 1. Interview Questions	
Questions	**Source**
5. Who are the main telecommunication providers in the country?	Sorensen, 2003
6. Who are the main Internet Service Providers in the country?	
7. Are there any key aspects (e.g. power supply, difficult geography) that could affect access, quality, and cost of health care in terms of telemedicine that should be known?	Field, 1996 Sorensen, 2003
8. What is the distribution of technical equipment (e.g. computers, digitized medical equipment) in hospitals, clinics and administrative units as it relates to using telemedicine for the purpose of improving access to and increasing the quality of health care services?	
9. Are there any plans for maintaining the technical equipment (e.g. computers, digitized medical equipment) to ensure reliability?	
10. In the case of local equipment vendors, are they likely to provide training?	Sorensen, 2003

SECONDARY DATA COLLECTION

Given our collaborative relationship with the Ethiopian government, we were allowed access to a substantial base of secondary data sources including policy documents and reports from Ethiopia's MOH, Addis Ababa University FOM, and the ETC to be used in this study. We performed on-site visits to the governmental sectors that provided access to the aforementioned secondary data. The site visits included reviews and assessments of relevant agency documentation and allowed for close examination of ICT policies and infrastructure. Additionally, the site visits provided a detailed understanding of stakeholder influences and involvement regarding telemedicine implementation in Ethiopia. This was especially important since our analysis was focused on clarifying and gaining a better understanding of the policy context that affects design, management, implementation, and utilization of telemedicine.

Besides policy documentation, we performed a thorough review of the literature on telemedicine diffusion from mainstream IS journals (which was very limited) as well as journals dedicated to global and cross-cultural IS issues. Combining the review of policy documentation and other government data, the literature review provided an understanding of the current operating environment of telemedicine in other developing regions, providing different perspectives of potential factors that could impact telemedicine diffusion success.

ONSITE INTERVIEW PARTICIPANTS

We selected agencies from public and private sectors including international, academic, and nongovernmental organizations to participate in the study. The following agencies were selected: Addis Ababa University FOM, Ethiopia's MOH, the ETC, the International Telecommunication Union (ITU), and the WHO. The abovementioned organizations were chosen based on their involvement with telemedicine in Ethiopia since 1997. The chosen organizations were visited multiple times to observe the environment of ICT for healthcare service delivery with a specific focus on telemedicine implementation(s). During each visit, semi-structured interviews, consisting mainly of open-ended questions, were conducted with head officials from these selected agencies. A total of 22 officials from functional and administrative areas, including doctors, department heads, ICT managers, and government officials, were interviewed.

Over a three-month period we conducted face-to-face interviews with key informants. The interview sessions ranged from 30 to 60 minutes. The key informants were known experts with experience in telemedicine programs in Ethiopia. The expert groups consisted of three senior IS

managers from government organizations, 11 physicians from government and private hospitals, four senior IS experts from international organizations, and four physicians from Ethiopia's National Telemedicine Coordination Committee (NTCC). Fifteen of the 22 participants were physicians, and the remaining seven were senior IS managers in the health sector. The participant distribution was sufficient to provide insights about telemedicine implementation and diffusion from technical, political, and medical perspectives.

IV. FINDINGS AND DISCUSSION

In the sections that follow, we present findings from the on-site visits and we corroborate and discuss these findings using relevant literature. The sections include (1) Application of Telemedicine in Ethiopia; (2) Telemedicine Initiatives in Ethiopia; and (3) Challenges to Telemedicine Diffusion in Ethiopia. We conclude with relevant implications for research, teaching, practice, and other application domains.

APPLICATION OF TELEMEDICINE IN ETHIOPIA

Clinical Purpose of Telemedicine Application

People living in remote, rural areas of Ethiopia have limited access to basic healthcare services (Swanson, 1999). Geographic isolation, the scarcity of physicians and clinics, and the difficulty to travel to larger cities, where such care is available, are among the factors limiting the access to healthcare. Efforts to encourage physicians and other health professionals to establish practices in underserved areas have only been partly successful. Telemedicine is one mean by which more and better healthcare services can be delivered to remote, rural areas (Perednia and Allen, 1995b, Watanabe et al., 1999). This is of importance given that professional isolation is a major reason why rural communities have difficulty in recruiting and retaining physicians.

Telemedicine helps doctors to keep up with the latest findings in their field and remain in contact with colleagues. By providing such linkages, telemedicine can help resolve the uneven distribution of physicians between urban and rural areas. For example, there are 49 ophthalmologists for three million inhabitants of Addis Ababa, in contrast with 16 ophthalmologists for the rest of the country's 70 million people (Alemayehu et al., 1995). The technology exists that allows healthcare professionals to examine patients, to electronically transmit medical records from one location to another, and to effectively communicate with their colleagues, regardless of the distance between them. To further illustrate this point, one of the doctors interviewed commented:

> *I understood well the impact of professional isolation…to be far from [the] main city and lack of experiences to assist the patients while I was in Gimma and Southern part of remote area of Ethiopia as a general practitioner…now I understand well how this problem can be overcome…using new technology such as email, telemedicine…*

Telemedicine can change traditional treatment and medical activities by shortening the distance between patients and expertise (Wootton, 1996). For example, there is one pediatric heart specialist in Black Lion hospital in Addis Ababa, but over 110 hospitals with pediatric units in the country. Therefore, heart patients need to travel to Black Lion referral hospital in order to get the necessary treatments. Telemedicine provides a link between heart patients and specialists in and outside of Addis Ababa, thus minimizing the need to travel. Telemedicine can also be beneficially used over short distances, for example, within the same hospital, within the same town, and among different units of health care (Wootton, 1996). Another doctor had this to say:

> …we were quite dissatisfied. Patients have to go to a specialist and it is so inconvenient. Certainly, there was a lot of frustration about obtaining consultations for people in remote areas and in particular people who had

> disease processes that interfered with their ability to travel. With conditions that required very little time for the consultation compared to the time traveling to the consultation. There was also the delay for consultations that typically would be between 6 weeks and 3 months.

Furthermore, effective working practices in the health service led to reduction in waiting lists, early diagnosis of condition, and a more rapidly and convenient provision of services. In a six-month study, referrals were avoided in 22% of the cases by connecting primary care physicians with specialists (Harrison et al., 1996). In contrast, the communication without telemedicine, between general practitioners (GP) and specialists has often been poor. Moreover, if allowed to continue, such poor communication could affect the delivery of healthcare services by delaying treatment and follow-up processes. A specialist had this to say:

> *…one of the problems we are facing… while patients are referred to their center … without any patient history document. Therefore, the patients are going through the standard medical procedures, like history of patient, general check up and other for the second time; this is a double cost for the patients. The other big problem is after treatments… follow up; most of the rural patients are not coming for follow up because of the distance and financial scarcity, and also equally difficult to establishing communication to a local health service provider.*

TELEMEDICINE INITIATIVES IN ETHIOPIA

There are many examples of telemedicine initiatives in Ethiopia supported by international organizations and non-governmental organizations. For example, telemedicine has already been applied to address image-based specialty "store–and-forward" medical problems over the Internet (Adam, 2001; ITU, 2000; Seife, 2001). In this section, we present and discuss two primary telemedicine projects/initiatives that can help ease the current burden of healthcare services delivery in Ethiopia.

Tele-education

Telemedicine can also be used as a means to educate healthcare professionals in rural and urban communities, hence the name tele-education. Tele-education provides healthcare providers access to up-to-date or specialized information (Murphy et al., 2002). For instance, the HealthNet Ethiopia project has been instrumental in providing a communication network for health professionals throughout Ethiopia. The 62 service points connect hospitals, medical schools, non-governmental organizations, clinics, and research centers (Shimelis, 2004).

Furthermore, telecommunications and the rapid advances and availability of computer-based systems such as virtual reality, multimedia, and the Internet give educators the potential to penetrate under-serviced areas and enhance education through distance learning. This facilitates development of relevant local content and faster delivery of information on technical issues as well as on basic human needs (Edeger, 2000). Different media combinations may, however, be best in different cases through radio, television, video cassettes, audio cassettes, video conferencing, computer programs, print, CD-ROM or the Internet (Zollo et al., 1999). These instructional technologies can have a profound impact on the way medical training is delivered and received. One policy maker had this to say:

> *…the other area of telemedicine application we are looking for [is] undergraduate and postgraduate education of health profession.*

An official commented:

Currently the available health centers are very few in number and unevenly distributed. To bridge this gap, the government is committed to construct new health centers. However, [with] the output of physicians from the existing three universities (Addis Ababa, Jimma and Gondar)…with this

pace, it will take 20-25 years…Therefore, [an] innovative and cost-effective strategy is critical…we think telemedicine…

Teledermatology

In 1998, the TDB of the ITU launched its first telemedicine project in Ethiopia. The telemedicine project connected the Tikur Ambessa hospitals, Faculty of Medicine in Addis Ababa and 10 hospitals in rural areas. Figure 1 illustrates the interconnection of the main hospitals within Ethiopia. The telemedicine project was set up by a multidisciplinary group of partners that included a national telemedicine committee, in close collaboration with domestic and international partners like WHO, ECA, UNESCO, E-Health Solution, WorldSpace, Tokai University of Japan, Addis Ababa University, the ETC, and the Ethiopian Telecommunication Agency (ETA).

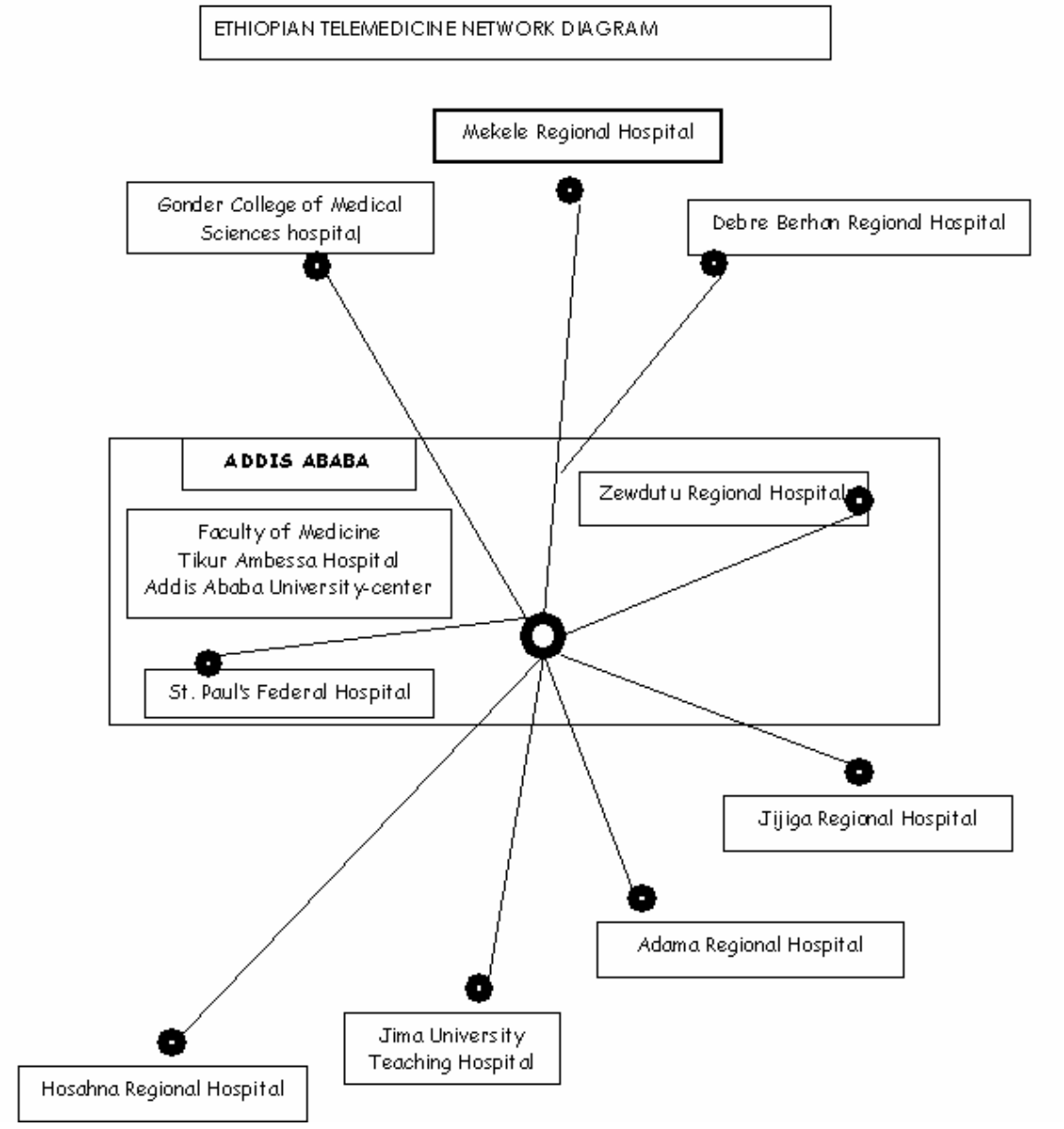

Figure 1: Teledermatology in Ethiopia: Interconnection of Main Hospital
Source: International Telecommunications Union, 1998

The project uses standard low-cost computer equipment, digital cameras, color scanners, and telemedicine software and telecommunication interfaces, all of which are installed at the central studio and at the remote hospitals selected to be networked. The Internet has been selected as the main telecommunication technology to connect hospitals in one telemedicine information network. The primary healthcare units will be able to benefit from the simple use of e-mail, which will provide them with access to doctors' advice (see Figure 2).

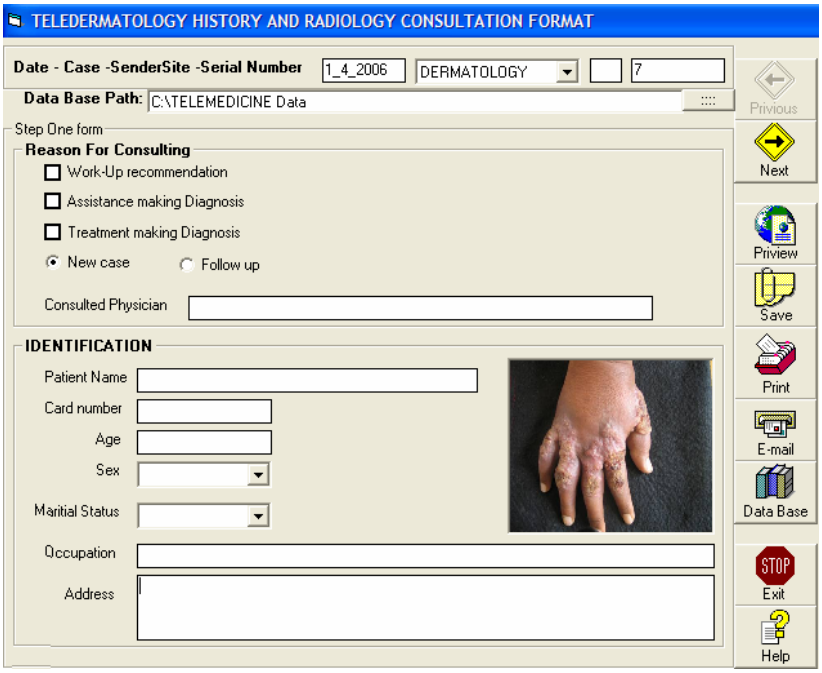

Figure 2: Teledermatology Consultation

Telepathology

In Ethiopia, telepathology is used by Black Lion Hospital in Addis Ababa to transmit still images to the University of Basel, Switzerland. This telemedicine initiative is mainly used for second opinions in the central referral hospital using the iPath web-based platform. The importance of telemedicine in clinical practice has been well observed as practitioners have been able to see interesting cases. For example, Figure 3 is an example of case where telemedicine was used to save a young boy's leg from being amputated. Furthermore, this example is indicative of telemedicine's educational value as it helped an experienced professor of pathology successfully obtain a second opinion.

Teleradiology

In May 2000, a teleradiology project was implemented in the Tigray region. The region has six hospitals with 640 beds and 18 other health centers with 220 beds, which are all owned and operated by the Ministry of Health (MOH). There are also 142 other small health stations in the region (132 MOH and eight others). The medical and communications equipment were installed in two regional hospitals in Mekele, the regions capital. The communication was done in two steps. The first connects a doctor traveling from village to village with regional hospitals, and the second connects the regional hospitals to Black Lion Hospital in Addis Ababa. This project was not only successful, but it was the first step in effectively implementing telemedicine in the country.

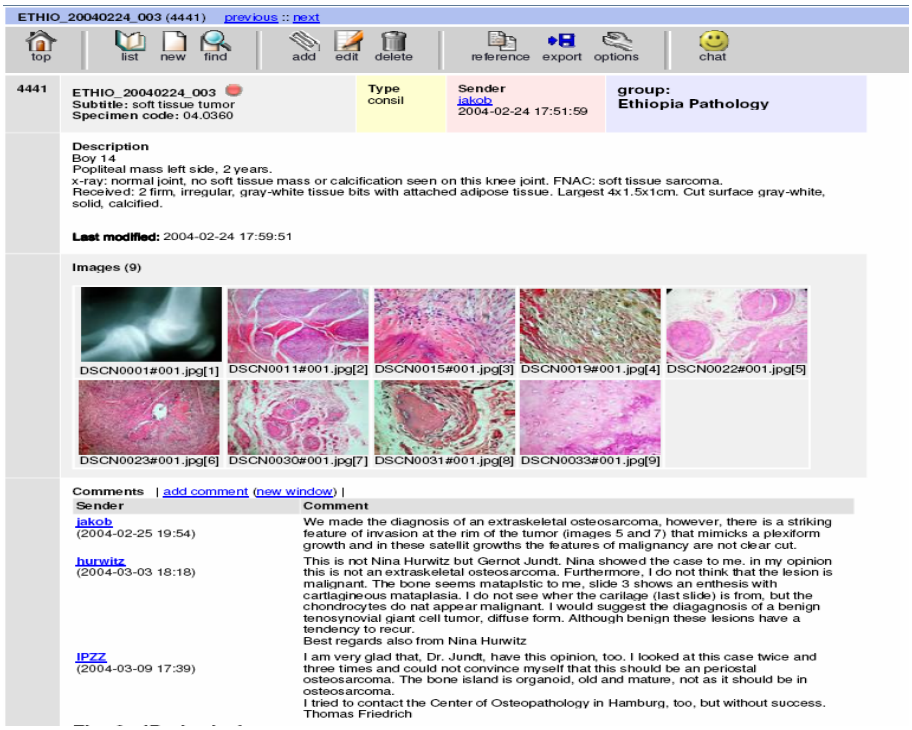

Figure 3: Telepathology Consultation Example

Teleophthalmology

Teleophthalmology in Ethiopia helps to reduce and prevent blindness by improving access to specialists, improving communication, sharing resources, and enhancing the capacity of health care service providers. The applications of teleophthalmology are also being used in many other ways such as for education, research, public health, health administration, and clinical care (primary diagnoses, screening and consultation). The primary advantage of this solution is closeness of vicinity to the patient as well as health care providers. The teleophthalmology health care centers are equipped with a complete but low cost ophthalmology system with an ordinary digital camera. Central ophthalmology centers maintain the software and provide technical support. The network of teleophthalmology in Ethiopia utilizes the existing network of connector colleges and universities, ophthalmology nursing schools, and regional hospitals.

Telecardiology

In Ethiopia, telecardiology service is being used for transmission still images or store-and-forward network from the local sites to the central telemedicine studio at the international health center. The transmitted images are X-rays, ECG (electrocardiography) printouts, and images of skin lesions. Specialists at the international health center make their diagnoses based on the still images and additional written information. They also use the still images to develop treatment plans and, if necessary, recommend more diagnostic tests. A physician at the domestic hospital is then able to provide qualified medical care with assistance from a senior specialist at a distant consultation center.

HealthNet

HealthNet Ethiopia was established in 1994 in collaboration with Addis Ababa University Medical School, which hosts the network. Initially, departments and units within the Faculty of Medicine were connected. Today, there are more than 60 points that are connected all over the country and making use of HealthNet's services. These points cover a wide geographical area and many institutions including hospitals, medical schools, non-profit organizations, clinics, health research

centers, and individual health care practitioners. There are more than 4,000 staff workers and students, from various regions, who use HealthNet.

Although the abovementioned projects are up and running, Ethiopia continues to face many challenges to the diffusion of telemedicine. In the next section, we will discuss constraints in the establishment and management of telemedicine projects, some of the challenges to the diffusion of telemedicine in Ethiopia, and factors that can help facilitate telemedicine diffusion.

CHALLENGES TO TELEMEDICINE DIFFUSION IN ETHIOPIA

Policy Considerations

In most developing countries, especially in sub-Saharan Africa, the formulation and implementation of policies in the ICT sectors are still rudimentary and calls for an integrated set of laws, regulations, and guidelines. These laws, regulations, and guidelines are expected to shape the generation, acquisition, and utilization of ICTs. Whereas most of these countries lack policies and strategies that facilitate the harnessing of new ICTs for healthcare development, those countries that have formulated policies lack proper implementation plans. Also review strategies are often lacking (Darkins and Cary, 2000; Fillip, 2000). One respondent had this to say:

> *The top manager awareness and willingness in the ministry is a major problem for the implementation of telemedicine in the national level…telemedicine is a really powerful tool in health system renewals. If we could have the senior managers understand or support that telemedicine is one of the ways that deliver services and that we have a good understanding of where it's appropriate and where it is not…*

A physician also commented:

> *Government awareness and readiness, as well as planning long term [rather] and short health care, and to have a policy is important. We have done a lot of talking to try to get people interested in trying to incorporate some telemedicine applications, and the top managers from ministry of telecommunication, health and finance don't understand or see the benefit of using such technology…some think it is a luxury.*

At present, the regulations are rigid and telecommunication tariffs and import duties on ICT equipment are high. This situation is further compounded by the lack of political good will. For example, a broad-based national ICT policy development began in 1997, and five years passed before the Council of Ministers adopted the ICT policy [Anonymous, 2002]. However, as it was written from the perspective of the government, it does not address international issues and review strategies, which are also fundamental to telemedicine. This particular issue is paramount since much of the technical infrastructure comes from developed countries (Anonymous, 2001; Anonymous, 2002).

High Telecommunication Costs

The cost of basic Internet remains a strong deterrent in many developing countries (see Table 2). Although market liberalization has led to the entry of several private sector Internet Service Providers (ISPs), service provision is through government telecom companies, whose monopolistic services are inadequate in terms of robustness (e.g., low bandwidth, congested lines). For example, one doctor stated:

> *Telemedicine can help in many ways to overcome the existing shortages of specialists…the biggest barrier is the network cost and another thing is access in some places is impossible. In sum, rural areas require a basic level of technical background in the form of appropriate telephone and electricity to participate in telemedicine.*

Table 2: Internet Statistics 2002

County	Dialup Internet Subscribers	International outgoing Bandwidth	Cities Point of Presence [POP]	Access to Cost [US$]
Kenya	35000	28000	2	123
Djibouti	850	2048	6	
Sudan	9000	10000	7	
Ethiopia	6500	8200	5	75

Currently, Ethiopia's Internet services use a 2 Mbps symmetric international link, provided by France Telecom. This does not allow for the efficient transfer of large data or images. The number of Internet subscribers reached 12,500 by the end of 2005, an increase from 6000 subscribers in 2001, with the large majority of users located in the capital city, Addis Ababa. The high subscription fees charged by the ETC heavily influence the average cost of Internet dial-up services. For example, a basic private subscription with eight hours of access costs USD $19 and USD $4 for each extra hour (Anonymous, 2004; Bekele, 1996; Fanta, 2001; ITU, 2002). These rates are economically prohibitive for the country's healthcare practitioners, especially since healthcare providers and institutions expressed dissatisfaction with the speed, capacity, and high charge for services.

Infrastructure

The telecommunication and electricity infrastructure in developing countries is lacking or is poorly developed in rural areas (Bakken, 2001; McCoy and Mbarika, 2005; Meso et al., 2006; Talero, 1996). Satellite and wireless technologies are now in use in some developing countries, but these are largely developed around urban cities, and even there the infrastructure is often inadequate (Mbarika et al., 2005; Petrazzini and Harindranath, 1996). There are problems of low bandwidth and there is a need for strengthening the Internet backbone. This lack of implementation is due to a monopoly within the telecommunications industry. The government controls most of the ICT infrastructure and maintains different policies that influence the acquisition and use of the infrastructures by private organizations. Some government policies have been found to be highly instrumental in diffusion of ICTs in a society while others hinder progress through monopolistic power. For example, the Ethiopian government owns and manages the telecommunications operator that provides phone lines for Internet, fax, and e-mail access. Consequently, policies prohibit or restrict privatization of ICT services. The lack of competition usually leads to expensive rates and poor service (ITU, 2000). A respondent had this to say:

> *Telemedicine offers solutions for long distance consultation, education and training for health professional as well as the communities. However, the problem of bandwidth is well known, nevertheless, for the time being it is not a question in Ethiopia's case because we have to make use of what we have before requesting additional capacity…African countries have to start using the existing infrastructure before demanding additional capacity and demonstrate the needs…*

Currently, there are approximately six telephone mainlines for each 1000 persons in Ethiopia. The capital city, Addis Ababa, accounts for about 57.2% of the total amount of installed lines, and other large towns account for the other 32.5%. Eight-five percent of the population lives in rural areas, where only 10.5% of the telephones lines are actually installed (Samuel, 2001).

Inadequate Human Resources

To ensure more meaningful participation in healthcare development, training, and capacity building must be an integral part of all projects. Users of telemedicine have to be trained in the use, application, and maintenance of telemedicine systems before they become confident and comfortable enough to use them (Richardson and Rajasunderam, 1999). Most staff managing ICT-based projects lack adequate training that would enable them to take full advantage of the new technologies. There is a need to invest in training and advisory services. Such training could be done through conferences, workshops, or training courses. Introductory and sensitizing workshops could be organized for different categories of users, and local experts could provide ongoing on-line support. One doctor had this to say:

> *The critical role of appropriately trained human resources at all levels [is necessary] to help achieve the goals of Vision 2020…there's a need to strengthen the personnel…using telemedicine for continuing education, distance education; practice-based learning, case conferences, consultation…*

Sustainability of Projects

Most telemedicine projects in developing countries established with external funding face major challenges after the project period has ended. Sustainability of these projects should be considered from the outset and, where possible, should have the support of the government, private sector non-governmental organizations, and the community. There are few examples of success in attaining such sustainability, and there is an urgent need for viable models to be developed and tested. One policy-maker made the following comment:

> *In Ethiopia's case, the key point is sharing the existing resources among multiple applications like telecenter, not just health but agriculture and education, because the country can't afford to maintain or exploit properly the system [hardware, software, network, human resources]. Adequate funding is needed to absorb the costs associated with starting a telemedicine service. But before we are trying to implement telemedicine, it is necessary to demonstrate, conferences, workshops, and proper training…*

Literacy, Language and Culture

Literacy provides the foundation for an educated population that can utilize, create, and manage information. It is also equally important for a country to establish an information policy within the context of the culture (Davis et al., 1996). This could possibly be the single most important and basic constraint that underdeveloped countries face in ICT development (Mansell and Wehn, 1998). A respondent commented:

> *More than 60% of the population is illiterate. Eighty-five percent of Ethiopians live in rural areas without basic facilities (electricity and telephone).In addition, more, than 80 different languages exist in the country, all this has to be considered in the development of ICT for health sectors…*

Other constraints to the expansion of telemedicine in Ethiopia include the lack of knowledge and practical experience among professionals in the field of telemedicine, coupled with the lack of awareness among the public about the potential benefits of telemedicine services. Such lack of knowledge and awareness seems to hinder the diffusion and growth of telemedicine in Ethiopia. Based on a review of existing literature and a review of existing telemedicine projects in sub-Saharan Africa, we will now discuss the three prominent factors believed to facilitate telemedicine diffusion in underdeveloped regions.

FACTORS THAT FACILITATE TELEMEDICINE DIFFUSION

The diffusion of telemedicine can have a strong impact on healthcare services, especially in underdeveloped countries (Edworthy, 2001; Wright, 1997). Similar to the case of Ethiopia, many developing countries suffer from inadequate technical infrastructure, knowledge, and financial resources. Hence, the potential salient factors for telemedicine diffusion in developing countries are necessarily fundamental as opposed to those in developed countries (Yellowlees, 1997). In the case of Ethiopia, as evident in past telemedicine diffusion efforts, three major factors emerge from our review of the literature and existing cases: *active involvement of institutions of higher education, the government's full cooperation, and foreign alliances* (see Figure 4).

Institutions of Higher Education

Educational institutions are the backbone of telemedicine projects worldwide because of their capacities, high involvement in teaching and research, and their dedication to new technology (Carolyn, 2003). The diffusion of telemedicine projects should start on a small scale. This will encourage government and donor investment, enabling the building of local capacity. In the USA and Europe, most telemedicine projects began with the collaboration of an institution of higher education, usually as a pilot project. They continued with the ongoing evaluation of the project through data collection, observation, and comparison of achievements with objectives (Whitten et al., 2000). Eventually, after gaining some experience, they expanded the project to full-scale diffusion. From such experiences, we see that institutions of higher education should be encouraged to undertake telemedicine initiatives (Legesse, 1999).

In Ethiopia, higher education institutions such as Addis Ababa University play an important part in capacity building and human resource development for telemedicine endeavors. The potential factors that facilitate telemedicine diffusion do not depend as much on the performance of different tools as they do on gaining the acceptance of the medical science community (Carolyn, 2003). The majority of the medical community of Addis Ababa University understands the need of ICT to enhance and optimize existing human resources. There is also a broad recognition of telemedicine in university communities across the country. This understanding has been achieved through the experiences of the HealthNet network and several other workshops on ICT.

Government's Cooperation

Most telemedicine projects involve institutions from various sectors at the national and international level. Telecommunication services, electricity, and other major infrastructures of most developing countries are owned and operated by government monopolies. Therefore, the governments of these countries play a major role in facilitating necessary conditions for telemedicine diffusion. The governments are working to integrate telemedicine services into the overall health infrastructure to ensure that a certain degree of balance is achieved between urban and rural access (Reeve and Rose, 1999; Roland and Bewely, 1992). In addition, they are responsible for developing clear policies regarding licensing, liability, confidentiality, and practitioner responsibility. For example, such policies will regulate the activities and increase the cooperation of all the stakeholders in the public and private sectors. Lastly, they must provide funds—or acquire them from other sources—for the diffusion of telemedicine (Mendelson and Salinksy, 1997).

The Ethiopian government has recognized the need to strengthen national capacities to address ICT for the health sector. The government has worked on policy and strategy, capacity building, and education in the health sector (King et al., 1994). All concerned stakeholders—universities, the telecommunication authority, the MOH, and other institutions and policy makers—have committed themselves to supporting telemedicine diffusion. This is very important since most of the existing healthcare institutions and the ICT infrastructure in Ethiopia, such as telecommunications and electricity, are owned and controlled by the government. Their use requires the permission and cooperation of concerned authorities. Such cooperation then

facilitates the diffusion of telemedicine projects as part of the overall healthcare infrastructure rather than merely an auxiliary service added to existing components.

As mentioned in the policy consideration section, the Ethiopian government has also shown its readiness to consider the development of ICT policies and programs of action that address socio-economic development challenges (Meso and Duncan, 2000). A broad-based national ICT policy, developed in a conference of stakeholders labeled "Ethiopia in the Knowledge Age," was held with the aim of developing an ICT vision for Ethiopia. The stakeholders shared examples of best practices and took practical steps towards the diffusion of successful ICT partnership projects. Ultimately, the Council of Ministers adopted the ICT policy. The document emphasizes the need for establishing ICTs in the health sector and building the necessary capacity for the deployment of the infrastructure. It also discusses needs for human resource development and the building and strengthening of institutions.

In addition to the adoption of a new ICT policy, the Ethiopian government is considering strategies that will lower telecommunications prices. This would encourage physicians, other healthcare practitioners, hospitals, rural communities, educational organizations, and patient groups to unite in using ICT technologies to enhance the use of telemedicine. Nevertheless, the cost of equipment and telephone charges are still high for the majority of government organizations and individuals.

Foreign Alliances with Ethiopia

Telemedicine is globally popular with practices reported from many countries over the past ten years. Lessons from the USA, Europe, and Australia show that there are indeed standard practices for telemedicine diffusion. Developing countries should seek advice from more experienced institutions in other countries throughout all stages of the telemedicine projects (Cane, 1992). Telemedicine is experiencing growth in becoming a significant domain of international cooperation, with several institutions contributing funds and expertise. Through foreign alliances, projects in developing countries can receive help in formulating policies and implementing strategies, creating government awareness, obtaining financial and technical assistance, and facilitating links and relationships between national and research institutions abroad (Dosa, 1985; Nagy et al., 1995).

Most telemedicine projects require qualified human resources, funds, and reliable infrastructure, such as telecommunications and power, which are often too expensive for governments or local agencies of countries like Ethiopia to implement without outside assistance. This has been made evident in past and current telemedicine endeavors in Ethiopia. Almost all telemedicine projects were conducted with a significant contribution from foreign institutions. In addition to providing financial and technical help, international institutions such as the United Nations (UN), the International Monitory Fund, and the World Bank have close links to top government officials and could be very influential in advocating for the need for telemedicine. In the next section, we discuss the implications of this study.

V. IMPLICATIONS

In Table 3, we mapped the challenges to diffusion (which have emerged from our data) to the factors (in the model in Figure 4) believed to facilitate telemedicine diffusion. Table 3 strengthens the link between our survey and data collection, the challenges to diffusion, and the factors that facilitate telemedicine diffusion. Additionally, it assists in the presentation of the implications of this study. Each cell in Table 3 indicates how a particular factor is mitigating, has mitigated, or might mitigate a particular challenge to diffusion. This approach provides an assessment of what Ethiopia is doing to promote telemedicine and provides prescriptions for what Ethiopia might do to better diffuse telemedicine.

Having noted the challenges to telemedicine diffusion, the potential factors of telemedicine diffusion, and the mapping of challenges to factors, we now turn our attention to the implications of this study. While the practice of telemedicine is still in its early stages in Ethiopia, there exist several current and potential implications associated with its growth within the country. We argue that the IS community can be a major player in addressing ICT issues such as telemedicine as a step to tackle Ethiopia's many socio-economic and medical dilemmas. Our arguments can bear major implications for research and practice.

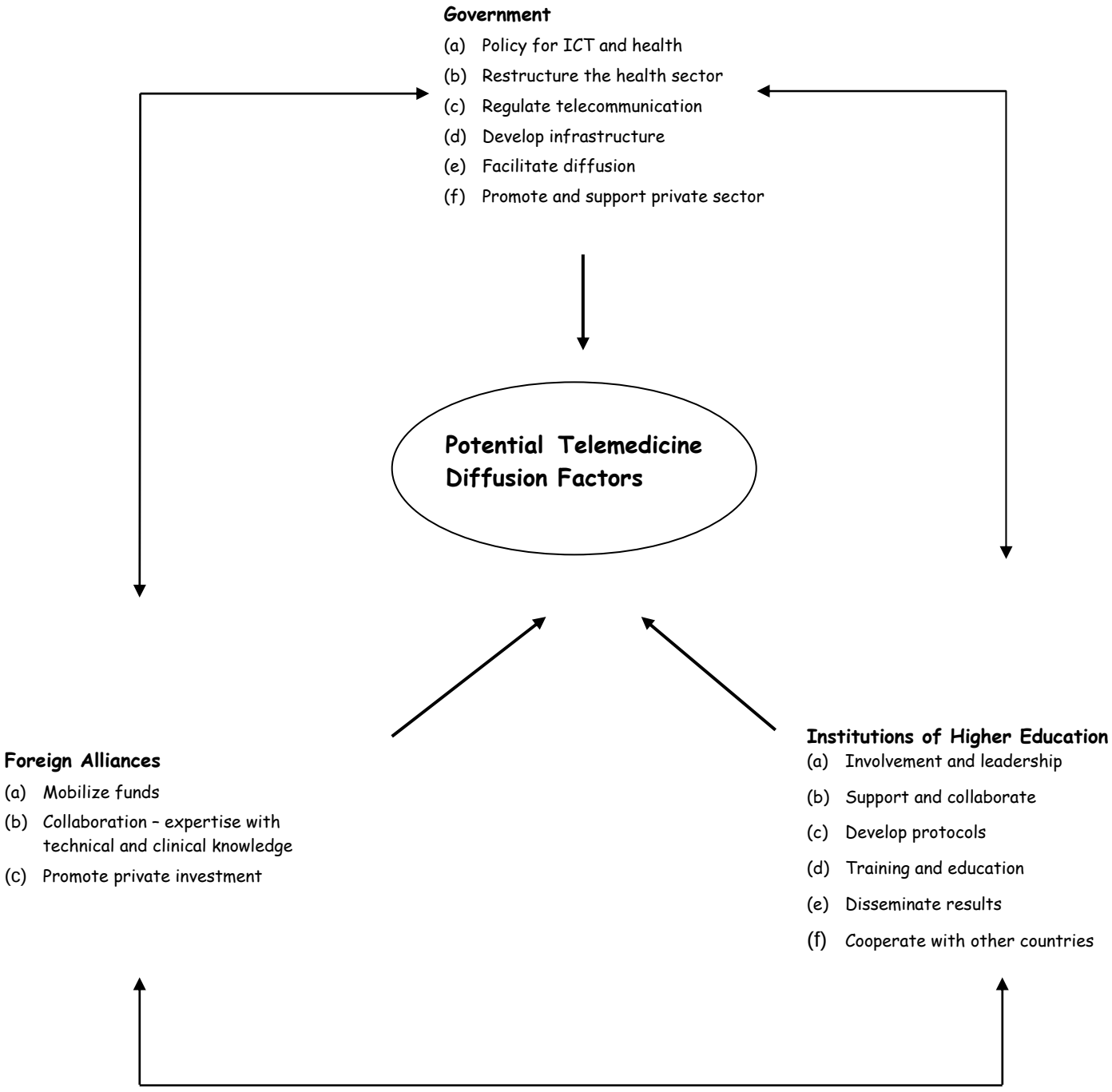

Figure 4. Potential Telemedicine Diffusion Factors

Table 3 Telemedicine Challenges and Telemedicine Diffusion Factors Matrix

Challenge / Factor	Government Policies	Telecom Costs	Telecom Infrastructure	Human Resources	Sustainability of Projects	Literacy, Language, Culture
Institutions of Higher Education	There is a broad recognition of telemedicine in university communities throughout Ethiopia. Academic institutions should work with national and local government agencies to establish policies and regulations that pertain to telemedicine.		The HealthNet Ethiopia project has been instrumental in providing a communication network for health professionals throughout Ethiopia.	The medical communities of the larger universities understand the need of ICT to enhance and optimize existing human resources. The institutions of higher education currently play a vital role in capacity building and human resource development for telemedicine endeavors.	Leaders and ICT experts at universities could serve as liaisons to organizations with telemedicine initiatives. This would allow organizations to leverage the knowledge and management skills of academicians to better ensure sustainability of telemedicine projects. In other words, the academic community could play a role similar to that of small business development centers in many US universities.	Academic institutions should bridge the gap between viable telemedicine initiatives and medical practitioners who are not knowledgeable about the benefits of telemedicine. Academic institutions can also facilitate the development of policies that are congruent with the country's culture.

Table 3 Telemedicine Challenges and Telemedicine Diffusion Factors Matrix

Challenge / Factor	Government Policies	Telecom Costs	Telecom Infrastructure	Human Resources	Sustainability of Projects	Literacy, Language, Culture
Government Cooperation	The Ethiopian government has worked on and adopted an ICT policy and strategy in the health sector. The government has also shown its readiness to consider the development of ICT policies and programs of action that address socio-economic development challenges.	The Ethiopian government is considering strategies that will lower telecommunications prices. The government could allow more competition in ICT delivery to medical practitioners and academic and medical institutions. The newfound competition could potentially make telecom services more affordable for these entities.	There is a commitment from the government to support telemedicine diffusion. This is very important since most of the existing telecom infrastructure is owned and controlled by the government. Government commitment facilitates the diffusion of telemedicine projects as part of the overall healthcare infrastructure. Governments must also take the	The Ethiopian government has worked on and continues to work on capacity building and education in the health sector. Government agencies should allocate more funding for training natives in the development, implementation, and use of ICT.	The government is working to integrate telemedicine services into the overall health infrastructure. The governments should provide funds additional funding to organizations that are making a serious attempt to diffuse telemedicine to improve health care services.	The government has adopted an ICT policy that, among other things, focuses on education in the health care sector. This should encourage physicians, other healthcare practitioners, hospitals, rural communities, educational organizations, and patient groups to unite in using ICT technologies to enhance the use of telemedicine.

Table 3 Telemedicine Challenges and Telemedicine Diffusion Factors Matrix

Challenge / Factor	Government Policies	Telecom Costs	Telecom Infrastructure	Human Resources	Sustainability of Projects	Literacy, Language, Culture
			next step and ensure that the ICT infrastructure is reliable and that access to the infrastructure is not prohibited or based on political affiliations.			
Foreign Alliances	Ethiopia should establish foreign alliance with more developed countries that help in formulating policies and implementing strategies pertaining to ICT and telemedicine. The foreign alliances could also aid in creating government awareness about the value of telemedicine and the interplay between ICT and	International institutions such as the UN, the International Monitory Fund, and the World Bank have close links to top government officials and could be very influential in advocating for the need for telemedicine. This could also include lobbying to consider offering telecom services to health care practitioners, academic and medical institutions. The potential competition could in	Foreign alliances with well-known and established telecom providers could lead to the deployment of higher quality and more reliable telecom infrastructure. The foreign relationships could also aid Ethiopia in obtaining financial and technical assistance.	Foreign alliances with countries and organizations that have a populace of technically competent individuals in the area of telemedicine and ICT could serve as a viable alternative for medical facilities and practitioners in Ethiopia. Ethiopian health care providers	Almost all past and current telemedicine projects in Ethiopia were conducted with significant contributions from foreign institutions. Other than having foreign institutions help supply funding to sustain telemedicine projects, Ethiopia could consider formulating joint telemedicine initiatives with	The foreign alliances could also aid in creating awareness about telemedicine initiatives in other parts of the world and the benefits other countries and people have received as a result of telemedicine. Foreign alliances could also facilitate the development of links and relationships between national and international research institutions. The relationships

Table 3 Telemedicine Challenges and Telemedicine Diffusion Factors Matrix

Challenge / Factor	Government Policies	Telecom Costs	Telecom Infrastructure	Human Resources	Sustainability of Projects	Literacy, Language, Culture
	telemedicine.	turn make it telecom more affordable for so that the implementation and use of telemedicine could be more widespread in Ethiopia.		could outsource the management of their telemedicine apps to member institutions of the foreign alliances.	member institutions of the foreign alliances. Not only will this help offset the cost of running the telemedicine projects, but it will also minimize the risk posed to Ethiopia.	could help Ethiopia as it provides a platform for the country to leverage the expertise of nations and institutions that are more developed and experienced in the diffusion of telemedicine.

IMPLICATIONS FOR RESEARCH

Although the purpose of this study is not to establish a theory base to study telemedicine diffusion or use in developing regions, it highlights some pertinent issues that could be further researched within the Ethiopian context as well as other developing countries. We believe it is very relevant and important to extend the social identity of IS research. Since its inception in the 1970s, the IS community has strived very hard to diversify topics that are beneficial to IS and other researchers across the globe (Benbasat and Weber, 1996; Robey, 1996) albeit risking an identity crisis (Benbasat and Zmud, 2003). Our study sets a stage for IS researchers to continue in this diversity by using existing IS theories to examine ICT issues related to Ethiopia. We also contend that previous popular IS theories such as the technology acceptance model (TAM) and innovation diffusion theories can go a long way toward helping to understand how individuals and organizations within these countries adopt and use various technologies.

Development and utilization of a research framework could serve as the basis for field studies in Ethiopia and other selected sub-Saharan African countries. This could lead to further development and subsequent testing of new theoretical models grounded in the IS literature that explain the process of telemedicine diffusion in the context of sub-Saharan Africa. With such an approach, IS researchers could offer important contributions to the academic and scientific community, industry, and government sectors in sub-Saharan Africa and, by extension, other developing countries. Some of the contributions could include:

- Establishing a rigorous, empirically driven theory base for telemedicine diffusion in sub-Saharan Africa. As previously mentioned, no known previous study has examined telemedicine technology within the sub-Saharan Africa context.
- Findings from studies that focus on the sub-Saharan Africa region could be used to hypothesize similar telemedicine and other ICT related issues in the context of other least developed countries (LDCs). In essence, findings from such research may spur IS researchers to explore the ability to generalize these findings across different developing countries with socioeconomic environments similar to those of sub-Saharan African countries.
- Assessing the feasibility of an underdeveloped country outsourcing technical aspects of its telemedicine initiatives to developed countries or other underdeveloped countries that have a high populace of technically competent and savvy people.

IMPLICATIONS FOR PRACTICE

Government policy-makers will have new insights into the effectiveness of various national ICT policies on telemedicine diffusion in their respective countries. This could help these policy makers fine-tune their policies in a bid to encourage telemedicine diffusion in the region. Telemedicine infrastructure providers such as equipment manufacturers and service providers will have empirical findings on which to base organizational practices for both local and multinational organizations. For example, telemedicine equipment manufacturers (mostly based in Europe and North America) can develop systems that fit within the cultural and educational context of specific countries within the sub-Saharan Africa region.

Another implication for practitioners is the need to develop relationships with foreign institutions. Specifically, the findings of our study suggest that government leaders and healthcare providers in Ethiopia need to develop foreign alliances that will also aid in creating awareness about telemedicine initiatives. This awareness could be about telemedicine initiatives in other parts of the world and the benefits other countries and people have reaped as a result of telemedicine. These relationships could help Ethiopia as it provides a platform for the country to leverage the expertise of nations and institutions that are more developed and experienced in the diffusion of telemedicine.

Additionally, telemedicine project stakeholders in Ethiopia should consider partnering with foreign entities (e.g., governments, corporations) to develop joint telemedicine initiatives. Joint telemedicine initiatives can potentially help offset the cost of initiating and sustaining telemedicine projects, and could also reduce the amount risk absorbed by Ethiopia in the event the project is not successful. As a developing nation that is relatively young in the diffusion of ICT, Ethiopia cannot afford to bear the costs of multiple failed telemedicine initiatives alone. Such an event could prove to be catastrophic, especially given the slow place at which policies to make telemedicine more feasible are implemented.

Beyond telemedicine, there are a plethora of major multinational companies (e.g., Microsoft, GM, Exxon-Mobil, UPS, FedEx, DHL, France TeleCom, British Telecom) in the sub-Saharan Africa region. Well-researched studies on the transfer and diffusion of ICTs to this region could benefit these companies and newer companies that intend to have a presence in the region. Relative to telemedicine, Ethiopia could learn from the way these multinational companies have been able to overcome scarce human resources through outsourcing. Foreign alliances with countries and organizations that have a populace of technically competent individuals in the area of telemedicine and ICT could serve as a viable alternative for medical facilities and practitioners in Ethiopia. Ethiopian health care providers could outsource the management of their telemedicine applications and tools to member institutions of the foreign alliances.

VI. CONCLUSION

While telemedicine has made significant contributions to healthcare sector of Ethiopia, several challenges loom large. These challenges include cultural, social, economic, organizational, and technical issues. For example, the few specialists in the country (such as the 38 radiologists serving a population of over 74 million people) are already overwhelmingly occupied with patients requiring diagnosis/treatment. It is, therefore, difficult for these doctors to find the time to learn how to use existing telemedicine technologies. From the authors' field visits in Ethiopia, however, there is a growing number of doctors showing keen interest in making time to learn these technologies. Further, the Ethiopian government has been instrumental in encouraging doctors to use telemedicine for their day-to-day medical practice. In April 2006, the Ethiopian government, in collaboration with the UN's Economic Commission for Africa, held a seminar/workshop to demonstrate telemedicine technologies to doctors from all over the country. Two of the co-authors on this paper were speakers at this conference that brought together hundreds of doctors from different parts of Ethiopia. Therefore, there is undoubtedly a growing interest in learning and using the technologies. Even more interesting is a recent study on doctors' intentions to adopt telemedicine that shows how Ethiopian doctors are showing strong intentions to adopt or to continue to use these technologies (Kifle et al., 2005).

Other challenges to telemedicine diffusion in Ethiopia include: a lack of reliable and affordable telecommunications and electric power infrastructure, high cost of Internet and other infrastructure services, lack of government awareness, practitioner dissatisfaction with low bandwidth, and delayed responses. The Ethiopian government is aggressively attacking the issue of low bandwidth through an ongoing project to lay down a fiber optic backbone for the country's telecommunications links within and outside its national boundaries. The project should be completed by 2008 and will be used for more than just telemedicine. For instance, there are plans for the fiber optic backbone to help establish tele-education and e-government infrastructures.

Despite the aforementioned challenges, it has been shown that many other steps are being taken to combat the vast healthcare problems by adopting telemedicine. We have presented multiple examples of real-life implementations of telemedicine in Ethiopia. The increased availability of personal computers and the Internet, reduced cost of hardware, and powerful, user-friendly tools, has enabled healthcare providers to use telemedicine. With continued support from Ethiopia's government and other key players, telemedicine will one day become a widespread modality in the country. However, we do not claim that telemedicine can solve all of Ethiopia's or sub-Saharan Africa's healthcare problems. While we realize that the current study does not lend itself

to conclusions or predictions about the welfare of telemedicine in Ethiopia that can be generalized, it does, however, raise several issues that warrant further investigation. These issues can be further investigated to understand diffusion of telemedicine in Ethiopia and by extension, to other developing countries with socioeconomic environments similar to those of Ethiopia. As others consider these issues, it is important to note that Ethiopia is resolving the technical issues described in this study at a much faster rate than the organizational and cultural issues.

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EDITOR'S NOTE: The following reference list contains the address of World Wide webpages. Readers, who have the ability to access the web directly from their computer or are reading the paper on the web, can gain direct access to these references. Readers are warned, however, that

1. these links existed as of the date of publication but are not guaranteed to be working thereafter.

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3. the authors of the webpages, not CAIS, are responsible for the accuracy of their content.

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Communications of the Association for Information Systems

ISSN: 1529-3181