An Overview of Potential Factors for Effective Telemedicine Transfer to Sub-Saharan Africa

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Abstract—This paper gives an overview of core factors mitigating effective transfer of TeleMedicine to Sub-Saharan Africa (SSA) as a capability for improving the extremely poor state of healthcare delivery systems in that region of the world. Using specific examples of TeleMedicine applications, such as in TeleRadiology and health education, the paper highlights the importance of TeleMedicine in SSA. It then presents the salient factors that influence TeleMedicine technology transfer in the form of a conceptual framework. In explaining the framework, the paper offers opinions and supportive arguments on the importance and significance of the identified factors in effective TeleMedicine “uptake” within SSA. We believe the framework provides a grounded theoretical basis that information and communications technologies (ICT) or technology transfer researchers can use for empirical investigation in order to understand the efficacy of TeleMedicine adoption within developing countries at large.

Index Terms—TeleMedicine, technology transfer, information and communications technologies (ICT), Sub-Saharan Africa (SSA), developing countries.

I. INTRODUCTION

“...Ever since my eye swelled up, I’ve gone to church three times a week to pray for a cure. As soon as I’m better I’m going back to thank God. I always knew He would send a way to make me better—I just didn’t know that it was going to be from London.” Anna Mobutsu, a 23-year-old farm laborer, cannot imagine taking a journey farther than a few hours’ bus ride from her home in the small town of Nelspruit in South Africa. As an illiterate single parent with a seven-year-old son and an elderly mother to support on R500 (about US$56) a month, Anna does not even have a television to introduce her to a world beyond her own.

“...But this afternoon I went to London. [1]”

Copyright (c) 2007 IEEE. Personal use of this material is permitted. As per WHO, owing to reasons such as poor salaries, ‘brain drain’ and limited training capacity, the situation may get worse (Figure I). We thus need to adopt exceptional measures to tackle these exceptional issues. ICT can contribute to the efforts to overcome these problems through information exchange and telemedicine.
While much has been published on use of ICT-based health service delivery at the individual [6], organizational [7], national [2] and international [8] levels, not much of this has focused on SSA. This paper briefly considers: (a) a number of factors affecting the transfer of TeleMedicine to SSA, and by extension, the transfer of ICTs to the region; and, (b) presents a conceptual framework that includes these factors and proposes further research direction. The paper is organized as follows. Section II outlines the geographical demarcations and economic background of SSA, Section III outlines the TeleMedicine instances in SSA, and Section IV presents the conceptual framework and potential future research propositions. Section V draws the study’s conclusions. We must caution that our arguments, for research and actual transfer of TeleMedicine, do not claim that this technology would solve all of sub-Saharan Africa’s medical problems. This could, however, be a starting point to reach Africans who will otherwise have limited-access to quality healthcare. Therefore, research in this domain could have far-reaching benefits as the world looks to help in resolving this region’s medical problems.

II. SUB-SAHARAN AFRICA: GEOGRAPHICAL DEMARCATION AND BASIC ECONOMIC BACKGROUND

Based on homogenous patterns of development, economically Africa comprises of two regions. One region is mostly north of the Sahara desert and the other, called sub-Saharan Africa, lies south of the Sahara. In the sub-Saharan Africa region, the Republic of South Africa represents an exception: the ‘Apartheid’ policy (1948-1994) led to a dualistic socio-economic environment where the indigenous white population lives as in Europe, but the majority of the black population lives like the rest of sub-Saharan Africa. Because of these diverging socio-economic characteristics, our interest in this study pertains only to the sub-Saharan Africa region excluding the Republic of South Africa. Even though the average condition of living is similar to the one in sub-Saharan Africa, we expect the pattern of technology diffusion in this country to be significantly different from the rest of sub-Saharan Africa.

Table I lists some basic socioeconomic statistics for sub-Saharan Africa. Sub-Saharan African countries have the typical characteristics of any low-income country suffering from enduring constraints against economic growth. In particular, these limitations consist of severe economic, social and political weaknesses. These inherent structural weaknesses explain why sub-Saharan Africa is home to 33 of the 48 least developed countries in the world.

III. TELEMEDICINE INSTANCES WITHIN SUB-SAHARAN AFRICA

TeleMedicine has been identified as a possible solution to some of sub-Saharan Africa’s serious medical problems [2][3]. Although like all ICTs, TeleMedicine also has its roots in the developed countries, it has already tasted success in sub-Saharan Africa [3]:

- In Senegal, three hospitals in Dakar, Fann, St. Louis, and Diourbel, are connected by ISDN, which allows transmission of medical images and other medical information [2].
- Physicians in Ethiopia use TeleMedicine technologies to schedule consultations and referrals, making it unnecessary for ill patients to travel long distances with no guarantee of seeing a physician [2].
- In response to a cholera epidemic in Zambia, the medical librarian at the University of Zambia obtained literature from her “partner library” at the University of Florida, and then disseminated the information to many doctors in the region. Medical libraries have been very helpful to many doctors and medical practitioners in Africa who do not subscribe to medical journals that discuss current issues that could help them in their practices [2].
- Malaria researchers at a remote site in northern Ghana used TeleMedicine technologies to
communicate daily with the London School of Hygiene and Tropical Medicine and the Tropical Disease Research Center in Geneva. The same approach can be used to educate African-based doctors on many other contemporary medical issues such as HIV/AIDS diagnosis, prevention, and treatment [2].

- The Interactive Tele-consultation Network for World Health Care Services (INCAS) project designed by Ente Nazionale Idrocarburi (ENI) provides remote consultations and assistance to African countries. There are linkages between the health center at Pointe Noire in Congo, and Luigi Sacco University Hospital in Milan, Italy. The specialists at Luigi Sacco provide consultations through a clinical management system that enables diagnosis, treatment and follow up for the patients in the Congo [8].

- In 1998, the International Telecommunication Union launched a digital microwave terrestrial and satellite link between the central hospitals in Beira and Maputo in Mozambique (ITU 1998). With PCs equipped with a radiological film digitizer, the TeleRadiology software exchanges and visualizes images and radiographs allowing doctors to easily exchange medical records to aid their diagnoses. TeleRadiology is a sub domain of telemedicine [10].

Although these initial successes are promising, they are relatively small and isolated projects. There is a critical need to better understand the factors affecting the transfer of TeleMedicine in sub-Saharan Africa, a region much overlooked in mainstream information systems research.

IV. CONCEPTUAL FRAMEWORK

Four critical determinants of technology transfer worth considerations for TeleMedicine transfer to SSA are: national ICT policies [11]; ICT implementation factors [9][13]; ICT Infrastructure [14][15]; and cultural differences between the makers and the users of ICT technologies [16][17]. Figure II displays the conceptual framework resulting from these four determinants. A brief explanation of each determinant ensues:

National ICT Policies

National ICT policies primarily dictate how each country utilizes computing in its society [11]. This is particularly important within the SSA context, where governments control most of the ICT infrastructure [2] and uphold relatively stringent policies that influence the acquisition and use of the infrastructures by private organizations. The ongoing privatization of the production of goods and services is one such policy example. In many SSA countries, the government owns and manages the monopolistic telecommunications operator that provides phone lines for Internet, fax, and e-mail access. Government policies in such cases forbid or restrict privately owned ICT services, rendering the services very expensive to users and usually of poor quality because of lack of competition [18]. Therefore, the shape, form and implementation structure of national ICT policies in the various countries could potentially affect the transfer of TeleMedicine. For example:

- Uganda’s e-Health ICT policy is an integral section within the framework of the National ICT policy [20].
- A country might eliminate tariffs and taxes on ICT equipment imported for medical uses, therefore making them cheaper and more easily accessible to practitioners and patients.

Although several African countries have now embarked on reforms, their effectiveness is still hampered by [27]:

- Few regulatory authorities, having little authority.
- Poor institutional linkages
- Depth of experience in regulatory functions
- Disparate institutional/ regulatory frameworks across the continent and within the different regions.

Other policy issues include: encouraging local manufacturing of telemedicine equipment, creating an environment conducive to local and especially foreign investments, establishing inter-country African/Foreign Alliances, and fostering localized maintenance of existing telemedicine resources. Therefore, while leaving it open for further research, we contend that:

- Telemedicine transfer outcomes in Sub-Saharan Africa are influenced by the nature of ICT policies and policy implementation.
  - The better the National policies, institutional linkages and regulatory frameworks pertaining to ICTs, the more favorable the telemedicine transfer outcomes in Sub-Saharan Africa;
  - The greater the efficacy of ICT policy-implementation, the more favorable the telemedicine transfer outcomes in Sub-Saharan Africa.

ICT Infrastructure

Another critical determinant of TeleMedicine transfer is the ICT infrastructure. In order to use TeleMedicine, a country needs a solid ICT infrastructure [15]. With the increasing spread of wireless telecommunications, mobile and ad hoc networks are starting to be available even in developing countries. [21]. Hence a broader perspective needs to be
Internet and email are expensive. Thus, while more research is services may be unaffordable if basic ICT services like of a telemedicine infrastructure, and they are directly Africa the average monthly cost is estimated to be close to US $20, whereas in developing world is approximately three times more costly than in the developed world. Total monthly cost of Internet access in the United States is around US $20, whereas in Africa the average monthly cost is estimated to be close to US $60 [26]. These operational costs form the majority of the cost of a telemedicine infrastructure, and they are directly proportional to the costs of ICT services. Hence, telemedicine services may be unaffordable if basic ICT services like Internet and email are expensive. Thus, while more research is needed to understand this phenomenon, we contend that:

- Telemedicine transfer outcomes in sub-Saharan Africa are influenced by the nature of ICT infrastructure.
  - The better the quality and maintenance of the ICT infrastructure, the more favorable the telemedicine outcomes.
  - The more affordable it is to access the services on the ICT infrastructure, the more favorable the telemedicine outcomes.

TeleMedicine Implementation Factors

TeleMedicine implementation factors constitute another critical determinant of TeleMedicine transfer in sub-Saharan Africa [12][13][18]. The IS literature identifies a number of implementation factors for ICTs in general. These include: user training, project champions, and top management support [10][23]. Traditionally, failure in the successful introduction of an information system is correlated with the pattern of its implementation. According to the International Development Research Center (IDRC) there is a need for further development of ICT training and top management support locally, as opposed to importing training and management from abroad. The IDRC therefore argues that local managers and experts be trained in a manner that they can train other local experts to manage ICT transfer for sustainable long-term purposes. Furthermore, looking at the costs involved, Africa cannot afford to buy telemedicine services from the developed world [26]. Successful Implementation can also be viewed as being the ability of designers to establish a shared and collective mindset about the ICT system to the multiple communities in which the ICT system must function [19]. Hence, in our opinion, culture-specific beliefs and values also influence the process of implementation. Therefore, to further understand the uniqueness of the implementation issues relating to Telemedicine, we contend that:

- Implementation Factors that foster localization of telemedicine expertise, such as recruitment, training, and empowerment of local experts will yield favorable TeleMedicine transfer outcomes in Sub-Saharan Africa
- Implementation Factors that encourage dependence on foreign expatriates and resources will diminish telemedicine transfer outcomes in Sub-Saharan Africa

Culture

Culture, the fourth critical determinant of TeleMedicine transfer in SSA, is a complex notion usually assessed in terms of multiple dimensions. Designers of a telemedicine system must be aware of existing patterns of culture and the likely effect the introduction of new technology will have if they wish to succeed [25]. A major contributing factor is the failure of designers to facilitate the interaction of incompatible cultural subsystems that prevent the transfer of knowledge from one cultural context to another [25]. For instance, the SSA region is notable for its incredible language diversity. For example, Cameroon, an SSA country with only a population of 14 million has 279 distinct languages, Nigeria has 515, and Ghana has 79. It would therefore be unreasonable to generalize the countries as homogenous when studying cultural factors about the SSA region. Although we have not identified literature that studies the impact of cultural factors specifically pertaining to TeleMedicine, there has been notable research examining the cultural dimensions of technology and their impact on ICT transfer in general. The beliefs and values ingrained in people by their cultural context significantly affect their ways of thinking and their perspective and, therefore, their approach to technology use [17]. The Culture construct has two sub-con structs: (a) Culture-specific Beliefs and Values – which represent specific beliefs or values that a person might hold because of the influence of their cultural background, and; (b) Technology Culturation - which represents a person’s exposure to a relatively technology-intensive culture [17]. In the context of studies of ICT diffusion in developing countries, this could indicate the degree to which a citizen of a developing country has been exposed to more technologically advanced cultures [13]. In the context of sub-Saharan Africa, we contend the following:

- Culture-Specific Beliefs and Values consistent with TeleMedicine practice in technologically advanced nations will yield favorable TeleMedicine transfer outcomes in sub-Saharan Africa;
- Technology Culturation of citizens will yield favorable TeleMedicine transfer outcomes in sub-Saharan Africa;
- Culture-Specific Beliefs and Values consistent with TeleMedicine practice in the countries where these practices have been created will improve the favorable effect of TeleMedicine Implementation factors on TeleMedicine transfer outcomes in sub-Saharan Africa;
• Technology Culturation of citizens will enhance the favorable effect of TeleMedicine Implementation factors on TeleMedicine transfer outcomes in sub-Saharan Africa.

In summary, looking at our conceptual model (Figure II), the primary issue of concern is TeleMedicine Transfer Outcomes, indicating the actual transfer of TeleMedicine. The model has four factors that we postulate directly affect TeleMedicine Transfer Outcomes. National ICT Policies reflect the aspirations of government policy makers to prioritize ICT for national development. It reflects both general ICT policies and those specific to TeleMedicine. ICT Infrastructure is the computer, telephone, wireless, and telecommunications infrastructure in a country that improves data communications. We posit that both National ICT Policies and ICT Infrastructure have a direct effect on TeleMedicine Transfer Outcomes, and that National ICT Policies also have a direct effect on ICT Infrastructure. TeleMedicine Implementation factors refer to a set of antecedents, such as training and management support. This set of factors determines the effectiveness of the process of ICT transfer. Culture, on the other hand, affects TeleMedicine transfer directly. We posit that culture may also have some moderating effects on how TeleMedicine implementation factors impact TeleMedicine outcomes. It should be noted here that the framework above is neither an indication of a process model nor any specific level of analysis. Some of these factors can be examined at both the national and individual level of analysis.

V. CONCLUSIONS

This paper shows that steps are being taken to combat the many medical problems of the continent through the adoption of Telemedicine. We further believe that the transfer of Telemedicine and research on this transfer is feasible for the SSA region. Therefore, it warrants the attention of TeleMedicine in Europe, North America, and Japan. Almost all the African-based Telemedicine projects have partners and alliances with these developed regions.

• There is substantial experience and expertise regarding Telemedicine in Europe, North America, and Japan. Almost all the African-based Telemedicine projects have partners and alliances with these developed regions.

• Health care already consumes a large portion of national budgets.

• Telecommunications access in terms of teledensity (needed for Internet access) is on an upward trend in most African countries. Recent reports indicate that the sub-Saharan African region has become one of the world’s biggest birthing grounds for the wireless telephone industry. Researchers expect African mobile subscribers to grow 22%, from 113.55 million in 2005 to 378.62 million by 2011 [22]. The rate of growth for the entire continent has been more than 82% a year, much faster than the 33% growth rate in the Americas.

• The Internet is making inroads into Africa. In the mid-1990s only 12 countries in Africa had Internet access. It is now available, at least in the capital cities, of all 54 African countries.

• Some global satellite networks, such as those provided by HealthNet, Inmarsat, and Intelsat are used for the delivery of TeleMedicine services to remote and rural areas.

• Most African countries are members of global satellite organizations and RASCOM, and have in place earth stations, which could be used for such delivery. Past research shows that such African-foreign alliances provide the opportunity for African countries to improve on their telecommunications infrastructure, including that needed for the adoption of TeleMedicine [18].

• Email, heavily used in the practice of TeleMedicine, has many benefits for poor countries: it is cheap, hardware and software requirements are simple, and the information transmission could be in store and forward mode.

As we earlier cautioned, we do not claim that TeleMedicine (or research thereof) can solve all SSA medical problems. However, we do contend that research on the transfer and widespread use of TeleMedicine is a starting point to reach Africans that live in areas with limited medical facilities and personnel. Hence, IS research with a focus on the SSA region could have far-reaching positive outcomes as the world looks to help this region’s medical and other socio-economic problems with a long term goal of sustainable development of this often “forgotten” region of the world.

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