

Development of Health and Education resources: Viability study for the use of Wireless Communications in Dessie, Ethiopia.

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Abstract

This study focuses on the viability to use wireless communication technologies in developing countries to improve health and education resources. It takes into account both the technical and the social aspects of this type of information networks. With regards to the technical requirements, the environmental conditions of Dessie (Ethiopia), the geographical distribution of the main public Health Centers and Schools, and the current communication infrastructure used have all been taken into account. Furthermore, the social repercussion of introducing wireless technology has been examined by interviewing local administrations and centers involved in health and education, and also by evaluating their general knowledge of information technologies.

The conclusions obtained show a lack of importance given to information technologies in developing countries, mainly because of the insufficient capital invested by the Government for education and health development. The presence of computers is limited, and they are only used for typography tasks; moreover, the knowledge of computing and basic user tools is very low and restricted to few people. According to this, the technology used to upgrade health and education resources must be assimilated by the local people, thus stimulating their own research on how these information technologies can contribute to the development of the country.

1. Introduction

Internet has become one of the most useful sources of information in the last years, and the wide range of possibilities that it can provide in terms of communication networks are endless, hence its importance in the health and education fields. However, one of the main difficulties found in developing countries is that basic needs are not totally covered, and communication infrastructure investment shifts to the background. For this reason, the concept of information

and communication technologies (ICT) has not been developed enough to be taken as an efficient means to improve health and education resources. The existing communication infrastructure is not prepared for broadband connection and it is not accessible to everyone, which means that the knowledge of Internet's sources of information is very low.

There is a single company in Ethiopia that offers telecommunication services, which is the state-owned Ethiopian Telecommunication Corporation (ETC), and all communication services are regulated by the Ethiopian Telecommunication Agency (ETA), both belonging to the Ministry of Transport and Communications. Recent studies about information and communication technologies have shown an important lack of infrastructure and development in this area. To illustrate this, in 2007 there were only 1.1 fixed telephone lines, 1.5 mobile cellular subscriptions and 0.4 Internet users per 100 inhabitants, and the average International Internet bandwidth per user was below 1kbit/s [1]. Therefore, it can be stated that Ethiopia is at the very early stage in ICT, and the major indicators are: the low level of skilled human resources related to ICT, the poor network infrastructure, the limited awareness on the role and potential of ICT, the undeveloped private sector and the legal and regulatory constraints [2].

In order to develop ICT, the Government has designed the ICT-Assisted Development Project, executed by the Ethiopian Information and Communication Technology Development Agency (ICTDA), within Ethiopia's *Public Sector Capacity Building Program* (PSCAP). Some of the on-going initiatives are the *School Net* (educational programs through plasma televisions for high schools), the *Woreda Net* (voice and data exchange), and the *Agri Net* (connection among agricultural institutions) [3]. However, the general economic constraints of the country are a handicap that may hinder the systematic evolution of the ICT.

The purpose of this study is to provide an accurate view of the current state of the information technologies in a concrete area (Dessie, Ethiopia), in order to discuss

about the viability to introduce low-cost technologies such as Wireless Local Area Network (Wireless LAN) communications to improve health and education resources. The objective is to create internal networks to share documents and useful information freely, both in medical and educational areas. Furthermore, these networks should be updated with any information requested using only a few Internet connections. This project would be feasible only if local administrations provided support to find out the best way to engage it in a long-lasting and useful manner. In fact, the only way to achieve success is by cooperating with the staff of local Health Centers and Schools, because they are both the final beneficiaries and responsible for the maintenance and usage of this technology.

2. Wireless technology in developing countries

Wireless communications are interesting to be taken into account not only because of their low cost, but also for the simplicity to set up and to manage. It is possible to set up connections without any additional wire, thus giving basic communication services such as data transference or phone connections. These services will be very helpful in health and medical tasks, like patient epidemiological control, communication between different health departments, as well as urgent moving of patients. In addition, schools could also be a part of this network in order to share information or to receive first aid assistance from those departments. As it can be seen, the implementation of this technology is interesting for educational reasons, since it is a way to improve the knowledge of communication technologies between young people.

Regarding the medical aspect of these applications, several studies have been made in South-America about the impact of the use of communication technologies for rural sanitary staff members. The results show not only an enhancement of medical services, such as distant support consultations, epidemiological vigilance or patient transportation coordination, but also a great acceptability by agents involved, like health managers and administrators, as well as users [4]. Nonetheless, it cannot be forgotten that this applications must be suitable for the beneficiaries, and it must have an established use, to avoid having a technological solution without a real problem to solve.

On the technical side, this technology improves communications between distant points without any additional infrastructure between them, so reducing the cost. Although the IEEE 802.11 wireless protocol was initially designed for local area networks, some studies have shown that, with certain distance limitations, it may be useful to deploy wide area networks at isolated regions in developing countries due to its flexibility and performance [5]. Related to this we can find different technologies, but the most common are Wi-Fi and

WiMAX. The second one gives a significant advantage because of the possibility to provide quality non line-of-sight (NLOS) coverage [6], in contrast with Wi-Fi products, but it is more expensive.

The basic parts needed in each point to communicate are the following: the antenna, to transmit the signal through the air; the wireless station, which prepares the information to be sent and received, and it also offers the possibility to implement phone connection, with the Voice over IP protocol (VoIP); and finally the computer, that gives access to the final user. In Figure 1, we can see one possible implementation extracted from the Spanish EHAS Foundation (Health Hispanic-American Link) project in Peru, together with the Rural Telecommunication Group within the Pontific Catholic University of Peru (GTR – PUCP) [7]:

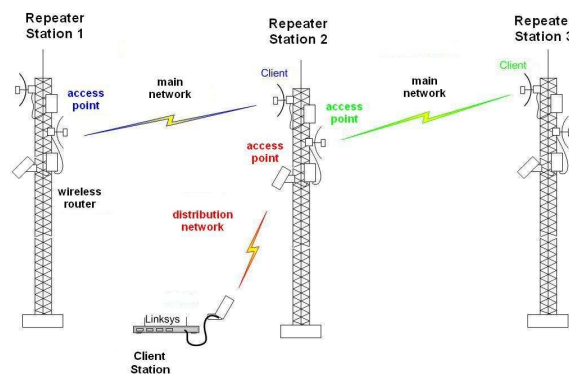


Figure 1. Basic wireless network implementation

3. Methods

The introduction of information technologies in developing countries must be planned carefully, in order to prevent results that are against the primary objectives of the project. The reason that many implementations have failed was because of the carelessness in the examination of the real needs, thus giving more importance to the technology used [8]. Given that, the real aim is to investigate how wireless technology can afford developing countries the opportunity to enhance their resources on health and education.

The analysis of the viability to introduce wireless communication networks in a developing country has two main aspects. First, there are the technical requirements to place the wireless network in an appropriate environment, where it can receive the required maintenance and parts supply. Besides, the services offered by this network must correspond with the needs of the users, and also giving a quality of service. Second, the social aspects must be considered to ensure that this technology will be useful and

adequate to be handled by local people. Moreover, the local administration must agree with the implantation of this technology and they must give their support so that it can be developed continuously.

A. Technical requirements

In order to collect data to evaluate the technical viability, the following classification has been made, with the corresponding methodology for each part:

1) *Environmental conditions:* Wireless technology has the advantage of being easy to install, because it does not require any wired infrastructure. However, it is preferable to have line-of-sight (LOS) between the points to communicate, in order to obtain high speed and quality links, depending on the technology used. Given that, a deep recognition of the terrain must be done; e.g., presence of obstacles (vegetation, hills or buildings), ground configuration of the whole area to be connected (flat land, valleys, mountains...), maximum distance to be covered, power supply conditions and availability to place the antennas. Apart from this, not only the physical conditions must be considered, but also the electromagnetic ones. Therefore, the frequency spectrum must be free from interferences at the frequencies used in wireless technology, taking into account the existent wireless devices like mobile phones or radios.

2) *Geographical distribution of Health Centers and Schools:* Once the environmental conditions have been clearly reported, the next step is to check the visibility among all the buildings that are going to be connected to the wireless network. The distribution of the centers will give the information to decide which topology of network is going to be used. There are different types of topologies depending on the situation of the points: star (one main Access Point that gives services to all Clients), ring (all points connected forming a circle), mesh (all points can act as Access Point or Client), or hierarchical among others.

3) *Available technology:* Another point to consider is the availability of the material needed for the network implementation and its maintenance. Although some specific wireless devices could be imported, it must be confirmed that there are common spare parts available near the placement of the network, for instance, network cables for internal connections, computer equipment and accessories, antennas, or basic electric tools.

B. Social aspects

Regarding the social part of this study, it is possible to specify different points to examine and the correct procedure to arrange the project. In fact, it is essential to emphasize the analysis of the impact of information technologies in the population, since it is the main

indicator of the success of the project. Unless local people feel comfortable with the new advances and the equipment used for this purpose, the effort will not be worth the cost [8].

1) *Human resources:* The local beneficiaries of the project will also have to take care of the installation and its maintenance, not only to keep the network operative but also to carry out future adjustments. So, apart from the technology transference, it is necessary to make knowledge transference depending on the competences of local people in this technology. For that reason, it is necessary to detail the technical aptitudes of the staff in the Health Centers and Schools regarding computing, telecommunication and information technologies. Through specific interviews, all that data must be gathered for a proper planning of the intervention.

2) *Local support:* As exposed previously, it is compulsory to have the support of local administrations, because they will have to appoint the responsible for taking care of the equipment. Owing to this, there is a need for what is called the *counterparty*, which is the local party that is in charge of this task, formed only by local people. This group will work together with the contributors or providers of the wireless technology, to find out the procedure to introduce these advances properly. So one of the tasks of the viability study is to find this *counterparty* and make an agreement to cooperate and give support to the project.

3) *Telecommunication authorities:* According to the legal context of the project, some permission must be obtained in order to install the wireless technology. The corresponding authorities must be informed about the purpose of the project, the technical advantages that it means, the financial report of the implementation, the social repercussions, and so on. There must be a meeting with all the stakeholders to discuss about the engagement of the network and to clarify any doubts about it. To summarize, all the parts must agree with the project and the Telecommunication Authorities must give clearance to go ahead with it.

4. Results

After putting into practice all the steps previously described to study the viability to use Wireless LAN in Dessie, there have been obtained some results to answer the questions raised initially. Nevertheless, due to the legal restrictions by the Ethiopian authorities, it was not possible to make any wireless implementation tests. Owing to this, the technical aspects have been examined only by thorough field observations, and it could not be provided any specific data results for network connection characteristics, such as link quality, reliability, reachable points or bit rates, among others.

So the results are simply taken by the analysis of the different aspects of the implantation.

A. Infrastructure information

This city, which is roughly 300 km far from the capital (Addis Ababa), has an average population of 170,000 inhabitants. There can be found several Governmental buildings related to health and education: three Health Centers, one Hospital, twenty six Elementary Schools, five Secondary Schools and two Preparatory Schools (to prepare students for the University). Additionally, there is one University Campus, the Wollo University. All telecommunication services are given by a single Governmental company, which is the ETC, and these services are basically fixed telephone line, mobile phone services, public phone stations and Dial-Up Internet connection (56kbps). There are other emerging Internet broadband services (up to 2Mbps) which are restricted to public purpose only, but their use is not developed enough to be affordable for most of the education and health centers. In the last years, the ETC has built a few communication towers, and they are planning to introduce Fiber Optics, but this project is still developing. As shown in the Figure 2, that is the radio electrical spectrum of Ethiopia above 100 MHz, it can be seen that frequencies belonging to the International Telecommunication Union's (ITU) Industrial Scientific and Medical band (ISM) from 5.725 MHz to 5 875 MHz [9] are not allocated, so they could be used for wireless communications.

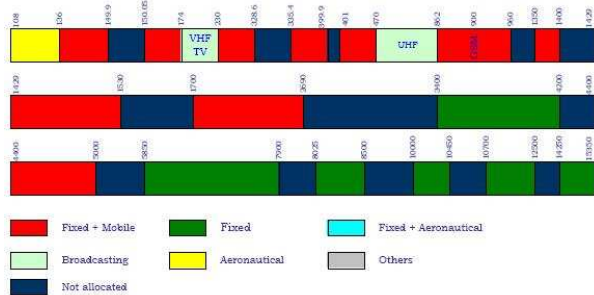


Figure 2. Ethiopian Frequency Allocation

The power supply infrastructure is divided into four areas; they are interconnected in pairs, so each pair is provided with electricity on alternative days during the first months of the wet season (July – August), and every day during the rest of the year, although that depends on the rain, because all the power supply comes from hydroelectric plants.

B. Global results

Through different interviews and visits to the several health and education centers, it can be concluded that there is a major absence of knowledge and usage of the

information technologies. After examining the current technology used in the different centers to manage the information, it has been found that few computers are used for this purpose, almost all the communications are carried out by telephone, and all the documents are delivered by hardcopy. Another widespread problem is the power supply, because electricity is not provided to the entire city. With this limitation it is not possible to guarantee a continued communication among all the centers connected to the network, and a solution to this issue is still to be found. The following classification describes the results of the different centers.

1) *Health Centers and Hospitals:* In those centers there are, at most, three or four computers, which are not connected to each other, and they are only used for typography tasks by the secretaries. The knowledge of informatics is reduced to word processors or even spreadsheets in some cases. All the information about the patients is in hardcopy and there is no transference of information among centers when patients move from one to another. Moreover, there is no exchange of information about endemic diseases or documentation of any kind between the centers, only periodical reports by hardcopy to the City Health Office, with numbers of patients treated and financial reports. There is no Internet connection in the majority of the centers, except one Dial Up connection in some director's office, but it is not always operative. Concerning the visibility, some of the centers have line-of-sight and could be easily connected by wireless communications, but some others could not (because of the terrain and vegetation) unless the ETC towers were used to place some repeater antennas.

2) *Schools:* In Elementary Schools, usually there is no more than one computer, which is used by the secretary for typography tasks. Nevertheless, in the two Preparatory Schools an Informatics Classroom can be found, with at least 20 computers for the students, and two or three ICT teachers. With the ICT subject, the students learn basic user computer tools, such as word processor, spreadsheets, folder management and Internet access in some cases, but this subjects are not studied in depth. In addition, these two schools belong to a program that provides satellite access to education channels, used in classrooms with plasma televisions (*School Net*, [3]), but they only have one Internet Dial Up connection for the Informatics classroom. As well as the Health Centers, some of the schools have line-of-sight and could also be easily connected by wireless communications, but some others would need ETC towers to be used.

3) *The Wollo University:* The Campus of this University is in the outskirts of Dessie but it has an ICT department and a Broadband Internet connection. They are planning to connect to the Internet by Fiber Optics, so a high-speed connection could be feasible in a near

future. The Campus has been recently built, so all the facilities are rather new, with computer laboratories, internal network infrastructure, and a public library. The ICT teachers are highly qualified and they should be able to carry out a Wireless LAN communication project and to handle its installation and maintenance, thanks to their knowledge of this subject.

C. Authorities

Many interviews and visits have been made with the different local administrations, centers and telecommunication authorities. Although there has not been any obstacle from the health and education centers, the ETC has established some legal steps to implement this kind of wireless communication networks. On account of the interference that it may cause to the existent mobile phone communications, this wireless technology must be approved by the Telecommunication Agency in Addis Ababa. This Governmental organization is responsible for all the regulations concerning telecommunication infrastructures and projects, so it is compulsory to have the permission from this authority. Once the project is submitted by the Dessie ETC Branch, with the support of all the local administrations and centers involved, it must be approved by the Telecommunication Agency, and then the project could be engaged.

5. Discussion

After analyzing the results obtained, it is possible to answer some questions about the viability of this project, both for the technical and for the social part. Despite the fact that this information networks will certainly contribute to the development of health and education resources, the way to introduce them in developing countries is not obvious and must be planned carefully. The reason is that this technology must be suitable for local people to be managed and to be developed on their own, once it is running. Besides, although everyone agrees with the project, bureaucratic red tape is commonplace in developing countries, also if we are talking about information sources, so everything must be considered before any intervention.

The technical requirements are not a handicap, because many solutions can be found to implement wireless links, either in a LOS or NLOS environment. However, it is necessary to have the permission to use the ETC towers for an optimum network deployment. About the informatics resources, more computers have to be placed in the different centers, and they must be interconnected before being connected to other centers. These networks must grow from inside first, organizing the information within each center, and then sharing it to outside. Last but not least, the power supply shortage may involve some risk of malfunctioning of the system, so it is necessary to find out alternative power supplies

such as solar cells; otherwise, it will not be possible to have a continuous communication service, despite the increase of the cost. The future research in this aspect must be focused on how to minimize the cost of alternative power supply, and how to obtain major investments on ICT material for health centers and schools.

On the social part, there is a good attitude and the willingness to work together in this project, but some knowledge aspects about information technologies must be considered. Local people are not used to digitalize information and to share it with the community. Given that, there is a need to make them understand the advantages of information networks, and lead them to investigate by themselves how this technology could help in the education and health areas. Apart from the wireless equipment, some software must be offered to contribute to the assimilation of these networks, and further investigations must be done on software health utilities to facilitate local users the to be used to information technologies. For instance, some open source programs could be developed with mailing options, upload and download of documents, chat-room, and so on. All this software must have a clear interface and must be easy to install and configure. Some example of this are the *Care2x Integrated Healthcare Environment* [10], or the EHAS interface developed for health centers [11]. Then, with some specific training to local people, they could manage all the computers attached to the network, and also they could also teach others how to use these information resources. The Wollo University is one of the best targets to take as the mentioned *counterparty*, not only because of the presence of qualified teachers in terms of telecommunication and informatics, but also for the capacity to develop and engage this ICT project in Dessie. Moreover, due to the legal constraints of the Ethiopian laws about telecommunication, it is very difficult for a foreign NGO to implement this kind of projects unless many bureaucratic arrangements are done [12].

To summarize, the viability of the Wireless LAN communication project depends on the support of local administrations and health and education centers, the telecommunication authorities and the support of the ETC, to help for the deployment of the network. Provided all this support, the project will represent an important enhancement of health and education resources, thus contributing to the development of the country and the improvement of the services given to the population. However, there must be major investigations on software development to contribute to local development of information technologies, and there must be a change in Ethiopian regulations about telecommunication implementation: the liberalization of communication market together with an increasing tolerance for foreign interventions in terms of

information technologies will lead to a better development of ICT.

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