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DEVELOPMENT OF E-HEALTH APPLICATION FOR RURAL COMMUNITY OF BANGLADESH

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ABSTRACT

Bangladesh is a developing country. In developing countries, there is a digital divide between rural and urban areas. We need to provide locally relevant ICT services to overcome these divisions. Traditional software development methods are not suitable for developing the software of rural areas because they cannot serve the unique needs and complexities of such areas. I have tried to find the most appropriate way to engineer suitable software applications for rural communities of Bangladesh. I have developed a methodological framework for creating software applications for rural community. Socially structured computing framework to create software applications using the principle of action research and participative Design Guide as the best practices that helped me address all the problems that affect the success of the application. On the validity of the framework, I show that by using it to create Telemedicine Communicator (TC). TC is a prototype system for remote consultations in health for rural communities. It allows for communication between a small hospital in a village and a bigger hospital in neighboring village. It uses Voice over Internet Protocol (VoIP) combined with a store and forward approach to communications. TC can be tested over a Wireless Fidelity (wireless) network as well. Within social consciousness, it is suitable for the local development of relevant applications for rural areas of Bangladesh. I found that TC is an improvement of the solution of telemedicine in the community of destiny. Using this approach also led to a lot of knowledge about best practices for ICT development projects. I am also proposing that VoIP and Wi-Fi technology is relevant to rural areas and that the liberalization of telecommunications in Bangladesh is still needed to promote technological development in rural and underserviced areas.

Keywords: *Digital Divide, Rural Community Of Bangladesh, Socially Structured Computing Framework, Telemedicine Communicator, Voip, Wi-Fi, Store And Forward Approach.*

1. INTRODUCTION

Digital divide between urban and rural areas are growing in developing countries. This distribution means the difference between those who receive the information and communication technology (ICT) and who have no access to ICT enabling technologies, such as the Internet. We know that access to information allows individuals and allows for better health, education and public services. It is therefore important that the gap should be reduced for growth, so that more and more people can get better information.

This article focuses on appropriate methods to engineer suitable ICT applications in communities up and down in rural Bangladesh. On loan from a user-oriented methodology and present lessons learned from previous initiatives, ICT development, which extended the standard software development life cycle to produce a cadre of socially conscious computing framework.

This intensification integrated an understanding of the social context of software into the software engineering process. It also added a research constituent to the software engineering process so that I could learn both from the application developed and the process itself.

In addition, I have developed the methodological framework for the creation of ICT application for rural communities in Bangladesh. Finally, from my experience in Bangladesh, I have formulated views on the limits of the law made in the

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telecommunications software development and widespread use of ICT in underserviced areas of our country.

2. SOCIALLY AWARE COMPUTING FRAMEWORK

To meet its goal, I extended the normal life cycle of software development. I found the traditional software development practices lacked awareness of the social context of the software. In addition, I felt that these approaches tend to be “top-down approach”. In other words, usually as an expert, I got the software specifications. This approach will not work in rural areas, if I want to deal with the real needs of community. Instead, the “bottom-up approach” is needed based on the requirements for the goals.

To address this gap in the traditional software development model and adapt it for use in rural areas of Bangladesh I looked for existing user centered methodology. I used the principles of action research (AR) and participatory design (PD), a project framework for the process. AR is a methodology aimed at resolving the target group of people, involve them in the process and use their expertise in their work area [1]. Its aim is to empower groups by creating an appropriate solution to their problems and advantages of both participants and researchers in this process. I got the steps I had to look at the local software engineering applications. It describes the process could be used to access the Community objectives and instructions on how to work with the community to determine problem areas and provide solutions to this problem.

PD has developed initiatives to increase employment in the industrial environment [2]. PD specifies techniques to increase user involvement in software development life cycle. This may act as a software solution for those who work for improvement. I developed software prototypes to meet users' needs to make sure that I can use the guidelines of PD including discussion groups and paper prototyping.

Also, I used the principles of previous ICT for development projects in a Real Access / Real impact (RA / RI) framework for software that is best in this work [3]. RA / RI is a guiding principles to formulate an overview of initiatives in ICT development worldwide. Designed by RA / RI in my process helped ensure that I ignore any aspects of applications that could affect its success. With all existing methodologies and guidelines in mind, consisting of cyclic approach to software development in rural and underserviced areas in Bangladesh. It gave me the opportunity to follow a flexible software development process prototype and contributing for rural communities, adding social and research aspects of the life cycle of software development.

3. OVERCOMING THE DIGITAL DIVIDE IN BANGLADESH

Earlier I presented the problems associated with the development to suit the conditions of software solutions for rural and underserviced areas. I also explained the purpose of the system. Here I am presenting background information on development efforts to use information and communication technologies (ICTs) to combat poverty. Furthermore, I show the need for locally relevant applications in these initiatives. First, I will explain the role of ICT for raising underserviced communities worldwide.

I then briefly describe the unique challenges of rural areas to the examples of initiatives in ICT development worldwide and in particular telemedicine worldwide. Next, I illustrate with examples, how development initiatives in Bangladesh were trying to use ICT for the empowerment of communities and isolated as it is often used in the implementation of these initiatives led to the failure of the application. To view multiple global studies, I present the factors that have the greatest impact on the success of the ICT development.

Finally, I outline the way forward in terms of how ICT can be used to improve disadvantaged communities. Specifically, I propose to approach the use of ICT as a tool for poverty reduction, I recall that the technology relevant to rural areas and, finally, a comment on how the regulatory framework should support the use of ICT in these communities.

4. DIGITAL DIVIDES AND DEVELOPING COUNTRIES

Digital divide is defined as the gap between information rich and information poor. This means that there is division among the people access to ICT and those without such an approach. ICT is defined by the World Bank as "hardware, software, networks for collecting, storing, processing, transmission and display of

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information (voice, data, text, images) [4]. These tools, which can be used to empower people, primarily by providing them access to information. To illustrate this, consider the rural farmers by mobile phone that allows him access to market information of agricultural crops that he wants to sell. This information allows him to price their products to market trends and ensure maximum return on their products, as shown in Figure 1 can be considered at the benefits of farmers without such information or technology, to obtain such information. The last farmer to rely on traders for their market information and cannot check prices in line with current market trends. He is unable to make calculated decisions on which markets to provide to sell his products at attractive price [5].

Figure 1 in last page indicates One application of ICTs is to enable rural farmers to gain access to market information through use of devices such as cellular telephones. They can then utilize this information to decide when and where to sell their crops as well as how to price the goods in order to turn a profit.

There are digital divide between developed and developing countries far behind in terms of infrastructure and resources. In fact, it excludes them from the global exchange of technological information. In developing countries there is a gap between urban and rural areas, and this division is the main focus. To overcome this internal division, access to ICTs should be provided in isolated rural and urban areas underserviced [6, 7].

A. Poverty Alleviation using ICT

World Bank Group and the Canadian International Research Center (IDRC) believe that ICT can be used for poverty alleviation and sustainable development [8, 9]. ICT provides quick access and allow dissemination of information. They also open new opportunities for this work. Some pointed to the benefits of ICT: improving market efficiency, improve the social and economic integration, especially for people in remote areas and the improvement of political activity. ICT can be used for education and health [10, 11].

Navas-Sabater et al. [12] developed from the fact that ICTs contribute to the integration of isolated communities in the global economy and assist in providing better public services. Indeed, they are a way of expressing the poor, allowing these communities to influence policy-making. With ICT, economically disadvantaged have the opportunity to participate in government's decisions.

In rural areas, using ICT to combat poverty is difficult due to unique conditions that exist in these areas.

In rural areas, introduction of ICT is needed to fight poverty affecting general conditions of these regions. For example, these regions suffer from lack or absence of public facility, such as reliable electricity, access roads and water, as shown [13, 14].

There are shortages of technical personnel in these areas, which have implications for maintenance and repair of technical problems with equipment installed in these areas. Moreover, these types of areas can have severe topological conditions, and this makes the leading Infrastructure expensive and sometimes impossible. Furthermore, climatic conditions are common in rural areas may place demands on the equipment installed in these areas. For example, the constant tripping and restoration of the electricity supply can damage computer equipment although this may be reduced by use of a Uninterrupted Power Supply (UPS) device; essentially a backup power supply.

Moreover, in rural areas, have low per capita income and low economic activity and low population density. Ties in these areas are crucial, but often there are very few phones in those areas with high rates of call on the phone. There is a need to have a basic level of education and training in ICT to achieve success in these areas. Most important, relevant content is critical to the success of any rural application. Possible areas of software technology, enhancing rural communities can be multimedia applications of telemedicine, education and government programs, and applications of electronic commerce.

B. Development Initiatives Using ICT in Developing Countries

There have been many initiatives to develop ICT use in underserviced areas. First example of ICT development initiatives can be mentioned in India. Indeed, India has many development projects that use technology to increase poverty areas. In Gujarat, many milk collection centers have a computer. Traditionally, the number and quality of milk was measured manually, and this led to a delay would mean farmers could collect payments only after 10 days of delivery. With the computerization process, farmers are confident that their products are properly valued and they

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can get paid immediately. Further examples of how to improve public service delivery, delivery of health and provision of microfinance in rural India are given in [15, 16].

Another event, the initiative demonstrates the potential of ICT Satellite carried out in Ghana, Kenya and Uganda [17]. This project provides medical staff with personal digital assistants (PDA) or laptop computers for field research. In addition, medical reference manual loaded with PDA, in order to provide health professionals with easy access to this information. The project was successful in reducing the time for field research using the device and improving the whole process of treatment research.

In this study, it is illustrated the various initiatives undertaken in the world. In studies reviewed, it is evident that, although it is considered a tool for strengthening ICT underserviced communities, there is no overall strategy by the board on how to successfully use them in economically disadvantaged areas. In addition, most studies do not contain any monitoring and evaluation methods, so it's hard to project a real success.

C. Telemedicine Case Studies

Houston and Houston [18] defines telemedicine as the use of telecommunication technologies and interactive media to provide health information and services over long distances. Telemedicine can be used for remote diagnosis and treatment of patients in real time consultation and continuing medical education for health workers. Applications and technologies used in telemedicine vary. Tuluá et al. [19] applied their classification in the field of telemedicine in the number of telemedicine projects and describe the cases of telemedicine using video conferencing, audio, data exchange, store and forward technology and Web systems. Infrastructure for telemedicine and differs from satellite communications, wireless communications for fixed lines. Typically, most telemedicine forma have used synchronous / real-time communications and asynchronous / store and forward communication, not both.

Bangladesh is a country of inequitable distribution of resources. About 70% of total population live in rural areas whereas 75% of total qualified physician are practicing in urban areas. Many of the patients come from remote places to metropolitan and divisional cities to get the medical services. Also hundreds of physicians go to remote places to provide service once in a week in district and sub district private health centers, rest of the days patients wait for their physicians for the next visit after 1 week. There are no specialist physicians in most of the districts and sub district levels in Bangladesh. Also almost all patient come to doctors without any previous health record. Roads and Highways are under developed where as well covered by Telecom network and rapidly growing. People need better, modernized medical services. Hence being a potential place, it is a crying need for Bangladesh to adopt e-health and telemedicine services and thus overall health services can be improved magically.

D. Bangladesh Society for Telemedicine and eHealth (BSTeH)

A group of responsible physicians, telecom and Information and Communication (ICT) specialist and eminent persons have come together and formed a common platform named Bangladesh Society for Telemedicine & eHealth (BSTeH). BSTeH's purpose is to promote E-Health, telemedicine and associated fields including research, development, practical applications and initial and supplementary training.

BSTeH Observed some research works about the health sector and acceptability of telemedicine and E-Health facilities in Bangladesh and other developing countries of several research organizations and expert individuals.

E. Telemedicine & E-Health Service Providers

1. GrameenPhone Ltd, Bangladesh.
2. AnovaTech Ltd, Bangladesh
3. Medinova Medical Services
4. Concept Hospital, Feni
5. Moon Hospital, Concept Hospital
6. Chevron Clinical Laboratory
7. Sitakund X-ray and Pathology
8. Telemedicine Reference Company Limited
9. Global Telemedicine Company

Recently these organizations are working on telemedicine and e-health by following some prospective manner to establish the facilities in Bangladesh. The telemedicine service providers are providing the following services:

- providing commercial services
- digital data store & forward
- medical video-conferencing
- Follow up cares

Benefits Obtained

- Cost effective

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  - Travel & accommodation
  - Investigation & Consultancy
- Family care & environment retained for the patient
- Prompt specialized opinion served to the remote & isolated areas
- Remote physician does not feel helpless
- Faculty development of the physicians

The case study illustrates how technology can be used for telemedicine in the developing world context. In the case, information is transmitted between two sites in order to assist with diagnosis, consultations and training. Information can include but is not restricted to images, text and verbal messages. In my research, I discovered that a simple telemedicine solution which also required the transmission of information between two sites are required.

F. ICT Development Strategies In Bangladesh

To fight poverty and improve the country's economic standing, the government has declared ICT as a "thrust" sector and a tool to facilitate the process of establishing good governance. Through its National ICT Policy (2002), Bangladesh aimed to work towards building an ICT-driven nation comprising of a knowledge-based society by 2006, with emphasis given to building a country-wide ICT infrastructure to be used for "human resources development, governance, e-commerce, banking, public utility services and various on-line ICT-enabled services."

In May 2008, the government embarked on a policy review and concluded that the National ICT Policy 2002 "could not reach the professed levels of success due to lack of appropriate plans to achieve the goals set in the policy as well as poor implementation of the underlying actions." Therefore, a new ICT Policy was crafted and proposed in September 2008, which incorporates all the ingredients of the National ICT Policy 2002 in a structured manner as well as new policy directions in line with the changing technological advancements. The major revisions include (i) a methodical framework of the policy document and (ii) inclusion of planned action items in conformity with policies and strategies.

The government has undertaken some initiatives for establishing ICT communications across various levels of the administration. The "Information Technology in Government: An Action Plan for Bangladesh" emphasized the need to establish ICT infrastructure, a pre-requisite to reap the benefits of the information age, including that of e-Government. The Action Plan was contained in the National ICT Policy 2008 (proposed), with the overarching vision to "expand and diversify the use of ICTs to establish a transparent, responsive and accountable government; develop skilled human resources; enhance social equity; ensure cost-effective delivery of citizen-services through public-private partnerships; and support the national goal of becoming a middle-income country within ten years and join the ranks of the developed countries of the world within thirty years. In 2009, the government adopted National ICT Policy 2009, which includes action items for realizing the goals of national development.

The Ministry of Science and Information and Communication Technology (MoSICT) is the government entity mandated to achieve the mission of supporting the attainment of overall socio-economic development through research, development, extension and successful utilization of science and technology including information and communication technology. One of its vision is to develop infrastructures and human resources for rapid growth and expansion of ICT and software export and be a model e-government ministry.

V. FACTORS AFFECTING THE SUCCESS OF AN ICT DEVELOPMENT PROJECT

From the examination of various case studies and reports of ICT development initiatives around the globe, the following themes emerge:

- First, Local content is key - Applications for underserviced areas need local content, if they are to successfully meet the needs of users, is considered useful for the society in which they live and who will successfully used. Slogan is that ICT will attract potential customers if they find them useful. Ernberg claims that demand for ICT will grow as an iterative process [20]. Because different groups of users learn to use tools and find that they can do with them, they will realize that the tool can be used. Thus, it stresses the importance of creating content that meets the needs of different user groups and customize existing information needs of people in rural and remote areas.
- Second, Training is a necessity - ICT are tools not the end. If someone brings new technologies in this area, sufficient training is needed to ensure that people

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can successfully use these technologies and their applications. This case illustrates the points that local content creation and training are prerequisites for the success of any community oriented development initiative in Bangladesh.

- Third, Participation helps build trust, use and contribute to creating conditions and relevant applications - Introduction of technologies needed to solve social problems usually accepted if the participation of approaches used. In addition, a joint approach often ally to local programs designed especially since it increases the sensitivity of the project on the social environment.
- Fourth, Bottom-up approach is much better chance of succeeding than Top-down approach - Bottom-up is more successful than top-down approaches because they are based on real situations of community. Also, consider Bridges.org where many initiatives in development throughout the world and is most of the projects was used approach is "top down", is based on the needs, interests and participation of local people.
- Fifth, Place and macro-economic and regulatory environment to support development initiatives in the ICT - Bridges.org states that there must be political will in the government to do whatever is necessary to integrate technology into society.
- Sixth, Successful projects are often used by local champion – Champion is the individual in the local community, which coordinates and other members of the community and lead the project.

- Seventh, Let it be simple - Often the most effective technology solutions is simpler - Here, modern and sophisticated telemedicine systems represented at the hospital had limited success, while the basic communication system was used to its full potential. It is therefore important to provide systems that allow local communications in a simple and effective way.

In this paper, I tried to create a conscious methodology to these factors built into it.

A. ***The Way Forward***

There are opportunities for Bangladeshi computer scientists to contribute to the fight against the digital divide in our own country. To meet the challenges, the first is to use more socially aware of the process of developing software that will create programs for underserviced area in Bangladesh. The second, is to find technologies that are best suited for rural areas due to their unique circumstances. Thirdly, to mobilize support for legislation at the government level to support development projects.

B. User Centred Methodologies

Obviously, in software development for rural areas in Bangladesh, local content is key to the success of the application. To develop relevant applications should take into account social aspects of computing and understand the needs of target communities. However, traditional methods of computer science are not, by nature, produce research results. For example, usually in software development, specification, which develops and tests a pending result for the client. There is no need for this approach, results of the process or application that is developed, this process only means to an end. In rural areas, this process should be tailored to users' needs and local conditions. First, in rural case, not necessarily a customer as first and second, rural community members cannot claim their needs in technical terms. Thus, conventional methods of software development alone will not be considered types of issues that arise in rural areas. To address these problems, users participating in the software development life cycle must be increased, and the process of discovery of user needs requirements should be included in the methodology.

Currently, according to Carroll et al. [21], most software development methodologies only call for the participation of beneficiaries, after the initial concept and ultimately, when the prototype implementation already exists. This is illustrated in one of the software development life cycles, typically used in software development, waterfall model, as shown in Figure 2.

It consists of five phases, consisting of requirement definition, system and software design and modular testing, integration testing and system operation and maintenance [22]. This procedure applies only to the client or user in the first phase, then a few involvement of user before delivery of product. This process is a typical range

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of user participation at all stages of standard product oriented life cycle of software.

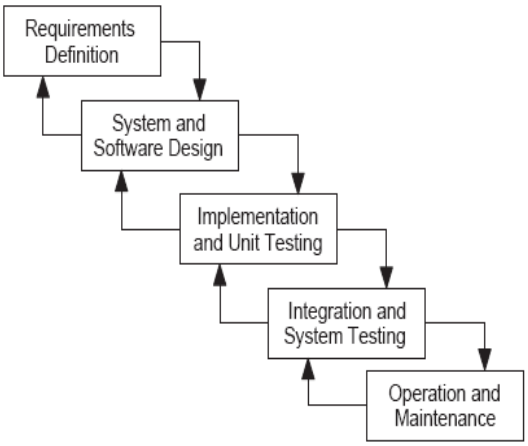

Figure 2: The Waterfall Model - This process has five stages with iteration between the stages. They consist of defining the user requirements in stage one, designing the entire system and software in stage two, implementing the system in stage three with the appropriate technologies and platforms, stage four entails testing each module comprising the system as well as the entire system itself, the final stage is when the software is installed at the client or user premises and requires operation and maintenance of the product.

Another process with a high degree of user involvement is an evolutionary prototyping [22]. Here, the phase of specification, design and verification are interleaved. The prototype is developed, and then exposed to customer feedback from users. The prototype is to meet the complete demands of customers. Again, the user is with minimal involvement and developer has the most control in determining the type of software system that is developed.

These examples show that in computer science, there is no social aspect of computing in many approaches of software development in practice now a days. If I would have used a standard approach to software development in rural areas, this is similar to the "top down" approach, which we saw earlier often fails. Thus, we must increase our software process to solve the problem of developing useful applications for remote and rural areas. For this, we need participation methodology focused on customer needs, and should learn lessons from past projects to use best practices in our own research.

C. Requirements of technologies for Rural Areas

We need to consider about technologies for rural areas which are suited to their unique conditions as described earlier. Two relevant technologies are Voice over Internet Protocol (VoIP) and Wireless Fidelity (Wi-Fi). In addition, the concept of store and forward is also relevant to rural situations in Bangladesh.

i. Voice over Internet Protocol

VoIP refers to a range of protocols designed to send voice over packet switched networks, traditionally the domain of internet traffic. Voice is sampled, digitized and broken down into packets before being sent to its destination. This is achieved by a signaling protocol for call setup and teardown as well as a transport protocol for transmitting the voice packets. The two most common signaling protocols are the International Telecommunication Union's (ITU) H.323 standard and the Internet Engineers Task Force's (IETF) Session Initiation Protocol (SIP). The transport protocol used in both implementations is Real-Time Transport Protocol (RTP) which has been optimized for the transmission of real-time data. RTP operates on User Datagram Protocol (UDP), a connectionless protocol used on the internet.

ii. Wireless Fidelity

Wi-Fi stands for wireless fidelity, which is the popular name for the IEEE 802.11b standard. It is the protocol behind "hot-spots", areas where wireless internet access is provided to the public. Essentially, the protocol defines how devices can connect to each other (ad hoc mode) or to a central access point in order to access another network (infrastructure mode); both wirelessly. 802.11b has a maximum channel bit rate of 11 Mbps (shared) and operates in the Industrial, Scientific and Medical (ISM) band at 2.4 GHz. This band is considered license-exempt by the ITU and many American and European countries follow this recommendation. The Wi-Fi protocol describes 2 layers of communication, a physical layer and a Media Access Control (MAC) layer. The physical layer defines how the data is encoded and transmitted and the MAC layer specifies how devices can use the transmission medium in an orderly and efficient manner. In the 802.11 standard, there are 3 ways to transmit data: frequency hopping spectrum; digital sequence spectrum and infrared.

iii. Store and Forward Approaches

Another concept for Bangladeshi rural areas is that of store and forward applications. The concept for these applications is borrowed from networks where store and forward technology is the basis of

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many ubiquitous applications such as email. Packet-switched networks are usually called store and forward networks. They describe the concept as when each node in the network first receives a complete packet over a link, then stores this packet in its memory before forwarding the packet to the next node in the network. Store and forward applications are an extension of this concept. They are applications capable of creating and storing data at a site and then transmitting or forwarding that data when appropriate. Data may be stored at many nodes along the way and then forwarded to the destination. Store and forward applications allow for asynchronous modes of communication and this is pertinent for situations where connectivity is sporadic.

6. SOCIALLY AWARE METHODOLOGIES

To develop new programs for rural areas in developing countries, the user centered approach is needed. The reason for this is that the methodology previously used to provide ICT for underserviced area largely didn't succeed. In addition, traditional academic concepts for software development focused exclusively on developing and supplying software. There is no research component of the standard methods of software development. If we want to explore the relevant software solutions for rural areas, we must add a component to study the life cycle of software development. This feature will allow us to take into account the social context in software development related software solutions for underserviced areas. Therefore, more practical and deliberate approach, if we want to overcome deficiencies that prevent the development of ICT initiatives in the past. By "socially conscious, I mean an approach which not only take into account the technology needed to create software solutions for rural areas.

Socially conscious approach should be aware of the larger picture, in which software and related technology needs, such as if a solution is cost effective and sustainable. In addition, we must consider what people need and use the experience of users in their working environment so that appropriate solutions can be developed in collaboration with these people. In addition, we must consider how software fits into the everyday people, and ensure that local conditions support the use of technological solutions created. Ideally, this should be a process of developing software solutions for a decent underserviced regions. They should also provide all parties involved in the project in some way. In other words, we want a process that not only produces software as in software development, but also conduct research results.

Two user-oriented methodologies, which may form the basis of socio involved software development life cycle are Action Research and Participatory design. These methods are selected for their relevance to the issue at hand, and a review of related work, where the two methods are found that are useful for the empowerment of appropriate solutions for the target communities.

A. Socially Engaged Software Development Life Cycle

The traditional waterfall model of software development life cycle (SDLC) is mainly to the implementation of the client. There is no research components present in this cycle. However, if we want to produce the relevant applications in a bottom up fashion in rural areas, we must do research to determine the performance required of the software system. In addition, the Research component of this process need to expand the traditional focus of the life cycle of software development so that issues beyond the program that affect its use are addressed.

For example, I should ensure that the program is integrated into everyday users. Furthermore, the addition of constituent studies of conventional software development allows me to strengthen and expand the use of experience gained in this process in rural and remote areas. I've added a research component for the synthesis of simple SDLC waterfall model of software development with the principles of PD, AR, and RA / RI.

This techniques help to shape the process of software development in the social aware approach for several reasons. Their goal is to maximize empowerment of the community project as well as providing solutions for local community problems. They also lead to mutual training and development for all participants.

With PD, I borrowed techniques developed for user interfaces and prototypes for the user. Among them were discussion paper and software prototypes that will help me to expand popular participation in my approach to software development. I borrowed from the AR process of interaction with the community to solve this problem. It is determined by cycle approach to work with them to the empowerment of communities in some way to use this technology, if necessary. I meet every stage of AR with corresponding stage of the waterfall model of

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software development.
Note that here I decided to use standard waterfall model of software development rather than other methodologies for software development, so that phase waterfall model can be easily integrated with the AR cycle stages. This is shown in Figure 3. At each stage I used PD decent methods to facilitate the participation of users in the process of software development. AR mainly reduce the gap between positivism and empirical studies, as well as standard software development focused on release of software applications. It also provides process research and positivist ultimate goal is to create a context intervention in my affairs, applications-oriented community.

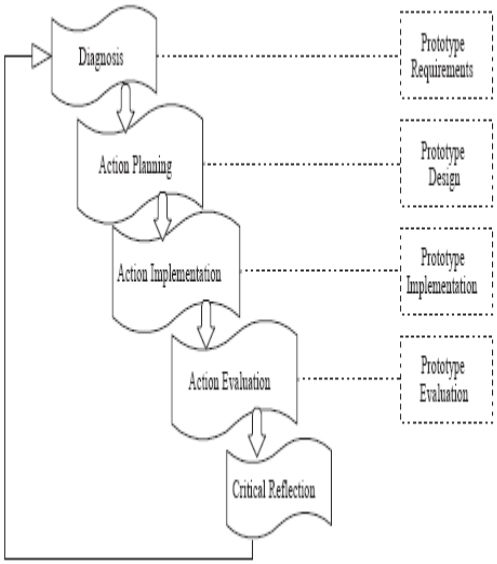

Figure 3: The methodological process is cyclical and iterative, involving stages where I analyze the circumstances of the target community, identify a problem to work on, plan an intervention, implement an intervention and evaluate the outcomes. Finally, after each cycle, I reflect on the results of that cycle in order to correctly plan for the next cycle. The dotted boxes indicate stages of the process where I gather the requirements and design for prototype applications as well as the points at which implementation and evaluation of a prototype occurs.

In particular, my approach is customized version of AR process, with PD and RA / RI principles in conjunction with a standard waterfall model of software development. All these changes are aimed at maximizing the user during the SDLC in order to obtain the appropriate technological solutions to the local community.
My process is participatory, because I included the target communities in the process of software development. This was achieved through discussion groups, partly structured interviews and consultations, cell phones and short messages (SMS). However, this aspect is not a universal means to truly socially conscious methodology. To ensure that I was always aware of the broader context of software solutions that help me ask the right questions at the right time, I must learn lessons from past development projects in ICT. For this, I used the best practices learned from successful initiatives and ICT development. To integrate in my social conscious process, I used the RA / RI framework at each stage of the application, to identify issues that cannot be technical but should be considered in order to ensure the greatest chances of success of the application.

7. TC PROTOTYPE

In the first phase, I determined the necessity of the community. It is time to implement a concrete software prototype to test my ideas. For this, my goal is to design and implement a telemedicine prototype based on the requirements.

A. Prototype Requirements and Design

From the study, several requirements became apparent for a telemedicine software prototype. In general terms, there is a need for improved communication between a small hospital in rural area and larger hospital nearby. A number of factors affect this communication. For instance, there are no reliable phone lines in the area and the electricity supply to both the hospital is erratic. Additionally, there can be power and network problems. Also, if the system only offers synchronous communications, it is difficult to fit in using the system because of personnel shortages leading to busy work schedules.
To improve telemedicine solutions more versatile tool is needed, one will allow multiple modes of communication: asynchronous and synchronous in order to cope with unreliable point, and allows for at least asynchronous communication if not synchronous communication is possible.
Watts and Monk [23] analyzed the problems of telemedicine and concluded that the voice and image are essential for most tasks. My prototype Thus, according to general trends in telemedicine software should support synchronous voice calls and asynchronous messages passing between both hospitals. This would allow much needed task of telemedicine should be executed. These reports were to contain text indicating the patient's illness

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and medical history, digital images of the patient or a particular problem, and voice messages will be known henceforth as voice mail. Voice mail will save time of typing and digital images is proposed in connection with the higher resolution.
The system also need to support a contact list showing a contact's availability or presence i.e. whether a contact is online and able to take a call or offline and unable to receive a call. The store and forward component is responsible for the creation, storage and forwarding of patient files and records. The VoIP component handles call initiation and maintains the information necessary to display presence of information on the contact list.
The participants in the system need to be familiar with the use of email. Thus, the basic Graphical User Interface (GUI) designed for the prototype need to follow similar conventions to an email client.
The concentration in the system is on rapid prototyping. Furthermore, work on security issues such as channel encryption and the GUI need to be given lower priority than fine tuning the basic functionality requires of the prototype. However, a log in and password dialogue should be provided to allow restricted access to patient data.
The prototype is similar to other telemedicine applications, that it uses a store and forward paradigm. On the other hand, it is a typical since it is multi-modal, i.e., it provides for both asynchronous and synchronous communication. Also, it uses a contact list to display a person's availability to receive messages or engage in a call, a feature usually associated with instant messaging tools. After, designing the prototype, I need to proceed with implementation.

B. Implementation of Prototype

Primitive prototype called the Telemedicine Communicator(TC), and can be implemented in C# on Microsoft. NET platform that allows rapid prototyping. TC first support multiple user profiles to allow users to save their money and details of the message separately. Users need to create an account for themselves after the first use of the system. Each profile is associated with a user name and password, and after the first Enter users only need to click on his username and enter your password to access the system. Each user has a list of contacts, which is updated regularly taking into account the status of each contact. Click on a contact name, brings the context menu from which user can choose to delete a call or view contact information.
TC consists of several components, namely RtcFunctions, File-Transfer, NetworkMonitor, Logs, VoiceCompressor, VoiceRecorder, Storage, PatientDetails, ContactDetails and RecordDetails. TC RtcFunctions includes GUI functionality and supports synchronous real-time voice call. It also depends on other components of the database for performance operations and transfer files. Calls made by using Microsoft's peer to peer real time communications (RTC) Application Programming Interface (API) can be designed to create a client for VoIP Session Initiation Protocol (SIP).
The site can be frequently inaccessible because of power outage, and hospitals may not be able to communicate by VoIP phones, because the server may be down. TC peer to peer calls overcome this problem, because it requires only two end points of call to be functional, i.e. both hospitals.
The RtcFunctions component also allows a contact list to be maintained. This list indicates the availability of a contact to take a call and is shown in the main TC screen in Figure 4. This enables a nurse or a doctor to determine if the other party is available to take a call.

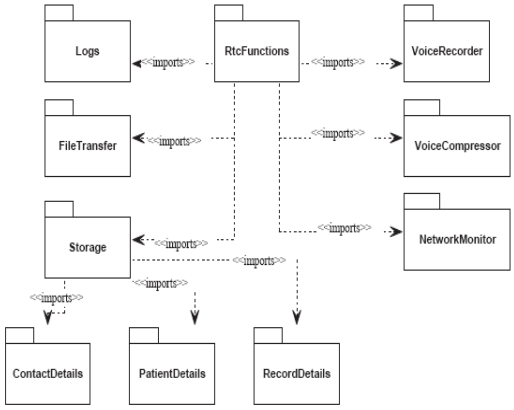

Figure 4: This package diagram shows the major components of TC. Each package implements a portion of TC's functionality. For an example, FileTransfer is responsible for transfer of messages between sites as well as file compression and decompression. The lines indicate associations between packages and RTC stands for Real Time Communications.

Storage Components implement all the store and access functions for database Microsoft Access/Other Database software. TC initially supports multiple user profiles, and all information stored in the database for each user. Each user has a number of patients, each patient has a number of records. Entries are divided into those who created

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or sent by users and those who got it from another source. Only file locations are stored in the database. PatientDetails, ContactDetails and RecordDetails will help to access to patient, contact, and record data using the Storage component.

Each record can contain text, images and voice mail. Voicemail VoiceRecorder enjoys using Microsoft DirectX. It can be compressed using Microsoft Windows Media Encoding (WME) API VoiceCompressor component. If the record is sent, all files and records summary component are compressed by FileTransfer, before those are moved to another location where they were unpacked. Pictures can be enlarged or reduced in a separate Image dialog box, which can be implemented under the component RtcFunctions.

Records can be sent immediately, if the connection on the other hand is available. If the connection is marked record will be sent as soon as it becomes available. Connecting to a network component NetworkMonitor constantly polled to determine when to forward stored messages. Events will be raised to signal the network and disconnect. Logs feature enables application logging data, identifying errors and significant events that occur during construction.

TC's main advantage is its multi-mechanism, which combines simultaneous VoIP asynchronous store and forward messages. Contact list allows users to determine if the person wants to contact is available or not. Telemedicine can be consulted synchronously, if both parties and if the power network is up. If power or the network is down, it will be unavailable to participate in synchronous communication, TC can allow store and forward approach for data. Text, voice and images can be captured at any moment and they are transferred when a connection is available. It means that asynchronous aspect help the overworked doctor to process the message when he has time. Digital files in the archives provide a high level of detail and voicemail reduces work of typing. One improves the video quality poor in former telemedicine system, and the other saves time for users with poor typing skills.

It is assumed that the system will save time and money for patients as they would not have to go to hospital for an appointment, if it is not necessary. This is especially important because most of the patients are unemployed in villages. In addition, travel between villages is also expensive for local residents.

8. RESULTS AND DISCUSSIONS

In order to evaluate the action implemented for the system, i.e., TC, it could be better if I could arrange a field visit. The purpose of the visit is to introduce the TC to the project participants. The project participants need to consist of health care professionals from small village, nurse and doctor from neighboring village hospital.

Implementation of the system requires training of the several persons involved with the system and testing of the system across the network.

A. Training the nurse

The nurse should be trained for the following purpose:

- Logging in
- Adding a patient
- Adding a record to the Outbox
- Recording a voicemail for an Outbox record
- Listening to the recorded voicemail for an Outbox record
- Adding text to an Outbox record
- Adding images to an Outbox record
- Sending an Outbox record to another participant
- Viewing a record received in the Inbox
- Viewing an image in an Inbox record
- Listening to a voicemail in an Inbox record
- Reading the text of an Inbox record
- Calling another participant

In addition, a rudimentary user guide is needed to provide to augment the training. The nurse is also need to be trained in basic battery life preservation so that the laptops power resources would be used efficiently, particularly during power failures.

B. Training the doctor

Training for the doctor is also needed to be the same format as the session described above and need to take place at the hospital.

C. Testing across the network

Before testing TC across the Wi-Fi network, I need to install the laptops at the hospitals sites. Each laptop needs to be connected via an Unshielded Twisted Pair (UTP) cable to a switch. The switch will then be connected to the main hub for the wireless network. Both the IP addresses for hospital's laptop are required to statically configured so that they would not change in case

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of a power failure. If this are not done, the server may assign each laptop a different IP address following a power failure and this would adversely affect the correct performance of TC.

Once the hardware is installed, TC needs to be started at both ends of the network, i.e., on the both hospital side.

The data that will be collected from observations of the doctor, the nurse and the other participants and the network assessment will yield the expected results from the system.

9. CONCLUSION

I have tried to devise a methodology from existing methodologies and also tried to develop locally relevant software applications for rural areas in Bangladesh. In addition, I wanted to approach a rural community and use the framework I developed to build, refine and test an application built in a bottom up manner to solve a problem for our target community. From this process, I aimed to learn about the validity of my methodology. Lastly, I wanted to derive comments on how telecommunications policies should enable the provision of telephony and value added services in underserviced regions with whatever technologies are necessary. To address these aims, I first devised a socially aware computing framework geared towards developing context appropriate software for rural areas. I synthesized this approach from existing user centered methodologies, namely Action Research (AR) and Participatory Design (PD) as well as best practice principles from previous Information and Communication Technology (ICT) development projects — the Real Access/Real Impact (RA/RI) framework.

The approach helped me identify community needs and I created a communication tool for telemedicine for the target community called Telemedicine Communicator (TC). This tool can be an improvement on the telemedicine tool because it allows both asynchronous and synchronous modes of communication. This is useful since the network connectivity is unreliable and both participants are often too busy to engage in synchronous communications.

I demonstrated that the socially aware computing framework is a valid approach for developing applications for rural areas by creating a working software application with functionality appropriate for the target community. Additionally, I learnt that needs drive development and dictate which technologies should be used to fulfill those needs.

The system can be further extended by making questionnaires to determine the actual need of the targeted community and also test the system thoroughly with the rural community of Bangladesh.

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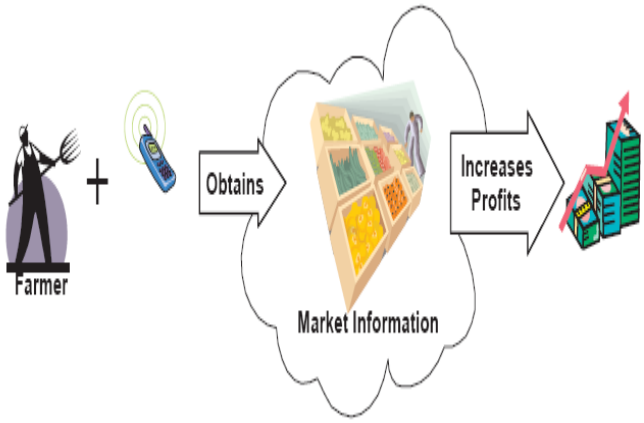

FIGURE 1