

# Implementing Healthcare Information in Rural Communities in Sri Lanka: A Novel Approach with Mobile Communication

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## Abstract

Access to effective and efficient healthcare services without any difficulty is one of the essential parameters to consider for a country's sustainable development. Though developing countries put much emphasis on improving their healthcare services, the disparity between service consumption of rural communities compared to their urban counterpart is still very visible. The effect is merely due to the disparity in service penetration levels between the urban and rural regions. Sri Lanka is also struggling to improve this scenario with various policy and tactical level approaches, yet there is lot to achieve. Improving healthcare and utility services through Information and Communication Technologies (ICT) is a prime research area among the scholars today. Like many other developing countries, Sri Lanka also initiated some projects to improve the healthcare sector infrastructure through ICT. This paper describes the need of a novel approach to provide better healthcare service to rural communities in Sri Lanka and details about such project which is at its final stages of development.

## Keywords

Healthcare Information, Rural development, Mobile applications, Digital divide, Information dissemination

## 1. Introduction

With the rapid growth of means of communication, mobile technologies have played an important role in the diffusion of information as well as business activity. People need to have access to information anytime, anywhere (Lim *et al.*, 2008). As information becomes one of the key resources for any activity, the role of mobile technology-based ICT services is becoming more significant for their users. Also, hand-held devices and the applications bundled within them are significantly cheaper and require very little training unlike most PC-based alternatives while supporting mobility needs of patients or medical practitioners who are always on the move (Ikhu-Omoregbe, 2008). With these advantages of mobile-based systems it is undoubtedly suitable to consider developing paradigm-shift application infrastructure to overcome problematic issues in present healthcare systems. With that in mind this project was initiated to implement a novel mobile-based framework for information sharing among the Sri Lankan community. This paper is composed of the conceptual background and project specific information of the work done for such a novel approach.

The organization of this paper is as follows. Section 2 will discuss background information in relation to this project. Section 3 discusses the problem scenario in brief. Thereafter Section 4 is included with the proposed solution model with descriptive PIM (Platform Independent Model) and

PSM (Platform Specific Model) level diagrams for the system Design and Development. The survey results, Section 5, shows information about a survey conducted to assess mobile users attitudes towards mobile-based healthcare Information Systems. Section 6, the future works shows the next stages of possible development of the system to enhance its value. Finally the conclusion along with the acknowledgements is included and the references will compile this paper.

## 2. Background

In the recent past Sri Lanka has initiated several projects to deploy ICT-based services to many sectors. Information Communication Technology Agency (ICTA) is the latest facet of the many such approaches throughout. ICTA has also initiated some projects to automate most of the healthcare-related functions through ICT but yet limited to back office automation and ERP functionalities. Building public awareness in healthcare information is still based on traditional approaches such as printed notices. However in rural areas these go easily unnoticed as the geographic distribution of households is wider and population density is less compared to urban areas.

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## 2.1 Sri Lankan Healthcare Sector

In recent history, Sri Lanka's healthcare system has followed a policy of free service to the entire population on the basis that it is an essential welfare service. This has been made possible by allocating a large proportion (about 55.9% for 2008) of the annual health budget for recurrent expenditure and a lesser proportion for the infrastructure development (only 18.7% for 2008). However, health budget is only 1.5% - 2.0% of the national budget (CBSL, 2008). Given these resource constraints, innovative approaches for health system improvements need to be explored, particularly ICT-based services in healthcare, which are only at their infancy in Sri Lanka.

Table 1 below shows the healthcare facilities in the country. There are no ICT based communication channels for efficient information sharing among these facilities. These facilities do not even have websites to share basic information with the public.

**Table 1**  
Medical Infrastructure Distribution in Sri Lanka – Adapted from Ministry of Health Annual Report 2006 (MOH, 2006)

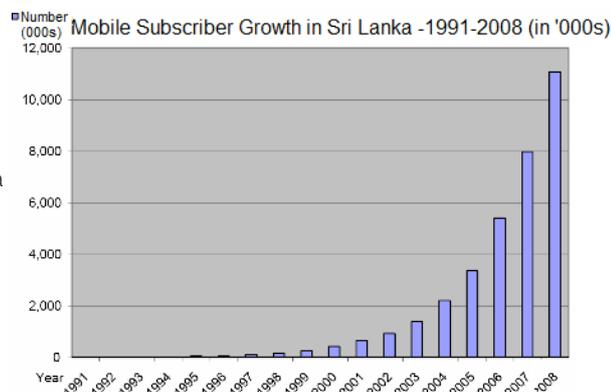
Medical Center Type	Total Number (2006)
Teaching Hospitals	16
Provincial Hospitals	8
Base Hospitals	45
District Hospitals	155
Peripheral Units	101
Rural Hospitals	196
Central Dispensaries	67
Other	35

Human resource capacity (staff), which can be a possible means to disseminate information and knowledge to the public, is about 236.7 key personal per 100,000 population (MOH, 2006). Because of these low numbers, staff are over loaded with their routine responsibilities and cannot assist with information dissemination.

## 2.2 Mobile Communication Sector – Sri Lanka

The mobile communication sector of Sri Lanka has shown rapid growth with more than 11 million subscribers at the end of 2008 (TRC, 2009) meaning nearly 55% of the population have access to mobile phones. Figure 1 shows the rapid growth of cellular subscriber growth (1991-2008).

**Figure 1**  
Cellular Subscriber Growth in Sri Lanka 1991-2008 – Adapted from Telecom Regulatory Commission Sri Lanka Statistical Report (TRC, 2009)



Looking at the mobile phone opportunities, banks and e-commerce services in Sri Lanka extended their services through mobile phones, which has resulted in a well established 11 million subscriber base. With regard to the healthcare services, the only significant mobile-based service that has emerged so far is channeling a physician through mobile phone: 'e-Channeling'. This is a proprietary software system and the total cost of channeling the doctor will be added to the mobile phone account of the user. This service, along with other mobile-based services have been very popular, accepted and adopted by the people, which is promising.

## 3. Problem

It is a known fact that due to geographical and infrastructure-based barriers, the rural population is at a disadvantage compared to the urban population. 'They may have to travel relatively long distances to obtain services. This problem is most obvious in those areas where transportation is unavailable, infrequently scheduled or prohibitively expensive' (Neuberger et al., 2001). Furthermore, the options for care limited and information is not up to date. Telemedicine and e-based healthcare automation are popular in many countries to overcome these issues. However in the Sri Lankan context it is premature to expect rural users to exploit healthcare opportunities through ICT based systems.

Information and Communication Technology Agency (ICTA) is the umbrella body of promoting ICT-based services in Sri Lanka. It is a joint initiative of Sri Lanka Presidents Secretariat and other organizations involved in ICT development of Sri Lanka. ICTA conducted a countrywide survey on assessing Sri Lankan ICT-based services consumption and their penetration in 2008 (ICTA, 2008). The survey results show how much less the ICT infrastructure was developed and the situation is much worse in rural areas. According to the survey results on different technical service infrastructure levels in the Nanasala residents (which are a reasonable indicator for the country in general), the survey showed 94.74% of the residents had Electricity Power and 89.47% had Television. Telephone access was 76.61% including all forms of telephone services. When it comes to the Computer and Internet connection the figures were 32.16% and 7.02% respectively (ICTA, 2008). As a result, only 7.02% of the people would be able to use the ICT based healthcare services from their homes. On the other hand if mobile phone based services were considered, it would have the potential to reach more than 50% of the population.

Moreover, the survey revealed the different levels of access for various Government websites. It is disappointing to find that only 1% of the internet accessing was for health information through the Health Ministry website (ICTA, 2008), which is the only central body that provides information related to healthcare. There are no regional or private healthcare information systems.

Although there have been many policy-level decisions and implementations to improve healthcare through ICT, but so far, not much is visible in terms of rural areas. There seems to be a lack of a mechanism to align strategic objectives with appropriate ICT technologies (Perera & Fernando, 2007). At the implementation level, the government's planned services are still not using mobile infrastructure which can solve most of the bottlenecks for rural people on healthcare information dissemination. At present without having the appropriate efficient communication medium to get latest information on healthcare services, the Sri Lankan rural community suffers immensely.

#### 4. Proposed solution

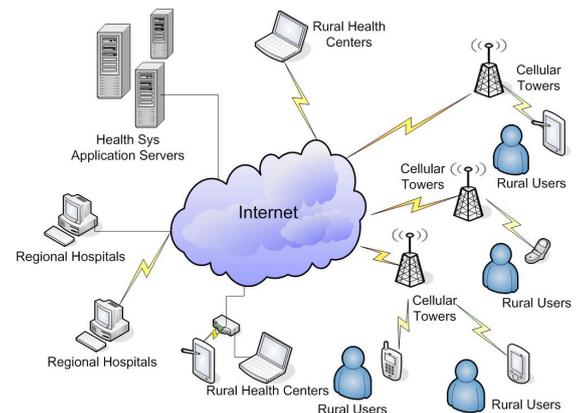
To overcome the above said problems, a simple yet comprehensive solution architecture, that was proposed and developed is described below. As discussed above, the major issue with the web based information sharing with Sri Lankan rural people is their low usage level of the internet. Furthermore internet and service penetration is low within the rural areas. Since there are significant mobile subscribers in rural areas, it is a good opportunity to use mobile based system for healthcare activities. However, it remains a challenging objective to create complicated applications that are executed on small, light, and mobile devices because the small size and low weight requirement of mobile devices imposes a considerable restriction on their processing power, memory capability and battery capacity (Tao *et al.*, 2005). This is especially the case with web browsing. Web pages should be rendered according to the device resolution ex: 176 x 208, 240 x 160, 320 x 240 etc (Phone Scoop, 2009). Allowing users with the basic functionalities through their mobile phones was one of the key considerations in this project which was made to deliver consistent and reliable service to a wide range of user community irrespective of their device limitations. "All the user wants is to be able to access a service in a simple and secure manner using an appropriate device without being burdened with (too much) technical complexity" (Leung, 2008). Therefore this project only focused to introduce healthcare news and information sharing facility through mobile phones for rural community. However the system was designed to support future extensions such as mobile based prescription, drug administration, m-commerce applications, etc easily.

##### 4.1 System Architecture

The high level architectural model proposed in this project is based on Client-Server Architecture. "The client server systems using mobile communications networks for data transmission became very attractive for many economic agents, in the purpose of promoting and offering electronic services to their clients" (Eugen *et al.*, 2008). Furthermore, the architecture allows deciding thin-to-fat client scenarios which is highly dependant on end user parametric conditions such as, processing capabilities of the device, end user computer

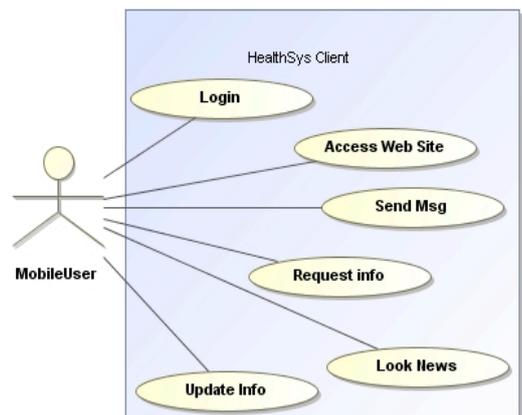
competency, and connectivity cost with speed. Most of the Sri Lankan mobile subscribers have GPRS connectivity with their phones and some support 3.0G and above with value added services. However for the facilitation of primitive service enabled cellular phones (ex, SMS and Call services only), the system architecture was developed in such a way that the system functionalities could be accessed at least only through those two services.

Figure 2 shows the high level architectural view of the system.

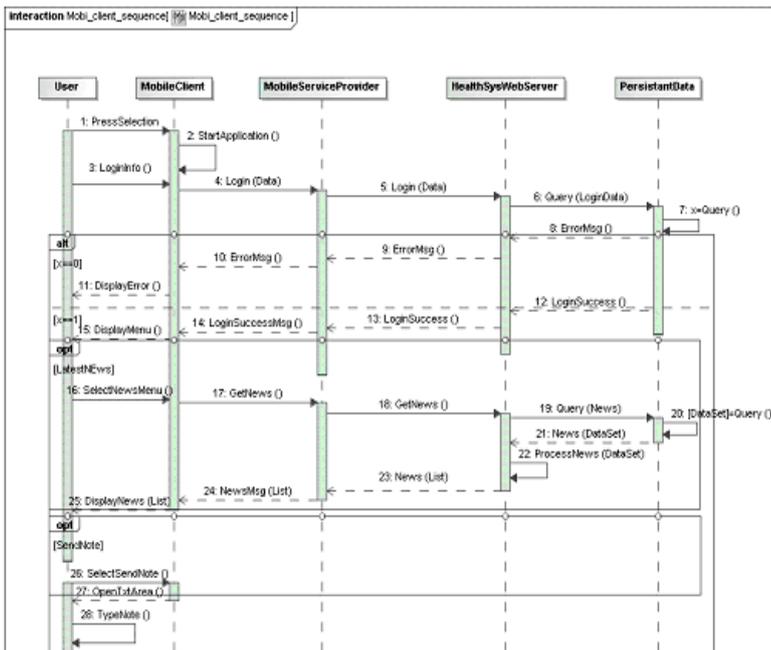


**Figure 2**  
High level architectural view of the system

In the detailed design phase, the critical processes for the client side and server side were identified along with their functional boundaries. As mentioned above due to the resource limitations at the client end, it was decided to develop the web interface just to cover the identified functionalities for the system without any styles or fancy graphical components. Some of the Use Case and Sequence Diagram according to the UML 2.0 are shown in the Figures 3 and 4 below, respectively. It is



**Figure 3**  
A System Use Case



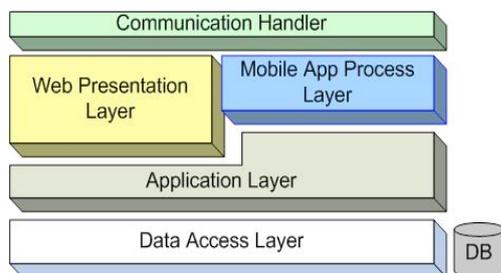
**Figure 4**  
Part of Sequence Diagram

important to note that since the system focus is to rural mobile users, the functionalities were defined for their main requirements, hence there is no significant difference in the PIM diagrams between client and server side.

**4.2 System Development**

The System was developed using a combination of technologies to suit each components. Most of the development is based on standard technologies to make it interoperable with heterogeneous systems. Also emphasis was given from the design phase to make the system technically flexible for integrating with other healthcare systems which are also based on standard technologies.

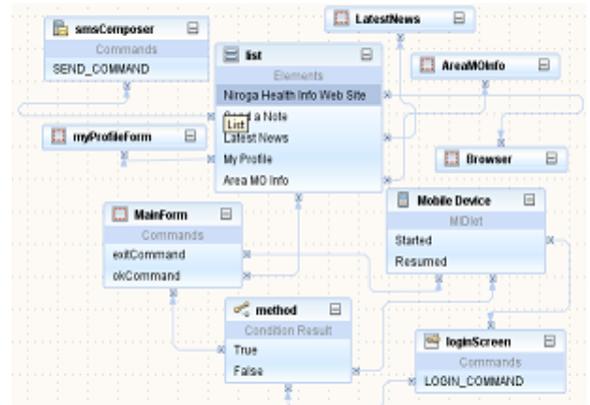
The server side programming was done using PHP 5.2.8 and MySql 5.1 as the persistent data storage. The NuSOAP library had to use for deploying web services from PHP script. WAP and WML supported PHP pages were developed to provide different resolution rendering for the client side web browsing. WAP and WML supportability is essential part in the Communication Handler and Web Presentation Layer components in the server system. Server side architectural block diagram is as follows in Figure 5.



**Figure 5**  
Server Component Diagram

The client Application was based on J2ME environment with MIDlet programming. NetBeans 6.5.1 is used to develop the client application with CLDC 1.1 Device Configuration and MIDP 2.1 Device Profile. Sun JAVA TM Wireless Toolkit

2.5.2 for CLDC was used as the Emulator platform. NetBeans IDE supported MIDlet state flow helped lot for reducing developer time. Partial client side state flow is shown below (Figure 6).



**Figure 6**  
MIDlet state flow diagram for the client

Figure 7 shows the developed system instances and the functions that a user could perform. If the user's mobile phone was capable of GPRS web browsing, s/he could connect to the Niroga information portal which allows him/her to get general and location based healthcare information. If not, other menu items could still be used to get latest regional news, send a message to the regional center, access regional healthcare service or update his personal profile information. The system architecture is single sign-on which synchronizes the information through web interface and mobile interface, at the persistent data layer. Healthcare institutes could upload their news items by connecting to the central HealthSys Application through the web interface. There is a need for centrally and regionally appointed system administrators with different system updating privileges to maintain and update the system.



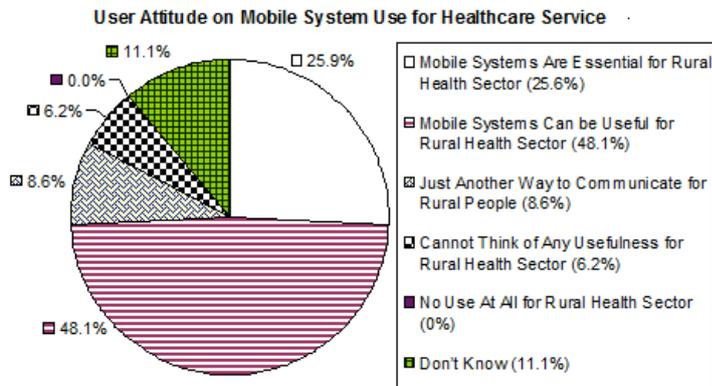
**Figure 7**  
Running instances of the program

**5. Survey analysis**

To have a basic understanding about the mobile user attitudes towards using mobile phones for healthcare service interfaces, a simple yet comprehensive survey was conducted among different sectors in the society. For the survey 81

participants' responses were collected. As Andrei et al. (2008) described, to define correct questions in the survey questionnaire, it should identify and have the main goal of assessing the impact of the proposed healthcare reforms. The participants were given six options and they had to select the one they agreed with. The options and their responses in percentage are shown in the graph in Figure 8.

**Figure 8**  
Mobile user attitude survey summary



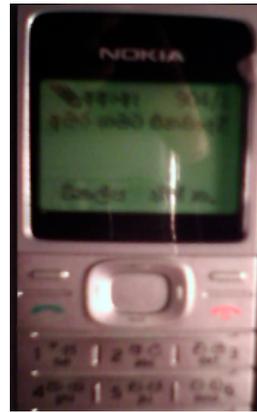
When the survey results were analyzed it was interesting to note that 73.7% responded in favor to mobile based application development for healthcare sector. This shows the desire of mobile users to get most of the services out there to their mobile phones. Furthermore, remarkably, no body thinks that there is no use from mobile based applications or mobile phones for rural health sector.

The results of the survey demonstrate the potential for success of the mobile based applications for the Sri Lankan healthcare sector.

## 6. Future works

Once the current development is completed and the system becomes stable, the project can be moved to its next phase, i.e. local language supporting phase. In fact it is not that difficult to provide local language support for Sri Lankan users, as almost all mobile service providers support localization through their services. Furthermore there are number of mobile manufacturing brands now support both Sinhala and Tamil (two Sri Lankan local languages) at their device level. The Figure 9 shows such mobile phone with local language support.

Despite the positive outcome from this research, there are relevant further studies that can be / should be considered. Examples are medical prescribing, diagnosis, or any drug treatment methods facilitation; these are not yet considered in this project. Though it seems bit challenging, it can be a valuable study area for future Sri Lankan healthcare improvement.



**Figure 9**  
Local language support in Sri Lankan mobile phones

Domain specific customization of the model and improvements to the system is an imperative future work area. This system was particularly designed and developed with the end users in mind. That might make the system simple and inflexible for doctors to use for their routine activities. However with the more expert input from healthcare sector and government this system can be further extended and integrated with other health sector enterprise applications to form a scalable health system framework in the future.

Due to the limited resources the development was done in a selected environment. Though the outcomes give impressive observations, it is essential to formulate a national scale project with different stakeholders such as mobile service providers, government officials and medical practitioners to implement the solution as a solution at a wider population level.

## 7. Conclusion

This mobile health project described here was started as a pilot project to develop basic technical solution framework to reduce the healthcare information and knowledge sharing bottlenecks among the Sri Lankan rural community. The project is still successfully functioning and delivering the expected outcomes. However to make it further worthwhile there should be a national scale implementation of this prototype. However this would require the involvement of a large number of stakeholders, as discussed above. Furthermore, although this system does not provide end-to-end process automation to healthcare services, this could be the stepping stone of such evolution in the future. It is believed that this project will lead a paradigm shift for healthcare services in rural Sri Lanka that would utilize modern mobile technology. In conclusion, on the one hand the author expects extensive usage of this system in real environments, and on the other an encouragement for other researchers to extend this project further so that it would truly assist in raising the quality of living of the people through bridging the digital divide.

## Acknowledgement

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