Towards a Sustainable e-Health Deployment

An Integrated Medical Information System for Sri Lankan Case

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Abstract—**Strategic deployment of information communication technology in health systems is promising to ensure reducing medical cost, enhanced medical treatment-quality and to serve the underserved population. International medical cooperation has served both developed and developing nations to overcome technological and social barriers in e-health deployment in many ways. However, most of the past e-health efforts reportedly either discontinued or exhausted their improvement potential due to isolation from other e-health activities in the health sector. For a rapid absorption of technology and sustainable development in the e-health sector in developing countries, it is an extreme necessity that years of financial investments and efforts exercised on scattered form of e-health developments are inline with the country's long term e-health development plans. In this paper, we propose a methodology that deploys a fully functional dedicated system, Integrated Medical Information System (IMIS), with the collaborative effort of system designers, medical practitioners and the government. IMIS is an extension of a previously designed system by the authors for international medical collaboration.**

Keywords-component: ***e-helath, telemedicine, system interoperability, e-government initiative***

I. INTRODUCTION

A. Background

Current health care delivery in many developed and developing countries is facing major challenges. Increasing medical treatment cost, demographic and geographic issues are the main challengers to overcome. The strategic deployment of ICT in health systems is promising to ensure reducing medical cost, enhanced medical treatment quality and to serve the underserved population [1]. This encompasses deployment of sustainable e-health systems that could utilize the existing ICT infrastructure, IT competency and technical expertise to foster both rural and urban health care development.

International medical co-operation plays a significant role in e-health deployment, especially in developing countries. It is often the case that this form of cooperation normally initiates as dispatch of medical experts or expert services from developed countries to developing countries where dedicated systems are used for distance communication and data sharing. However, the major problem with these e–health support systems is that they are isolated from other e-health activities in the country and difficult to integrate to the country's synergetic healthcare development. As a result, these efforts discontinued or exhausted their improvement potential when the activity comes to an end with the termination of the international cooperation project duration. This situation is noted in Sri Lanka from many sporadic e-health efforts.

On the other hand, e-government initiatives in developing countries such as Sri Lanka, Pakistan and India have been creating a revolutionary development in the IT infrastructure. While the infrastructural development is addressing the broad IT requirement of the country, the main focus is the transformation of government departments which involves in public administration. Although the health-sector is very important developing the overall economy, it is often the case that e-health promotion is not considered as a primary goal of e-government initiatives due to complex and investment intensive nature of the health sector. However, with the improvement of the communication infrastructure more isolated e-health projects emerge at an increasing frequency.

B. Problem statement

In the wake of e-government initiatives, as the basic IT infrastructure in the country is boosted up, e-health efforts will take place sporadically in the country both in public and private sector mostly in the form of international cooperation that we mentioned above, but implemented totally decoupled to the e-government implementation plans. Self funded systems will also appear in the government as well as in the business sector as the developing infrastructure reveals the obscured benefits of e-health systems. (e.g. collaborative telemedicine in Sri Lanka funded by Japan, Sweden and UK as well as e-health promotional efforts in major private and state hospitals in Sri Lanka). However, very few successful projects will remain functional due to one or many identifiable reasons mentioned below:

- *Continuing external influence*: A situation that the expert-recipient interaction continues through remote means is a good indication for continuation. To support this interaction the e-health system will remain functional.
- *Internal absorption*: The system being integrated to the routinely activities of the medical institution is also a positive factor. Once the medical practitioners experience the benefits of the IT based system, the system will improve and absorbed more in to the system. IT competency among medical fraternity is also very important for this acceptance.
- *Personal Dedication:* It is observed that the whole project is handled by the control of several motivated individuals. When theses individual efforts are absent the whole activity will come to an end.

The system will be also abandoned due to lack of infrastructural provisions, discontinuation of a paid service or a

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paid job position after the project duration that initiated the e-health system is over.

The scattered nature of e-health developments aggravated by the inherent fragment nature in health institutions results in systems that do not comply with a common standard. Thus in the long run, these e-health efforts suffer a sever problem of interoperability among one another as well as new systems to come under the subsequent major government implementations. As a result, even the few e-health endeavors that continue functioning actively might either have to undergo costly modifications/replacements or to operate in a totally isolated and independent manner, creating most of current e-health efforts to be less effective to directly contribute to the long term development in the health sector of the country. Therefore, it is a timely importance for e-health facilitators to investigate effective deployment methodologies that would fruitfully contribute to the countries overall development of the health-sector. It is also a responsibility of e-government transformation mandate to create an environment that is conducive for a sustainable e-health penetration.

C. *Purpose of this work*

In this work the authors do not intend to provide a total solution to the above problem or challenge the problem of interoperability as a whole. However, the authors believe that according to their expertise in the respective fields namely: system development, advanced surgical services in tertiary care centers, overseas medical/surgical expert advice, and health administration would create a capable environment to address this problem. Moreover, the recent involvement of Asia Pacific University in Japan with Sri Lankan government through Information Communication Technology Agency (ICTA) as consultants for e-Government transformation will provide conducive grounds to influence on e-health standards and systems for Sri Lanka. The Post Graduate Institute of Medicine in Sri Lanka (PGIM) and the Health Informatics Society of Sri Lanka (HISSL) could largely support for sustainable e-health deployment in the country by regulating the deployment strategies. With this background, the authors intend to propose a novel system and a deployment strategy for developing countries with special emphasis to Sri Lankan e-health situation. The features of the proposed system and deployment strategies are:

- Design a system that integrates functions for both medical collaboration and hospital management with flexibility of customizing/adapting to various clinical needs and future compatibility compliance requirements.
- Ensure that system is easy to install, user friendly and functionally rich, so that the medical physicians as well as medical institutions will tend to use the system for routine activities.
- Ensure maintaining a public server that provides system software, continuous updates, supportive documentation and discussion blogs.
- Continuous collaboration with the government to maximize internal acceptance and minimize interoperability gap.
- Help with already exiting systems to adopt/interwork with the designed system with minimal changes.

The rest of the sections of this paper are organized as follows: Section II presents an overview of e-health development in Sri Lanka. In Section III we present the rationale of the proposed system development its features. Conclusions and future work appear in section IV followed by References.

II. E-HEALTH DEVELOPMENT IN SRI LANKA

Sri Lanka is a country with a population of approx. 20 Million people. According to annual health statistics report of Sri Lanka in 2006, health personnel per 100,000 population accounts for 51.7 medical officers, 5.9 dental surgeons, 125.7 nurses, 25.5 public health midwives. There are 623 government hospitals that include one national hospital in Colombo, 18 teaching hospitals, 5 provincial general hospitals, 18 district general hospitals, 75 base hospitals, 122 district hospitals and 777 other peripheral units (mostly rural dispensaries). Computer awareness of the household population in the age group of 5 - 69 years stands at 37.1%. Average 8.2% of all households in Sri Lanka now possess a personal computer and 17.8% of urban households, 6.9% of rural and 1.1% of estate sector households own computers. Internet facility is available in 2.4% of rural households and 7.1% of urban sector households. Broad-band ADSL is available in most of cities and 3G cellular is becoming a popular and economic form of emerging broadband access method.

A. *Snapshot of e-helath actitivities in Sri Lanka*

Due to complexity and cost intensive nature, IT penetration to the health sector has not been considered by government's major IT plans. However, many projects are launched to improve the IT literacy in various professions such as e-health Initiative Professional Development Program [3] that primarily targets to enhance IT competency of different categories of medical staff. The government is setting up computer resource centers from where ICT services and knowledge are provided for people.

Health Informatics Society of Sri Lanka (HISSL) has been continuously conducting e-health promotional activities. Its last conference held in July 2008 [4] in Colombo reported many ongoing e-health activities across the country. The Postgraduate Institute of Medicine (PGIM) in Colombo has initiated a novel two year training program, M Sc in Biomedical Informatics, for medical and non-medical graduates. This will no doubt generate a group of qualified personnel to handle e-health activities in future.

Many sporadic e-health implementations are run in the country due to foreign aids. JICA Overseas Development Assistance (ODA) projects have been initiated in various health fields, namely: medical, dental, as well as nursing institution etc. Several local e-health implementations by using home grown technologies can also be seen [4] [5]. Many private hospitals maintain primitive Electronic Medical Records (EMR) and some of them offer e-consultations with specialists. Few Government hospitals have central recording of patient data using excel sheets or access databases that will help to generate patient's statistics, inventory handling, pharmacy

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management etc. Most of these e-health efforts are established due to medical cooperation with foreign counterparts to absorb technology.

B. *Problems with current e-helath implementations*

Current state of e-health systems suffers following problems and issues:

- Although EMR is used in most large hospitals, incorporation of computerized clinical data and digitized records of images such as x-rays into central record systems has not being practiced due to system limitations.
- Telemedicine activity has been limited to free available video conferencing tools like *skype* which totally isolates the activity from the institution's activity and restricts medical collaboration to mere video conferencing.
- Most e-health efforts in the government sector are due the hard work of one or few motivated and capable personnel, whose absence results in a non-functional system.
- Some institutions find obstacles to computerize clinical data because of the lack of suitable infrastructure. Therefore it is only being limited to demographic data and statistics which is not useful for clinical work.
- Due to lack of government involvement, inadequate system usability, and lack of IT technical support impedes internal and external technology acceptance.

III. A SYSTEM FOR SUSTAINABLE E-HEALTH DEPLOYMENT IN SRI LANKA

The authors' experience in Sri Lankan e-health development through deploying a medical collaboration system to link remote medical experts and local trainees can be considered as a successful e-health effort [6]. Since 2003, some of the authors have involved in developing and using a medical collaboration system between Saga University Japan and university of Peradenuya in Sri Lanka [7] to support a medical expert dispatching project funded by Japan International Cooperation Agency (JICA). Lately, a modified system with group communication support [8] was used to facilitate a *third country training program* on Maxillo-facial surgeries, which aimed at transferring the technology absorbed from Japan to the region by University of Peradeniya acting as a teaching center under the supervision of Japanese experts.

The successful deployment of the medical collaboration system for the above activities has shown us its potential to landscape Sri Lankan e-health penetration. This has motivated the authors to jointly design an *Integrated Medical Information System* (IMIS) that is proposed in this paper. IMIS can be customized to the needs of medical institutions and does not depend on high-speed transmission networks or costly equipments.

A. *IMIS architecture and features*

The proposed system is essentially a modular development as illustrated in Fig 1. to keep flexibility in customizing to various clinical needs. IMIS is formed by integration of two sub systems: already designed *international medical education and collaboration system* (IMECS) and newly proposed hospital information system (HIMS). A Sharable Content Model (SCO) is used to store data that extends flexibility to sharing and reusing. SCO is an object which is defined using metadata that describes its properties and methods that can be implemented on it. For example, each patient comes for consultation is defined with a set of semantic properties that describes his/her personal information, past episodes, medical records etc. Similarly, an x-ray image scanned and stored in JPEG format has its metadata to define its ownership, date scanned, radiologist's comments etc. Any document of which internal data is unknown to the system is stored as an *asset*. We adopt this model to facilitate a high-level and well defined content structure while keeping the content development burden as painless a manner as possible to the users at initial deployment. As the system evolves with advanced semantic type metadata extraction methods Richter medical database will be created.

All the contents are stored in the content store as ASCII character base text files (TXT), portable document formats (PDF/ DOC/ OTF), image files (JPG/ PNG), audio files (MP3/ RA/ RAM), video file (.MPEG, MP4/ MOV/ 3GP), flash movies, and streaming media files (ASF/ WMV/ WMA). The contextual metadata is stored in a XML database. The content management modules use semantic data linking that makes easy navigation and searching possible. Further semantic sharing handled by CMM easily caters for compatibility standards specified by HL7, which might be enforced in future.

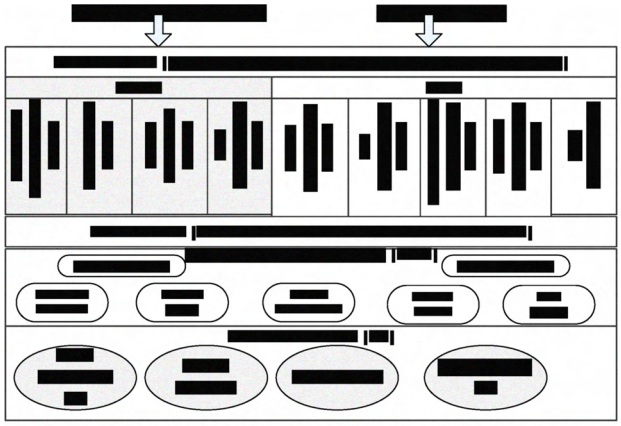

Fig. 1 Design Architecture of IMIS

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B. *Integrated multimedia education and collaboration system (IMECS)*

In our proposed system, IMECS sub system is an already completed design that we have successfully used for international medical collaboration [8]. IMECS integrate several functional modules such as video conferencing, remote collaboration, patient information management and user management. Fig 2 illustrates a snap-shot of the group communication system we developed for delivering remote expert services from Japan to Sri Lanka on Maxillo-facial surgeries. By simple customization, this system can be easily adopted for group meetings, remote consultation, and patient monitoring. An add-on for monitoring medical instruments

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signals is also planned in the proposed system.

IMECS also incorporates a web based asynchronous system that handles patient information management as illustrated in Fig 3. In our original design this system was supposed to provide shared access to patients' records during collaboration. Due to its SCO based flexible design, the system can be customized to manage personal or institutional wide multi-user patient information management. This module is to be extended to EPR module in the novel system.

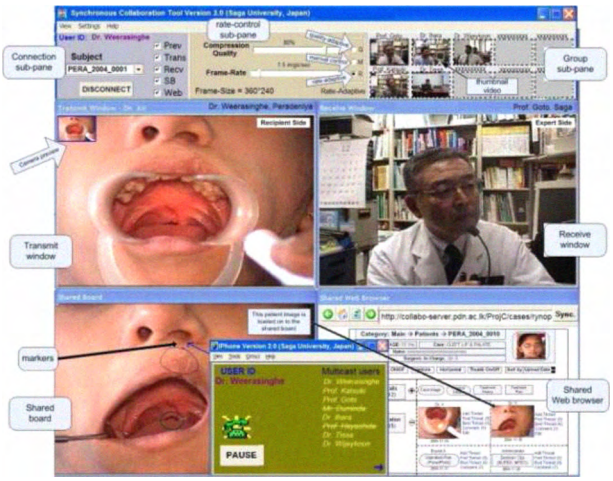

Fig. 2 Snapshot of the group medical collaboration system

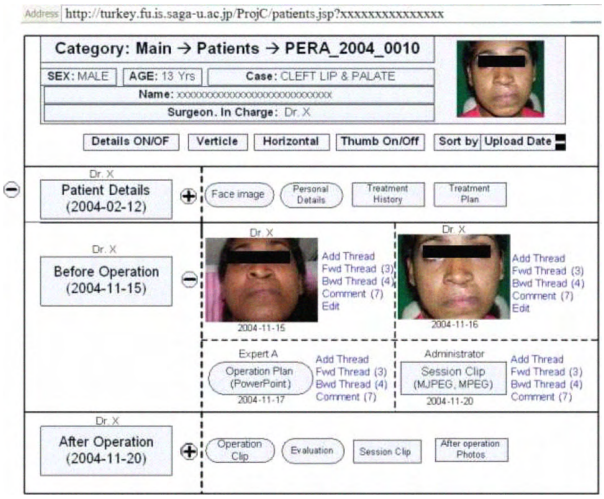

Fig. 3 Snapshot of the web-based patient information system

C. *Hospital management system (HIMS)*

HIMS subsystem, which is currently under development, incorporates several important modules that covers hospital management. All these modules share the common features of our SCO model, but facilities additional software artifacts for data entry and browsing. Cross-sharing of data is a promising way of interoperability made possible by semantic sharing among objects.

The electronic patient record (EPR) module is an extension to the patient information system already available. EPR module accommodates different levels of deployment: patient data inputs ranging from complete scanned patient data sheets to fully hypermedia based patient records. While our system address the primary needs of HIMS it leaves flexibility to incorporate advanced sub modules like theater management and ICU management as the system evolves. We also believe the existing systems installed in hospitals can be ported to this system without much effort, as necessary.

IV. CONCLUSIONS AND FUTURE WORK

In this paper we presented a workable system that could enforce sustainable e-health deployment. Although this is a non-trivial task; the authors' technical capabilities, practical involvements in health activities and interaction with Sri Lankan e-government initiative motivates the authors to challenge this mission. We presented a snapshot of proposed integrated medical information system (IMIS) which is an extension of the already developed *integrated medical education and collaboration system* (IMECS).

As for future implementations publishing a website for IMIS is planned (http://nish.ict.apu.ac.jp/IMIS). The system will be available for download and install in windows systems. Other modules currently being developed will be dispatched in 2010. Installation instructions, demos and remote consultation is provided in collaboration with institutions in Sri Lanka such as ICTA and PGIM. We conduct a massive survey on scattered e-health activities in Sri Lanka, their formation and current status best understand the needs for customizing the designed system. The authors also invite collaborative partners in Japan and Sri Lankan universities to join this venture to expedite the process. We believe the proposed system will support future Sri Lankan e-health initiatives majorly and will adapt to the future e-health requirements with Sri Lanka by closely working with Sri Lankan health sector and the government.

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