Application of RFID Technology in e-Health Management and Outsourcing in Bhutan

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Abstract
The evolution of medicine and Information Technology has enabled emerging health informatics to be used in healthcare system in innovation ways. This has given rise to recent e-health applications that support public access to e-health facilities. This paper focuses on e-health management and its introduction in Bhutan through the use of RFID technology and also the use of digital health records together with communication between the health care-givers and patients over long distances (referred to as outsourcing). This paper proposes a health management system using RFID technology that tags patients, health records, health workers and equipment for an automated database update system for tracking and tracing.

Index Terms: auditing system, e-health, outsourcing, RFID technology, Bhutan.

Introduction
Recent evolution in Information Technology in health informatics has enabled us to look at existing healthcare systems in new ways, the ultimate goal being delivery of the best possible health care services for anyone, at anytime from anywhere. E-health is a recent term used in relation to healthcare provision ‘combined use of electronic communication and information technology in the health sector; the use in the health sector of digital data - transmitted, stored and retrieved electronically - for clinical, educational and administrative purposes, both at the local site and at distance’ (Della Mea, 2001).

Public access to e-health applications is growing but e-health care services will not be used unless both patients’ and clinicians’ expectations and experiences are taken into account during their design and adoption (Gustafson and Wyatt, 2004). Recent improvements in IT technologies have significantly aided health care sectors in different parts of the world and it is now important to develop initiatives to improve service to patients. The Commission of the European Communities indicated that the e-Health market is currently some 2% of total healthcare expenditure in Europe and has the potential to more than double in size (Stroetmann et al, 2006; Sahar and Asi, 2009). E-health tools have tremendous potential to encourage people to adopt healthy behaviours to promote disease prevention, healthy life style, and early detection (Neuhauser and Kreps 2010).

People are increasingly using e-health applications, particularly the internet, to seek health information, to communicate with others who have a similar disease or illness, to receive prevention messages and health promotion advice, and to communicate with healthcare providers. Trends in 2000 indicated that Internet users seeking health information and healthcare services would more than double from 2000 to 2005, reaching 88.5 million people (Shumaker et al, 2009).

Areas of health informatics
According to Svensson and Per-Gunnar, 2002, there are three areas of health informatics based on the predominant type of user or use (Svensson and Per-Gunnar, 2002).

Consumer informatics: This category focuses on the patient and public communications regarding health topics.

Medical and clinical informatics: this category is related to health care structure, processes and outcomes. The main application is medical records like computer based personal records that will facilitate access to low cost therapies and computer based patient records that will facilitate clinical decision making.

Bio informatics: this category is related to creation and advancement of databases, algorithms, computational and statistical techniques and theory to solve formal and practical problems arising from the management and analysis of biological data.

A survey was carried out in California to investigate the rate of adoption of service systems such Electronic Health Record (EHR), Computer Physicians Order Entry Systems (CPOE), Radiology Information Systems (IS), Pharmacy IS, Laboratory IS, Administration IS (AHA, 2008) and the results are depicted in Table 1. Table 1 show a survey of 33 Hospitals in California with the number of responses and corresponding percentages depicted respectively.
Bhutan is a Himalayan kingdom with a population of about 700,000 and is a developing nation with basic health facilities. Although the country and its citizens have the benefit of free healthcare, because of its difficult terrain and mountainous nature, the health facilities are unavailable in some remote areas. A visit to the best facility that is situated in the capital would take a minimum of one day making it difficult and risky for patients. This paper proposes a possible solution to support better healthcare management in Bhutan and discusses the solution using emerging technology such as Radio Frequency Identification (RFID), digital scanning and outsourcing etc.

National Referral Hospital, Bhutan

The main hospital in Bhutan is The National Referral Hospital known as the Jigme Dorji Wangchuck National Referral Hospital situated in the capital of the country, Thimphu. Since it was established in 1972, the hospital has been supplying free basic medical treatment as well as advanced surgeries and emergency services to citizens from all over the country. It provides the most sophisticated health evaluation and management services in the country.

In the late 1990s, a plan was launched to upgrade the then 175-bed Jigme Dorji Wangchuck Hospital to a National Referral Hospital with assistance from the government of India. Investigation showed the existing structure to have limited functionality and the planners proposed upgrading to a new 350-bed hospital. By 2002 a laboratory building, compound wall, gift shop, doctors’ and nurses’ quarters and an internal road system was completed.

The hospital caters to the population of the Thimphu district, non-referred patients from neighbouring districts and referred cases from the 20 district hospitals. The hospital not only functions as the National Referral Hospital for the entire country but also functions as:

- Human resources pool and technical backup for hospitals.
- Clinical training centre for the Royal Institute of Health Sciences (RIHS).
- Technical support to the Public Health Programs

Medical records in Bhutan

JDWNRH is the only National Referral Hospital providing tertiary medical care to the people of 20 districts and technical backstopping to all the hospitals and health centers. The medical referral committee of this hospital also refers many patients requiring special investigation, treatment and/or surgery to India and third party countries. Consequently, it is of the utmost importance to maintain individual patient records for all patients, for reference purposes. In 1995 on the invitation of the Health Department, Mr. Peter Parslow, who was the Administrative Officer of Mongar Leprosy Mission hospital introduced a computerized patient record keeping system for the In-patients at JDWNRH which was developed in FoxPro software and this was used until December 2004. However, the data currently in the system does not give adequate information and the system is in the process of being upgraded to accommodate new changes but this requires logistical as well as technical support.

There is a vision of a fully computerised medical record keeping system using a local area network (LAN). All patients attending JDWNRH will be registered using a computerised system at the Registration counter and disease and treatment information will be recorded in the Pharmacy unit. This type of computerised Individualized Patient Record (IPR) system will show a patient’s lifetime record of hospital visits with all the information concerning patient illness and treatment.
Gradually all the wards, Doctor’s chambers and Out Patient Department (OPD) chambers will be fully connected by LAN to enable information to be accessed from authorized health service personnel.

To maintain accurate individual records vital information such as full name, date of birth, National ID number of the patient or ID of parents in case of minors, father’s name, permanent Dzongkhag where one’s census is recorded, present Dzongkhag working or living at, contact address in case of emergency etc, would be recorded. This is some of the important information a patient or guardian would need to provide at the Registration Desk for the initial registration. However, for subsequent visits it will be relatively easy to retrieve the information just by entering the Patient Registration Number into the system.

The primary function of Electronic Health Records (EHR) is to enable the delivery of safer, higher quality and more person-centred healthcare and especially to enable seamless care across the traditional health service boundaries. In providing a more comprehensive picture of health demands and resource utilisation, it also greatly supports the management information function (Department of Health and Children).

**RFID System as a solution in Health Care**

In Information and Communication Technologies (ICT) there is increasing interest in the use of Radio Frequency IDentification (RFID) in hospitals, which comes from the possibility of obtaining improvements in terms of efficiency, quality of health care treatment and error reduction (Correa et al. 2007, Thuemmler et al. 2007). RFID allows wireless detection of data that can then be automatically stored and retrieved from a database. In a hospital environment the adoption of RFID can assist in information processes and support staff in providing efficient medical services. Nevertheless, any organization that plans to adopt RFID has to face multiple challenges, including overcoming the technological, managerial and organisational problems (Wang et al, 2006). The main goal of the present study is to propose an RFID based service platform for hospitals, which is consistent with a service science driven design approach.

Figure 2 shows an example of a typical hospital layout. There are RFID reader antennas situated at various points in the hospital to pick up the tags that are either placed on patients or objects (Jervis, 2005). These readers would normally be operating continuously to monitored and record data from tagged objects such as patients and assets etc. This information is then continuously being logged into the database to maintain the hospital records.

The use of RFID provides an integrated solution to provide real time status information on hospital medical assets such as defibrillating equipment and pharmacy issues etc. Reducing the time taken to locate medical equipment for seriously ill patients could improve prognosis and avoid dangerous delays. RFID systems help locate medical equipment tagged with RFID tags within a shorter period of time and reduce manpower required in locating such equipment.

Another use of RFID in hospitals is the automatic update of the patients’ information into their records during the required treatment and service provision at the hospital.

**Figure 3: RFID System for Asset Tracking in a Hospital**

Figure 3 outlines a proposed scalable platform for asset tracking in the hospital. The asset tracking platform has two major components, namely, Pharmaceutical tracking and Medical Devices tracking. The Medical Devices tracking solution also provides data to the Clinical Engineering Database (CED) of the hospital that enables faster repairs of critical equipment by tracking their usage log. In this platform, all the tracking data is first collected by the readers installed throughout the hospital premises. The readers could collect data from tagged medicines or medical devices or tagged blood containers and organs etc, which are in the vicinity. All the collected reader data is fed into the centralised data aggregator, filter and router. This unit will collect all the data flowing from each individual reader and filter it for false reads, multiple reads etc. Once the data has been filtered, it...
will be channeled to the appropriate database. The information collected from the tagged medicines, blood containers and available organs would be stored in the Pharmaceutical Database (PD). The reason to group medicines data with blood containers and available organs data is because of the similarity in the Radio Frequency (RF) nature of these items. Blood or available organs would be retrieved for a patient only on the recommendation of a doctor in a similar way to medicines. Also these items have similar composition (organic and water based), which would result in similar tag responses when the RFID reader enquires.

The second set of data collected from all the tagged medical devices is sent to the Medical Device Database (MDD). The Medical Device Database is connected to the Clinical Engineering Database (CED), which stores all the repairs and servicing information of the medical devices. The device usage history log can be used in addition to the CED data by the repair engineers for faster malfunction detection. The data stored in MDD, PD and CED is accessible to authorised hospital staff through the Hospital Staff Interface. The blood bank and pharmacies can be linked with the hospital system using similar RFID readers by tagging their products. The data path between the blood/organ banks and the pharmacies could be through dedicated lines or through the Internet depending upon the infrastructure present in the hospital and capital investment requirements.

Due to the high read rate of RFID tags, the database might need to have improved data filtering and streaming capability. Compatibility with existing systems is essential to encourage wider use in adopting new technology and this can be easily arranged from the migration from bar code reading systems to RFID systems.

Bhutan being a mountainous country with dangerous terrain roads and unreliable weather makes the transfer of seriously ill patients time-consuming, dangerous and risky to the health of the patient. RFID technology along with wireless networks can be used to provide long distance assistance to patients. Thus the patient could still be in one area and receive health related advice from another area in Bhutan. Cases like regular tests (as in the case of diabetic patients) or medical advice and solutions for some minor problems can be dealt without having to travel.

**Outsourcing**

This paper has described the use of RFID technology for data collection and tracking of medical equipment and patients etc. Digitalising of patient records (Sangwan et al, 2005); treatment and medication etc would also be beneficial. The adoption of digitalised health care systems from the compilation of digital data would also enable transfer of data both internally or to any part of the world through satellite transmission. Figure 4 illustrates an application where a hospital in Bhutan could transfer information internationally for medical support. When a patient consults a local doctor and is advised for a CAT scan (Computerised Axial Tomography), the CAT scan is taken and its details are logged into their personal file in the database. This data can then be sent to another facility overseas for a specialized consultant (Ho and Atkins 2005) e.g. from UK to advise and support the local doctor in Bhutan regarding the patient’s treatment and/or operations.

**Recommendations**

Though the idea of e-health has been readily accepted in peoples’ lives, there are number of challenges that need to be resolved:

**Enhancing interaction:** The majority of patient and clinician encounters take place for purposes of exchanging clinical information. It is estimated that only a small fraction of physicians offer e-mail interaction, a simple and convenient tool for efficient communication, to their patients (Institute of Medicine, 2001) The health messages and advice always originate from the experts and are directed down the chain to consumers. Too often, the authoritative delivery of health information without active consultation with consumers is perceived as intimidating and off-putting (Neuhauser and Kreps, 2003).

**Increasing the interoperability:** A wide range of consumers and care-givers must be able to work together in the e-health communication system.

Complex health problems often involve collaborative efforts between numbers of health care experts. Though the experts work in different offices, or health care systems, they must be able to have timely access to accurate health records for effective care coordination.

Creating e-health communication that is dynamic and engaging.

Designing communication to have the reach of mass media and the impact of interpersonal connections.

**Conclusion**

The paper uses the National Referral Hospital, Bhutan as an example to propose an RFID based system which is consistent with a service science driven design approach. The different
steps of the service design methodology have been drawn from the literature. Various operations that could be streamlined by the introduction of RFID technology to improve their efficiency and performance have been showcased. A sequential customisable adoption technique for the hospitals would be introduced depending on priorities and finance. This allows the hospitals to optimise the RFID service platform in a way that benefits their operations. Future studies should focus on action research, in order to empirically identify organizational and technical issues concerning the implementation of the service system proposed.

There are numerous applications of information technology to health care practices. The e-health sector covers various topics such as telemedicine, electronic records that provide paperless systems, recruitment, procurement, healthcare score cards, audits, information systems etc. The recent rise in the use and study of e-health offers the advantages of using telecommunication to deliver improved health services. E-heath has the advantages of reducing costs, improving quality, and improving access to care in rural and underserved areas of the country. However the extent of these advantages is largely speculative at this time (Khanna, 2005).

References


