RFID-based Drug Management and Monitoring System, Case of Public Hospitals in Tanzania, A Review Paper.

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ABSTRACT

RFID is an automatic identification technology that enables tracking of people and objects. Recently, RFID technology has been deployed in hospital environment for patient and equipment tracking, surgical equipment monitoring, medication monitoring and improving health record access in emergency cases. The main advantages RFID technology are to provide resource optimization, quality customers' care, enhanced accuracy, efficient and effective business processes and healthcare processes. The pharmacy department undergoes challenges such as complex manual work of record keeping and inventory management. The RFID technology can be deployed in pharmacy hospital unit to automate pharmacy process. In this work we present a review on current pharmacy management practices in the case study of public hospital in Tanzania, review on different research work to address the pharmacy challenges and finally proposed a system to overcome the limitation identified in the current systems.

Keywords: RFID, UHF Radio Frequency, Drug management and monitoring, public hospital

1. INTRODUCTION

Radio Frequency Identification (RFID) is an automatic identification technology that enables tracking of people and objects [1]. RFID utilizes electromagnetic waves for transmitting and receiving information stored in a tag to/from a reader [2]. A typical RFID system is made by at least three components: the radio frequency transponder (tag), the reader which is basically a transceiver controlled by a microprocessor used to inquiry a tag, client software to communicate with a reader through a reader protocol, collecting, storing, and/or processing codes retrieved from the tags. RFID Technology has an edge over other identification systems such as barcode systems, magnetic strip cards, smart cards, and biometrics (voice, fingerprinting, retina scanning) because it requires no line of sight for communication, sustains harsh physical environments, allows for simultaneous identification, has excellent data storage, wide read range and is cost and power efficient.

Public hospitals are all health care providers that are publically owned, operated by the government as their service to the citizen. Health care providers, such as hospitals, have a pharmacy department within the hospital that coordinate the ordering drug from supplier and dispensing of drugs to the patients and other hospital units. In Tanzania all public hospitals receive or purchase drugs/medications from the national medical store department (MSD) and few drugs from other suppliers or distributors. The pharmacists in health care institutions have

been burdened with the increasingly complex manual work of record keeping and inventory management that results from hospitals caring a numbered of patients every day [3].

The pharmacists in hospitals are responsible for filling individual patient prescriptions on a daily basis; maintaining sufficient inventory of each drug in order to have enough quantities of the drug in hospital stock to administer to patients on a daily basis; accounting for the purchase of drugs to be used in the hospital; accounting associated with the giving of drugs to individual patients; distributing the drugs to the appropriate nursing stations and wards within the hospital to suit each station's daily demands; tracking of drug expiration dates to get rid of expired drugs; tracking of drug lot numbers, reporting to the hospital management on all matters concerning drug ordering, dispensing and delivery. In addition to that there has been several instances reported on theft and loss of drugs in hospital environment, for instance, MSD's Internal Audit investigation report of October 2007 the missing/stolen medicines valued at USD 133,000 (163.2 million TZS) [4]. Another case reported by Bate et.al (2010) [4] revealed that some public sector medicines had been diverted to private markets. That is, medicines intended to be dispensed free of charge to public health facilities, which may have been donated by countries or manufacturers as part of aid programs, or sold at very good discounts, were bought by researchers at varying market rates in the private sector [5]. Thus, there is a potential reason on developing a technological means on monitoring the drug supplied to hospital to reduce losses and unintended use of drugs.

Despite the fact that all these duties can be simplified by integrating the information system management yet no electronic system is deployed in public hospitals in Tanzania. Various methods have been employed to assist a hospital's pharmacy department with maintaining accurate records while attempting to reduce the burden of managing all of the information associated with drug distribution. This paper provides a review on review of different technologies which are used for drug monitoring and management. The paper is organized as follows: part 1 is covers general overview of the pharmacy challenges, overview of information systems in use in the case study and explain how the pharmacy department is being managed. Part 2 reviews various research work done to combat the explained challenges and their limitations. Then Part 3 explains the proposed solution to the challenges facing pharmacy management in hospitals, while part V concludes the paper.

1.1 INFORMATION SYSTEMS IN TANZANIA'S PUBLIC HOSPITALS

The existence of hospital information management system had catalyzed this research proposal since the government and health institutions had recognized the importance of information system in streamlining health provision. For instance, the AICC hospital in Arusha uses the Care2x system for its hospital management. However, the only limitation of the system being that it does not offer drug tracking and monitoring capability for prevention of unauthorized drug movement outside the hospital. Also the system is limited on stock automatic updating and capturing.
The government of Tanzania in collaboration with Management and development for health (MDH) has established a CTC care databases where by every HIV infected patient receiving ARV drugs is recorded and monitored. The limitation of the system is that the drugs in stores cannot be automatically tracked and managed.

In case of unauthorized drug dispensing the system cannot sense and notify the relevant authority.

The Health Management information System (HMIS) project with main goal in The provision of quality data and indicators on MDG 4 & 5 [6] Through this system which is installed in every district and region the health information is easily exchanged and managed. However in all these system the module for managing and monitoring the pharmacy department is missing. The presence of this system managing other health data like maternal and child care information the development of drug monitoring and management system can be integrated and thus simplifying information transfer on the actual stock status and usage of all drugs supplied to hospitals.

1.2 CURRENT DRUG MANAGEMENT PROCESS IN PUBLIC HOSPITAL IN TANZANIA

Most pharmacists in Tanzania's public hospitals use traditional way of paper-based process to document disbursed drugs at hospital facility, ordered drug from suppliers, order follow ups before delivery and receive ordered drugs Moreover they also need to verify the orders, keep received drugs in stores, maintain them in the storage facility till they got dispatched to the intended unit Also, pharmacists are responsible for keeping records on all pharmacy related matters, keep track on drug and carefully dispose the expired drugs. Despite the fact that pharmacists spend most of their time on paper works and ensure all drug records are updated. The pharmacy store receives drugs and medical equipment from suppliers in bulk thus had to maintain them in stores until they dispatched to the intended parties.

The dispensing unit where by patients obtains drugs from, the records are kept through filling individual patient prescriptions and amount of money paid for the drugs. Basically, the whole procedure is done by filling up several information on the papers and other monitoring activities need to be done manually.

2. REVIEW ON VARIOUS DRUG MONITORING AND MANAGEMENT SYSTEMS

The problem on pharmacy management and monitoring had brought attention of many researchers. In addressing the hospital pharmacy management problems several studies from academia and industry have been carried out to mitigate some challenges faced in hospitals. This section presents some literatures addressing some pharmaceuticals research problems and thus would provide a better solution by bringing new ways suit the Tanzania's environment. This section is divided as follows; pharmaceutical supply chain management protocols, drug dispensing systems, and medication monitoring systems.

2.1 PHARMACEUTICAL SUPPLY CHAIN MANAGEMENT PROTOCOL

Other research works were concentrating on establishing the protocols and procedures to manage and monitor drugs at the hospital environment. Work done by Kelle et.al (2012) aims at developing a model for proper utilization of resources at the pharmacy store, the study came out with order and refill levels of drugs in the information systems [7]. This provide the basis in system designing where by the proposed refill revel could be used as reference stock level to alert users to reorder prior to total stock out.

2.2 SMS BASED DRUG MONITORING SYSTEMS

The Novartis Company developed the SMS-based system for anti-malarial drugs in sub-Saharan Africa. The technology was developed to prevent stock-out of antimalarial drugs in remote areas by taking advantage of the present availability of mobile phones network coverage even in rural areas. The system automatically sends weekly SMS text messages to mobile phones at public health facilities requesting information on their updated stock levels [8]. The major challenge for the effectiveness of this system is that the remote health centers are served by the district hospital where the automated drug monitoring and ordering system is not in place. Thus even if the SMS from the remote health center will be received will be difficult to be processed since even the district level can get out of stock without notification. This can be considered as a call up on development of information system for drug monitoring and management at the hospital level.

2.3 MEDICATION MONITORING SYSTEMS

Medication errors are an important cause of patient morbidity and mortality and excessive costs [9] thus the development of assisting information system is vital in efficient health care provision. Howard et.al (2013) developed a system for maintaining drug information and communicating with medication delivery devices, the system includes software for use in hospital pharmacy and biomedical environments [10]. Also, Zhou (2012) designed and developed the medication error control system which was RFID-based prototype software that can be used to monitor and administer the drug medication in hospital environment [11]. One of the problems with the system is that they are limited to medication error control not extended to pharmaceutical monitoring and management.

2.4 DRUG DISPENSING MONITORING SYSTEM

Over the past decade hospitals in developed countries has been assisted by electronic drug management machines [12]. Lester et al. (2000) developed a system for drug and health care supply distribution and replenishment. The system performs drug information transfer, drug inventory management, and drug packaging. Moreover, machines are placed at each dispensing point and electronically connected to central pharmacy department for trucking drug administered to patients at that particular health care unit. As a result, hospitals have improved to some extent in terms of how drugs are dispensed to patients and the record keeping required by the pharmacy departments Reardon et al (2013) designed a drug

distribution system which utilizes a central pharmacy and database to track all prescriptions for sensitive drugs., Information is kept into the database showing all physicians allowed to prescribe the sensitive drugs, and recipients of drugs/medications so as during drug dispensing the system will cross check to ensure that the right doctor prescribes sensitive drugs/medications to the right patients [13]. However, the system is more advanced and suitable to the hospitals with well-established information system network across all hospital units, which is not the case for the Tanzania's hospitals. Also the limitation of drug management and replenishment system is that in public hospitals there are no electronic systems for patient records nor for medical prescription and therefore deploying such a system is not feasible.

3. PROPOSED DRUG MONITORING AND MANAGEMENT SYSTEM

Although barcode labeling is inexpensive, reliable, and widely used, the technology's limitations such as the line-of-sight requirement and short-range reading distance make it a slow and labor-intensive process [2]. Receiving, storing, sorting, and shipping processes will all benefit from this wireless technology and become more efficient and effective [14]. The proposed system intends to utilize Radio Frequency Identification (RFID) technology to manage and monitor drugs in hospital environment for the case of public hospitals. The proposed system intends to be of low cost by utilizing UHF RFID tags to tag the drug to be monitored. The system will comprise of central database, the RFID network, and user/administration interfaces. The proposed system will prevent unexplained drug loss, save government expenditure by ensuring available resources are well spent, simplify stock keeping, prevent stock-out by integrating re-ordering notification on preset stock level, well record keeping, improve health service and eliminate manual work performed by pharmacy staff.

Traditionally RFID technology thought to be deployed in health care to identification of a patient in emergency situations; patient vital signs measurements (for example, for patients with chronic diseases); recording significant medical information and transfer to an electronic monitoring device; monitoring the elderly, even at their home; monitoring of goods and equipment; controlling drugs administration and blood transfusions, thereby reducing medical errors in hospitals [15]. This work intends to research the usability of RFID in health care in drug monitoring and management.

RFID technology is classified as a wireless Automatic Identification and Data Capture (AIDC) technology that uses electronic tags to store identification data and other specific information, and a reader to read and write tags [16]. RFID network therefore consists of tags, readers, middleware and database. Tags are small chip with an antenna and there are three different types of RFID tags: passive ones that use the reader's signal to be activated, and active tags which have battery, and semi-passive which battery-assisted, activated by a signal from the reader. Depending on the type of tag, RFID tag can carry more information (such as product code, serial number, expiry date, batch code) as compared to similar technology such as barcode which keep only product code. The RFID tag transmits the information data stored directly and without direct line of sight to a reader by radio frequency. The reader

transfers this information to the middleware for its transmission to a central database for further processing and decision making. The drive of using RFID technology in this research is the automatic identification and tracking of the objects with RFID tags which when utilizes can counteract unexplained drug loss and theft and thus increase drug availability in the hospital environments. Figure 1 shows the proposed system architecture.
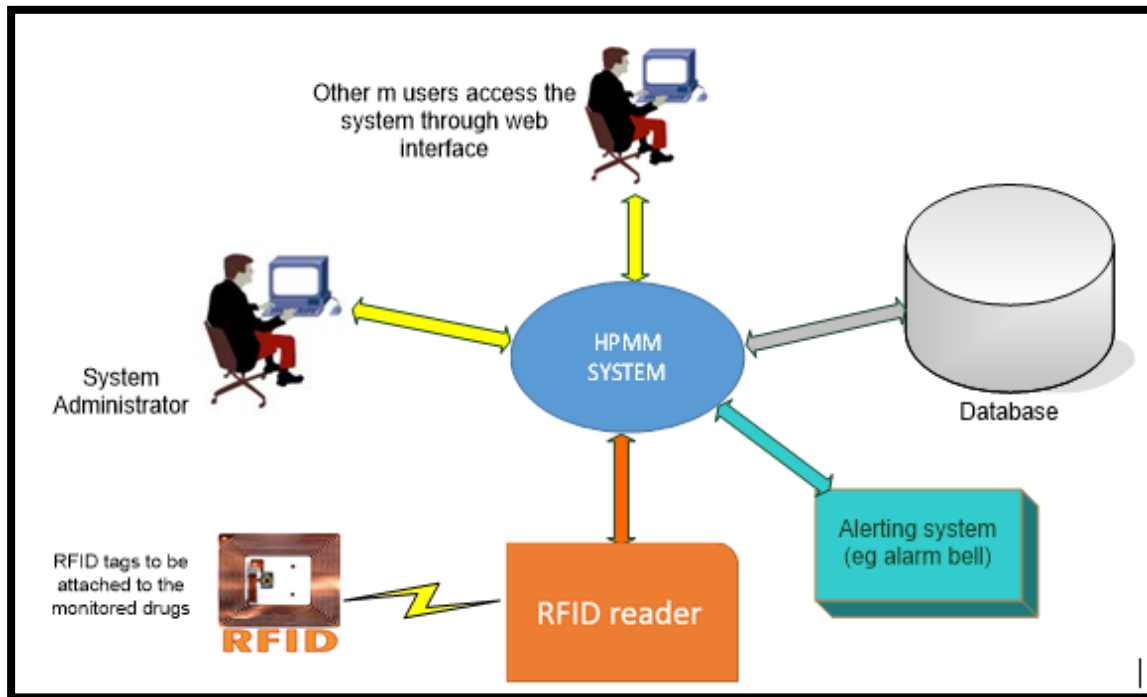

FIGURE 1: Proposed system architecture

4. CONCLUSION

The application of RFID technology in health industry can provide significant benefits in improving the pharmaceuticals supply chain management in hospital environment. This paper has presented a review on the actual situation of pharmacy management system the case of public hospitals in Tanzania and later a review on other research works done by other researchers in addressing pharmaceutical challenges and thus providing sustainable health service by ensuring drugs are available and well managed.

Lastly, we introduced and propose the RFID technology and its application in pharmacy management systems which can be adopted to mitigate problems faced by most of public hospitals in Tanzania. The proposed system intends to be of low cost by utilizing UHF RFID tags to tag the monitored drugs which will counteract drug diversion or loss in the government owned hospitals to the private sectors and therefore ensure drug availability at the hospital.

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