

## RFID: OPPORTUNITIES AND CHALLENGES WITHIN THE HOSPITAL ENVIRONMENT

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### **Abstract:**

Radio Frequency Identification (RFID) technology offers a range of potential benefits to hospitals. The constant movement of equipment, patients and staff around the hospital, makes it difficult to have real time information about them, such as their location, and their availability. RFID can improve the efficiency of hospital processes by reducing the time staff spent locating misplaced equipment, improving patient safety by matching the right drug to the right patient, and reducing overall cost of the supply chain. However these benefits have yet to be realised in large scale initiatives. This paper will provide a comprehensive review of different source of articles that look at RFID application in healthcare sector, more specifically in the hospital context. The review will identify factors that restrict RFID implementation in hospitals, factors that facilitate this implementation process, and the impact of RFID implementation on hospital business processes. RFID technology has great potential to deliver benefits in the healthcare sector in terms of business process efficiency and patient safety; however issues such as privacy, security, data management and reliability of the system and integration with suppliers need to be investigated before any implementation process.

### **Keywords:**

RFID, HOSPITALS, SUPPLY CHAIN

### **1. INTRODUCTION**

Increasing patient safety, making sure the right drugs are available to the right patient, maximizing medical staff productivity and reducing costs associated with healthcare processes are some of the main issues that face hospitals [1]. Issues such as wrong medication, counterfeit drugs, loss of high cost medical equipment and shortages of staff are the important problems any hospital can face [2]. Information technology plays a strong role in supporting hospitals in their attempts to increase patient quality care and meeting business process pressures (long waiting list, lack of staff, lack of equipment) [3].

RFID is one of the promising technologies that can support hospitals in their efforts to improve their business process needs [2]. RFID is a technology that depends on radio waves, which work as data carrier. Radio waves carry data from tags attached to an object to the reader. These tags could be active or passive depending on the application; frequency and the read range required are important parameters also. The readers transfer data to the middleware. This will then be applied to the enterprise system. The system may then use this data to support the business process such as patients care, and efficient resource management [4]. Data generated by RFID system help hospital to increase the

efficiency, reliability and quality of care provided to patients [5]. Correa *et al.* [1] believe that RFID help hospitals to apply lean principles (reduce waste and increase value) in their operations. According to a number of international research and studies, medication errors are mainly caused by medical administration process and mismatching patients (26%-34%), in Finland 33.6% of medication errors were in the administration process [6]. Using RFID technology to identify patients can reduce the number of misidentifications, and help hospitals to improve patient safety [7], improve the medical process and work flow [8], manage its resources in a more efficient way, manage its patient medication, ensure outpatient compliance with medication treatment after hospital discharge [9], manage its supply usage, reduce costly thefts, reduce operating cost, controlling the hospital or treatment centre access, and improve the documentation process [7, 10]. Glabman [11] estimated that medium size hospitals with 200 beds could save \$ 600,000 annually; a 500 beds hospital could save a \$1 million annually in form of fewer rentals, and improving staff productivity. Tagging medical devices at Bon Secours Health System Hospital, Virginia, USA, helped the hospital to save nurse time and improve their inventory management. It has been estimated that 25-33% of hospital staff time is spent locating medical equipments [9].

## 2. Research Methodology

The research methodology used in this paper is an inductive research method, where a comprehensive review of the literature relating to hospitals and RFID were conducted. Scholarly journals, academic magazines, white papers, conference proceedings between 2000 and 2009 and reports were reviewed and analysed. Databases were searched using the key words 'RFID', 'hospital', 'supply chain', 'challenges', 'opportunities'. Papers dealing directly with RFID in hospitals were reviewed to understand the pattern of RFID implementation in hospitals. Papers were analysed according to the following issues RFID application, challenges, and RFID in hospital supply chain.

## 3. RFID Applications within hospitals:

Vilamovska, *et al.* [12] in their detailed study on RFID applications in healthcare have identified four main functions of RFID used within a hospital environment as follows:

- Tracking: aims to track an object and provide real time information about its status and location.
- Identification and Authentication: a core function when it comes to patient safety, it helps to accurate patient identification, ensuring that the right drug is given to the right patient.
- Automatic Data Collection: aims to increase the process automation and reduce process time, and manage inventory. Also this function provides valuable information which can be used in quality control.
- Sensing: is related to patient safety. It helps provide real time information about patient condition, including monitoring patient compliance with medication prescriptions.

These functions could be applied for patients, medical staff and asset management. Tracking function is the most widely used RFID application in hospital. Identification is the second major function used within hospitals. The following table shows the main RFID applications within hospital environment. The table reflects the analysis of most of RFID

pilots and projects in different hospitals in different countries based of the previous main functions.

RFID Application	RFID Function	Benefits	Value to Patient	Expected Economic Value	Key Challenges
<b>1- Asset Management</b>	1-Tracking	1- Real- Time location & inventory control 2- regular maintenance 3- Management of surgical instrument	Quick locating when equipment needed especially in A&E department	1-Reduce the purchasing and rent bills. 2- Optimise medical equipment usage.	1-RFID could interfere with medical equipment signals
<b>2- Inventory Management</b>	1-Tracking 2- Identification and authentication 3- Automatic data collection & transfer	1- Inventory utilisation 2- Reduce misplacement of inventory 3- Improve restocking process.	1-Improve quality of patient care. 2- Increase the resource availability.	1-Reduction in inventory level and carrying costs  2- Ordering & receiving the right amounts of assets and equipment	1- Information security risk (data integrity)
<b>3- Patient Identification</b>	1- Tracking 2- Identification and Authentication 3- Automatic data collection 4- sensing	1- Improve work flow in hospital 2- Monitoring patient flow and location 3- Managing access to the hospital 4-Reducing administration processing time 5- Preventing data entry and collection errors	1- Improve patient safety	1- Less compensation expenses	1- Information security 2- Increased demands on nursing staff to keep RFID system working
<b>4- Staff Identification</b>	1- Tracking 2- Identification and authentication 3- Sensing	1- Real-time location information 2-Keeping current and comprehensive patient charts 3- Infection control 4- Intelligent medication monitoring	1- Reduce incidents harmful to patients (wrong drug, time, does, procedure) 2- Reduce errors due to misidentification 3- Reduce patient complication	1- Improve staff productivity 2- Reduce labor cost	1- Information privacy 2- Active tag size 3- Lack of clear laws about tracking of goods and people
<b>5- Drug Tracking</b>	1- Tracking 2- Identification and authentication	1-Insure right drug to right patient. 2-Enhance inventory levels 3-Track medication from time of dispenses until the patient receives it 4-Monitoring drug expiry date	1- Increase patient safety	1- Reduce inventory costs	1- Radio waves could have some effect on the drugs.
<b>6- Blood Tracking</b>	1- sensing 2- Tracking	Blood bags equipped with temperature sensors in hospital to ensure cold chain and efficacy	1-Reduction in the number of sample rejected 2- Reduction in patient safety incident 3- Improved traceability of blood product.	Amsterdam pilot estimated that average hospital can save \$550,000 annually	Active RFID tags could cause some interference with other equipment

Table 1: RFID Main Application in Hospital Environment

#### 4. Challenges of RFID Implementation:

According to ID TechEX prediction, the market for RFID in the US medical industry will reach \$ 86.3 billion in 2010 [13]. Improving patient safety and reducing medical mistakes are the main drivers of RFID implementation in healthcare industry. Also cutting cost along the

supply chain is one of the promising drivers of RFID implementation in healthcare sector. With RFID tags attached by the up stream suppliers (drug manufacturers, medical equipment manufacturers) through the logistic process, hospitals could benefit by reducing supply chain cost [7]. Based on the review of RFID implementation within hospitals three sets of challenges, have been identified, economic challenges, operational challenges and technical challenges.

#### **4.1 Economic Challenges**

##### **4.1.1 High implementation and operational costs:**

Costs include the costs of tags, readers, middleware, system integration, staff training, and the cost of system maintenance. Page[12] estimated that RFID infrastructure cost for medium- sized hospital could be between \$200,000 to \$600,000 for implementing proper RFID tracking system. Hosaka [14] estimates that for 1000 bed hospital, will use approximately 20,000 tags per day. The system cost will remain the major barrier of RFID implementation in the near future [5, 13, 15].

##### **4.1.2 Value generation and ROI expectation**

What value can RFID generate for the hospital? That is the first question managers ask when it comes to implementing RFID technology. Rush [16] argues that RFID implementation is an infrastructure investment not application investment, and the ROI of this investment comes from the application not from RFID system itself. When RFID system placed in the processes, hospital can benefit from different applications which use the same RFID infrastructure. However many hospitals claimed that their RFID application has proved itself on ROI terms. Mercy Hospital, USA, used RFID tags to track medium and low risk patients. This pilot reduced one-to-one patient watch activities by 64% resulting on \$110,000 saving cost annually [17]. The value of increasing patient safety, improving the work flow and helping medical staff in doing their job is acceptable in justifying RFID implementation [5].

#### **4.2 Operational Challenges**

##### **4.2.1 Data Management**

Data management is a critical issue in the implementation phase [18]. It includes data collection, filtering, management and interpretation tasks between RFID system and hospital enterprise application. Tags should be programmed to send purely required data; otherwise the system will receive large volume of data which could result in system failure [19].

##### **4.2.2 Implementation Strategy**

RFID implementation strategy in hospitals should involve all parties within the hospital in the implementation process starting from the design stage. Medical staff and IT staff should work closely. Medical staff should identify which processes needed to be addressed and IT staff should design how RFID application can work [5]. Lee and Shim [15] conclude that top managers should have knowledge about RFID ability. The lack of awareness of the potential benefits and implementation issues could prevent a hospital from adopting RFID. Also the literature shows that there is no leader of RFID implementation in healthcare industry that promoting RFID implementation within the hospitals [15].

##### **4.2.3 Open and Closed Loop Systems:**

Understanding the differences between the two systems is an important issue in the implementation process. In closed loop systems tags are used within the organisation. In

hospital environment, this is applied to track equipments, patients and medical staff. In a closed loop system involving only one hospital, a hospital can apply its own standards to track and identify their assets. The main aim of closed system within hospital is to control the internal process, inventory management, improve work flow, identify patients, tracking drugs and tracking medical staff [20].

Open loop system objects move through the whole supply chain from the equipment manufacturers through logistic providers to the end users [20]. RFID tags will be used in every stage in the supply chain; this brings attention to the importance of standardisation along the supply chain. The goal of open system is to improve the performance of the entire supply chain. In a hospital context this is important to enable any hospital to cut its supply chain costs. Strak [21] argues if hospitals manage to reduce 3% of their supply costs in terms of logistics cost and suppliers cost this can lead to 1% reduction in the hospital procurement expense. For any hospital to realise these figures more work will be needed with a wide range of suppliers and logistic providers to create standardised systems.

#### **4.2.4 Asset Management**

Many factors affect the critical RFID process of data transmission. These must be taken into account in the implementation process. Issues include who or what is to be tagged, the physical characteristics of an object, how often tags should send data to the readers, any interference occurring in the area of the application, and the layout of the hospital building. All these factors are important and have major effects on system implementation [5].

#### **4.2.5 Security and Privacy**

Data generated by RFID has highlighted issues such as security, privacy, integrity and the ownership of the data collected by different RFID application through the hospital. Patients' data will be available to different parties within the hospital, patients should be confident that their data will not be misused. Hagland [cited in [12] suggests that "neither personal, nor confidential information is transmitted via RFID". Also hospital staff should feel comfortable with the idea that they will be tagged and tracked all the time [3, 7, 9, 12, 22].

### **4.3 Technical Challenges**

#### **4.3.1 Radio Waves Interference**

Interference is another issue in RFID implementation as different wireless technologies and medical equipment will be used at the same time and area. This could cause interference between radio waves which results in system interruption, which is very critical in terms of patient safety [7, 23].

#### **4.3.2 Standardisation**

Which standard should any hospital use when it comes to RFID implementation? In the case of internal applications (patient tracking, medical equipments tracking) standard is not major issue, as hospital can use its own standards. However, in the open system case when products move through the entire supply chain from the manufacturer to the hospital, standard should be the same in order to reduce the cost of the operation and unity standards used along the entire supply chain [9]. Hospital should start to develop their own standards and RFID infrastructure as soon as possible otherwise "other industries will impose their own standards" [24]. Fuhrer and Guinard [9] argue that the Electronic Product Code (EPC) standards should be used as much as possible. EPC helps organizations to track and identify assets through their life cycle.

### 4.3.3 Reliability

A major benefit of an RFID system is real time accurate data. Data accuracy has direct effects on the reliability of the system, any false or failure reading can reduce data accuracy which also reduces the utility of the system. Hospitals should be able to face any missing or wrong data generated by the system, otherwise patient life it will in risk [8, 22].

## 5. RFID and Hospital Supply Chain:

Hospitals have drivers for RFID implementation, such as patient safety, equipment management, inventory management, and efficient business process. Some of these drivers will generate benefits only at the hospital level; however RFID has the potential to impact the entire supply chain from equipment manufacturers through the logistic providers to hospital. This raises the importance of open loop system; in this case the suppliers will tag each product moving through supply chain. This leads to two major aspects. Firstly the need of same standard to be used through the supply chain, secondly the cost associated with tagging products. Table 2 shows the costs and benefit associated with each party through the supply chain [20].

	<i>Supplier</i>	<i>Logistics Provider</i>	<i>Hospital</i>
<b>Costs</b>	Reader infrastructure	Reader infrastructure	Reader infrastructure
	Tagging	Integration to existing IT infrastructure	Integration to existing IT infrastructure
	Integration to existing IT infrastructure		
<b>Benefits</b>	Distribution	Reduce transport costs	Asset management
	Inventory management	Anti-counterfeiting	Inventory management
	Theft control	Increased visibility thus reduced	
	Support for recalls	business logistics process losses	

Table 2: Benefits and Costs of Supply Chain Parties [Adapted from [20]]

All supply chain parties can profit from RFID implementation if it is managed collaboratively. Suppliers can benefit from improved inventory management, and better distribution management. Pharmaceutical companies will be able to have efficient product recall. Logistics providers will be able to reduce business process losses and increase the visibility within the supply chain. Hospitals will be able to gain in financial terms by reducing supply chain costs [20].

## 6. Conclusion

RFID has the potential to support hospitals in their processes. From the patient's point of view, RFID is able to reduce harmful incidents caused by misidentification, and increase patient care quality. From an economic point of view, RFID can help to manage medical equipment more efficiently, reduce inventory level, and improve medical staff productivity. RFID is still an unclear technology for many hospitals' managers due to the lack of a clear return on investment (ROI) model to support their investment. However the literature documents many cases where RFID reduced costs and demonstrated ROI especially in asset management and inventory management applications.

The literature shows that in the open loop system, the majority of the hospitals have used just one RFID application within its operations, whether this application is asset tracking, patient identification or inventory management. Interference and the reliability of the system will be the main challenges of this kind of systems. Hospitals should take steps to increase the scalability of RFID implementation within their processes to increase patient safety, the quality of patient care, and reduce operating costs. In an open loop system, hospitals should work closely with their suppliers and their logistic providers to reap the benefits of RFID through the entire supply chain. Standardisation will be the main challenging issue in open loop system. The literature also documented that there is no leader driving RFID implementation in healthcare, in contrast to the Department of Defense (DoD) in the defense sector and Wal-Mart in the retail sector in the United States (USA). Also there are many players and agendas in healthcare sector which make the implementation depending on hospital level. RFID in hospitals is a valuable area to search. Issues such as how hospitals and suppliers can optimise simultaneously the benefits of RFID implementation, and change management within hospitals are rich areas for future research.

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