

Research on application of RFID technology in health care

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Abstract

Radio frequency identification (RFID) technology has gained ubiquitous applications in various aspects in recent years. However, RFID adoption in health care has been sluggish and far behind public expectations. The classification tree structure of RFID research is constructed on the basis of problems faced in health care and the corresponding RFID solutions in order to present a systemic and comprehensive research about RFID in health care. Then the benefits and barriers to implementing RFID technology are summarized. Finally, suggestions for successful RFID adoption are proposed to aid future RFID applications in health care. This paper is intended to provide a good resource and guidance for better designed RFID systems so as to avoid unnecessary cost in adopting RFID technology in health care.

Keywords: RFID, health care, benefits and barriers, successful factors.

1 Introduction

Radio frequency identification (RFID), as a fast developing technology, has been successfully applied in the manufacturing, logistics, retail, and other industries. One important reason for the rapid development of RFID is attributed to the adoption of RFID by Wal-Mart, the US Defense Department, and Tesco [1].

RFID is considered to be the next-generation technology for data collection and tracking, a technological revolution in the next era of information. Generally, an RFID system is composed of tags, readers, antennas, and middleware. In contrast with barcode scanning, RFID can transfer data from tags attached to movable items to readers without line-of-sight and contact.



The health-care industry is directly linked with people's health and requires that medical supply be accurate and adequate, based on the corresponding needs of patients [2]. So it needs to reduce operational costs and increase patient safety, which can be complicated and challenging. RFID is believed to be the potential solution to problems in health care. Many health-care organizations in the world have successfully implemented RFID technology in the United States, the Netherlands, Singapore, etc., to improve efficiency and effectiveness [3]

Although RFID is reliable, fast, and does not require line-of-sight, the progress for its applications in health care has been slower than in other areas, like supply chain management. Reasons contributing to this problem need further investigations; the purpose of this paper is to help initiate and guide such research by classifying RFID applications in health care on the basis of problems faced in health care and the corresponding RFID solutions. By analyzing the benefits and barriers to implementing RFID technology, suggestions for successful RFID adoption are concluded to aid future RFID applications in hospitals.

The rest of this paper is organized as follows. We present classification tree structure in Section 2. The benefits and barriers to implementing RFID are provided in Section 3. Suggestions for successful RFID adoption are proposed in Section 4. Finally, the conclusion is summarized in Section 5.

2 Classification tree structure

To present systemic and comprehensive research about RFID in health care, the classification tree was constructed, which first classified RFID research into two broad categories: challenges faced in health care and RFID applications in health care. Then, both the categories were subdivided into more detailed classes. With progress in the process of classifying RFID research, the classification tree structure was developed. The structure is shown in Fig. 1.

2.1 Challenges faced in health care

Currently, hospitals are confronted with various and severe challenges, such as surging operating cost, serious counterfeit drugs problem, and low efficiency in emergency events [4]. There is an urgent need to improve patient safety and reduce pressure on hospital expenditure.

Counterfeit pharmaceutical products are a major threat to patient safety. The problem is so serious that it has become a growing concern for health-care supply chain and deserves enough attention.

In the surgical field, about 1,500 objects are left inside patients after surgery every year in the US, and two-thirds of them are sponges [5]. Patient safety is severely affected by medical errors, and a viable solution is badly needed.

The health-care industry plays an important role in the world's economy. Rising operating cost has posed an annoying problem to governments. Meanwhile, inefficient workflow in the face of natural disasters and catastrophic events significantly



impedes operations. Another concern related to health care is that, on average, one-third of hospital staff's time is wasted daily in searching lost equipment and assets across the hospital [6]. This translates to deteriorating efficiency and productivity at the workplace.

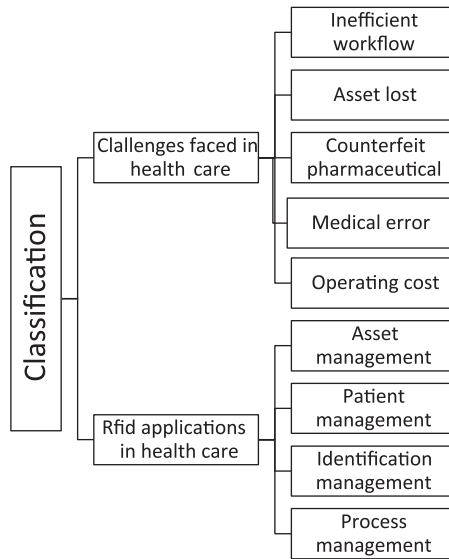


Figure 1: Classification tree structure.

2.2 RFID applications in hospital

Faced with the above-mentioned challenges in health care, RFID technology provides potential corresponding solutions and has been successfully implemented in several hospitals in the world. With the aid of RFID, hospitals could reduce medical errors, improve patient safety, and increase workflow efficiency.

The tracking capability of RFID technology has been widely taken advantage of in asset management such as in preventing theft and reducing time to search lost equipment. A pilot RFID project was tested at the Bank of Cyprus Oncology Center in Cyprus to locate medical equipment [7].

RFID has tremendous potential in terms of improving patient safety, which is a major responsibility of hospitals. In the health-care space, automated staff and patient identification can enhance security and reduce medical errors. Misidentification of patients is a common problem that many hospitals face on a daily basis. RFID technology can be employed for medical items in hospital. The US Food and Drug Administration has mandated pharmaceuticals that supply drugs to the US market to affix RFID tags on each of their drugs to avoid counterfeits [8].

RFID can not only realize the tracking and identification of items or patients, but also ensure safety in the complete health-care process and improve efficiency.

The pharmaceutical industry has applied RFID in tracking drugs from creation to receipt as they move along the supply chain to guarantee drug safety [4].

3 Benefits and barriers

The benefits of and barriers to RFID technology adoption were analyzed after RFID research classification. Furthermore, our ultimate objective was to make essential tactical suggestions to aid the construction of RFID systems in the health-care industry. Table 1 summarizes the benefits of and barriers to RFID adoption in health care.

Table 1: Summary of benefits of and barriers to RFID adoption in health care.

Benefits from adoption	Barriers to RFID adoption	
Prevention of theft or loss	Technological issues	Interference
Prevention of counterfeit pharma products		Read rate
Improvement in patient safety		Standardization
Time saving/cost saving	Financial issues	Implementation cost
Improvement in workflow	Privacy issues	Privacy and security
Reduction in medical errors		

3.1 Benefits of RFID adoption

We can benefit from RFID adoption through the classification of RFID applications in health care. The benefit of prevention of theft or loss can be realized through asset management using RFID technology. By tagging an asset with an RFID tag, real-time location information can be obtained, which can prevent loss of valuable medical equipment like IV pumps, wheel chairs, and telemetry transmitters, which in turn can save significant financial costs for hospitals. Meanwhile, staff in hospitals can reduce time taken to search lost medical devices.

The counterfeit pharmaceutical product problem can be alleviated by introducing RFID in tracking and tracing pharmaceutical products. RFID adoption in patient identification management and process control management can reduce critical medical errors. Leveraging RFID's tracking capability in asset management, gauze sponges can be embedded with passive RFID so that they can be detected if they are left inside patients after surgery [9]. With reduction in medical errors, patient safety will improve.

The application of RFID in patient management can notably improve patient safety. RFID has been successfully implemented to help elderly dementia patients in case they get lost and help navigate patients within a hospital toward their preferred destination without any waiting time [10]. This will result in increasing workflow efficiency.

In summary, benefits of RFID adoption include prevention of theft or loss and counterfeit pharma products, improvement in patient safety, time saving, operating cost saving, improvement in workflow efficiency, and reduction in medical errors.



3.2 Barriers to RFID adoption

Although there are substantial benefits of RFID adoption in health care, three main aspects of barriers to successful RFID implementation, in terms of technology, finance, security and privacy, have to be taken into consideration.

A hospital's unique environment could pose specific problems for RFID implementation because of the possible interference with radiation-emitting medical devices [11]. Therefore, onsite surveys are indispensable to avoid interference problems. Another concern about RFID is the fact that the read rate is affected by many factors, such as tag placement, angle of rotation, and read distance. Finally, lack of standardization of protocols for RFID at the hardware and software levels is a major obstacle for the deployment of RFID systems in hospitals.

The enormous financial investment for RFID technology implementation is a problem that any health-care sector that wants to deploy the system has to weigh carefully. The cost involves initial hardware and software purchase, as well as subsequent RFID infrastructure maintenance fee and staff training [12]. Furthermore, there is a potential of incurring extra cost when integrating RFID with existing hospital information system.

Security and privacy issues have to be confronted in RFID adoption in hospitals. To eliminate the anxiety of hospital staff and patients, it is crucial to tell them the purpose of the data collection and ensure the security of communication between RFID readers and patients' tags or the remote database through air interface.

4 Discussion

On the basis of the analysis of benefits and barriers, it can be concluded that RFID provides potential solutions to challenges faced in health care. Hospitals can benefit from the adoption of RFID technology in various aspects. RFID application in asset management can eliminate valuable-equipment loss and effectively prevent the circulation of counterfeit drugs, which will lower the operating cost of hospitals. Inefficient workflow will be alleviated with the realization of automatic data capture and accurate access to patient information, which will reduce medical errors as well. Furthermore, patient safety and satisfaction will improve. The challenges faced in hospitals and the corresponding RFID applications are closely correlated (Fig. 2).

Although the benefits of RFID adoption are apparent and attractive, the barriers have to be considered when implementing RFID in hospitals. Generally, three specific challenges will impede successful deployment: technological, economic, and privacy issues. Hence, the following suggestions are proposed for the successful implementation of RFID systems.

When implementing RFID systems in hospitals, other than top management's support, a clear objective and strategy, as well as a reliable and experienced RFID vendor and privacy and security issues must be considered. When an RFID project involves tagging patients, they have the right to reject it in case they believe there is



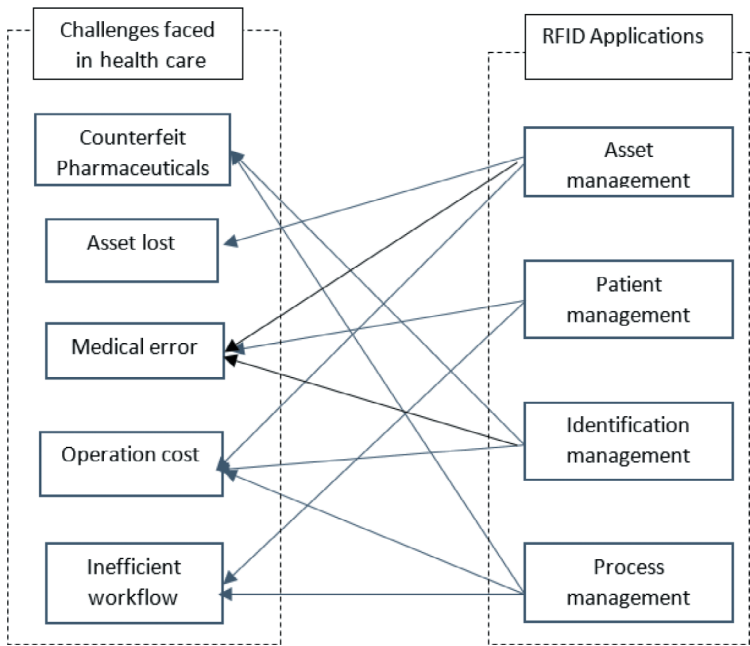


Figure 2: Correlations between challenges and RFID applications.

a possibility for personal information leaking out. Without their consent, an RFID system cannot be successfully deployed.

Table 2: Suggestions for successful RFID implementation.

Strategic suggestions	Tactical suggestions
Support of top management	Site survey
Clear objective and plan	Start with a small RFID project
Reliable RFID vendor	Publicity of RFID technology
Privacy consideration	Analysis of return on investment

Because of the unique environment in hospitals, RFID radio waves may interfere with medical equipment like X-ray machines. Meanwhile, RFID read rate could be affected by tag placement, angle of rotation, and read distance. All these problems cannot be identified unless a site survey is conducted. Furthermore, RFID-system performance should be tested by starting with a small RFID project. For example, an RFID system can be deployed at one department initially, and then depending on the performance, the hospital can decide whether to extend it to other departments.

It is better to publicize the RFID technology to patients and hospital staff in advance so that they have a better understanding of the benefits acquired from the adoption and potential privacy problems. This will ensure less resistance when implementing the RFID system.

Economic issue is a problem that cannot be avoided before deploying an RFID system. Stakeholders should perform a sound and clear analysis of return on investment for the RFID system. However, it should be reminded that, in addition to the tangible benefits of RFID system adoption such as reduction in medical errors and cost savings, there are intangible benefits like improvement in patient safety and satisfaction of medical conditions and refined business processes.

In general, suggestions for successful RFID implementation in health care (Table 2) can be summarized at two levels: strategic suggestions and tactical suggestions.

5 Conclusion

By conducting systematic and comprehensive research concerned with the application of RFID technology in health care, we aim, through this paper, to provide a good resource and guidance for better designed RFID systems so as to avoid unnecessary costs in adopting RFID technology in health care. During research, a content-driven classification tree structure was employed to classify RFID research into two broad categories: challenges faced in health care and RFID applications adopted. Then the categories were further subdivided into detailed and specific subclasses. With progress in the process of classifying the research, the classification tree structure was developed. By analyzing the classified RFID research, the benefits of RFID adoption were determined: prevention of theft or loss and counterfeit pharma products, improvement in patient safety, time saving, operating cost savings, improvement in workflow efficiency, and reduction in medical errors. Meanwhile, the barriers to RFID adoption were also derived, which were concentrated in three aspects: technological, economic, and security and privacy issues. In this study, we also proposed several suggestions to realize the successful implementation of RFID systems. In addition to top management's support, a clear objective and strategy, as well as privacy and security issues must be considered. A site survey should be carried out before RFID-system implementation. Publicizing the RFID technology to patients and hospital staff in advance will facilitate the progress of RFID-system deployment. Research on RFID applications in health care will grow rapidly, and this paper can serve as a guidance for future RFID implementations.

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