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THE USE OF RFID TECHNOLOGY IN THE PATIENT TRACKING SYSTEM

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Abstract

RFID has been deployed in a variety of sectors, including healthcare, however the acceptance and usage of RFID remain a concern. Despite its promise to increase healthcare provider efficiency and patient safety, there are several drawbacks to its use. The purpose of this thesis was to analyse the barriers, challenges, advantages, and disadvantages of using RFID in patient tracking system.

This thesis was conducted as a scoping review. The process for collecting and analysing data was done following the protocols described in literature. Literature searches were conducted using electronic databases (PubMed, Google Scholar, ProQuest, Wiley online, Sage Journals and Theseus). Only freely accessible studies published in English between 2010- 2022 have been included. The search process was done systematically, and only 20 articles were selected for further analysis in this scoping review.

Perceived advantages are the major aspect in promoting RFID use in healthcare. The research concludes that RFID in patient tracking system has barriers like privacy issues. Besides the advantages, there are also disadvantages of using RFID technology in the patient tracking system. To make the system more secure, issues related to the patient safety (i.e., security, privacy) need to be resolved.

Keywords:

RFID, Patient Tracking, Healthcare, Barriers, Challenges

CONTENTS

LIST OF SYMBOLS AND TERMS

RFID	Radio Frequency Identification
IT	Information Technology
IS	Information System
SARS	Severe Acute Respiratory Syndrome
IoT	Internet of Things
WARD	Wisely Aware RFID Dosage
WSN	Wireless Sensor Network
HIS	Healthcare Information System
ECG	Electrocardiogram
RTLS	Real-Time Location-based Services
ICT	Information Communication Technology
JCAHO	Joint Commission on Accreditation of Hospital Organizations
ISBT	International Blood Transfusion
FDA	Food and Drug Administration
ERP	Enterprise Resource Planning
CRM	Customer Relationship Management
DoS	Disk operating System
HIBCC	Health Industry Business Communication Council
EHR	Electronic health record

1 INTRODUCTION

Radio frequency waves are used by Radio Frequency Identification (RFID) technology to transmit and gather data. A transponder (sometimes known as a "tag"), a tag reader, as well as a computer program are all components of an RFID system. RFID tags include a microchip or a connection device (e.g., antenna). RFID tags may be classified according to their purpose and memory capacity. RFID, unlike barcodes, does not need a direct line of sight for transferring data. Another possibility is that non-conducting material could be used to electronically read data. It's now been made possible to take many measurements at the same time (Álvarez López et al., 2018).

As early as the 1940s, the RFID was originally used to identify friendly aircraft. Today, the RFID technology has been effectively used in manufacturing, supply chain, farming, transport, healthcare, as well as services (Martínez Pérez et al., 2012; Pérez et al., 2016; Yao et al., 2011).

RFID has recently been used in hospital administration. In the hospital, the RFID is useful for promptly retrieving and tracking the situations of patients. Creating a more secure healthcare system might reduce the incidence of medical mistakes.

Medical mistakes may be grouped into five categories: bad decision making, poor communication, insufficient patient monitoring, patient misidentification, and failure to react swiftly and poor patient tracking (Abugabah et al., 2020b). The current trend in boosting patient safety is to use novel information technology to eliminate these flaws and achieve the Joint Commission on Accreditation of Healthcare Organization (JCAHO) patient safety standards (Wu, 2019).

Even though there is little understanding about the benefits and drawbacks of RFID technology, it is expected that the technology will continue to grow and prosper within the health sector. According to the findings of Zhao et al., (2017), the health care service delivery may benefit from the information technology (IT) solution system in the form of authentication as well as identification of staff, patient data, blood verification, prescription and dispensing (Zhao et al., 2017).

2 BACKGROUND

RFID is a rapidly evolving technology that makes use of radio waves. When it comes to tracking items in warehouses, RFID technology has traditionally been employed (Duroc & Tedjini, 2018). For a variety of businesses, RFID has been shown to boost cost-cutting methods and increase efficiency. RFID has the capacity to autonomously collect data without the need for human involvement. Unlike barcode reading, RFID does not need a direct line of sight between the reader and the tag. When it comes to (RFID), there are two parts: tags, and readers. The reader contains a tool that emits radio waves as well as receives the signals directly from RFID tag, which contains one or even more antennas. It is possible to have passive or active tags, that transmit information to adjacent readers through radio waves. The reader provides power to passive RFID tags, which do not have their own internal battery. The batteries that power active RFID tags are indeed a relatively new technology (Perez et al., 2012). From a single serial number to multiple pages of data, RFID tags may hold a variety of information. When a reader is placed on a post or above, it may be carried by the user, or it can be hung on the wall. Cabinets, rooms, and buildings may all have reader systems integrated into their design (Xu et al., 2016).

Improved security, gap identification and closure, better bed allocation, physician schedule updates, and improved patient experience are all made possible by patient tracking in health facilities. Using RFID and Internet of Things (IoT) technology, it is now possible to follow patients and store and analyse their data.

RFID bracelets are provided to patients when they arrive at the hospital. Each tag contains pertinent information about the patient, such as the patient's ID, name, electronic health record, allergens, current health status, lab results, and suggested drugs. Information regarding a patient's position is collected by readers just on ceilings and walls of a hospital, which then transmits this to the IoT cloud to collection and processing. Analysis can be done in real time, for instance, to identify emergencies, or using historical data (e.g., medical record information), and to discover bottlenecks in internal hospital procedures and treatments. Once a patient has been discharged, the tag is retrieved and given to another.

The purpose of this literature study was to investigate the advantages and disadvantages of deploying RFID technology in the healthcare industry and to provide suggestions for overcoming possible obstacles.

The processing and incorporation of health data is a crucial responsibility in the healthcare system. To identify patients and the form of services delivered to them, as well as the history of the medication provided and accessing patient data, are all part of the normal patient service conventional approaches. Also, it requires human interaction in collecting and managing patient data, which might result in errors and drastic consequences. According to the latest estimates, around 44,000 individuals, and even more than 98,000 persons each year die in clinics as a result of preventable medical errors (Hailemariam et al., 2020).

This study focuses on the usage of RFID technology in the patient tracking system, that help hospital employees, including patients, physicians, nurses, technicians, admins, and other medical care providers. The application of RFID technology in healthcare systems has resulted in a remarkable breakthrough by reducing problems in the healthcare industry such as paper-based processes, poor perceptibility of patients, employees, hospital instruments, and records. However, before implementing this technology in the healthcare environment, numerous other critical concerns must be addressed, such as cost control, personnel management in healthcare sectors and ethical and legal constraints.

In conclusion, this research identifies the advantages, disadvantages of RFID technology in the patient monitoring system, as well as the challenges and obstacles that healthcare organizations face while implementing RFID technology.

2.1 Overview of RFID in healthcare

Patients' lives are at risk, thus any missteps in medical care might have long-lasting implications. Improved medical care is supplied to individuals because of an older population and better health care. Because of this, healthcare systems have the difficult job of improving their performance to provide better treatment in a more effective manner. Researchers have studied Information and Communication Technology (ICT) and its usage in healthcare extensively to overcome this problem. Patients may monitor their own health and avoid medication mistakes by using a variety of ICT solutions that have been created by medical

organisations. Many studies show that information and communications technologies (ICTs) may improve the quality of healthcare while also bringing down the overall cost (Sato et al., 2020).

The application of Automatic Identification and Data Capture (AIDC) procedure is one of the advantages of ICT. These methods not only make it possible to identify quickly and easily, monitor, and trace items or persons, but they may also automatically gather data. Using a computer system to store the data eliminates the possibility of human mistake. Identifying patients at the point of service is the primary usage of these technologies in healthcare. When barcodes were introduced, the identifying procedure became more efficient and standardised (Wen et al., 2018).

In addition, RFID scanners may scan many goods at the same time, and they don't need a direct line of sight to read the tag information. Its range, ease of data transfer, reusability as well as data security are all further benefits of RFID technology. In comparison to barcode technology, RFID offers superior tracking and tracing, as well as greater data integrity and precision, allowing for real-time response and end-to-end visibility. Among the several ICTs now available, RFID has received a lot of attention since 2005. However, the healthcare industry is seen as RFID's next significant consumer market (Frith, 2015).

Most healthcare RFID applications focus on the identification, tracking, and tracing of patients, medications, medical devices, and people. When it comes to monitoring and finding hospital assets (such as supplies or personnel), these tools are designed to automate and streamline the process. In the long run, it improves patient safety while also allowing healthcare providers to operate more efficiently (Chen et al., 2020).

Throughout this section, a comprehensive study has been provided to examine how RFID may be used in the healthcare sector. Research articles pertinent to RFID deployment in universal healthcare are analysed in this section to help researchers identify its role. RFID plays five major functions during clinical encounters (Yoon et al., 2008). These functions are tracking, identification and verification, sensing, data collection and triggers and alarms. Next, these functions are described in more detail.

2.1.1 Tracking

It's possible that RFID technology may make it easier for equipment to track the movement of people or objects. As a result, RFID-enabled monitoring is required to show the location and activities of a person in real time at key points, such as entrance and exit points. This feature is particularly important for individuals with dementia, requiring healthcare providers to disclose their destinations with their families (Oztekin et al., 2010)

RFID may also be used to locate patients and staff in an emergency with pinpoint accuracy. Patients, doctors, paramedics and other bureaucratic, security, and social workers are all included in the scope of person monitoring. Throughout the pharmaceutical industry, the production process is closely regulated before the products reaches its destination in order to prevent drug money laundering, smuggling, and the misuse of medical commodities. RFID tags are attached to drug flasks in order to identify fake injections of narcotics. In practice, Purdue Pharma and OxyContin use these strategies to assure the safety of pharmaceuticals (Gutierrez et al., 2013).

Devices like breathing apparatuses, wheelchairs, blood bags, etc. can be easily monitored using RFID systems. Hartford Hospital in the United States uses passive RFID tags to detect telemetry transmitters, while RFID active tags, together with bar code technology, are employed throughout the hospital facility for critical care to identify prefilled syringes, beds, and other moving objects. The results show that surgical tools can be located quickly and easily, improving patient safety and reducing repair time (Ruan et al., 2018).

- A medical facility's inventory control will be improved when RFID is used in conjunction with stock management software.
- Improving expenditure accuracy and streamlining the way money is managed.
- In order to ensure patient safety or staff safety, it is important to quickly locate and retrieve any equipment that may be a threat.
- The complete delivery of health instrument operations, from acquisition and termination, will be improved by RFID technology in real time (Lee et al., 2019).

2.1.2 Identification and Verification

RFID is useful for patient identification and verification. A common cause of medical mistakes that may be reduced by RFID is misdiagnosis. In some institutions, the principal type of medical record depends on hand wristbands, which might lead to indecipherable or rotographing problems, or both, in the patient's identification. The wristbands would help hospital staff by allowing them to share patient information, such as gender, birth date, input of instructions, remuneration, and the location of operation, using RFID labels (Choi et al., 2010).

Patient safety may be improved using RFID by reducing the medical errors, or even operating on a fake patient which can be a major source of deadly situations. As a result, medical experts were able to get precise information about each patient via the use of RFID. Detection has also benefited from improved verification and identification among patients, as well as between mothers and neonates (Li et al., 2020).

2.1.3 Sensing

Another fascinating, well defined RFID characteristic is the ability to read and respond to signals in order to acquire or compute sensor-derived information. A number of studies have shown that RFID sensors may aid in the assessment of a patient's clinical state (Álvarez López et al., 2018; Jebali & Kouki, 2018; Tu et al., 2019). These e-health apps allow hospitals and other important healthcare systems to remotely operate equipment using RFID technology. Sensors may also be used in managing systems, maintenance processes, and general machine patching speeds (Camacho-Cogollo et al., 2019). Studies have demonstrated that RFID sensing may be used for a variety of purposes outside patient monitoring, such as compliance monitoring. For example, it may be printed on employee ID cards to remind them to practice good hygiene, such as washing their hands after using the restroom. Employees may enter and depart an organization based on their degree of protection using RFID sensing features like device access protection intent (Li & Becerik-Gerber, 2011).

2.1.4 Data Collection

Another fascinating feature is the ability to collect and transmit information wirelessly. As a result of the RFID device's automation, time handling and human errors may be reduced by promptly ordering certain medical items resources from the market. This technology eliminates the need for medical staff to spend time filling out forms, sorting them, and other administrative tasks that maybe handled by an automated system. Australia's Alfred Hospital has used RFID in its HIS (Health Information System) system to deliver smart clinical care and recovery support (Vagaš et al., 2019).

Using a self-pill device allows clinicians to administer dosages more easily and comfortably, and it helps patients with brain injury and clinicians with limited vision by automating manual processes. For example, it measures the length of time spent in the hospital after discharge to improve healthcare efficiency by administering a dose that is slightly higher and for a longer period of time (Hornyak et al., 2016).

As per researches, RFID will allow blind or short-sighted people to travel indoors (Álvarez López et al., 2017). In addition, hospitals will be able to check medical equipment and worker paths through RFID records in the event of an accident. For trash management, RFID data may be used to provide documentation of distribution and receipt, as well as monitoring and data collection in order to assure the appropriate conduct of all recycling and removal activities (Van der Togt et al., 2011).

2.1.5 Triggers and Alarms

During surgical procedures, blood transfusions, drug deliveries, and other types of medical procedures, alarms and indications are used to help keep patients safe and avert potentially life-threatening circumstances. When it comes to US medical treatment, an estimated 1500 things are left in the body of a patient per year. While a portable band scanner was proposed and assessed at numerous health institutions versus tagged pellets, RFID tags in operation were proven to be more effective and pleasant for patients. There is a potential benefit to informing sanitation workers about RFID possibilities. This capability will be used to monitor employees'

compliance with their daily universal healthcare duties in order to prevent the spread of disease. When an employee uses the gadget in an incorrect way or fails to process it properly, the buzzer goes off and the data is sent to the system (Yao et al., 2011).

Approximately 98,000 people die each year because of medical mistakes. Misdiagnosis, incorrect prescription, and surgical mistakes are all common causes of medical errors. When it comes to medical negligence, patient misidentification is the most common problem in hospitals. Patients' health and safety are jeopardized when this kind of malpractice occurs in the medical field. An investigation has showed that a significant proportion of clinical blunders resulting from undesirable drug events have been driven by patient misidentification. There seems to be a risk that medical staff may approach patient identification as a casual matter. This may be linked to many contacts they've had with healthcare professionals. As a result, health care providers were unable to learn about the misidentification of patients (Haddara & Staaby, 2018)

The primary goal of using RFID technology in the healthcare sector is to avoid risks. It's possible for RFID to include medical information and the patient's current location to improve the accuracy of patient identification and the prescriptions needed for treatment. A wearable RFID tag might be used to record patient information and follow patients so that they are always aware of their prescriptions. Tracking a healthcare provider's errors might potentially be done using RFID. So, for example, if a patient keeps their surgical equipment after treatment, the doctors may be alerted, and any harm averted (Fosso Wamba et al., 2013).

In order to prevent medical property theft and mechanical failure, RFID is utilized to map and regulate the medical properties. Regulating surgical equipment makes it easier for doctors and nurses to get their hands on the necessary tools and care for patients. This results in a happier and more efficient staff, as well as quicker medical treatment. A small hospital may save $1 million a year by doing this. Medical data retrieval may be automated using RFID, which increases productivity. By storing and collecting data, manual processes may now be made more efficient. It also affects the way clinicians are treated from the time of their admission until they are discharged from the hospital (Camacho-Cogollo et al., 2019).

2.2 IT Adoption in RFID Programs

Many studies have identified several possible determinants of Information Technology (IT) adoption, in addition to analytical and methodological frameworks. The influence of idiosyncratic characteristics on the organization's technological choices has been widely documented in recent studies. It is essential to have enough staff, internal reengineering, and a strong customer acceptance throughout the whole firm in order to successfully implement RFID programs. Health IT administrators may be swayed by the Agency hypothesis because of uncertainty over long-term benefits and short-term efficiency problems resulting from RFID implementations. Even if a company's senior leadership approve of a new technology and are willing to accept the risks associated with its spread, the innovation is unlikely to be adopted. If a company's senior executives are enthusiastic about key activities like technology reviews and implementation, this is a good sign that IT has gained widespread acceptability. Managers must be able to assume the risk of adopting fresh ideas in order to make sound decisions (Sato et al., 2020).

According to the findings of recent studies, RFID adoption has been hampered by the high cost of implementation. Healthcare institutions will need financial assistance to cover the costs of the RFID project, which will be spread out over many years. Firms that are financially efficient are the most likely to use electronic business models. RFID solutions will be more effective if firms are ready to install and integrate them into their existing IT infrastructure. An IT network is defined as a set of existing technological platforms and business structures that may be used as a basis for the development of RFID applications. Various studies have shown that enough financial resources and technical expertise can be found experimentally (Chen et al., 2019). According to research, the Electronic Data Interchange (EDI) adoption is heavily influenced by factors including financial resources and IT complexity. Considerations such as the potential benefits, administrative support, financial incentives, and expenses and technical skills associated to RFID's operational backdrop all influence the introduction of hospital technology. As a result, the choice to use RFID in clinics is influenced positively by organizational factors (Li & Becerik-Gerber, 2011).

The organization's choice influenced by compatibility, and incompatibility between developing technology and established standards and work procedures is portrayed as a primary obstacle in the IT adoption (Gulcharan et al., 2013).

RFID technologies will have a significant impact on hospital workflow and business processes, necessitating significant changes to how hospitals operate. On the other hand, new improvements, should be more compatible with the existing IT infrastructure. Previous study suggests that managers' perceptions of the cultural and technical hurdles offered by current technologies may impact their choice to approve a company. RFID decision-making in hospitals is thus influenced favourably by technological factors (Hornyak et al., 2016).

2.3 Aim of the study

Many doctors are concerned about the increasing number of patients who've been misidentified ahead, during or after medical assistance. Moreover, an error in patient identification might result in the wrong prescription being given to the patient, as well as the need for an expensive treatment.

To overcome these medical errors, to ensure patient care and security and to improve administration and productivity in healthcare service sector, this study identified the advantages, disadvantages, challenges, and obstacles in the way of implementation of this technology.

2.4 Research Questions

To analyze the role of RFID technology in the healthcare system by investigating the advantages, disadvantages, challenges, and obstacles that hospitals face in implementing RFID technology, there are two research questions:

- What are the advantages and disadvantages of RFID technology in the patient tracking system?
- What would be the challenges, and obstacles in implementing of RFID technology in the patient tracking system?

2.5 Research Objective

The main objective of this study is to identify the advantages, disadvantages, challenges, and obstacles in implementing of RFID technology in the patient tracking system.

3 RESEARCH METHODOLGY

3.1 Scoping Review

Scoping studies are a way to synthesis information from a wide variety of research designs in a comprehensive manner. Scoping studies are "exploratory efforts that carefully map the literature available on a subject, finding significant ideas, hypotheses, sources of evidence and gaps in the research"(Hamel et al., 2020). Researchers may conduct a scoping study in order to assess the breadth, depth, and diversity of research being carried out, as well as the benefit of doing a comprehensive systematic review.

Increasing numbers of health researchers are turning to scope studies. Scoping studies have mushroomed in the last six years, with more than half of them published after 2012, highlighting their expanding potential to shape research agendas as well as policy and practise recommendations. No quality standards or reporting rules have been developed for scoping studies, unlike other methodological techniques like systematic reviews and clinical practise recommendations. It is possible to improve the reporting of scoping studies by following specific recommendations that address aspects of scope, evidence inclusion, as well as iterative nature which are unique to scoping studies.

In 2005, Arksey and O'Malley published methodological guidelines for establishing scoping studies including the identification of a research question, the search for relevant research and the selection of research as well as the charting, compilation, summary, and reporting of data. When Levac et al. published their scoping study framework in 2010, they included guidelines for furthering and using scoping studies in health research.

This literature study was conducted using a scoping review. This sort of review is an investigation of the extent and scope of the existing body of knowledge on a certain subject (Munn et al., 2018, p. 2).

To achieve the proposed objectives, the researcher identified advantages, challenges, and obstacles faced by hospitals in utilization of RFID technology. To determine the type and breadth of research evidence, a scoping review offers a preliminary evaluation of the size and scope of research literature. Scoping reviews, in contrast to conventional systematic reviews, may be used to map the fundamental ideas underlying field. As a result of the lack of randomized controlled trials in this field, scoping reviews may be especially useful. Yet at the same time, a systematic scoping study is feasible and, in many respects, desired, which is the goal of this review (Reumers, Bekker et al. 2021).

3.2 Search strategy

Because of the rapidly growing of RFID technology in the past 12 years, studies from 2010 to 2022 were identified by searching Google Scholar, ProQuest, Science Direct, PubMed, Sage Journals and Wiley Online electronic databases. By carefully analyzing available material, researcher was able to classify RFID applications and evaluate the use of RFID technology, advantages, disadvantages, challenges, and obstacles that RFID confronts today.

"RFID technology" as well as "RFID in hospitals" were among the terms used to search the literature, as were “RFID benefits”, “RFID advantages and disadvantages”, “RFID challenges” and "RFID problem". Researcher selected relevant research articles based on the research questions. For this research, Researcher utilized previous literature gathered from searching e-databases. This study followed the method suggested by prisma.org to illustrate the flow of information through the different phases of this scoping review.

There were originally 404 studies in the electronic database. During the first stage, 150 articles were excluded as they were in any other language rather than English. Second, 200 articles were eliminated by duplication, screening title and abstract for general eligibility criteria. The 30 articles which were before 2010 were eliminated. After that, 4 articles were excluded which were not relevant to the research questions. Finally, out of 404 articles only 20 articles were selected which were accessible for free.

Researcher has defined the inclusion and exclusion criteria as follows:

EXCLUSION CRITERION	INCLUSION CRITERION
Studies before 2010	Studies after 2010
Published in any language	Published in English
Not accessible for free	Accessible for free
Lack of qualitative source or irrelevant research question	Relevant to the research question with qualitative source

3.3 Analytical Framework

The data was analyzed based on the following analytical framework:

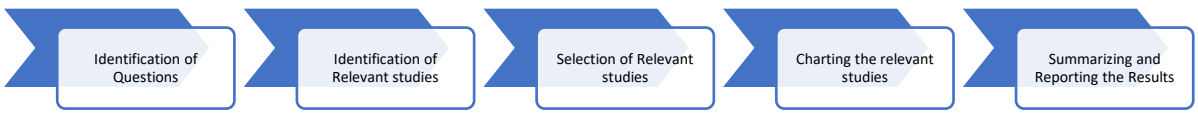

Figure 1 shows the analytical framework

3.4 Quality Assurance

The Johanna Briggs Institute (JBI) Critical Appraisal Checklist for Qualitative Research was used to evaluate the methodological credibility of the project. The included papers were evaluated based on 10 different criteria to determine their methodological quality. All 20 studies have already been evaluated, bearing in mind the author's limitations in appraising the research. There is no academic or research background for the researcher, and the subject

matter is relatively fresh. This study's quality has already been rigorously evaluated before publishing, since all the included papers have already been peer reviewed and published in well-respected scientific publications.

4 RESULTS

The table shows the articles which were selected. This table describes about the author, year, title, and purpose of the study. These articles were analyzed for the scoping review:

Table 1. List of included studies in the scoping review

Author(s), Year	**Title**	**Purpose of the Article**
Kim, 2012	Privacy and security issues for RFID healthcare system in wireless sensor networks.	Provide details about privacy and security in healthcare system
Fosso Wamba et al., 2013	A literature review of RFID-enabled healthcare applications and issues	Give details about RFID enabled healthcare application and their issues
Chen et al., 2017	Implementation of radio frequency identification middleware with database	Provide information regarding implementatin of RFID
María Martínez Pérez et al., 2012	Application of RFID Technology in Patient Tracking and Medication Traceability in Emergency Care	Give detail about application RFID in patient tracking system
Dobson et al., 2013	A systematic review of patient tracking systems for use in the pediatric emergency department	Provide detail about pateint tracking system in emergency department
Wu, 2019	An radio-frequency identification security authentication mechanism for Internet of things applications.	Provide IoT information for identification, security and authentication
Omar et al., 2016	Smart patient management, monitoring and tracking system using radio-frequency identification (RFID) technology	Provide detail about the smart patient management and their monitoring
Pérez et al., 2016	Evaluation of a tracking system for patients and mixed intravenous medication based on RFID technology	Evaluate tracking system for patients and medicaation
Camacho-Cogollo et al., 2020	RFID technology in health care	Give a detailed information about RFID technology used in healthcare

Hornyak et al., 2016	Radio frequency identification–enabled capabilities in a healthcare context: An exploratory study	Provide details about RFID capabilities in healthcare context
Cao et al., 2014	Contained nomadic information environments: Technology, organization, and environment influences on adoption of hospital RFID patient tracking.	Provide details about factors which influences the adoption of RFID in patient tracking system
Peng & He, 2017	Optimization of Event Processing in RFID-Enabled Healthcare	Provide information about the RFID enabled healthcare
Abugabah et al., 2020	A review of challenges and barriers implementing RFID technology in the Healthcare sector	Give details about the challenges and barriers in implementing RFID
Zhang et al., 2019	Round-priority-based anti-collision tag identification method in a mobile radio-frequency identification system.	Provide details about the challenges for anti collision tag for identification system
Haddara & Staaby, 2018	RFID applications and adoptions in healthcare: A review on patient safety.	Provide details about safety of patients regarding RFID applications and adoption
Vagaš et al., 2019	Wireless data acquisition from automated workplaces based on RFID technology	Provide details about the wireless data equisition in the workplace
Leema & Hemalatha, 2013	Proposed prediction algorithms based on hybrid approach to deal with anomalies of RFID data in healthcare	Give predictions to deal with challenges or issues of RFID data
Gulcharan et al., 2013	Limitation and Solution for Healthcare Network Using RFID Technology: A Review	Give limitation and solution for using RFID in healthcare
Wickboldt & Piramuthu, 2012	Patient safety through RFID: Vulnerabilities in recently proposed grouping protocols	Provide details regarding patient safety and vulnerabilites
Ebrahimzadeh et al., 2021	Evaluation of the effects of radio-frequency identification technology on patient tracking in hospitals: A systematic review	Provide details for the evaluation of effects of RFID in patent tracking system in hospitals

4.1 Benefits of RFID in Healthcare

By monitoring assets and people, RFID in healthcare may cut costs and enhance efficiency while also improving patient safety and saving lives. There are several benefits to RFID-enabled health reform. RFID might have a significant impact on healthcare quality, efficiency, and administration if it is used properly. Efficiency benefits encompass investment as well as

stock reductions; operational costs; labour cost reductions; individual care enhancements; as well as workforce cost savings (Omar et al., 2016).

For example, eradicating errors such as prescribing the incorrect medicine to the wrong person or performing the wrong technique should be included as should all other benefits associated with improving quality of patient care, improve patient satisfaction, strengthening infection prevention and control capabilities, as well as trying to improve the capacity to inhibit as well as appropriate equity inadequacies (Ebrahimzadeh et al., 2021).

4.1.1 Main benefits

4.1.1.1 Patients Safety

Patient safety must be prioritised since, medical and human mistakes in hospitals result in about 42.7 million adverse events each year (Kim, 2012). Healthcare quality may be improved for patients by eliminating human mistakes in interactions between patients and healthcare workers using RFID. One of the most common causes of medical mistakes in hospitals is the misidentification of patients. An RFID-enabled smart bracelet might be used to identify patients and expose personal data such as birth date, name, insurance information, allergies, blood type, and prescription needs as part of a positive patient identification system. Plethora of research suggests medical facilities must endeavour to avoid these mistakes by improving hospital safety processes by creating an adequate patient identification system. Similarly, smart RFID technology might help to reduce the number of patient identification mistakes. Patients are identified by RFID, which might be used to search and collect relevant medical data from a variety of current healthcare information systems, possibly reducing the number of mistakes in patient management. RFID may also be used to identify surgical patients to verify that the treatment is carried out on the correct person (Fosso Wamba et al., 2013).

RFID is currently being considered as a technology that may improve medical care and safety by monitoring vulnerable patients, rather than an asset tracker. Tracking the movements of long-term old or confused patients, as well as youngsters to prevent infant snatching, is an example of this. To immediately detect and identify patients in the ER, RFID monitoring of patients has also been utilised to promptly begin delivering medical help. This means that RFID

patient monitoring technologies have the ability to cut waiting times by automatically displaying what stage a patient is in as well as providing transparency for patients and staff in the surgical trajectory and improving patient flow. Identifying patients who are ready to be discharged from the hospital may also be done via RFID tagging. This helps to reduce unnecessary hospital stays and better allocate resources. For patients with chronic illnesses, it may also be used to monitor them from their own homes. Persons who have been in touch with people who are infected may be tracked down by following the movements of visitors, employees, and patients. Several Asian hospitals used RFID during the Severe Acute Respiratory Syndrome (SARS) outbreak to track infected patients (Camacho-Cogollo et al., 2020). When SARS broke out in Taiwan, the Show Chan Hospital employed active RFID tags to track patient temperatures as well as identify those who were at risk of infection. After that, it was put to use at an elderly citizen's residence to transmit cognitive and psychosocial data from residents who were unable to leave their beds (Vagaš et al., 2019).

4.1.1.2 Medical Reporting

Healthcare information systems (HIS) may help doctors make better decisions and diagnose patients faster by providing them with quick access to the accurate data about the patient. Case studies in Saudi Arabia have shown that RFID wristband sensors for monitoring and wirelessly ECG monitors for taking vital signs and delivering devices electronically may be used for elderly patients with chronic diseases.

Also, it's possible that RFID could be used to improve drug adherence. With the use of wristbands as well as bar codes, the Wisely Aware RFID Dosage (WARD) system would help hospitals create an effective and safe medical healthcare system by lowering the possibility of medication mistakes (Ebrahimzadeh et al., 2021). RFID tags may be used to find a patient at a specific area and determine the correct amount of prescribed medication. It is possible for doctors to monitor patient adherence to medicine using RFID data that is connected to a centralised database. Prototypes such as an RFID-tagged pill dispenser that monitors medication usage as well as human facial recognition were on display at the CES trade show. As soon as a medication's use-by date approached, the system alerts healthcare practitioners. RFID-enabled smart bandages may potentially be utilized to direct the distribution of post-surgical medications to patients. Scientists in Greece conducted another research in which the

usage of RFID technology was used for the intention of tracking and controlling blood samples. RFID as well as barcode technologies may be used to reduce the risk of blood production waste and inaccurate identification. Transfusion department could also benefit from RFID technology, which might also help them to better organise samples of blood as well as ensure that the correct blood donations are being supplied to the correct patient (Dobson et al., 2013).

4.1.1.3 Expense Mitigation

The rising expenses of healthcare may be mitigated in several ways. As an example, an RFID-based asset tracking and monitoring system may assist avoid the theft of expensive assets and equipment. Improved worker productivity, reduced equipment rental costs and improved regulatory compliance are just some of the other advantages. Employee in the healthcare may save a great deal of time and energy by using the RFID to find medical supplies in their everyday work. Small-scale hospitals may save as much as $1 million a year because to these changes (Roper et al., 2015).

In order to reduce money and increase patient happiness, hospitals are looking to optimise patient throughput and operational processes. The laborious methods that are generally used to record data may be automated using RFID's automatic data capture and storing capabilities. The active monitoring of asset and patient movement through the hospital by RFID does have the potential to greatly enhance operations. The captured data may be examined in order to increase hospital efficiency. In addition, RFID technology has additional advantages, such as preserving medicine supplies and increasing resource usage (Álvarez López et al., 2018).

Avoiding ongoing capital expenditures, operating as well as maintenance cost reductions, and higher throughput all lead to new income opportunities as well as enhanced patient safety. Patients and caregivers will be happier and more productive, allowing for more attention at the bed as well as a higher standard of care. The define-measure-analyse-improve-control paradigm was used in conjunction with the Six Sigma technique, which discovered that RFID technology improves healthcare efficiency, as well as safety. Resource allocation and utilisation may be improved through RFID. For example, the inventory database is updated in real time using data acquired via auto-ID. Tracking the number of products received from suppliers, sent to hospitals, and the real inventory level, things no longer available, back-

ordered item identification and number, and physical conditions, locations, and ages may all be accomplished using RFID (Omar et al., 2016).

In order to decrease inventory-related expenses, managers must be aware of disparities in physical flows and be able to identify the variables that contribute to mistakes. Inventory shortages, underutilization, and inflated inventory may all be reduced via the use of real-time location-based services (RTLS). Using RFID, employees may be alerted to theft and asset loss in real time, eliminating the gap between predicted inventory levels and actual physical counts (Pérez et al., 2016)

There is a risk to people when pharmaceuticals and medical equipment are kept over their expiry dates, mishandled temperature conditions as well as short life cycles are not properly managed. Patient lives are at jeopardy if faulty medical equipment is not identified and repaired as soon as possible. Information on the date, time, batch number, and other aspects of manufacturing may be used to create recall systems. Researcher conducted a case study at the UC San Diego Health System involving an emergency recall of medical equipment by the Food and Drug Administration (FDA) (Cao et al., 2014).

Managers may discover unnecessary replacement inventory as well as rental expenditures by tracking and evaluating equipment utilisation rates. In order to determine whether assets need an extra safety stock, idle equipment monitoring, and equipment utilisation patterns are critical. High service levels, high shortfall costs per item, high demand, quick delivery times, and cheap ordering costs per order placed in an environment all contribute to the Real-Time Location-based Service (RTLS) benefits (Hornyak et al., 2016).

4.2 Barriers in the Implementation of RFID

In the healthcare industry, there are several obstacles to RFID deployment. Both industrial and healthcare applications suffer tremendously as a result of these roadblocks to widespread adoption of RFID. Many factors must be taken into account before RFID technology may be used in healthcare. Technical and environmental factors are just two of the limitations (Roper et al., 2015).

4.2.1 Technical Limitations

The discovered limitations in technology might have a significant influence on the adoption of RFID in general and on its use in medical care. Some people have physical constraints that make it difficult for an RFID reader to reliably identify a tag when it is within its reading range (Abugabah et al., 2020).

Adoption is also hindered by technical issues like as system faults, RFID tag readability interruptions with medical devices, or interface with other health information systems. Interoperability issues have arisen as a result of the rapid development of health information systems in many organisations. Consequently, interoperability issues may arise from the lack of standardised RFID software and hardware. System problems may be caused by a variety of factors. Interference inside the electromagnetic field created by other medical devices, metal objects, fluids, glass, as well as damp conditions may cause RFID scanners to provide incorrect readings. When tags are misplaced or destroyed, the systems lose their accuracy and reporting capabilities. The system won't perform to its maximum potential if its components aren't in good functioning order. Progress has been made to develop this technology, but it is critical to know exactly where to set the reader in order to transmit the information. A human mistake must be remedied if we are to avoid these technological obstacles (Roper et al., 2015).

Another technical constraint is the RFID reader's ability to simultaneously scan many tags. The computational power of RFID readers and computer networks is what really makes RFID operate. Analysis of RFID anti-collision techniques at that time is problematic (Zhang et al., 2019). Lack of scalability is impacting the spread of RFID in both the healthcare business and other industries. In order to avoid collisions, the readers and the network device must have enough computing power to handle the quantity of tags needed by the approach (Haddara & Staaby, 2018).

Certain firms adopting new technologies may also run into problems with data management posed by RFID tags. Backend databases and applications must be able to handle the massive amount of RFID results. In many cases, IT teams fail to consider the impact of RFID on their current computer infrastructure. RFID findings cause a slew of issues for medical facilities. These gadgets create enormous amounts of data in a short period of time. The management of raw data and the distribution of it to centralized places would be a challenge for health

organizations with localized IT regions (Wu, 2019). The IT networks have to be able to handle a large quantity of data flow. Alternatively, such systems would be unable to manage the data flow and would ultimately influence other sensitive systems that might compromise the safety and operations of patients and facilities. The lack of worldwide RFID technology regulations and guidelines is another technical challenge (Vagaš et al., 2019).

4.2.2 Environmental Factors

Official stress may impact the professional development of a health care practitioner. This stress includes legislative and regulatory authorities, business participants and competitive suppliers as well as consumers and distributors and insurance providers. For the sake of preventing this uncertainty, healthcare practitioners need to speed the implementation of information and communications technology (ICT), including patient health records and RFID as well as internet data technology. An emergent technology is more likely to be developed under an atmosphere of uncertainty and volatility, according to previous studies in Information Systems (IS) (Aboelmaged & Hashem, 2018; Leema & Hemalatha, 2013).

4.3 Barriers to RFID Adoption

Technical, economic, social, and managerial issues, using RFID technology in the healthcare business to improve patient safety is a difficult task to undertake. the most significant obstacles and conclusions from the existing research are summarised below.

4.3.1 Problems with the system

RFID's technological constraints, particularly in healthcare, may hinder its adoption. In the first place, medical gadgets, such as those used in hospitals, might be affected by RFID. Finally, the absence of widely agreed industrial standards for RFID data structure, air-interface, as well as

local interface prevents RFID adoption on a widespread scale. Common standards for healthcare systems are being developed by the “Health Industry Business Communication Council” (HIBCC) (Fosso Wamba et al., 2013).

4.3.2 Cost

Equipment and software acquisitions as well as ongoing spending for infrastructural maintaining and upgrading, personnel training and education are all part of RFID expenditures. Additional servers, database, middleware, as well as software must be installed in relation to tags and readers. It might make a huge impact if equipment as well as patients are marked. Back-end systems and synchronisation networks are necessary for RFID to be effective. As a whole, the cost may be prohibitive (Abugabah et al., 2020b).

4.3.3 Privacy

The benefits of RFID must be realised in medical settings unless the patients are confident that their personal information would not be misused. RFID tags that are connected to a patient's body may retain personal details, including the patient's name, sex, residential address, but also health information. This information is highly mobile and extremely sensitive. Consequently, healthcare providers must ensure that RFID does not transmit any private or confidential data. A secure server is required by the HIPPAA for this kind of information. In particular, medical staff and patients should be made aware of the purpose of this data collection in order to ease their anxieties. Despite the fact that a 2007 national public opinion study found a positive correlation between curiosity in RFID individual healthcare technology and high degree of confidence and support networks, only 1404 Americans were surveyed (Gulcharan et al., 2013). There were just a limited number of people who were opposed to this kind of application. The public's fears will be lessened if the technology is controlled by more governmental agencies.

In addition to a lack of organisational support, trust difficulties and security concerns are further obstacles to RFID implementation.

4.4 RFID adoption in health care

RFID is adopted in healthcare for authentication, safety, tracking patients, and blood transfusion medicines.

4.4.1 Authentication

Authenticating a patient's identity in the age of electronic health records is a common and time-consuming task. Adoption rates can only rise if a compromise can be made between the two competing demands of convenience and privacy (Hornyak et al., 2016).

4.4.2 Safety

Preventing privacy and security breaches during inpatient drug delivery is a top priority in the healthcare industry. There are several instances of RFID technology deployments for increasing medicine safety. RFID-aided drug delivery is seldom explored in terms of data protection. In the end, the evidence was discovered to be vulnerable to DDoS and replay assaults. After that, a lightweight binding proof technique for RFID and medicine authentication and verification provided enhanced security. Low-cost RFID tags may be used in conjunction with increased security mechanisms in the new protocol. Additional methods for privacy, security, and anonymity are available (Cao et al., 2014).

With a one-way hash and encrypted data, the RFID reader and tags are authenticated. In addition, a challenge-response system is used to prevent replay assaults. A secure RFID protocol is needed in this area because of pharmaceutical safety, privacy and security issues (Omar et al., 2016).

4.4.3 Tracking patients

It is feasible to use passive RFID patient monitoring in an outpatient clinic. As a result of noise and missing readings in raw data, tag location cannot be determined at a rate of 60–70 percent that would be optimal. False positives and false negatives may be reduced by using a fuzzy

logic approach. Tracking a patient's medical history isn't very useful if the data isn't reliable. Tracking patients entering the incorrect operation room and alerting medical staff is shown. Asset monitoring in operating rooms has been studied by others in a similar fashion. Using an automated RFID system, Patients were quickly reassigned after the RFID technology correctly identified all of the events that had occurred in the incorrect operating room. Patients in multi-disciplinary health care organisations might benefit greatly from RFID, but there are several challenges to solve (Ebrahimzadeh et al., 2021).

4.4.4 Blood transfusion medicine

Transfusion medicine uses RFID technology effectively. International Blood Transfusion (ISBT) and Food and Drug Administration (FDA) have accepted RFID for use in integrating and augmenting barcode data on blood supplies. Described technique is the first FDA-approved implementation of all blood transfusion stages, from donor to transfusion. If database access isn't possible due to a catastrophe or conflict, all pertinent information about the blood product may be found on its label, according to an established concept in blood transfusion medicine described by the authors. As a passive system, it adheres to ISBT Code 128 for blood product labelling, which was established in the year 2000. A checksum is also kept on the RFID tag to ensure the accuracy of the data (Dobson et al., 2013).

Radio frequency exposure was shown to have no negative impact on blood products prior to deployment. This information (such as the patient's name and date of birth) is kept on an RFID tag after it has been read and validated to match a patient order. In the event of a failed transfusion, the patient's data is either cleaned or destroyed by the nurse at the completion of the procedure. Furthermore, no privacy or security safeguards are described when RFID technology is used in blood bank medication. However, they may claim that bar codes do not provide privacy protection, since RFID technology is supposed to enhance bar codes. RFID data, on the other hand, may be eavesdropped on from a considerably greater distance without the need for a direct line of sight. After the blood product is matched to the patient's blood type and clinical transfusion order, recipient patient details are saved on a unique RFID tag. Using a fake blood product tag or listening in on an eavesdropper would raise serious privacy and safety issues (Kim, 2012).

4.5 Challenges in Implementing RFID for healthcare organizations

The success or failure of RFID frameworks in emergency clinics is further complicated by the presence of social and hierarchical factors. Considering the social effects of RFID frameworks, such as the safety of nursing staff and other personnel in emergency clinics, should be a priority from the start, especially throughout the planning and implementation of the innovation. Despite the fact that RFID technology has been around for more than a few decades, there are a number of issues that need to be solved before a large and efficient use of this technology in the healthcare sector can be realised. The following sections go into further depth about some of the other significant implementation problems. RFID (hardware or software) will need more expensive maintenance equipment throughout the course of its useful life. Businesses are still reluctant to use this technology because of rising expenses despite the fact that the price has decreased over time. Regardless of whether tags are active, semi-passive, or passive, the price of the tags has an effect on a company's ability to manage its budget (Abugabah et al., 2020b).

RFID tags employ electronic waves as a communication channel, which can't work well with metals or fluids but there are tags which were specifically designed for metallic objects and fluids, and they are complex and expensive. Although RFID is a cutting-edge technology, metals and liquids interfere with the electronic wave transmission, making it ineffective (Dobson et al., 2013).

As a result of the widespread usage of RFID technology in the United States, training in the use of this technology might be a challenge. There is a dearth of technical assistance and ability when deployed in poor nations with commercial backing from local distributors. If you don't have the necessary technical know-how and resources, learning about different RFID tags and frequencies might be difficult. Despite the fact that the asian healthcare industry is enormous, the full-scale application of RFID is still in the early stages (Wickboldt & Piramuthu, 2012).

There is a substantial danger of fraudsters misusing sensitive medical data if a reader device for RFID is used by anybody who has access to the patient's information. An RFID chip may be implanted into a human in one of two ways: as an external tag to be worn or even as an injected internal chip implant or alternatively as a subcutaneous implant. In both cases, the individual's agreement is critical. However, this permission does not ensure that the implanted electromagnetic powered RFID tag will not cause any harm. As a result, people's freedom in

society will be reduced since this technology follows and informs the legal authorities of every movement of the individual in the digital world (Pérez et al., 2016).

As compared to WIFI devices as well as other FMCW radios, RFID has a small channel bandwidth. According to the authors, RFID technology may not be able to accurately monitor vital signs. USRPs like these might be used to generate additional signal characteristics for a better comprehension of the vital signs, according to the report (Leema & Hemalatha, 2013).

"RFID subcutaneous microchip" has been the subject of just a handful of experiments. The authors conducted empirical experiments to establish a model for assessing the adoption rate of the RFID –SM model. The findings showed that the expected ease of any new technology, including RFID-SM, was of greater importance in terms of adoption. It's possible that widespread acceptance of current technology will take some time as these studies develop (Ebrahimzadeh et al., 2021).

4.5.1 RFID-enabled staff management

RFID-enabled workforce management may help hospitals streamline their operations. Employee details efficiency, mistake avoidance, increased productivity, as well as quicker processing times are just a few of the benefits of these programmes (Ebrahimzadeh et al., 2021).

4.5.2 Issues related to RFID-enabled healthcare

There are three categories of difficulties in the large number of studies on RFID-enabled healthcare systems. These include technical challenges such as data processing and data security; confidentiality issues; as well as financial and operational problems.

It is difficult to define the context of RFID-enabled implementing the process and to put them into practise technically (e.g., integrating RFID systems into healthcare system but also identifying standard guidelines) if there were no Wi-Fi interconnection in health centres, which would enable RFID-enabled healthcare projects.

Implementing new RFID-enabled healthcare practises and incorporating RFID through into firm's culture and conventions is difficult, as is managing change (Cao et al., 2014).

4.5.3 Challenges posed by new technology

In the healthcare industry, RFID adoption is hindered by a few technical restrictions. Biomedical equipment may be affected by electromagnetic interference (EMI) from RFID wireless broadcasts. EMI created by RFID tags poses a serious threat to the functioning of electronic medical devices and equipment and posing a danger to patients' safety in healthcare facilities. This presents a difficulty for RFID applications (Hornyak et al., 2016). Some medical equipment, such as pacemakers or syringe pumps, may be damaged by electromagnetic interference (EMI) emitted by RFID tags. This would put patients at risk directly. RFID tags may not perform as intended in particular settings or with some items, compared to the typically trustworthy barcodes. In order to accurately read an RFID tag, a number of elements must be taken into consideration, including the tag location, the read distance, the object tagged, and the angle of rotation, as well as the existence of things containing fluids, metal objects, and local magnetic interference. It's difficult to adopt RFID systems in hospitals since there are no industry standards or guidelines to guide implementations. There is a lack of industry standards because of the potential security and privacy violations and implications of RFID technology.

4.5.4 Challenges relating to data security, privacy, and management

In the healthcare industry, data privacy, management, and security are critical factors. One of the most difficult aspects of transmitting data via RFID is to make sure it is secure and private. In many cases, privacy issues stem from the counterfeiting of RFID tags that contain unencrypted sensitive data or the unlawful access to sensitive data. HIPAA (Health Insurance Portability and Accountability Act) rules in the United States may also see unencrypted patient data kept on RFID tags as a breach of federal privacy laws. Eavesdropping and standards that need the RFID tag or reader to be authenticated are both major concerns when it comes to data transfer. In healthcare, privacy and security concerns are slowing down the deployment of RFID. Adding human centric IoT sensors to RFID systems raises additional security issues, which might have a negative impact on people's health. Although the safety, privacy, and ease of use of patient data are critical considerations when using RFID in healthcare. Only a limited amount of technological research has addressed these concerns. According to new research, medical staff's willingness to utilise RFID in hospitals may be influenced by cognitive

characteristics, the durability of RFID data, and their understanding of the presence of a security policy (Leema & Hemalatha, 2013).

4.5.5 Challenges in both business and finance

An enormous amount of money must be put up front before an RFID system can be put into operation. The cost of RFID tags, even if it has fallen dramatically over the last decade, is still regarded considerable. Active RFID tags cost up to 20 dollars per tag, which is an enormous expense for hospitals if all of its assets, personnel, and patients are being tracked (Fosso Wamba et al., 2013). The RFID infrastructure also necessitates middleware, databases, servers, and applications in addition to RFID tags and readers. The cost of training, business process reengineering, organisational shifts, and RFID infrastructure maintenance must also be included into the total cost of implementation. Adoption costs were identified as the most significant impediment to widespread RFID use in a recent US research.

The use of RFID technology in hospitals is also supported by a number of additional case studies (Roper et al., 2015). As a result, the high prices of technology are justified by the high expenses of service and the high risk of the patient. RFID installations in hospitals are seen as a critical success element in the early stages of the project because of the backing of senior management. Accordingly, upper management is generally unaware of the potential advantages and savings associated with RFID, which is a barrier to widespread use of RFID. A further impediment to widespread RFID uses in healthcare is thought to be medical staffs' lack of technological proficiency. However, the medical team's participation in the various stages of RFID implementation projects might possibly reduce resistance to change risks and boost acceptance rates. Iranian research also found that environmental obstacles and government data usage rules might hamper the deployment of RFID in underdeveloped nations' healthcare sectors. Cultural and ethical constraints to technology adoption may also be considered (Fosso Wamba, 2012).

An RFID-based cure has reduced the prescription recall phase from 20 to 30 hours to roughly two hours for example in Gastonia, North Carolina. Using an RFID system in conjunction with an EHR system, the emergency department at Monongahela Valley Hospital has been able to improve admission, discharge, and clinical transesterification (Wang & Bolić, 2017). While opening its 1.6 million-square-meter complex on May 1, 2012 the University of Johns Hopkins

School of Medicine demonstrated an effective system for locating and monitoring the movement of thousands of clinicians, hundreds of tubing, wheelchair users, as well as other increased mobile devices (Hsu & Yuan, 2011).

Even while RFID technology has advanced significantly, it still faces several issues. It was found that many healthcare institutions are reluctant to employ RFID technology because of a lack of resources and clear guidelines. But fresh research has proven that this is no longer the case in the modern world (Haddara & Staaby, 2018)

5 DISCUSSIONS

Medical and human mistakes caused by incorrect identification of patients, bad decision making, inadequate monitoring, poor tracking, failure to react quickly, and medication non-compliance may all be reduced using RFID technology. However, there are a few difficulties with RFID that hospitals and other medical institutions should be aware of before using the technology in order to increase patient safety. These difficulties include technology, data management, security, and privacy, as well as organisational and financial concerns. Globally, medical mistakes are now the biggest cause of mortality. In the United States alone, medical mistakes are responsible for 250,000 fatalities per year (Tolentino & Park, 2010). Errors in identification, including those involving specimens or medications, are the most common cause of preventable mortality in the healthcare industry. RFID patient identifying, monitoring, tracking, as well as prescription administration systems may be used by hospitals as well as other organizations to address this issue.

Research published in journal of Healthcare Information Management concluded that perceived patient identification (PPI) systems prevent medical staff from making compromises while identifying individuals and their drugs (Hornyak et al., 2016). By reducing drug misidentification but also non-compliance, RFID-enabled patients and prescription identifying systems appear to enhance patient care. As previously mentioned, that there are a number of patient-related uses of RFID that offer significant gains in terms of both efficiency and safety. Patients' electronic medical records may be accessed by malevolent people, or they can be subjected to physical monitoring since RFID tags automatically react to inquiries from RFID readers without notifying the tagged individual. Security and privacy make it increasingly challenging to install patient-related RFID over resource. The lack of business regulations in the healthcare sector is partly due to security and privacy issues about RFID technology. Because of this, it is critical to weigh the benefits of RFID devices against the privacy and safety concerns they raise before using them in healthcare settings.

The hospitals used RFID controls to reduce the disease from proliferating. In this context, it is apparent that patient-related RFID implementations may improve patient safety as well as save life, but this could come at the expense of safety and privacy problems owing to the current state of RFID systems or applications but also regulations. Hospitals may enhance diagnostics and decision-making by using RFID-enabled patient identification and monitoring (Abugabah et al., 2020b). There are many positive aspects to the use of RFID technology in healthcare,

but they can only be achieved if institutions have the necessary IT expertise to take use of it. As a result, hospitals without such systems may be reluctant to use RFID because of the significant expenses involved. Using RFID systems alone, will put healthcare organisations at a disadvantage. But when combined with electronic health records, hospital information systems, and decision support systems, they can help reduce medication, diagnosis, and medical error rates significantly (Lee & Shim, 2007). However, despite the fact that RFID technology is considered an infrastructural technology, its value can only be realised via the data it generates.

Using passive RFID and active RFID tags with barcodes, propose a low-cost effective system that achieves the same purpose as more advanced RFID systems while saving money on RFID expenses (Fisher & Monahan, 2008). As a result, RFID may be out of reach for hospitals on a budget. The difficulties in using RFID in healthcare settings are still another barrier to widespread use. RFID is still a relatively new technology, and many hospitals are reluctant to invest in it because of the lack of successful RFID installations in the healthcare industry. RFID use in healthcare is hindered by lack of information regarding the technology (Metras, 2005).

Accordingly, a greater understanding of IT would reduce the level of ambiguity about the adoption, leading to a less hazardous adoption (Martínez Pérez et al., 2012). There is a strong correlation between RFID use and healthcare companies' expertise of information technology. Because of this, managers and healthcare workers who are less technologically savvy need to be educated on the benefits of RFID.

Researchers can evaluate the existing scientific understanding on RFID-enabled healthcare, analyse the significance for both theoretical and practical aspects, and recommend possible future research routes via the examination of this literature review. However, this paper also presents the possible drawbacks of RFID-enabled medical care initiatives, such as technical problems, data management problems due to concerns about privacy and confidentiality, as well as administrative and monetary problems, all of which could limit the project's ability to deliver business benefits. Managers may use this information to better focus on resources and possible problems that may arise during the deployment of RFID-enabled healthcare initiatives. Academics in the field of healthcare informatics might use these findings as a starting point for future work. When it comes to RFID network externalities, future study might examine the influence of RFID technology on healthcare value chain activities, as well as significant economic and technical concerns of executing RFID-enabled projects for a high degree of value

realisation. An examination of how RFID expenditures in healthcare might well be linked to other corporate assets, like human resources, would help to transform the sector through innovative business operations, improved approaches, and enhanced models. It's an interesting research topic, for example, how RFID technology affects the job qualities and effectiveness of healthcare employees (nurses, doctors). This will be interesting to see how RFID-enabled healthcare affects patient-nurse interactions, nurse-physician interactions, especially doctor-patient relationships. Future studies should also look at the costs of integrating RFID technology into asset management, patient management, and staff management activities. As a result, future research should examine the adoption and usage of RFID-enabled healthcare apps and patient management and staff management applications in the healthcare sector using current prevalent theoretical frameworks (e.g., diffusion of innovation, technological acceptance model). Future studies should focus on how RFID technology might help cut down on patient transaction expenses.

"Technological challenges" (Abugabah et al., 2020b), followed by "Organizational and funding concerns", and then "Data management, security, and privacy issues" are the most often discussed topics in the literature on RFID-enabled healthcare (Kim, 2012). Many publications about RFID adoption have focused on organisational and financial difficulties rather than data security and privacy issues, which is in line with the great majority of articles at this stage of the technology's development. Future study into RFID-enabled healthcare challenges might benefit greatly from the discoveries made here, as shown by this discovery. Future studies should, for example, examine the best strategy for analysing the explosion of RFID-enabled healthcare data. How can RFID-enabled healthcare apps enhance healthcare service delivery by analysing large data created by RFID-enabled healthcare applications? Future studies should also investigate the optimal technique for resolving security and privacy challenges associated with RFID-enabled healthcare applications. As early studies have shown, customers' concerns regarding confidentiality have a negative influence on the adoption and use of RFID technology. Future study must also focus on the best RFID-enabled healthcare infrastructure (e.g., data-on-the tag vs. data-on-the network). It is possible that there will be further study on the network externalities as well as the major technical and financial challenges involved with incorporating RFID technology into the entire healthcare value chain (Escribano & García, 2012).

There are several avenues for further investigation in this area. Future research must concentrate on the management of such new RFID-enabled healthcare capacities in effort to

expand improvements in outcomes. The "underlying mechanisms" through which IT skills effect business success are still unclear, according to previous research on IT-enabled corporate performance. The creation and achievement of economic interest from RFID projects in transportation and production needed great leadership, organization development, human resources practices, as well as organisational change. For this reason, future research should investigate whether "the healthcare environment provides high levels of difficulty but also complexity that can stimulate information systems (IS) theory extensions and invention" (Sundaresan et al., 2015).

Future research should evaluate other factors that may affect the adoption and use of RFID-enabled health applications, drawing on existing adoption theories and establishing new ones as appropriate. Other studies are required to examine the impact of RFID-enabled item-level tagging throughout the healthcare value chain on medical outcomes and expenditures. Healthcare providers have an enormous challenge in understanding the true costs of delivering treatment to each individual patient. As a result, some scientists believe that RFID technology might be critical in resolving these problems (Mathew et al., 2018).

RFID as well as other health - care IS adoption studies would be intriguing in order to evaluate the impact of various healthcare stockholders on their counterparts. Study by Polycarpou et al., (2012) suggest that social conceptual framework and conceptualizations may assist to "understand employees' system use" by incorporating informal linkages that support traditional structures in addition to behavioural intentions (Polycarpou et al., 2012).

Research on IT adoption shows a link between business process reengineering and IT usage and value. According to recent RFID adoption literature, this is a growing trend. There is a need for more study on the reengineering of patient, asset, and staff-related healthcare processes to increase commercial value from RFID-enabled healthcare initiatives. RFID technology concerns (e.g., RFID tag reading accuracy and performance) had a detrimental influence on RFID-based patient management applications. RFID-enabled healthcare applications have significant privacy and security challenges. Research on improved ways to integrate RFID into healthcare procedures and operations should be conducted in the future as well. RFID-enabled healthcare projects will need to be defined in future research, and the technology's influence on incremental and/or process change will need to be evaluated. Research investigating how RFID-enabled healthcare initiatives are helped or hindered by important healthcare stakeholders should thus be included in future studies. Future studies

should involve the creation of a comprehensive performance evaluation and management system for evaluating the value provided by RFID-enabled healthcare activities. A comprehensive understanding of the effects of sector-wide transformative projects is absent since "performance assessment and management takes place around different units that report up the line" (Shim et al., 2011).

6 CONCLUSIONS

Patients have suffered severe injuries because of medical interventions, and the primary goal has been to reduce and eliminate such incidents as much as feasible. An extensive financial investment in hardware devices (tags, readers, and access points) is required for the system's development and implementation. This cost is related both to the scale of the functioning area but also to the entities (patients or medication) that need to be tracked.

Expertise acquisition in the medical field is clearly a time-consuming and difficult endeavour. Furthermore, in this scenario, the developed models cannot be applied to other healthcare facilities or services. The RFID component providers don't provide adequate information on how to construct these projects. As a final consideration, care units and hospitals have varying needs when it comes to patient tracking systems. Variables like building materials and zone layouts may impact the accuracy of patient localization and access point distribution. Because of this, a large portion of the system's design and development must be tailored to the unique context in which the system will indeed be put into use.

This research examines how RFID may be used in healthcare, as well as the existing obstacles that healthcare providers must overcome in order to use RFID for patient monitoring. When these issues are resolved, new possibilities for RFID data processing and administration become apparent, and advice is provided for large-scale deployment and worldwide acceptance.

According to this research study, the health care industry's overall organisational climate has a significant impact on whether or not RFID is used. This research uncovered four distinct aspects of an organization's culture, structure, managerial backing, and financial commitment That have been previously documented.

Finally, this research found that three aspects of the health care industry's environmental context influence RFID adoption. Patient privacy expectations, legal requirements, and external pressure all factors into this equation. External pressure is the most well-documented of these three factors. It supports the idea that the health care sector is very competitive. While IS diffusion research in health care supports patient privacy expectations, RFID-specific studies reaffirm conformity with law and norms. This study also shows that the attitudes of administrators, IT managers, doctors and nurses, and patients all have a role in the decision to deploy RFID technology. RFID adoption in a healthcare context is facilitated by patients, who play a significant role. Perceived advantages are a major aspect in promoting healthcare RFID use. Prior research support three aspects of the construct: greater efficiency, less human involvement, and real-time patient location information. Streamlined processes are also shown to be a key advantage of RFID in healthcare. This idea is in line with a common need for process improvement heard in a variety of places. This study found that RFID adoption was hampered by the high cost of new tags, which is in line with the findings of other researchers. The results suggest that RFID adoption and deployment need a high level of organisational preparedness.

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APPENDIX 1

JBI CRITICAL APPRAISAL CHECKLIST FOR QUALITATIVE RESEARCH

Reviewer_____Date_____

Author_____Year_____ Record Number_____

		Yes	No	Unclear	Not applicable
1.	Is there congruity between the stated philosophical perspective and the research methodology?	☐	☐	☐	☐
2.	Is there congruity between the research methodology and the research question or objectives?	☐	☐	☐	☐
3.	Is there congruity between the research methodology and the methods used to collect data?	☐	☐	☐	☐
4.	Is there congruity between the research methodology and the representation and analysis of data?	☐	☐	☐	☐
5.	Is there congruity between the research methodology and the interpretation of results?	☐	☐	☐	☐
6.	Is there a statement locating the researcher culturally or theoretically?	☐	☐	☐	☐
7.	Is the influence of the researcher on the research, and vice- versa, addressed?	☐	☐	☐	☐
8.	Are participants, and their voices, adequately represented?	☐	☐	☐	☐
9.	Is the research ethical according to current criteria or, for recent studies, and is there evidence of ethical approval by an appropriate body?	☐	☐	☐	☐
10.	Do the conclusions drawn in the research report flow from the analysis, or interpretation, of the data?	☐	☐	☐	☐

Overall appraisal: Include ☐ Exclude ☐ Seek further info ☐

Comments (Including reason for exclusion)