



## ADOPTION AND IMPLEMENTATION OF RADIO FREQUENCY IDENTIFICATION (RFID) IN A HEALTHCARE SECTOR: A SYSTEMATIC LITERATURE REVIEW

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### Abstract:

*Today's world is moving around different innovative technologies. One of the technologies which have evolved in the present scenario is Radio frequency identification (RFID) which has gained an enormous impetus in today's age. It has been used extensively in the majority of the working sectors. Apart from other sectors in the country, the use of RFID in the healthcare sector has also increased widely. India is expanding its healthcare sector by introducing new and developing healthcare facilities, which can be a future gain. Nowadays, the healthcare industry has started using RFID based applications to keep records of inventory, instruments, supplies, demands, reduce errors during the treatment of patients, and so forth. The study investigates the adoption and implementation of RFID systems in the hospital environment. Also, this research work highlights the applications of RFID in the medical field and explores future research directions of RFID technologies in the healthcare system. The current study presents a literature review on RFID, for exploring different means of adoption, implementation as well as asset tracking in the medical field. This paper will guide researchers and practitioners to evaluate the impact of RFID technologies in healthcare supply chain management.*

**Keywords:** Research in Radio frequency identification (RFID), healthcare, supply chain management, medical field.

### 1. INTRODUCTION

In the present situation, where new technologies had emerged on a large scale, Radio Frequency Identification (RFID) technologies have replaced traditional working practices in many fields of study. It is an unfolding technology that uses radio frequencies for data collection and transfers with very little human interference involved in the process. RFID is a small computerized badge that could be used in different forms in various sectors of the country. These badges can be used in hospitals on commodities, patients, staff, etc. for handling, tracking, and locating information via a centrally controlled system (6). In the healthcare sector, RFID technology should be used for successfully managing medical resources in a well-organized manner. The major drawback faced by the working sectors for implementing RFID is the cost factor. Hence in any working environment, most of the time, the number of RFID readers is less than the required amount (14). Specific investigations were carried out by the 2011 Hospital Security survey, which was also supervised by the American Society for Healthcare Engineering for studying RFID in detail. The research states that administrative work using RFID systems will be executed in the coming years for trailing patients, health workers, assets, medical appliances, supply chains, etc. (16). RFID has the vision to scrutinize multiple badges on different commodities for a long distance. It can also be used for tracking of the asset in various fields. In the healthcare sector, RFIDs can be used for managing the process, handling medical supply chain, charge capturing, patient's treatment in the hospital's premises, and also after their discharge. The process involved in Healthcare supply chain management is acquiring resources, managing supplies, and distributing goods and services to patients and suppliers. For accomplishment of these operations, commodities and data related to medical

products and assistance usually go through several individual stakeholders, including producer, insurance firms, hospitals, suppliers, group procuring organizations, and several governing agencies. (1)

The crucial role of any healthcare sector is setting up standards for obtaining zero defects in the process of managing the issue of patient's security and safety. Hence for achieving these goals, different applications of RFID in the healthcare sector needs to be investigated. There will always be a managerial pressure to reduce the overall working cost in a hospital. Hence adoption and Implementation of RFID technologies in the Hospital's environment help in establishing standards, tracking assets, reduce moving cost and improve patient safety and security. According to the Journal of Commerce (2004, 1), RFID can restructure the business operations, covering a broad span of industries that comprise the healthcare sector as well. Keeping this in mind, the current study explores and focusses on the implementation and adoption of RFID technologies in the healthcare sector (9).

The on-going investigations targets to achieve the following objectives:

- To map the current state of scrutiny on the Implementation and adoption of RFID in the healthcare sector.
- To investigate various RFID applications in the hospital environment.
- To explore future directions in the study of RFID technologies in the healthcare industry.

Arrangement of the remainder paper is as follows: The second part argues upon various search strategies for inspection and

distribution of research articles based on RFID technologies. The third section of the study classifies the literature in three forms viz., RFID Applications in the healthcare industry, Asset Management in the healthcare sector, and RFID adoption and implementation in hospital Environment. The fourth section presents the conclusions and Managerial Implications of the review. The Fifth section discusses the limitations of the research. The last section highlights and gives essential guidelines for future study.

## 2. REVIEW METHODOLOGY

### 2.1 Approach Adopted for Searching the Articles.

Research papers using various search engines were collected for conducting the review of this study. Also, a systematic

literature review approach was followed, as shown in Fig 1. An amalgamation of three keywords, viz., RFID, AND Healthcare AND Supply chain, was used for the search of relevant research papers. The Scopus network is used as the leading source of collecting information. Research papers from the year 2004-2019 were selected for the study. For the current study, only peer-reviewed articles related to RFID adoption and implementation were considered, and the other sources like proceedings, a chapter from books, white papers etc. were discarded. To ensure complete investigation backward snowballing method was used along with the title and abstract search on recent journals of the particular field. Comparative analysis between the recently explored investigations in the field of RFID in the healthcare sector was conducted. (18). Ultimately, 23 research articles were selected for the study.

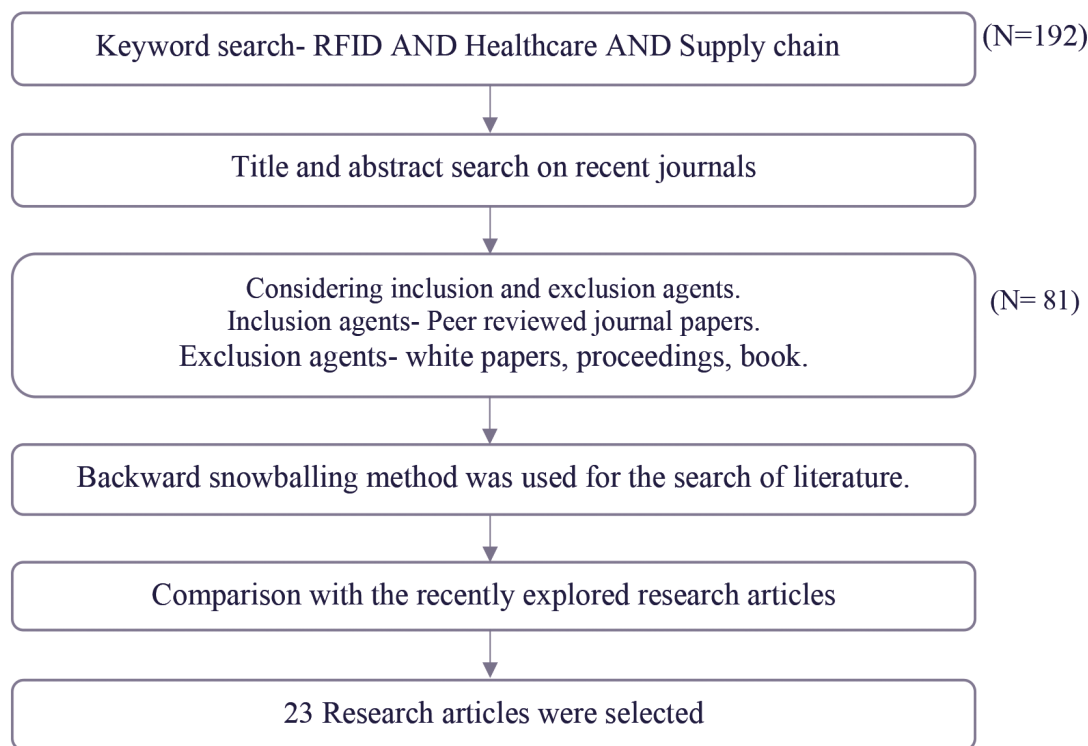


Fig 1. Search Methodology (Source: Surajit Bag et al., 2018)

### 2.2 Selection Criteria of the Articles.

This stage demands proper documentation of data from 23 articles. For data collection, a template was made which addresses the supporting questions: (20)

- What is the influence of RFID adoption and application in the healthcare industry?
- Which are the different RFID adoption methods in hospitals?
- Which cases were studies discussed in the research articles?
- Which countries were entailed in the research?

- What were the methodologies used in the study?
- What were the critical outcomes, findings, and future scope in the study?

### 2.3 Annual Dispersion of Articles.

In this section, research work related to RFID implementation and adoption in the healthcare sector is shown in the form of an annual dispersion from the year 2004 to 2019. The distribution shows a steep increase in the publication from the year 2004 to 2007. With the passing years, there is a steep decline in the editions from the year 2008-2010. A flat growth can be seen in the number of articles from the year 2012-2014. During that time, research on the Implementation and adoption of RFID was

more concentrated on its applicability and operating principles in the healthcare industry. Also, the study discussed different asset management techniques and their limitations in hospitals using RFID readers. From the year 2015 to 2019 again, growth

in the research of RFID has increased and decreased, as shown in fig 2. Research in recent years mainly focuses on the adoption of RFID and asset management by using this technology in the healthcare sector.

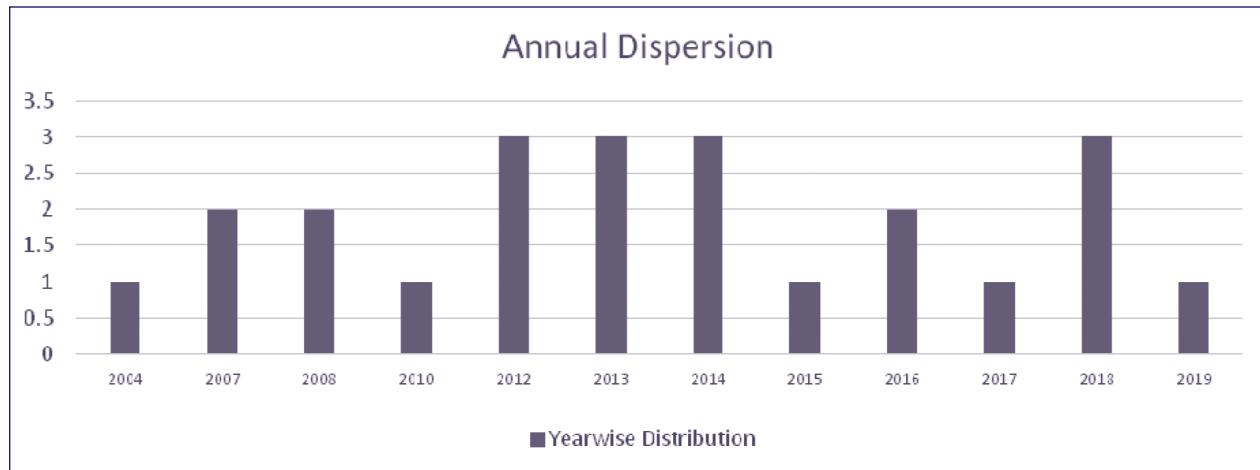


Fig 2. Annual dispersion of articles.

2.4 Country-wise Dispersion of Articles.

In the initial days, only hospitals in the United States (U.S) were mainly involved in the research and development activities related to RFID badges. With the forthcoming years, its implementation and development have spread across different countries. Fig 3 shows the country-wise dispersion of the studied articles. It is obvious that almost 50% of the study is based on the U.S. healthcare industry. The U.S healthcare

sector is keener to adopt RFID technology as it decreases the supply chain cost and personnel expenses in the hospitals. Also, countries like the U.K, Malaysia, and Taiwan healthcare sector added 9% to the literature analysis. Countries like South Africa, Israel, and Italy, had contributed 5% in the research. Countries like Canada and Europe had also started implementing RFID technologies for managing finances and optimizing the working and performances in their healthcare sector. These countries had contributed 4% in the research.

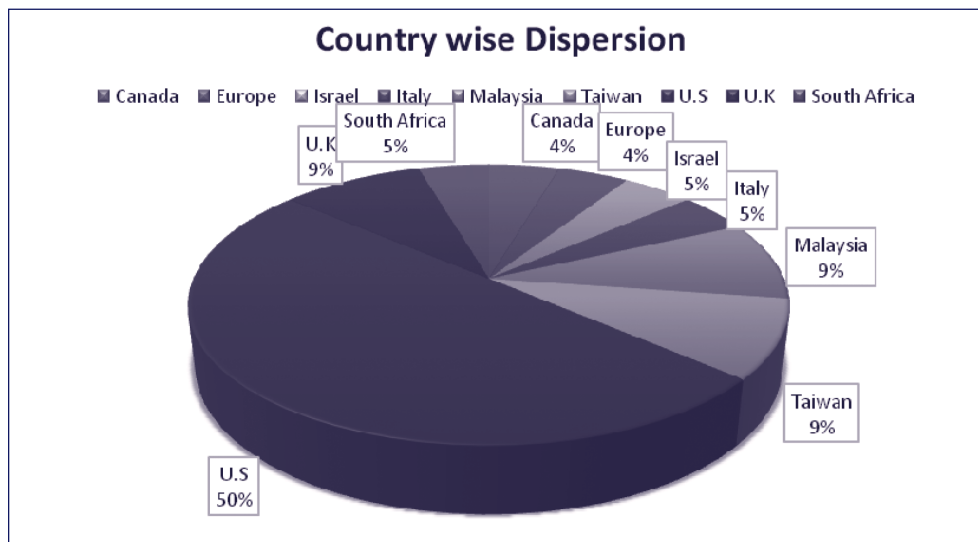


Fig 3. Country-wise dispersion of articles.

2.5 Journal-wise Dispersion of Articles.

This study highlights the adoption and implementation of RFID in healthcare industry. Hence, an investigation of 21 research papers of 15 peer-reviewed journals from the year 2004 to 2019 was done. Fig 4 shows the Journal wise dispersion of the reviewed study. These journals are from different backgrounds viz., Healthcare, Operations management, supply chain

management, Production management, decision making, and Information Technology. 29% of the published articles were from the Journal of Medical Systems. Also, Production and operations management journal contributed 21% of the study. Journal of decision support systems and the Journal of Production Economics come up with a 14% contribution to the research. The rest of the journals, which are shown in Fig 4, had made 7% contribution to the study.

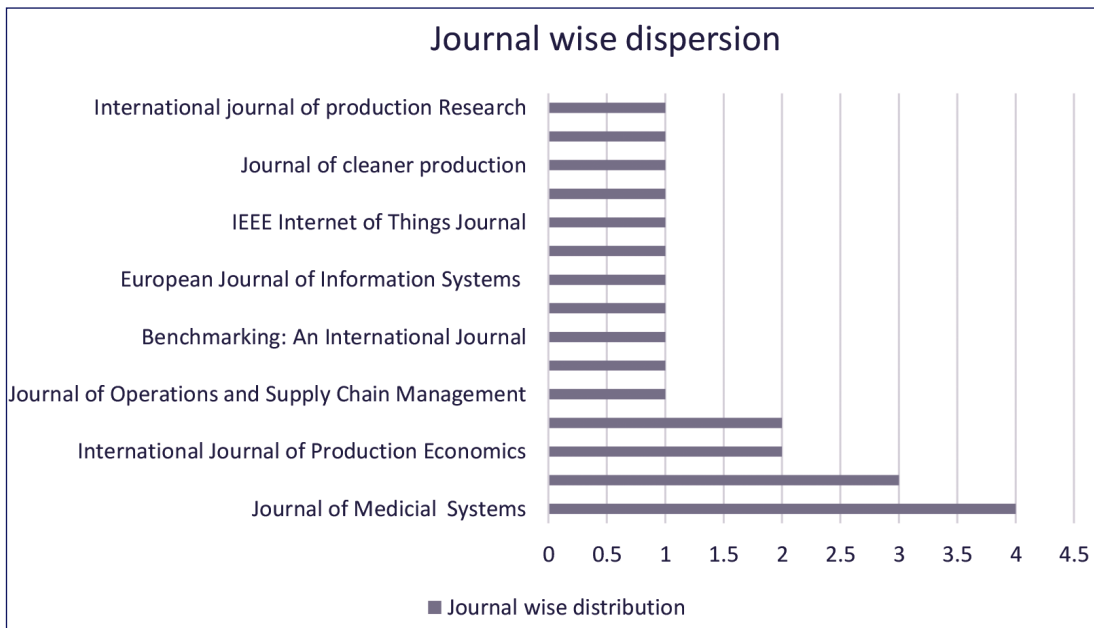


Fig 4. Journal-wise distribution of articles.

3. CLASSIFICATION OF LITERATURE

In the coming years, with the boon and development of new technologies at a rapid scale, majority of the researchers and practitioners had studied various methods of RFID implementation in the healthcare industry. In this process,

different case studies and literature reviews were explored for getting clarity on RFID implementation in hospitals. The current survey of RFID can be classified into three themes viz., had focused on RFID adoption and implementation in the healthcare sector, various applications of RFID in hospitals, and improvement of asset tracking in the healthcare industry.

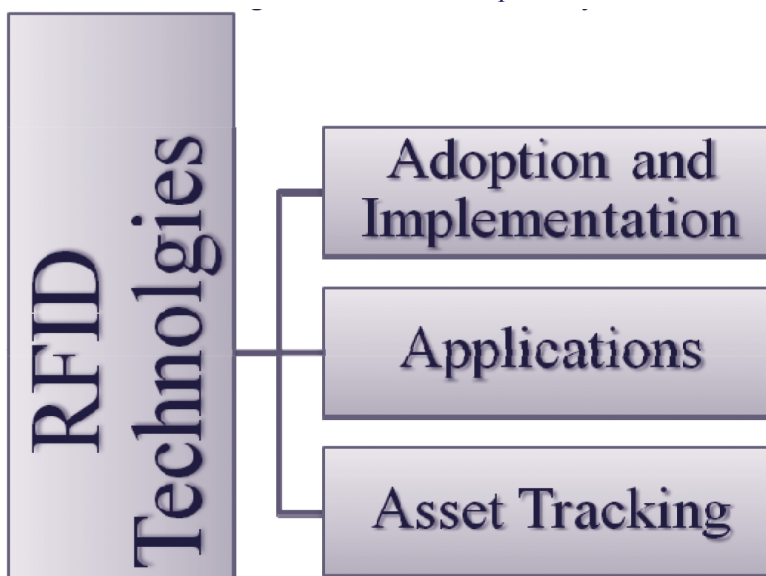


Fig 5. Classification of Literature-based on RFID Technologies.

3.1 RFID Applications in the Healthcare Industry.

In the new era of technology, RFID is inclining towards digitization in the healthcare section. Nowadays, hospitals willingly support the Implementation of RFID technologies. These technologies can be applied for enhancing the safety of patients, keeping a record of medication and testing of drugs, handling security issues, etc. Angela Wicks et al. investigated possible areas of RFID implementation practices, difficulties faced by the hospitals, and different policies

adopted in the hospital environment for smooth functioning (9). Sameer Kumar et al. provided actual real-time facts to the senior executives to make correct decisions about RFID implementation and adoption in the firm. They also highlighted RFID business applications in the healthcare sector (11). Sara Amendola et al. scrutinized state of the art for the claims of RFID on the body-centric system and collected in-depth details about the end user’s lifestyle in the living world (12).

### 3.2 RFID Adoption and Implementation in Hospital Environment.

Nowadays, hospitals use RFID to handle inventory, trail instruments, and supplies, manage employees and patients, and proper drug delivery to reduce errors. Different elements that affect the adoption and deployment of RFID in the healthcare industry are highlighted. Suhaiza Zailani et al. investigated tests conducted on RFID on the abate role of professional level and study components affecting RFID adoption in the Malaysian healthcare sector (10). Cheon-Pyo Lee and Jung P. Shim explored the inspiration and hidden agenda, which is vital for adopting RFID using the notion of need pull and technology push, within firms in the healthcare industry (13). For conducting analysis of the elements that affect RFID implementation and adoption, Ming-Tsang Lu et al. developed an estimation framework by implementing hybrid Multiple Criteria Decision Making (MCDM) method called as DDANPV that unites DEMATEL (decision making trial and evaluation laboratory), DANP (DEMATEL-based A.N.P.), and VIKOR. Their study helps in capturing complex factors that influence adoption and are interdependent (15). Asoke Kumar Dey studied the impact of the T.O.E. model with RFID adoption in U.S. hospitals and understood the requirement, challenges, and influence of the T.O.E. model on the RFID adoption (16). Igal M. Shohet and Sarel Lavy defined a core theme related to the healthcare facilities management model and I.C.T. by reviewing five main domains associated with the management of healthcare facilities and their interconnection with each other (17). Also, Alain Yee-Loong Chong et al. extended his research work by combining the unified theory of acceptance and use of technology (UTAUT) and personal disparity and demographic attribute ) to anticipate RFID adoption in the healthcare supply chain (22).

### 3.3 Asset Management in the Healthcare Sector.

For supervising the Hospital's supply chain, there would always be a requirement of data regarding asset management, functionality, and other operations involved in the process. Randy V. Bradley et al. evaluated and studied the outcome of linkages between E.D.I. and RFID on the overall performance of hospitals viz., personal expenses, hospital readmission rates, and supply chain cost efficiency (1). Ygal Bendavid et al. managed shipment and high-quality utility items that require product level accountability by using RFID entitled traceability system in the healthcare sector (2). Linda Castro et al. provided factual data to show that RFID can easily use and transform resource management by updating knowledge and potential in staff, improving usage, and enhancing the transparency of data (3). Amitava Dutta et al. investigated three drivers of RFID implementation and adoptions, viz., exploring an architectural model of RFID and highlight its key drivers, solving issues of quantifying data, and managing assets in the healthcare sector (4). Scott C. Ellis et al. studied new unsupervised learning system viz., the use of RFID tags in significant data investigations for solving issues related to Hospital's supply chain management (5) M. Bevilacqua et al. defined RFID as

a tool to create a technologically evolved system for the safe channeling of drugs in the healthcare system (6). Peter B. Southard et al. developed a trade model to generate quantitative evidence supporting the benefits of implementing Radio Frequency Identification (RFID) technology, which limits the scope to sending patients outside the hospital premises for treatment (7). Asil Oztekin et al. provided optimal methods to decision-makers for designing a tracking system that manages finances in the medical field (14). Shiou-Fen Tzeng et al. proposed a framework for assessing the professional value of RFID technology (23).

## 4. CONCLUSIONS AND MANAGERIAL IMPLICATIONS

In this paper, research is carried to understand the impact of adoption and Implementation of RFID technologies in the healthcare environment. For doing this, 21 research papers from peer-reviewed journals were taken for study. The investigations were predominantly classified into three categories viz., RFID Applications in the healthcare industry, Asset Management in the healthcare sector, and RFID adoption and Implementation in hospital Environment. However, the following conclusions are drawn:

- Our study identifies that managing finances and optimizing the working and performances of the hospitals are the main objectives in the healthcare sector.
- Also, efforts were made to address issues arising in the implementation of RFID, which lead the way to future studies. In the review, some benefits of RFID implementations are discussed.
- It was found that the overall accountability of high-quality utility items can be increased significantly by redesigning the process and using RFID entitled traceability system. This practice saves time, which can be utilized in other healthcare activities.

Managerial Implications drafted from the study are:

- RFID perception in hospitals is an add on for improvising the decision-making process, outlining the improvement in planning and duty-bound process in the system.
- The use of RFID tags saves time and helps the administrator to diminish errors by reducing their effort of identification and location of drugs.
- RFID technologies can be implemented, which allows the organization to save yearly costs and sending patients outside the hospital premises for treatment.
- RFID technologies can be achieved, which helps the organization in saving annual costs and sending patients outside the hospital premises for treatment.
- There should be a focus on the senior executive's approach to inventory management by using RFID applications in hospitals. For achieving this, investigations were conducted in the respective domains of the executives.

- The Implementation of RFID should be associated with durable targets. Considering the needs of the customers, updating, and purchase of tags and paraphernalia should be the primary aim of an organization.
- For getting accurate outcomes, a longitudinal study that investigates the link between senior executives and supporting staff is to be done over a period of time.

## 5. LIMITATIONS

Firm's readiness is a crucial aspect for building up or declining the probability of adopting RFID in hospitals. The actual advantage of RFID implementation and adoption is far more than agreement on the hospital's underlying issues.

- The susceptible nature of medical records leads to less access to data in the system.
- Implementation of RFID is too costly; hence this technology should be supported and handled by considering cost factors in an effective way.
- In hospitals, adoption of RFID has become difficult due to interference of the management, privacy issues, cost concern, and lacking standardization.
- Also, there is less understanding between senior executives and healthcare staff on deciding the factors that influence RFID implementation and adoption in the healthcare sector.

## 6. FUTURE SCOPE

Future research is focused on overall working and management of hospital Environment, which should be redesigned by conducting extensive research to study the impact of adoption and Implementation of RFID technologies.

- In order to have proper knowledge, acceptance, fulfillment, and dispersal in the domain like healthcare, a better understanding of topics like an allotment, acknowledgment, and suitability concerning RFID implementation and adoption, acts as a critical factor.
- Establishing the base RFID infrastructure today is the crucial driver for total supply chain adoption and benefit realization tomorrow. There should be an improvement in the existing practices and for building a better future by setting up the base of RFID technologies for the Hospital's supply chains.
- The Broad scope should be given for conducting sturdy investigations on the decision-making framework in RFID entitled environment.
- Implementation and adoption of RFID technologies can also be frugally used in retail by promising supply chain transparency in the system.
- Study the influence of private affairs on the firm's RFID implementation and adoption, which will aid in the development of RFID adoption shortly.

This research work supplicates the benefits and uses of adoption and Implementation of RFID technologies in the healthcare industry to upgrade marketing, improve potency, which leads to the contentedness of the patient. This paper guides researchers and practitioners to evaluate the impact of RFID technologies in healthcare supply chain management. Through this study, RFID adoption and implementation can be studied from the point of view of the healthcare providers.

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