American International University-Bangladesh (AIUB)

RESEARCH REPORTON

“Title”

Application of RFID in Hospitals

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Introduction:

The efficient use of resources will increase the effectiveness of the time spent treating patients, allowing hospital staff to spend less time looking for medical equipment and supplies. Handling and integrating healthcare data is a significant task in the healthcare environment. Identifying patients, determining the services to be provided, learning about previous treatments, and gaining access to records are just a few tasks that make up a typical patient service.

Patient information, Identifying and managing patient data using conventional methods requires human intervention, which is susceptible to mistakes that can have fatal consequences. The healthcare sector is quickly utilizing Radio Frequency Identification (RFID) [1] to track medical supply inventory, identify patients, and manage the workforce [1]. A transponder (tag), a transponder reader, and other components make up RFID, which can collect data without human intervention. As well as database software [2], The transponders are once more divided into active (those with their energy source) and passive (those whose energy source depends on the transponder reader) [3]. [4]. Using radio frequency signals, the transponder reader gathers data from the tag, including the identification proof, encrypted data in the tag, and the tag's location [5]. With the help of this technology, medical asset tracking is more effective, healthcare service providers are cost-effective, and patient safety is improved [9] [25]. All participants in the hospital environment, including patients, physicians, nurses, technicians, administrators, and other medical care providers, are impacted by using RFID technology. By using RFID technology to track healthcare assets, patients, and staff, it is possible to decrease medical errors [1] [7] and the workload of healthcare providers, enhancing the effectiveness of patient care [1] [6] [7]. By removing issues in the healthcare sector like the long-established paper-based process, and low discernibility of patients, staff, medical equipment,

and data, implementing RFID technology in healthcare systems has led to an enhanced and remarkable transformation. Before implementing this technology in the healthcare environment, several additional crucial factors must be considered, such as cost management, people management in busy healthcare sectors adapting to changes in operations, and ethical and legal considerations [6] [27]. When implemented, the RFID innovation in the healthcare services sector has the potential to provide enormous benefits, including increased effectiveness (e.g., lower operational and labor costs), quality benefits (e.g., better patient care and fewer medical errors), and intensified management benefits (e.g., process enhancement overall, regulatory agency compliance, and coordination between healthcare service providers and medical insurers) [11]. To enhance patient care, the healthcare sector has begun devoting more time and money to various technologies. There are several challenges when using technology to handle sensitive patient data. The significance of having practical and viable RFID-based solutions in healthcare served as inspiration for this.

This paper outlines the difficulties and roadblocks the healthcare industry encountered when attempting to implement an RFID-based solution to enhance various services. When used carefully, RFID can be used in the healthcare sector for various tasks, including tracking patients and medical staff, medical tools and assets, inventory, laundry, and medical wearables. The essay's goal is to:

- To review the existing RFID technology literature and offer insight into the current RFID usage in the healthcare industry.
- To research the difficulties, problems, and challenges the healthcare sector faces in implementing RFID in their businesses.
- To determine potential solutions to get past issues with security, data visibility, and other workplace snares and successfully adopt the technology.

Literature Review:

The initiatives, current literature, publications, stages of RFID implementation, and implementation-related difficulties are all summarized in this section. The ability of RFID to trace and track products in the supply chain is well known, but it has yet to be well adapted in the modern healthcare sector [12]. The authors discuss the advantages, potential uses, and implementation difficulties of RFID in the healthcare sector, particularly in hospital settings [12]. In addition, the hospital setting comprises various technologies like RFID, sensor networks, and patient data management. As this model is focused on supporting the care for the elderly population, Ho et al. project .'s [13] proposed integrating sensor networks and RFID technologies to build a system for the elderly to monitor their in-home medication intake for older people. The developed model is divided into two stages: learning and development, where sensor compatibility is examined, networks' learning phase when interacting with RFID systems, while the latter phase builds a system that consists of high-frequency RFID system components and sensors. The authors of this paper further examined the difficulties associated with integrating both of these technologies into a user-friendly healthcare system. The healthcare industry now has access to countless opportunities and possibilities thanks to the Internet of Things (IoT) and innovative technologies, which have improved patient care facilities and increased the security of the entire healthcare ecosystem [14] [28] [29] [30]. With the help of innovations, cutting-edge medical insurance companies, and the medical services portability arrangement, IoT can automate the patient consideration work process. A state-of-the-art RFID application for user information retrieval and body-centric systems is created in [14]. Carr et al. concentrate on the elements affecting RFID adoption in healthcare organizations [15]. In order to determine the usefulness of the

factors for the healthcare industry, a variety of direct and indirect relationships, as well as risk factors, were examined. To support the relationship between various factors and to use it practically, the authors' analysis could not turn up any pertinent data. Because it demands high quality, the aging population has raised significant concerns about housing, economic development, and quality of life [31]. The research model developed by Jang et al. [31] identified a study to identify quality characteristics of universal healthcare (u-healthcare) for healthcare services that impact the goals of healthcare service providers. The person's goals for using u-healthcare.

Additionally, the study provides direction for decision- and policy-makers in designing and implementing long-term care systems. The ability of RFID to track assets is one of its most promising uses. By carefully observing resource courses offered by an organization, Alvarez López et al. [24] and booth et al. [32] examined the application of RFID technology in the integrated healthcare environment to track medical staff, patients, and medical equipment enabling analysis of this data for process improvement. The use of RFID technology, according to the authors, will enhance patient safety, improve clinical services, improve medical care delivery, control billing, and stop the theft of hospital property or equipment [10] [32] [26]. An RFID-based Healthcare Management System (RHMS) was developed and put into use in a setting that was somewhat similar to the real world by Ngai et al. The output of the suggested model demonstrates the system design for the RHMS. Li et al. [17] discuss a mobile healthcare service system that uses RFID technology to identify people and objects inside and outside the hospital grounds while treating an acute infection spreading throughout society. The mechanism for obtaining patient location information and specifics about their health status so that control measures can be taken are discussed [17]. In order to transform electronic healthcare into mobile healthcare, this proposed model highlights various approaches to providing

healthcare services to regions across various geographic locations. From Lingle's [25] article for Packaging World outlines why an organization might be reluctant to accept RFID implementation. *Cost* is the main issue, followed by operational complexity, a lack of technical know-how, an understanding of how to use RFID data, and other diverse issues.

When using RFID technology, ethical concerns about the tracing and tracking of people and objects are a top priority. Although RFID is a promising technology for managing and tracking assets, there may be a security concern if a malicious hacker gains access to the data. IoT, AI, pervasive computing, intelligent networks, and human-computer interfaces are just a few examples of the innovative technologies that make up ambient intelligence (HCI) [18] [29] [30]. The adoption of ambient intelligence as the framework for intelligent healthcare technologies makes sense because it is a system-based environment that reacts and responds when humans are present. One of the characteristics of ambient intelligence is its awareness of adapting to the needs and desires of the individuals, being aware of contexts, understanding spoken commands, and recognizing gestures. According to AmI (Ambient Intelligence), Kosta et al. [19] evaluated five scenarios focusing on the homecare sector, assistive technology, and daily life activities. The authors talk about how mobile devices are changing and becoming tools for interacting with the environment—dealing with people and their interactions with the environment or systems results in collecting vast data. An overview of RFID and ambient intelligence technology that uses tags to collect data is provided by Metras [20].

The latter focuses on information on servers (both centrally located and geographically dispersed), which users can access by using URLs stored in tags. The legal and ethical concerns with implementing ambient technology, such as ransomware attacks, are a significant source of worry as this technology is still in its infancy. The combination of ambient intelligence and RFID is still debatable

because RFID deals with sensitive patient data. Medical errors are the third leading cause of death in the US and can involve incorrect diagnosis or treatment of a disease, infection, or syndrome [21]. To ensure patient safety, healthcare organizations must prioritize reducing medical errors. Hospital Information Systems (HIS) cannot currently monitor the

Accurately the patient's credentials, the operational site, and the time [22]. Integration is a significant problem in healthcare and is often the root of serious medical mistakes that occasionally have fatal consequences.

Wu et al. [22] identified the provision of medicine in healthcare as the primary contributor to medical error after reviewing the existing literature and conducting numerous interviews with medical experts. A self-regulatory RFID-backed system will guarantee the patient's identity, validate the various medications given to the patient at various stages of treatment, and control the patient registration process [22]. Medical errors can be reduced or eliminated if errors are eliminated just before returning to their original state. When the majority of research studies in the literature concentrate on the benefit

Ting et al. [23] discuss the management-based challenges in establishing RFID projects throughout the healthcare sector. A case study on the medical organization Humphrey and Partners Medical Services Limited was conducted to analyze, determine a development framework, and identify crucial factors to consider before implementing an RFID-based project. Medical errors are the third leading cause of death in the US and can involve incorrect diagnosis or treatment of a disease, infection, or syndrome [21]. To ensure patient safety, healthcare organizations must prioritize reducing medical errors [26]. Hospital Information Systems (HIS) cannot track patient data in its current state. The precise time, location, and patient credentials information [22]. Integration is a significant

problem in healthcare and is often the root of serious medical mistakes that occasionally have fatal consequences. Wu et al. [22] identified the provision of medicine in healthcare as a significant contributor to medical error after reviewing the existing literature and conducting numerous interviews with medical experts. A self-regulatory RFID-backed system will guarantee the patient's identity, validate the various medications given to the patient at various stages of treatment, and control the patient registration process [22]. Any errors can be removed before returning to their original state, which minimizes or eliminates all medical errors. Ting et al. [23] discuss the management-based challenges in developing RFID projects across the healthcare industry, even though most research work in the literature focuses on the advantages of RFID technology for healthcare. A case study on Humphrey and Partners Medical Services Limited, a medical organization, was conducted to identify a development framework and critical factors to consider before implementing an RFID-based project.

This research review aims to gain knowledge about the advancement of RFID technology and the security risks associated with its widespread use in the healthcare sector. This is significant due to our analysis of numerous expert interviews from the healthcare sector, scholarly research articles, and healthcare organizations' annual reports on the adoption and use of RFID technology [24]. The analysis of various factors influencing the widespread adoption of RFID technology in the healthcare industry has been the subject of extensive research and study. It is crucial to research the findings of previous studies to pinpoint the difficulties and shortfalls in successfully adopting this ground-breaking technology to serve customers better.

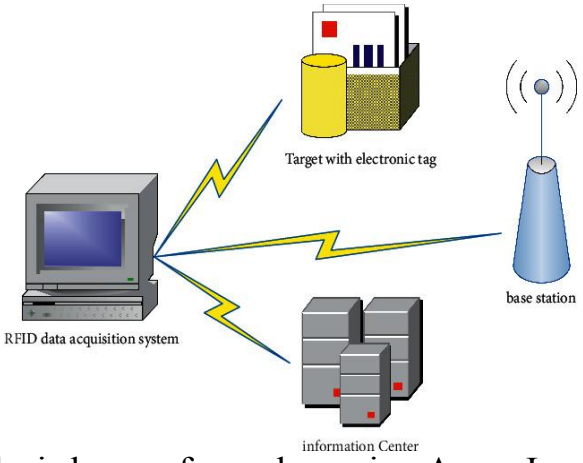
Analysis and Interpretation of the Data:

I. Data Analysis

It will be simulated of an Emergency Department (a public hospital in Turkey) in

this study. The duration of all procedures between stations and mean waiting times of the patients will be analyzed. Total length of stays in Emergency Department and utilizations will be seen. A 24-hour database was created as a result of the Hospital Information and Management System, the measurements taken from the observations and face-to-face interviews with the department's professionals. In this way, the existing structure and improvement processes of the system (total waiting times, total staying times, optimum number of employees, or leaving the hospital without payment or without any excuse)

II. Data Analysis of Triage Department and Design with Arena Simulation Program The priority levels (1-Red Code, 2-Yellow Code, 3-Green Code) of the patients are determined according to their urgency status in Triage Departments. Patients are directed to there after the patient information is entered into the system. In this area, Triage Nurses follow the vital signs (pulse, blood pressure, fever diabetes level) of patients and evaluate their past stories and make prioritization. Statistical distribution analysis has performed as using Arena Input Analyzer Program according to database (in seconds). As a result of this analysis, it was seen that the triage nurses processing times belonged to Weibull Distribution (Chi-Square Test p-value = 0,396> 0,05). Simulation 1; The number of employees in the Triage Department (Triage Nurse: 3 Person) and the processing times are defined to the Arena Simulation Program according to the statistical data analysis obtained from database. Through this simulation, the existing workflow and waiting times of the department will be evaluated and then improvement works will be planned. Simulation 2; This area has been designed with RFID Technology and integrated into Arena Simulation Program as follows: A signal is generated every minute to measure the intensity of the patient queue with Create Module. After, the condition in the queue is checked with Decide Module. If the average waiting time of the patients in the Triage Department exceeds 15 minutes, increasing the number of Triage Nurses + 1 (min: 2 current capacity - max: 4 variable capacity), to reduce average waiting times. If the average waiting time exceeds 15 minutes, RFID Technology sends an alarm signal to the to the Management Center, so it provides real time monitoring. Then, the management center evaluates the processes for reducing average waiting intensity and they assign +1 Triage.



III. Data Analysis of Examination Department and Design with Arena Simulation

Program Medical examinations are performed according to patients triage levels in Examination Department. In this way, patients are diagnosed and treatment plans are established. Statistical distribution analysis has performed as using Arena Input Analyzer Program according to database (in minutes). As a result of this analysis, it was observed that doctor processing times could not be used for simulation model because Chi Square Test was not positive (p-value <0.05). In this case, if a data set does not fit to any known standard distribution, an Empirical Distribution can be generated. So, doctors processing times generated by this distribution and defined to the Arena Simulation Program such as : CONT (0.000, 8.210, 0.000, 8.505, …etc.). Simulation 1; The number of employees in the Examination Department (Doctor: 7 Person) and the processing times are defined to the Arena Simulation Program according to the statistical data analysis obtained from database. Through this simulation, the existing workflow and waiting times of the department will be evaluated and then improvement works will be planned. Simulation 2. This area has been designed with RFID Technology and integrated into Arena Simulation Program as follows: A signal is generated every minute to measure the intensity of the patient queue with Create Module. After, the condition in the queue is checked with Decide Module. If the average waiting time of the patients in the Examination Department exceeds 10 minutes, increasing the number of Doctor+ 1 (min: 7 current capacity - max: 9 variable capacity), to reduce average waiting times. If the average waiting time exceeds 10 minutes, RFID Technology sends an alarm signal to the to the Management Center, so it provides real time monitoring. Then, the management center evaluates the processes for reducing average waiting intensity and they assign +1 Doctor within UNIF Distribution (1,5) minutes.

C.IV. Data Analysis of Observation Department and Design with Arena Simulation ProgramA short-term care of patients according to treatment plans are performed in Observation Departments. Patients who have level of Red Codes, are prioritized in the waiting area. Observation Nurses start to perform the first controls immediately which determined by the doctors for this patient. It can take 30 minutes for level of Yellow or Green Codes. Statistical distribution analysis has performed as using Arena Input Analyzer Program according to database (in minutes). As a result of this analysis, it was seen that the observation nurses processing times belonged to Normal Distribution (Chi-Square Test p-value = 0,07> 0,05). Simulation 1; The number of employees in the Observation Department (Observation Nurse: 9 Person) and the processing times are defined to the Arena Simulation Program according to the statistical data analysis obtained from database. Through this simulation, the existing workflow and waiting times of the department will be evaluated and then improvement works will be planned. Simulation 2; This area has been designed with RFID Technology and integrated into Arena Simulation Program as follows: A signal is generated every minute to measure the intensity of the patient queue with Create

Module. After, the condition in the queue is checked with Decide Module. If the average waiting time of the patients in the Examination Department exceeds 5 minutes, increasing the number of Observation Nurse + 1 (min: 9 current capacity- max: 13 variable capacity), to reduce average waiting times. If the average waiting time exceeds 5 minutes, RFID Technology sends an alarm signal to the to the Management Center, so it provides real time monitoring. Then, the management center evaluates the processes for reducing average waiting intensity and they assign +1 Observation Nurse within UNIF Distribution (1,5) minutes. So, it is prevented that patient's long term waiting without any treatment.

Findings:

The healthcare sector gains a lot from the usage of RFID in terms of patient safety, tracking, caregiving efficiency, and provider satisfaction. According to research, RFID can aid to increase patient safety. RFID tags have the opportunity to lessen healthcare misidentification problems. The study assessed how efficient and successful the identification and confirmation techniques using RFID technology were at preventing medical errors. The study's findings demonstrated that the system recognized real-time medical personnel, patient IDs, medication data, and blood sample data with accuracy. The study discovered that the RFID point-of-care system was efficient at distinguishing between people and drugs. Critical mistakes weren't made during the trial. Hwang (2011) saw an increase in patient identification verification from 75% prior to deployment to 100% following implementation of RFID technology in the operating room. Completion rates for physician time-outs increased from 43% to 70%. From 0.146% to 0.089%, instrument loss decreased.

Recommendation:

Although there are obstacles to adopting RFID technology, the data on current utilization is encouraging. The following suggestions and tactics are provided to help healthcare organizations embrace RFID technology in order to get beyond

these obstacles. In order to address adoption cost issues, it is necessary, according to Modrák (2012), to examine the economic impact of RFID installation. A detailed cost-benefit analysis should be performed by an organization before implementing RFID because the overall cost to adopt and maintain RFID technology can prevent enterprises from employing the technology. Healthcare firms might also benefit from evaluating the impact RFID has already had on supply chain management. A small-scale test of RFID in a real-world healthcare environment gives an organization confidence that the technology can achieve its goals. Since the capabilities of RFID technology differerent from product to product, companies must determine whether the chosen product can achieve the implementation's anticipated aim.

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