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USING REAL TIME TRACKING TO IMPROVE THE EQUIPMENT MANAGEMENT SYSTEM IN THE OPERATING ROOMS

by
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ABSTRACT
OF THE PROJECT OF

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Effective management of medical equipment within hospital operating rooms (ORs) is crucial for ensuring patient safety, timely surgeries, and efficient resource utilization. However, manual inventory checks often lead to misplaced or missing expensive equipment and overdue maintenance, resulting in unnecessary delays and financial losses. This project proposes the implementation of an automated equipment management system in the ORs of the American University of Beirut Medical Center (AUBMC) to address these challenges.

Drawing upon the Systems Life Cycle Model (SLCM), specifically focusing on the Analysis and Planning phases, the project aims to analyze current inventory management practices and design a comprehensive plan for the implementation of an automated system. By leveraging technology, such as radio-frequency identification (RFID) tagging and inventory tracking software, the system will streamline inventory checks, enhance equipment traceability, and facilitate maintenance scheduling.

The anticipated outcomes include significant time savings in locating and retrieving surgical equipment, improved control over inventory misplacement and loss, and enhanced management of equipment maintenance schedules. These outcomes not only contribute to operational efficiency within the ORs but also mitigate risks associated with surgical delays and financial implications for the hospital.

Through this project, AUBMC endeavors to enhance patient care quality, optimize resource utilization, and establish best practices for medical equipment management in OR settings.

Keywords: medical equipment, equipment management, maintenance, automated system, RFID

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CHAPTER I

INTRODUCTION

Current healthcare institutions are highly reliant on diverse types of medical equipment, without which it would be impossible to deliver high-quality care (Oshiyama et al., 2014; Taghipour, 2011). With the advancement of technology, hospitals are expanding, and an increase in demand for more equipment is required, leading to a higher need for effective equipment management systems (Liu et al., 2022). Managing medical equipment is a process that helps hospitals oversee and maintain their equipment and thus ensure its safe, efficient, and cost-effective use. Consequently, accountable organizations are asked to create and evaluate their medical equipment management process to guarantee that the equipment is being used in compliance with the manufacturing facility's operating guidelines, and kept in a secured place (Ghasemi et al., 2022).

In the hospital, the operating room (OR) is a high-cost center and specialized unit. An increase in its efficiency is fundamental for the survival of healthcare institutions (Cima et al., 2011). It is widely recognized that the OR setting is complex and uses a range of medical equipment to support surgical procedures (Sewberath Misser et al., 2018). Thus, proper management of medical equipment in the OR influences the quality of diagnosis, the prevention of surgical complications, and the treatment of specific illnesses (Daba et al., 2017).

A. Problem Description

The biomedical engineering department at American University of Beirut Medical Center (AUBMC) provides the OR department with an Excel sheet with all the equipment purchased under the OR service. A manual inventory check is routinely done to monitor the availability and maintenance of the equipment. Two recurrent problems are that during inventory checks, several expensive equipment are missing or displaced from the OR store, and the maintenance dates for many of the equipment are overdue.

B. Problem Significance

Physically searching and manually entering each piece of equipment is a lengthy process that is prone to a number of issues, such as human errors, misplaced equipment, difficulty to track borrowed equipment and maintenance dates. The displacement of equipment is causing unnecessary delays in getting the right equipment for scheduled surgeries. Such unnecessary delays can endanger patients' health, cause patient dissatisfaction, decrease staff's job satisfaction, cancelation of the assigned case, and have negative financial implications for the hospital (Ren & Wu, 2022; Daba et al., 2017; Karimi et al., 2017). Failure to follow the equipment's maintenance schedule may result in incidents leading to complaints, lost data, or device damage (Maktabi, 2021).

C. Purpose of The Project

The purpose of this quality improvement project is to identify a best-fit automated equipment management system in the OR that provides real-time tracking of OR equipment, avoids system failures and maintenance delays, and captures and stores data accurately (Roper et al., 2015). The automated system will be able to track each piece of equipment in real time just by searching for it electronically. Also, more details will be accessible for the end users, such as the maintenance date, price, manufacturing facility, and year of purchase. Such system will assist in increasing the perceptibility and functional efficiency of clinical and organizational workflows in the healthcare setting (Gholamhosseini et al., 2019).

CHAPTER II

LITERATURE REVIEW

Four primary tracking technologies have been identified and implemented successfully by numerous hospitals in real-world tracking systems for inventory management.

A. Medical Equipment Inventory Maintenance Systems (MEIMS)

Medical Equipment Inventory Maintenance Systems (MEIMS) is an electronic system designed to manage and monitor medical equipment in healthcare facilities. This system automates all information related to medical equipment and enhances the availability of reports and alert notifications for planned preventive maintenance. MEIMS focuses on manually entering the medical equipment details such as name, type, category, quantity, equipment function, serial number, and location. Frequent maintenance and inventory updates are required to ensure the current condition of every piece of medical equipment available (Labib, 2014). MEIMS requires both software and hardware components to function properly. The inventory, maintenance, dashboard, profile, and monitoring logs serve as the basis for the programming codes. A study by Nwaneri and Olaoye (2023) utilized the Medical Equipment Inventory Management System (MEIMS) to manage medical equipment in the hospital. The findings revealed an improvement in the maintenance processes of medical equipment and a significant decrease in maintenance costs. However, this system is only suitable for large hospitals and was not sufficiently tested in different healthcare facilities to ensure its effectiveness.

B. Near-Field Communication (NFC)

Near-field communication (NFC) is another wireless technology used for user identification. NFC technology enables the integration of services from a wide range of applications into one single smartphone. Most smartphones are sold with an integrated NFC hardware module, and almost all smartphone/Mobile Operating Systems (MOSs) have NFC support. An NFC device is not only a reader, but also a tag. NFC has three different operation modes: peer-to-peer mode, reader/writer mode, and card emulation mode (Kang et al., 2021). In reader/writer mode, the data is transferred from the tag to the device or vice versa. Peer-to-peer mode includes two-way communication where the transfer of information occurs between two NFC devices. In the card emulation mode, the smartphone acts as a regular smart card when is touched by an NFC reader; as a result, the NFC will connect automatically with the secure element (Coskun et al., 2015). This ensures that users can send identification details to the receiver wirelessly for tracking purposes (Sautter et al., 2022). This technology has a short operating distance and has a specific power supply constraint (Olenik et al., 2021).

C. Internet of Thing (IoT)

The Internet of things (IoT) is a network of physical devices embedded with sensors that allows data exchange either by locating the device or controlling it. IoT necessitates the presence of software, hardware, data, and services. IoT can integrate the physical world into a digital system, making it more efficient and precise, while reducing costs and human intervention (Ranjbar et al., 2019). The IoT enables the healthcare monitoring system to track equipment through the internet to gather, share, save, and analyze the data that is generated by these equipment (Abdulmalek et al., 2022). A study by Aborujilah et al. (2021) used IoT to manage the medical equipment in the intensive care unit efficiently. The research revealed that the technology enables real-time access to medical equipment from any location, reducing maintenance costs and avoiding duplication of information inputs. However, implementing IoT requires specialized information technology experts and adequate budget allocation. Additionally, it is important to note that any system may face faults or threats at any time.

D. Radio Frequency Identification (RFID)

Radio Frequency Identification (RFID) forms part of the IoT's technology. An RFID reader is installed in equipment by utilizing suitable communication standards, which includes message queuing telemetry transport and medical information buses to connect with the web server in the hospital. The RFID readers are located in the equipment to determine, track, and monitor it automatically. RFID can also be used in inventory management (Aborujilah et al., 2021). The process starts with reading the RFID tag placed on the equipment without any physical contact. With the utilization of radio waves, the data gets collected and transferred automatically. The RFID reader can read more than one tag at the same time from an extended range (Profetto et al., 2022). An RFID tag is made up of two main components: an antenna and an electronic circuit. This circuit is located inside a capsule and is assigned a unique identification number. The RFID reader collect the information secured in the tag. The RFID reader consists of two parts: a decoder that decodes the received data, and an antenna that transmits and receives the RF waves that carry information between the tag and the reader (Kumari et al., 2015). According to a study conducted by Okoniewska et al. in 2012, the implementation of a RFID system can benefit clinicians by saving time in asset tracking, improving the throughput of equipment, reducing hospital costs, and assisting in tracking and identifying challenging patients. However, it was observed that this system requires frequent calibration, which can be demanding and time-consuming when implemented on a large healthcare institute due to the significant investment required.

Radio Frequency Identification (RFID) is a technology that uses radio waves to identify and track items, whereas Internet of Things (IoT) refers to the network of networked devices that can communicate and share data with each other. When these two technologies work together, seamless communication and real-time data collecting are made possible, which improves productivity, efficiency, and insights for a variety of applications (FasterCapital, 2024). There are many advantages to IoT and RFID integration, but there are drawbacks as well. Among these challenges is the security and administration of massive data sets produced by networked devices. To safeguard sensitive data, strong data governance and security protocols must be in place. Furthermore, small enterprises may find it prohibitively expensive to install RFID and IoT technologies (FasterCapital, 2024).

CHAPTER III

CHOOSING THE BEST FIT TECHNOLOGY

A. Comparing The Different Technologies

RFID is an element of the Internet of Things (IoT). RFID tags are often designed to be inexpensive and simple, but IoT devices are typically more sophisticated and costly. RFID reads data from neighboring tags in one direction, while IoT may exchange data over wired and wireless networks (Lawton, 2022).

NFC is a type of RFID technology with a shorter range of operation (only up to 0.1 meters) compared to standard RFID which can operate from hundreds of feet away. NFC is interactive, meaning that user input is required for tasks such as payment or access. Overall, NFC technology plays a crucial role in various industries and applications (RFID vs NFC - What's the Difference?, 2021). On the other hand, multiple tags may be scanned simultaneously by an RFID scanner, which is highly useful for warehouse inventory. When it comes to communication, NFC enables two-way communication, while RFID only supports one-way communication from the tag to the reader. Additionally, NFC has a higher data storage capacity, allowing for the storage of more complex data beyond just unique identifiers. NFC tags can store up to 4KB of data. Data can come in different formats such as text, media, and URLs. Although most modern smartphones can read NFC tags, RFID tags usually require expensive scanners to access data. Consequently, using NFC tags is more economical as people can retrieve the data using their cell phones (RFID vs NFC - What's the Difference?, 2021).

The web based medical equipment inventory maintenance system has been developed and tested, but it does not track equipment in real time. The system uses asynchronous communication, which means that the sender and receiver do not have to communicate at the same time to achieve the desired outcome. The system has 8 GB of memory and a 500 GB hard drive for data storage. The system is connected to the internet, which enables it to be encrypted and password protected. It is user-friendly and easy to implement, and it is primarily used in the fields of clinical or biomedical engineering. (Nwaneri & Olaoye, 2023).

Table 1. Comparing the features of four equipment management technologies

	NFC	RFID	IoT	MEIMS
Range	Within 0.1 meters.	Hundreds of feet.	Long range communication : exchange data over wired and wireless networks.	Manual entry and follow up system.
Communication	Two-way communication (specific user input is required to	One-way communication (Does not require action	Two-way communication.	Communicate asynchronously (the sender and the receiver does

	complete tasks).	& can read more tags).		have to communicate at the same time).
Data storage	Can store up to 4KB of data.	64 bits to 1 KB.	100 KB to 10 GB.	8 GB memory and 500 GB hard drive.
Cost	NFC doesn't need any sophisticated equipment and the cost is affordable (user can simply use their smart phone to read the data)	Require expensive scanners to extract data.	Sophisticated and costly.	Built-in system by the IT department and doesnot cost much
Ease of implementation	Battery free in passive mode, rapid and indirect transmission, wireless	Is easy to implement because it doesn't require purchasing	Complex (purchase of sensors and hardware)	Is easy to implement and user friendly.

	communication.	additional hardware.		
Best area of use	Is very important in several areas, including mobile payments, public transit, and access control.	Is used in production, logistics, retail, tracking and asset inventory tracking and management.	Used in supply chain management, healthcare, and agriculture.	Used in clinical or biomedical engineering.

After comparing the features of the four technologies, two options are eliminated: the MEIMS and NFC. The built-in automation relies on human data entry and manual follow-up of inventory, in addition to its inability to provide real-time tracking. As for the NFC, the main drawback is its short range (0.1 meters) which does not fit the OR context need. Accordingly, two solutions are left, RFID and IoT technology. Table 2 illustrates a detailed comparison of their characteristics.

Table 2. Comparison Table between IoT and RFID

Characteristics	IoT	RFID	Advantage
Line of Sight	No	No	Equal
Data Recording	Automatic	Automatic	Equal

Cost	High	Moderate	RFID
Range	Thousands of meters	Meters (adequate for OR context)	Equal
Ease of Implementation	Sophisticated	Easy	RFID
Data Storage	Huge	Adequate for OR context	Both
Communication	Automatic Recording	Automatic recording	IoT

After analyzing the table, it was determined that RFID features are more beneficial than IoT characteristics in the context of OR installation as a pilot project. The cost of RFID is lower than that of the Internet of Things, and it only requires a short range of a few meters instead of thousands. Therefore, RFID is the ideal choice for usage.

CHAPTER IV

CONCEPTUAL MODEL FOR IMPLEMENTATION

A. The Staggers and Nelson Systems Life Cycle Model (SLCM)

The Staggers and Nelson Systems Life Cycle Model (SLCM) is a well-used model in the information system design and implementation. It will be used as a conceptual model to describe the phases of this project. It includes seven steps (Nelson & Staggers, 2018): (1) analysis, (2) planning, (3) testing the system, (4) implementing, (5) maintaining and evolving, (6) evaluating, (7) returning to analysis. Only the first 2 phases of the model will be used.

B. Description of Context

The operating room (OR) department at AUBMC consists of ten rooms, each assigned for a specific specialty. Rooms 1 and 2 are for orthopedic cases, room 3 for vascular or gynecology cases, room 4 for robotics and urology cases, room 5 for neurosurgery cases, room 6 for adults' open-heart surgeries, room 7 and 9 for general surgery cases, room 8 for plastic surgery cases, and room 10 for pediatric open-heart cases. Most of the equipment is kept in the OR equipment storeroom, while others are stored in the OR room, induction room, or corridors. Each room is equipped with specialty-specific equipment, such as the Revolix Laser in induction room 4, exclusively used in urology cases. However, during the evening duties, some urology cases may not be assigned to Room 4, which means the orderly has to search for the equipment in Induction Room 4. If the equipment is not found there, the orderly must search other rooms and the store. This process can take up to thirty minutes, which could impact the OR schedule and turnover rate. Unfortunately, there is no tracking system available to help locate the equipment accurately.

C. Description of Current Process

As per the "Management of Equipment in the OR" policy of AUBMC, every piece of equipment that is to be sent to OR must be tagged and inspected by the biomedical engineering department. The tag should include the machine's lot number and the date for the next maintenance. In case any equipment malfunctions, the registered nurse (RN) will inform the manager and remove it from the room. An "Out of Order" sign will be placed on the equipment, and the OR clerk will fill out a request form. The equipment will then be sent to the biomedical engineering department for assessment and repair. To keep everyone informed, the nurse manager will send an official email to all the registered nurses in the OR to let them know that the equipment is under repair.

An annual equipment inventory check is carried out manually. In case of any missing equipment, it is reported to the biomedical engineering team, who then conduct their own equipment inventory to search for it. An email is sent to inform whether the mentioned equipment is not found in the department, out of order, or under repair.

D. Identified Gaps in the Current Process

During the review of the existing procedure, several flaws were identified. These include the likelihood that equipment may not always be returned to its designated storage area by staff members, the time-consuming and potentially delayed process of physically tracking equipment, the annual nature of inventories that increases the risk of equipment loss, and the variety of inputs used in maintenance and malfunction that result in delayed routine maintenance and an increase in malfunction incidents. (Table 3).

Table 3.Gaps in the Current Process

Equipment Storage	**Equipment Tracking**	**Inventory Management**	**Equipment Maintenance & Managing Malfunctions**
The staff who use the equipment do not always return it to its allocated storage area.	Physical tracking is time consuming, causing delays and inefficient use of OR time.	Inventories are checked manually once per year that may cause delays in identifying and tracking lost equipment.	Is time consuming and implies several communications and input from different persons. Leading to delays in routine maintenance and frequent incidents of malfunctions.

E. Proposed Process Change

After the installation of RFID, the operating room registered nurses (OR RNs) and the nurse manager will be able to track and identify specific equipment whenever necessary. Each OR room and storage area will be equipped with RFID readers and tags. Whenever the medical equipment comes within the range of an RFID reader, it will read the RFID tag attached to it, generating updated information in the database. Both administrative staff and end-users will have access to the saved data that will allow them to keep track of inventory and usage of the equipment. Additionally, the system will display the maintenance date to confirm that all equipment is current. By unifying the RFID system and maintenance management software, the biomedical engineering department and the OR NM will receive automated warnings when equipment scheduled maintenance is needed. In case of equipment malfunction, the system will instantly update and notify registered nurses that the equipment has been moved to the biomedical engineering department.

CHAPTER V

PLANNING THE INTERVENTION

The second step of the Staggers and Nelson Systems Life Cycle Model is planning.

A. Objectives and Expected Outcomes

The two main objectives of introducing an automated equipment management system in the OR are: (1) To have a real time tracking of the OR medical equipment; (2) To ensure timely maintenance of the OR medical equipment. Accordingly, the expected outcomes are:

1. The OR nurses will be able to locate equipment promptly and effectively.
2. There will be a decline in equipment that is lost or misplaced.
3. A decline in cases involving malfunctioning medical equipment.

B. The Planning Team

During the planning phase, an advance practice nurse (APN) will lead a multidisciplinary team including a biomedical engineer, Information technology technician, OR nurse manager, OR medical director, and quality officer. This team will be responsible for identifying the types and workflow of information required from the automated system at each level of the equipment management process. The Input–process–output (IPO) model will be used to guide the team identify the needed features of the software (Deng et al., 2022). **The Input** refers to data provided to a system, and it is essential for starting processes and creating the intended outputs (Khatri et al., 2022). The equipment names and specifications will be entered into the RFID system by the biomedical engineering department. **Processes** are described as system performance activities or processes based on supplied input data (Khatri et al., 2022). This will entail data coding and granting access to the people involved. The system access will primarily be restricted to the OR nurse manager and the charge nurses, and the director of engineering and biomedical engineering. Given the efficacy of this model, it will assist in transforming the conventional OR management system (referred to as "input") into an intelligent one (referred to as "output") based on the objectives. **The output** refers to the end result such as inventory lists, maintenance schedules, equipment use dashboard, equipment profile, and monitoring logs.

C. Cost-Benefit Analysis

CBA is a mechanism for weighing the benefits of a new project or other change against the costs of a decision. Accordingly, a decision is justified if the advantages outweigh the costs. If the Benefits/Costs ratio is more than one, the project is deemed to be positive and adds value. Otherwise, it doesn't. To calculate the ratio, monetary values must be assigned to both the costs and benefits (Finkler, Jones, & Kovner, 2013). The cost-benefit analysis (CBA) for a technology project includes the following steps: (1) Identify the expected benefits from the project, (2) Quantify the benefits for comparison against costs, (3)Identify the expected costs for the project, (4) quantify the identified costs for comparison against benefits, and (5) determine whether the project's benefits exceeds the costs; if yes, accept the project (Roper et al., 2015).

1. *Expected Outcomes*

Implementing RFID technology to track and locate OR equipment is expected to prevent delays in locating misplaced equipment and thus, using the OR time more efficiently. Moreover, RFID is expected to prevent delays in preventive maintenance that may lead to increased equipment downtime, longer asset life, fewer interruptions to critical operations, increased workplace safety and improved compliance with the Occupational Safety and Health Administration (OSHA), and improved efficiency (Roper et al., 2015; The advantages & disadvantages of Preventive Maintenance, n.d).

2. *Quantifying the Benefits*

Quantifying all the benefits can be challenging. However, they will prevent the loss of operating room time and associated costs. Currently, it can take up to 30 minutes to locate OR equipment that has been used and not returned to its original place. Childers and Maggard-Gibbons (2018) have reported that the average cost of operating room (OR) time ranges between $36 and $37 per minute. This means that any delay in surgical procedures can result in financial losses every minute, with even a single hour of delay each day resulting in a loss of $2,220. If such a delay occurs on weekdays alone, this could add up to a total loss of $44,400 in a month. Thus, using RFID technology might save $44,400 in a month.

3. *Costs of the RFID Implementation*

The full costs rely on the system's technological composition, how efficiently the implementation is planned, and the scope of training needed. Fixed cost of this implementation as shown in Table 4 are the reader systems, tags, basic application, infrastructure, tags, and maintenance costs.

Table 4. Costs of the RFID Implementation

Variables	Quantity	Cost per item	Total cost
RFID infrastructure	1 unit	$20,000 per unit *(Coustasse et al., 2013)*	$20,000
Passive RFID tags	150 tags	$1.20 per tag *(Newman-Casey et al., 2020)*	$120
RFID readers	13	$50 per reader *(Lou et al., 2011)*	$650
RFID antenna	13 antenna	$233.6 per antenna *(Álvarez López et al., 2018)*	$3,036
RFID Certification by RFID4U	One time	$2950 *(RFID4U, 2024)*	$2950
Software deployment and infrastructure setup	One time	$7,400 *(Vertical Systems, 2023)*	$7,400
Maintenance and software licensing	Yearly	$5,800 *(Vertical Systems, 2023)*	$5,800
		Total	**$39,956**

The cost of setting up an RFID infrastructure for a medium-sized hospital ranges from $200,000 to $600,000. However, in the case of implementing the RFID system only in the operating room (OR), the cost would be approximately $20,000 per unit. The total cost of the 150 RFID tags required is $180 if each tag costs $1.2. Furthermore, 13 RFID readers are required, and each one costs $50, making a total of $650. Additionally, 13 RFID antennas are required to cover the 10 operating rooms, the OR main desk door, store door, and the biomedical engineering entrance door. The total cost of the antennas and RFID is $2,860 EUR, which is approximately $3,036. The entire process would cost $39,956.

4. Benefit-Cost Ratio

A benefit–cost ratio of greater than 1 is deemed to be a rational capital expenditure. After comparing the costs of RFID and delays in the OR, the benefit-cost ratio of 1.12 shows that the benefits outweigh the costs. According to Roper et al. (2015), several recent pilot studies revealed that RFID implementation and staff training lead to many advantages that exceed the implementation costs (Roper et al., 2015). One of these studies used RFID for inventory purposes of medical devices including defibrillators, pacemakers, and catheters. The main goal was to reduce inventory by $30,000 to $40,000. After finishing, the supply chain manager reported outcomes better than expected, realizing $65,000 in savings (Kumar et al., 2010).

D. Implementation Steps of the RFID in the OR

The Staggers and Nelson Systems Life Cycle Model includes seven steps. Only the first 2 steps of the model were detailed in this project. The rest of the implementation steps are summarized as follows:

1. Testing the System

"Extensive testing" refers to a meticulous and precise examination of the intended system to identify any possible vulnerabilities or areas where it may not perform as expected. The goal of these tests is to detect any deficiencies or gaps in the system's intended functionality. Determining whether to proceed with the current deadlines or to postpone them entirely depends on the identification of any existing inadequacies. This decision-making process is often referred to as "go-or-no-go" decisions. Essentially, it helps in deciding whether the project can move forward ("go") or if it would be preferable to wait until the problems are resolved ("no-go") (Broglio et al., 2022).

2. Actual Use of the System

Before the installation phase, training sessions are crucial as they provide nurses with an introduction to the new technology and its advantages. In order to maximize patient care, super users in this system will train staff members to grow and expand their knowledge following these sessions and use the learned knowledge and abilities. Following that, the nurses will start using the system during their shift, with regular follow-up and assistance from the superuser.

3. Maintaining and Evolving Steps

The project is regarded as routine and integrated into regular operations in to and IT after about 90 to 120 days after execution. To keep software current and fulfill system modification requests, regular upgrades are required. The entire procedure will be modern and incorporated into the practice. A revised policy will be created with an emphasis on its goal, protocol, and unique circumstances. Every year, this policy will be reviewed for any updates.

4. Evaluating

The evaluation inquiries center on the extent, caliber, and complexity of the implementation: What observable shifts in performance have occurred; how are the anticipated results being measured (for example, are there instances of delays in locating and recovering OR equipment? Are there still instances of OR equipment being lost or misplaced?); expense; and employee satisfaction.

5. ***Returning to Analyze***

The SLCM is a continuous process of analyzing and refining software. This process involves reviewing and evaluating the software's functionality and compatibility with organizational objectives. It helps in resolving issues, enhancing functionality, and improving features to better suit user requirements. Adding new features or making improvements to existing ones may involve installing new software versions with improved performance or functionality.

CHAPTER VI

CONCLUSION

The operating room is a highly specialized and expensive area of a hospital. To ensure the hospital's sustainability and financial stability, it is crucial to have an effective equipment management system that can enhance OR productivity. This involves minimizing streamlining workflows, reducing downtime caused by equipment malfunction or unavailability, and ensuring the right equipment is available when needed. Accountable organizations are responsible for developing and evaluating their medical equipment management plan to ensure its safe and effective use.

This project has the potential to expand the use of RFID technology, which can be used for tracking surgical instruments in the operating room and all medical equipment in the facility. However, additional case studies are necessary to establish specific and scalable protocols for the deployment of automated equipment management systems in operating theaters.

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