

# Development of an RFID-based Application for Medical Equipment Inventory Record Maintenance

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Medical Equipment Inventory, Radio Frequency Identification (RFID), Android

## Abstract

The proposed project focuses on developing a device and a system that utilize RFID technology that will change the way health inventory is managed. Built within the Android Studio and implemented using Java programming language and connected to a phpMyAdmin database through PHP, this application helps maintain records of inventories. Through issuing unique RFID tags to the equipment it is easier to retrieve data since after scanning the RFID tags all the details of the specific equipment is retrieved without necessarily going through other details of other pieces of equipment thus saves time. It guarantees the proper store of functional medical equipment, increases the accuracy level of inventory, and leads to the improvement of the overall patient care, which proves the effectiveness of RFID imagery's role in the digital disruptiveness of healthcare.

## 1. Introduction

Information technology, especially in the use of IoT with RFID, can be adopted in one of the growing health areas that deals with the management of medical equipment. This is the rationale for constructing this project which will lead to the development of an application that will allow easy and instant access and control of records in medical equipment's one of the sub-disciplines of Biomedical Engineering comprised in the Biomedical equipment Management Systems (BEMS). The details of this application are applied within the environment of the hospital to support the uninterrupted maintenance of the medical devices which are installed, tests, commissioning procedures and planned schedules of preventive maintenance. Secondly, it enables the faster reporting of breakdown incidences. It is a revolutionary concept that helps locate and trace the equipment within healthcare organizations such as hospitals [1] as well as ensure that one does not lose resources hence cutting down the overall expenses [2].

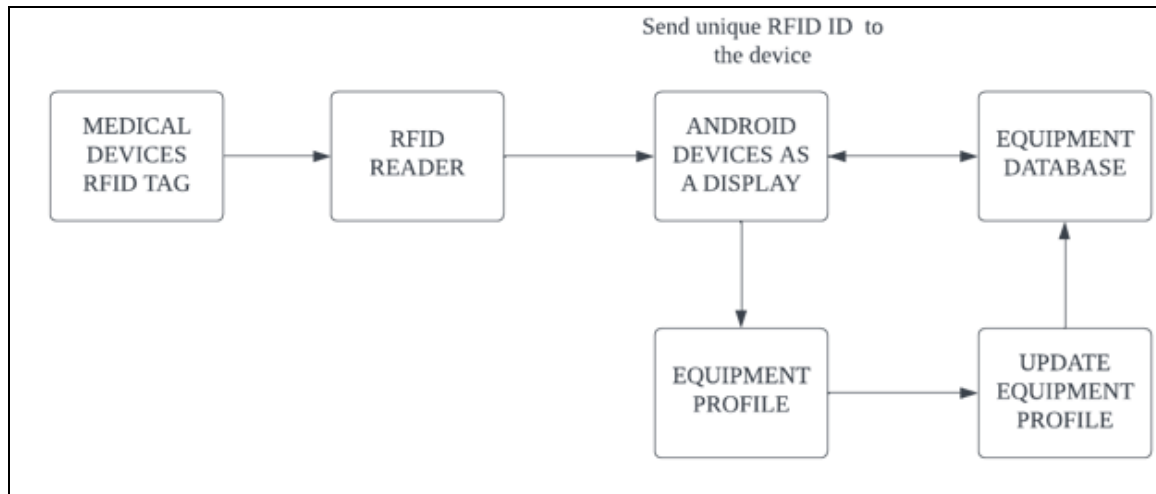
The proper working of health care institutions depends on the test and commissioning and planned preventive maintenance that is related to medical devices in hospital. Improving the efficiency of management of medical equipment record can positively impact on health care regarding operation, reduce on costs and be able to extend the capacity of being able to handle many patients for high quality treatment. The case study for this project can be regarded as the enhancement of healthcare management with the help of IoT and RFID is a big step forward. This is in harmony with the change that has taken place in the healthcare industry due to the digital wave and can add value if used properly.

## 2. Methodology

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Fig. 1 shows the flow of medical equipment within the hospital and how they progress. The data is obtained from the RFID tag of the equipment by reading it using the RFID reader. The reader then transfers it to the phone/tablet through the type C port. In the application, it will display the equipment profile from the database based on the RFID information. For the sake of this solution, the admin or vendor can input and keep the medical equipment information in a database.



**Fig. 1** Block diagram of proposed system

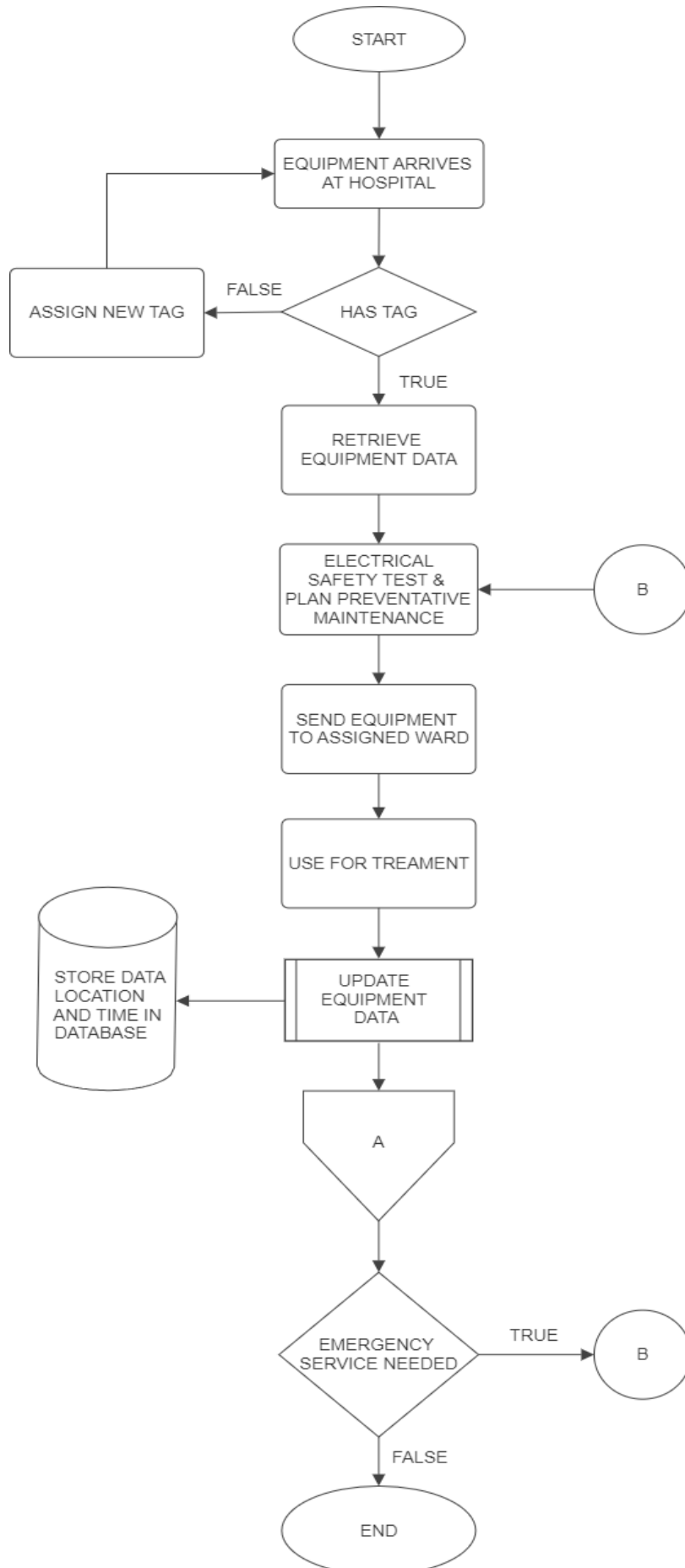
## 2.1 Operational Flow of the RFID System

Fig. 2 illustrates the operational flow of the RFID system in a hospital setting. The equipment's RFID tag presence is verified upon their arrival. Each piece of equipment will be assigned a new tag when the equipment does not have an RFID tag or is a new arrival. For equipment with an RFID tag, it is used to retrieve their relevant information. Subsequently, the vendor will do electrical safety test and plan preventative maintenance before sending each equipment to the assigned ward. The user, which is the biomedical engineer, will only check the equipment details and send reports in case of emergency to the vendor if any of the equipment having trouble. Otherwise, the process concludes at this point.

## 2.2 Software and Hardware Setup

It focuses on supporting any Android based tablets for the easy use of the app. For development of this project the following software was used; Android Studio used to develop the software application, phpMyAdmin used as the database and Visual studio code used to create the database. Android Studio is the primary integrated development environment for developing android applications which comes equipped with many convenient features and tools in development, debugging process and creating UI's. phpMyAdmin is a web-based system that allows users to manage MySQL databases and performs tasks like creating new databases or executing queries using a GUI and no SQL codes most of the time. Visual Studio Code is an open-source, build by Microsoft that has a rich feature set and content impressiveness for editing source code which has flexibility to install addons and has cross platform compatibility.

In terms of hardware, the utilization of high-frequency (HF) RFID is implemented for individual identification of each medical apparatus to access information from the database. This form of RFID functions at a frequency of 13.56 MHz falling within the range of 3 to 30 MHz [3]. The project incorporated the use of 13.56 MHz NFC tags (NTAG 216). Such tags commonly provide security attributes like password protection and optional read-only locking and are applied in various systems including access control and inventory management [4]. To scan the RFID tags, an external RFID reader was employed, connecting to the tablet through a type-c port. This external RFID reader is expressly crafted to be compatible with Android devices, allowing individuals to exploit RFID technology conveniently while on the move [5].



**Fig. 2** Operational flow of the proposed system

### 3. Results and Discussion

#### 3.1 Results

As for this project, the specification and requirement of the application must be pointed out in the application developing course. Since the application envisaged to be developed should be a portable medical equipment data retrieval application, the application should also be developed in that mold. Therefore, the most appropriate device that will be used will be tablets with operating system – android. Fig. 3 illustrates the overall context of this work. The rfid reader that will be connected to the tablet through a type-c port will scan the RFID tag and key in the rfid identification in the database. Wear’s RFID tag consist of identification number that is unique from other tags [6]. The process of searching will be initiated immediately the reader scans the RFID tag as input by the reader.

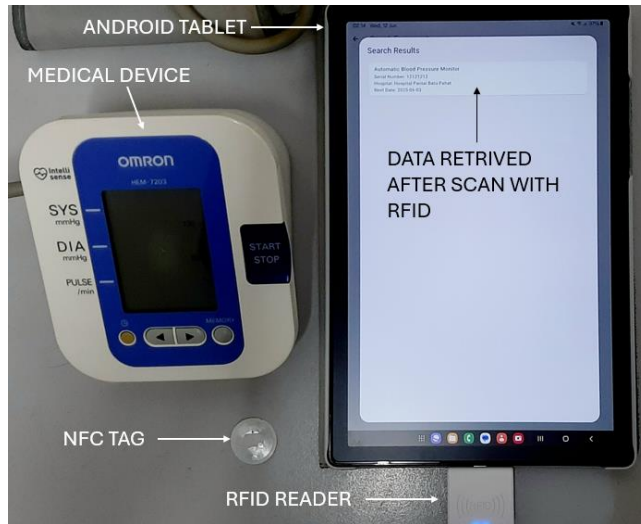


Fig. 3 Overall setup

Fig. 4 shows the database of the application. It has several tables to keep the data that has been entered through the tablet. If a new user needs to use the app, their information will be stored on users table. The hospital information will be stored in the hospital table. The medical equipment information will be stored in the equipment table with the unique rfid id. The system uses a single RFID tag to retrieve and update medical equipment histories, storing vital information such as maintenance records and next service records.

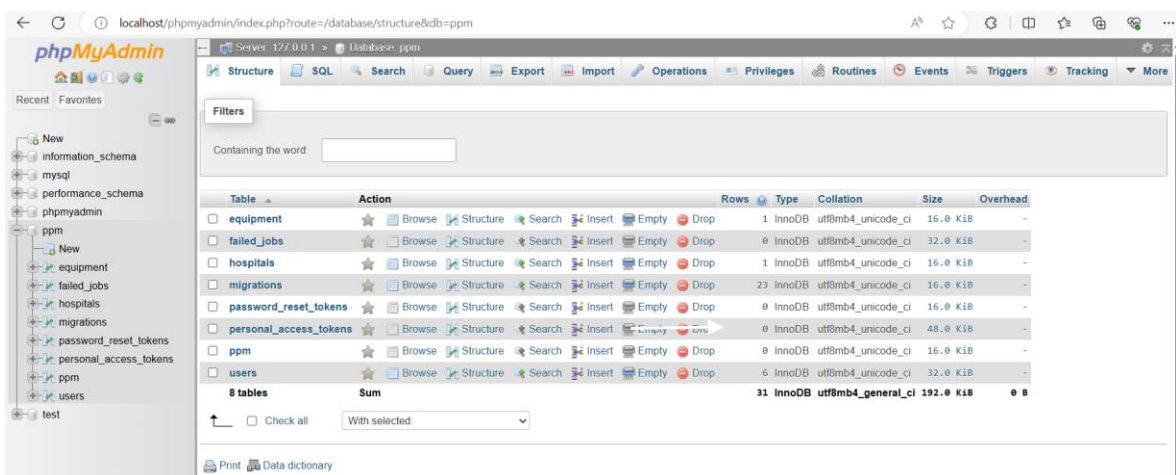


Fig. 4 Database

Fig. 5 shows an illustration presented to demonstrate a sample of medical equipment information. The information includes essential details such as equipment name, serial number, manufacturer, hospital, department, ward number, person-in-charge, equipment class and type and plan preventative maintenance current date and next service date. A distinctive RFID tag is assigned to each equipment, providing a unique identification number. This unique identification number kept hidden for safety purposes and will be stored in equipment database.

Fig. 5 Equipment information

Fig. 6 shows the user table from the database depicted, showcasing the collection of vendor and user information as an example. Each time a new vendor or user is registered, their details are recorded and stored within this table. But only a vendor can add a user(PIC) during a visit to the assigned hospital and the user will get an email regarding their account password. So, this app can be used on multiple devices at the same time by the users.

id	name	email	email_verified_at	password	hospital	token	remember_token	created_at	updated_at
1	Hazwan	ad190240@student.uthm.edu.my	NULL	Hazwanrock12	Vendor	214	NULL	2024-03-27 04:18:28	2024-03-27 04:18:28
2	Pervain	he220053@student.uthm.edu.my	NULL	Pervain123	Hospital Pantai Batu Pahat	test	NULL	2024-03-27 04:18:37	2024-03-27 04:18:37
3	Dhivaakar	ce190127@student.uthm.edu.my	NULL	Dhiva123.	Hospital Pantai Batu Pahat	test	NULL	2024-03-27 04:20:59	2024-03-27 04:20:59
4	Sivajothi Harikaran	ce200037@student.uthm.edu.my	NULL	Siva123.	Hospital KPJ Batu Pahat	test	NULL	2024-03-27 14:41:55	2024-03-27 14:41:55
5	Siva	sivakabuto@gmail.com	NULL	dhiva	Vendor	test	NULL	NULL	NULL

Fig. 6 User table

### 3.2 Discussions

Fig. 7 shows the equipment records table. It contains old and newly added equipment history of the past visitation to the hospital. Here it has two most important data which is the reference identification (unique id) and service date. Whenever a new equipment was brought into the hospital the vendor will record the details of the equipment, do the electrical safety test, plan preventative maintenance, and scan the NFC tag which contains the unique id. The users can either scan the RFID or manually search the details to retrieve the data. There is a timestamp whenever a new equipment is inserted in the database table. In the event of malfunction or loss of the RFID tag, a new tag can be assigned, and the corresponding tag number can be easily updated in this database. Overall, this retrieval system will make the users work easier to prevent using papers and quickly move on to the next.

id	eq_name	eq_serial	eq_manuf	eq_hospital	eq_department	eq_ward	eq_pic	pic_email	eq_class	eq_type	date	nextdate	ref_id	vendor	cre
5	Automatic Blood Pressure Monitor	12121212	Omron	Hospital Pantai Batu Pahat	Cardiology	Wad 3A	Sivajothi	sivam27@yahoo.com	Class 2	Type B	2024-06-03	2025-06-03	0449532932	sivakabuto@gmail.com	2024-06-03 14:55
7	Automatic Blood Pressure Monitor	13131313	Omron	Hospital Pantai Batu Pahat	Cardiology	Wad 3A	Sivajothi	sivam27@yahoo.com	Class 2	Type B	2024-06-03	2025-06-03	0449729540	sivakabuto@gmail.com	2024-06-03 14:55
8	Automatic Blood Pressure Monitor	14141414	Omron	Hospital Pantai Batu Pahat	Cardiology	Wad 3A	Sivajothi	sivam27@yahoo.com	Class 2	Type B	2024-06-03	2025-06-03	0449598488	sivakabuto@gmail.com	2024-06-03 14:55
9	Automatic Blood Pressure Monitor	15151515	Omron	Hospital Pantai Batu Pahat	Cardiology	Wad 3A	Sivajothi	sivam27@yahoo.com	Class 2	Type B	2024-06-03	2025-06-03	2906877292	sivakabuto@gmail.com	2024-06-03 15:00

Fig.7 Equipment information table

#### 4. Conclusion

In conclusion, adopting RFID for the IoT-based medical equipment inventory record maintenance system helps enhance the efficiency of managing the inventory as explained above. In healthcare facilities, RFID makes it possible to track and manage assets related to medical equipment in numerous ways that cut across the following benefits. They do not involve manual search and retrieval as well as sorting through physical records or through a file containing many spreadsheets. When the devices are fitted with RFID tags, medical care stakeholders can easily read data from such tags and obtain relevant details within the shortest time possible. It plays a great role in decreasing incidences of making wrong decisions and saves a lot of time which can be spent more and again on enhancing patient care. In that case, using RFID technology helps improve the security of the inventory records as well as the reliability of the records. RFID tags can be locked and decrypted by using authentication which means that only those with the passcodes and privileges can open what has been locked. This system also enhances effectiveness in operations in that it simplifies accountability on the medical equipment, so that every equipment in the facility is accounted for and can be easily retrieved whenever required to be used on a patient.

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#### Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

#### Author Contribution

The authors confirm contribution to the paper as follows: **study conception and design:** Sivajothi Harikaran, Ashok Vajravelu; **data collection:** Sivajothi Harikaran; **analysis and interpretation of results:** Sivajothi

*Harikaran; draft manuscript preparation: Sivajothi Harikaran, Ashok Vajravelu. All authors reviewed the results and approved the final version of the manuscript.*

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