Evolution in Electrical and Electronic Engineering Vol. 4 No. 1 (2023) 363-370

EEEE

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/eeee
e-ISSN : 2756-8458

Medical Devices Monitoring Using RFID

Muhammad Har A'izzat Baharom[1], Nur Ilyani Ramli[1]*

[1]Faculty of Electrical and Electronic Engineering,
Universiti Tun Hussein Onn Malaysia, Parit Raja, Batu Pahat, 86400, MALAYSIA

*Corresponding Author Designation

DOI: https://doi.org/10.30880/eeee.2023.04.01.043
Received 15 January 2023; Accepted 30 March 2023; Available online 30 April 2023

Abstract: The Medical Devices Monitoring system is proposed to address the asset management issues encountered in government hospitals. These issues include the inability to accurately track the location and utilization of medical devices, which can result in inefficient resource management, delays in patient treatment, and the risk of medical errors. The proposed solution utilizes RFID technology to track and monitor medical devices in real-time, improving asset management and contributing to patient safety. The system includes an RFID reader, which allows users to scan devices that have RFID tags when borrowing them. Real-time data on the utilization and performance of medical devices can be provided through RFID technology, allowing for effective resource management. Additionally, sophisticated monitoring features ensure responsible device usage, further enhancing patient safety. The proposed system was built using Arduino IDE, Google Spreadsheet, Apps script, RFID tags and readers, and Node MCU. Testing was conducted through test plans, user acceptance, and accuracy testing, and based on the testing results, the system was successfully implemented and is ready to be deployed. Despite limitations, future enhancements have been suggested to further improve asset management in healthcare facilities. In summary, the proposed Medical Devices Monitoring system offers an effective solution to address asset management issues encountered in government hospitals. The system utilizes RFID technology to track and monitor medical devices in real-time, contributing to patient safety and optimizing resource management.

Keywords: Medical Devices, Monitoring, RFID

1. Introduction

The healthcare sector in the twenty-first century must be efficient in managing their supply chain in order to facilitate patient and resource access and management. Government hospitals, like any other company, must examine its information technology infrastructure on a regular basis in order to remain competitive in the face of technological advancements [1]. Health-care supply chains must be capable of providing cost-effective service while also allowing for efficient management of the organization's operations. RFID (radio-frequency identification) technology is just now beginning to

*Corresponding author: ilyani@uthm.edu.my

make inroads into the healthcare industry. RFID (Radio Frequency Identification Devices) are the most advanced technology accessible today, and they give a better answer to the healthcare business by minimising medication mistakes and enhancing patient care. It is also vital to monitor missing or misplaced medical devices such as infusion pump, syringe pump, defibrillator and many more [2].

2. Methodology

The medical devices tracking and monitoring system discussed in this chapter is composed of three main parts: input, process, and output as in Figure 1. The input part includes a 9V power supply and an RFID reader, which is responsible for reading the staff identification who borrows the equipment. The process part includes a Node-MCU, a spreadsheet database, and a WIFI module. The Node-MCU processes the data read by the RFID reader and sends it to the spreadsheet database, which stores all the recorded data. The output part is composed of an administrator laptop, a website. The medical devices identification is displayed on smartphones or laptops with the Spreadsheet on it [3]. The results data can be viewed through the Spreadsheet IoT platform via the WIFI module. The flowchart, block diagram, and the hardware and software used are explained in detail in the chapter. The significance of each step in ensuring the successful completion of the project is also addressed, with a focus on one phase of the system.

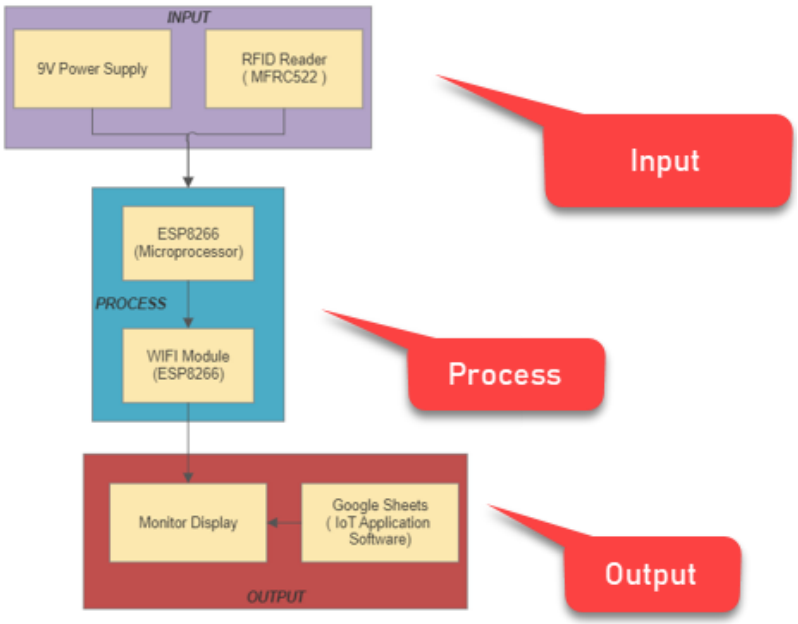


Figure 1: Block diagram for the Medical Devices Tracking and Monitoring System

Figure 2 shows the flowchart of the project system, which is start with the study of various literature review to gain necessary knowledge in order to develop and design the passive RFID system. The system consists of into two categories which are hardware and software development. In the hardware development, the tag for the medical devices is developed with the necessary component such as microcontroller, WIFI module, RFID sensor and RF transceiver and then the microcontroller is uploaded with the written coding for the tag [4]. For this project, the tag for the device consists of identification device, date and time.

The reader is made up MFRC522 RFID reader module kit that is directly connected to the Node-MCU ESP32.

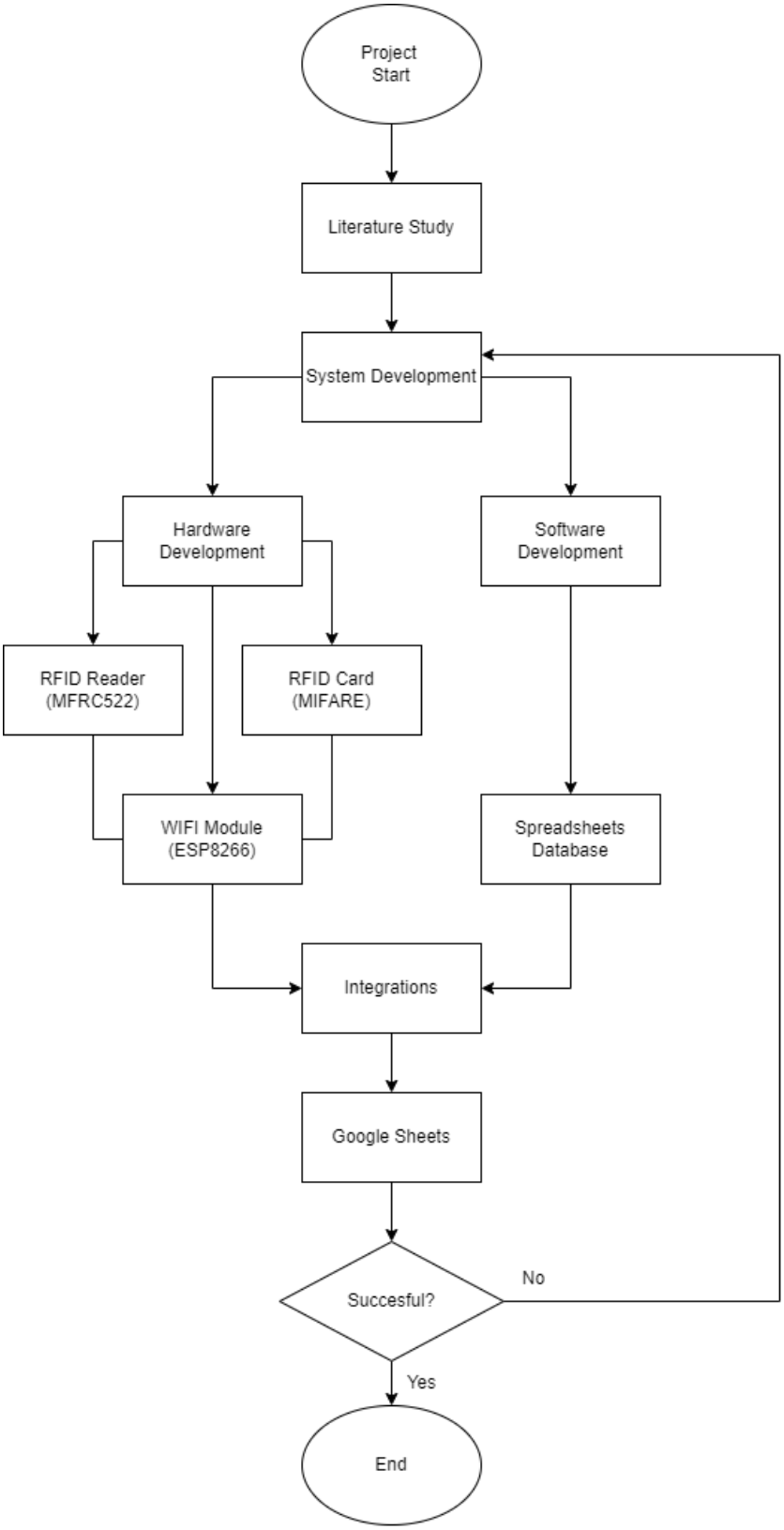


Figure 2: Flowchart of the Project

Figure 3 depicts the complete schematic of the medical device monitoring system, which utilizes a Node MCU ESP8266 microprocessor and a WIFI module [5]. MFRC522 is then linked to ESP8266 to function as an RFID reader, allowing the user to scan their card to the reader. The WIFI Module acts as an interface between the microcontroller and Google Sheets. It is wirelessly connected via Wi-Fi in

ESP8266, so the administrator can check the status of medical devices using a smartphone or personal computer to access a spreadsheet database [6]. Therefore, this monitoring system will make the user's task more accessible in terms of searching for borrowed medical devices by contacting the borrower [7].

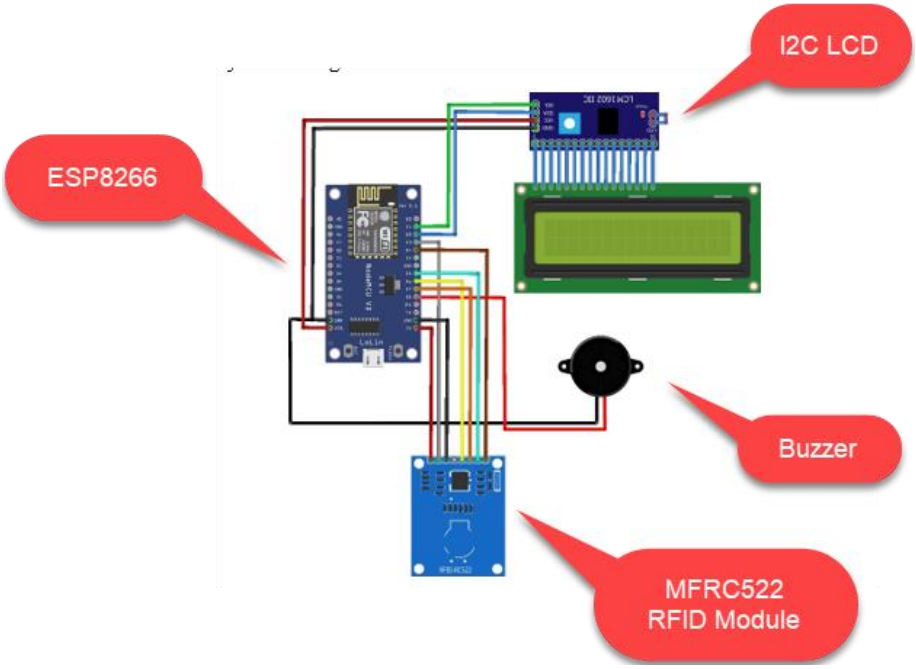


Figure 3: Full Schematic Circuit of Medical Devices Tracking and Monitoring System

3. Results and Discussion

This section discusses the methods used to develop the medical device tracking and monitoring system, including the hardware and software used, and how they were tested and integrated. The system is demonstrated in a hospital ward setting, using RFID cards as both staff identification and medical device tags. A syringe pump is used as an example of the system's application in a medical facility. The chapter also provides the results of the development process and how they match the project objectives.

3.1 Store data into RFID card (Staff and Device)

Storing data on a MIFARE card is the process of writing information on an RFID card, commonly used for various applications. In this project, five MIFARE cards were used, three for staff members and three for medical devices. The medical staff scan their MIFARE cards to borrow medical devices and their access is controlled and tracked by the system. Move the MIFARE card closer to the RFID reader and make sure it is not moving away from the reader. If it is, you will get an error while writing the data to the card. So here the step on how to write the data for Staff card.

To program RFID cards for medical devices, move the card close to the RFID reader and keep it still until the process is completed. Then, open Arduino IDE and select the Staff data item file. Compile and upload the code, then enter the data through the serial monitor. When prompted, enter the staff ID followed by a hashtag (#) and then the staff name with a hashtag. Repeat this process for each additional staff member. Once all the staff cards have been programmed, proceed to the next step of storing data on RFID card for medical devices. Figure 4 shows the completed registered cards for staff and devices. There are five of them that will be used in this project. The next step is to create a web application using Google Sheets.

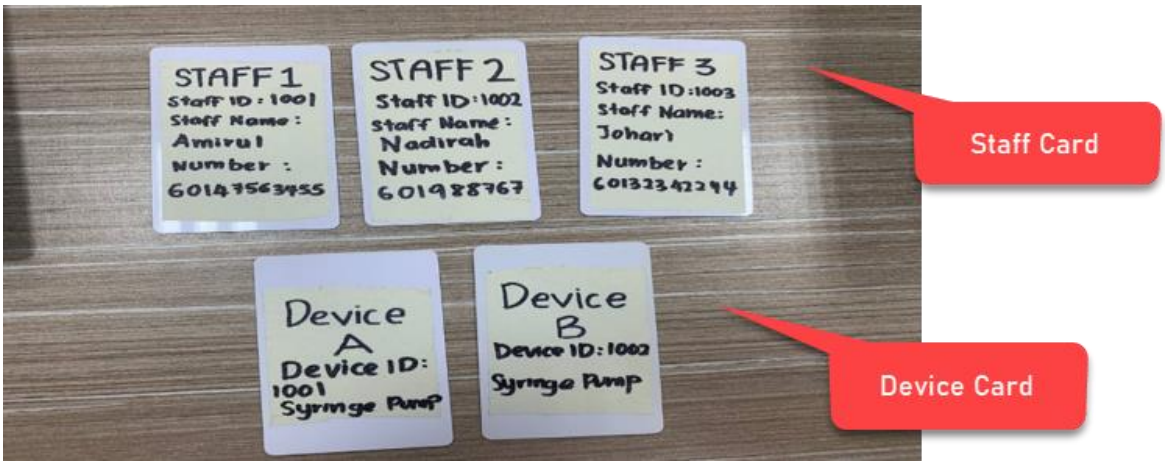


Figure 4: Registered Staff and Medical cards

3.2 IoT development using Google Sheets

For this part, IoT development will be explained using Google Sheets. By creating a database in Google Sheets, it is possible to store and organize the data collected from the devices, allowing it to be easily accessed and analyzed. An explanation of using Google Sheets will be provided below. The first step is to create a Blank Sheet and entered the column name to store the incoming data from the project. Figure 5 shows a Column title for Database. This Database create using Google Apps Script as Database.

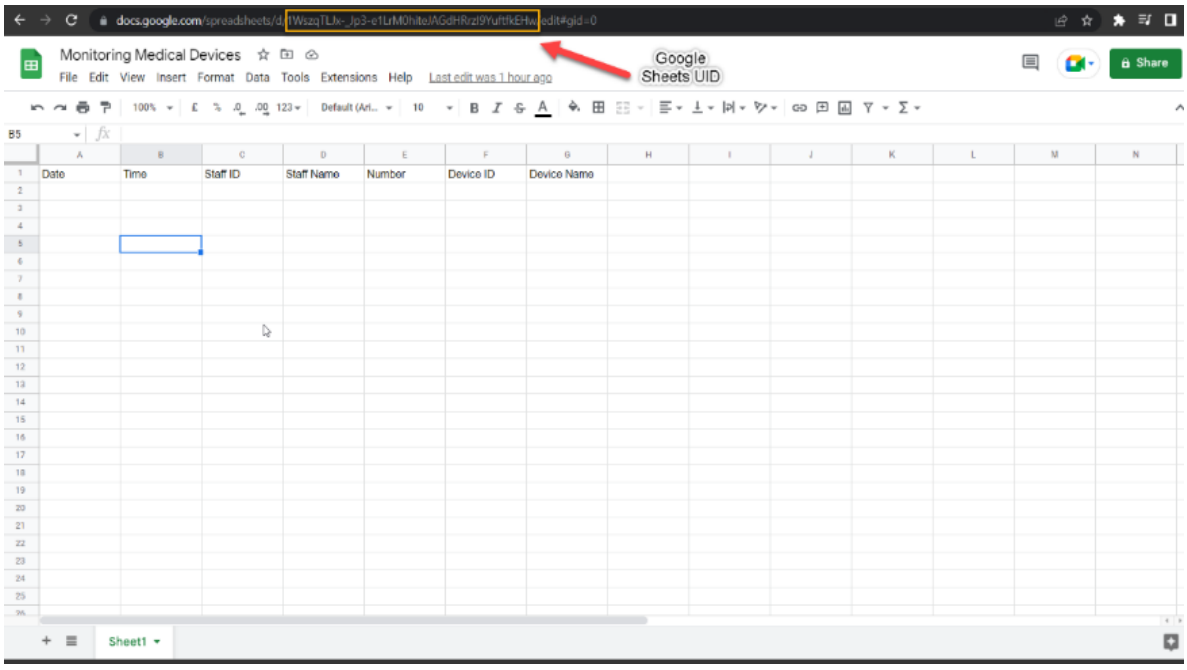


Figure 5: Column title for Database

3.3 Medical Devices Tracking and Monitoring Testing Result

In the first test, a simulation of a staff member borrowing Device A was conducted. The RFID card was used to register the borrowing transaction, and the Google Sheet was checked to confirm that the date, time, staff ID, and device information were recorded correctly. The process of the testing is as in the Figure 6. First, the staff need to be scanned as in Figure 6(a), then Followed by the Device A card

as in Figure 6(b). For last test, the scenario is when all three staff borrowed Device A and Device B. Figure 6(c) shows that the result after one staff borrowed one device. Whenever there is user who borrowed the device, the device data will send to Google Sheet, which is can be monitor by the person in charge or admin. This the result from the Google Sheets Database. It will keep the Staff Name, Staff UID, and Contact number. This scenario shows when the Staff 1 want to borrowed item from the store.

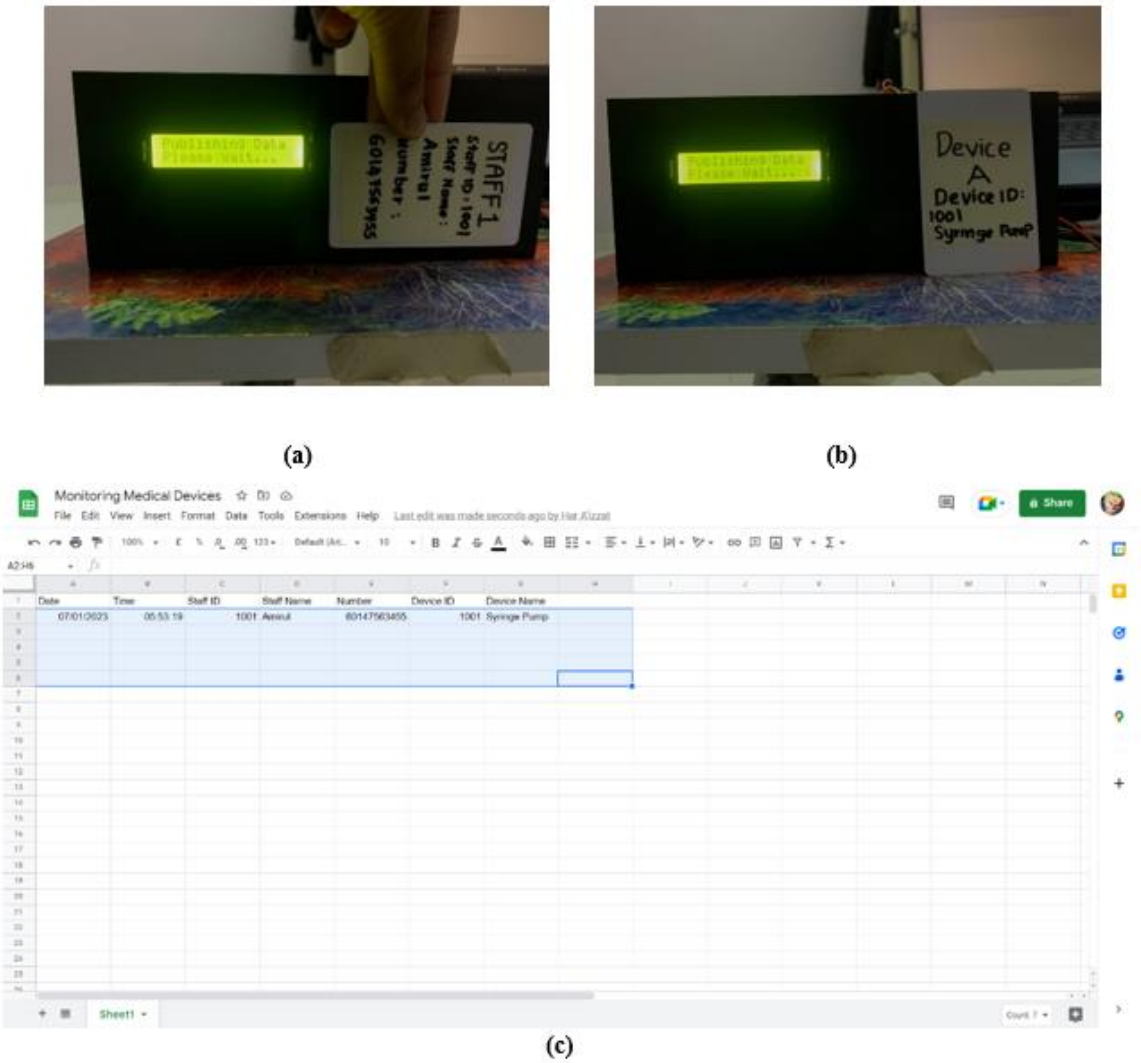
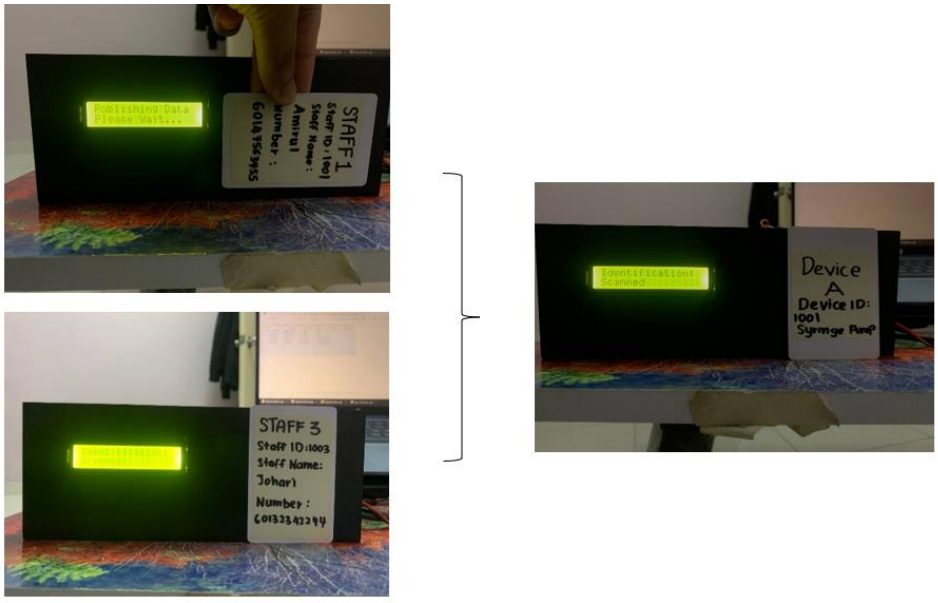
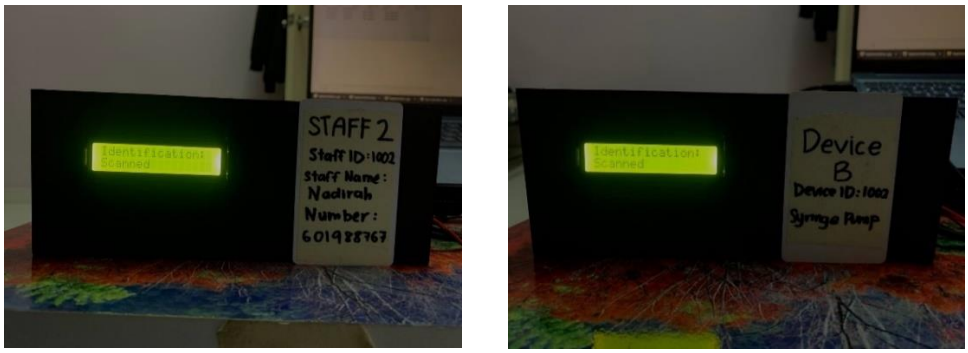


Figure 6: Result after Staff 1 Borrowed Device A

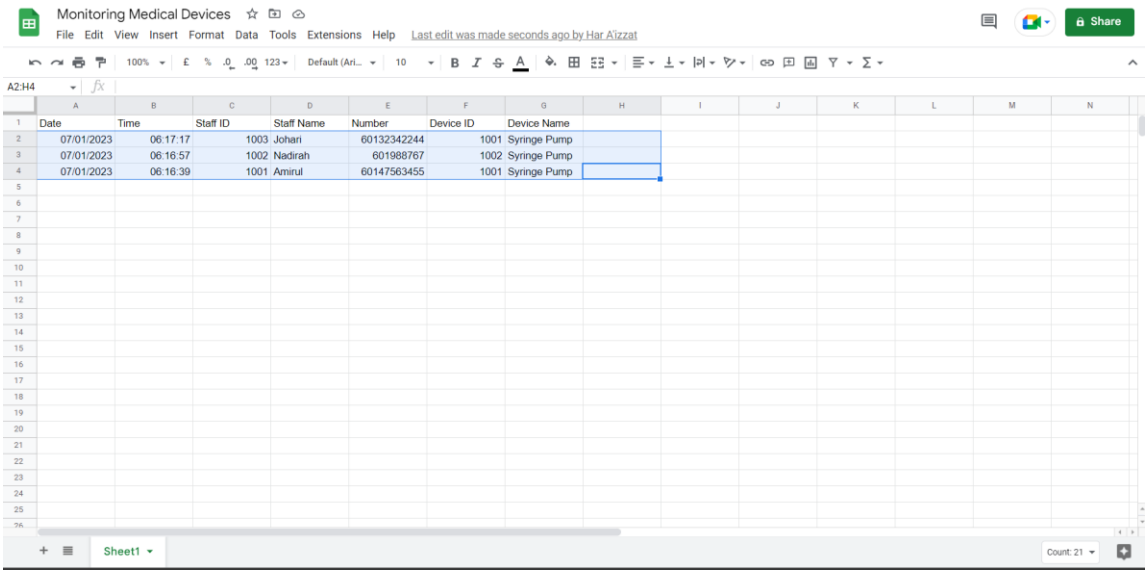
Figure 7 shows that the result after all staff borrowed multiple devices. The user needs to scan the item two times if the they want to borrowed two medical devices. This is the scenario after all the staff borrowed the devices. Staff 1 and Staff 3 borrowed Device A (Figure 7(a)) and Staff 2 borrowed Device B (Figure 7(b)). The results from the Google Sheets database shows that two devices have been borrowed by all Staff (Figure 7(c)). The 'Device' and 'Staff' columns are recorded all once to indicate this.



(a)



(b)



(c)

Figure 7: Result after all staff borrowed Devices A and B, where (a) Staff 1 and Staff 3 borrows Device A, (b) Staff 2 borrows Device B, (c) display in Google Sheet

4. Conclusion

In conclusion, The Medical Devices Tracking and Monitoring System using RFID has been a successful project that accurately tracks and monitors medical devices within a healthcare facility, ensuring proper usage and availability for patient care. The system was designed using Fritzing software and web application was developed using Google Spreadsheets and apps script. The components consist of ESP8266 as the microcontroller, MFRC522 working as RFID reader, and MIFARE card used as RFID tag. The system's performance was successfully evaluated and the information of the user and the device ID can be monitored. The RFID technology has been proven to be reliable and efficient. The system also allows for easy monitoring of user and device information, for example, when user A borrows Device A, it will be clearly displayed in the Google Spreadsheets, similarly for different scenarios. The system is an effective tool for enhancing the quality and safety of medical care.

Acknowledgement

The authors would also like to thank the Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia for its support.

References

[1] Lehpamer, H. (2008). RFID Design Principles. Retrived from https://books.google.com.my/books/about/RFID_Design_Principles.html?id=Cm7O1ppKte8C&redir_esc=y

[2] RFID Journal Staff Writer. “RFID: Frequently Asked Questions”,2005. RFID Journal.

[3] Coustasse, A., Tomblin, S., & Slack, C. (2013). Impact of radio-frequency identification (RFID) technologies on the hospital supply chain: a literature review. Perspectives in Health Information Management, 10(Fall).

[4] Wang, S. W., Chen, W. H., Ong, C. S., Liu, L., & Chuang, Y. W. (2006). RFID application in hospitals: a case study on a demonstration RFID project in a Taiwan hospital. In Proceedings of the 39th Annual Hawaii International Conference on System Sciences (HICSS'06) (Vol. 8, pp. 184a- 184a). IEEE.

[5] Components101. (2020, April 22). NodeMCU ESP8266 [Online]. Available: https://components101.com/development-boards/nodemcu-esp8266-pinout-features-and-datasheet.

[6] Components101. (2019, June 12). RC522 RFID Module [Online]. Available: https://components101.com/wireless/rc522-rfid-module

[7] AndroidErode.com. (2019, October 30). I2C Lcd Display Module Details [Online]. Available: https://www.androiderode.com/i2c-16x2-lcd-display-module-details/