Enhancing Counter Monitoring System Through IoT Integration

Wardah Wahab[1], Afzanizam Alias[2*], Mohd Helmy Abd Wahab[1]
[1]Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn, Persiaran Tun Dr. Ismail, 86400 Parit Raja, Johor, Malaysia
[2]Department of Information Technology and Communication, Politeknik Sultan Abdul Halim Mu'adzam Shah, Bandar Darulaman, 06000 Jitra, Kedah, Malaysia
*Corresponding author: afzanizam@polimas.edu.my

Abstract

This project details the design and development of an IoT, enabled electronic counting system to address the inefficiencies of current queue management methods. Traditionally, users must be on-site, take a queue number, and wait, often leading to wasted time if they miss their turn. IoT-based queue system optimizes waiting times by allowing users to monitor their queue status via their mobile phones. With the counter monitoring system, users can take a number at the office and track it remotely, managing other tasks while they wait. When their turn approaches, they can return to the counter promptly. Initially implemented in clinics to reduce patient waiting times, this system is currently under development, using NodeMCU ESP8266 hardware and a Structured Query Language database. Preliminary results show that this web-based system effectively displays queue information on smartphones, enhancing user convenience and efficiency. By leveraging IoT technology, the project aims to streamline queue management and improve user experience.

Keywords: - Counter monitoring system, queue management, patient waiting time

1. Introduction

The long waiting time at the outpatient counter is a persistent issue faced by public clinics. Waiting time refers to the duration patients spend in the queue before receiving service, with the outpatient division of public health clinics encountering the most significant challenges compared to other departments. This issue is a common complaint among patients. To alleviate congestion and address these complaints, the implementation of a smart counter management system using the Internet of Things is proposed as a practical solution. With this system, patients no longer need to endure long waits in the waiting room; instead, they can return when their queue number is approaching. Additionally, the system includes a database created using Structured Query Language (SQL) to collect and store data efficiently.

A log is used to store queue numbers, which are displayed through a web-based system. According to analysis, patients who had to wait more than 15 minutes were frustrated, and those waiting over 30 minutes were even more likely to experience frustration (Manaf, 2009). The provider also experiences indirect losses because it will lower work efficiency, profit, even giving rise to an image that is bad for the patient (Ramadhan & Vikaliana, 2023).

Burungale et al. (2018) introduced a system designed to streamline the process of booking appointments, including features for online payment and cancellation. This system, accessible via mobile devices, allows users to enroll in a waiting list, ensuring they are notified if there are any appointment cancellations by other patients. This approach aims to make medical appointments more accessible and convenient for users

The outpatient department typically experiences an average waiting time ranging from 1 hour to 2 hours and 45 minutes (Ahmad et al., 2017). Research by Hassan et al. (2015) indicates that patients who endure longer waiting periods often report dissatisfaction. Outpatient departments are usually busy, particularly during early morning registrations and after afternoon breaks. The combined productive work time of eight doctors in the outpatient department totals 49 hours. According to Johnson (2008), the lack of experienced staff significantly contributes to prolonged waiting times. Developing a project focused on reducing patient waiting times is crucial, as it would enable individuals to engage in other tasks while waiting.

1.1 System Framework

For this system to function effectively, the user must first obtain a sequence number by pressing a button at the clinic's front desk after submitting all the necessary information. This number will be displayed on a Liquid Crystal Display (LCD) connected to a NodeMCU ESP8266 microcontroller (see Fig. 1). The system connects to a cloud server via Wi-Fi. The user can then access a web-based application on their smartphone or computer to view the data. Once the system is fully operational, users can monitor their queue number through the web application.

eISBN 978-629-7710-01-3

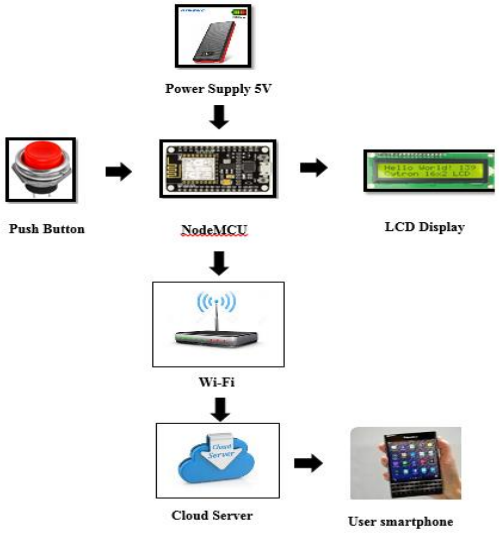

Fig. 1. Proposed of system

Queue Management Theory

Afrane & Appah (2014) highlight that queuing theory has been effectively applied in fields such as traffic management, banking, supermarkets, and healthcare. In public health settings like hospitals or clinics, queuing systems manage the process of patients arriving for services, waiting for assistance, receiving the service, and then departing. These systems are characterized by the arrival times of patients, the duration of services, and the number of patients. Gimba et al. (2020) demonstrated that integrating a queue monitoring system with IoT and an IR sensor at the entrance can count customers and display the waiting queue in real-time for both bank staff and customers

At clinics, there are different types of patients: those with appointments and those without. Patients without appointments fall into three categories: new patients visiting the clinic for the first time, patients with existing appointments, and emergency patients. For appointments, patients must first visit the front desk to identify any health issues they may have and determine if they need lab tests. On the other hand, patients without appointments need to go through the registration process to provide their information. After completing all treatment processes, patients should collect their medication from the pharmacy before leaving the clinic.

To improve the existing outpatient clinic system, Lakshmi & Iyer (2013) suggested that the government should take responsibility for studying and implementing online registration systems. This system could create methods to give privileges to specific groups, such as disabled individuals (OKU) and senior citizens.

2. Methodology

2.1 Hardware Component

Part of the methodology involves planning and executing the queue management system with meticulous detail to ensure smooth and efficient implementation. The project is divided into two main sections: hardware development and software development. The hardware development phase focuses on selecting and configuring necessary components such as microcontrollers, sensors, and displays. This phase includes designing circuitry, assembling components, and testing functionality to ensure they meet system requirements. Simultaneously, software development creates applications and programs to drive the queue management system, managing patient queues, monitoring waiting times, and displaying information on various devices. Integration with databases for patient information storage and communication interfaces for real-time updates is also crucial. Testing and validation procedures ensure hardware and software work together seamlessly, with scenario testing to identify and resolve issues or bugs.

2.2 Software Component

Fig. 2 presents a flowchart of the software design, detailing the program flow using Arduino IDE for the hardware and Notepad++ for the website. This application employs Agile methodology to configure both hardware and software, ensuring adaptability to changes.

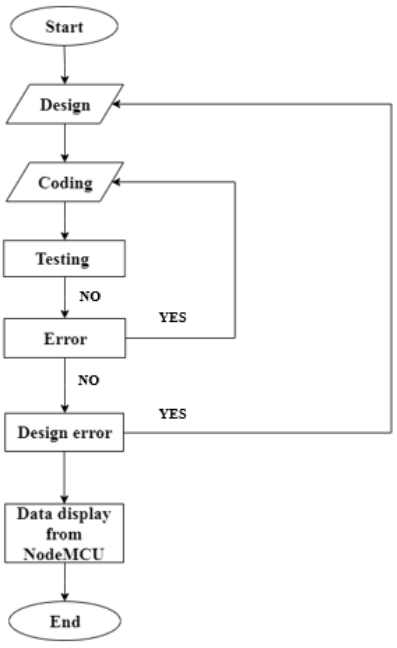

Fig. 2. Flow chart for software is based on the coding

The software design flowchart outlines the sequential steps and decision points in the program's execution, guiding the development of code on Arduino IDE and the website through Notepad++. Agile methodology is employed to facilitate iterative development and frequent adjustments, accommodating modifications to both hardware and software components as needed. This approach enhances flexibility and responsiveness in the design process, allowing for efficient configuration and deployment of the queue management system.

3. Result and Discussion

This queue management system, leveraging the Internet of Things (IoT), is designed to display queue numbers at clinics. The project employs the ESP8266 NodeMCU module for data storage in a database system and connects to the internet via a Wi-Fi connection. A Raspberry Pi acts as an intermediary between MQTT and Node-RED, reading data from the NodeMCU and saving it to a MySQL database when a button is pressed. XAMPP is utilized to create web-based interfaces using PHP. Upon pressing the button, the queue number is displayed on the LCD, while registration information is accessible through web-based interfaces or smartphones.

Multiple users have tested this project, which includes three sections: the registration counter, room one, and room two. This system operates by displaying the queue number on an LCD when a button is pressed. The number shown on the LCD is also updated on a corresponding website. Furthermore, rooms one and two can view the next sequential number by pressing a button, as depicted in Fig. 3, illustrating the layout of the tested area.

Fig. 3. The layout of the tested area

This system features a login form, as shown in Fig. 4, which ensures that only authorized administrators can access or modify any data information. If incorrect login credentials are entered, access is denied until the correct username and password are provided. Once logged in, the administrator can navigate the interface shown in Fig. 5, where they can select from a menu bar that includes three buttons: refresh, reset, and log out.

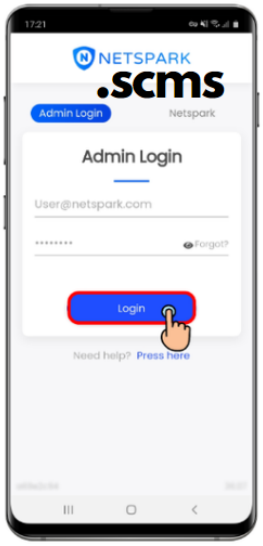

Fig. 4. Login page for admin

Fig. 5. GUI for admin

Fig. 6, allowing users to track queue numbers. The system provides various information, including the total number of registered patients. Users can monitor patient queues and track patients who have received treatment in each room. One of the key advantages of this system is that it allows users to manage their time productively while waiting for treatment.

Fig. 6. GUI for user

Fig. 7 displays the Quick Response (QR) code interface, enabling users to conveniently access the website without the need to manually type the URL link.

Fig. 7. Quick Response (QR) code interface for user

4. Conclusion

This paper focuses on using an IoT platform to address queue waiting times, allowing customers to access real-time queue status updates through web-based or mobile applications. This system aims to enhance user experience by enabling efficient time management during clinic visits. In future developments, the system plans to integrate machine learning into mobile apps to improve service effectiveness and user experience. These advancements will enable predictive queue time estimates and personalized notifications for patients, ensuring they are informed about their queue status and estimated wait times.

Furthermore, the system will explore the integration of sensor cameras to monitor and manage queues in real-time. By analyzing data from these sensors, the system can dynamically adjust staffing levels and allocate resources more effectively, optimizing service delivery. This proactive approach ensures that the clinic operates efficiently, reducing waiting times and enhancing overall patient satisfaction with the service provided.

References

Afrane, S., & Appah, A. (2014). Queuing theory and the management of Waiting-time in Hospitals: The case of Anglo Gold Ashanti Hospital in Ghana. *International Journal of Academic Research in Business and Social Sciences*, *4*(2), 34.

Ahmad, B. A., Khairatul, K., & Farnaza, A. (2017). An assessment of patient waiting and consultation time in a primary healthcare clinic. *Malaysian family physician: the official journal of the Academy of Family Physicians of Malaysia*, *12*(1), 14.

Burungale, S., Kurane, K., Mhatre, S., & Vora, P. D. (2018). Patient queue management system. *International Journal of Engineering Science Invention (IJESI)*, *7*(2), 39-41.

Gimba, U. A., Okoronkwo, C. D., Yusuf, M., Musa, A. S., & Ali, M. S. (2020). Queue monitoring system for bank. *Dutse Journal of Pure and Applied Sciences (DUJOPAS)*, *6*(2), 269-276.

Hassan, H., Rahman, M. S., & Sade, A. B. (2015). Contemporary Healthcare Experience in Malaysian Hospitals. *Journal of Applied Business & Economics*, *17*(4).

Johnson, J. (2008). Simple queuing theory tools you can use in healthcare. *A Presentation at the Hospital Information Management Systems Society, February 2008*, 1-6.

Lakshmi, C., & Iyer, S. A. (2013). Application of queueing theory in health care: A literature review. *Operations research for health care*, *2*(1-2), 25-39.

Manaf, A. N. H. (2009). Practice follows structure: QM in Malaysian public hospitals. *Measuring Business Excellence*, *13*(1), 23-33.

Ramadhan, F., & Vikaliana, R. (2023). The Queuing System Analysis for Patient Registration Counters at a Hospital. *Journal of Emerging Supply Chain, Clean Energy, and Process Engineering*, *2*(2), 161-169.