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# Design and Implementation of a Persuasive Application System for Real-Time Monitoring of Safety Compliance of Healthcare Workers

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## ABSTRACT

Occupational hazards in healthcare environments pose significant risks to the safety and well-being of medical personnel, but despite the existence of safety protocols, there remains a gap in real-time monitoring, adherence evaluation and enforcement of compliance among healthcare workers. This study presents the development and implementation of a Persuasive Application System (PAS) designed to address these challenges by promoting the use of Personal Protective Equipment (PPE) and ensuring strict adherence to occupational safety standards. The PAS integrates key modules including user authentication, event scheduling, a monitoring algorithm, and a reward-and-repercussion system. Developed using Python (Flask/Django), React (JavaScript), and MySQL, the system allows administrators to assign tasks and enforce PPE compliance through real-time tracking and automated notifications. Non-compliance triggers warnings and penalties, while adherence is incentivized through a reward system. The system was tested at Memphis Hospital, Enugu, Nigeria, using real hospital staff as participants. The evaluation process included user registration, task assignment, PPE reminders via email and monitoring of compliance behaviour. Results of the study implementation showed that the PAS effectively monitored staff actions, provided timely safety reminders and recorded adherence data accurately. The reward and repercussion module proved instrumental in promoting safe practices. This study demonstrates the potential of intelligent, persuasive systems in enhancing occupational safety management in healthcare settings. The PAS provides a scalable, transparent, and efficient solution for reducing risks and improving overall safety compliance in hospital environments.

**Keywords:** Occupational Safety; Healthcare Workers; Personal Protective Equipment; Persuasive Application System; Real-Time Monitoring

## INTRODUCTION

Medical professionals working in basic health care centers in several developing part of the world confront numerous occupational risks, such as physical harm, chronic stress, and infectious disease exposure. These risks are further compounded by insufficient safety measures and scarce resources such as PPE. These challenges impair not just the physical and mental health of medical staff members but also make them vulnerable to unknown threats, infections, diseases, and even sudden death. In [1], an investigation revealed that health care workers are exposed frequently to chemical, biological, and physical occupational hazards. In addition, [2], revealed that in sub-regions of Africa (including Congo, Malawi, Botswana, and South Africa), 11.8% of causalities due to Hepatitis B virus, 2.8% of deaths due to hepatitis C virus, and 5.1% of deaths due to human immune deficiency virus are all results of occupational hazards in the healthcare environment. In the context of Nigeria, while it is difficult to get an exact value for the number of health care workers causalities, [3], posited that health care workers in the country are poorly prepared to manage occupational hazards, which therefore makes them vulnerable to injuries, infection, and illness while rendering health care services. The vulnerability of staff in the HCFs is compounded by the inadequacy of facilities with equipment that could enhance best practices in their profession.

According to [4] and [5], another reason for occupational hazards in health care is the violation of safety regulations such as non-compliance with the use of Personal Protective Equipment (PPE), inadequate safety protocols, poor infrastructure, outdated working tools, and exposure to infectious diseases, which makes them vulnerable to infections. In addition, the lack or limited availability of PPE and lack of training about occupational hazards have further compounded these problems, leading to more risk of infection exposure and necessitating the need to explore innovative solutions to enhance the safety of health care workers in the healthcare environment. According to [6], one area that has recorded increased application of PAS is healthcare; however, [7] revealed that while these application systems have improved quality of service in health care, there is no universal evaluation framework that measures the user experience factor. In addition, [6], revealed that these applications are only focused on usability, while critical factors such as user experience evaluation are ignored, necessitating a holistic system design that considers both user experience and evaluation. In addition, [8], identified six key attributes, which are goal setting, reward, cooperation, social comparison, and social learning, as main components for a reliable PAS; however, it is difficult to identify a PAS that considers these components in their entirety and hence affects their reliability. For instance, [9], investigated the factors that affect user behaviour on mobile health applications, while [10], proposed a technology acceptance model that focused on supporting user participants in the health care process rather than a persuasive approach. In [11], a mobile application system as a regional agent for improved management of COVID-19 patients was presented, while [12], investigated the impact of PAS on the wellbeing of humans through the development of a health monitoring application system. While these studies have all contributed greatly to the management of health information, to the best of the researcher's knowledge, PAS for occupational safety in health care is rare in literature. In addition, existing PAS lack critical features like evaluation and rewards and are focused mostly on user experience. A reliable PAS must be tailored towards the realities of medical practitioners, specific needs to minimize risk to occupational hazards, and able to ensure that users are persuaded to adhere to the safety rules and regulations in health care environments. In order to achieve this, this research proposed a persuasive technology to promote the occupational safety of medical practitioners in primary health care centres. By modelling and implementing the proposed system, the study will reduce incidence due to occupational hazards, enhance safety compliance, and ultimately ensure the well-being and productivity of health care workers.

## RESEARCH METHOD

The method adopted in this study involves in addressing the unique challenges of occupational safety in healthcare, where it also identified that there are limited studies that considered occupational hazard for health care workers, and there is inability of workers to evaluate user's adherence to occupational safety protocols and overall issue of reliability with the existing are gaps identified. In realizing this method, Agile approach was applied where the first step was to characterize selected healthcare activities and also safety requirements to develop a new data model. Upon the characterization, a persuasive application software model was developed using the user interface design, monitoring algorithm which measures the adherence of users to the safety requirements and also notify them when not adhered to. In addition, the behavior of the user is recorded and serves as input to a reward and repercussion model which encourages the adherence to the safety requirements and also queries users not following safety requirements. System integration utilized visual studio, MySQL and JavaScript to implement the models while the testing and validation of the model will be done to evaluate the performance of the PAS.

## THE PROPOSED PERSUASIVE APPLICATION SYSTEM (PAS)

This section presents the PAS for the management of occupational hazard in health care environment. The major components of the proposed PAS constitute the user authentication platform, the event scheduling platform as the workplan, safety requirements, monitoring algorithm, reward and repercussion, then the system integration. The Figure 1 presents the proposed PAS block diagram.

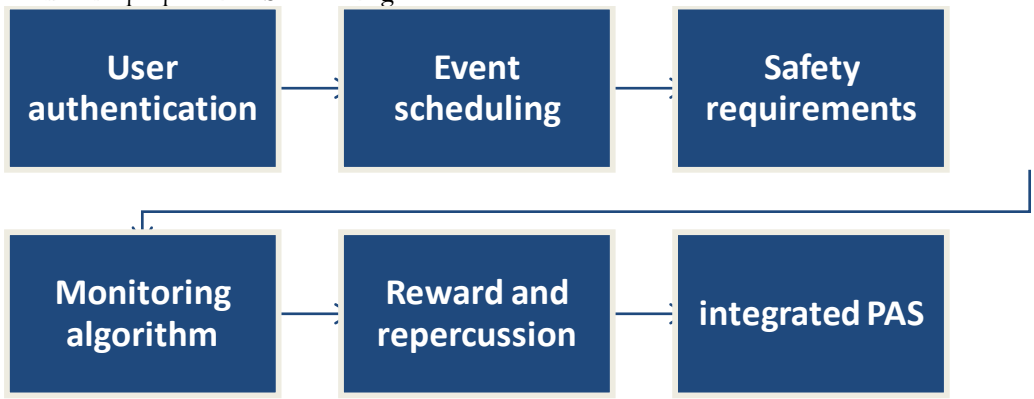


**Figure 1: The PAS Block Diagram**

The block diagram in Figure 1 showed the essential components of the PAS system created to oversee workplace safety in a medical facility. User Authentication is the first step in ensuring that only people with permission can access the system. Event Scheduling has to do with planning occupational activities by the medical practitioner. The Safety Requirements section lists the procedures that must be adhered to while carrying out the scheduled activities. The Monitoring Algorithm part is in charge of monitoring compliance with these safety guidelines in real-time and continuously reminding the user until adherence to the safety rules. Based on adherence to the safety regulations, a system of rewards and penalties is suggested in the Reward and Repercussion block. Finally, an integrated PAS model which connects all of these components into platform application software to aid occupational safety in health care environment. The data flow diagram of the proposed system is presented in Figure 2.

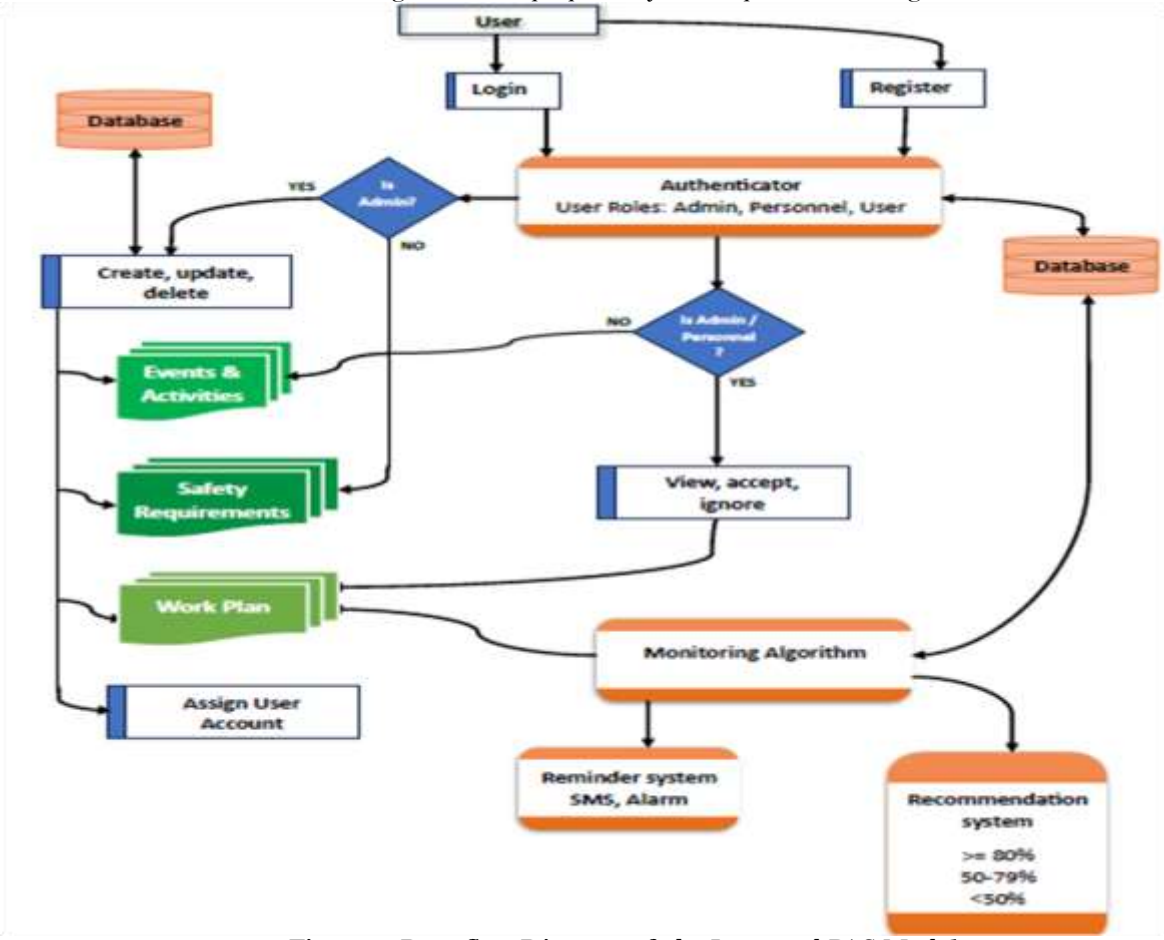


**Figure 2: Data flow Diagram of the Improved PAS Model**

The figure illustrates the new PAS with user management and safety compliance features. Users upon logging in or registering are authenticated based on their roles as admin or normal staff which in this context are nurses or doctors. The admin registers activities in the workplace and assign task with their PPE for users. The monitoring algorithm user compliance, issuing reminders through SMS to ensure that before carrying out the task, the necessary safety protocols are adhered to. Depending on compliance levels, the system uses a recommendation feature to categorize users based on their adherence to safety protocols, prompting further actions such as reward, warning, and query if required.

## High level Model of the proposed System

This section presents the high-level model of the proposed PAS. This model is made of four major sections which are the user authentication section, event scheduling, monitoring for occupation hazard and management as shown in the Figure 3.

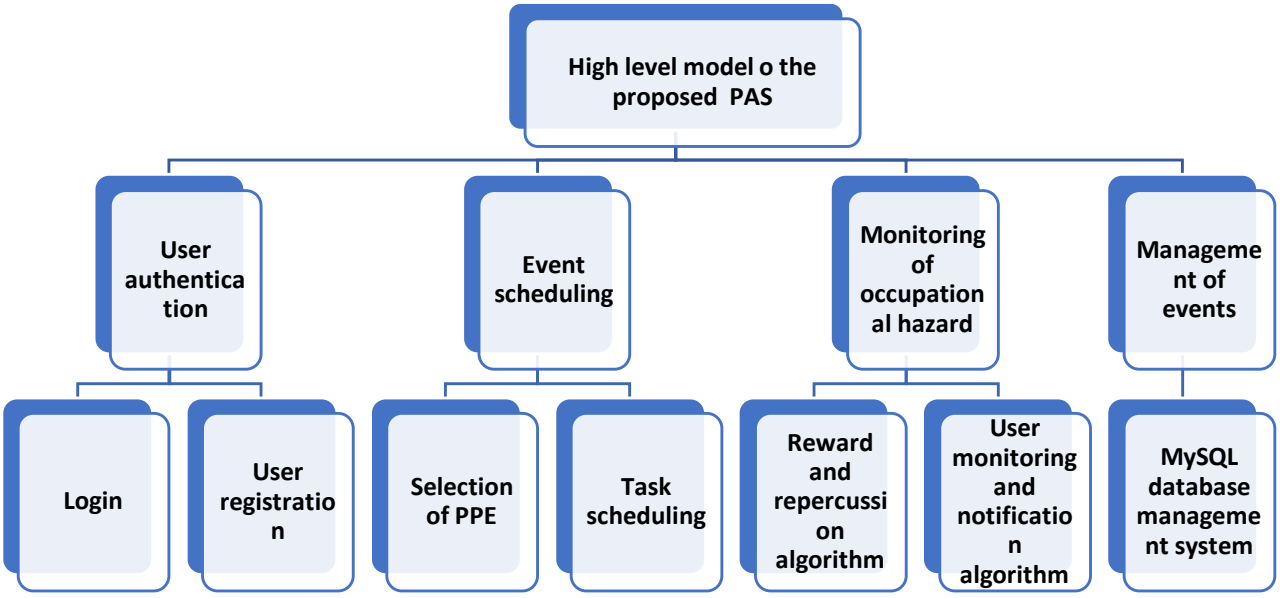


**Figure 3: High Level Model of the Proposed PAS**

The Figure 3 presents the high-level model of the proposed PAS. The model began with the user authentication section, which allows authorized access for registered users. Upon user registration and login, events are scheduled using date and time, while the PPE for that particular task are also selected and submitted by the admin. The schedules events are made available to the respective staffs expected to carry out the task. When the event is scheduled, the monitoring for occupational hazard section is initiated using the user monitoring algorithm, reward and repercussion algorithm respectively. The user monitoring algorithm ensures that the user accepts utilization of the PPE during the task, while the rewards and repercussion algorithm will ensure that users upon adherence to the PPE during task are recommended for rewards, while those who do not adhere to this PPE application are recommended for repercussion. The recommendation will be based on the overall adherence of users to the PPE.

**Architecture of the Persuasive Application System (PAS)**

This section presents the integrated model of the PAS system. The section combined the registration, the different models such as the user registration and login model, the task scheduling model, monitoring algorithm, reward and repercussion algorithm to form the core of the PAS system as shown in Figure 4 below.

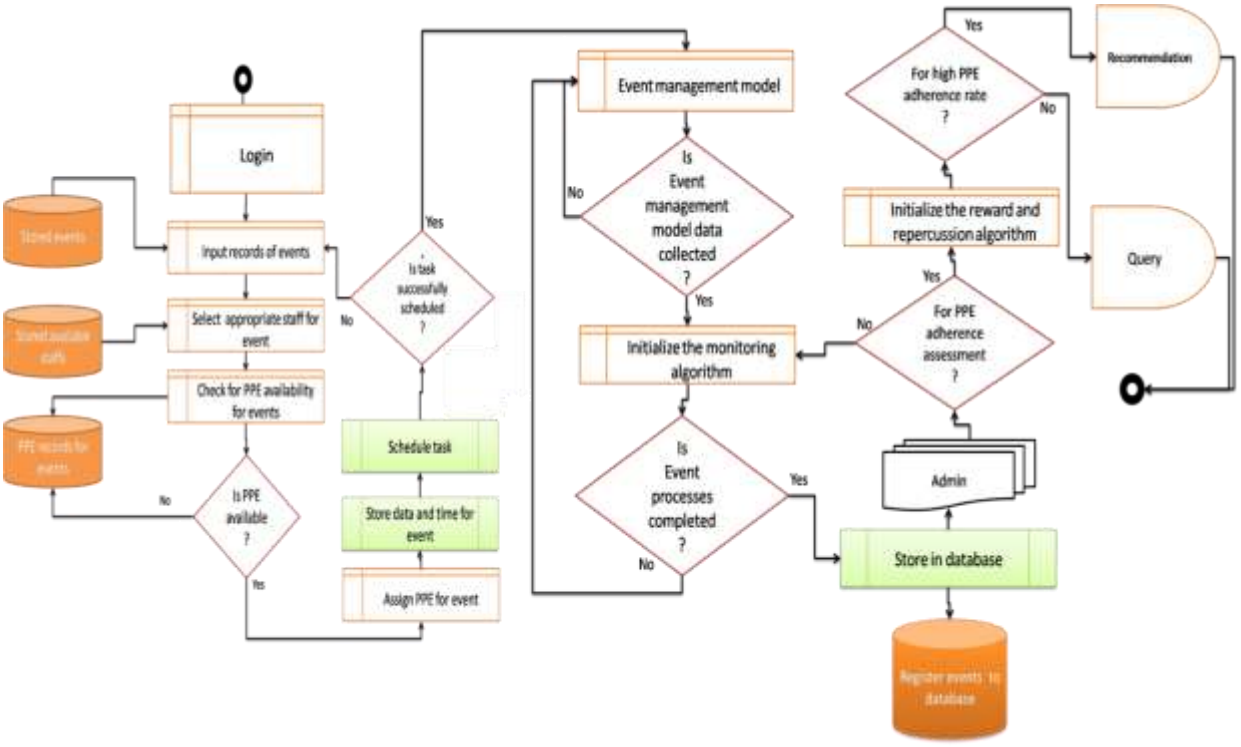


**Figure 4: The Overall Object diagram of the new System PAS**

The PAS which integrated the Event Management System with a Monitoring, Reward and Repercussion System are integrated in Figure 4. The User Admin accesses the system and enters event records during the login procedure. The system makes it possible to choose the right personnel for the task and verifies that Personal Protective Equipment is available. The assignment is booked if PPE is accessible, and pertinent information is recorded, such as the event's date and time. After that, PPE is allocated to the event, guaranteeing that personnel are adequately outfitted prior to starting work. The Monitoring System further assesses PPE adherence. If staff members maintain a high adherence rate to PPE usage, the reward and repercussion algorithm is initialized. This mechanism ensures compliance by incentivizing proper PPE usage and discouraging non-compliance. The system evaluates the level of PPE adherence, determining whether staff members followed safety guidelines during the event. This helps in ensuring workplace safety and reducing occupational hazards. Finally, the results of the assessment are stored in the database. Admin oversee this process, ensuring that all event data, adherence records, and monitoring feedback are securely stored. The system allows for recommendations based on performance, providing insights that can improve future scheduling and PPE management. Additionally, users can query the system for stored data, enabling better decision-making and reporting. This event scheduling and monitoring system ensures that tasks are effectively managed while maintaining a structured approach to workplace safety.

**Design of Login User Interface and Even Scheduling Interface**

The PAS system's registration, login and event scheduling interfaces are essential parts that guarantee safe user access and effective task management. Authorized users, including administrators, physicians, and nurses, can safely access the system using the login interface, which acts as the entrance point. In order to confirm identification before allowing access, it usually contains sections for user credentials (password and username) and authentication methods. In contrast, the event scheduling interface makes it easier to assign and manage work in a medical context. Users can enter event information, choose staff, set deadlines for tasks, and assign resources like Personal Protective Equipment (PPE) using this interface. To increase productivity, it incorporates tools for tracking progress, prioritizing tasks, and setting up automated reminders. Figure 5 presents the login interface for users, Figure 6 presents user registration, the while Figure 7 presents the Event Scheduling Interface Design.

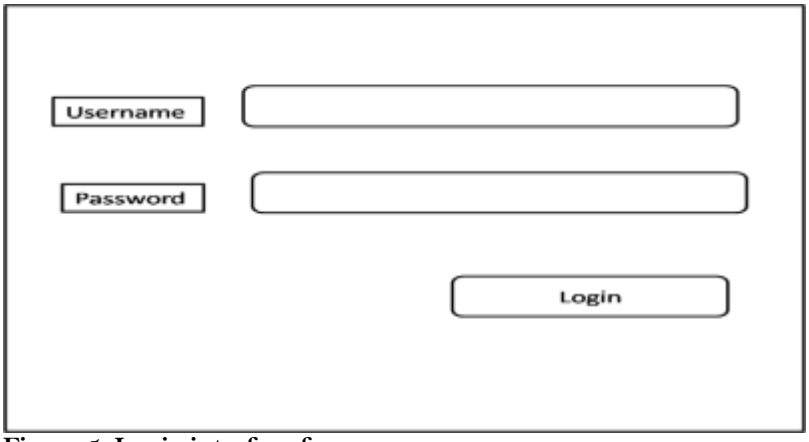


**Figure 5: Login interface for user**

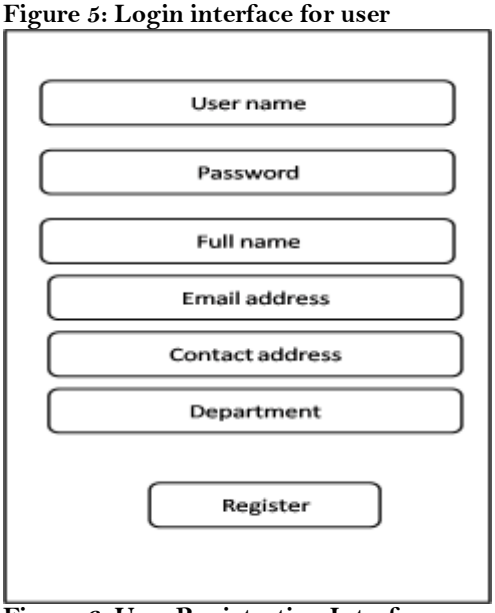


**Figure 6: User Registration Interface**

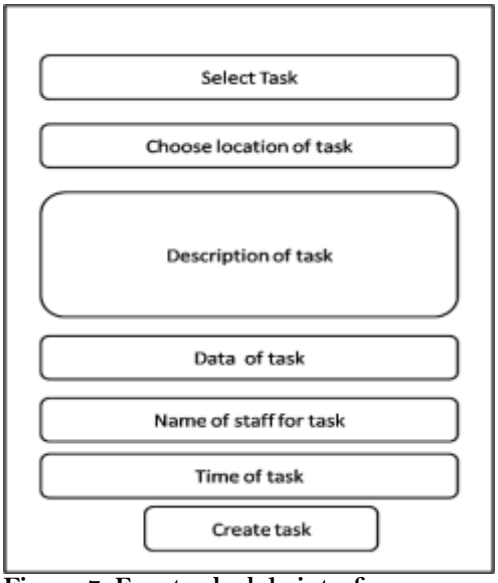


**Figure 7: Event schedule interface**

The Figure 6 presents the user registration interface, while Figure 7 presents the interface design of the event scheduling section. The user registration allows administrators, physicians, and nurses to register as new users. The interface has spaces for entering personal information such name, department, role, and contact data. To provide safe access to the system, authentication credentials such as a username and password are also necessary. The system's overall user interface design or task scheduling offers a simple and easy-to-use layout for navigating through its many features. Important areas including task name, data, time, description and staff for the task. The design maintains a high degree of security and operational efficiency while guaranteeing smooth interaction, enabling users to effectively manage hospital chores. Figure 3.8 presents the user interface design software for the login, while Figure 3.9 presents the event scheduling platform.

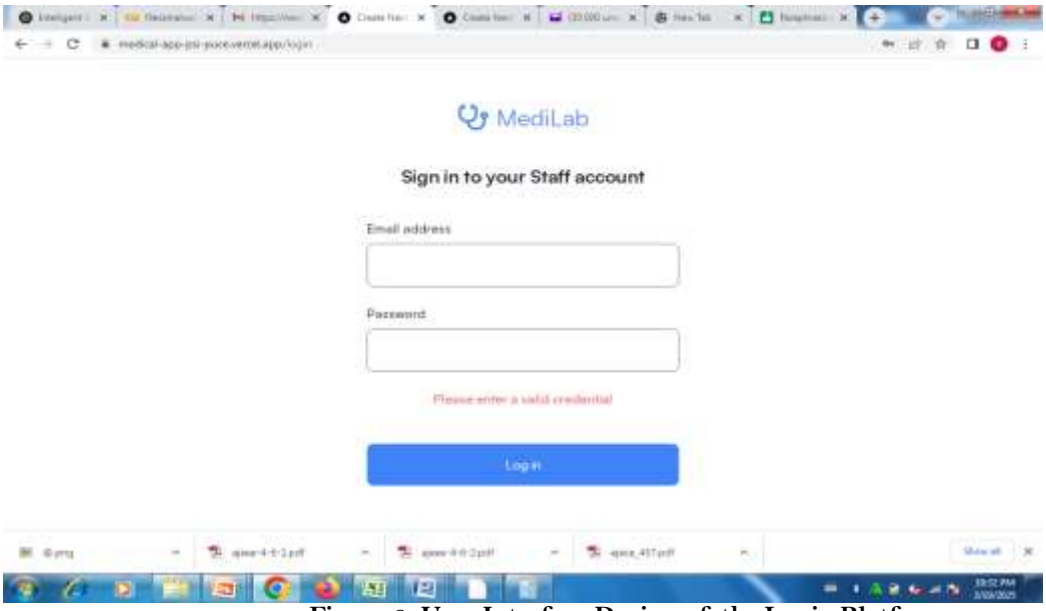


**Figure 8: User Interface Design of the Login Platform**

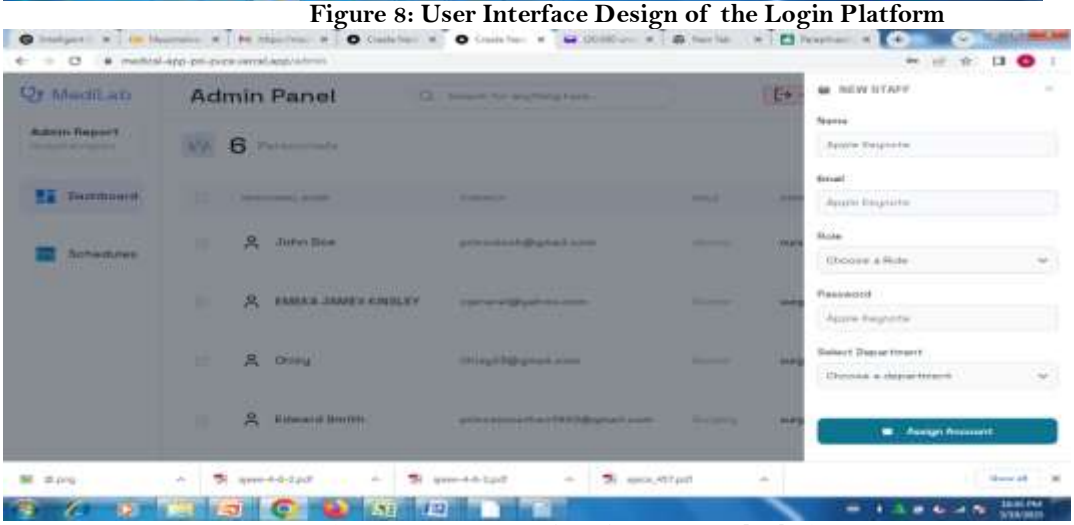


**Figure 9: User Interface for Event Scheduling System**

**Program Modules**

The system is structured into several program modules, each responsible for handling specific functionalities to ensure smooth operation. These modules interact with one another to provide an integrated solution for real-time monitoring, event scheduling, and user management. The key program modules are reported in Figure 10.

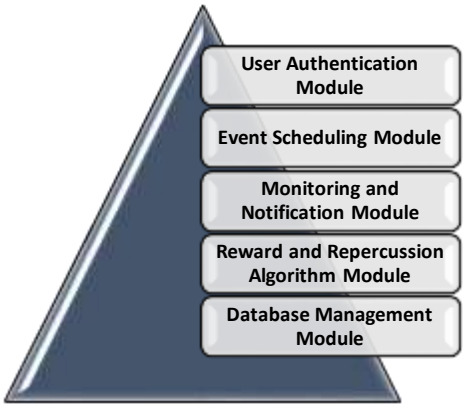


Figure 10: Program Modules Diagram

In the Figure 10, the program module diagram. The user interface module handles user login, registration, and authentication. It ensures that only authorized personnel (doctors, nurses, and administrators) can access the system. It employs encryption techniques for password security and role-based access control. The event scheduling module is responsible for scheduling hospital tasks by assigning duties to personnel. It includes task allocation, PPE selection, and setting the date and time for each scheduled event. The monitoring and notification module tracks ongoing events and personnel activities. It integrates a real-time monitoring system to assess task completion status, PPE adherence, and potential hazards. Automated notifications are sent to users regarding task deadlines and alerts for incomplete assignments. The reward and repercussion module evaluates staff performance based on adherence to scheduled tasks. It implements a reward system for personnel who complete their tasks efficiently and a consequence system for those who fail to comply. The database module ensures efficient storage and retrieval of user data, scheduled events, PPE records, and monitoring logs. It uses MySQL for structured data management and supports queries for reporting and analytics. Each module works collaboratively to enhance Hospital Task Management, improve efficiency, and ensure accountability among medical personnel.

## SYSTEM IMPLEMENTATION

The implementation of the persuasive application system involves translating the designed models, database structures, and user interfaces into a functional system. This phase includes setting up the development environment, integrating modules, and deploying the system for real-time usage. First the environmental setup is presented. This is achieved using a combination of programming languages and frameworks. The backend is implemented using Python (Django/Flask) for server-side logic, while HTML, CSS, and JavaScript (React) are used for the frontend. The database is managed using MySQL, which stores user information, event schedules, and monitoring data. In the module integration, the key modules, including user authentication, event scheduling, monitoring, reward/repercussion algorithm, and database management, are integrated into a single system. API Endpoints are developed to facilitate seamless communication between the frontend and backend. A user-friendly interface is designed to allow medical personnel to interact with the system efficiently. The interface includes login functionality, event scheduling forms, and monitoring dashboards to track real-time activities. The system undergoes rigorous testing, including Unit Testing, Integration Testing, and User Acceptance Testing (UAT). Bugs and Performance Issues are identified and resolved before deployment. The system is deployed on a Web Server or Cloud-based Platform for accessibility. Continuous monitoring and updates are performed to improve functionality and security based on user feedback and evolving requirements. Through these steps, the persuasive application system is successfully implemented, ensuring effective task scheduling, personnel monitoring, and performance evaluation in a hospital environment. Figure 11 presents the system implementation results.


**Figure 11: The Homepage of the Implemented System**

## RESULT OF THE SOFTWARE VALIDATED AT MEMPHIS HOSPITAL ENUGU

This section tested the software at the Memphis hospital, Enugu Nigeria as one of the data sources. In testing the software, two of the staffs were used as entities and the results were recorded and discussed here to prove the effectiveness of the system in real world scenario. The testing sequence includes registration of users, login of

users, task scheduling by admin, task acceptance by user, reminder to use PPE as email notification and finally the reward and percussion model which evaluates the effectiveness of users in adhering to PPE usage for task. Figure 12 reported the login of admin,

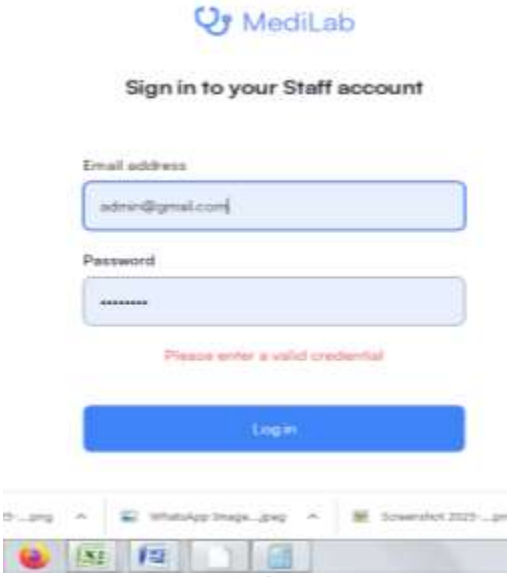



**Figure 12: Result of admin login** **Figure 13: Result of staff login**

The Figure 12 and Figure 13 showed the result of the system when admin and staff login respectively. The admin login to create account for new staffs, assign task, monitor staff acceptance of task, and adherence to safety. The staff on the other hand, logs into know when staff has been assigned to them and the either accept or reject the task. In Figure 14, the admin creates account for the new staff named Dr, Njoku Ekene on the 4th Aril, 2025, while in Figure 15, the new staff was able to login and view task scheduled and to accept or reject the task.

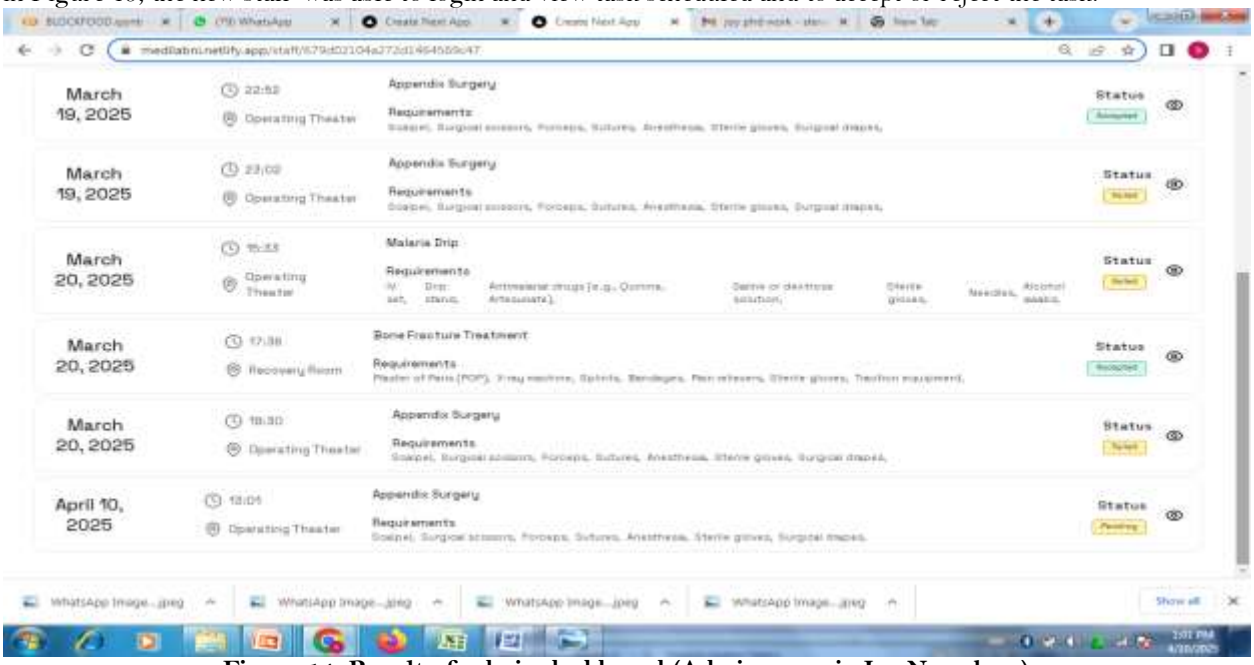


**Figure 14: Result of admin dashboard (Admin name is Joy Nwankwo)**

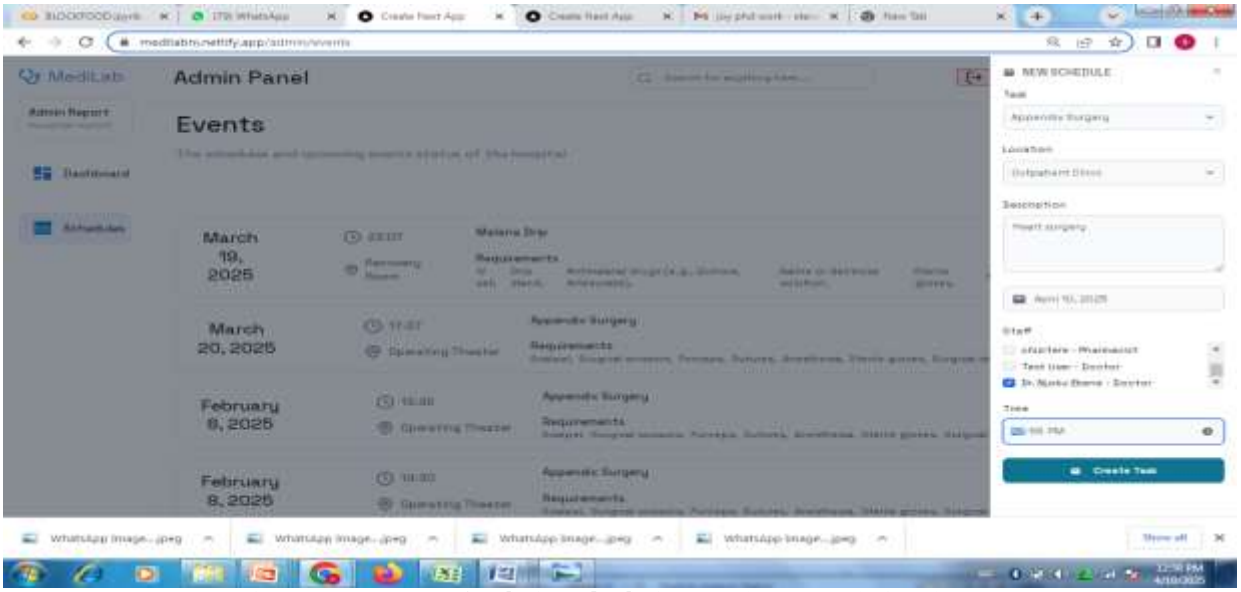


**Figure 15: Result of Admin Scheduling Task to Dr Nkoju Ekene C.**

The Figure 14 revealed the dashboard of the admin where task can be assigned to users. In the Figure 16, task was assigned to Dr Njoku. The circle part of the figure is where the staff can be selected by the admin and as shown, Steve was the selected Staff. The Figure 17 showed the email sent to Dr Njoku, notifying of the task schedules, while Figure 18 is the dashboard of Dr Njoku to access event scheduled, for either acceptance or rejection.

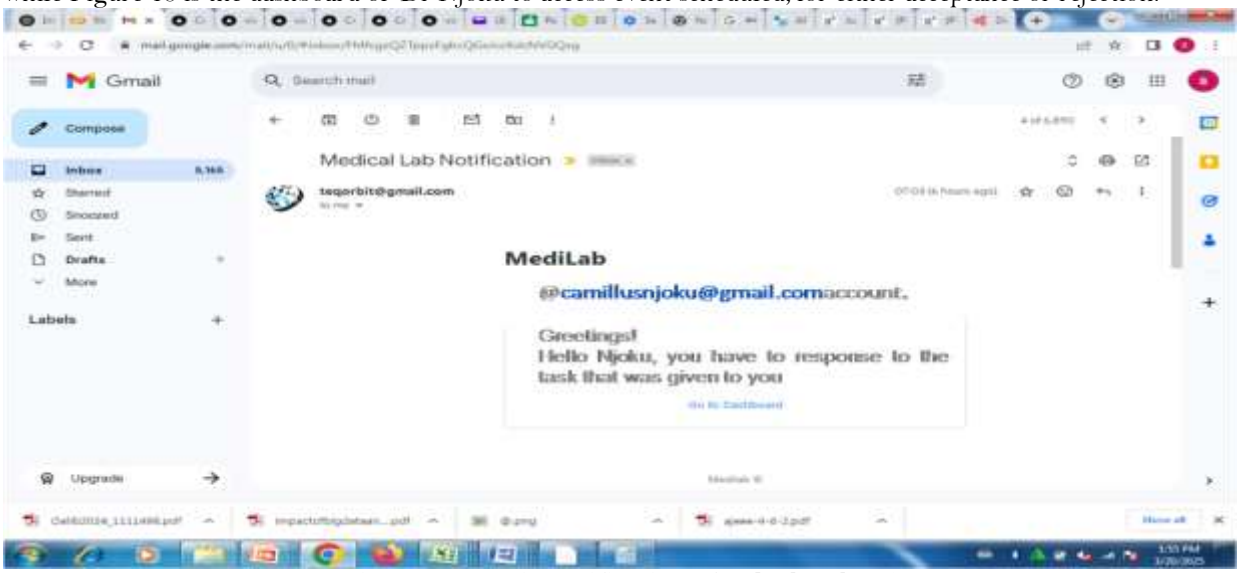


**Figure 16: Email Notification of Scheduled task.**

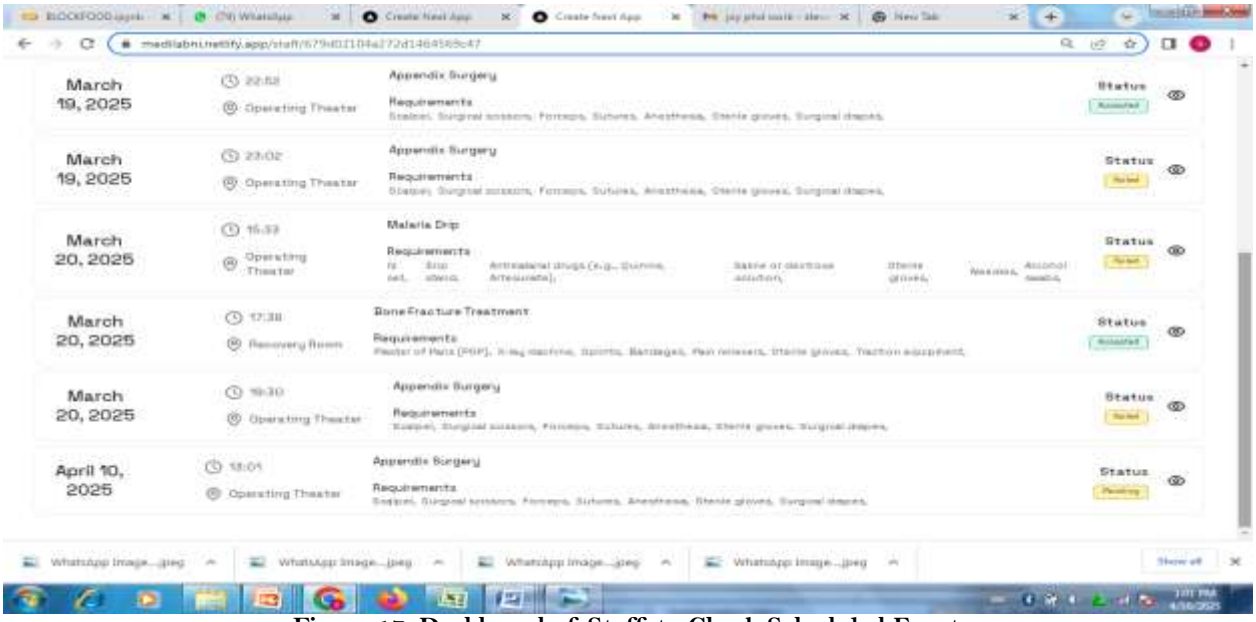


**Figure 17: Dashboard of Staff to Check Scheduled Event**

Figure 16 revealed the dashboard of Dr Njoku, showing different task assigned in the past, those accepted, those failed and the recent pending task as shown in the block circle. The Figure 5.5 showed the screen where the task was accepted, while the reflection on the dashboard was reported in Figure 17.


**Figure 18: Result of Task Acceptance by Dr Njoku**

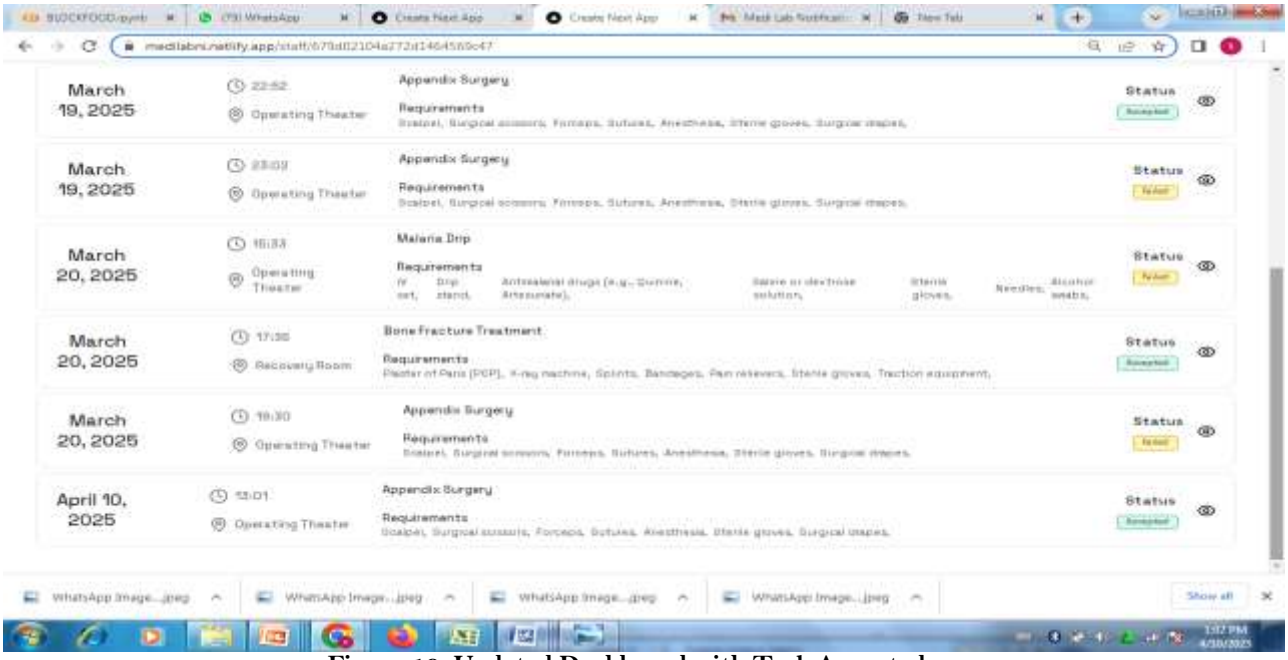


**Figure 19: Updated Dashboard with Task Accepted**

The Figure 18 showed the accepted task option for the task, while in Figure 19, the updated dashboard which showed the compliance of Dr Njoku to carry out the task was reported. Through this dashboard, there is transparency on the number of task carryout by every staff, number of pending task and number of those rejected. Upon acceptance of the task, the Figure 20 showed when the staff is reminded with mail to adhere to the PPE.


**Figure 20 Result of Notification to Use PPE**

The Figure 20 presented the email sent by the system to notify user to use PPE before carrying out the task. This email was sent sequentially according to the monitoring algorithm developed which tracks the adherence of staff to PPE before carrying out a particular task. Figure 21 presents the final notification message sent to remind Dr Njoku to use PPE for the task.

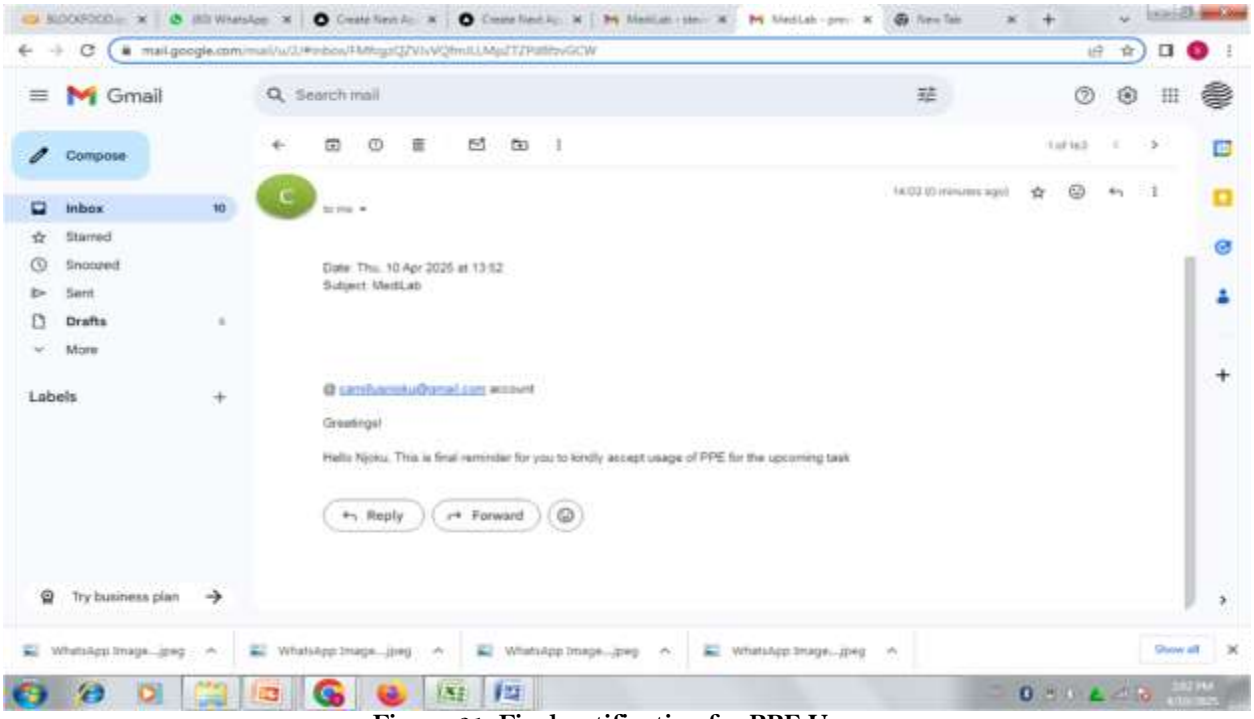


**Figure 21: Final notification for PPE Usage**

The Figure 21, reported the final notification message sent to Dr Njoku to confirm usage of PPE for the task. After the message was sent and Dr Njoku did not use the PPE, it was then uploaded to the admin dashboard that his adherence factor is 0% (meaning no adherence to PPE while carrying out task).

## CONCLUSION

Since time memorial, several health care workers have lost their lives due to infection, contamination and exposure to occupational hazard. While health care workers are ensuring safety of individual, it is also a collective responsibility to ensure the safety of health workers. To achieve this, this research model persuasive technology for occupational safety of medical practitioners. To achieve this, the software research methodology adopted is Agile methodology, due to Agile's flexibility, iterative progress, and regular feedback cycles ensure that user needs and requirements are frequently revisited and adjusted. The method of the work is a systematic approach which began with designing a PAS. The PAS was tailored towards real time monitoring, management and persuasion of health care practitioners to adhere to safety precautionary measures while carrying out their duty. The PAS was made of several key components which are the login and user registration system, event scheduling system, real time monitoring and notification system, then the reward and repercussion system. The user registration section allows users to create account so as to prevent unauthorized to the system. The event scheduling model was designed using rule-based approach, MYSQL database; date and time control function to develop a system which allows admin upon registration and creation of staff account to schedule them for task. The algorithm monitors the task status of staff, considering time and date to make sure they are reminded of the task data earlier before time for preparation. The system was integrated as a software application system for health care using PHS, HTML and react programming language. The performance testing process considered the different approaches which include unit testing, module testing and integration testing. The results showed that the system was able to facilitate task scheduling, upon task acceptance, monitors adherence of staff to PPE, notify user to adhere to PPE, then evaluate staff overall adherence factor to PPE during task execution. To validate the system, Staff of Memphis hospital Enugu was used as subjects to test the system functionality in real-world healthcare scenario. The results showed that healthcare practitioners are correctly managed effectively and encouraged to apply PPE when carrying out the duties.

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