Development of Appointment Scheduling System for Dialysis Patients

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Abstract - **This study focuses on design and Development of the Dialysis Appointment Scheduling System for Dialysis Patients, enhancing the scheduling efficiency of patients, nurses, and administrators. The proposed system addresses several problems commonly encountered in the handling of appointments manually, such as delays, overlapping schedules, and difficulty in tracking patient records. For flexibility and accessibility, the web-based platform's integration with a mobile application enables the booking, rescheduling, and cancellation of appointments. Its administrators create user accounts, check patient eligibility, and monitor system operations, while nurses endorse the appointments and monitor the activity of the patients. The system will utilize a centralized database to store information to update the schedule, patient history, and reports in real-time. It will be deployed on a shared web hosting environment for cost efficiency. With connectivity through mobile devices, users can access these services at any time. The mobile app will provide notifications, reminders, and quick access to their appointment details for patients' convenience. Overall, the system enhances operational workflow by reducing the administrative workload and offering a more organized and responsive scheduling process within the dialysis facility. This project shows the impact digital automation can make on healthcare service delivery and patient management.**

Keywords - Dialysis, Appointment System, Mobile Application, Scheduling, Healthcare, Patient Management, Web-based System, Automation.

I. INTRODUCTION

Healthcare institutions, particularly dialysis centers, require a structured approach in managing patient scheduling treatments. Information technology plays a significant role in improving administrative processes by reducing manual workload, enhancing data organization, and supporting service delivery. Nishanthan et al. (2023) highlight that manual record handling in hospitals is time-consuming and prone to errors, emphasizing the need for automation to enhance efficiency in medical transactions and patient management.

Nasralla and Abd Alameer (2023) underscores the benefits of implementing electronic systems to streamline administrative tasks in healthcare settings. Their findings suggest that such systems can significantly improve accessibility and coordination, providing a foundation for developing specialized applications focused on appointment scheduling.

This study centers on designing a mobile application dedicated to automating appointment scheduling within healthcare facilities. By addressing the inefficiencies associated with manual scheduling processes, the research aims to develop a mobile application that assists healthcare staff in managing patient appointments, tracking treatment schedules, and sending automated notifications. The anticipated outcomes include minimizing scheduling conflicts, enhancing operational efficiency, and improving communication between healthcare providers and patients.

II. PROBLEM STATEMENT

Currently, Total Care Dialysis Center Tagoloan, the appointment scheduling process primarily relies on manual methods with just the use of Excel spreadsheets for treatment tracking and text messaging for appointment notifications. As the number of patients increases, these methods become increasingly difficult to manage, leading to inefficiencies in scheduling, patient communication.

In addition, the Total Care Dialysis Center Tagoloan facility still relies on manual processes for storing scheduling appointments, and notifying patients about their treatments. Although computers are used, patient treatment schedules are primarily stored in Excel spreadsheets, making appointment scheduling management increasingly challenging as the patient population grows. Appointment notifications are sent manually via text messages, and in some cases, patients only receive updates during facility visits

III. OBJECTIVES OF THE STUDY

This study aims to develop a mobile system that effectively manages appointment scheduling and communication for dialysis patients, enhancing the overall efficiency and quality of care in healthcare facilities in Total Care Dialysis Center Tagoloan, Misamis Oriental.

A. Specific Objectives

Specifically, it aims to:
1. To develop a mobile application that automates appointment

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scheduling for dialysis patients.
2. To create a database that organizes patient information and treatment schedules.
3. To provide automated notifications to remind patients of their upcoming dialysis sessions.
4. To reduce errors in scheduling such as double bookings and missed time slots.
5. To improve the efficiency of the staff by minimizing manual scheduling and text messaging.
6. To ensure patient data is protected through secure login and privacy measures.

IV. REVIEW OF RELATED WORK

Recent studies indicate that web-based and mobile healthcare appointment scheduling applications are more effective in improving efficiency, accuracy, and patient accessibility than manual scheduling approaches. A major aim of these applications was to automate the process of patient appointment scheduling, managing, allocation, and communication between healthcare providers and patients. Through automation, the applications were capable of eliminating scheduling conflicts, human errors, and coordination problems between patients, nurses, and administrators. According to these studies, having a centralized system is important in managing huge amounts of data from patients and appointments while maintaining appropriate timely updates and notifications in healthcare setups.

Previous research employed various software development methodologies such as the Waterfall Model. Despite methodological differences, many studies utilized similar technologies, including mobile and web frameworks, cloud-based databases, and notification services. Systems developed using tools such as Firebase and Flutter demonstrated acceptable functionality and performance. However, several limitations were identified, including unreliable notification delivery, lack of real-time synchronization, limited scalability, and insufficient integration of clinical data such as patient medical histories and treatment records.

Studies focusing on specific domains such as for the hospital outpatient services, specialty clinics, and chronic care management features, the need for real-time scheduling, resource tracking, and friendly interfaces was emphasized. Systems with reminder services, role-based access, and automated conflict resolution showed positive outcomes regarding patient turnout, workload management, and efficiency of services. However, most of the existing systems considered only the generic features of appointment management and were not integrated with the more crucial requirements of the healthcare domain, which include recurrent treatment sessions, observation of bed availability, nurse allocation, and secure processing of confidential medical information.

Overall, the reviewed literature reveals a clear need for a more specific, secure, and integrated appointment scheduling system designed for dialysis facilities specifically. Although the Appointment Scheduling Systems developed helped alleviate some problems in the healthcare scheduling process, these systems still have shortcomings when it comes to handling repeat dialysis sessions and the sharing of resources for treatment processes. It is through these shortcomings that the need for the development of the Appointment Scheduling System for Dialysis Patients arose with the goal of providing an improved, secure, and patient-focused appointment scheduling process for healthcare, including the Philippines context specifically.

V. METHODOLOGY

The study used the Waterfall software development methodology, a linear and sequential approach consisting of requirements gathering, analysis, system design, implementation, testing and evaluation, and deployment. This was chosen because the system requirements were clearly defined and stable, since this is appropriate for the healthcare environment where accuracy, documentation, and reliability are paramount. Requirements were elicited through on-site interviews and direct observation from the head nurse at Total Care Dialysis Center Tagoloan regarding prevailing workflows on appointment scheduling, operational challenges, and salient system features necessary for said system, such as booking, bed assignment, nurse approval, and automated notifications to patients. Because the Waterfall model is structured, transition to another phase would not be possible until a particular phase has been completed and verified. This systematic approach allows for good documentation and traceability of requirements.

To clearly represent user interactions, system processes, and database relationships during the design phase, system functionality and data structures were modeled using use case diagrams, data flow diagrams, and entity relationship diagrams. Low-fidelity and high-fidelity prototypes of the user interface were designed to ensure the system was usable and accessible by patients, nurses, and administrators. Later on, the system was implemented as a mobile and web-based application using Flutter for the user interface and Firebase for backend services such as authentication, real-time storage, and notifications. A three-tier architecture was adopted, separating layers such as presentation, application logic, and database, which enhanced maintainability and scalability. The system was proved stable, user-friendly, and efficient in sorting out scheduling conflicts and delays in communication through functional testing and usability evaluation using the System Usability Scale. The system was successfully deployed in the cloud, showing its appropriateness for real-world usage in a dialysis center.

VI. RESULTS AND DISCUSSION

This section presents the evaluation, analysis, and discussion of the developed Appointment Scheduling Systems for Dialysis Patients. The results focus on system performance, usability, and functional effectiveness compared with traditional manual event management processes. Evidence gathered from system testing, usability evaluation, and functional comparison demonstrates the effectiveness of the developed web-based application in improving event planning, coordination, and communication among clients, staff, and administrators.

Fig. 1. *System Performance Evaluation*

This section presents the evaluation, analysis, and discussion of the developed Appointment Scheduling Systems for Dialysis Patients. The results focus on system performance, usability, and functional effectiveness compared with traditional manual appointment scheduling processes. Evidence gathered from system testing, usability evaluation, and functional comparison demonstrates the effectiveness of the developed web-based application in improving appointment scheduling, coordination, and communication among patients, nurses, and administrators.
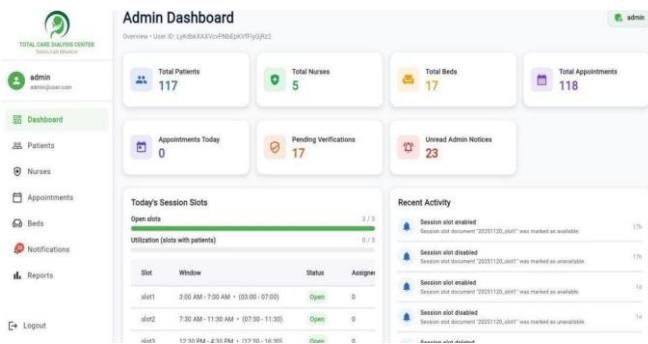

Figure 1. Admin Dashboard Page

Figure 1 presents the Admin Dashboard Page, which allows the administrator to instantly view total clinic statistics, track urgent tasks like pending patient verifications, monitor the real-time status and utilization of daily dialysis sessions, and review a secure history of recent system activities.
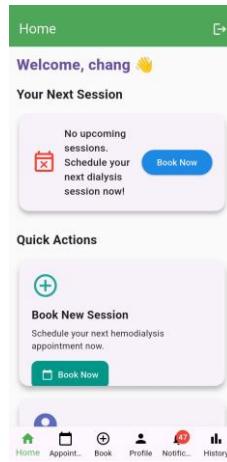

Figure 2. Patient Dashboard Page

Figure 2 represents the patient dashboard that allows patients to manage their healthcare activities in one centralized platform. It enables patients to book, view, reschedule, or cancel appointments, access personal and medical information, and receive real-time notifications and reminders. By providing clear appointment status updates and easy communication with healthcare staff, the patient dashboard improves accessibility, reduces waiting time, and empowers patients to actively participate in managing their own healthcare.
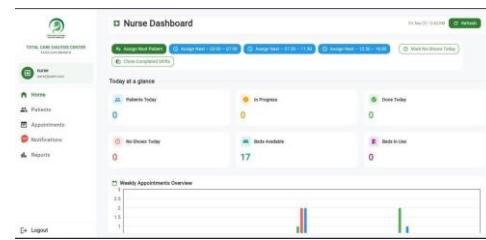
Figure 3. Nurse Dashboard Page

Figure 3 presents the nurse dashboard as a centralized interface that enables nurses to efficiently manage patient care and daily operations. It provides real-time access to appointment schedules, patient records, and task assignments, allowing nurses to approve or update bookings, monitor patient status, and record vital signs and clinical notes. Through integrated notifications and status updates, the dashboard enhances coordination, reduces delays, and minimizes errors, ultimately supporting timely, organized, and high-quality patient care within the healthcare facility.

Fig. 2. *Usability Results And Analysis*

System usability was evaluated using the System Usability Scale (SUS). The results indicate that users found the system easy to use, well-structured, and efficient for completing tasks such as booking events, selecting services, updating schedules, and generating reports. The interface design supported users with minimal technical background, reducing the need for extensive training and improving overall user satisfaction.

TABLE I.   System Usability Scale (SUS) Result

Table 1 presents the final SUS score of the Event Management System. The obtained SUS score falls under the "Good" usability category, indicating that the system meets essential usability standards while remaining intuitive and accessible to its intended users. Minor enhancements may further improve user experience and system interaction.

Item		Participant				
		P1	P2	P3	P4	P5
1	I think that I would like to use this system frequently	4	3	4	3	3
2	I found the system unnecessarily complex.	0	3	3	1	2
3	I thought the system was easy to use.	4	2	2	2	3
4	I think that I would need assistance to be able to use this system.	4	2	1	3	1
5	I found the various functions in this system were well integrated.	4	3	3	3	3
6	I thought there was too much inconsistency in this system.	3	3	3	3	3
7	I would imagine that most people would learn to use this system very quickly.	3	3	3	3	3
8	I found the system very cumbersome or awkward to use.	4	4	3	3	3
9	I felt very confident using the System.	4	4	3	3	3
10	I need to learn a lot of things before I could get going with the system.	4	2	1	3	1
	TOTAL	34	29	26	27	26
	Multiply by 2.5	85	72.5	65	67.5	65
	Average	71				

Fig. 3. *System-Based Functional Comparison*

This section compares the traditional manual event management process with the developed Appointment Scheduling Systems for Dialysis Patients in terms of data handling, system features, and workflow efficiency.

The functional differences between the manual process and the developed system. Manual methods rely on handwritten records, spreadsheets, and verbal coordination, which are prone to errors, data duplication, and delays. In contrast, the developed system supports digital data entry, centralized data storage, automated scheduling, real-time notifications, and report generation. These features improve data consistency, reduce processing time, and enhance coordination among all stakeholders
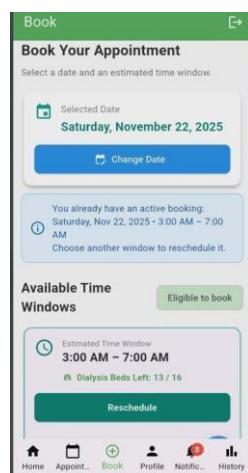

Fig. 4.   Patient Booking Page

Figure 4 represents, where patients can view available dialysis appointment slots, book sessions, and monitor the status of their appointments. It displays upcoming and previous bookings, along with real-time availability of schedules, helping patients select suitable time slots without conflicts. The system automatically validates bookings and shows appointment statuses such as pending or approved. Overall, the dashboard simplifies appointment management, improves communication, and ensures organized and accurate scheduling for dialysis patients.
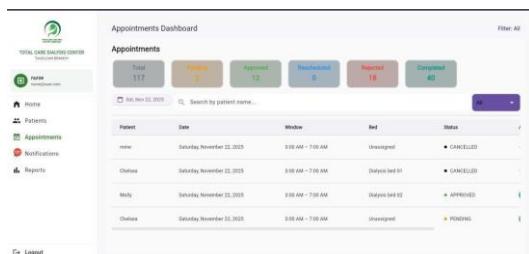
Fig. 5.   View Appointment Schedule

Figure 5 presents the View Appointment Schedule refers to a system feature that allows nurses to see a list of scheduled appointments. This function displays important details such as the appointment date and time, patient name, and the current status of the appointment (e.g., pending, confirmed, completed, or canceled). By providing a clear and organized overview of all appointments, this feature helps users monitor

schedules, avoid conflicts, and ensure that services are delivered on time and efficiently.

Fig. 6. Appointment Notification
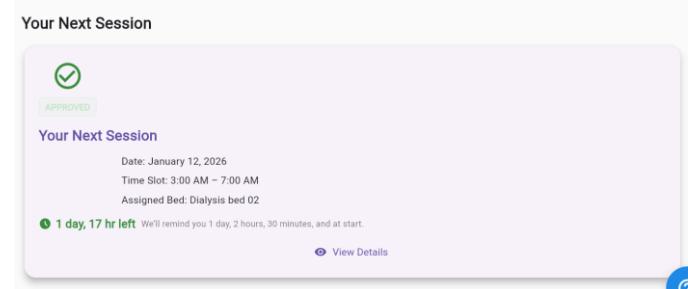
Figure 6 presents the Appointment Notification feature, which automatically sends reminders and updates regarding appointments schedules and important announcements. This feature improves communication efficiency between Admin, Patients, and Nurses.

VII. CONCLUSION AND FUTURE WORK

The developed Appointment Scheduling System for Dialysis Patients has been able to meet all the objectives. This development has taken into consideration important functionalities such as secure login, effective appointment management and rescheduling, automated reminder messages, nurse approval, and real-time management of appointments and beds. These features, along with conflict resolution, role-based management, and record management, are effective for a comprehensive and functional solution in a healthcare setting.

The positive usability rating further justifies that this system is user-friendly, and it can be used without undergoing extensive training. Users from all backgrounds found this system reliable and easy to use in their day-to-day functioning. This research further validates that the automated scheduling system has greatly diminished the administrative work, reduced human error, and improved the overall management of dialysis center working. This also asserts the use of technology in a healthcare setting, where timing, coordination, and communication are of vital significance.

In addition, it can be seen that the Waterfall Model has proven effective in developing a healthcare-related project with a clearly identified set of needs. Furthermore, this story has demonstrated a successful project implementation as a result of comprehensive documentation, a structured workflow, and systematic testing. In conclusion, this project can be seen as a functional scheduling system, which can also be used as a model for similar healthcare institutions.

Future research can be done to optimize system performance for low-end mobile devices and to ensure that the system is reliable even in circumstances of limited/intermittent internet access. Some other improvement suggestions for future research can be to implement a complete module for Electronic Medical Records for patient history management, treatment recording, and lab results. Additionally, improving the reliability of the notification system by implementing scalable SMS gateways along with email and in-app notifications can be considered for future research. The system can be further enhanced to include sophisticated report generator interfaces with predictive summaries to aid administrative planning and decision-making. Finally, to widen patient access to the system regardless of smartphone availability, a patient portal for the system can be implemented for easy patient management. Real-time system notifications to increase efficiency can be a necessary addition to the system as well. Further enhancements of the system for multi-clinic deployment to centrally manage multiple dialysis facilities can be done in future research as well. It is suggested to continuously improve the system by following the Waterfall model development methodology for proper testing and maintenance of the system to ensure reliable efficiency for a prolonged period in real-life healthcare settings.

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