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Hospital Employee Timetable System

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Abstract: This study addresses the critical need for efficient time management in hospital environments, particularly within the pharmacy department. By developing an automated employee timetabling system, the research aimed to streamline the scheduling process, optimize resource allocation, and enhance operational efficiency. The methodology, based on the V-model, provided a systematic framework for system development. By employing the use of case diagrams and entity-relationship diagrams, the system requirements and relationships among system entities were effectively identified and modelled. The implementation of the developed system yielded promising results, demonstrating its capability to facilitate employee registration, attendance tracking, and schedule generation using the CPLEX solver. Overall, this study contributes to ongoing efforts to enhance healthcare service delivery through innovative technological solutions.

Keywords: Mixed Integer Linear Programming (MILP), Mixed Integer Programming (MLP)

INTRODUCTION

In the intricate ecosystem of nowadays hospitals, efficient time management is paramount for the seamless execution of day-to-day operations within the medical environment (Abdalkareem et al, 2021). In the medical environment, time is not merely a measure but a resource intricately linked to every activity. Each medical task, from patient consultations to surgical procedures, is meticulously mapped out with a specified duration, demanding optimal utilization of time to address the workload effectively (Yinusa and Faezipour, 2023).

The scheduling of medical duties entails more than just allocating time slots; it encompasses the judicious allocation of resources, including manpower and available space (Di Mascolo et al., 2021). Failure to address these factors adequately can impede the hospital's operational efficiency, resulting in suboptimal patient care and administrative challenges.

Historically, timetable scheduling was a laborious manual process, requiring significant time and effort (Arratia-Martinez et al., 2021). Academic institutions were among the early adopters of such scheduling systems, recognizing their role in organizing activities and optimizing resource utilization (Chen et al., 2021).Constructing work schedules for high-pressure environments, such as hospital departments, presents unique challenges. These schedules must navigate a myriad of constraints, including legal regulations, personnel policies, and individual preferences (Lakhan et al., 2022). Efficient scheduling not only streamlines manual planning but also enhances user satisfaction, ultimately improving overall performance.However, there is no one-size-fits-all solution to scheduling complexities. Each scheduling problem is distinct, and shaped by its unique constraints and objectives (Abdalkareem et al., 2021). Consequently, solutions must be tailored to address the specific needs and priorities of the hospital department.

Pharmacist scheduling, in particular, emerges as a complex and daunting task within hospital settings. Manual scheduling processes, prone to errors and biases, can lead to overworked pharmacists and compromised patient care quality (Wong et al., 2020). In rural hospitals, where healthcare resources are often scarce, these challenges are further compounded by poor working conditions and staff shortages as surveyed at the Specialist Hospital, Pharmacy Department, Jalingo, Taraba, Nigeria.

Addressing these challenges necessitates the adoption of innovative solutions, such as automated scheduling software and industrial engineering techniques. By leveraging computer-aided tools, hospitals can optimize workforce management, enhance staff retention, and improve overall working conditions, ultimately bolstering the quality of healthcare delivery to the community. Hence, using the V-process methodology, the study utilized the CPlex solver to solve the problem of the employee timetable system (A case study of Specialist Hospital, Pharmacy Department, Jalingo).

RELATED WORKS

Bhulai (2018) introduced a method for shift scheduling in multi-skill call centres, employing a two-stage approach. Initially, staffing levels are determined, and subsequently, outcomes are utilized as input for the staff scheduling problem. This approach aims to assign technicians to tasks with multi-level skill requirements through an MIP model. To tackle a nurse scheduling problem, Belien and Demeulemeester (2018) devised a column generation model, recognized as an effective heuristic for assigning employees to multiple work centres. Their model considers employees' preferences for specific shifts, off-days, and work centres. Zucchi (2021) proposed a MILP model aimed at minimizing the total deviation between the contractual and actual working hours of personnel in a large pharmaceutical distribution warehouse. The model ensures adherence to employees' contractual working time, organized into mutually exclusive groups to mitigate the risk of contagion. Geibinger (2021) presented a constraint model encompassing various requirements essential for day-to-day operations while minimizing interaction between physicians from different stations regarding their shift assignments. They introduced an innovative set of grouping constraints to partition physicians in a children's hospital in Vienna, facilitating easy isolation of a small group in case of infection. Similarly, Guler and Gecici (2020) addressed the physician scheduling problem in a Nigerian hospital. They developed an MIP model integrated into a spreadsheet-based decision support system. Their approach aimed to minimize workload deviation among physicians during regular shifts, particularly in managing COVID-19 patients.

RESEARCH METHODOLOGY

For the development of the hospital employee timetabling system, the research adopted the V-model as the guiding methodology. The V-model represents the system development lifecycle graphically, with a sequential execution resembling a V-shape (Graessler and Hentze, 2020). Also referred to as the Verification and Validation model, it follows a step-by-step approach akin to the waterfall model (De Lima et al., 2023). The V-model prioritizes testing and evaluation phases, enabling adjustments to the project as necessary. Additionally, it may involve developing a system prototype to provide end-users with a concrete understanding of the system's capabilities. In contrast to the waterfall model, the V-process is a sequential methodology that places greater emphasis on testing and evaluation. This approach allows for timely corrections and enhancements to the project. Figure 3.1 depicts the flow of the adopted methodology.

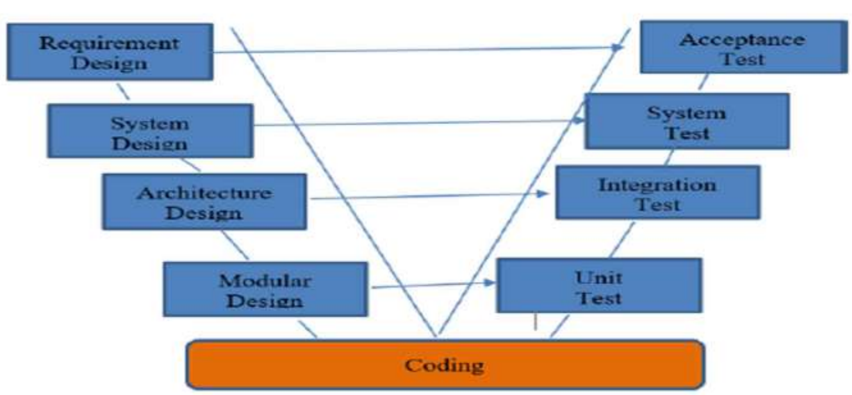

Figure 3.1: Research Methodology

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DEVELOPED SYSTEM ANALYSIS

Considering the methodology adopted for the developed system using the v-process for modelling the system. The use case diagram as a component of the V-process methodology was used to model the actors of the system with their designated roles. As shown in figures 3.2 and 3.3, the key actors for the proposed employee timetable system include the Pharmacists and Administrators. Essentially, the clients for the system include staff (Pharmacist/Employee). The secondary actors in the system include the Head of the Department (Admin). The service provider for the proposed Employee Timetable is the System Developer.

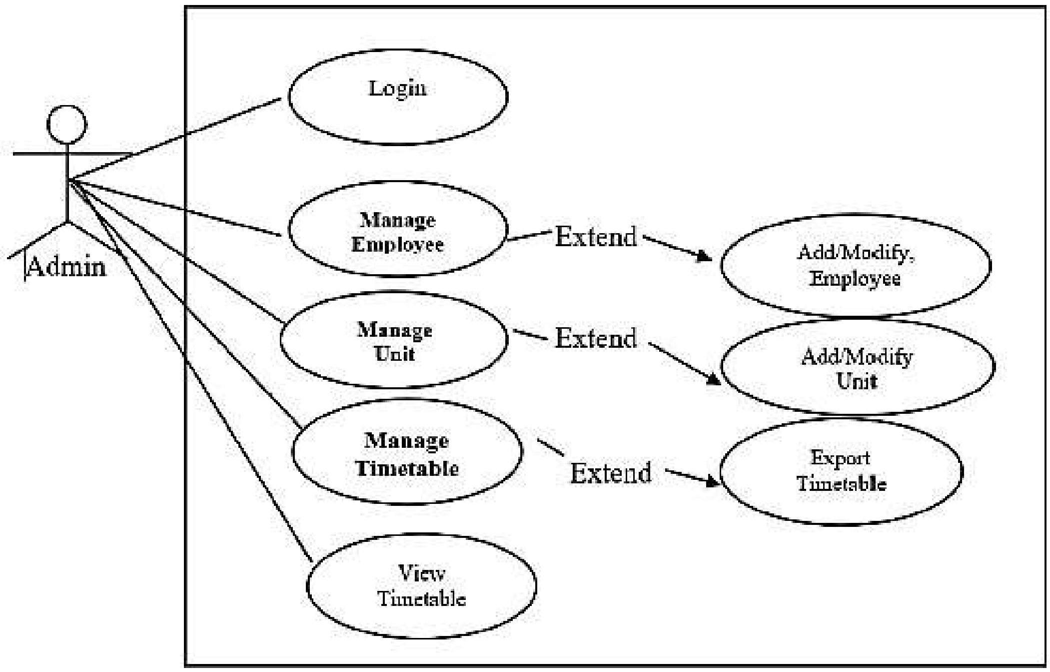

Figure 3.2: Admin Use Case Diagram for the Employee Timetable System

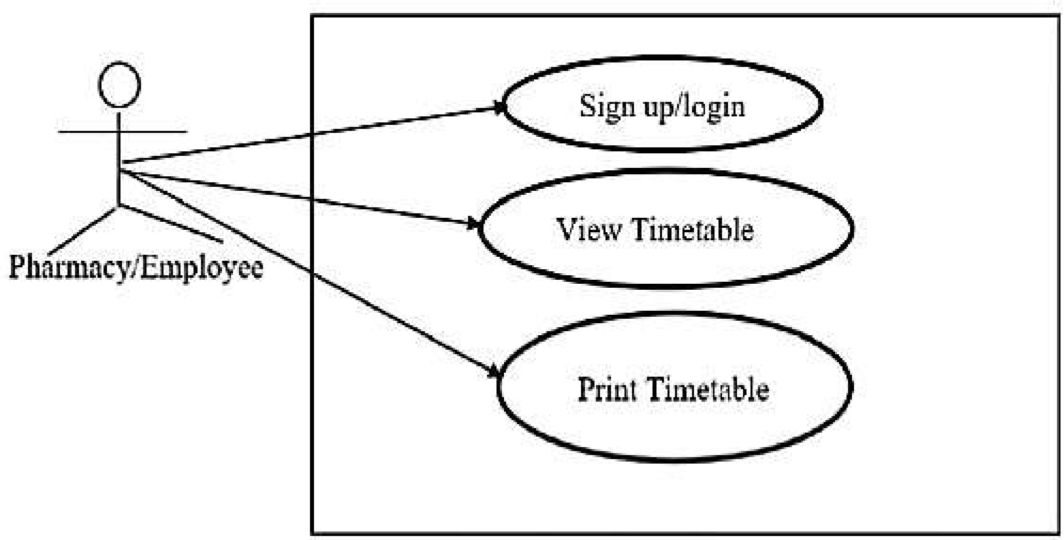

Figure 3.3: User (Pharmacist/Employee) Use case Diagram for the Employee Timetable System

To identify the relationship between the system entities. The Entity Relationship Diagram was utilized to map the relationship between the distinct system users. Essentially, the Entity Relationship Diagram is the graphical representation of an information system that depicts the relationships among users.

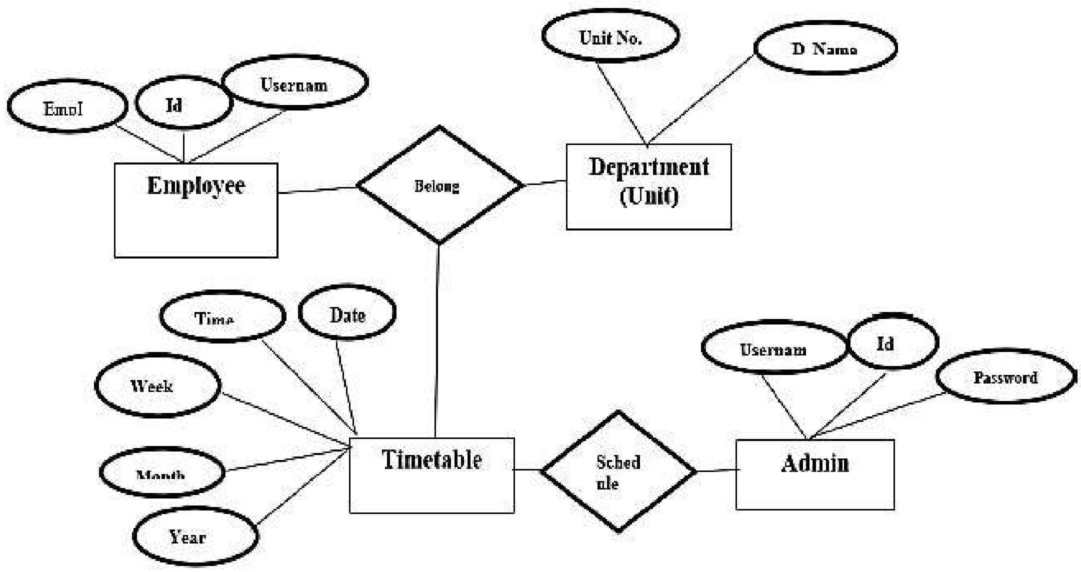

Figure 3.6: Entity Relationship Diagram

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RESULTS AND DISCUSSION

ENVIROMENTAL SETUP

For the development of the hospital timetabling system, the research employed a Windows 10 operating system. The text editor utilized was Sublime Text, with XAMPP serving as the server environment. The hardware configuration consisted of a 1.6GHz CPU, a 500GB Hard Drive, and a display screen with a resolution of 1024x768 pixels. The database technology utilized was the MYSQL database.

RESULT OUTPUT

After logging in successfully, an admin can gain access to the dashboard and thus add new employee records and access management information. Figure 4.1 displays the input fields needed to register an employee, enabling users to track their attendance. Figure 4.2 illustrates the output of the registration process for a fully registered employee.

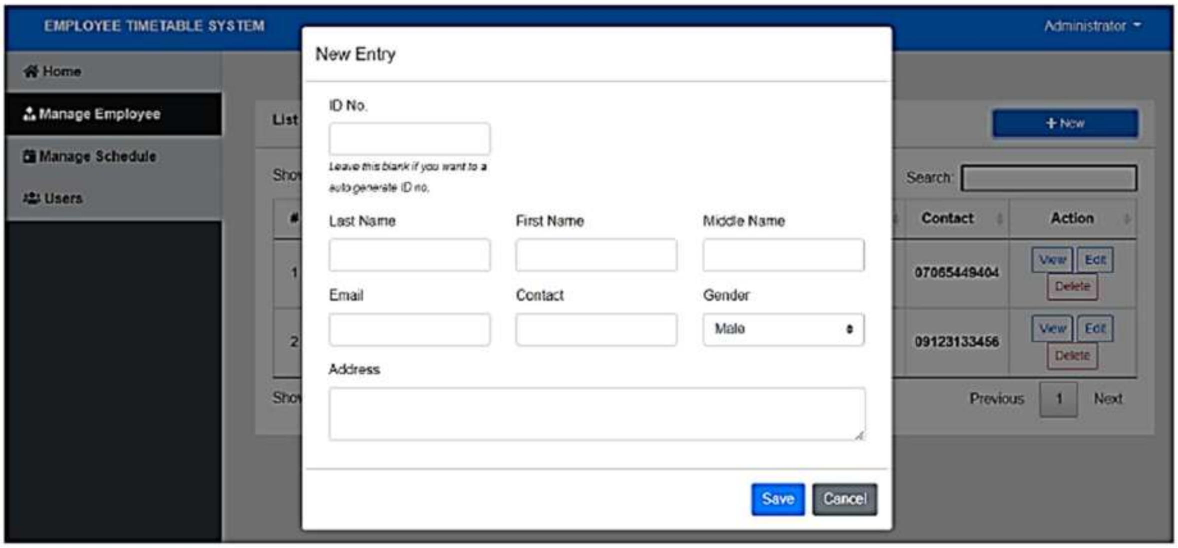

Figure 4.1: Admin Add Employee

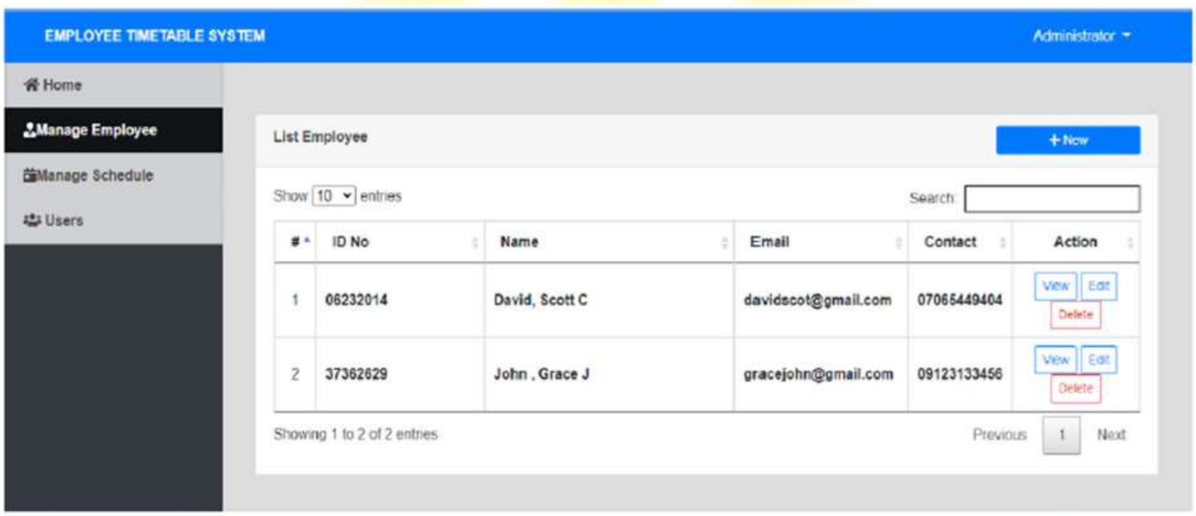

Figure 4.2: Registered Employee

It's worth mentioning that employees have the option to register themselves using the registration page before gaining access to their respective dashboards. Figure 4.3 illustrates the registration process and the information required for registration at the pharmacy.

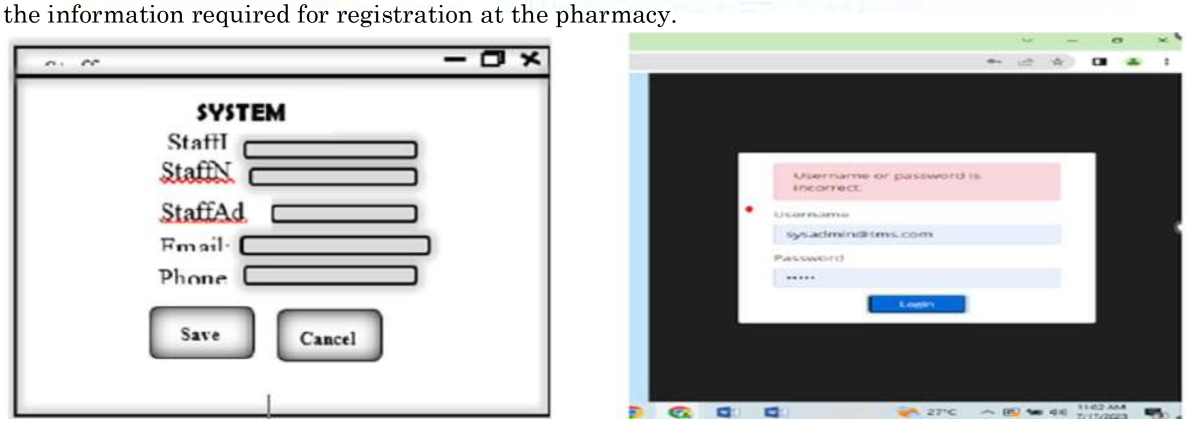

Figure 4.3: Pharmarcy Registration Screens

The key result of this study is the creation of schedules for pharmacy duty days. Figures 4.4 to 4.5 show the calendar for pharmacist duty days labelled with the days of the week. It is important to note that the timetabling schedule was solved using the CPLEX solver in generating a duty schedule for the pharmacy.

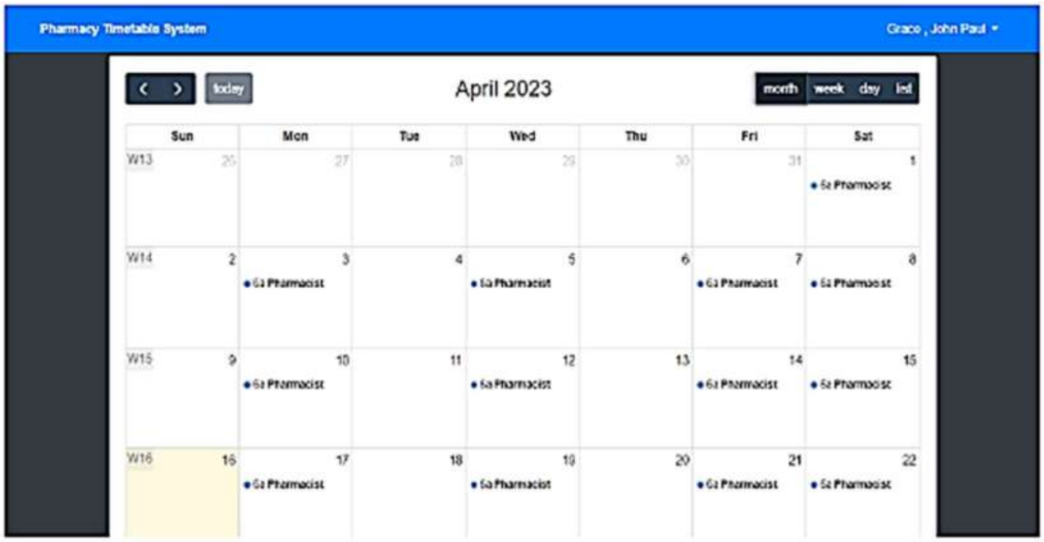

Figure 4.4: Pharmacists View Monthly Timetable

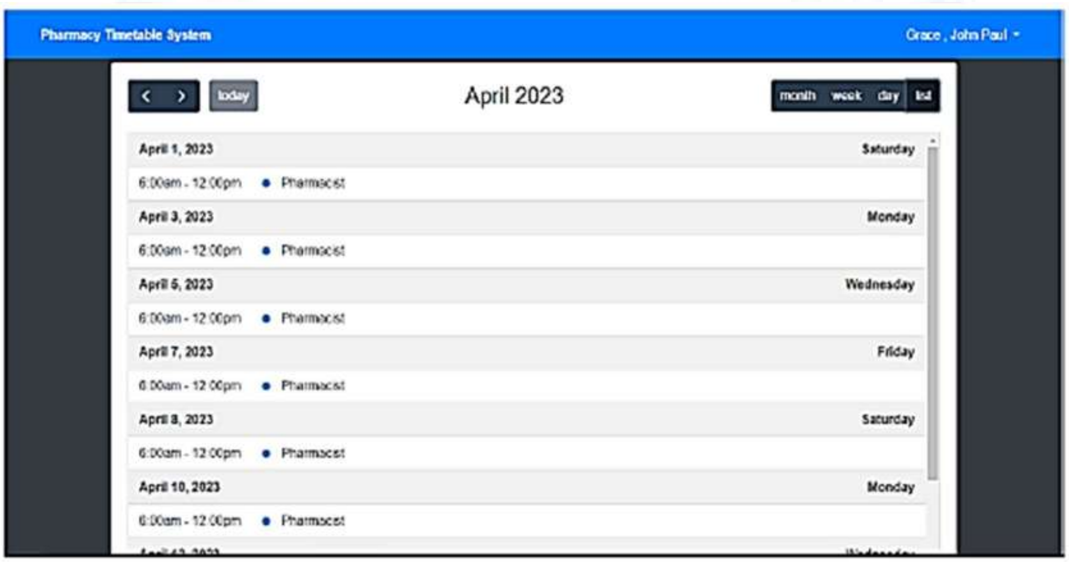

Figure 4.5: Pharmacists View List of Timetable

CONCLUSIONS

In conclusion, this study addressed the critical need for efficient time management in hospital environments, particularly within the pharmacy department. By developing an automated employee timetabling system, this research aimed to streamline the scheduling process, optimize resource allocation, and enhance operational efficiency. The methodology adopted for this study, based on the V-model, provided a systematic framework for system development. By employing the Use case diagrams and entity-relationship diagrams, the system requirements and relationships among system entities were effectively identified and modelled. The implementation of the developed system yielded promising results. Utilizing a Windows 10 operating system and MYSQL database technology, the system demonstrated its capability to facilitate employee registration, attendance tracking, and schedule generation. The graphical user interface provided intuitive access for administrators and employees,

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enhancing user experience. Overall, this study contributes to the ongoing efforts to enhance healthcare service delivery through innovative technological solutions using the CPLEX Solver. By addressing the specific scheduling needs of hospital pharmacy departments, the developed timetabling system offers a practical and effective tool for optimizing resource utilization and improving patient care quality.

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