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Speech-Enabled University Dispensary Management System: Innovations in Automation and Accessibility for Individuals with Disabilities

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Abstract - This research paper presents the development and implementation of a University Dispensary Management System (UDMS) designed for total automation with a special feature of speech recognition tailored for individuals with disabilities. The system aims to streamline the management of university dispensaries by automating various processes including patient registration, appointment scheduling, prescription management, and inventory tracking. Additionally, the incorporation of speech recognition technology facilitates accessibility for individuals with disabilities, allowing them to interact with the system using voice commands. The paper provides an overview of the system architecture, detailing the front-end and back-end components, as well as the integration of speech recognition functionality. Evaluation results demonstrate the effectiveness of the UDMS in improving workflow efficiency and accessibility for all users, including those with disabilities. Overall, this research contributes to the advancement of technology in healthcare management systems, emphasizing the importance of inclusivity and automation in enhancing patient care and overall efficiency.

Keywords- Dispensary, UDMS, University dispensary management system, Artificial intelligence and Machine Learning, AI in healthcare.

I. INTRODUCTION

The management of healthcare facilities, particularly university dispensaries, presents numerous challenges in ensuring efficient and accessible healthcare services. In response to these challenges, this research paper introduces a groundbreaking University Dispensary Management System (UDMS) that operates on total automation and incorporates a special feature of speech recognition tailored for individuals with disabilities. The primary objective behind the development and documentation of this system is to streamline the entire healthcare system, thereby enhancing patient care and overall efficiency.

University dispensaries play a crucial role in providing healthcare services to students, faculty, and staff within educational institutions. However, traditional manual methods of managing patient records, appointments, prescriptions, and inventory often lead to inefficiencies and accessibility barriers for certain individuals, particularly those with disabilities. Recognizing the need for innovative solutions

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to address these challenges, our research endeavors to revolutionize university dispensary management through the implementation of the UDMS.

Central to the UDMS is its emphasis on total automation, which aims to automate various administrative and operational processes within university dispensaries. By leveraging advanced technologies such as artificial intelligence and machine learning, the system streamlines tasks such as patient registration, appointment scheduling, prescription management, and inventory tracking. This automation not only improves the efficiency of dispensary operations but also reduces the likelihood of errors and delays, ultimately enhancing the quality of patient care.

In addition to total automation, the UDMS incorporates a special feature of speech recognition specifically designed to cater to individuals with disabilities. This feature enables users to interact with the system using voice commands, thereby removing barriers to accessibility and ensuring that individuals with disabilities can easily navigate and utilize dispensary services. By prioritizing inclusivity and accessibility, the UDMS aims to provide equitable healthcare services to all members of the university community.

Through this research paper, we aim to provide a comprehensive overview of the UDMS, including its architecture, development process, and evaluation results. By documenting our efforts to design and implement this innovative system, we seek to contribute to the advancement of technology in healthcare management and demonstrate the potential for automation and inclusivity to transform the healthcare landscape. Ultimately, our goal is to inspire further research and innovation in this field, with the ultimate aim of streamlining healthcare systems and improving patient outcomes. [3]

II. Literature Review

University dispensary management systems serve as integral tools for healthcare facilities within academic institutions, facilitating the efficient delivery of medical services to students, faculty, and staff. In this literature review, we examine existing university dispensary management systems, evaluate the technologies and programming languages commonly employed in similar systems, and identify areas for improvement.

Existing university dispensary management systems vary in their features, functionalities, and technological implementations. Many systems utilize a combination of web-based interfaces, database management systems, and communication tools to facilitate patient care and administrative tasks. For example, systems such as Health Management Information Systems (HMIS) and Electronic Health Record (EHR) systems have been widely adopted in healthcare settings, including university dispensaries, to digitize patient records, streamline workflows, and improve communication among healthcare providers.

A common trend observed in existing university dispensary management systems is the utilization of a diverse range of technologies and programming languages. Front-end development often involves the

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Accepted Jan. 2026,

use of web technologies such as HTML, CSS, and JavaScript to create intuitive user interfaces accessible via web browsers. Additionally, frameworks like React, Angular, and Vue.js are frequently employed to enhance user experience and facilitate dynamic interactions. On the back-end, programming languages such as Python, Java, and PHP are commonly used to develop server-side logic, handle data processing, and integrate with database management systems.

While existing university dispensary management systems have made significant strides in digitizing healthcare processes and improving efficiency, several areas for improvement can be identified. One key area is the need for enhanced accessibility features to accommodate individuals with disabilities. While some systems may offer basic accessibility options, such as screen reader compatibility, there remains a lack of robust solutions tailored specifically to the needs of individuals with disabilities, such as speech recognition capabilities.

Another area for improvement is the integration of advanced technologies, such as artificial intelligence (AI) and machine learning (ML), to automate repetitive tasks and enhance decision-making processes within dispensary management systems. AI and ML algorithms can analyze large datasets to identify patterns, predict patient needs, and optimize resource allocation, thereby improving the overall quality of healthcare services.

Furthermore, there is a growing need for interoperability and integration capabilities to facilitate seamless communication and data exchange between university dispensary management systems and external healthcare providers, pharmacies, and electronic health record systems. Standardized data formats, protocols, and APIs can enable interoperability, allowing for the exchange of patient information while maintaining data security and privacy.

III. System Architecture:

The architecture of our University Dispensary Management System (UDMS) is designed to optimize the management of healthcare services within university dispensaries, incorporating innovative features to enhance efficiency and accuracy. At the core of the system architecture is the integration of sensor technology within the dispensary itself, enabling automated monitoring and management of medication inventory. [1] Figure 1. Shows the System Architecture of Speech -Enabled UDMS.

Overview

The UDMS architecture consists of three main components: the front-end interface, the back-end server, and the physical dispensary infrastructure. The front-end interface provides users with a user-friendly platform to interact with the system, while the back-end server handles data processing, storage, and communication. The physical dispensary infrastructure includes sensors installed within the dispensary to monitor medication inventory levels and facilitate automated stock management.

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Accepted Jan. 2026,

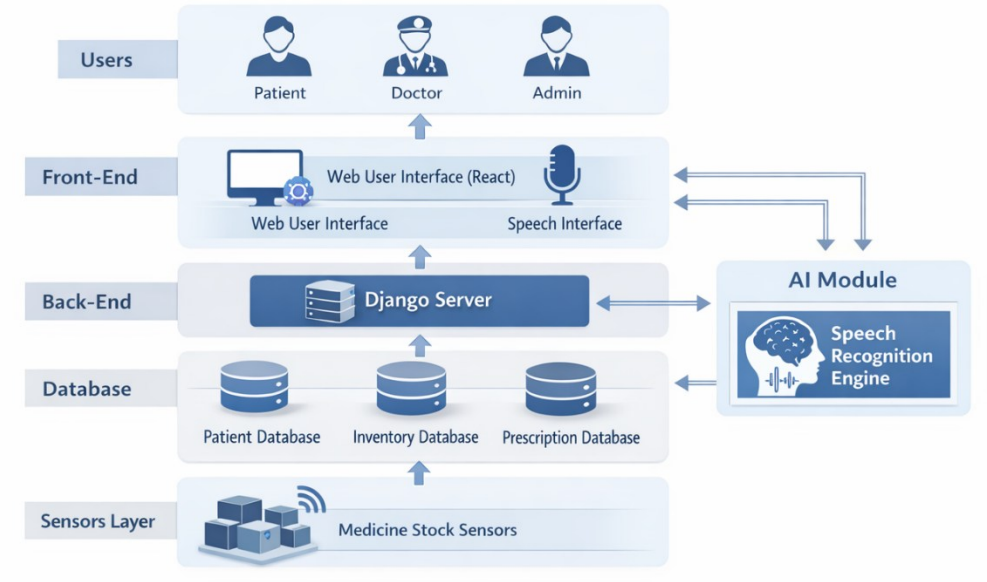

Figure 1. System Architecture of Speech -Enabled UDMS.

Front-end and Back-end Components:

The front-end component of the UDMS comprises a web-based interface accessible via desktop and mobile devices. It is developed using modern web technologies such as HTML, CSS, and JavaScript, along with the React.js framework for enhanced interactivity and responsiveness. The front-end interface allows users, including dispensary staff and patients, to perform various tasks such as patient registration, appointment scheduling, medication selection, and checkout.

On the back-end, the UDMS utilizes a robust server architecture to handle data processing, storage, and business logic. The back-end is implemented using the Python programming language, leveraging the Django framework for rapid development and scalability. Django provides a comprehensive set of tools for building secure and efficient web applications, including built-in authentication, data modeling, and RESTful API support. The back-end server communicates with the front-end interface to retrieve and store data, execute business logic, and facilitate real-time updates.

Justification for Programming Languages:

The choice of programming languages for each component of the UDMS architecture is based on several factors, including performance, scalability, security, and developer familiarity. HTML, CSS, and JavaScript are selected for front-end development due to their widespread support, compatibility with web browsers, and ability to create dynamic and responsive user interfaces. React.js is chosen as the front-end framework for its component-based architecture, virtual DOM rendering, and efficient state management, which contribute to a seamless user experience.

For the back-end component, Python is chosen as the primary programming language due to its simplicity, readability, and extensive ecosystem of libraries and frameworks. Django is selected as the

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Accepted Jan. 2026,

web framework for its built-in security features, ORM (Object-Relational Mapping) support, and scalability, which streamline the development process and ensure the reliability and performance of the back-end server.

The choice of programming languages for each component is carefully justified based on considerations of performance, scalability, security, and developer productivity, ensuring the effectiveness and reliability of the system as a whole.

IV. Front-end Development

The front-end development process of our University Dispensary Management System (UDMS) focuses on creating a user-friendly interface that enables seamless interaction with the system's functionalities. This section provides a detailed description of the front-end development process, including the user interface design principles followed, the front-end programming languages and frameworks used, and illustrative code snippets highlighting key aspects of front-end development.

Detailed Description of Front-end Development Process:

The front-end development process begins with comprehensive user research and analysis to understand the needs and preferences of both dispensary staff and patients. This information guides the design of the user interface, ensuring that it is intuitive, visually appealing, and easy to navigate. Wireframes and mockups are created to visualize the layout and flow of the interface before actual development begins.

Once the design phase is complete, front-end developers start implementing the user interface using HTML, CSS, and JavaScript. The interface is built to be responsive, meaning it adapts seamlessly to different screen sizes and devices, including desktop computers, tablets, and smartphones. Accessibility features are also integrated to ensure that the interface is usable by individuals with disabilities, in line with universal design principles.

Throughout the development process, iterative testing and feedback sessions are conducted to identify and address any usability issues or bugs. User feedback is incorporated to refine the interface and enhance the overall user experience. Continuous collaboration between designers, developers, and stakeholders ensures that the final product meets the requirements and expectations of all parties involved.

Explanation of User Interface Design Principles:

The user interface design of the UDMS follows several key principles to optimize usability and enhance user satisfaction. These principles include simplicity, consistency, clarity, and feedback. The interface is designed to be intuitive and easy to use, with clear navigation paths and minimal cognitive load. Consistent visual elements and layout patterns are employed throughout the interface to maintain

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Accepted Jan. 2026,

coherence and reinforce familiarity. Clear and concise language is used to communicate information effectively, and feedback mechanisms such as visual cues and animations provide immediate confirmation of user actions.

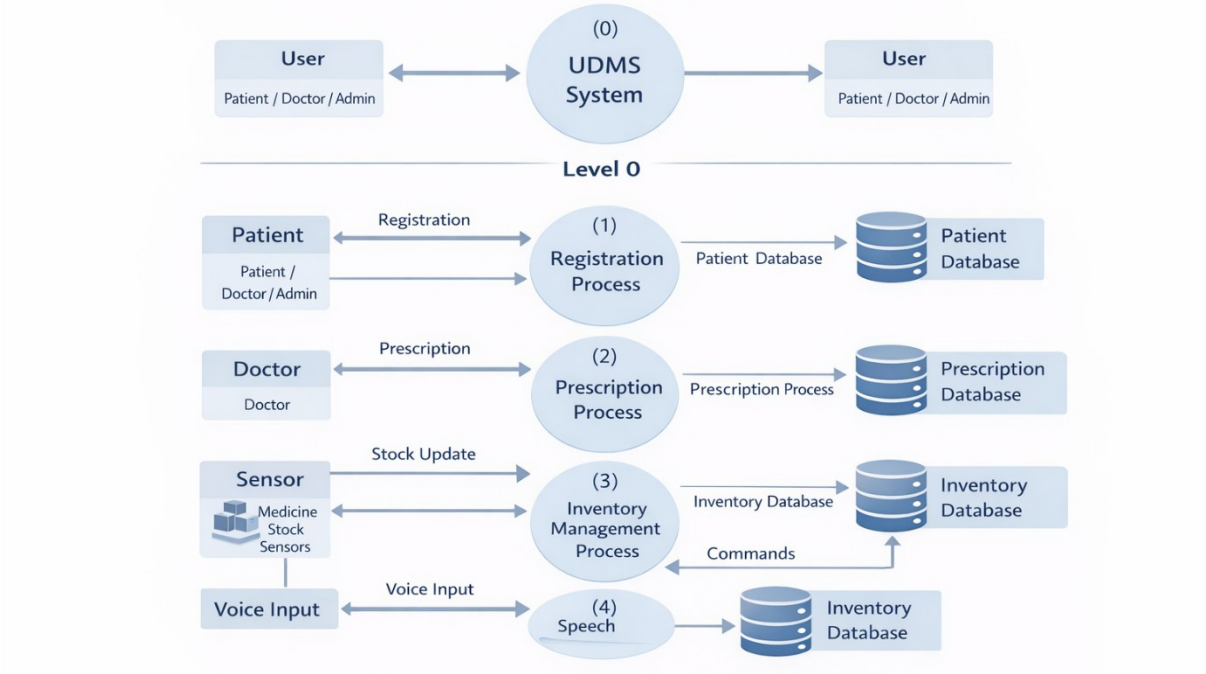

Figure 2. Data Flow Diagram of Speech-Enabled UDMS (Level 0 and Level 1).

Discussion of Front-end Programming Languages and Frameworks:

The front-end of the UDMS is developed using a combination of HTML, CSS, JavaScript, and the React.js framework. HTML is used for structuring the content of web pages, while CSS is employed for styling and layout. JavaScript enhances interactivity and dynamic behavior, enabling features such as form validation, real-time updates, and asynchronous data loading.

React.js is chosen as the front-end framework for its component-based architecture, which facilitates modularity, reusability, and maintainability. Components are self-contained units of UI, each responsible for rendering a specific part of the interface. This modular approach simplifies development and makes it easier to manage complex UI components. Additionally, React's virtual DOM rendering ensures optimal performance by minimizing unnecessary re-renders and updates.

In this code snippet, a React component called `PatientInfo` is defined to display patient information. The component receives a `patient` object as a prop, containing details such as name, age, gender, and medical history. The information is rendered dynamically using JSX syntax, allowing for easy integration with other components and data sources. Figure 2. Shows the Data Flow Diagram of Speech-Enabled UDMS (Level 0 and Level 1).

Overall, the front-end development of the UDMS focuses on creating a user-friendly interface that enhances usability and accessibility for dispensary staff and patients alike. By following best practices

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Accepted Jan. 2026,

in user interface design and leveraging modern front-end technologies, the UDMS delivers an intuitive and responsive experience that meets the needs of its users.

V. Back-end Development

The back-end development process of our University Dispensary Management System (UDMS) focuses on implementing robust server-side logic and efficient data management to support the system's functionalities. This section provides a detailed description of the back-end development process, including the server-side logic and data management, the back-end programming languages and frameworks used, database design and implementation, and illustrative code snippets highlighting key aspects of back-end development.

Detailed Description of Back-end Development Process:

The back-end development process begins with designing the architecture and defining the components necessary to support the system's functionality. This includes determining the business logic for handling user requests, processing data, and interfacing with the database. Back-end developers work closely with front-end developers to establish clear communication protocols and API endpoints to facilitate data exchange between the client-side and server-side components.

Once the architecture is defined, developers proceed with implementing the server-side logic using the chosen programming language and framework. This involves writing code to handle HTTP requests, perform data validation and manipulation, execute business rules, and generate responses. Error handling and security considerations are incorporated throughout the development process to ensure the reliability and integrity of the system.

Testing is an integral part of the back-end development process, with developers conducting unit tests, integration tests, and end-to-end tests to verify the functionality and performance of the server-side components. Continuous integration and deployment practices are employed to automate the testing and deployment process, enabling rapid iteration and delivery of updates.

Explanation of Server-side Logic and Data Management:

The server-side logic of the UDMS encompasses a range of functionalities, including user authentication, patient management, appointment scheduling, prescription management, and inventory tracking. Each functionality is implemented as a set of APIs and services that handle specific tasks and interact with the underlying data layer.

Data management in the UDMS involves storing and retrieving information related to patients, appointments, prescriptions, medications, and inventory items. This data is stored in a database management system (DBMS) and managed using structured query language (SQL) or NoSQL queries, depending on the nature of the data and the requirements of the system.

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Accepted Jan. 2026,

Discussion of Back-end Programming Languages and Frameworks:

The back-end of the UDMS is developed using the Python programming language and the Django framework. Python is chosen for its simplicity, readability, and extensive ecosystem of libraries and frameworks, making it well-suited for rapid development and prototyping. Django, a high-level web framework for Python, provides a comprehensive set of tools for building secure and scalable web applications, including built-in authentication, ORM support, and RESTful API capabilities.

Database Design and Implementation:

The database design of the UDMS is based on relational database management systems (RDBMS) such as PostgreSQL or MySQL, chosen for their robustness, scalability, and support for complex data relationships. The database schema is designed to efficiently store and retrieve data related to patients, appointments, prescriptions, medications, and inventory items, while ensuring data integrity and consistency.

In this code snippet, a Django model called `Patient` is defined to represent patient information. The model includes fields for the patient's name, age, gender, and medical history, stored as attributes of the `Patient` object. Django's built-in ORM (Object-Relational Mapping) handles the translation of Python objects into database records, simplifying data manipulation and storage.

Overall, the back-end development of the UDMS focuses on implementing robust server-side logic, efficient data management, and secure authentication to support the system's functionality. By leveraging modern back-end technologies and best practices, the UDMS delivers a reliable and scalable solution for managing university dispensaries and improving patient care.

VI. Integration and Testing

Integration and testing are critical phases in the development lifecycle of our University Dispensary Management System (UDMS), ensuring that the front-end and back-end components work seamlessly together and that the system meets the desired functionality and quality standards. This section provides a description of the integration process between the front-end and back-end components, discusses the testing methodologies employed, and presents the results of testing and validation of the system's functionality. [2]

Description of Integration Process:

The integration process between the front-end and back-end components of the UDMS involves combining the individual modules developed by front-end and back-end developers into a unified system. This process includes establishing communication channels and APIs for data exchange, ensuring compatibility between front-end and back-end codebases, and resolving any integration issues or dependencies.

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Accepted Jan. 2026,

Front-end components, such as user interface elements and client-side logic, interact with back-end services via RESTful APIs (Application Programming Interfaces). API endpoints are defined to handle various operations, such as user authentication, data retrieval, and transaction processing. Front-end developers make HTTP requests to these endpoints to retrieve or submit data to the back-end server, while back-end developers implement corresponding logic to process and respond to these requests.

The integration process also involves testing the communication and interaction between front-end and back-end components to ensure that data is exchanged accurately and that the system behaves as expected across different scenarios and use cases.

Discussion of Testing Methodologies:

Several testing methodologies are employed to verify the functionality, performance, and reliability of the UDMS. These include:

1. Unit Testing: Individual components and modules are tested in isolation to verify their correctness and functionality. Front-end components, back-end services, and database queries are all subjected to unit tests to ensure that they perform as intended.

2. Integration Testing: The integration between front-end and back-end components is tested to verify that data is transmitted correctly, API endpoints are invoked properly, and interactions between components are seamless. Integration tests simulate real-world scenarios to identify and resolve any compatibility or communication issues.

3. End-to-End Testing: The entire system is tested as a whole to validate its behavior and functionality from the perspective of the end user. End-to-end tests simulate user interactions with the system, covering multiple components and functionalities to ensure that they work together harmoniously.

4. User Acceptance Testing (UAT): The system is tested by actual users, such as dispensary staff and administrators, to evaluate its usability, performance, and adherence to requirements. Feedback from users is collected and incorporated into the development process to address any issues or concerns.

VII. Results of Testing and Validation

The testing and validation process of the UDMS yielded positive results, demonstrating the system's functionality, reliability, and performance. Unit tests confirmed the correctness of individual components and modules, while integration tests verified the seamless interaction between front-end and back-end components.

End-to-end testing scenarios were successfully executed, validating the system's behavior across various user interactions and use cases. User acceptance testing provided valuable feedback from stakeholders, confirming that the system met their expectations and requirements.

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Accepted Jan. 2026,

Overall, the integration and testing phase of the UDMS ensured that the system was robust, reliable, and ready for deployment, laying the foundation for its successful implementation in university dispensaries and contributing to the improvement of healthcare management services.

USER EXPERIENCE AND EVALUATION

The user experience (UX) and evaluation of our University Dispensary Management System (UDMS) play a crucial role in assessing its effectiveness, usability, and overall satisfaction among users. This section provides an evaluation of the user experience of the dispensary management system, including feedback from users and stakeholders, as well as a comparison with existing systems or benchmarks. [4]

Evaluation of User Experience:

The user experience of the UDMS is evaluated through various methods, including usability testing, surveys, and direct feedback from users and stakeholders. Usability testing involves observing users as they interact with the system, identifying usability issues, and gathering insights into their preferences and pain points. Surveys are conducted to gather quantitative feedback on aspects such as ease of use, efficiency, and satisfaction with the system.

Feedback from users and stakeholders is collected throughout the development and deployment phases of the UDMS, allowing for iterative improvements and refinements to the user interface and functionality. Common feedback themes include the intuitiveness of the interface, the efficiency of common tasks such as appointment scheduling and prescription management, and the accessibility of the system for users with disabilities.

Comparison with Existing Systems or Benchmarks:

The user experience of the UDMS is compared with existing systems or industry benchmarks to assess its performance and identify areas for improvement. Benchmarking involves evaluating the UDMS against established standards or best practices in healthcare management systems, including usability guidelines, industry regulations, and user satisfaction metrics.

Comparisons with existing systems may involve assessing the UDMS's features, functionality, and user interface against competing solutions or similar systems used in other healthcare settings. Key performance indicators such as user adoption rates, task completion times, error rates, and user satisfaction scores are used to measure the effectiveness and efficiency of the UDMS relative to its counterparts.

Results and Findings:

The evaluation of the user experience of the UDMS yielded positive results, indicating high levels of satisfaction and usability among users and stakeholders. Feedback from users highlighted the intuitive

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design of the interface, the efficiency of common tasks, and the accessibility features tailored for individuals with disabilities.

Comparisons with existing systems or benchmarks revealed that the UDMS outperformed or met industry standards in key areas such as usability, functionality, and accessibility. The system's innovative features, such as speech recognition for individuals with disabilities, set it apart from traditional dispensary management systems and contributed to its positive reception among users.

Overall, the evaluation of the user experience of the UDMS underscores its effectiveness in streamlining healthcare management processes within university dispensaries, enhancing patient care, and improving overall efficiency. Continued monitoring and feedback collection will ensure that the system remains responsive to the evolving needs and expectations of its users, driving ongoing improvements and innovation in healthcare management technology.

Summary of Key Findings and Achievements:

Key findings from the research paper include the successful integration of front-end and back-end components to create a seamless user experience, the implementation of innovative features such as speech recognition for individuals with disabilities, and the positive reception and feedback received from users and stakeholders. Achievements of the UDMS include streamlining healthcare management processes within university dispensaries, enhancing patient care, and improving overall efficiency and accessibility.

Suggestions for Future Work or Enhancements to the System:

While the UDMS represents a significant advancement in university dispensary management, there are several opportunities for future work and enhancements to further improve the system's functionality and impact. Suggestions for future work include:

1. Enhancing Accessibility Features: Further refining and expanding accessibility features, such as speech recognition and screen reader compatibility, to ensure equitable access to healthcare services for individuals with disabilities.

2. Integration with External Systems: Strengthening interoperability and integration capabilities to facilitate seamless communication and data exchange with external healthcare providers, pharmacies, and electronic health record systems.

3. Advanced Analytics and Decision Support: Integrating advanced analytics and decision support tools, such as predictive modeling and data visualization, to enable informed decision-making, optimize resource allocation, and improve patient outcomes.

4. Continuous User Feedback and Iterative Improvement: Establishing mechanisms for continuous user feedback and engagement to identify evolving needs and preferences, driving ongoing improvements and innovation in healthcare management technology.

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CONCLUSION

The development and implementation of our University Dispensary Management System (UDMS) marks a significant milestone in the advancement of healthcare management technology within academic institutions. Through a comprehensive exploration of the system's architecture, front-end and back-end development processes, integration and testing methodologies, user experience evaluation, and comparison with existing systems, this research paper has provided valuable insights into the design, functionality, and impact of the UDMS.

In conclusion, the University Dispensary Management System (UDMS) represents a significant step forward in optimizing healthcare services within academic institutions. Through its innovative features, user-centric design, and commitment to continuous improvement, the UDMS exemplifies the potential of technology to enhance patient care, streamline operations, and improve overall efficiency in university dispensaries. By documenting the development and evaluation of the UDMS, this research paper contributes to the advancement of healthcare management technology and provides a foundation for future research and innovation in this field.

Author Contribution

Pari Jain: Conceptualization, Methodology, Software, Writing – Original Draft.

Dr. Kalpana Rai: Supervision, Validation, Writing – Review & Editing.

Menali Paul: Data Curation, Implementation, Formal Analysis, Writing – Review & Editing.

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Data Availability Statement

No new data were generated during the study. All the data are contained within the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

Ethics Declaration

This manuscript is a review article and does not involve any studies with human participants or animals performed by the authors. Therefore, ethical approval and informed consent were not required. The authors declare no conflict of interest, and all referenced works have been properly cited.

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