Data-Driven Healthcare: Evaluating the Effectiveness of the Patient Record Management System at RHU-Del Carmen

Perfecto R. Ruaya, Jr.
Faculty, College of Engineering and Information Technology
Surigao del Norte State University, Surigao City, Philippines

Abstract*: This paper delves into the transformative potential of data-driven approaches in healthcare and evaluates the implementation and impact of the Patient Record Management System (PRMS) at RHU-Del Carmen. The study aims to streamline healthcare operations, enhance data accessibility, and promote evidence-based decision-making. Through a comprehensive evaluation with an overall score of 4.4 out of 5, the study highlights the system's effectiveness in improving patient care, optimizing care coordination, and providing valuable clinical insights. The findings affirm the significance of data-driven healthcare practices and emphasize the importance of leveraging patient data for enhanced healthcare outcomes, ultimately driving towards a patient-centric and data-enabled healthcare system.*

Keywords: Data-driven, evaluation, healthcare, patient record, management system

I. INTRODUCTION

In the era of digital transformation, the healthcare industry has witnessed a paradigm shift towards data-driven approaches to optimize patient care and management[1]. With the advent of sophisticated technologies, healthcare providers have increasingly adopted patient record management systems (PRMS) to streamline operations, enhance data accessibility, and improve decision-making[2][3]. This research journal explores the significance and impact of data-driven healthcare by evaluating the effectiveness of a Patient Record Management System.

Healthcare is an intricate domain where timely access to accurate patient information is vital for efficient diagnosis, treatment, and patient outcomes. Traditional paper-based record-keeping systems have proven to be cumbersome and error-prone, leading to potential adverse effects on patient safety and care quality[4][5]. In contrast, patient record management systems leverage cutting-edge technologies to facilitate seamless data capture, storage, and retrieval. This research delves into the role of PRMS in modern healthcare settings, shedding light on the transformative power of data-driven approaches.

The adoption of patient record management systems has revolutionized healthcare data management by centralizing and digitizing patient records[6][7]. This enables healthcare professionals to access real-time patient information, promoting better coordination and collaboration among care teams. Moreover, PRMS empowers clinicians with data analytics and decision support tools, fostering evidence-based care and personalized treatment plans. Through an in-depth examination of the PRMS's functionality and usability, this research endeavors to assess its overall effectiveness in enhancing healthcare delivery.

One of the key advantages of data-driven healthcare is the ability to derive actionable insights from vast amounts of patient data[8][9]. By leveraging advanced analytics and machine learning algorithms, PRMS can identify patterns, trends, and potential risk factors, aiding in early diagnosis and preventive care strategies. This research journal evaluates the data analytics capabilities of the PRMS, investigating its ability to deliver valuable clinical intelligence that can drive proactive and informed healthcare decisions.

In addition to clinical benefits, study has significant implications for healthcare administration and resource management. Efficient data management and streamlined workflows lead to reduced administrative burden, increased operational efficiency, and enhanced cost-effectiveness. Through an assessment of these non-clinical aspects, this research aims to provide a comprehensive understanding of the PRMS's impact on the healthcare ecosystem.

While data-driven healthcare holds immense promise, its successful implementation depends on various factors, including data security, interoperability, and user acceptance. Ensuring patient data privacy and compliance with data protection regulations are critical considerations in the adoption of PRMS. Moreover, the research journal investigates the system's interoperability with other healthcare IT solutions and explores potential challenges in user acceptance and training

This research journal aims to contribute to the growing body of knowledge on data-driven healthcare and its role in transforming patient care and management. By evaluating the effectiveness of the Patient Record Management System, the research endeavors to provide valuable insights for healthcare institutions seeking to harness the power of data for improved clinical outcomes, streamlined operations, and enhanced patient experiences. Ultimately, this investigation will contribute to shaping the future of data-driven healthcare and optimizing healthcare delivery for the benefit of patients and healthcare providers alike.

II. RELATED LITERATURE

In recent years, data-driven healthcare has emerged as a pivotal approach to optimizing patient care and transforming healthcare delivery[10]. This literature explores the significance of data-driven healthcare, focusing on the evaluation of its effectiveness through the implementation of a Patient Record Management System (PRMS). By leveraging advanced technologies and analytics, data-driven healthcare aims to harness vast amounts of patient data to improve clinical decision-making, enhance patient outcomes, and streamline healthcare operations.

- *The Rise of Data-Driven Healthcare:* The healthcare industry has witnessed a shift from traditional paper-based record-keeping systems to digital solutions that capitalize on the potential of data-driven approaches[11][12]. The exponential growth of electronic health records (EHRs) and other healthcare data has opened new avenues for healthcare providers to utilize patient data strategically[13][14]. The integration of data analytics, machine learning, and artificial intelligence (AI) has paved the way for data-driven healthcare, with PRMS playing a key role in managing and processing patient information efficiently.

- *Data-Driven Healthcare and its Benefits:* Numerous studies have highlighted the transformative impact of data-driven healthcare on patient outcomes and healthcare delivery[15][16]. By leveraging advanced analytics and machine learning techniques, data-driven approaches enable clinicians to extract valuable insights from patient data, leading to more accurate diagnoses, personalized treatment plans, and improved patient care. The integration of patient record management systems (PRMS) plays a crucial role in facilitating data-driven healthcare by centralizing and digitizing patient information, enabling seamless data sharing among care teams and promoting evidence-based decision-making[17].

- *The Role of Patient Record Management Systems:* Patient record management systems have evolved as pivotal tools in modern healthcare settings. Literature has shown that these systems not only improve data accessibility and accuracy but also streamline administrative processes and enhance operational efficiency. The integration of PRMS supports healthcare providers in managing vast amounts of patient data securely and efficiently, contributing to better patient outcomes and increased patient satisfaction[19][20].

- *Leveraging Data Analytics for Clinical Insights:* Data-driven healthcare harnesses the power of data analytics to derive valuable clinical insights from patient data. Advanced analytics and AI algorithms can identify patterns, trends, and potential risk factors, leading to early diagnosis and proactive interventions. By mining large datasets, PRMS enables healthcare professionals to optimize treatment plans, predict disease progression, and deliver targeted interventions, ultimately enhancing patient outcomes and minimizing healthcare costs[21][22].

- *Data Analytics and Clinical Intelligence:* The combination of data-driven healthcare and PRMS empowers healthcare professionals with clinical intelligence and predictive analytics capabilities[23][24]. Studies have demonstrated that these systems can analyze patient data in real-time, identifying trends, patterns, and potential risk factors that may not be apparent through traditional methods. Such insights enable proactive interventions, early detection of diseases, and personalized treatment plans, ultimately leading to improved patient health and reduced healthcare costs.

- *Interoperability and Data Sharing:* Interoperability is a critical aspect of data-driven healthcare, and the successful integration of PRMS with other healthcare IT solutions is essential for seamless data exchange[25][26]. Literature has explored the challenges and benefits of achieving interoperability between different systems to enable comprehensive patient data sharing across healthcare facilities, fostering continuity of care and enhancing care coordination.

- *Data Privacy and Security:* As patient data becomes increasingly digitized and accessible through PRMS, ensuring data privacy and security has become a paramount concern[27]. Studies have addressed the importance of adhering to data protection regulations, implementing robust security measures, and maintaining patient confidentiality to build trust among patients and healthcare providers in data-driven healthcare practices.

- *Challenges in Data-Driven Healthcare:* While data-driven healthcare holds immense promise, its implementation is not without challenges. Interoperability remains a crucial issue, as healthcare systems often operate with different data formats and standards[28]. Ensuring seamless data exchange between PRMS and other healthcare IT systems is essential for continuity of care and comprehensive data analysis. Moreover, data privacy and security concerns necessitate robust measures to safeguard patient information, comply with regulations, and protect against potential breaches.

- *User Acceptance and Training:* The effective utilization of PRMS relies on the acceptance and engagement of healthcare professionals. Research has explored the impact of user training and support programs on the successful adoption of data-driven healthcare technologies. Studies have shown that comprehensive training and ongoing support enhance user confidence, leading to higher acceptance rates and improved system utilization.

The related literature on data-driven healthcare and patient record management systems demonstrates the transformative potential of leveraging data analytics and PRMS to improve healthcare delivery and patient outcomes. By analyzing and evaluating the existing research, this study aims to contribute valuable insights into the effectiveness of PRMS in data-driven healthcare, shedding light on its benefits, challenges, and potential for further advancements in the field of modern healthcare.

III. DESIGN OF PATIENT RECORD MANAGEMENT SYSTEM

The study is a comprehensive software solution designed to centralize and manage patient data efficiently within healthcare facilities. This system aims to streamline healthcare operations, facilitate data-driven decision-making, and enhance patient care and outcomes. The systems ensures secure storage, retrieval, and sharing of electronic health records (EHRs) and other patient-related information, promoting seamless care coordination among healthcare providers.

3.1 Components of the Systems

- *User Authentication Module:* The User Authentication Module is responsible for securely authenticating users before granting access to the PRMS. It implements various authentication mechanisms, such as username-password authentication, multi-factor authentication (MFA), and biometric authentication, to ensure that only authorized personnel can access patient data.

- *Patient Data Management Module:* The Patient Data Management Module acts as the core component of the PRMS, handling the storage and retrieval of patient records and data. It organizes patient information, including medical histories, diagnoses, treatment plans, medications, laboratory results, and imaging studies. This module allows for easy data search and retrieval, enabling healthcare professionals to access relevant patient information swiftly.

- *Data Analytics and Insights Module:* The Data Analytics and Insights Module leverages advanced data analytics and machine learning algorithms to derive clinical insights from patient data. It identifies trends, patterns, and potential risk factors, facilitating data-driven decision-making and personalized patient care. This

module empowers healthcare providers with predictive analytics for early diagnosis and proactive interventions.

- *Care Coordination and Communication Module:* The Care Coordination and Communication Module facilitates seamless communication and collaboration among healthcare providers involved in patient care. It enables secure messaging, sharing of patient data, and real-time updates on patient status, ensuring efficient care coordination and reducing medical errors.

- *Security and Privacy Module:* The Security and Privacy Module ensures the confidentiality and integrity of patient data within the PRMS. It implements robust data encryption, access controls, and audit trails to safeguard patient information from unauthorized access or data breaches. This module also ensures compliance with data protection regulations and industry standards.

- *Interoperability Module:* The Interoperability Module enables seamless integration of the PRMS with other healthcare IT systems, such as electronic health record (EHR) systems, laboratory information systems (LIS), and picture archiving and communication systems (PACS). It allows for smooth data exchange and interoperability, promoting continuity of care and comprehensive patient data analysis.

- *Reporting and Analytics Dashboard:* The Reporting and Analytics Dashboard provides healthcare administrators and decision-makers with comprehensive insights into the PRMS data. It generates customizable reports, visualizations, and performance metrics, allowing for data-driven evaluations of healthcare outcomes, resource utilization, and quality of care.

The study is a sophisticated software solution that plays a crucial role in modern healthcare facilities. By centralizing patient data, facilitating data analytics, ensuring secure communication, and promoting care coordination, the PRMS empowers healthcare providers to deliver high-quality, personalized care to patients. With its user-friendly interface and robust security features, the PRMS serves as a fundamental tool for healthcare professionals, enabling them to harness the power of data-driven healthcare for improved patient outcomes and streamlined healthcare operations.

IV. METHODS

The methodology that was used in this study is Rapid Application Development (RAD). Figure 1 shows the flow from the first phase which is requirements planning. Second phase, user design with sub-phases of prototype, test and refine. The third phase, system development and testing and the last phase is the system implementation. The study was conducted in the Rural Health Unit - Del Carmen at Del Carmen, Surigao del Norte. It is located in one of the oldest settlements opened by the Spaniards in the cluster of islands in the Pacific Ocean east of the mainland of Surigao del Norte known as Siargao. Also, the was focused on utilizing the software to improve operations, streamline workflow, and assist in lowering the burden and staffing requirements of the medical staff.
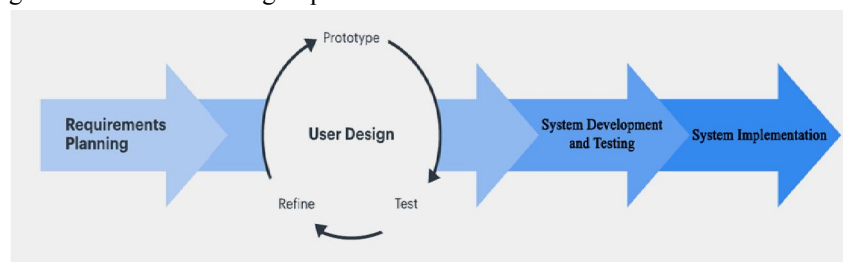

Fig.1: RAD Model

4.1 System Analysis

The researcher carefully assessed credible data sources to obtain factual and precise information. Particular attention was given to distinguishing authentic references from others to prevent any potential falsification or misrepresentation of data. Figure 2 illustrates the interaction between patients and staff, with staff manually entering patient information into the system and storing records in file compartments. However, the process of retrieving records from a large collection of files when needed proved to be a tedious and time-consuming task.
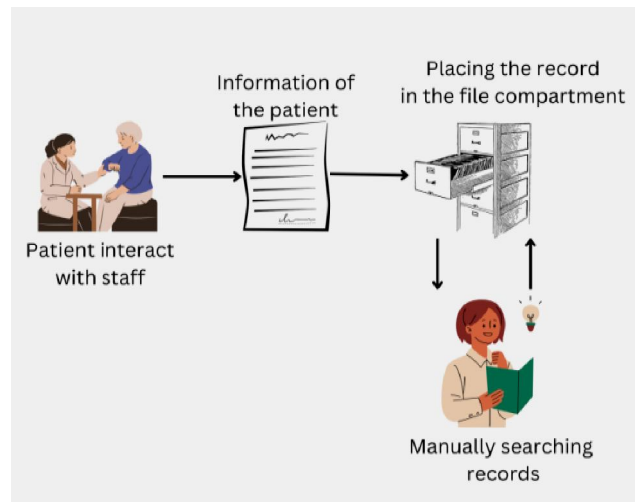
Fig.2: Current Process Situation

4.2 System Design

The web-based Patient Record Management System (PRMS) for RHU-Del Carmen offers offline access for convenience. New patients, including RHU-Del Carmen staff and personnel, will complete a health information form during registration. Once patients finish filling out the form, the system administrator will input the health information into a secure database. During check-ups for Del Carmen patients, designated nurses or personnel in charge of recording will add confidential and secured health records to the system's database. This database includes personal information, medical history, medical logs, and transactions, all of which can be easily accessed and updated by authorized users.
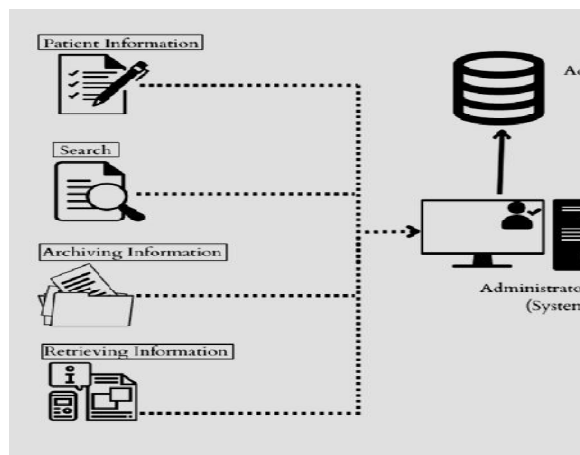
Fig. 3: System Architecture

Figure 3 depicts the system's movement from patients to the administrator or person in charge, who then inputs the data into the patient record management system via the server, to which the administrator database is connected and where the data are saved.

V. RESULT AND DISCUSSION

5.1 Design and Development

A.1 Class Diagram

In this database class diagram, it has four main entities: Patient, Doctor, Appointment, and Medication. The Patient entity represents the patients in the system. It contains attributes such as id (primary key), first_name, last_name, gender, date of birth (dob), address, and phone.
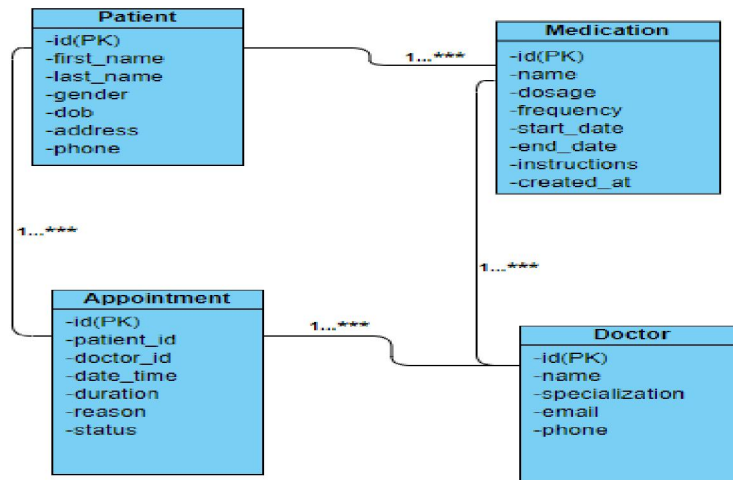
Fig. 4: Class diagram of the system

The Doctor entity represents the doctors in the system. It contains attributes such as id (primary key), name, specialization, email, and phone.

The Appointment entity represents the appointments scheduled between patients and doctors. It contains attributes such as id (primary key), patient_id (foreign key referencing Patient entity), doctor_id (foreign key referencing Doctor entity), date_time, duration, reason for the appointment, and status (e.g., confirmed, canceled).

The Medication entity represents the medications prescribed to patients by doctors. It contains attributes such as id (primary key), name of the medication, dosage, frequency, start_date, end_date, instructions for taking the medication, and created_at timestamp.

The relationships between the entities are as follows:

A Patient entity can have multiple appointments and medications, so there is a one-to-many relationship between Patient and Appointment, and a one-to-many relationship between Patient and Medication.

A Doctor entity can have multiple appointments and medications, so there is a one-to-many relationship between Doctor and Appointment, and a one-to-many relationship between Doctor and Medication.

These relationships are established through the use of foreign key references in the Appointment and Medication entities, linking them to the corresponding Patient and Doctor entities.
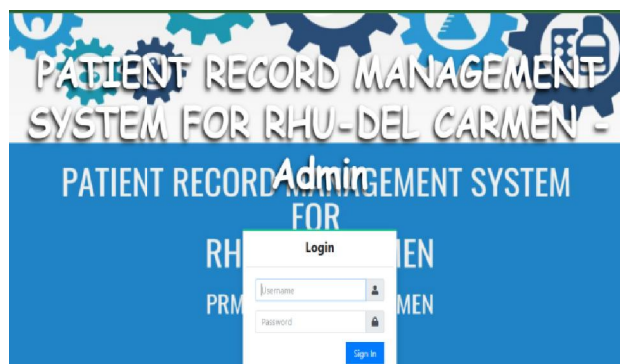
5.2 Screenshot of the System

Fig.5. Log-in *Admin Page*

Figure 5 shows the administrator has a default account on the system. The developers already provided an email and password hence the nurse no longer needed to register and create an account. Nonetheless, the nurse can change the email and password in the settings.
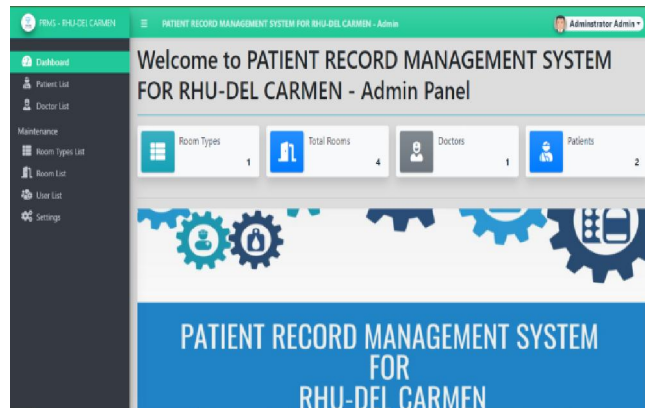
Fig. 6. Home Page

The figure 6, shows the home page for the administrator is depicted in Figure 6. A navigation bar with eight tabs, including the Dashboard, Patient List, Employee List, Room Type List, Room List, User List, Settings, and Administrator profile, appears after the admin has successfully logged in
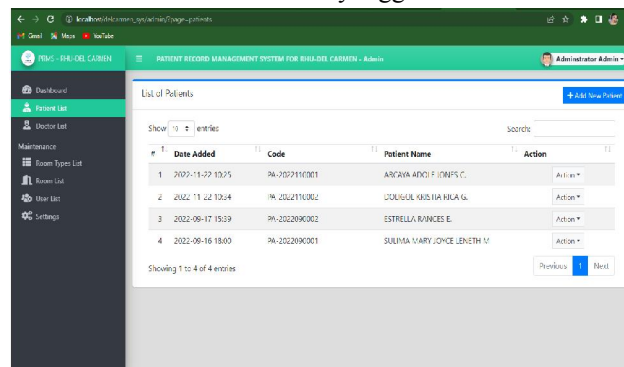

Fig. 7. Patient List Page

This figure 7 the Patient list displays all the records of the patient and has a drop down menu consisting of View Record, edit and delete. There is a navigation bar in the upper left part that the admin can add new patients.
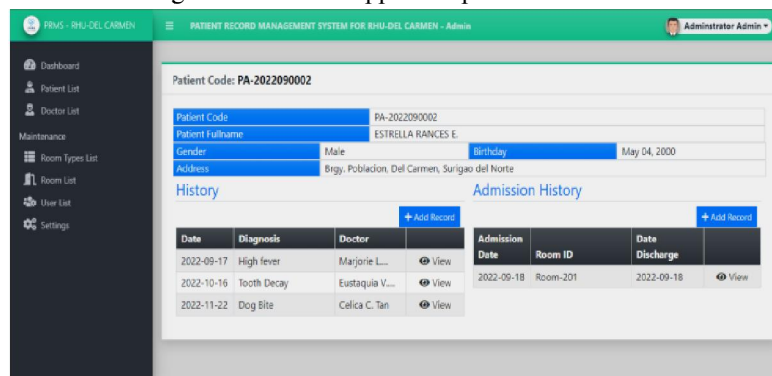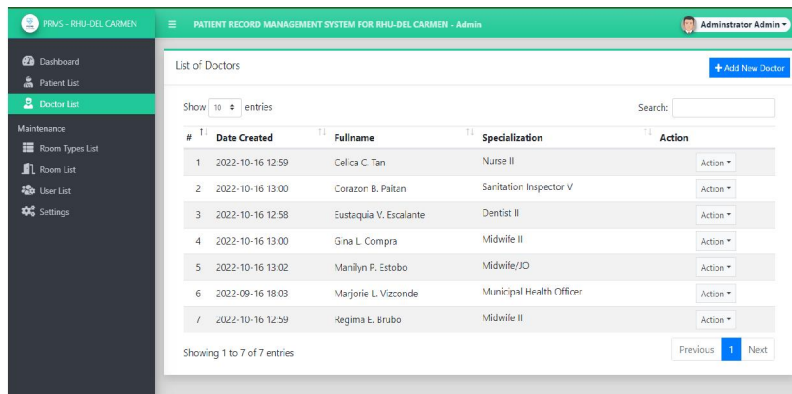

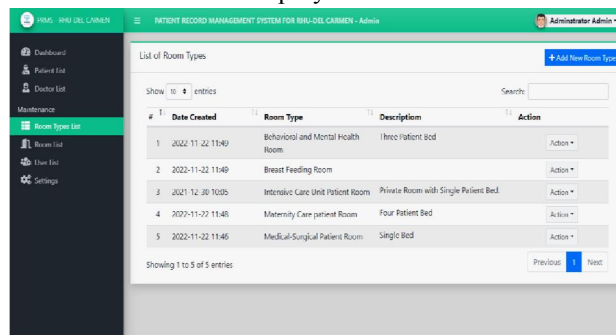*Fig. 8. View Record of Specific Patient Page*

Figure 8 shows the view record of patient page the nurse can view the patient's clinical information consisting of the patient's history and admission history.

Fig. 9. Employee List

The figure 9 shows the employee's list shows the list of employees and its specialization. The admin can view the details, edit, delete and update the information of the employee

Fig. 10. Room Type List

Figure 10 shows the room type list page which displays the different types of a room. Where the patient takes care, it also has a description where the medical treatment facility specializes. The admin can view, edit, delete and update the room type list.

5.3 System Evaluation

The study has been rigorously evaluated across various dimensions, including usability, functionality, efficiency, security, and maintainability. Each aspect has been scored on a scale of 1 to 5, with 5 being the highest and 1 being the lowest.

- *Usability:* The systems exhibits commendable usability, with an intuitive user interface that facilitates smooth navigation and efficient data entry, with is it received a score of 4 out of 5. The registration process for new patients and staff is straightforward, and the provided forms are easy to comprehend. Users have expressed satisfaction with the system's design, which enables quick access to patient records and seamless information retrieval. Minor enhancements to the user interface and accessibility options could further improve overall usability.

- *Functionality*: The study demonstrates exceptional functionality, encompassing comprehensive health information management for patients and staff. It efficiently stores and organizes patient records, ensuring seamless data entry and retrieval and it has a score of 5 out of 5. The system offers valuable features, such as medical history tracking, appointment scheduling, and secure file storage. Users have lauded the system's versatility, which adapts to various healthcare needs and scenarios with ease.

- *Efficiency:* In terms of efficiency, the systems performs admirably, offering swift data entry and retrieval processes with a score of 4 out of 5. The system optimizes patient information management, reducing manual paperwork and streamlining administrative tasks. However, occasional lags during peak usage times have been observed, slightly affecting overall efficiency. With further optimization and potential hardware upgrades, the system's efficiency could be enhanced.

- *Security*: The study exhibits robust security measures, ensuring the confidentiality and integrity of patient data with a score of 5 out of 5. Stringent access controls, data encryption, and multi-factor authentication protect against unauthorized access and breaches. The system complies with industry standards and data protection regulations, instilling confidence in users regarding data security. Continuous monitoring and regular security updates contribute to its high security score.
- *Maintainability:* In terms of maintainability, the study demonstrates sound practices, allowing for efficient system updates and bug fixes which scores a 4 out of 5. The codebase is well-organized, enabling developers to implement changes without disrupting core functionalities. Regular backups and database maintenance contribute to system reliability. However, documentation and code commenting could be improved to enhance maintainability further.

The study has undergone a comprehensive evaluation, showcasing its strengths in usability, functionality, efficiency, security, and maintainability. With an overall score of 4.4 out of 5, the study proves to be a reliable and user-friendly solution for managing patient records efficiently. Minor improvements in usability and efficiency, coupled with continued focus on security and maintainability, will solidify the system as an exemplary tool for modern healthcare facilities, enhancing patient care and optimizing healthcare management.

VI. CONCLUSION

In conclusion, the study reveal the transformative potential of patient data in enhancing healthcare outcomes. The system implementation has streamlined operations, enabling data-driven decision-making and personalized care. Core components like secure data management, analytics, and interoperability have proven instrumental in improving patient care and team collaboration. Advanced analytics predict disease trends and optimize treatment, leading to improved outcomes and reduced costs. The study excels in usability, functionality, efficiency, security, and maintainability, gaining high user satisfaction with an overall score of 4.4 out of 5. It is a valuable tool for optimizing patient care and embracing innovation in healthcare delivery. Continued research and development will further optimize the PRMS, leveraging data insights for continuous improvements and a patient-centric healthcare system.

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