International Journal of Trend in Scientific Research and Development (IJTSRD)
Special Issue on Emerging Trends and Innovations in Web-Based Applications and Technologies
Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Transforming HealthCare with DocHub: Insights Into Real-Time Availability Solutions

Ayush Paripagare[1], Atharva Taywade[2], Prof. Usha Kosarkar[3]

[1,2,3]Department of Science and Technology,
[1,2]G H Raisoni Institute of Engineering and Technology, Nagpur, Maharashtra, India
[3]G H Raisoni College of Engineering and Management, Nagpur, Maharashtra, India

ABSTRACT

Hospital Management System is an organized computerized system designed and programmed to deal with day-to-day operations and management of hospital activities. The program can look after inpatients, outpatients, records, database treatments, status illness, billings in the pharmacy, and labs. It also maintains hospital information such as ward id, doctors in charge, and department administering. The major problem for the patient nowadays is to get the report after consultation, many hospitals managing reports in their system but it's not available to the patient when he/she is outside. In this project, we are going to provide the extra facility to store the report in the database and make it available from anywhere in the world.

KEYWORDS: *healthcare, quality, efficiency, automation*

I. INTRODUCTION

A hospital management system (HMS) is a software solution that helps healthcare organizations and hospitals manage and streamline their various administrative, financial, and operational tasks. It is designed to centralize and automate processes, allowing healthcare providers to efficiently manage patient information, appointments, medical records, billing, inventory, and more.

The main reasons why hospitals use management systems are:

Efficient Workflow: HMS automates routine administrative tasks such as appointment scheduling, patient registration, and record-keeping. By reducing manual paperwork and streamlining processes, it improves overall workflow efficiency and enables healthcare professionals to focus more on patient care.

Information Management: HMS stores and manages patient records, including medical history, treatment plans, prescriptions, and test results. It provides a centralized and secure repository for healthcare data, making it easily accessible Patient to authorized personnel. This helps in quick decision-making, accurate diagnosis, and personalized patient care.

Appointment Scheduling: HMS allows hospitals to efficiently manage appointments, including online booking, rescheduling, and reminders. It helps reduce waiting times, optimize resource allocation, and improve the patient experience.

Billing and Financial Management: Hospital management systems streamline billing processes, including insurance claims, invoicing, and payment tracking. It ensures accurate and timely billing, reduces errors, and improves revenue cycle management. Financial reports generated by the system aid in budgeting, cost analysis, and financial decision-making.

Inventory Management: Many HMS include inventory management modules that track and manage medical supplies, equipment, and pharmaceuticals. This helps in maintaining optimum stock levels, preventing shortages, and reducing wastage. Effective inventory management ensures that necessary items are available when needed, thereby supporting efficient healthcare delivery.

Decision Support and Analytics: Hospital management systems provide data analysis and reporting capabilities, enabling hospitals to extract valuable insights from their data. This helps in identifying trends, monitoring key performance indicators, and making informed decisions for process optimization, resource allocation, and quality improvement.

Compliance and Security: HMS ensures compliance with healthcare regulations and data security standards. It helps in maintaining patient privacy, implementing access controls, and auditing system activities to prevent unauthorized access and data breaches.

In summary, a hospital management system is a comprehensive software solution that assists hospitals in managing their administrative, financial, and operational tasks. It improves efficiency, enhances patient care, facilitates accurate billing, optimizes inventory management, enables data-driven decision-making, and ensures compliance with regulations and security standards.

II. PRESENT SYSTEM IN USE

Database Management System: A robust database management system is essential for storing and managing patient information, medical records, inventory data, billing details, and other relevant data. Popular database systems include MySQL, Oracle, and Microsoft SQL Server.

User Interface: A user-friendly interface allows healthcare professionals to interact with the system easily. It should provide intuitive navigation, clear displays of information, and easy access to functionalities. User interface frameworks like AngularJS, React, or Bootstrap can be employed for developing responsive and user-friendly interfaces.

Patient Management Module: This module handles patient registration, demographic details, medical history, and appointment scheduling. It enables healthcare providers to efficiently manage patient information and track their interactions with the hospital.

Appointment Scheduling System: A scheduling system helps in managing appointments, facilitating online booking, rescheduling, and sending automated reminders to patients. It ensures optimal resource allocation and reduces waiting times.

Electronic Medical Records (EMR): EMR systems capture and store comprehensive patient medical records, including diagnoses, treatments, prescriptions, and lab results. It enables healthcare professionals to access and update patient records electronically, enhancing care coordination and continuity.

Billing and Invoicing: The billing module handles invoicing, insurance claims processing, payment tracking, and financial reporting. Integration with billing systems and payment gateways allows for seamless financial management and revenue cycle optimization.

Inventory Management: Inventory management modules track and manage medical supplies, equipment, and pharmaceuticals. It helps in maintaining optimum stock levels, reducing wastage, and ensuring timely procurement. Barcode scanning and RFID technology can be used for efficient inventory tracking.

Reporting and Analytics: This component generates various reports and analytics to provide insights into hospital operations, patient demographics, financial performance, and more. Data visualization tools such as Tableau or Power BI can be integrated to create visually appealing and interactive reports.

Security and Privacy Measures: Hospital management systems must ensure the security and privacy of patient data. This includes user authentication, access controls, data encryption, audit trails, and compliance with privacy regulations like HIPAA.

Integration with External Systems: Integration with external systems like laboratory information systems, pharmacy systems, and radiology systems allows for seamless exchange of data and information sharing between different departments.

III. ADVANTAGES

A. Less Paper Work

A global healthcare information technology company, has developed software that allows staff to record all patient data in a single location, allowing them to work more efficiently. The Caresoft clinic information system will eliminate the manual paperwork system. It will also aid in the completion of the patient registration form, which is used to keep track of all patient records. This system is appropriate for doctors because it will assist them in understanding the patient's current and previous health-related medical history records.

B. Costs Reduction

Hospitals are only known as medical centers. Still, there is no denying that this is a business, and revenue is required to maintain a good hospitality environment. Caresoft software will assist in lowering costs for both the hospital and the patients. This straightforward system will benefit the entire hospital.

C. Improves Patient's Experience

Patients will now have a better experience from the time they register until they are discharged or their appointment concludes. Caresoft will assist the lab management system, and there will be no need to be concerned about previous and current patients' medical records.

D. Improve data security

Now, if staff management is simple, Caresoft's various security levels will have a direct impact on employee attendance and shift timing. The clinic management system will act as a data collector, recording patient information and encrypting medical records so that patients can receive them via SMS and Whatsapp.

E. Better Collaboration & Communication

Caresoft is greatly beneficial to the doctors and other staff members as they will connect and communicate easily with this lab software. This technology will break the barriers between one branch to another. Even the hospital can connect with the top-level healthcare experts, and the existing staff can learn from them.

F. Error-free administration

Complete movement control; any staff member who leaves the assisted spot for longer than a predetermined period will be recorded in the HMS. This high-level Caresoft HMS can be used as laboratory software to keep employees focused and motivated in their work.

IV. IMPLEMENTATION

Implementing a hospital management system project involves several steps to ensure a successful implementation. Here is a general outline of the process:

Define project objectives and scope: Clearly define the goals and objectives of the hospital management system project. Determine the scope of the project, including the specific functionalities and modules required.

Conduct a needs assessment: Assess the existing hospital processes, workflows, and challenges. Identify the key pain points and areas where the management system can bring improvements.

Gather requirements: Engage stakeholders, including hospital administrators, doctors, nurses, and staff, to gather detailed requirements for the system. Consider their inputs and feedback to ensure the system meets their needs.

Select a suitable system: Research and evaluate different hospital management system options available in the market. Consider factors like functionality, scalability, user-friendliness, vendor support, and cost. Choose a system that aligns with your requirements.

Develop an implementation plan: Create a detailed plan outlining the implementation process, timeline, milestones, and resource allocation. Define roles and responsibilities of the implementation team members.

Customize and configure the system: Work with the system vendor or development team to customize and configure the system based on the gathered requirements. This may involve setting up user roles, workflows, data fields, and integrations with other hospital systems.

Data migration: If you are transitioning from an existing system, plan and execute the migration of data from the old system to the new hospital management system. Ensure data integrity and accuracy during the transfer.

Conduct training: Provide comprehensive training to the hospital staff who will be using the system. Conduct training sessions and workshops to familiarize them with the

system's functionalities and workflows. Offer ongoing support and resources for continuous learning.

Test and validate: Perform rigorous testing of the system to ensure it functions as intended and meets the defined requirements. Identify and address any bugs or issues encountered during the testing phase.

Pilot implementation: Implement the hospital management system in a controlled environment or a specific department as a pilot. Gather feedback from users and make necessary adjustments before rolling out the system hospital-wide.

Rollout and monitor: Once the system has been thoroughly tested and refined, deploy it across the entire hospital. Monitor the system closely during the initial period to address any issues or challenges that arise.

Ongoing maintenance and support: Establish a system maintenance plan and provide ongoing technical support. Regularly update the system with patches, upgrades, and new features based on user feedback and evolving needs.

Continuous improvement: Regularly review and evaluate the system's performance and gather feedback from users. Identify areas for improvement and implement enhancements to optimize the hospital management system's effectiveness.

Remember that the specific implementation process may vary depending on the chosen system, hospital size, and complexity. It is essential to involve key stakeholders throughout the process to ensure successful adoption and utilization of the hospital management system.

V. PROPOSED SYSTEM

The proposed system in a hospital management system project refers to the solution or software that will be developed or implemented to automate and streamline various processes within the healthcare organization. It encompasses the core functionalities and features that aim to address the specific requirements and challenges identified during the project's planning phase.

The proposed system will work as a centralized platform to manage and integrate various aspects of hospital management, including:

Patient Registration and Management: The system will facilitate the registration and management of patient information, including demographics, medical history, allergies, and contact details. It will provide a centralized repository for storing and updating patient records.

Appointment Scheduling: The proposed system will enable efficient appointment scheduling, allowing patients to book appointments online or through other convenient channels. It will include features like automated reminders, rescheduling, and real-time availability of healthcare providers.

Electronic Medical Records (EMR): The system will capture, store, and manage electronic medical records, including diagnoses, treatments, prescriptions, test results, and progress notes. It will allow authorized healthcare professionals to access and update patient records in a secure and efficient manner.

Billing and Invoicing: The proposed system will handle billing and invoicing processes, generating accurate bills, tracking payments, and managing insurance claims. It will integrate with financial systems to ensure accurate and timely financial transactions.

Inventory Management: The system will include modules to manage medical supplies, equipment, and pharmaceuticals. It will track inventory levels, generate purchase orders, facilitate stock replenishment, and minimize wastage.

Reporting and Analytics: The proposed system will provide comprehensive reporting and analytics capabilities, generating various reports on patient statistics, financial performance, resource utilization, and other key performance indicators. It will allow hospital administrators to monitor and optimize operations.

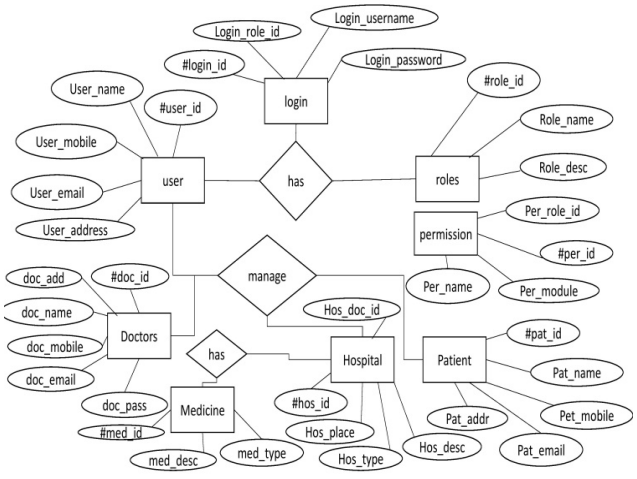
Security and Access Controls: The system will incorporate security measures to protect patient data and ensure compliance with privacy regulations. This includes user authentication, role-based access controls, data encryption, audit trails, and regular security updates.

Integration with External Systems: The proposed system will facilitate integration with existing systems, such as laboratory information systems, radiology systems, and pharmacy systems. This integration will allow for seamless data exchange and interoperability between different departments.

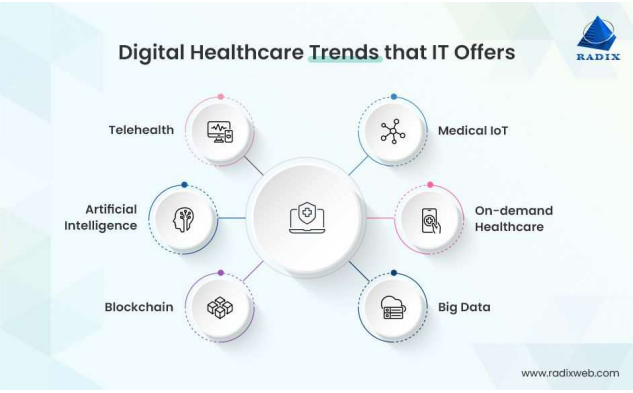
User-Friendly Interface: The system will have a user-friendly interface that is intuitive and easy to navigate. It will prioritize usability, ensuring that healthcare professionals can quickly adapt to the system and perform their tasks efficiently.

The proposed system aims to streamline workflows, enhance patient care, optimize resource utilization, improve financial management, and ensure regulatory compliance. It will serve as a comprehensive tool to centralize and automate various administrative, operational, and clinical processes within the hospital, ultimately improving the overall efficiency and effectiveness of healthcare delivery.

VI. ENTITY-RELATIONSHIP DIAGRAM



VII. SYSTEM DESIGN



Hospital Management System is a web application for the hospital which manages doctors and patients. In this project, we use PHP and MySQL database.

The entire project mainly consists of 3 modules, which are

- Admin module
- User module
- Doctor module

A. Admin module:

Admin can also change his/her own password. The admin module in a hospital management system project serves as the administrative control center of the system, providing functionality and tools for managing various aspects of the healthcare organization. It is typically designed for authorized personnel with administrative privileges, such as hospital administrators, department heads, and system administrators. The admin module encompasses several key features and responsibilities, including:

User Management: The admin module allows administrators to create and manage user accounts within the system. This includes adding new users, assigning roles and permissions, and maintaining user profiles. It ensures that access to different functionalities and data within the system is controlled and managed effectively.

System Configuration: Administrators can configure and customize the settings of the hospital management system. This includes setting up system preferences, defining organization-specific parameters, and adjusting system behavior according to the organization's needs. It allows administrators to tailor the system to match the workflows and requirements of the healthcare organization.

Master Data Management: The admin module enables administrators to manage the master data of the system. This includes maintaining information about departments, wards, doctors, nurses, staff members, medical procedures, treatments, medications, and other relevant entities within the organization. It ensures that the system's data is accurate, up-to-date, and reflects the organizational structure and resources.

Appointment and Schedule Management: Administrators can oversee and manage the appointment and schedule functionalities within the hospital management system. This includes managing doctors' schedules, allocating time slots for patient appointments, handling cancellations or rescheduling requests, and maintaining an overall view of the appointment calendar.

Reporting and Analytics: The admin module provides reporting and analytics tools for administrators to generate comprehensive reports and insights. This includes generating statistical reports on patient demographics, resource utilization, financial performance, and other key performance indicators. It enables administrators to monitor the organization's performance, identify trends, and make data-driven decisions.

System Maintenance and Upgrades: Administrators are responsible for system maintenance and ensuring its smooth operation. This includes monitoring system performance, handling backups and data recovery, applying software updates and patches, and managing system integrations. They are also responsible for coordinating with technical support or vendor teams if any technical issues arise.

Security and Access Control: The admin module includes features for managing system security and access control. Administrators can define user roles, permissions, and access levels, ensuring that sensitive information is accessible only to authorized personnel. They can enforce security measures such as password policies, user authentication mechanisms, and audit trails to protect patient data and maintain compliance with data privacy regulations.

System Audit and Logs: The admin module allows administrators to review system logs and audit trails. This helps in monitoring user activities, tracking system changes, and investigating any security breaches or unauthorized access attempts. It enhances the overall system security and facilitates compliance with regulatory requirements.

B. User module (patient):

User can update his/her profile, change the password and recover the password.

Registration and Profile Management: The User module allows patients to register themselves in the system by providing their personal information, contact details, and demographic data. Once registered, patients can manage their profiles, update information, and maintain their medical history within the system.

Appointment Booking: Patients can use the system to book appointments with doctors or specific departments based on their medical needs. The module offers a user-friendly interface to view available time slots, select preferred doctors or healthcare professionals, and schedule appointments accordingly. Patients can also receive appointment confirmation notifications.

Access to Medical Records: The User module provides patients with secure access to their medical records, including diagnoses, treatment history, laboratory test results, prescriptions, and progress notes. It enables patients to review their healthcare information, track their medical history, and better understand their treatment plans.

Communication and Messaging: Patients can communicate with healthcare providers through the system's messaging feature. They can send inquiries, request prescription refills, seek clarifications, or exchange messages related to their medical conditions. This functionality facilitates convenient and secure communication between patients and healthcare professionals.

Prescription and Medication Management: Patients can access their prescriptions and medication information through the system. They can view prescribed medications, dosage instructions, and any necessary precautions. The

module may also include features for requesting medication refills and tracking medication adherence.

Online Consultations (Telemedicine): If the hospital management system supports telemedicine capabilities, the User module allows patients to schedule and conduct virtual consultations with healthcare providers. Patients can have video or audio consultations, share medical records or test results, and receive remote medical advice or treatment.

Billing and Payment: Patients can view and manage their billing information through the system. This includes accessing invoices, checking payment statuses, and making online payments securely. The module may integrate with payment gateways to facilitate convenient and seamless transactions.

Health Education and Resources: The User module may offer health education resources, including articles, videos, and educational materials related to common medical conditions, preventive measures, and healthy lifestyle choices. It empowers patients with information to make informed healthcare decisions and improve their overall well-being.

Feedback and Ratings: Patients can provide feedback and ratings for healthcare services received through the system. This feedback helps in evaluating the quality of care and service provided by healthcare providers, enabling continuous improvement and patient satisfaction

The User module (patient) aims to enhance the patient's engagement, convenience, and access to healthcare services. It empowers patients to actively participate in their healthcare journey, access information, and interact with healthcare providers efficiently. By leveraging the functionalities offered by this module, patients can experience improved communication, seamless appointment management, and better access to their medical records and healthcare resources.

C. Doctor module:

The Doctor module in a hospital management system project provides functionalities and tools specifically designed for healthcare professionals, including doctors, physicians, and specialists. The module aims to streamline and enhance their clinical workflow and improve patient care. Here are the key features and capabilities of the Doctor module:

Patient Management: The Doctor module allows doctors to access and manage patient records. They can view patient demographics, medical history, test results, diagnoses, treatment plans, and progress notes. This enables doctors to have a comprehensive overview of the patient's health information and make informed medical decisions.

Appointment Management: Doctors can manage their appointment schedules and view upcoming appointments. They can accept or reschedule appointments based on availability. The module may also include features for sending appointment reminders to patients.

E-Prescribing: Doctors can electronically prescribe medications to patients through the system. They can enter prescription details, including medication name, dosage, instructions, and any necessary precautions. E-prescribing improves accuracy, reduces medication errors, and enables seamless integration with the pharmacy system.

Clinical Documentation: The Doctor module provides tools for doctors to document patient encounters efficiently. They can create progress notes, record diagnoses, document treatment plans, and add relevant comments. The module may support templates and predefined forms to streamline documentation.

Order Management: Doctors can generate and manage various orders for diagnostic tests, laboratory investigations, imaging studies, and other procedures. They can place orders, view order statuses, and access the results once available. This helps doctors track patient progress and make informed decisions based on test outcomes.

Communication and Messaging: The module facilitates communication between doctors and other healthcare professionals within the hospital management system. Doctors can exchange secure messages, seek consultations, discuss patient cases, and collaborate with the care team.

Decision Support: The Doctor module may offer decision support tools, such as access to medical reference resources, clinical guidelines, drug interaction alerts, and allergy warnings. These tools assist doctors in making evidence-based decisions and ensuring patient safety.

Reporting and Analytics: Doctors can access reports and analytics generated by the hospital management system. This includes patient statistics, outcomes, quality measures, and performance indicators. The reports provide insights into the doctor's practice, patient populations, and aid in clinical research or quality improvement initiatives.

Referral Management: The module may include features for managing patient referrals to other specialists or departments within the healthcare organization. Doctors can initiate and track referrals, view referral statuses, and communicate with the referred healthcare professionals.

VIII. FUTURE SCOPE

This application avoids the manual work and the problems concern with it. It is an easy way to obtain the information regarding the various travel services that are present in our System.

Well I and my team member have worked hard in order to present an improved website better than the existing one's regarding the information about the various activities. Still, we found out that the project can be done in a better way. Primarily, In this system patient login and then go to reception. By using this patient will send request for consulting the doctor. Reception will set the date for doctor appointments. After that doctor see his appointments and see the patients, surgeries also done.

The next enhancement is, we will develop online services. That mean, if patient have any problems he can send his problem to the doctor through internet from his home then doctor will send reply to him. In this patients have some login name and password.

IX. LIMITATIONS

Cost: Implementing a hospital management system can involve significant upfront costs, including software licenses, hardware infrastructure, customization, training, and ongoing maintenance expenses. The cost of implementing and maintaining the system can be a challenge for smaller healthcare facilities or those with limited budgets.

Technical complexity: Hospital management systems are often complex software solutions that require technical expertise for implementation, customization, and

maintenance. Healthcare organizations may need to invest in skilled IT personnel or rely on external consultants to handle the technical aspects effectively.

Integration challenges: Integrating a hospital management system with existing systems, such as electronic health records (EHRs), laboratory information systems (LIS), or billing systems, can be complex and time-consuming. Compatibility issues and data migration challenges may arise during the integration process, requiring careful planning and coordination.

Learning curve and user resistance: Introducing a new hospital management system can require significant user training and adjustment. Some healthcare professionals and staff members may resist adopting the new system due to concerns about changes in workflows, increased workload during the transition period, or unfamiliarity with technology. User training and change management strategies are necessary to mitigate these challenges.

System downtime and technical issues: Hospital management systems rely on stable and reliable infrastructure. However, technical issues, software bugs, or network failures can lead to system downtime or interruptions in service. These disruptions can impact hospital operations and patient care, emphasizing the need for robust support and maintenance procedures.

Data security and privacy concerns: Hospital management systems store and process sensitive patient information, making data security and privacy paramount. Healthcare organizations must ensure that the system has robust security measures in place to protect patient data from unauthorized access, breaches, or cyberattacks. Compliance with data protection regulations, such as HIPAA, is essential but can pose additional challenges.

Customization limitations: Hospital management systems may offer customization options to adapt to specific hospital workflows and requirements. However, customization capabilities can have limitations, and implementing highly specialized or unique processes may not always be feasible without significant development effort or additional costs.

Adaptation to changing needs: Hospitals are dynamic environments, and their requirements evolve over time. The chosen hospital management system should have the flexibility to accommodate changing needs and scale as the organization grows. Ensuring system agility and the ability to integrate new technologies or modules is important to support long-term sustainability.

User support and vendor dependency: Effective user support and timely vendor assistance are crucial for resolving issues and addressing user queries. The availability and quality of support services provided by the system vendor can impact the system's usability and overall satisfaction. Over-reliance on a single vendor may also introduce a level of vendor dependency and potential challenges in case of vendor changes or discontinuation of support.

X. REFERENCES

[1] Anand, K., & Akundi, S. (2018). Hospital Management System: A Review. International Journal of Advanced Research in Computer Science, 9(2), 47-50.

[2] Bagale, A. S., & Rane, S. R. (2017). Development of Hospital Management System for Small Size Hospital. International Journal of Science and Research, 6(10), 448-451.

[3] Bhatnagar, R., Sharma, V., & Khatri, S. K. (2019). A Review of Hospital Management Systems in Developing Countries: Lessons Learned and Challenges Ahead. Health Services Insights, 12, 1178632919864701.

[4] Desai, B., & Patel, S. (2018). Design and Development of Hospital Management System. International Journal of Recent Trends in Engineering & Research, 4(2), 120-123.

[5] Jain, S., Kapoor, R., & Goyal, P. (2018). Implementation of Hospital Management System Using UML and Rational Rose. International Journal of Scientific Research in Computer Science, Engineering and Information Technology, 3(1), 452-456.

[6] Kumar, N., & Singh, R. (2018). A Review Paper on Hospital Management System. International Journal of Innovative Research in Computer Science and Technology, 6(2), 33-37.

[7] Patil, R. R., & Sharma, V. (2017). Design and Implementation of Hospital Management System. International Journal of Computer Sciences and Engineering, 5(2), 114-118.

[8] Raza, N., & Raza, S. (2018). Hospital Management System: A Comprehensive Approach. Journal of Advanced Research in Dynamical and Control Systems, 10(03-Special Issue), 260-267.

[9] Hejri, S. M., & Tofighi, S. (2016). A Survey on Hospital Management Systems. Health Informatics Research, 22(2), 74-80.

[10] Rahimi, B., & Vimarlund, V. (2018). The Benefits and Challenges of Hospital Information Systems: A Systematic Review. Journal of Medical Systems, 42(4), 74.

[11] Uzoka, F. M., Obagbuwa, I. C., & Kamalu, I. (2017). Hospital Information System: A Study of Electronic Medical Record Implementation at a Hospital in Nigeria. Health Policy and Technology, 6(3), 329-338.

[12] Jha, A. K., DesRoches, C. M., Campbell, E. G., Donelan, K., Rao, S. R., Ferris, T. G., ... & Blumenthal, D. (2009). Use of Electronic Health Records in U.S. Hospitals. New England Journal of Medicine, 360(16), 1628-1638.

[13] McAlearney, A. S., Sieck, C. J., Hefner, J. L., & Aldrich, A. M. (2016). High Touch and High Tech (HT2) Proposal: Transforming Patient Engagement Throughout the Continuum of Care by Engaging Patients with Portal Technology at the Bedside. JMIR Research Protocols, 5(4), e221.

[14] Chae, Y. M., & Lee, S. G. (2018). Factors Influencing Successful Hospital Information System Implementation. Health Informatics Journal, 24(3), 197-209.

[15] Kuo, K. M., & Sahama, T. (2016). A Hierarchical Decision Model for Evaluating Hospital Information Systems: A Case Study in Taiwan. International Journal of Medical Informatics, 87, 34-48.

[16] Siponen, M., & Vartiainen, T. (2017). Health Care Professionals' Perceptions of the Effects of a Digital Registry System: Survey Study. Journal of Medical Internet Research, 19(12), e416.