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Enhancing Neurology Clinic Operations through Agile Methodology: A Study on Medical Record Information System Development

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ABSTRACT
This research aims to evaluate the influence of Agile Methodology implementation in developing Electronic Medical Record Systems (EMRs) on enhancing operational efficiency in neurology clinics. The identified issue lies in the complexity of information management within neurology clinic environments, affecting the efficiency and accuracy of medical information provision. Results indicate that the adoption of Agile Methodology in EMR development has a positive impact on neurology clinic operations. The contribution of this research lies in the profound understanding of the significance of adaptive development methods that respond to user needs, thereby enhancing operational efficiency and service quality in neurology clinics. Furthermore, this study provides a foundation for further research in information technology development within healthcare contexts, emphasizing adaptability, responsiveness, and user satisfaction.

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INTRODUCTION

Neurology clinics, as specialized clinics, primarily focus on diagnosing and treating nervous system disorders. These clinics cater to a variety of neurological conditions ranging from neurodegenerative disorders like Alzheimer's and Parkinson's disease to acute neurological disorders such as stroke and head injuries. Due to the diversity and complexity of the treated diseases, neurology clinics often face unique challenges related to patient information management(Barman et al., 2023; Boonstra et al., 2021; Horita et al., 2023; Migliorelli et al., 2023). Electronic Medical Record Systems (EMRs) are essential in neurology clinic operations. EMRs serve as the digital health information foundation managing patient medical records, including medical history, diagnoses, test results, treatment plans, and other critical information. In neurology clinics, EMRs play a crucial role in ensuring timely and comprehensive patient information availability, accurate diagnosis, and effective treatment management. However, neurology clinic environments also encounter various challenges in information management. One of the primary challenges is the increasing complexity and volume of data over time. Large and diverse patient data require information systems capa-

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ble of efficiently managing this information, minimizing the risk of errors, and enabling quick and secure access for healthcare professionals involved in neurological patient care.

In this context, developing robust and integrated Electronic Medical Record Systems (EMRs) becomes crucial for neurology clinics to enhance operational effectiveness, improve patient service quality, and optimize the utilization of existing resources. Therefore, research on using Agile Methodology in EMR development to enhance neurology clinic operations becomes relevant and essential to explore further. The integration of Agile methodology in EMR development is expected to provide adaptive, efficient, and user-responsive solutions tailored to the needs of neurology clinics in better-managing patient information. Agile Methodology, an iterative software development methodology responsive to change, has become widely recognized in the information technology industry(Al-Saqqa et al., 2020; Bomström et al., 2023; Dingsoeyr et al., 2019; Dingsøyr et al., 2012; Najihi et al., 2022; Rindell et al., 2021; Santos et al., n.d.; Serrador & Pinto, 2015; Shrivastava & Rathod, 2014). This methodology emphasizes team collaboration, delivering measurable value periodically, and adapting to changing customer needs. In healthcare information system development, Agile Methodology has several characteristic principles(Batliner et al., 2022; Humpert et al., 2022; Kantola et al., 2022; Ouriques et al., 2023).

The main definitions and characteristics of Agile Methodology include iterative development with short cycles, a focus on solid team collaboration, and the ability to rapidly and flexibly respond to changing customer needs(Abusaeed et al., 2023; Altuwaijri & Ferrario, 2022; Hinderks et al., 2022; Leong et al., 2023; Pérez-Piqueras et al., 2023; Senabre Hidalgo, n.d.; Wiechmann et al., 2022). In Agile, development occurs in short cycles called sprints, where the team focuses on developing basic functionalities that can be delivered to end-users quickly. The basic principles of Agile Methodology, documented in the Agile Manifesto, underline the importance of individuals and interactions, functioning software, customer collaboration, and response to change. Implementing these principles in healthcare information system development involves forming multidisciplinary teams, regular sprint planning, daily meetings for synchronization, and retrospectives for continuous learning and improvement.

The advantages of Agile Methodology in healthcare information system development include the ability to rapidly and flexibly respond to changing needs and priorities, better collaboration between development teams and healthcare stakeholders, and the delivery of adaptive and relevant products to end-users. However, there are also potential areas for improvement, such as the need for intensive involvement from development teams and stakeholders, the risk of losing focus on data security and privacy, and profound communication challenges regarding healthcare needs and applicable regulations. A deep understanding of the characteristics, principles, advantages, and weaknesses of Agile Methodology in the context of healthcare information system development is crucial to ensure the successful implementation of this methodology. Close collaboration between information technology teams and healthcare stakeholders, a good understanding of applicable healthcare regulations, and the selection of Agile approaches that fit the specific needs and

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environments of clinics or hospitals can help minimize risks and optimize the outcomes of healthcare information system development.

Electronic Medical Record Systems (EMRs) digitally manage and store patient medical information. The main components of EMRs include patient identity data, medical history, diagnoses, laboratory test results, prescription medications, and other relevant information for patient care. EMRs aim to improve the accuracy, accessibility, and security of medical information and facilitate integrated care coordination. The role of EMRs in improving the efficiency of neurology clinic operations is significant. With EMRs, medical teams can access patient medical information quickly and easily, allowing for faster and more accurate diagnoses and more effective treatment planning. EMRs also help reduce the risk of human errors in medical information management, such as data duplication or transcription errors, which can disrupt healthcare service quality.

However, the implementation and use of EMRs in neurology clinics are not without challenges and obstacles. One of the main challenges is integrating EMRs with existing systems in clinics, such as hospital management systems or laboratory information systems. Additionally, changes in work culture and healthcare practitioners' habits in using medical information technology are obstacles that must be overcome. Integrating Agile Methodology in healthcare information system development offers several significant benefits in addressing these challenges and obstacles. Agile Methodology enables developers to respond more flexibly and quickly to changing needs, thus accommodating the dynamics often encountered in neurology clinic environments. Adaptive Agile Methodology strategies for EMR development in neurology clinics involve forming collaborative teams, iterative planning, and integrated testing throughout the development process.

This research focuses on identifying the potential integration of Agile Methodology in developing Electronic Medical Record Systems (EMRs) in neurology clinic environments to improve clinic operational efficiency, patient service quality, and medical information management. By understanding the challenges faced in EMR implementation and the benefits offered by Agile Methodology, this research aims to develop Agile adaptation strategies tailored to the specific needs of EMR development in neurology clinics and compare them with traditional software development methodologies to evaluate relative advantages and the potential for successful implementation.

METHODS

This research aims to identify the potential integration of Agile Methodology in developing Electronic Medical Record Systems (EMRs) in neurology clinics, focusing on improving operational efficiency, patient service quality, and medical information management. The initial phase involves an in-depth analysis of EMR user requirements, followed by the development of the EMR application based on Agile Methodology principles, and finally, user acceptance evaluation to assess readiness and satisfaction with the developed information system as shown in Figure 1.

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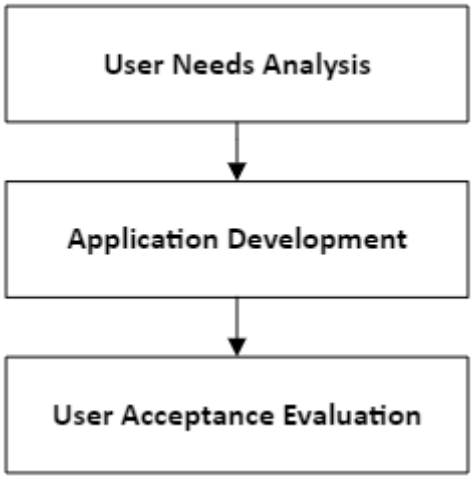

Figure 1. Research Stages

User Needs Analysis

In this stage, an in-depth analysis of the user needs for the Electronic Medical Record System (EMR) in neurology clinics is conducted. The first step involves conducting structured interviews with the medical team, clinic administrators, and potential EMR users to gain a comprehensive understanding of the clinic's operational processes and their expectations for the new information system. The results of these interviews and discussions are then used to identify the features and functions required in the EMR. A comprehensive requirements analysis document is compiled, including user stories, use cases, and UI/UX mockups to visualize the desired solution.

Application Development

After the user needs analysis is completed, the next stage is developing the EMR application based on the analysis results. The development team will translate the requirements analysis document into software architecture designs aligning with Agile Methodology principles. Agile methodologies such as Scrum or Kanban organize iterative development, setting clear milestones and sprint goals for each development iteration. This process involves coding, testing, and gradually integrating EMR application modules during each sprint.

User Acceptance Evaluation

Once the EMR application is developed, the final stage is user acceptance evaluation. Beta testing involves the medical team and potential EMR users to evaluate the application's functionality, usability, and reliability based on real-world usage scenarios in neurology clinics. Feedback from users is used to identify deficiencies or improvements needed in the EMR. Subsequently, user acceptance evaluation sessions are conducted to assess the level of satisfaction and readiness of users to use the EMR routinely in their daily practices at the neurology clinic. From the results of this evaluation, it can be assessed whether the EMR has effectively met users' expectations and needs.

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RESULTS AND DISCUSSION

User Needs Analysis

The User Needs Analysis stage results indicate a deep understanding of the needs and expectations of various stakeholders involved in using the Electronic Medical Record System (EMR) in neurology clinics. Through interviews and discussions with the medical team, clinic administrators, and potential EMR users, it was found that the medical team prioritizes fast and accurate access to patient medical information. In contrast, clinic administrators emphasize the integration of the EMR with existing hospital management systems and comprehensive data analysis reporting. On the side of potential EMR users, expectations were found for an intuitive user interface, support for mobility, and high system adaptability to match the clinic's changing needs. This analysis identifies key features and functions of the EMR, including electronic medical record management, integration with laboratory and radiology systems, real-time patient monitoring, and integrated reporting systems. The resulting requirements analysis document, such as user stories, use cases, and UI/UX mockups, provides detailed and clear guidance for the subsequent development stage, ensuring that the developed EMR will effectively meet users' needs and expectations.

Table 1. Data Collection Results

Stakeholder	Main Needs	Challenges Addressed	Expectations and Desires
Medical Team	Fast and accurate access to patient medical information, efficient medical record management	Difficulty in accessing and managing traditional medical information	Intuitive user interface, mobility support, easily adaptable system to match clinic's changing needs
Clinic Administrator	Integration of EMR with hospital management systems, comprehensive data analysis reporting	System integration difficulties, time-consuming manual data analysis	Integrated data analysis reporting, system adaptability to match clinic's needs and developments
EMR Users	Intuitive user interface, system adaptability, mobility support	Need for adaptation to changes in clinic's needs	Easily adaptable system, real-time patient monitoring features, strong developer support to address changing needs

In the application development stage, the results of the user requirements analysis from the user needs analysis stage are translated into software architecture designs that align with Agile methodology principles, such as Scrum or Kanban. These Agile principles serve as the foundation for organizing the development of the Electronic Medical Record System (EMR) application with an iterative approach that is responsive to changing user needs. The development team initiates iterative EMR development by identifying clear milestones and sprint goals for each development iteration, allowing development pro-

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gress to be regularly monitored. During each sprint, the team conducts coding and testing and gradually integrates EMR application modules. This aims to ensure good functionality, identify bugs or technical issues that must be addressed, and ensure alignment between various application components. With the iterative and responsive approach proposed by Agile Methodology, the Application Development stage aims to provide an EMR solution that is adaptive, efficient, and aligned with the previously identified user needs.

Figure 2 depicts the application development process from requirement analysis to completion. The initial stage begins with requirement analysis, where user requirements and needs are carefully understood. Next, the analysis results are used to design the application before proceeding to the development stage, where active program code is created based on the established design. After development, the application undergoes testing to ensure its performance and reliability. If all tests are successful, the application is considered complete and ready for release to end-users. With this structured workflow, the application development process can be carried out efficiently and aligned with user needs.

The Entity Relationship Diagram (ERD) in Figure 3 displays the entity structure and relationships between entities in developing an electronic medical record system in a neurology clinic. The main entities include "Neurology Clinic" with attributes ClinicID, ClinicName, Location, and PhoneNumber; "Agile Team" with attributes TeamID, TeamName, TeamLead, and Members; "Medical Record" with attributes RecordID, PatientID, DoctorID, Diagnosis, Treatment, and AppointmentDate; "Patient" with attributes PatientID, FirstName, LastName, BirthDate, Address, and PhoneNumber; "Doctor" with attributes DoctorID, FirstName, LastName, Specialty, and PhoneNumber; and "Appointment" with attributes AppointmentID, PatientID, DoctorID, AppointmentDate, AppointmentTime, and Notes. The relationships between entities are indicated through links that indicate the interconnection between entities. This ERD provides a clear overview of the data structure needed for developing an electronic medical record system in a neurology clinic, including the relationships between patients, doctors, clinics, Agile teams, and appointment schedules, which serve as the basis for efficient and responsive application development to meet the operational needs of the clinic.

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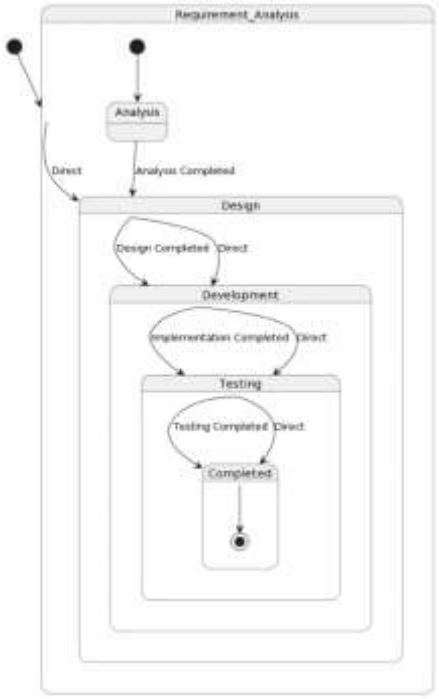

Figure 2. State Diagram

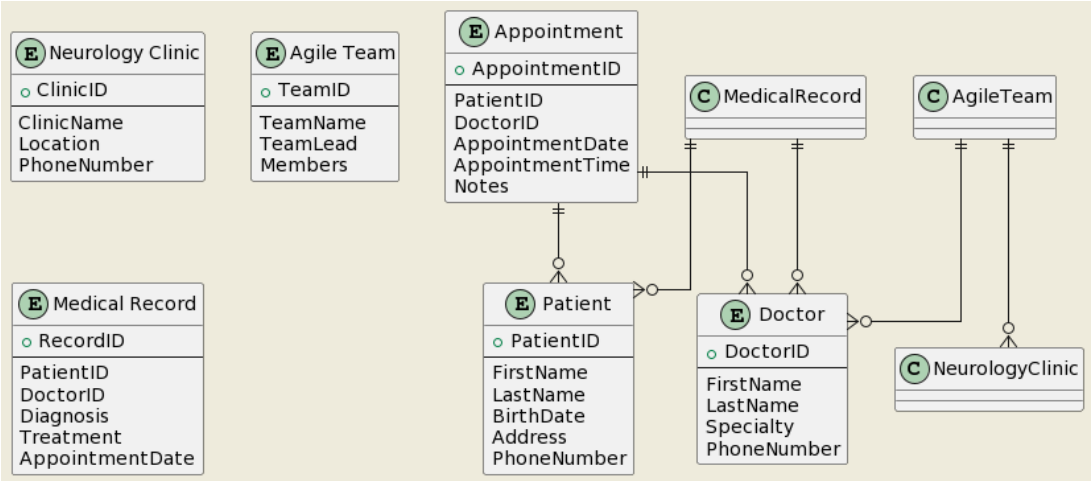

Figure 3. ERD

User Acceptance Evaluation

In the User Acceptance Evaluation stage, a beta testing of the Electronic Medical Record System (EMR) application is conducted involving the medical team and potential users in the neurology clinic. This testing aims to evaluate the functionality, usability, and reliability of the EMR based on real-world usage scenarios in the clinic environment. During the testing phase, users provide valuable feedback regarding any deficiencies or improvements needed in the application. This feedback serves as a basis for making improvements and

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adjustments to make the EMR more aligned with the needs of users and the operational processes of the neurology clinic. After the testing is completed, a user acceptance evaluation session is conducted to assess the level of satisfaction and readiness of users in using the EMR routinely in their daily practices. The results of this evaluation stage serve as a guide for making final adjustments before the EMR is widely implemented in the neurology clinic, thus providing a positive impact on improving efficiency and quality of service in the environment.

CONCLUSION

The implementation of Agile Methodology in developing the Electronic Medical Record System (EMR) in neurology clinics contributes significantly to improving operational efficiency. The structured research stages, from in-depth user needs analysis, application development with responsive design to changes, to routine user acceptance evaluation, result in an EMR that better meets the needs and expectations of users. The outcomes include increased accuracy of medical information, accelerated patient diagnosis and treatment processes, and improved communication among medical teams. Moreover, the adaptability of the EMR to the evolving needs of the clinic and technology is also an advantage resulting from the implementation of Agile Methodology. Thus, this research provides a significant contribution to systematically and effectively improving service quality and information management in the neurology clinic environment.

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