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Optimizing the Development of Online Appointment System for Dental Clinics through Agile Methodology Implementation

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ABSTRACT
This research addresses the problem of optimizing the development process of an online appointment system for dental clinics. The study focuses on implementing Agile methodology to improve collaboration, change responsiveness, and the overall value delivered to users. The methodology involves iterative testing and gathering user feedback to ensure better alignment with user needs and expectations. The study's findings highlight the significant benefits of Agile methodology in enhancing system acceptance and flexibility in addressing challenges during development. The research contributes to the understanding and application of Agile methodology in healthcare system development, particularly in improving the effectiveness and responsiveness of dental healthcare services through information technology.

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INTRODUCTION

The advancement of information technology has transformed many aspects of human life, including the healthcare sector. One significant impact of technological progress is the adoption of information systems that provide more efficient and affordable healthcare services(Ariyanto et al., 2022; Bomström et al., 2023; Choi & Ha, 2022; Mahadzir et al., 2021; Rakhmonov et al., 2022). Dental clinics, as an integral part of the healthcare system, generally experience increased demand for services, particularly in patient appointment management. The main challenge faced by dental clinics is how to optimize the patient appointment process to be faster, easily accessible, and provide quality service(Alahmad & Alnafea, 2023; Chin et al., 2024; Hoogenkamp et al., 2023; Ishimaru et al., 2023; Kouhi et al., 2024; Montoya et al., 2023; Shu et al., 2024; Song et al., 2024).

Online appointment systems for dental clinics have become a digital solution that allows patients to schedule appointments independently via the Internet. Adopting this system provides practical benefits and brings about a paradigm shift in managing dental healthcare services. The primary advantages of implementing online appointment systems are diverse and crucial to consider. One main advantage that can be identified is the reduction of queues at physical registration counters. By utilizing the online system, patients can register and make appointments without physically visiting. This saves patients' time and reduces the likelihood of crowding and congestion at registration areas, thereby enhancing

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comfort and safety for all involved parties(AlKhairAllah et al., 2022; Alsaleh et al., 2024; Chau et al., 2024; Mahdi et al., 2023; Mrugalska et al., 2021; Wang et al., 2021).

Moreover, online appointment systems can also optimize time utilization for patients and medical staff. Patients can choose suitable appointment times without waiting long at the clinic. On the other hand, medical staff can schedule appointments more efficiently, reduce waiting times between patients, and improve productivity and service quality(Birant et al., 2023; Cheng, Chang, et al., 2023; Cheng, Wang, et al., 2023; Hsiang-hua Lai, 2023; Lagla Abata et al., 2024; Sachedina et al., 2023). Additionally, the system provides benefits in terms of patient data management. With organized digital records of appointments and patient histories, clinics can easily access crucial information about patients, such as medical histories, allergies, and other health conditions. This supports more accurate decision-making in the medical service process.

The trend of technology use in dental healthcare services also plays a crucial role in adopting online appointment systems. The increasing number of dental clinics switching to online systems reflects patients' evolving needs and expectations. Patients now rely more on technology to obtain information, schedule appointments, and interact with healthcare providers. Therefore, adapting to this trend is necessary for dental clinics to meet expectations and maintain competitiveness in the constantly changing healthcare industry.

The conventional development methods commonly used in developing appointment systems for dental clinics include the waterfall approach or linear software development life cycle(Lee et al., 2022; Leong et al., 2023; Najihi et al., 2022). Although these methods have proven effective in some contexts, their weaknesses become evident when applied to projects that require flexibility, quick adaptation to changes, and active stakeholder involvement. In the context of online appointment systems, traditional methods often face challenges in need development times, lack of interaction with end-users, and difficulty adapting to dynamic market needs.

In the face of the complexity and dynamics of developing online appointment systems for dental clinics, the concept of Agile methodology emerges as a promising solution(Al-Saqqa et al., 2020; Dingsoeyr et al., 2019; Dingsøyr et al., 2012; Santos et al., n.d.; Serrador & Pinto, 2015; Shrivastava & Rathod, 2014). Agile methodology is not just a software development approach but a transformative strategy focusing on collaborative work, responsiveness to changes, and iterative delivery. Basic Agile principles such as valuing individuals and interactions, functional software, collaboration with customers, responsiveness to changes, and continuous monitoring provide a strong foundation for improving the effectiveness of developing online appointment systems for dental clinics. The advantages of implementing Agile methodology are significant, including its ability to provide added value quickly, increase user engagement, and enhance adaptability to changing market needs(Alami et al., 2022, 2023; Estrada-Esponda et al., 2024; Meiliana et al., 2023; Michalides et al., 2023; Tøndel et al., 2022).

This research is of paramount importance as it aims to deeply understand the needs and expectations of dental clinic users, including patients and medical staff, regarding online appointment systems. This understanding is crucial and forms a strong basis for de-

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veloping a responsive and high-quality system that truly caters to their needs. Furthermore, the research aims to apply Agile principles in developing online appointment systems. By applying Agile methods, the system is expected to be more flexible in adapting to user and environmental needs and provide quick and accurate responses to user requests. Additionally, the research aims to compare the performance and outcomes of developing online appointment systems using Agile methods with traditional methods that are more conventional. This comparison will provide a clearer understanding of the benefits and advantages of Agile methods in the context of healthcare system development.

Lastly, the research aims to evaluate the benefits and challenges associated with implementing Agile methods in developing online appointment systems for dental clinics. This evaluation will help gain a more comprehensive understanding of the effectiveness and relevance of Agile methods and pave the way for developing adaptive, responsive, and user-centric healthcare information systems. These systems, aligning with user and environmental needs in a constantly evolving healthcare landscape, have the potential to significantly improve the efficiency and quality of dental healthcare services through information technology. Thus, this research is expected to significantly contribute to developing such systems, marking a new era in healthcare service delivery.

METHODS

This research is designed in four structured phases, as depicted in Figure 1. The first phase is requirement definition, where user needs are understood through surveys and in-depth interviews to formulate clear and specific system requirements. The second phase is planning, which involves developing a development plan, including work schedules, resource allocation, and system specification documents. The third phase is development, where the system is designed, coded, and periodically tested according to Agile principles to ensure quality and alignment with user needs. The final phase is functional testing and user acceptance analysis, where the system is thoroughly tested and receives feedback from users to ensure optimal acceptance of the developed system. Thus, this research follows a structured and planned approach to produce an adaptive, responsive online appointment system for dental clinics that meets user needs and expected quality standards in an academic environment.

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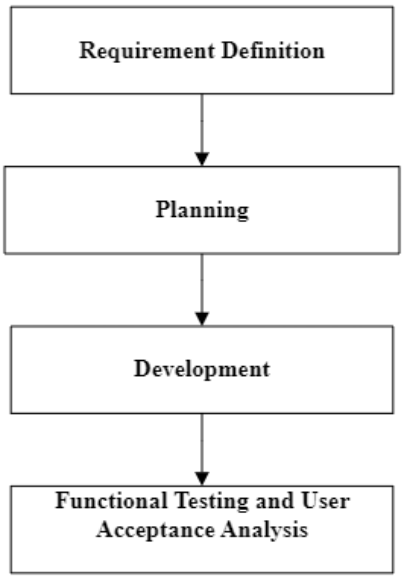

Figure 1. Research Stages

Requirement Definition

The first phase in this research is the requirement definition phase, which involves identifying and profoundly understanding the users' needs for the online appointment system in dental clinics. The main activity in this phase is conducting surveys and interviews with potential users, including patients and medical staff, to gather data on preferences, expectations, and challenges faced in using the system. The data is then comprehensively analyzed to formulate precise, specific system requirements that align with user needs and research objectives.

Planning

After defining the system requirements clearly, the next phase is the system development planning phase. This collaborative effort involves developing a work plan encompassing development schedule, resource allocation, cost estimation, and risk management. We value our development team's expertise and input, including IT experts, dental clinic users, and other stakeholders. Detailed system specification documents are also prepared, covering functional and non-functional requirements, system architecture, and workflow.

Development

The development phase is where the online appointment system for dental clinics begins to take shape, following the previously laid out plan. This is an iterative process, implementing Agile principles in system development. We believe in continuous improvement and alignment with user needs. The development team will design and code the system according to the specified requirements. Additionally, unit testing and integration testing are performed periodically during the development process to ensure system quality and alignment with user needs.

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Functional Testing and User Acceptance Analysis

Once the development phase is completed, the system undergoes functional testing to ensure that all features function as expected. The final phase is conducting beta testing involving users, both patients and medical staff. The results of testing and user feedback are then analyzed to determine necessary improvements and ensure optimal user acceptance of the developed system.

RESULTS AND DISCUSSION

Requirements Definition

The results of the Requirements Definition Phase indicate that the identification of user needs (patients and medical staff) for the dental clinic's online appointment system has been accomplished. Through a series of surveys and interviews with potential users, including patients and medical staff, a deep understanding of user preferences, desired features, and challenges faced using the system has been obtained. A comprehensive analysis of the data obtained from surveys and interviews has also been conducted to formulate clear and specific system requirements. This data includes functional and non-functional requirements, feature priorities, user interface preferences, and technical challenges that must be addressed in system development. The outcomes of this phase serve as a strong foundation for developing the dental clinic's online appointment system that is responsive, adaptive, and aligned with user needs and the expected quality standards in the academic environment.

Tabel 1. Results of defining requirements

Data Source	Results
Patient Survey	Preferences for system features, such as flexible scheduling options.
	Ease of registration and cancellation of appointments.
	Integration with appointment reminder system via SMS or email.
	Good accessibility across various devices, such as smartphones and computers.
	User-friendly interface design that is easy to understand.
Medical Staff Interview	Integration with patient medical records for quick access to health history.
	Automatic updates on practice schedules and doctor availability.
	Prioritization of emergency cases over routine appointments.
	Notification system to remind patients of upcoming appointments.
Survey Data Analysis Appoinments	Ability to book and cancel appointments online.

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	Data security and privacy protection measures. Availability of technical support services for system users.
Interview Data Analysis Appoinments	Information availability on doctor specializations and patient reviews before booking appointments. Efficient registration process without requiring redundant information. Flexibility in rescheduling appointments to avoid time and cost loss. Responsiveness to specific needs, such as accessibility for disabled individuals.

Planning

The results from the Planning Phase, as shown in Figure 2, indicate that a comprehensive development plan has been successfully formulated, considering detailed work schedules, optimal resource allocation, accurate cost estimation, and meticulous risk management. This plan also involves establishing a development team comprising various experts in information technology, dental clinic users, and other stakeholders, who are expected to contribute significantly to the development process. Additionally, system specification documents have been meticulously created, covering functional and non-functional requirements, the architecture to utilize, and the system workflow. These documents will serve as crucial guidelines for the development team to execute each implementation stage, aiming to ensure that the developed system meets the expected standards of quality, performance, and user requirements.

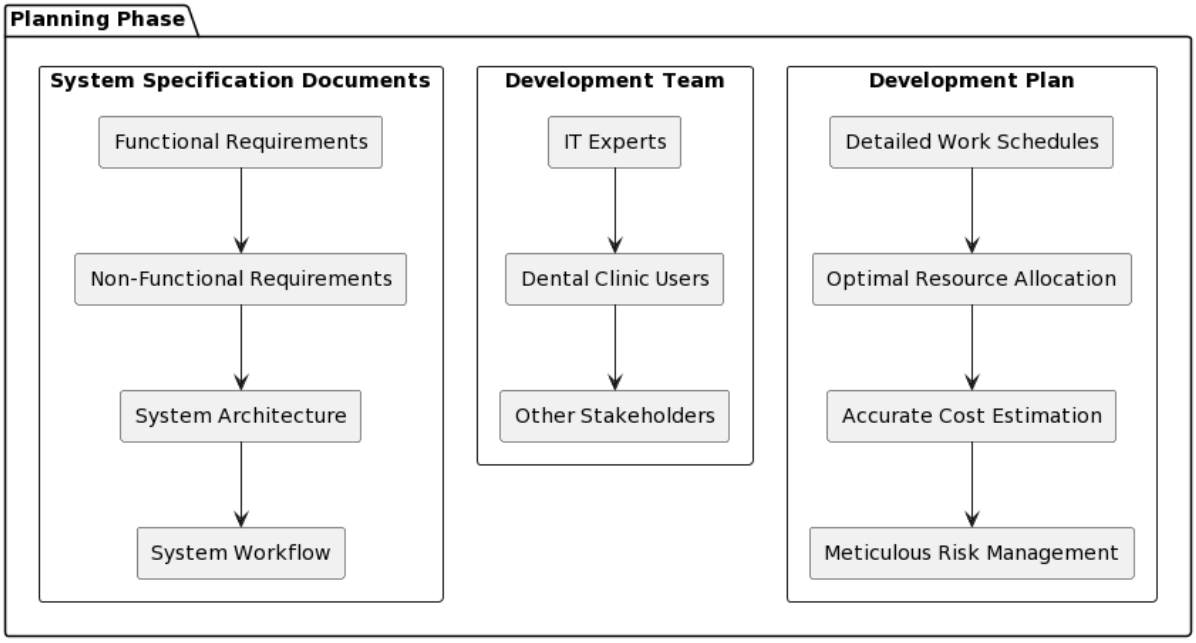

Figure 3 The Planning Phase

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Development

The results of the Development Phase indicate a successful implementation of Agile principles, including forming a collaborative team, sprint planning, and iterative development. The development team worked synergistically and responsively, executing a continuous development cycle to produce a system that is responsive and adaptable to changes in user needs, as depicted in Figure 3. The online appointment system has also been designed and coded according to the established specifications, emphasizing adequate architecture and a user-friendly interface. Unit testing and integration testing were conducted periodically during the development process to ensure the quality and suitability of the system for user needs, identifying potential bugs or issues before widespread system implementation, thus providing an optimal user experience and a stable system.

The ERD in Figure 4 depicts the structure and relationships between related entities in the online dental clinic appointment system. The Patient entity represents individuals registered as system users, with attributes such as Patient_ID, Name, Address, Email, and Phone_Number crucial for identifying and contacting patients. The Appointment entity illustrates appointments scheduled by patients with dentists, featuring attributes like Appointment_ID, Date, Time, and Status that aid in efficiently tracking and managing appointments. The Dentist entity portrays dental practitioners providing services at the clinic, with attributes such as Dentist_ID, Name, Specialization, and Practice_Schedule crucial for scheduling and managing dentist availability

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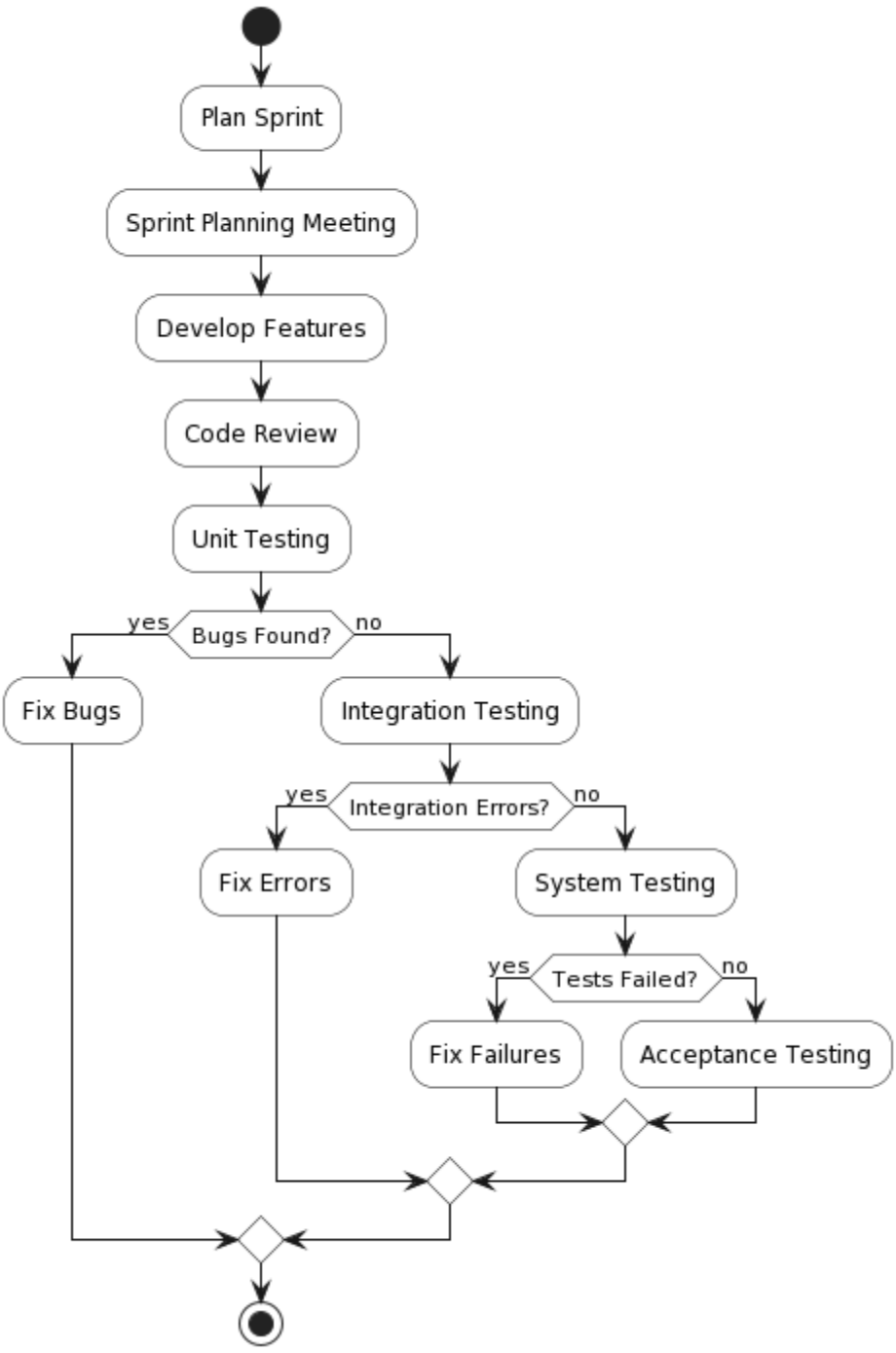

Figure 3 Development Phase

The Medical Record entity stores detailed information about patient visits and treatments, including attributes like Record_ID, Patient_ID, Appointment_ID, Complaint, Diagnosis, and Treatment, facilitating efficient medical data recording and retrieval. The Notification entity manages communication between the system and patients regarding appointments or other information, with attributes like Notification_ID, Patient_ID, Appoint-

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ment_ID, Type, and Notification_Content, aiding in efficient notification delivery. The Technical Support entity handles patient queries and support requests, with attributes like Ticket_ID, Patient_ID, Ticket_Date, Message_Content, and Ticket_Status supporting tracking and resolving technical issues. The Medicine entity represents medications available at the clinic, with attributes like Medicine_ID, Medicine_Name, Medicine_Type, and Medicine_Content supporting medicine and prescription management. The Prescription entity links appointments with prescribed medications, featuring attributes like prescription_ID, appointment_ID, medicine_ID, and Quantity facilitating prescribed treatment management. Finally, the Payment entity tracks payment details related to appointments, with attributes like Payment_ID, Appointment_ID, Payment_Method, and Total_Cost supporting financial transaction management. This ERD analysis highlights the importance of data integrity, communication channels, and system functionality in providing quality healthcare services to online dental clinic patients.

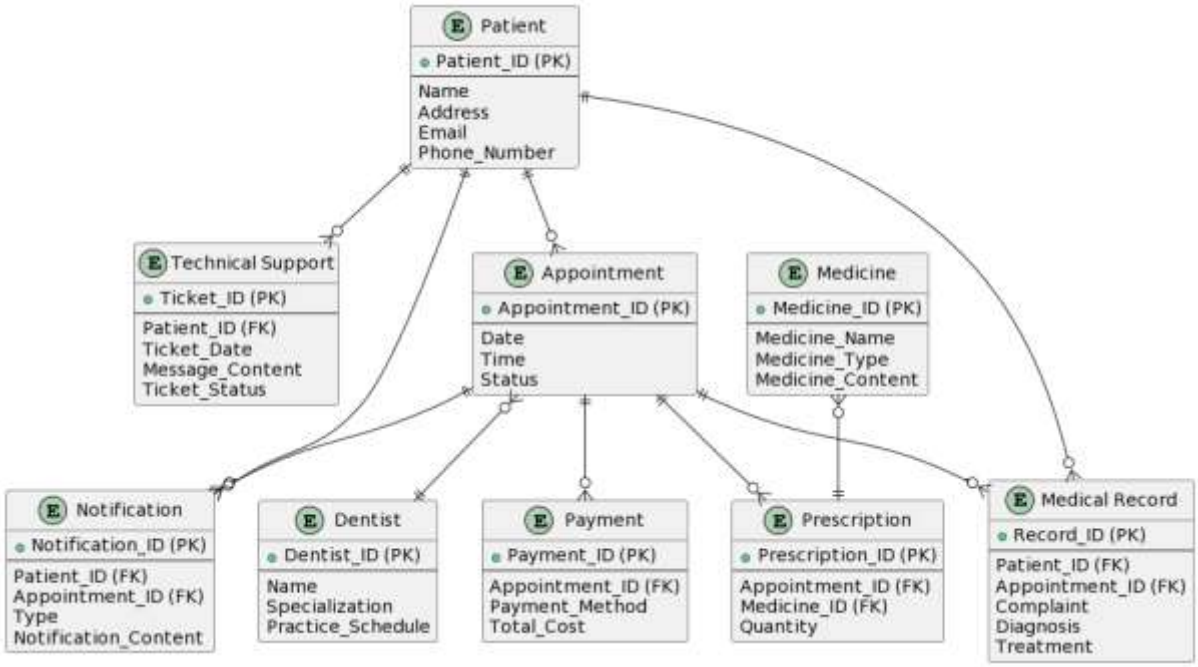

Figure 4 ERD

Functional Testing and User Acceptance

The results of the Functional Testing and User Acceptance Analysis Phase indicate that the functional testing of the system has been successfully conducted to verify system functions and ensure that all features operate as expected. Inviting users, including patients and medical personnel, to conduct alpha and beta testing has provided direct feedback on user experience and system alignment with their needs. The results of these tests and user feedback were then thoroughly analyzed to determine necessary improvements to ensure optimal user acceptance of the developed system. The analysis included evaluating system performance, identifying potential bugs or technical issues, and adjusting features to align with user needs and expectations. Thus, this phase becomes crucial in ensuring that the

online dental clinic appointment system can provide users with a satisfying and responsive experience tailored to their overall needs.

CONCLUSION

This study's use of the Agile methodology has significantly improved the system development process. Agile methodology enables developers to work collaboratively, be responsive to changes, and deliver quick value to users. Iterative testing and gathering user feedback allow for better adjustments to meet user needs and expectations, enhancing overall system acceptance. Moreover, implementing Agile methodology also provides the flexibility to address challenges and changes during development. Thus, this research contributes significantly to understanding and applying Agile methodology in healthcare system development, particularly in enhancing the effectiveness and responsiveness of dental healthcare services through information technology.

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