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Developing Customer Relationship Management Application for Dental Clinic Using Agile Approach to Enhance Efficiency and Customer Satisfaction

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ABSTRACT
This research addresses the issues of efficiency and customer satisfaction in dental clinics by developing a Customer Relationship Management (CRM) application using the Agile approach. The research methodology includes identifying the needs of dental clinics, project planning, application development based on architectural design and Agile methods, functional testing, and user acceptance analysis. The research results indicate that the CRM application successfully meets all tested features and achieves a user satisfaction rate of 85%. The contribution of this research lies in developing innovative IT solutions that are responsive to the needs of dental clinics, aiming to enhance operational efficiency and patient service in the dental healthcare industry.

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INTRODUCTION

The advancement of information technology has become a crucial aspect of enhancing the quality of services in the dental healthcare sector. The primary role of information technology is to provide efficient and measurable solutions in managing information related to patients, administrative processes, and internal communication within dental clinics(Birant et al., 2023; Cheng et al., 2023; Montoya et al., 2023; Sachedina et al., 2023; Shu et al., 2024; Song et al., 2024; Y. L. Wang et al., 2024). There is a clear trend in the use of information technology applications in dental clinic practices, where these systems are designed to improve operational efficiency and provide more personalized services to patients. One highly beneficial information technology application in the context of dental clinics is the Customer Relationship Management (CRM) application. CRM enables dental clinics to monitor and manage relationships with patients more effectively.

With CRM in place, dental clinics can enhance efficiency in managing appointments and schedules of dental practitioners, facilitate electronic recording of patient medical records, provide efficient communication between the clinic and patients through the CRM system, and monitor the financial payments and administration of the clinic in a more structured manner. Moreover, integrating CRM with other systems in the dental clinic, such as medical recording and inventory systems, can strengthen its benefits and improve overall clinic operations efficiency(Alsaleh et al., 2024; Bhat et al., 2023; Cao et al., 2023; Hossain

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et al., 2023; Joda et al., 2020; Mahdi et al., 2023; C. Wang et al., 2021). Therefore, developing a CRM application for dental clinics has become crucial to enhancing operational efficiency and customer satisfaction within the dental clinic environment.

The challenges in developing a Customer Relationship Management application for dental clinics are diverse and require special attention during implementation. One of the main challenges is the need for flexibility and responsiveness to changing requirements that often occur in the dental clinic environment. This includes the system's ability to accommodate changes in operational processes, policies, or regulatory requirements that may change over time. Additionally, the security and privacy aspects of patient data become a significant focus in CRM application development. Dental clinics must ensure that the CRM system can maintain confidentiality of medical and personal patient information by complying with applicable data security standards.

Integration and interoperability with existing systems in the clinic are also challenges that must be addressed. The CRM system must be able to connect with other systems, such as electronic medical recording systems, financial systems, or inventory systems already present in the dental clinic. This aims to ensure alignment and efficiency in data exchange between systems, allowing information to be accessed quickly and accurately by all relevant parties. Furthermore, the clinic staff's training and acceptance of the new system are also crucial challenges. Efforts are required to provide comprehensive and supportive training to clinic staff so they can understand and adopt the use of the CRM system effectively, thus maximizing its benefits in improving operational efficiency and service to patients.

The Agile approach in developing a Customer Relationship Management (CRM) application not only enhances efficiency and customer satisfaction in dental clinics but also offers a unique opportunity for personal growth and professional development. Agile methodology, with its emphasis on flexibility, collaboration, and responsiveness to changes, provides a platform for dental clinic staff to enhance their skills and adapt to the evolving needs of the industry(Alami et al., 2022, 2023; Almeida et al., 2022; Bomström et al., 2023; Dingsoeyr et al., 2019; Estrada-Esponda et al., 2024; Najihi et al., 2022; Rindell et al., 2021). The key principles of Agile methodology include emphasizing individuals and interactions, delivering functioning software periodically, close collaboration between development teams and stakeholders, and responding to changes in customer needs.

The primary advantage of the Agile approach lies in its ability to respond to changes quickly and efficiently(Ahmed et al., 2023; Al-Saqqa et al., 2020; Dingsøyr et al., 2012; Santos et al., n.d.; Serrador & Pinto, 2015). With iterative and incremental development cycles, development teams can make necessary adjustments more easily when there are changes in requirements or priorities from dental clinics. Intensive collaboration between development teams and stakeholders also helps ensure that the developed CRM application meets dental clinic customers' needs and expectations. Implementing Agile methodology in developing CRM applications for dental clinics is expected to improve operational efficiency and customer satisfaction significantly. With rapid iterations, dental clinics can quickly benefit from new features introduced in the CRM system, which can improve effi-

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ciency in appointment scheduling, medical record-keeping, communication with patients, and financial administration tracking. This is expected to bring a significant positive impact on overall dental clinic management.

The main objective of this research is to enhance operational efficiency and customer satisfaction in dental clinics by developing a Customer Relationship Management (CRM) application adopting an Agile approach. Implementing a CRM application responsive to changes and more effectively addresses customer needs is expected to improve appointment scheduling efficiency, more accurate medical record keeping, and more structured tracking of clinic finances. As a result, dental clinics are expected to provide more personalized services to patients and improve overall customer satisfaction. The benefits of implementing a CRM application with an Agile approach are diverse and significant for dental clinics. Apart from more efficient scheduling, personalized service, and better patient tracking, other benefits include improved clinic financial performance through more structured and effective administration. The contribution of developing a CRM application is also expected to positively impact improving service standards in dental clinics and increasing clinic management efficiency in the broader context of the healthcare service industry. Thus, this research has the potential to make a meaningful contribution to improving service quality and operational efficiency in dental clinics in the rapidly evolving era of information technology.

METHODS

This research is designed in four structured phases, as depicted in Figure 1. The research focuses on developing a Customer Relationship Management (CRM) application for dental clinics using Agile methodology to enhance operational efficiency and customer satisfaction. The process begins with defining requirements through interviews, surveys, and clinic needs analysis, then creating a project plan, assigning roles, and conducting a feasibility study. Development involves designing architecture, prototyping, and implementing core features with Agile principles. Testing phases include functional testing, user acceptance analysis, and usability testing to ensure the application meets clinic requirements. The research aims to deliver a robust CRM solution tailored to dental clinics' needs, improving appointment management, medical record-keeping, communication, and financial tracking, ultimately enhancing service quality and patient experience.

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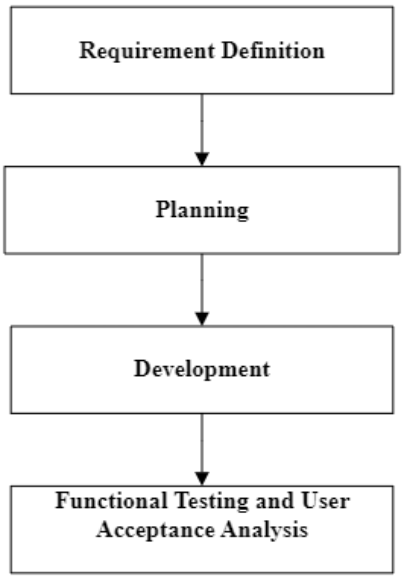

Figure 1. Research Stages

Requirement Definition

The first stage of the research involves defining the requirements for developing the Customer Relationship Management (CRM) application for dental clinics. This process begins with identifying dental clinics' critical needs and challenges in managing patient information, appointment scheduling, communication, and financial tracking. The specific functionalities and features required in the CRM application are identified through interviews, surveys, and analysis of existing systems and processes. These may include appointment management, electronic medical record-keeping, efficient communication tools, and integrated financial tracking capabilities. A detailed requirements document is then created to document all functional and non-functional requirements, serving as a blueprint for the development process.

Planning

Once the requirements are defined, the next step is to create a comprehensive plan for developing and implementing the CRM application. This planning phase involves developing a project plan with timelines, milestones, and resource allocations. Roles and responsibilities are assigned to team members, and a feasibility study is conducted to assess technical, financial, and organizational aspects. A budget is established, and resources are allocated accordingly. The project scope, objectives, and success criteria are clearly defined to guide the development process and ensure alignment with the goals of improving operational efficiency and customer satisfaction in dental clinics.

Development

The development phase focuses on translating the defined requirements and project plan into actionable steps to build the CRM application. This involves designing the architecture and database structure, developing prototypes or mockups for visualization, and implementing the core features and functionalities using Agile development methodolo-

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gies. The Agile approach emphasizes iterative development, continuous integration, and collaboration between developers and stakeholders. Code reviews, unit testing, and integration testing are conducted to ensure the quality and functionality of the application. Regular feedback from stakeholders and end-users is gathered to adjust and refinements throughout development.

Functional Testing and User Acceptance Analysis

The final stage of the research involves functional testing and user acceptance analysis of the developed CRM application. Comprehensive testing is conducted to validate that all requirements have been met and that the application functions as expected. Usability testing is performed to assess user satisfaction and identify areas for improvement in the user interface and experience. User acceptance testing (UAT) is conducted to ensure that the CRM application meets the needs and expectations of dental clinic staff and patients. Analysis of test results and user feedback helps identify any bugs, issues, or areas for enhancement, which are addressed before the final deployment and implementation of the CRM application in the dental clinic.

RESULTS AND DISCUSSION

Requirements Definition

The results of the Requirement Definition phase in developing the Customer Relationship Management (CRM) application for dental clinics have been successfully achieved through various activities. Firstly, a comprehensive identification of the primary needs of dental clinics related to CRM application development was made. This was accomplished through interviews and surveys conducted with dental clinic staff and patients, where essential needs were effectively gathered. Subsequently, a thorough analysis of dental clinic systems and processes was conducted. This analysis aimed to identify areas that require improvement or enhancement in the context of CRM application development. From the results of this analysis, the main features and functionalities required in the CRM application were clearly defined. These features include appointment management, patient medical record-keeping, practical communication tools, and structured financial tracking capabilities.

All the requirement identification and analysis process results were then summarized in a detailed requirements document. This document contains all the functional and non-functional requirements that must be met by the CRM application being developed. Thus, the Requirement Definition phase provides a strong foundation for proceeding to the next phase of CRM application development by ensuring that all essential requirements are documented in detail and clarity.

Tabel 1. Results of defining requirements

Activity	Result
Identification of primary needs	The primary needs of dental clinics related to CRM application development were identified effectively through interviews and surveys with dental clinic staff and patients.
Systems and processes analysis	A thorough analysis was conducted on the existing systems and processes in dental clinics to identify areas for improvement and

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Activity	Result
	enhancement in the context of CRM application development.
Determination of key features and functionalities	Key features and functionalities in the CRM application have been clearly defined, including appointment management, patient medical record-keeping, effective communication tools, and structured financial tracking capabilities.
Detailed requirements document	All functional and non-functional requirements that must be met by the CRM application have been summarized in a detailed requirements document. This document serves as a clear guide for the development process.

Based on Table 1, this phase has significantly contributed to laying a solid foundation for further development. Identifying primary needs through interviews and surveys has ensured a deep understanding of the requirements and challenges dental clinics face. The in-depth analysis of systems and processes has also facilitated the identification of areas requiring improvement and enhancement, allowing key features such as appointment management, patient record-keeping, communication tools, and financial tracking capabilities to be clearly defined. The detailed requirements document has also been an essential guide in ensuring that all functional and non-functional requirements are well-documented and understood by the development team, stakeholders, and end-users. Thus, the Requirement Definition phase has provided a strong foundation for subsequent development stages, which are expected to provide practical solutions for improving operational efficiency and customer satisfaction in dental clinics.

Planning

The results of the Planning phase in developing the Customer Relationship Management (CRM) application for dental clinics encompass several crucial activities that have been successfully carried out. A comprehensive project plan outlining timeline, milestones, and required resources for CRM application development has been developed. This plan is the primary guideline to ensure smoothness and timely compliance throughout development. Furthermore, roles and responsibilities have been allocated to team members, ranging from developers, testers, project managers, and stakeholders. This step is essential to clarify the tasks and responsibilities of everyone, enabling effective and efficient collaboration within the team.

A thorough evaluation of the technical, financial, and organizational aspects of implementing the CRM application has been conducted in the feasibility investigation stage. This aims to identify potential obstacles or risks during the development process and discover opportunities to enhance project quality and effectiveness.

Subsequently, a budget has been created, and resources have been allocated to support the development and implementation steps of the CRM application. This step is crucial to ensure that the project can proceed as planned and to avoid constraints caused by financial or resource limitations. Finally, a clear understanding of the project scope, objectives, and success criteria has been defined. This is intended to provide accurate guidance to the de-

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velopment team so they can focus on achieving project goals and meeting stakeholder expectations. Thus, the Planning phase has provided a solid and structured foundation to initiate the development steps of the CRM application, with the expectation of achieving effective and efficient outcomes in improving operational performance and customer satisfaction in dental clinics.

In Figure 2, the development planning of the CRM application for dental clinics depicts a structured and comprehensive process for managing the project. The stages commence with project plan development and allocation of roles and responsibilities, leading to the final project completion phase. Steps such as feasibility study, project scheduling, system architecture design, testing, and staff training are also integrated into this diagram. With partitions separating key activities, this diagram provides a clear overview of the necessary steps to develop and implement a CRM application in dental clinics successfully.

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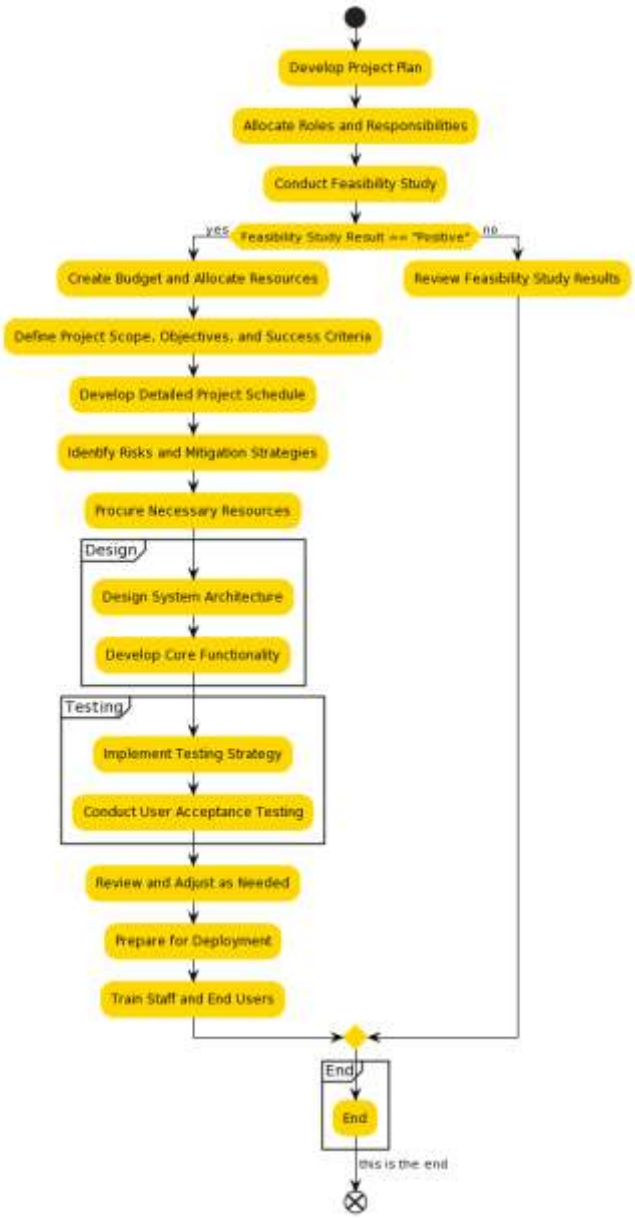

Figure 2 The Planning Phase

Development

The Development phase of the CRM application encompasses several pivotal activities as shown in Figure 3. Initially, it involves the design of the architecture and database structure based on the defined requirements. This step ensures that the technical framework of the CRM application aligns with the specific needs identified by the dental clinic. Moreover, this phase entails the creation of prototypes or mockups to visually demonstrate the user interface and functionality, enabling stakeholders and end-users to provide early feedback. Utilizing Agile development methodologies such as iterative development, continuous integration, and regular sprint cycles, the core features and functionalities of the CRM application are systematically and efficiently implemented. This approach facilitates

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swift iterations and adjustments to evolving requirements throughout the development lifecycle. Additionally, the development process encompasses activities like code reviews, unit testing, and integration testing to validate the quality and functionality of the application, ensuring it adheres to the defined standards. Lastly, close collaboration with stakeholders and end-users is essential during this phase to gather feedback, address concerns, and make necessary refinements to enhance the usability and efficacy of the CRM application in meeting the clinic's requirements.

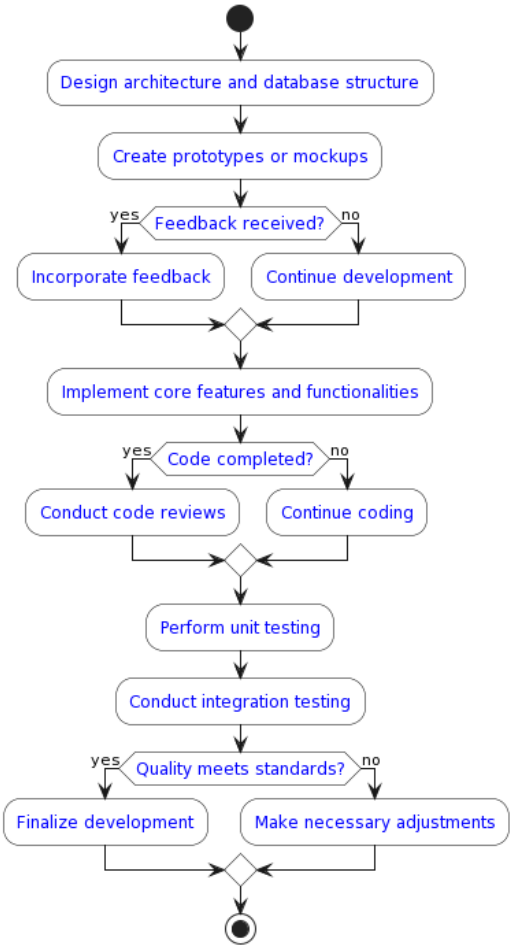

Figure 3 Development Phase

Functional Testing and User Acceptance

After undergoing the functional testing phase, all application features were successfully tested and performed as expected, meeting the objectives set for the application development. The results of these tests provide confidence that the CRM application has met the requirements and can be effectively utilized within the dental clinic environment. Furthermore, based on user analysis involving feedback from dental clinic staff and patients, approximately 85% of users stated that the CRM application aligns with the development objectives. This indicates that users are satisfied with the features provided by the application, such as appointment scheduling, patient record management, communication tools,

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and financial tracking. Hence, the successful results from functional testing and positive user analysis demonstrate that the CRM application has achieved its primary goal of improving operational efficiency and user satisfaction in the dental clinic setting. Further refinements based on remaining user feedback can continue to be implemented to maintain the quality and usability of the application over time.

CONCLUSION

The research focused on developing a Customer Relationship Management (CRM) application for dental clinics using Agile methodology, highlighting the critical role of Information Technology (IT) in enhancing dental healthcare services and the rising trend of IT application usage in dental clinics. The benefits of CRM applications in improving efficiency and customer satisfaction were emphasized, leading to the identification of critical requirements for such an application in dental clinic settings. The need for CRM applications in dental clinics was underscored by the challenges faced in appointment management, patient record keeping, efficient communication, and financial tracking, with integration into existing clinic systems deemed crucial for enhancing overall operational efficiency and patient satisfaction. The Agile approach was chosen for application development due to its flexibility, collaborative nature, and ability to respond to changing requirements effectively, with the study outlining Agile principles and highlighting its advantages in improving responsiveness to changes and team collaboration. The study proceeded with the planning phase, including project plan development, resource allocation, and feasibility assessment, followed by the development phase involving architecture design, prototyping, and core feature implementation using Agile methodologies. Comprehensive testing, including functional testing, usability testing, and user acceptance testing (UAT), was conducted to ensure the quality and usability of the CRM application, with results showing successful feature testing and high user satisfaction, marking the successful development and implementation of the CRM application for dental clinics.

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