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Development Of A Dental Emergency Response App: Agile Solutions For Timely Patient Care

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ABSTRACT
This research aims to develop a responsive and efficient emergency dental application for providing emergency dental care to patients. The research includes user needs analysis, application development, and user acceptance evaluation stages. The agile solution's development method involves beta testing with potential users and iterative improvements based on feedback. The evaluation results indicate 87 percent of users stated that the application met their expectations. This application features essential functionalities such as integration with medical information systems, emergency notifications, interactive communication, and doctor schedule management. In conclusion, this application is expected to enhance responsiveness, efficiency, and quality of emergency dental care services, providing timely and quality solutions in handling dental emergency cases.

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INTRODUCTION

Emergencies in dentistry require prompt and accurate responses as they can cause severe pain, bleeding, infection, or even more serious issues if not addressed promptly(Chau et al., 2024; Montoya et al., 2023; Shu et al., 2024; Song et al., 2024). One urgent example of a dental emergency case is a tooth abscess, where an infection in the tooth root can rapidly spread to surrounding tissues, potentially leading to significant swelling and excruciating pain. In this context, every second becomes highly valuable as the patient's condition can deteriorate rapidly. Tooth abscesses, for instance, can cause serious complications such as the spread of infection to the jawbone, bloodstream, or even threaten the patient's life(Cheng, Chang, et al., 2023; Ramli et al., 2023; Sachedina et al., 2023; Veenman et al., 2024). Furthermore, unbearable pain can also hinder daily activities and a person's quality of life.

The absence or delay in addressing dental emergency cases can negatively impact higher treatment costs, prolonged healing processes, and increased risks of complications(Cheng, Tang, et al., 2023; Cheng, Wang, et al., 2023; Ishimaru et al., 2023; Karunakaran et al., 2024; Kouhi et al., 2024). Patients may also experience disruptions in oral functions such as chewing and speaking, as well as significant social and psychological impacts due to prolonged pain. Thus, emergency dental services are not only directly related to oral health but also impact patients' overall well-being and quality of life. Therefore, a quick, accurate,

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and effective response to dental emergencies becomes crucial in preventing potential negative impacts.

Challenges faced in emergency dental services encompass several crucial aspects that must be seriously considered. Firstly, limited accessibility poses one of the significant barriers that can slow down appropriate responses in dental emergency cases. Especially in remote areas or areas with limited healthcare infrastructure, patients may encounter difficulties promptly accessing necessary emergency dental services(Cronin, 2023; Demaerschalk et al., 2023; Kumar & R.S., 2022; Mahdi et al., 2023). This could lead to delays in emergency case management and increase the risk of complications for patients. Delayed responses also pose a significant challenge in emergency dental services. The emergence of dental issues requiring immediate attention, such as severe bleeding or acute infections, demands quick and accurate responses. However, in some cases, delayed responses may occur due to various factors, including the need for coordination among patients, medical personnel, and healthcare facilities involved.

Coordination issues become a primary concern in emergency dental situations. Effective synchronization between patients needing assistance, duty medical personnel, and healthcare facilities providing emergency dental services is necessary. Poor coordination may result in difficulties in providing optimal services and promptly responding to emerging dental emergency cases. Overall, challenges in emergency dental services include limited accessibility, potential delayed responses, and coordination issues among various involved parties. To improve the effectiveness and efficiency of emergency dental services, efforts need to be made to address these challenges through better coordination strategies, increased accessibility to services, and a deeper understanding of the needs of dental emergency patients.

Technological advancements have become crucial in transforming healthcare services, including emergency dental services. Technology is a potential solution to enhance responsiveness and efficiency in handling dental emergency cases more effectively. One of the most notable roles of technology is in improving response speed to dental emergency cases. With integrated medical information systems, mobile applications, and advanced communication technologies, medical teams can obtain patient information more quickly and accurately. This enables them to plan appropriate treatment more efficiently, minimize response times, and reduce the risk of potential complications. With this system, patient information can be accessed in real time by all medical team members involved, even during non-regular working hours. This allows for better coordination among various involved parties and ensures patients receive timely care without administrative barriers. Additionally, technology is also utilized in advanced diagnostic procedures and dental interventions. For example, imaging technology such as CT scans or MRIs detect complex dental issues and enable dentists to plan more precise and practical actions.

Overall, the role of technology in enhancing emergency dental services is significant. By continuously adopting and developing appropriate technological solutions, emergency dental services can become more responsive, efficient, and of higher quality, ultimately providing significant benefits to patients and the healthcare system. In emergency dental services, the

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need for agile solutions is critical. Agile solutions can respond quickly to changing situations and patient needs, thus providing significant benefits in handling dental emergency cases.

Firstly, agile solutions are essential because they quickly respond to changing situations(Alami et al., 2022; Almeida et al., 2022; Hasan et al., 2013; Najihi et al., 2022; Rindell et al., 2021). Dental emergency cases often develop rapidly and require immediate attention. With agile solutions, medical teams can dynamically adjust treatment strategies according to the patient's condition development. This helps minimize response times and reduce the risk of complications that may arise due to delays in treatment. Agile solutions offer adaptability and flexibility (Baxter et al., 2023; Beecham et al., 2021; Humpert et al., 2022; Kantola et al., 2022; Mishra & Alzoubi, 2023) in dealing with dental emergency cases. Each dental emergency case may have unique characteristics and require different approaches. With agile solutions, medical teams can easily adjust treatment strategies based on the specific patient's condition and the severity level of the dental problem. The benefits of adaptability of agile solutions are also reflected in their ability to integrate the latest technology and innovations into emergency dental services. With the adoption of appropriate technology, agile solutions can improve process efficiency, enhance diagnostic accuracy, and facilitate better coordination among various involved parties in the medical team. Overall, the need for agile solutions in emergency dental services accelerates responses to changing situations and patient needs and provides the adaptability and flexibility needed to deal with various types of dental emergency cases. Thus, agile solutions become crucial in improving the effectiveness and quality of emergency dental services.

This research aims to introduce the concept of developing agile emergency dental application solutions for timely patient care. It seeks solutions that address emergency dental services' main challenges through technology and responsive approaches. The contribution of this research is expected to enhance the effectiveness and quality of emergency dental services by promptly responding to changing patient situations and overcoming accessibility limitations and potential response delays.

METHODS

This research involves three stages: user needs analysis, application development, and user acceptance evaluation to develop a responsive emergency dental application as shown in Figure 1. The analysis stage explores user needs and expectations, followed by application development based on the analysis findings. Once the application is completed, an evaluation is conducted with potential users to ensure functionality, usability, and application acceptance before its official launch. With this systematic approach, the application is expected to provide timely and effective solutions in emergency dental services.

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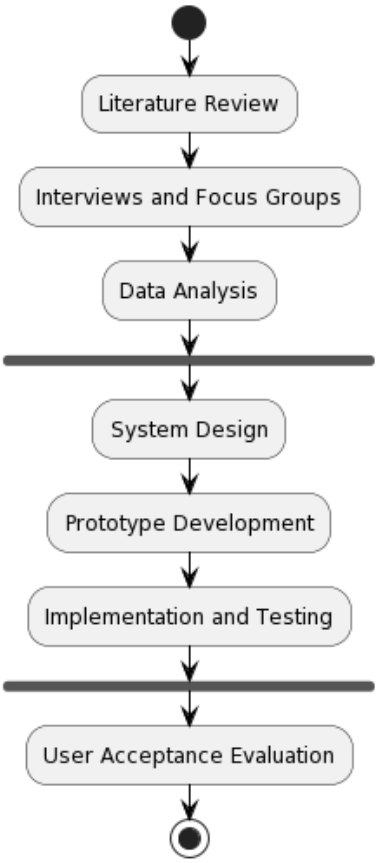

Figure 1. Research Stages

User Needs Analysis

The first stage of this research is the User Needs Analysis. In this stage, we conducted surveys and in-depth interviews with various stakeholders, such as emergency dental patients, dentists, and other medical personnel, to comprehensively understand their needs and expectations regarding the emergency dental application system. The data and information obtained from the surveys and interviews were then meticulously analyzed to identify key features that the application should possess. Additionally, we organized focus group discussions (FGDs) with participation from various stakeholders to gather further input and feedback regarding user needs, thus establishing a solid foundation for subsequent development.

Application Development

Once the needs analysis stage was completed, we proceeded to the Application Development stage. In this stage, we assembled an application development team of IT experts, UX/UI designers, and dental professionals. This team collaborated to initiate the application development process by defining the technical and functional specifications of the application based on the user needs analysis results gathered earlier. Additionally, we implemented agile

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development methodologies, such as Scrum or Kanban, to ensure that the development process ran efficiently and responsively to any changing needs that might arise during development.

User Acceptance Evaluation

The final stage is the User Acceptance Evaluation. After the application was developed, we conducted beta testing sessions with a small group of potential users, including emergency dental patients and dentists, to test the functionality and usability of the application. The feedback and evaluation obtained from beta testing users were then utilized to iterate and improve the application before its official launch. Additionally, we conducted a final evaluation of the application based on predefined user acceptance criteria to determine the readiness of the application for widespread use in emergency dental services. By following this systematic approach, we are confident that the emergency dental application we developed can provide optimal benefits to users and meet the expected quality standards.

RESULTS AND DISCUSSION

User Needs Analysis

From the surveys and interviews with patients, dentists, and other medical personnel, a deep understanding of their needs and expectations regarding the emergency dental application system was obtained. Patients desired quick and easy accessibility to information about emergency dental services. At the same time, dentists emphasized the importance of features that support rapid diagnosis and effective emergency case management. Data analysis from these surveys and interviews also helped identify critical features the application should have, such as real-time patient status updates, integration with medical information systems, and the ability to connect patients with available dentists quickly. Additionally, focus group discussions (FGDs) with various stakeholders, including patient representatives and medical professionals, obtained further input and feedback regarding user needs, which will serve as the primary guidelines for further development. Thus, the user needs analysis results provide a strong foundation for developing a responsive emergency dental application that meets the actual needs of users.

Table 1. Data Collection Results

Stakeholder	Key Needs	Challenges Addressed	Expectations and Desires
Patients	Accessibility to quick and easily accessible emergency dental care information	Delay in obtaining emergency dental care information	Access to quick and easily accessible information in dental emergencies
Dentists	Features supporting quick diagnosis and effective emergency case management	Lack of integration with medical information systems	Application capability to update patient status in real-time and quickly connect patients with available dentists

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Other Medical Staff	Application integration with existing medical information systems	Coordination among medical teams in emergency dental cases	Simplified communication and coordination among medical staff in handling emergency dental cases
Patient Advocates	User-friendly application accessibility for patients	Accessibility limitations in emergency situations	Having a user-friendly application that understands emergency dental patient needs

The results of this stage are summarized in Table 1, where each stakeholder has different primary needs according to their role and perspective in emergency dental care. The challenges addressed refer to the obstacles identified by these stakeholders' primary needs. At the same time, hopes and desires depict the aspirations expected to be fulfilled by developing a responsive and practical emergency dental application.

Application Development

The application development process begins with assembling an application development team of IT experts, UX/UI designers, and dental professionals. This team plays a crucial role in ensuring that the developed application has good technical quality, attractive user interface, and meets clinical needs in emergency dental care. Furthermore, the development team defines the technical and functional specifications of the application based on the results of the user needs analysis that were previously obtained. This includes key features such as integration with medical information systems, real-time patient status updates, and an intuitive user interface. The development team also implements agile development methodologies, such as Scrum or Kanban, to ensure that the development process runs efficiently and responsively to any changing needs that may arise during development. With this approach, the developed application is expected to have high quality and reliability and provide practical solutions in emergency dental care.

Table 2. Features

Key Application Feature	Function
Integration with Medical Information Systems	Allows direct access to integrated patient medical records, facilitating accurate diagnosis and treatment
Real-Time Patient Status Updates	Enables dentists and medical teams to track and update patient statuses directly in emergency situations
Emergency Notifications and Prioritization	Sends emergency notifications to involved medical teams and prioritizes emergency cases based on severity
Emergency Dental Information Accessibility	Provides detailed information about emergency dental cases, recommended actions, and medication usage guidance
Interactive Communication	Enables direct communication between patients, dentists, and medical staff through text messages or video calls
Doctor Schedule Management System	Facilitates patient appointment scheduling with available dentists and manages dentist practice schedules efficiently

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Key Application Feature	Function
Data Collection and Analysis	Gathers structured patient data for further analysis, allowing for more effective solution development

Table 2 presents key features of the application encompassing various essential functionalities for developing an emergency dental care application. Integration with the medical information system is a primary feature that enables direct access to integrated patient medical records, thereby supporting accurate diagnosis and management in dental emergencies. Subsequently, the Real-Time Patient Status Update feature allows dentists and medical teams to track and update patient statuses directly, enhancing responsiveness and effectiveness in handling emergency cases. The Emergency Notification and Priority feature allows sending emergency notifications to the involved medical team and prioritizing emergency cases based on severity levels, ensuring swift and appropriate handling according to the patient's condition. Furthermore, the Dental Emergency Information Accessibility feature provides detailed information about dental emergency cases, recommended actions, and medication usage instructions, enhancing understanding and knowledge in emergency case management. The Interactive Communication feature enables direct communication between patients, dentists, and medical personnel through text messages or video calls, facilitating team coordination and providing practical communication support in handling emergency cases. The Doctor Schedule Management System facilitates patients in scheduling appointments with available dentists and managing doctors' practice schedules efficiently, enhancing patient service accessibility. The Data Collection and Analysis feature gathers structured patient data for further analysis, enabling more effective solutions based on an in-depth understanding of emergency case patterns. The table reflects the importance of features supporting rapid response, effective communication, and quality emergency dental case management in developing an emergency dental care application.

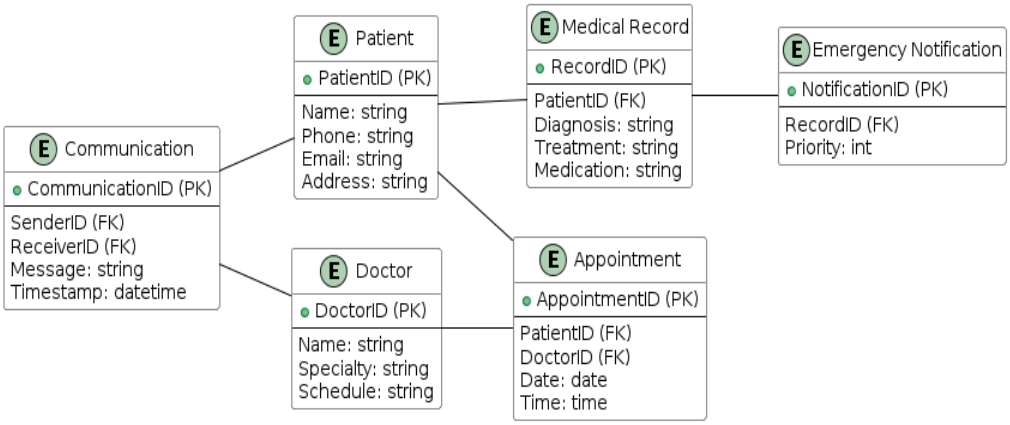

Figure 3. ERD

The entity Relationship Diagram (ERD) in Figure 2 depicts the data structure consisting of several interrelated entities in the context of developing an emergency dental care application. The first entity, "Patient," includes attributes such as Patient ID, Name, Phone Number,

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Email, and Address, representing patient identity and contact information using the application. The second entity, "Medical Record," has attributes such as Medical Record ID, Patient ID, Diagnosis, Treatment, and Medication, used to store medical information related to patient diagnosis, treatment, and medication given. Furthermore, the "Emergency Notification" entity includes attributes covering Emergency Notification ID and Medical Record ID, which are used to send emergency notifications to the medical team in handling patient emergency cases. The "Doctor" entity includes attributes such as Doctor ID, Doctor Name, Specialization, and Schedule, representing information about doctors handling patient cases. The "Appointment" entity includes Appointment ID, Patient ID, Doctor ID, Date, and Time, which are used to schedule appointments between patients and available doctors. Lastly, the "Communication" entity includes attributes such as Communication ID, Sender ID, Receiver ID, Message, and Timestamp. These support interactive communication between patients, dentists, and medical personnel via text or video calls.

User Acceptance Evaluation

User Acceptance Evaluation is crucial in developing an emergency dental care application. This stage aims to ensure that the developed application meets standards and is well-received by potential users. Firstly, beta testing sessions are conducted with a small group of potential users, including emergency dental patients and dentists. In these sessions, comprehensive testing of all application features is conducted to ensure that each feature functions correctly and as expected. The testing results indicate that the application has successfully passed the testing phase, with each feature operating optimally.

Subsequently, feedback and evaluations obtained from beta testing users are systematically collected. This data is then used to iterate and improve the application before its official launch. This iterative process allows developers to fix bugs, enhance less optimal features, and improve user experience weaknesses. The user acceptance analysis revealed that 87 percent of users stated that the application met their expectations. These results indicate that users are satisfied with the application's functionality, usability, and reliability. The final evaluation of the application is also conducted based on previously established user acceptance criteria to determine the application's readiness for widespread use by end-users. An application that successfully passes the User Acceptance Evaluation stage is expected to be ready for official launch and provide maximum benefits to users in emergency dental care situations.

CONCLUSION

This research has produced an integrated emergency dental care application with a Medical Information System, enabling real-time patient status updates, emergency notifications, prioritization of cases, dental emergency information accessibility, interactive communication, doctor schedule management, and patient data collection for analysis. Application development through agile solutions, such as beta testing and iterative improvement based on feedback, successfully addressed challenges of accessibility limitations, slow response, and coordination among various stakeholders. User acceptance evaluation indicates that 87 percent of users stated that the application met their expectations, confirming user satisfaction with

its functionality, usability, and reliability. Thus, this application is expected to provide a responsive, efficient, and well-received solution by potential users, improving emergency dental care services and responding to patient needs promptly.

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