DEVELOPMENT OF PATIENT DENTAL CHARTING (CDAS): A CASE STUDY FOR OMG DENTAL CLINIC.

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Abstract* - The development of a Clinical Dental Analysis System (CDAS) specifically designed and tailored for the O.M.Gigi Dental Titiwangsa Clinic. It is examined this thesis is to address the invaluable tool for caries detection in dentistry, International Caries Detection and Assessment System (ICDAS) has emerged as a invaluable tool, offering a standardized framework for the evaluation. However, the traditional manual charting associated with ICDAS are time-consuming, often error-prone, and poor visualisation on paper-based records. The clinic recognizes the need to enhance efficiency and achieve it objective by switching to a digitized ICDAS charting methodology. The study has concluded that thorough assessment, strategic architecture planning, and user-friendly design are essential for successful CDAS implementation. Making sure the system is user-friendly and effective for patient registration, booking appointments, and dental chart tracking, usability testing is essential. The system has been greatly influenced by the information provided by the staff at the administration, dental assistants, and dentists. An overall user satisfaction score of 80% in the usability test results from survey methodology indicates the app is functional and easy to use. Although the interface received positive reviews, users recommended enhancements for the patient registration text field, search functionality, error handling, and navigation features. With an overall satisfaction rating of 80% (effectiveness), 78% (efficiency), satisfaction at 79%, These results point to areas that should be improved to maximize the CDAS for dental professionals.

***Keywords:* Clinical Data Analysis System (CDAS), Usability Testing, O.M.Gigi Dental Titiwangsa Clinic, ICDAS Charting, Digital Health Records, Dental Charting**

1. INTRODUCTION

Tooth decay, or dental caries, is a common oral health problem that affects people of all ages. Early detection and successful treatment of caries depend on accurate and thorough caries assessment. A uniform framework is offered for this purpose by the International Caries Detection and Assessment System (ICDAS)[1]. But conventional manual commentary tagging and charting are labor-intensive, prone to mistakes, and dependent on paper-based records.

The Clinical Data Analysis System (CDAS) is being used in this project to present a contemporary, digital method of caries assessment. The CDAS is an intuitive cloud-based platform that improves data visualization and collection, enabling an organized framework with a focus on the user. Thorough testing guarantees the dependability of the system. This cutting-edge system seeks to enhance patient care by offering faster, more precise caries detection and documentation. This paper aims to present a combination of modern dentistry assessment with established methods so that dentists can provide patients with comprehensive and expedient evaluations and practitioners can provide higher-quality care. By putting this digital solution into practice, we hope to revolutionize dental practice in the twenty-first century by setting a new benchmark for caries detection and assessment.

I. Research Background

The ICDAS is renowned for offering adaptable and widely used techniques. These techniques help dentists in both public health and medical settings with the planning, monitoring, and analysis of tooth decay. However, problems like data loss and security breaches can occur when ICDAS is manually recorded, particularly in the Malaysian dental care system.

- Current Issue: Manual Documentation and Record Keeping

- Specific Problem: Visualization Technique and Organized Tooth Charting History in CDAS

I. Aim and purpose of the paper

This section provide information about the aim of the paper in resolving the problem statement. By doing this, the necessary aspects to concentrate on during application development will become more manageable. The following is a list of the goals:

- To investigate the current charting process by gathering data using various collection methods.
- To facilitate prototype development through strategic architecture planning, ensuring a well-structured and scalable framework.
- To test the developed prototype & system design, address any issues, and gather user feedback for a successful product launch.

II. Research Significance

By switching from manual to digital record-keeping, the CDAS project is essential to O.M. Gigi Titiwangsa Dental Clinic's modernization of dental care management. It streamlines clinic operations by managing patient data, appointments, and clinical charting through a single hub, eliminating inefficiencies and errors linked with traditional paper-based charting. The accuracy and thoroughness of assessments are improved by advanced features like ICDAS charting, which greatly improves patient care and treatment planning. In general, CDAS is a revolutionary step toward improved standards and operational effectiveness in the dental healthcare industry.

III. Related Work

In order to address issues in clinical practices, particularly in dental care, it is imperative that the healthcare industry switch from paper charts to digital systems. By addressing problems like data loss and security breaches, the CDAS project at O.M.G Titiwangsa Dental Clinic seeks to increase operational efficiency, standardize clinical procedures, and guarantee data accuracy and security. The objectives of the CDAS project and its potential to revolutionize dental healthcare in Malaysia are outlined in this section.

i. ICDAS & Dental Practitioners

By expediting patient care and cutting down on manual documentation time, the Clinical Data Analysis System (CDAS) installation greatly improves dental practices at O.M. Gigi Dental Clinic. With its user-friendly design, extensive patient records, and analytical tools, CDAS improves clinical tasks by facilitating better diagnosis and treatment planning.

In line with the principles of minimal intervention dentistry, digitizing the International Caries Detection and Assessment System (ICDAS) within CDAS expedites data entry and improves early detection [7]. Research validates that ICDAS evaluations are doable in high-volume dental practices [5] and efficient in harmonizing dental practices across the globe [2]. To help with well-informed treatment decisions, digital ICDAS enhances caries severity classification and decreases errors [3]. provides accurate data collection for epidemiological research, improving population-level caries understanding and management [8].

ii. Development of Mobile Application in dentistry

With features such as real-time data entry, improved portability, streamlined workflows, and reliable notification systems, mobile applications are being increasingly incorporated into dental practices. [16] emphasizes the benefits of apps such as Brush DJ for patient education and oral hygiene. [17] provides an example of how patient treatment management is supported by mobile apps. In order to enhance patient-centered care and communication, [18] investigates the use of a smartphone app for medical and dental integration.

Overall, mobile applications improve dental practices' productivity, accuracy, and patient involvement, supporting the movement toward patient-centered care and enhancing results.

iii. Mobile applications for dental care efficiency

The implementation of a mobile application for CDAS charting transforms caries detection and management, thereby greatly improving dental healthcare. By ensuring accurate and current patient records, real-time data entry reduces the possibility of errors and delays [9]. Additionally, mobile applications are portable and accessible, enabling professionals to view CDAS charts from any location, enhancing the standard of patient care and decision-making [9].

By tailoring these applications to the particular workflows of dental practices, workload efficiency is increased and administrative burdens are decreased [13]. Furthermore, to guarantee consistent patient care, integrated reminder and notification systems make it easier to manage follow-up evaluations and treatment plans [13]

iv. Mobile Application for Dental Practitioner Utilization

One major advancement in healthcare is the integration of mobile applications, especially through systems like CDAS, into dental practices. These programs maximize effectiveness and raise the bar for patient care by providing intuitive user interfaces that make navigating and interacting with them simple [12] Research indicates that user-friendly applications such as Dental Aid and Cavity Free 3D improve patient satisfaction and clinical outcomes.

ICDAS charting visualization is further enhanced by mobile applications, which offer comprehensive, interactive views to support accurate diagnoses and assessments (Datta, 2020). Thorough documentation and well-informed decision-making are made possible by sophisticated visualization tools and extensive commentary tagging. Furthermore, the methodical arrangement of dental charting history guarantees continuity of care and improves record-keeping efficiency [15].

Table 1: Comparison System

Aspects	**System/application**			
	OMG CLINIC	***UITM (HIS)***	***Dentiflow***	***CDAS APP***
Accessibility	Limited due to physical	Campus LAN	Digital interface	Authorize from various locations
Visualization	Manual, low detail	Digital with constraints	Digital imaging	Advance digital imaging
Commentary tagging	Not available	Available	Available	Available

3.0 METHODOLOGY

The methodical approaches employed are described in this chapter, commencing with the Agile model's adoption because of its adaptable and iterative qualities, which make it perfect for technological advancements in dental care. Several research methods are implemented for this project to gather a sufficient research and understanding on the issue; Requirement Gathering, Collect all data and compilations, Analyze the data collected, Design, Develop the system using SDLC and Test the performance & efficiency measurement.

I. REQUIREMENT GATHERING

The primary method of data collection in the O.M.Gigi Titiwangsa clinic case study is through interviews with dentists, which is essential for comprehending the requirements for dental care management. The process of gathering requirements begins with defining the problem statement and gathering pertinent information. To support and resolve the issues, related articles are then examined. In an interview with dental professionals, assistants, and administrative personnel in-person offers insights into their daily routines, difficulties, and particular needs. This qualitative data provides a thorough grasp of the user requirements and contextual factors influencing system utilization.

Table 2: Requirement Gathering Method

Interviews	The initial step in this project involved identifying the problem statement and collecting relevant data.
In depth observations	To see first-hand how current systems are used and where improvements can be made. This method captures real-time data on user interactions and system performance.
Comparison studies	To determine the status of data management and spot any gaps that the CDAS can fill, a review of previous records, reports, and documents pertaining to dental practices was conducted.

II. COLLECT ALL DATA AND COMPILATIONS

The features of the mobile app were determined based on comprehensive data gathering and examination. This phase involved compiling a list of needs, focusing on operational efficiency, digitalizing the system, and enhancing the visualization of ICDAS. A combination of primary and secondary data sources, including academic publications, books, and reports, was utilized to gather insights for the mobile application.Interviews revealed that the ICDAS and patient record systems at O.M.Gigi Titiwangsa clinic are managed manually, with physical documents used for charting and manual registration of patient profiles. Other than that, observational studies were also conducted within dental clinics to see firsthand how current systems are used and where improvements can be made. This method captures real-time data on user interactions and system performance.

III. ANALYZE THE DATA COLLECTED

The data from primary and secondary resources reveals that the client desires a user-friendly mobile application tailored for iOS, particularly for use on iPad. Practitioners seek technological advancements and modern image visualization for ICDAS charting, efficient commentary tagging, and a cloud-based server for seamless usage. To analyze the data gathered from primary sources, narrative analysis is chosen as the most suitable methodology. This qualitative research method systematically examines stories shared by O.M.Gigi dentists, aiming to uncover deeper meanings, structures, and themes within the system.

IV. DESIGN

In the context of the CDAS project, Object-Oriented Analysis and Design (OOAD) serves as a comprehensive methodology for structuring and organizing the system's components. The initial step involves identifying key objects within the CDAS system, such as Patients, Dentists,

Appointments, and Medical Records. Each identified object is then translated into classes, defining their attributes and associated methods.

V. SYSTEM DEVELOPMENT LIFECYCLE (SDLC)

To provide stakeholders a clear picture of the research development, every each stage of the approach was carefully designed to satisfy both technical and user-focused requirements. The paper ends with a summary of the main conclusions and insights, emphasizing the sequence of processes in the development of a useful, user-friendly CDAS that helps dentists and clinic administration, as listed.

- Requirement Gathering: objectives set, put together the project team, and carry out preliminary project planning. Focusing on CDAS features and functionalities, collaboratively collect and hone project requirements.
- Design and Prototyping: Creation of the database structures and user interfaces for the CDAS system. Wireframes created or prototypes to illustrate are an important feature and get early feedback from users.
- Development: Begin the development of key CDAS functionalities, like patient data management and digital charting. Making sure it is aligned with stakeholders' expectations by checking in frequently.
- Testing and Iterative Refinement: Test developed features thoroughly, fixing any bugs and guaranteeing functionality. Obtain user feedback, then make the required iterative improvements.

VI. Gantt Chart

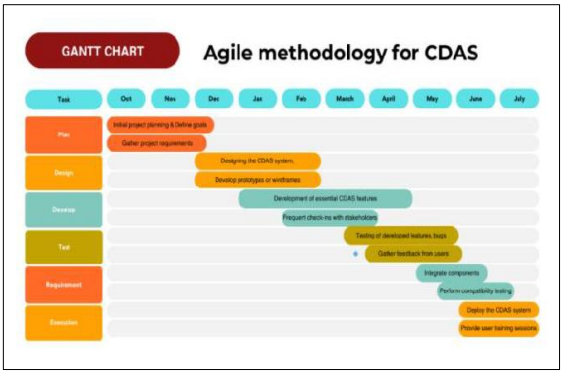

Figure 1: Gantt Chart

The project timeline provides an estimated duration for the project's completion within the allocated two-semester period. Starting in October 2023, the project is anticipated to conclude in October 2024. This timeline clearly delineates each phase of project development, establishing a structured schedule to guarantee compliance with the deadline and the successful delivery of the project.

VII. Use Case Diagram

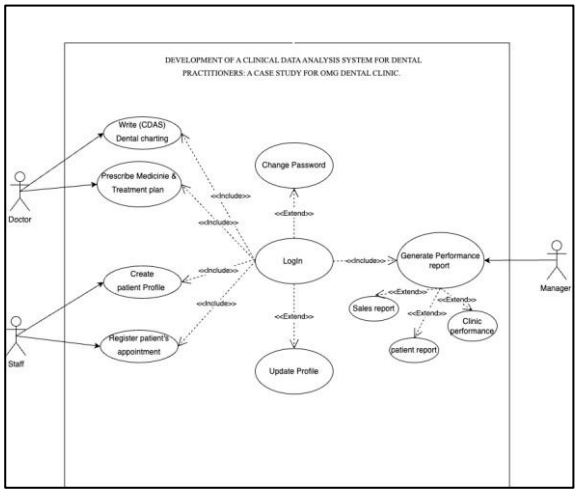

Figure 2: Use Case Diagram

The user-centric features of the CDAS system streamline dental clinic operations. These features include the creation of user profiles for identification and authentication, easy patient appointment scheduling, prescription generation that updates patient charts, CDAS charting from patient case notes for accurate records, and thorough clinic performance reports for strategic decision-making. Together, these characteristics improve dental clinic management's efficacy and efficiency.

v. Class Diagram

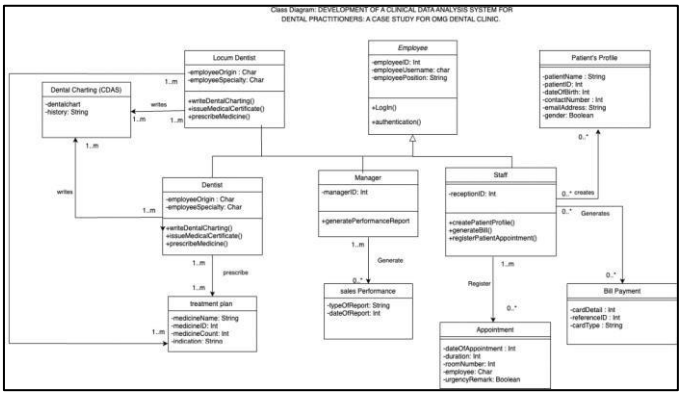

Figure 3: Class Diagram

The OMG Dental CDAS class diagram, shown in Figure 3, illustrates how various roles and components work together. "Locum Dentist," "Dentist," "Manager," and "Staff" are all members of the "Employee" class, having inherited from it. Multiple dental charts can be created by "Locum Dentist" and "Dentist" (many-to-many relationship). One-to-many treatment plans are assignable to the "Dentist" class. Managers have the ability to create numerous sales reports (zero-to- many). Workers are able to schedule numerous appointments (one-to-many). Employees have the ability to create zero-to- many patient profiles. Multiple bill payments (zero-to-many) can be generated for each patient profile. These connections show how different parts and roles in the system rely on one another.

vi. Sequence Diagram

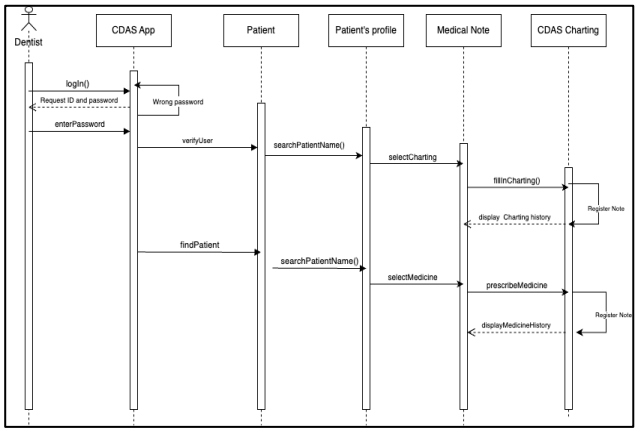

Figure 4: Sequence Diagram

Dentist will logIn() into CDAS apps and if wrong passwords, system will response with RequestID andPassword if correct, system will verify and lead user into patient page allowing to searchPatientName() in patient's profile and selectCharting in Medical Note. Dentist will be able to fillInCharting() in CDAS charting and system will register note and diplayChartingHistory.

vii. Activity Diagram

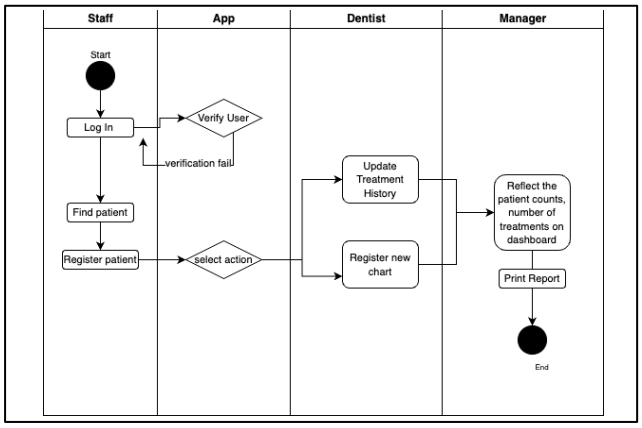

Figure 5: Activity Diagram

The activity diagram in Figure 5 shows the dental clinic workflow starting from employee login. After successful authentication, the employee registers the patient. The system provides action options, and if treatment history is involved, it moves to the dentist, who updates the records. The manager then reviews patient and treatment numbers. Finally, the administrator prints the report, completing the process. This diagram outlines the steps in patient registration, treatment documentation, and reporting.

7.0 PROTOTYPE DEVELOPMENT

Significant discoveries were made through the development and implementation of a CDAS specifically designed for dentists, especially in relation to the O.M.Gigi dental Clinic. This chapter provides a detailed overview of user feedback, extensive testing conducted, and the overall suitability and reliability of CDAS for dental applications. Through extensive research and advancements, this project have ensured that CDAS not only meets, but exceeds, the demands of dentists.

The durability and the suitability of the CDAS system for dental use were confirmed by a rigorous testing protocol. For usability testing, a representative sample of both new and experienced users was selected in accordance with ISO 9241-11:2018 guidelines. The significance of comprehensive testing and user feedback is emphasized by the third objective, " To test the developed prototype & system design, address any issues, and gather user feedback.

There were several testing stages carried out:

I. *Unit testing*

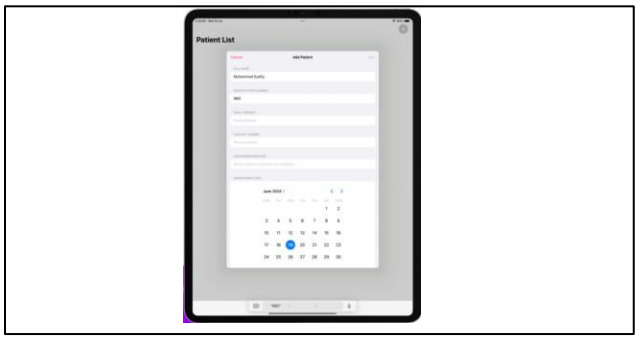

Figure 6: Filling Patient's record

To guarantee reliability and functionality, the patient registration portion of the CDAS application is put through a rigorous testing process. Key functions like "validateInput()," "savePatientRecord()," and "generatePatientID()" are identified during this process to guarantee correct input validation, recording, and acknowledgment. To improve module reliability, comprehensive test cases cover a wide range of input scenarios, including anomalous and erroneous data.

A selected framework is used to test each function, and the results are examined for irregularities. According to preliminary testing, patient data is successfully registered by the patient registration system, which operates as anticipated. Test failures trigger code corrections and retesting to make sure problems are fixed. The module's functionality and dependability are ensured by this iterative cycle of testing, debugging, and retesting, which eventually improves patient management and user experience (Beck, 2002).

II. *Integration testing*

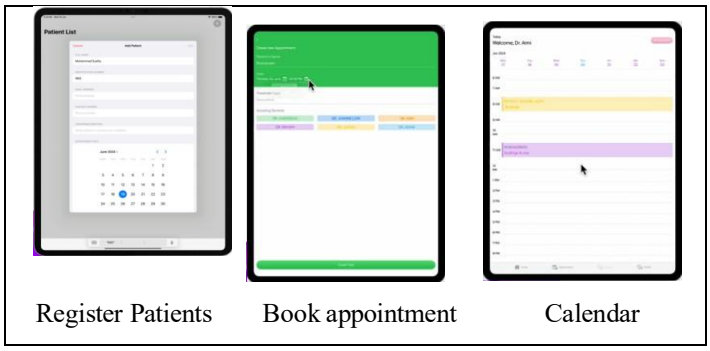

Figure 7: Integration testing

The interface between the modules for scheduling appointments and patient registration was thoroughly tested to ensure efficient data transfer and communication. Establishing communication channels between the patient admission and registration modules and outlining the sharing of patient data for appointment scheduling marked the first step in the process. One of the scenarios involved setting up an appointment immediately after a patient checks in, guaranteeing smooth information exchange.

Real-time data updates and transfers between modules were the main focus of integration testing. The system's ability to successfully register patients and pair them with suitable doctors was confirmed by the results, indicating efficient real-time data interaction. We found, trouble shoot, and fixed any data transfer anomalies or module malfunctions before retesting to make sure all problems were fixed.

III. *System Testing*

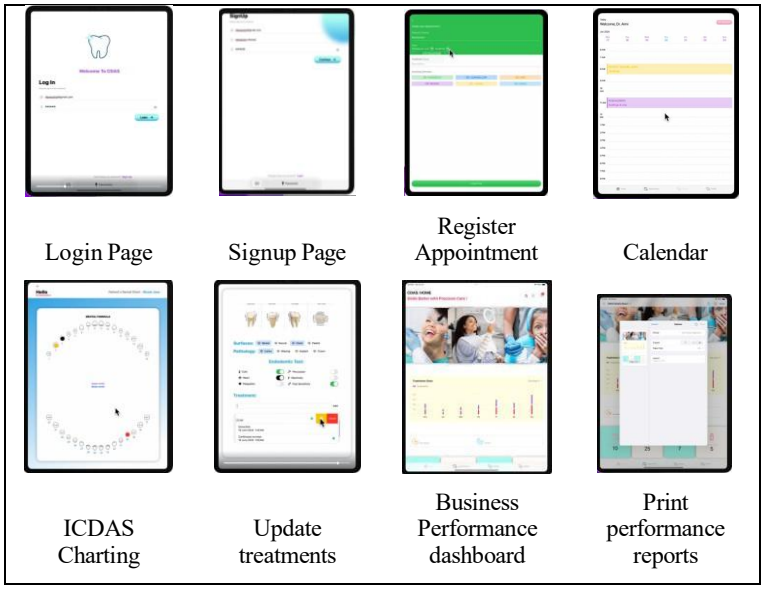

Figure 8: Integration testing

Every component of the CDAS system, such as patient registration, dental billing, and appointment scheduling, was thoroughly tested. A testing schedule, comprehensive test objectives, parameters, procedures, and tools were established. Functionality in common use cases such as patient registration, dental record-keeping, and appointment scheduling was guaranteed by tools that emulated end-user actions.

Critical performance metrics like throughput, response time, and resource utilization were continuously tracked to identify any irregularities or performance degradation. Load testing tools assessed system performance under high user loads. All test scenarios were handled by the system with success, demonstrating that the CDAS works as intended. Retesting will be done to make sure that problems are fixed and reliability is maintained after infrastructure improvements, code optimizations, or configuration adjustments are made to address performance issues or bottlenecks.

IV. *Usability testing*

These questions are crafted to address the core usability aspects of efficiency, effectiveness, and satisfaction, as outlined by Jakob Nielsen's usability principles. This structured approach will help gather comprehensive insights into the user experience with the CDAS mobile app. By aligning usability testing goals with metrics for effectiveness, efficiency, and user satisfaction,

developers can gain comprehensive insights into how well the app meets user needs. Since that dental clinics are the intended use of CDAS, a variety of stakeholders should be included in the participant categories for testing:

- Dentists: Prominent users of the system who will utilize it for patient management, medication prescription, certification of qualifications, and registration.
- Dental assistants are secondary users who help with staff selection, schedule appointments, and manage patient registration.
- Clinic Administrators: Both novice and seasoned administrators are in charge of scheduling appointments, billing, and performance reports.

These categories guarantee thorough testing of usability, taking into account various user interactions as noted by Nielsen (1994), Usability.gov, and ISO 9241-210:2010 standards. This alignment ensures that usability testing not only identifies issues but also guides improvements to enhance the overall user experience. The overall percentage can be gained by calculating the total percentage of overall satisfactory rate based on each user's feedback.

Table 3: User Feedbacks calculation table

Rate	Dr. Hanessha (primary user)	Dr. Joanne (Secondary User)	Dr. Aimi (New User)	**Total**
	24/30	26/30	20/30	70/90
Efficiency (%)	77.78%			
Rate	26/30	27/30	19/30	72/90
Effectiveness (%)	80%			
Rate	31/40	36/40	28/40	95/120
Satisfaction (%)	79.16%			

The efficiency rating of the CDAS mobile app was 77.78%, indicating that it was easy to navigate and perform tasks. However, there is still room for improvement in terms of task completion time and navigation. At 80%, effectiveness scored the highest, indicating that the app can facilitate precise task completion with few errors. This proves the app's dependability for managing patients and recording dental charts. A 79.16% user satisfaction rating indicates a generally good user experience with an easy-to-use interface. Users did, however, draw attention to a few areas that needed work, including form input validation and functionality.

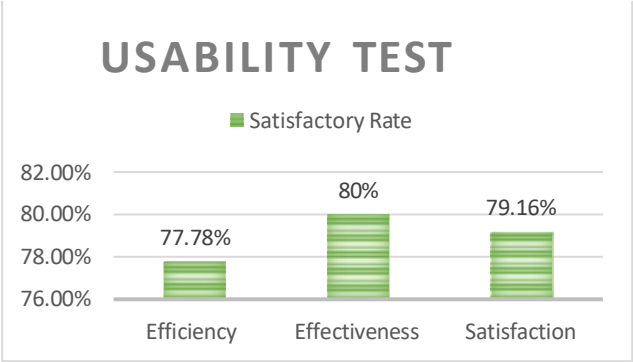

Figure 9: Satisfactory rate for usability test

5. CONCLUSION

The CDAS mobile application's usability test provided important information about the user experience and areas for development. Users gave the app an 80% overall satisfaction rating, saying it was effective and easy to use, especially for tasks like patient registration and charting from the usability testing's method use which is surveys.

Nielsen Norman Group, a leading authority on user experience, does not prescribe specific benchmarks or "ideal" percentages for effectiveness, efficiency, and satisfaction in usability testing. However, emphasise on the importance of context and continuous improvement is mentioned. The goal is generally to achieve as high a score as possible in each area, with the understanding that these metrics will vary based on the complexity of the task, the user base, and the specific goals of the application.

For effectiveness, typically, a high effectiveness rate would be close to 100%, indicating that almost all users can complete the tasks they set out to do without errors. In this project, with an effectiveness of 80%, most users can complete their tasks successfully, but there might be some room for improvement. While this project's efficiency at 78%, there's no "ideal" number; higher percentages indicate that users can achieve their goals more swiftly and with fewer steps, which is always preferable. Lastly, satisfaction is highly subjective and varied; higher scores (close to 100%) are desired, in this case 78% indicates users feel confident and comfortable with the app, which can lead to higher adoption rates and more frequent use. Although the CDAS mobile app functions well overall, a few issues need to be fixed to improve usability and user satisfaction.

I. Future Recommendation - Based on Findings

Enhancing search capabilities for swift data retrieval, putting flexible form input validation in place to minimize errors, and simplifying the navigation menu for improved usability are all part of improving the CDAS mobile app.

Enhancing task efficiency and preventing form resets can be achieved by fortifying error-handling mechanisms. Giving users thorough support documentation will enable them to handle problems on their own.

Ensuring that the app adapts to user needs and expectations is ensured by regularly incorporating user feedback into the development process. Increased productivity, user satisfaction, and general system usability are the goals of these enhancements (Nielsen, 1994; Jacobs, 2003).

II. Future Recommendation - Specific User Scopes

Introducing specific user scopes in the CDAS system will enhance its functionality and management as the clinic grows. Administrators will have advanced access control to manage user roles, ensuring secure handling of sensitive information and approving requests like reimbursements and intensive care plans. Managers will be able to generate critical reports such as sales, admission, and performance reports, aiding strategic business planning and operational efficiency. Dentists and locum dentists will be empowered to prescribe treatments, issue Medical Certificates, and manage detailed patient records, improving patient care and ensuring comprehensive documentation (Nielsen, 1994; Jacobs, 2003).

III. Further Enhancement

To improve operational efficiency and patient experience, several enhancements are recommended for the CDAS system. Introducing bill payment generation will automate invoicing, payment tracking, and reminder sending, streamlining the billing process. Adding medical certificate generation will allow dentists to issue official documents directly through the platform with customizable templates, ensuring compliance and consistency.

An approval action request feature will enable staff to submit requests for refunds, patient referrals, and treatment plans, enhancing decision-making and accountability. Enhanced user access configuration will allow administrators to manage user roles and access levels, ensuring data security and compliance. Lastly, implementing monthly clinic performance reports will provide valuable insights into key performance indicators, aiding in strategic planning and continuous improvement (Nielsen, 1994; Jacobs, 2003).

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