

An Information System for Private Dental Clinic with Integration of Chat-Bot System: A Project Development Plan



Jovanne C. Alejandrino^{1*}, Efhrain Louis P. Pajota²

¹Professional Schools, University of Mindanao, Davao City, Philippines,

²College of Computing Education, University of Mindanao, Davao City, Philippines,

jovanne_alejandrino@umindanao.edu.ph, efhrain_pajota@umindanao.edu.ph

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ABSTRACT

Businesses that use Information Systems are likely to have an advantage over those still using conventional systems. This paper proposes a design of a Web-based Dental Information Management System for a private dental clinic. This design will facilitate the automation of business processes such as storing dental records, billing processing, generation of reports, and integration of Artificial Intelligence through Chatbot technology for smart appointment systems, as well as accessibility to various users, including patients, dentists, and staff. For software development and testing, the project will use the V-Model methodology. The Information System development plan was prepared by first identifying major work packages and conducting stakeholder interviews. Thus, the time and cost needed were estimated, which led to the creation of a budget plan with an amount of PHP431,774.04 with a total duration of 158 working days. A two-year Financial Viability analysis is used to determine the project's cost/benefits evaluation. If the clinic serves an average of 10 clients per day, the time spent on the activities is reduced to 68.75%, which implies it can handle more patients because the processing time is significantly reduced. It is recommended for future improvement of this plan to integrate Decision-support systems for detecting tooth diseases and dental treatments in patients.

Key words : Information Systems, Dental Clinic, Project Management Plan, Chatbot

1. INTRODUCTION

Oral health is vital to general health [1][2]. Most oral-related diseases are considered as one of the contributing factors for chronic diseases [1]. Recent epidemiologic research has shown relationships between oral and cardiovascular health. [2]. Aside from cardiovascular health, it was also found out that good oral health reduces the risk of diabetes patients. [3]. Oral health education needs to become a priority for healthcare providers in educating patients about the potential benefits of oral health.

Dental Clinic is one of the health institutions responsible for providing medication and health treatment for different types of dental diseases[4]. Patients who suffer from oral diseases will visit the clinic which nearby their location. However, most of the staff in the clinic still use a traditional method in handling their patient's information. This means that the customers must manually fill in their details in the patient's forms. This can cause delays when retrieving patient information and reports [5]. Patient-centered care relies on the timely availability and accessibility of accurate information [6].

Aside from the manual process, an efficient patient appointment scheduling system is essential in dental clinics, especially with the spread of the COVID-19 virus. Both dental patients and staff are at high risk of being infected by the virus. To guarantee that dental clinics perform services effectively, efficiently, and safely, a well-designed appointment system must be realized. In most cases, most patients frequently lament how long it takes for the dental staff to attend to them when they enter the clinic. Mobile appointment systems have been proposed for use in the health sector, particularly in dental clinics, to optimize efficiency and better schedule patients based on their priorities. [7].

The rapid advancement of computer technology is used to expand computer assistance in solving intricate problems. Enhancing the organization's processes for data creation, management, and use is important due to the demand for accessible, quick, and efficient information access. [8]. The use of management information systems by businesses helps them achieve their goals, plan and control their daily operations, and maximize their overall efficiency in order to acquire a competitive edge and increase their profitability. [8][9].

An effective and high-quality patient-centered approach is supported using healthcare management systems. Instead of the conventional paper-based one, the electronic patient record has already surpassed it as the leading record method in the healthcare industry. [10]. In the Fourth Industrial Evolution Era (FIRE), we can observe new emerging technologies using so-called big data analytics, artificial

intelligence, internet-of-things for health monitoring. These tools are used to track patients' health conditions continuously. As a result of the development of these technologies, clinicians can now see new opportunities for structuring care and treatment in a way that can be more practical for our daily lives. [10].

Artificial Intelligence (AI) is one of the technologies emerged in the FIRE. AI is the ability of a computer or machine to imitate the skills and traits of the humans, including learning from examples and experience, object recognition, language comprehension, decision-making, problem-solving, and the combination of these to carry out tasks in a manner similar to that of a human [11]. A chatbot, often known as a chatterbot, is an AI component that may be included into a variety of messaging and system applications. A chatbot is a computer software that simulates human conversations in their natural text or spoken forms by utilizing artificial intelligence techniques including Natural Language Processing (NLP), audio analysis, and image and video processing audio analysis. [12]. AI algorithms that assess user inquiries will be used to create a chat-bot for dental clinic systems. Using NLP to stimulate and engage in a conversation with a patient, getting them to reveal symptoms, and then transmits that data to doctors, along with a partial analysis.

This project is a project development of implementing new computer-supported dental clinic information management system. Aside from the automation of the business process, this project aims to embed Artificial Intelligence with the use of Chat-bots using Natural Language Processing in pre-diagnosing dental patients and an automated smart scheduling appointment system..

1.1 Project Objectives

The objective of this project is to fully automate the clinic’s daily operation by designing a Dental Clinic Information Management System, leading the clinic to operate in an effective and efficient way to eliminate paperwork and resources and provide accurate records and reports.

Specifically, the objectives of this study are to:

1. Design a system module for the Dentist to view and record patient dental history and design a treatment plan for orthodontics patients.
2. Design an appointment booking system that integrates the Rule-based Chatbot AI technology, that analyzes the patient’s query and automatically book dental appointments for the patients.
3. Design an Inventory System that can keep track of medicine and dental supplies.
4. Design a system module that will automate the medical prescriptions, medical certificates, and billing statements;
5. Design a module that will allow the clinic to connect with other third-party platforms, such as the Customer Relationship Management System, Payment Processor Integrations, Analytics, and Reporting Tools through API integrations.
6. Design a website using Content Management Software to increase the clinic’s brand credibility and visibility to the customers and gain a competitive advantage over competitors.

7. Rank the clinic website on the top result page of search engines in Dental Clinic in Panabo City using Search Engine Optimization tools and techniques..

1.2 Scope and Limitations

The scope of this project is to design a Web-based Clinic Information Management System for Romero Dental Clinic. The system focuses on keeping patient dental records, online viewing services, online scheduling with rule-based Chatbot System using Natural Language Processing, inventory system for medical and dental supplies, and notifying patients with SMS and Decision Support System for the dental treatment plans. The system also generates reports according to the needs of the dentist and can view the previous and current patient records.

1.3 Project Stakeholders

The participating stakeholders are identified and grouped in two- the external and internal organization.

The external interface of the project is composed of the following: The Dentist, the dental staff, the radiologist, and the laboratory technician. Figure 1 shows the project’s external interface hierarchy.

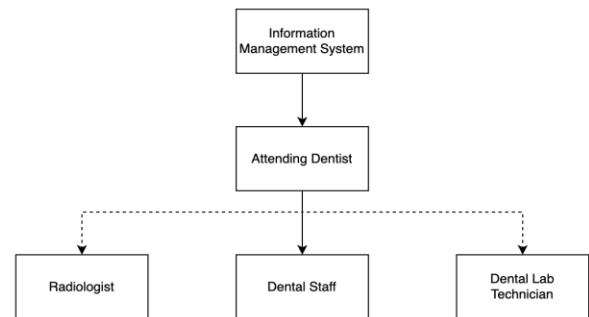


Figure 1: External Organization

The project's internal interface consists of the Project Sponsor, a Project Manager, the Lead and Junior Programmer, System Analysts/Designer, the Quality Assurance Tester, and the Database Administrator. Figure 2 shows the project's internal interface hierarchy.

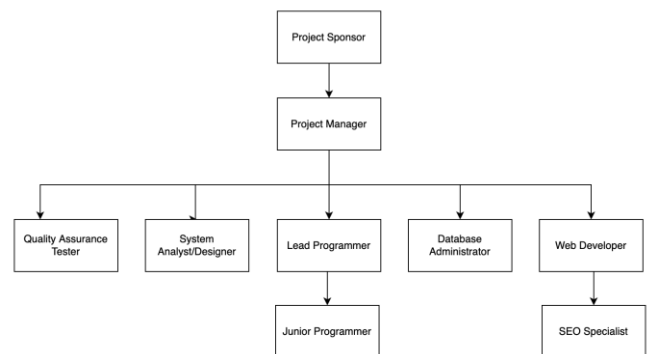


Figure 2: Internal Organization

2. MANAGERIAL PROCESS PLANS

This section presents the schedule and cost estimates of the proposed Information Systems. The expected budget, which was determined using the ground-up costing method, is shown in the tables below. The cost obtained at each level of the work breakdown structure is calculated and compiled for addition at each phase of the project.

2.1 Manpower Cost Estimates

Table 1 shows the estimated cost of manpower for the project based on the estimated number of man-days required for each role and the estimated daily rate of each role.

Table 1: Manpower Cost Estimates

Roles	Mandays	Rate/Day	Costs
Project Sponsor	13.45	0	₱0
Project Manager	42.70	₱1,818.18	₱77,636
Sad	23.63	₱1,150.59	₱27,183
Database Admin	14.81	₱1,522.36	₱22,550
Senior Programmer	51.31	₱1,518.73	₱79,164
Junior Programmer	47.75	₱1,136.36	₱54,261
Quality Assurance Tester	36.50	₱1,011.23	₱36,910
Dentist	0.25	₱0.00	₱0
Dental Assistant	0.25	₱768.73	₱192
Dental Lab Technician	0.25	₱1,135.77	₱284
Patient	0.25	₱1,000.00	₱250
Web Developer	11.39	₱1,136.36	₱12,940
SEO Specialist	8.13	₱1,136.36	₱9,233
TOTAL	251.48		₱320,603.32

2.2 Schedule Estimates

Table 2 shows the summary of the project schedule, broken down per phase.

Table 2: Manpower Cost Estimates

Phase	Duration (Mandays)	Start Date	End Date
Definition Phase			
Project Proposal and Approval	3.31	April 1, 2024	April 8, 2024
Project Preparation	3.00	April 10, 2024	April 15, 2024
Project Research and Development	3.56	April 16, 2024	April 22, 2024
Project Planning	8.19	April 23, 2024	May 7, 2024
Project Procurement	3.75	May 8, 2024	May 15, 2024
Project Kick-off	8.75	May 15, 2024	May 30, 2024
Phase Total	30.56	April 1, 2024	May 30, 2024

Build Phase			
System Design	14.50	May 31, 2024	June 28, 2024
System Development	59.14	July 1, 2024	Sept 27, 2024
Phase Total	73.64	May 31, 2024	Sept 27, 2024
Trial Phase			
System Testing	7.25	Sept 30, 2024	Oct 9, 2024
Implementation	5.00	Oct 10, 2024	Oct 16, 2024
Phase Total	12.25	Sept 30, 2024	Oct 16, 2024
Live Phase			
User Training and Acceptance	5.88	Oct 17, 2024	Oct 25, 2024
System Validation	5.25	Oct 28, 2024	Nov 5, 2024
System Monitoring	26.25	Nov 7, 2024	Nov 12, 2024
Project Closure	3.50	Dec 13, 2024	Dec 19, 2024
Phase Total	40.88	Oct 17, 2024	Dec 19, 2024
TOTAL	157.33	April 1, 2024	Dec 19, 2024

2.3 Hardware Cost Estimates

Table 3 shows the estimated cost of the required hardware.

Table 3: Hardware Cost Estimates

Hardware	Specification	Qty	Price	Total Cost
Desktop Computer	Core i3-9100F 8GB DDR4 Memory 512GB SSD Keyboard Mouse 18inch LCD Monitor	1	₱27,859.00	₱27,859.00
InkJet Printer	Print Method: On-demand inkjet (Piezoelectric) Maximum Print Resolution: 720 x 720 dpi	1	₱1,599.00	₱1,599.00
Total cost				₱29,458.00

2.4 Software Cost Estimates

Table 4 shows the estimated cost of the required software.

Table 4: Software Cost Estimates

Software	Qty	Price	Total Cost
XAMMP	1	Free	Free
Laravel	1	Free	Free
Sublime Text	2	₱0.00	₱0.00
Domain Name	1	₱2,500.00/year	₱2,500.00
Web Hosting	1	₱2,200.00/year	₱2,200.00
Total cost			₱4,700.00

2.5 Project Cost Summary

Table 5 shows the monthly budget allocation for the project. The following costs are included: Work Breakdown Cost, Technology Cost, Audit Cost, and Effort Cost.

Table 5: Project Cost Summary

Year	Month	WBS Cost	Technology Cost	Audit Cost	Effort Cost	Total Cost	Cumulative Cost
2024	April	₱28,291.91		₱ 5,000.00	₱ 2,658.74	₱35,950.65	₱35,950.65
	May	₱36,816.12	₱ 29,458.00	₱ 5,000.00	₱ 3,613.54	₱74,887.66	₱110,838.31
	June	₱25,396.72		₱ 5,000.00	2,539.67	₱32,936.39	₱143,774.70
	July	₱63,118.86		₱ 5,000.00	₱ 6,473.84	₱74,592.70	₱218,367.40
	August	₱44,153.55		₱ 5,000.00	₱ 4,415.35	₱53,568.90	₱271,936.30
	September	₱31,346.49	₱ 3050.00	₱ 5,000.00	₱ 3,134.65	₱42,531.14	₱314,467.43
	October	₱31,350.68	₱ 550.00	₱ 5,000.00	₱ 3,139.03	₱40,039.71	₱354,507.14
	November	₱29,515.32	₱ 550.00	₱ 5,000.00	₱ 2,951.53	₱38,016.85	₱392,523.99
	December	₱30,636.41	₱ 550.00	₱ 5,000.00	₱ 3,063.64	₱39,250.05	₱431,774.04
	TOTAL	₱320,626.05	₱34,158.00	₱45,000.00	₱31,989.99	₱431,774.04	

2.6 Financial Viability Evaluation

The first step in determining the project's financial sustainability is to achieve the cost of executing clinical activities by regularly delivering their customers their services. The total time spent multiplied by the hourly rate of the employees provides the cost of the activity in each activity.

To compute the total annual saving for this process, first, compute the expenses incurred for the current process and get the difference from the proposed process computation. The Table 6 shows the computations of the time spent for the current and proposed processes.

Table 6.: Time spent: Current vs Proposed Processes

Processes	Current	Proposed	Difference
1. Billing Process	10 mins	3 mins	7 mins
2. Preparation of Sales Report	30 mins	7 mins	23 mins
3. Preparation of Inventory Report	10 mins	5 mins	5 mins
4. Booking Appointment Process	15 mins	5 mins	10 mins
5. Inventory Process	15 mins	5 mins	10 mins
Total	80 mins	25 mins	55 mins

Table 7 shows the computations of the expenses for the current and proposed processes.

Table 7: Expenses: Current vs Proposed Processes

Processes	Current	Proposed	Difference
1. Billing Process	₱15.63	₱4.69	₱10.94
2. Preparation of Sales Report	₱46.88	₱10.94	₱35.94
3. Preparation of Inventory Report	₱15.63	₱7.81	₱7.82
4. Booking Appointment Process	₱23.44	₱7.81	₱15.63
5. Inventory Process	₱23.44	₱7.81	₱15.63
Total	₱125.00	₱39.06	₱85.94

To compute the total savings per month, we will simply divide the annual savings (P226,875.00.) by twelve (12) which will yield a monthly savings of P18,906.25. Doing a projection for the next twenty-four (24) months, the cumulative costs and cumulative savings are computed as shown in Table 8.

Table 8.: Cumulative Cost VS Cumulative Saving

Month	Cost	Savings	Cumulative Savings
Dec 2024	₱ 431,774.04	₱ 18,906.25	₱ 18,906.25
Jan 2025		₱ 18,906.25	₱ 37,812.50
Feb 2025		₱ 18,906.25	₱ 56,718.75
Mar 2025		₱ 18,906.25	₱ 75,625.00
Apr 2025		₱ 18,906.25	₱ 94,531.25
May 2025		₱ 18,906.25	₱ 113,437.50
Jun 2025		₱ 18,906.25	₱ 132,343.75
Jul 2025		₱ 18,906.25	₱ 151,250.00
Aug 2025		₱ 18,906.25	₱ 170,156.25
Sep 2025		₱ 18,906.25	₱ 189,062.50
Oct 2025		₱ 18,906.25	₱ 207,968.75
Nov 2025		₱ 18,906.25	₱ 226,875.00
Dec 2025		₱ 18,906.25	₱ 245,781.25
Jan 2026		₱ 18,906.25	₱ 264,687.50
Feb 2026		₱ 18,906.25	₱ 283,593.75

Mar 2026		₱ 18,906.25	₱ 302,500.00
Apr 2026		₱ 18,906.25	₱ 321,406.25
May 2026		₱ 18,906.25	₱ 340,312.50
Jun 2026		₱ 18,906.25	₱ 359,218.75
Jul 2026		₱ 18,906.25	₱ 378,125.00
Aug 2026		₱ 18,906.25	₱ 397,031.25
Sep 2026		₱ 18,906.25	₱ 415,937.50
Oct 2026		₱ 18,906.25	₱ 434,843.75
Nov 2026		₱ 18,906.25	₱ 453,750.00

Based on the table above, the expected payback period will commence after 22 months of implementation. During this time, at the cost of ₱431,774.04 the cumulative savings will be ₱434,843.75.

3. QUALITY CONTROL

Software quality can be seen as having three aspects: functional quality, structural quality, and process quality. Functional quality means that the system can perform the tasks it is intended to do for its users. The structural quality considers how the structure of the codes. Process quality, on the other hand, talks about the quality of the development process.

3.1 Software Development Methodology

The project will employ the V-Model for software development and testing approach to solve these three factors. The two components of the model—Verification and Validation—as well as its structure is why it is known as the V-model. All deliverables must be checked and verified for each stage in the model. Software testing is carried out for validation to guarantee software quality. The V-Model parallel plans the corresponding testing phase of the development phase. Phases of verification and validation are located on opposite sides of the "V," respectively. The V-two Model's sides are connected by the coding phase. Figure 3 below shows V-Model Software Development and Testing Methodology.

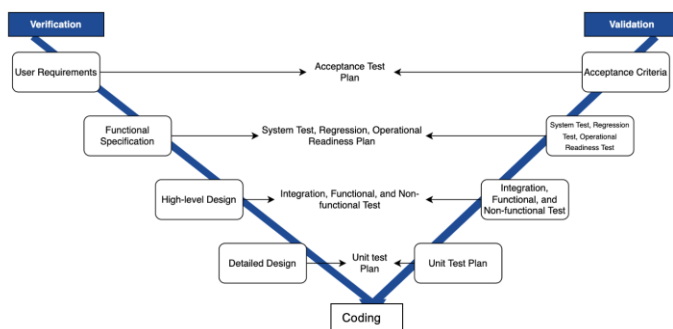


Figure 3: V-Model Software Development and Testing Methodology

3.2 Risk Management Process

In the standard (AS/NZS 4360:2004), risk management is described as "the systematic application of management policies, processes, and practices to the activities of setting the context, identifying, analyzing, assessing, treating, monitoring, and communicating."

It is an iterative approach that can gradually enhance an organization by giving management a better understanding of risks and their effects with each cycle.

The procedure for managing risks for the project is shown in Figure 4.



Figure 4: Risk Management Process

3.3 Project Framework

The goal of the project is to improve the current business process of the clinic by creating an Information System with the following modules.

1. Admin Module – This module will allow the owner/admin to manage data, control access to the dental records, and manage different modules of the system.
2. Billing Module – This module will allow the clinic to effectively execute their billing and payment transactions. This module will be in for managing the billing information of the patients.
3. Inventory Module – this module will allow the dental assistant to monitor and manage the inventory of medicine and dental supplies.
4. Patient Module – This module allows the patients to view general information online. This will also allow them to request dental records and payment records. Additionally, this module will also allow them to book appointments.
5. Reporting Module
 - a) Reports – this module will allow the staff to generate standard reports needed by the top management and DOH.
 - b) Dashboard – This feature will allow the organization to view data and statistical information provided by the organization for decision making. Figure 5 below shows the project framework.

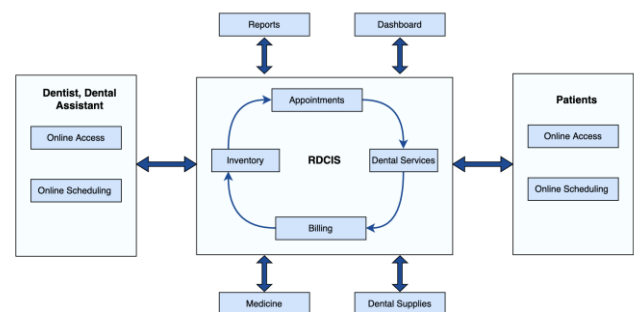


Figure 5: Project Framework

3.4 System Architecture

Figure 6 below shows the system architecture of the Dental Information Management System. The users of the system are the patients, dentists, and dental assistants. A web-based system will be deployed while the patients will be accessing the system via the Internet. A server will manage all database and web transactions.

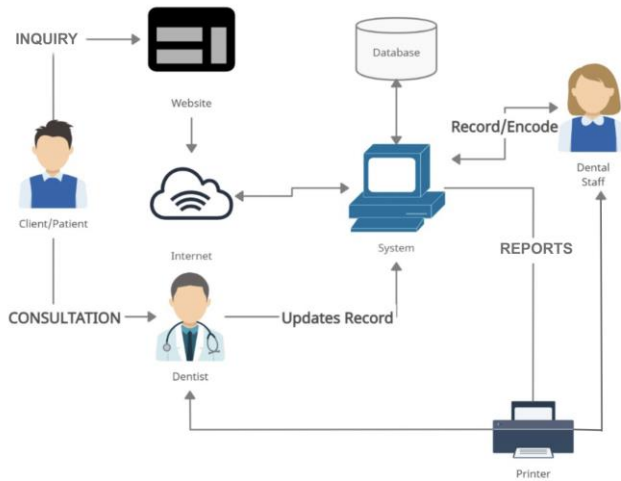


Figure 6: System Architecture

3.4 Continuous Improvement

The Plan Do Check Act (PDCA) framework will be followed to support continuous improvement (figure 7).

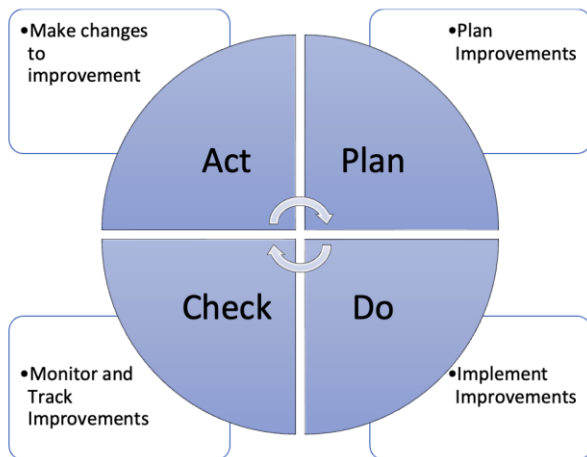


Figure 7. Continuous Improvement Process

4. CONCLUSION

This proposed Dental Clinic Information System helps dental clinics gain a competitive advantage over those still using conventional systems. Dental clinics must have a reliable method of managing business processes, securing patient records, and scheduling patient appointments, especially given

the spread of the COVID-19 virus. The Fourth Industrial Revolution Era (FIRE), which has seen a rapid advancement in technology, requires that we continue to work in the direction of artificial intelligence in order to increase the effectiveness of dental information systems.

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