



CDAP - PROJECT PROPOSAL

Smart Dentassist;

An Interactive System for Dental Support and
Patient Management

Project ID : 15-085

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SUPERVISOR

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Name	Signature	Date

DECLARATION

“We declare that the project would involve material prepared by the Group members and that it would not fully or partially incorporate any material prepared by other persons for a fee or free of charge or that it would include material previously submitted by a candidate for a Degree or Diploma in any other University or Institute of Higher Learning and that, to the best of our knowledge and belief, it would not incorporate any material previously published or written by another person in relation to another project except with prior written approval from the supervisor and/or the coordinator of such project and that such unauthorized reproductions will construe offences punishable under the SLIIT Regulations.

We are aware, that if we are found guilty for the above mentioned offences or any project related plagiarism, the SLIIT has right to suspend the project at any time and or to suspend us from the examination and or from the Institution for minimum period of one year”.

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Abstract

This proposal will describe the necessity of an Interactive System for Dental Support and Patient Management for the oral health sector in Sri Lanka, to address common issues faced by dentists as well as patients in general dentistry. This document also contains descriptions of the technologies that will be used and the impact of the project on the selected segment working from literature surveys, reviews and interviews. It is quite clear that no similar system exists for the Sri Lankan context. Once approved, the research project will be carried out according to its objectives, goals and the scope according to the way it is planned. In general, if the project is carried out successfully, it would certainly add numerous benefits to the oral health sector. The project formally commenced in February 2015. Although it is said to be of a time span of one year, the project is intended to be completed by the second week in November 2015.

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1. Introduction

1.1 Background

Oral diseases such as dental caries and periodontal diseases are the most common type of diseases plaguing a greatly significant percentage of humans regardless of age factor. However widespread and common oral diseases may be, they are also the most neglected and ignored health conditions in today's context. Dentistry can also be considered as the most stagnating field of medicine with respect to the advancement of technologies used. The main reasons for the high prevalence of oral diseases are quite simple and clear; negligence, poor hygiene, poor education, harmful habits and unavailability of dental health facilities. It is also worthy of mentioning that oral diseases are a category of diseases which can be easily diagnosed, prevented and cured but unfortunately the most frequently neglected and ignored.

The WHO sums states that worldwide nearly 100% of adults and 60-90% of children suffer from oral diseases. The WHO identified the most common risk factors as poor oral hygiene, unhealthy diet, use of tobacco and alcohol.^[1] BDF identifies that sugary food and drinks have a major ill impact on children's oral health.^[2] In Sri Lankan context, chewing betel is the most harmful habit for oral health, inevitably resulting in oral cancer.

The WHO concludes that prevention of oral diseases can be achieved by ensuring proper oral hygiene and maintaining a healthy diet.^[1] It is a well-known fact that visiting a dentist once in six months is healthy practice^[2], but unfortunately these check-ups are frequently forgotten until one faces some pain or discomfort or visible change related to the oral cavity. Hence, preventative measures are not neglected. The WHO has discovered that oral diseases could ultimately lead to cardiovascular diseases, cancer, chronic respiratory diseases and diabetes. .^[1]

The causes and prevention of oral diseases are clear and simple, yet frequently neglected.

1.2 Literature Survey

According to the **WHO Media Centre Fact Sheet**, the result of a survey carried out worldwide;.^[1]

- 100% of adults suffer from dental caries.
- 60-90% of children suffer from dental caries.
- Severe periodontal (gum) diseases which may lead to tooth loss is found in 15–20% of middle-aged (35-44 years) adults.
- Globally, about 30% of people aged 65–74 have no natural teeth.
- The incidence of oral cancer ranges from 1 - 10 cases per 100 000 people in most countries.
- The prevalence of oral cancer is relatively higher in men, in older people, and among people of low education and low income.
- Almost half (40–50%) of people who are HIV-positive have oral fungal, bacterial or viral infections.
- Across the world, 16-40% of children in the age range 6 to 12 years old are affected by dental trauma.

The WHO also states that “the prevalence of oral disease varies by geographical region, and availability and accessibility of oral health services. Social determinants in oral health are also very strong. The prevalence of oral diseases is increasing in low- and middle-income countries, and in all countries, the oral disease burden is significantly higher among poor and disadvantaged population groups.”^[1]

According to the **National Institute of Dental and Craniofacial Research** in the USA;^[3]

- The percentage of children with caries in primary teeth
 - 2 to 5 years - 27.90 %
 - 6 to 11 years - 51.17 %

- The percentage of adolescents with caries in permanent teeth
 - 12 to 15 years - 50.67 %
 - 16 to 19 years - 67.49 %
- The percentage of adults with caries in permanent teeth
 - 20 to 34 years - 85.58 %
 - 35 to 49 years - 94.30 %
 - 50 to 64 years - 95.62 %
- The percentage of seniors with caries in permanent teeth
 - 65 to 74 years - 93.25 %
 - 75 years or more - 92.70 %
- Prevalence of periodontal diseases among adults
 - 20 to 34 years- 3.84 %
 - 35 to 49 years - 10.41 %
 - 50 to 64 years - 11.88 %
- Prevalence of periodontal diseases among seniors
 - 65 to 74 years - 10.20
 - 75 years and over - 11.03

According to the **British Dental Health Foundation**, poor dental health could lead to ^[2]

- Dental decay
- Oral cancer
- Strokes
- Heart diseases
- Lung conditions
- Bad breath
- Tooth loss

- Gum diseases
- Diabetes

According to the **Sri Lanka Annual Health Bulletin-2012**, the unawareness of dental diseases^[4]

- among children is 75.81% ,
- among adults is 44.39%
- among the elderly is 71.15% .

It has been observed in 2012 that In Sri Lanka, prevalence of oral cancers is taking an upward curve among the youth, middle aged and elderly populations. ^[4]

Ministry of Health in collaboration with the World Health Organization has conducted three National Oral Health Surveys including the present survey in 1983/84, 1994/95 and 2002/2003. These surveys indicate overall declining trend in prevalence and severity of dental caries yet marking a substantial problem among all age groups. ^[4]

The reasons for these in Sri Lankan context mainly being negligence of oral health, poor education, poor hygiene, smoking and chewing betel and tobacco. ^[4]

**Table 4.4 : Prevalence and Severity of Dental Caries
by National Oral Health Surveys**

Age group	Prevalence & severity	1983/84	1994/95	2002/2003
6 yrs	Prevalence (%)	78	76.4	65.5 (5-yrs)
	DMFT	4.4	4.1	3.6 (5-yrs)
12 yrs	Prevalence (%)	67	53.1	40.0
	DMFT	1.9	1.4	0.9
35 - 44 yrs	Prevalence (%)	92	91.1	91.5
	DMFT	9.2	10.1	8.4

Figure 1/ Prevalence and Severity of Dental Caries

As of 2012 in Sri Lankan context, the total number of dental specialists is 59, total number of dental surgeons in public sector is 1462, total number of dental surgeons in private sector is 795. It is clear that there is a shortage of oral health personnel in Sri Lanka as the number of dental surgeons per 100,000 population is 6.0 (where as the number of general medical officers per 100,000 population is 78.6). Basic oral health services are provided by dental surgeons while specialised care is given in oral maxillo facial, restorative, orthodontic and community dental consultants. Yearly 75 – 85 dental doctors join the workforce. According to section '4.2.8.1 *Plans for 2013*' in Sri Lanka Annual Health Bulletin – 2012, recruitment of dental surgeons to fill all the vacancies in the government sector seems to be a priority. ^[4]

Sri Lanka Dental Association defines oral health as the absence of any active disease and defines oral hygiene as the sum of a person's healthy habits to keep their teeth, gums and mouth in general away from such diseases. ^[5]

1.3 Research Problem

Sri Lanka is not yet a fully developed country where the resources and technology are equally distributed among all its areas. This is no exception when referring to the medical field; its human resources, drugs, equipment, facilities and other relevant services. According to the interviews and literature survey carried out by the research team, technology of the field of dentistry is further behind. **Sri Lanka Annual Health Bulletin** – 2012 states that as previous years, in 2012, specialized hospitals are the most overcrowded institutions in Sri Lanka. Among these hospitals, Dental Institute is the most overcrowded hospital with a bed occupancy rate of 116.7. ^[4]

On going Preventive Oral Health Care Activities as mentioned in **Sri Lanka Annual Health Bulletin** – 2012 ^[4]

- Oral health care programme for Pregnant Mothers– Pregnant mothers are being screened in at the first trimester of the pregnancy to identify the prevailing oral health problems and provide the treatments accordingly.

- “Save molar project” - Initially pilot project is carried out in selected MOOH areas. From 2013 onwards this will be expanded in and scale up manner island wide to preserve the sound permanent molar teeth to achieve the ultimate goal of “20 teeth at 80 years of age”.
- Prevention of early childhood caries– Children under 3 years of age will be screened for high risk for caries in milk teeth and if found fluoride varnish will be professionally applied.
- Prevention of fluorosis - Initially colorimeters were distributed among high fluoride areas to identify the wells with high fluoride contents. By doing people are motivated to access the wells with standard concentration of 0.7ppm. Fluoride 0.7ppm be in drinking water to be suitable for drinking.
- Oral cancer prevention programme
- Distribution of tooth brushing demonstration models.
- Production of Oral Health wall chart

Plans for 2013 as mentioned in **Sri Lanka Annual Health Bulletin – 2012;** ^[4]

- Recruitment of dental surgeon to fill all the vacancies in the government sector
- Training of School Dental Therapists
- Establishment of IOH
- National Standard of performance and regional variations
- Review of dental surgeons’ returns
- New dental hospital project at Ward Place
- Oral cancer programme
- Yearly 75 – 85 dental doctors join the workforce (call Medical council)

It is evident that no necessary plans have been made to improve the technologies used in the field of dentistry.

1.4 Research Gap

As a result of the literature survey and interview sessions carried out with certain dentists practicing in the government sector, the research team identified the necessary steps to be carried out to uplift the existing oral health conditions.

- Providing better education to patients on their dental conditions.
- Educating the common citizen about causes of oral diseases, impact of oral health on the human body.
- Educating children especially, as well as adults about the oral diseases can be prevented.
- Emphasizing the need for bi-annual dental check-ups.
- Providing a patient management system for dentists which could send updates and reminders to their patients.
- Providing better means of communication to dentists with their consultants, as the geographic distribution and availability of dental personnel is low.
- Providing a decision support system to the dentists.

The research team discovered that automated systems to address the issues related to oral health is not being used and that the usage of technology was minimal in Sri Lanka.

The research team concluded from the requirements gathered that an effective automated system must consist of the main components

- Oral Health Education
- Patient Management System
- Teleconferencing System
- Diagnosing, treating and simulating outcome
- Dental Information Knowledge Base

2. Objectives

The main objective of this research project is to address the issues related to oral health and uplift the current oral health conditions in Sri Lanka.

The specific objectives of this research project are as follows,

- To provide a better dental health care service to patients, irrespective of where they live.
- To educate patients clearly on their dental conditions with the visual output of intra oral cameras.
- To educate children as well as adults on how to prevent oral diseases.
- To provide patients with a better understanding of the outcomes of treatments carried out.
- To educate children and adults the best practices of maintaining good oral health.
- To improve the technology of the dental medicine field
- For “knowledge balancing” among dentists
- To provide better communication facilities for dentists with specialists and consultants
- To create a “Knowledge Base” for dentists which helps in decision making.

3. Methodology

The literature survey was done successfully at a very initial stage of the project. Through this the research team did an online research on how systems with similar concepts and purposes have been developed. The team was able to gain an understanding on the technical aspects as a result of this online research. The next research performed is that to study the Sri Lankan context of the fields of medicine and health. A detailed research in depth should be conducted in order to carry out the project successfully; to ensure the high quality and the standards of the deliverable. As it is a commonly known fact, the distribution of resources is quite irregular in Sri Lanka. Under such circumstances the people in rural areas very often suffer due to lack of facilities. The team intends to study further the current and prevailing modes of communication, knowledge-based and knowledge-sharing systems to develop the solution. Several meetings, discussions and interviews with dentists (serving in remote areas, urban areas, specialists, etc) and other medical officers have already been carried out. More data will be gathered by distributing questionnaires where appropriate. The team also hopes to study about the drawbacks the doctors have to face when serving in remote areas, such as: not having opportunities to update their knowledge, and to enhance their skills with the usage of modern equipment.

The proposed solution is an Interactive System for Dental Support and Patient Management. This consists of the features,

- Oral Health Education
- Patient Management System
- Teleconferencing System
- Diagnosing, treating and simulating outcome
- Dental Information Knowledge Base

3.1 Oral Health Education:

The system will simulate correct practices related to dental health, (eg: correct brushing techniques) which will educate children. The system will display the current dental conditions, the required treatment and the outcome of the treatment, thus providing a better understanding the patient on their oral health conditions and gaining their confidence on the treatment to be carried out. This educating process will be a sub features of the features “Diagnosing, treating and simulating outcome” and “Patient Management System”

3.2 Patient Management System :

The system must register new patients by taking the essential details such as name, date of birth, gender, address, telephone numbers, email address, allergies and generate a unique barcode for each patient. When the barcode is scanned, the patient's details will be displayed. Images captured from intra oral cameras, medical history and all other relevant data will be stored in patient folder. The system will generate a virtual waiting list for the dentist. When patients arrive at the dental clinic, they will be entered into the system at the reception. The dentist will be able to view the patient being treated as well as the list of patients who are waiting for their turns. The system will maintain an independent timer for each person to track appointments and to send reminders.

3.3 Teleconferencing System :

The system will allow the dentist to teleconference with other dentists to share images or to live stream video to get their opinions or support if needed. The system will also transmit images or video from the intra oral camera to a tablet so that the patient will be able to see and understand the condition of the disease as well as the treatment being performed.

3.4 Diagnosing, treating and simulating outcome :

The system will model a patient's lower and upper jaw and enable editing. Any modification of a tooth will be displayed on the 3D model. Standard tooth numbering system will be used. The system will enable the dentist to create prescriptions, save a copy in patient's folder, and print a copy. The system will maintain patients' history. The system will save images captured by intra oral camera in the particular patient's folder. The system will also allow the dentist to comment on images and will store them accordingly. The system will simulate the outcome of treatments using 3D modelling. These simulations will be shown to the patient during explanations. The system will suggest treatments based on the images captured and processed.

3.5 Dental Information Knowledge Base :

The system will store images captured from intra oral camera along with their comments to create a knowledge base for the dentist. The diseases will be categorized and images will be saved according to the disease. This knowledge base should provide the dentist with treatment suggestions based on the data it stores. The system must allow the sharing of the content in knowledge base with other dentists in remote locations. If diagnosing is problematic, the dentist will be able to refer the knowledge base to check previously treated cases, treatments given, drugs used, and comments.

3.6 The technologies that will be used in this research project

- Image Processing. (Dental Imaging)
- Game development software to model simulations.
- 3D modelling to model dental structures
- 2D to 3D conversion
- Statistical data analysis.

3.7 Hardware components of the proposed solution

The hardware components needed for this research project will be ;

- Laptop computer
- Intraoral camera
- Tablet PC
- Bar code reader

The **laptop computer** which will be used by the dentist, will contain the proposed software system and will perform the necessary processing activities.

The **intraoral camera** will capture images of the patient's oral cavity and transmit them to the laptop computer, where the processing will take place.

The **tablet PC** will serve as the education tool for the patient, on which images captured by the intra oral camera will be displayed and simulations of the treatments and outcomes will be displayed.

The **bar code reader** serves as a tool for patient management, where a unique bar code will be generated for each patient, and once the bar code is scanned patient profile will be displayed on computer.

3.8 The system diagram of the proposed solution

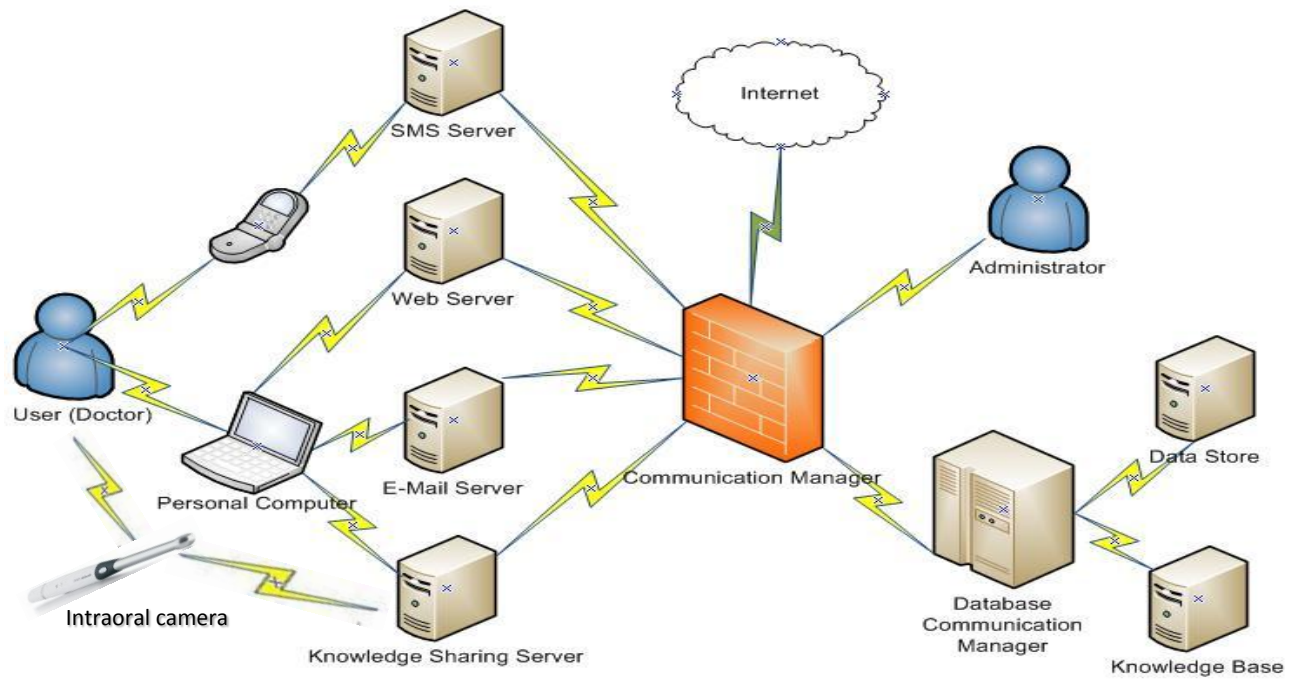


Figure 2/ System Diagram

3.9 Gantt Chart

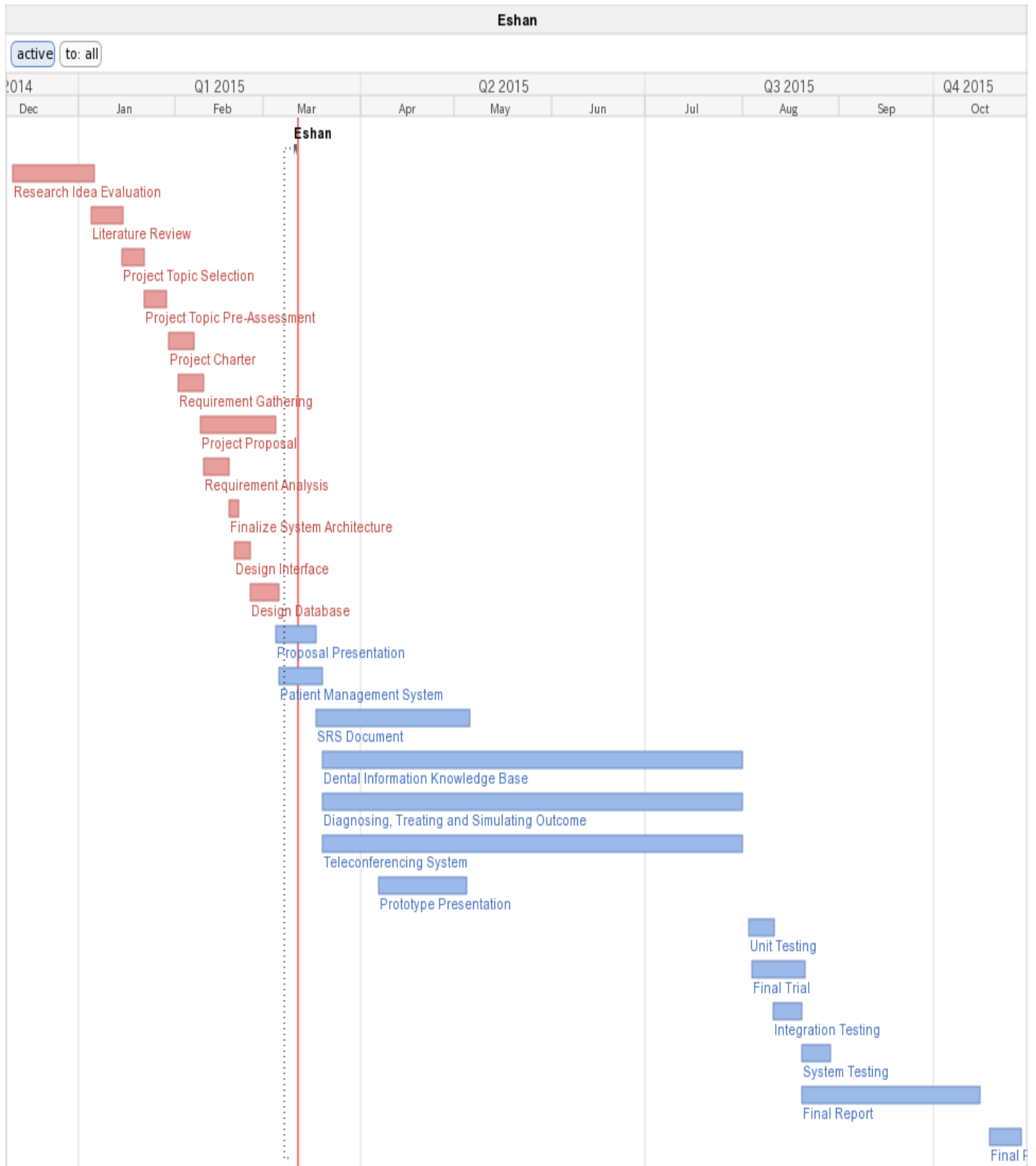


Figure 3/ Grant Chart

3.10 Work Breakdown structure

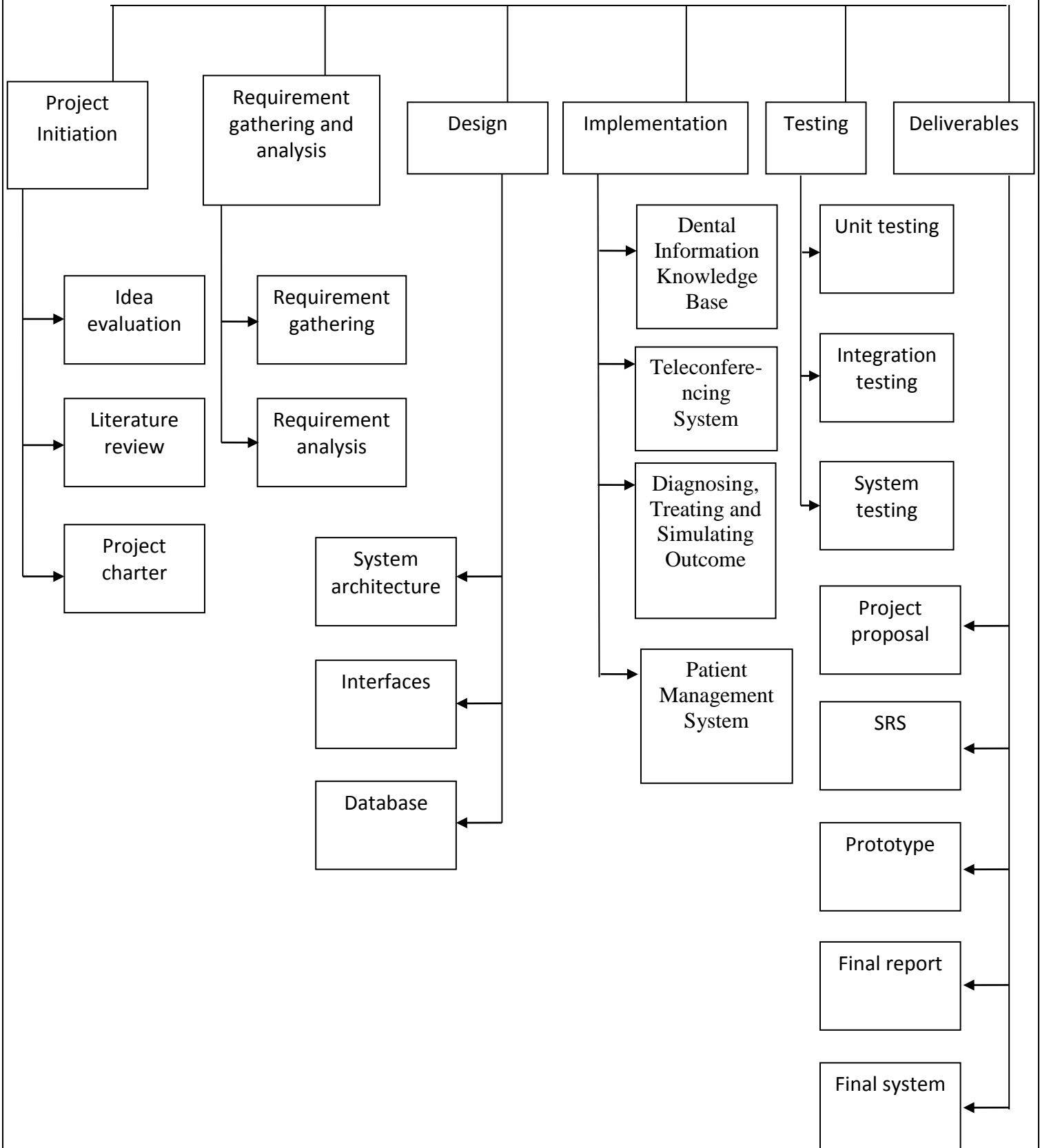


Figure 4/ Work Breakdown Structure

3.11 Development Life Cycle

To bring the proposed system into existence, several formal processes will be carried out. The intended system will be developed according to a well-defined model of a standard software development life cycle. We intend to follow the concept and steps of “Prototyping Method” as first we intend to create a ‘model’ (the Prototype) of the actual system. Then we would present it to the client, so that the client would easily understand how the actual system would behave in advance! We can make necessary adjustments to the system where necessary after the prototype presentation.

Therefore, the critical stages of this project can be documented as:

- Feasibility study
- Requirement Gathering and Analyzing
- Design
- Implementation
- Testing
- Maintenance

3.11.1 Feasibility study

Feasibility was evaluated based on different components such as technical feasibility, schedule feasibility and legal feasibility. “Interactive System for Dental Support and Patient Management” systems are rarely used here in Sri Lanka and the doctors, especially those who serve in rural areas very often face many problems caused due to the insufficient and inefficient modes of communication. This prevents doctors from updating their knowledge about medicine and other medical equipment. It is clear that the doctors who serve in remote areas; also the patients from such areas are less privileged in many ways. Interactive decision support systems are not at all in use in Sri Lanka and the necessity for such a system is a much-felt need, simply to enhance the knowledge of the doctors; in turn to provide better service to the patients. As an outcome of our “Feasibility Study” we understood that the current situation is a result of the technical feasibility

being very low. The other aspects of the Feasibility Study had no barrier for us to proceed with our project. The doctors will be the clients of our project.

3.11.2 Requirement Gathering and Analyzing

This would have already been carried out to a certain extent. This is also a highly critical phase in the project as this phase has a great impact not only on the privileges, features and functionalities of the system and the way they are to be implemented, but also on the scope and the objectives of the project.

The main purpose of this phase is to verify “What the client actually needs”, before proceeding to any further step in the project. Several meetings and discussions have already been held with the dentists in order to understand and clarify all the matters regarding the requirements. The system and its requirements must be well defined and documented in detailed descriptions. The requirements can be categorized under two subheadings: Functional and Non-functional. The requirement document, well-known as the “Software Requirement Specification” (SRS), acts as a detailed contract which should be well understood and agreed both by the client and the development team. The SRS will be delivered in due course.

3.11.3 Design and Implementation

Since it's still the stage of submitting the proposal, we have not completed the “Requirement Gathering and Analysis” phase. Therefore some of the functionalities have not been studied in depth. However, we have the clear understanding that the functionalities of our system can be listed under five main categories.

- Oral Health Education
- Patient Management System
- Teleconferencing System
- Diagnosing, treating and simulating outcome

- Dental Information Knowledge Base

3.11.4 Testing

In the testing phase we hope to perform several testing techniques to evaluate the main functions of the system.

3.11.5 Regression Testing

We will write test cases to perform this. The availability of test cases encourages the programmer to write code in small chunks that can be tested independently.

3.11.6 Unit Testing

Unit Testing will be done unit by unit; module by module simultaneously with the implementation process. This mechanism enables us to spot bugs and to fix them before proceeding with such errors to further steps of the project. This also ensures the high quality of the coding.

3.11.7 System Testing

After completing the system we will apply “System Testing” techniques to test the entire system as a whole. The completed system will consist of four main features. We will use sample data as inputs and do intend to observe the outputs matching them with what is actually expected. This method will be followed to ensure that the system operates properly when all the parts are merged.

The database connectivity will be tested by storing and retrieving sample data.

3.11.8 Acceptance Testing

Further, we will deliver the system to the client to perform acceptance testing and will get the feedback. The requirements mentioned in the SRS can be verified by the results of acceptance testing.

3.11.9 Maintenance

Over the lifetime of the system, its original requirements will have to be modified and updated as customer needs keep on changing constantly.

4. Benefits

The proposed solution, “Smart Dentassist” will benefit dentists as follows;

- Ease of access of enhanced technology and knowledge
- Easy communication among dentists for dental issues
- Constantly updating knowledge base
- Enhanced patient database.
- Better means of communication with patient through reminders

“Smart Dentassist” will benefit patients as follows ;

- Enhanced dental care.
- Better dental education and understanding of dental conditions.
- Ability to view simulation of treatment and outcome.
- Being reminded of upcoming appointments and treatments.

5. Description of Personal and Facilities

Supervisor – Dr. Rohan Samarasinghe

Workload Distribution

Student Name	IT number	Research Component
R. M. S. M. Rathnayaka	IT 12038510	Dental Information Knowledge Base
B. L. H. M. Gunarathna	IT 11229162	Teleconferencing System
A. H. E. D. Kumara	IT 12043842	Diagnosing, Treating and Simulating Outcome
K. G. L. Bogahawatte	IT 12062034	Patient Management System

As this is a group project, the tasks will be divided among the members as follows:

Student Name	IT number	Assigned Tasks
R. M. S. M. Rathnayaka	IT 12038510	Designing, Implementation, Testing
B. L. H. M. Gunarathna	IT 11229162	Implementation, Testing
A. H. E. D. Kumara	IT 12043842	Implementation, Testing
K. G. L. Bogahawatte	IT 12062034	Documentation, Implementation

6. Budget and Budget Justification

<i>Total</i>	45000.00
<i>Printouts and Bindings</i>	2000.00
<i>Telephone and Internet Charges</i>	1000.00
<i>Travel Cost</i>	5000.00
<i>Intraoral Camera</i>	20000.00
<i>Barcode Reader</i>	5000.00
<i>Tablet PC</i>	12000.00

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8. Appendices