



**Web Based System  
for  
Maganeguma Rural Road Development  
Programme**

**M.P.M.Abeyratne**

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**Name of the Supervisor:**

**Mr. Fayaz Thahir**

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# DECLARATION

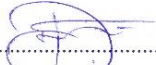
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.....  
M.P.M. Abeyratne  
(Name of the Candidate)

Date: 30/10/2017

Countersigned by:



.....  
Fayaz Thahir  
(Name of the Supervisor)

Date: 30/10/2017

# ABSTRACT

Maganeguma Rural Road Development Programme was initiated in the year 2004 under the Ministry of Highways for the development of roads in the rural sector. About 73% (84,380 km) of the total road network of Sri Lanka belongs to the rural roads category. Many methods were employed in developing the roads such as Gravelling, Metaling, Tarring and Concreting. In addition to those development strategies on rural roads, structures like side drains, retaining walls, rural bridges, culverts and causeways are also being constructed simultaneously.

The current manual system is a highly time consuming process with lots of paper work and increased postal, stationery and telephone charges. The space needs to store the documents continue to raise day by day. Lack of transparency leads to some illicit affairs which makes an unpleasant attitude of people towards this program. Complaints are always come about poor quality and lack of maintenance of some roads.

The system was developed using PHP (PHP) Hypertext Preprocessor open source server side scripting language, MySQL as the database tool and Apache as the web server to run the system. Rational Unified Process (RUP) was chosen as the development methodology as its flexibility compared to others.

The proposed system should be consisted with access privileges specifically for the users of the system and proper management of roads. Estimate preparation and bill payments can be achieved with the system. Actual progress of the Rural Development Programme can be seen with higher accuracy.

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# LIST OF ACRONYMS

|        |   |                                     |
|--------|---|-------------------------------------|
| ADSL   | - | Asymmetric Digital Subscriber Line  |
| CD ROM | - | Compact Disk Read Only Memory       |
| CSS    | - | Cascading Style Sheet               |
| DBMS   | - | Database Management System          |
| DS     | - | Divisional Secretary                |
| EE     | - | Executive Engineer                  |
| EO     | - | Electorate Organizer                |
| GB     | - | Gigabite                            |
| GHz    | - | GigaHertz                           |
| GIS    | - | Geographic Information System       |
| GN     | - | Grama Niladhari                     |
| HSR    | - | Highway Schedule Rates              |
| HTML   | - | Hypertext Markup Language           |
| MB     | - | Megabite                            |
| MP     | - | Member of Parliament                |
| NIC    | - | National Identity Card              |
| OOAD   | - | Object Oriented Analysis and Design |
| PDF    | - | Portable Document Format            |
| PHP    | - | Hypertext Pre-processor             |
| RAM    | - | Random Access Memory                |
| RDA    | - | Road Development Authority          |
| RUP    | - | Rational Unified Process            |
| SQL    | - | Structured Query Language           |
| UML    | - | Unified Modeling Language           |
| URL    | - | Uniform Resource Locator            |
| WRD    | - | Web based Road Development          |
| WWW    | - | World Wide Web                      |
| XAMPP  | - | Windows/Linux Apache MySQL PHP Perl |

# CHAPTER 1- INTRODUCTION

## 1.1. Introduction

Greater part of the total road network of Sri Lanka is consisted with rural roads and agriculture is the main livelihood of the people living in rural areas. A very low attention had been focused in the past for the rural road development.

As a remedy for this situation “Maganeguma” Rural Road Development Programme was initiated under the vision “By establishing a sustainable rural road network suitable for plying the way for the development of other infrastructures, to provide supportive backing for the development of social, economic and all other activities of the rural people while making further increases on the investment for the development of rural roads in next years to come”.

At the beginning of the year according to the allocation amount set apart for the Maganeguma Rural Road Development Programme, requests for the roads are invited from MPs, Chief Organizers and General Public. The implementation is given to the Road Development Authority where every district is divided into several Executive Engineer divisions and after the completion of the roads payments will be made by the Rural Road Development Programme. Regular field visits are done by the officers of both Rural Road Development Programme and the Road Development Authority.

Current manual system is paper, book and file based and that caused the whole process to slow down and frequent data duplications. It is perceived that Rural Road Development Programme is in need of an automated system to speed up current process and future developments.

## 1.2. Motivation for the project

With the expansion of the Rural Road Development Programme for more than a decade it is realized the best thing is to go into an automated system as the whole process from requesting road projects to making payments for them has been compelled to an unmanageable situation.

There is no proper way to know the total length of roads or no of structures constructed for a particular year accurately. Due to the huge amount of requests are being coming it is very difficult to sort out which road projects are to be offered the priority.

When allocation is being provided for road projects to the MPs, it is essential to know the amount of allocation a specific MP was given already. Manually it is a very time consuming task to search the files to make the decision even the accuracy cannot be guaranteed because several records are possible to be missed. With the proposed automated system the decision making process will be easily achieved within the total allocation limit, providing an equal and unbiased distribution of allocation among MPs.

It takes a lot of time for the district subject clerks to search a certain road project information such as approvals or payments when they are asked which results other office work to be put off. Final Bill set with mistakes are returned by registered post again to the relevant Executive Engineer division and get corrected which leads to higher postal charges.

Field inspections are done very often and that cause the office work run into a delay. Approval for road projects and payment approvals cannot be accomplished in a timely manner. The proposed system will furnish the ability to get into the system wherever the users are.

Being written and kept all road project information in books and files the important details go into unauthorized parties and they make use of the information for unnecessary affairs that affects badly for the reputation of the Rural Road development Programme. Evaluation of the actual progress of the Rural Development Programme is a monthly and annually vital thing. It is really hard to achieve the accuracy of the reports always.

### 1.3. Objectives of the project

Objectives focus on the desired outcomes of the project rather than the tasks within it – they are the ‘post conditions’ of the project [1].

The main objective of this system is to provide a proper mechanism to manage the activities of the Rural Road Development Program and accelerate the efficiency of their work through that mechanism. Following are the objectives of the system.

- Design and implement a web based user authentication system to provide different access levels according to designation.
- Create a database in one place to secure the details of the roads and payments.
- Remove the data duplication.
- Reduce the time and manual effort in searching records in files, checking estimates and final bill documents.
- Enhance the accuracy of decision making process.
- Increase the confidentiality of data.
- Minimize the possibility of data loss by being kept in a centralized location.
- Decrease the wastage of resources and save the unnecessary stationary cost.
- Generate reports with accuracy and in a timely manner.

## 1.4. Scope of the Project

Managing the scope primarily concerns defining and controlling what is and what is not included in the project. For software, the definition of project scope includes features and quality attributes that are needed and desired by stakeholders [2].

The scope of the project identifies the main areas the project should have a touch with. To be precise, it declares the requirements gathered and boundaries with which the client needs to fulfill their tasks. When it comes to project analyzing defining the project scope is the most critical step. The main purpose of scope definition is to clearly describe the boundaries of the scope. The scope of the developed Rural Road Management System is comprised of following modules.

- User Management Module
  - Users of the system should be provided with specific access privileges according to their user type (Designation).
- Project (road) Management Module
  - The system should allow the way for the Requests for Rural Road Projects from MPs, Electoral Organizers and General Public to be entered and stored.
  - Road Requests can be amended before Approve, Hold or Reject.
  - The system should be provided with the facility to Approve, Hold or Reject the Road Requests and the status can be viewed.

- If approved, the project will be assigned a project number.
  - Preparation of estimates for rural road projects and giving approvals for the estimates can be done with the system.
  - Extension of time period for the construction work can be requested through the system.
  - The system let the Executive Engineers to make the Estimate and get approval by the Engineer (Maganeguma) through the system. He is offered the permission to request extension of time period for the construction work too.
  - Field Inspection details can be entered to the system and approval will be given for the field inspection report.
- Bill Payments module
    - Preparation of the Final Bill for the rural road project according to the estimate and giving approvals for the final bill should be done by the system.
    - Preparation of Test Reports and giving approval for them should be done with the system.
    - System should be able to get uploaded the documents and photos needed for the final bill payment (GN report, agreement, two photos of the road before and after development).
    - System should be able to generate the voucher for the final bill.
- Report generating module
    - System should generate reports to evaluate the progress of the Rural Road Development Program monthly and annually and reports for having the decision making process easy.

## 1.5. Dissertation Structure Organization

Requirements gathering, analyzing and management techniques are discussed in Chapter 2 (Analysis). How the current system works and functional and non-functional requirements are identified here. In Chapter 3 (Design) initial design diagrams and the methodological approach used in the system designing, alternative approaches and their justification for not using in the system are discussed.

The system specification is converted into practical situation in Chapter 4 (Implementation) with web development languages. Implementation environment, technologies used and reused modules are discussed too. In Chapter 5 (Evaluation), planning test cases and using different testing methodologies evaluation is done to test the accuracy of the system. User acceptance test is also done in this stage. The lessons learnt by implementing this system with a brief description of the Rural Road Development Programme and future improvements are discussed in Chapter 6 (Conclusion).

# CHAPTER 2 – ANALYSIS

## 2.1. Introduction

Requirement gathering and Analysis is the very important phase in any software development. Success in this phase lead to success in the whole project. Therefore significant amount of time and effort has been put in this phase compared to other phases in the development life cycle. Domain understanding, requirements collection, classification, Structuring, Prioritization and Validation are some of the steps taken in this phase. Use case diagrams and more figures make the proposed system understand easily.

Overview of the existing manual system, fact finding techniques, collected functional and non-functional requirements studied to gain knowledge and understanding are described below in this chapter.

## 2.2. Requirement gathering techniques

**Sampling of existing documentation** – Since there is an existing manual system this was very useful to develop a good effective computerized system.

**Observation** – Observation of existing manual system was done in parallel with other techniques to understand how the work is performed manually within the company. Both active and passive observations were used.

**Document Review** – This method was used to discover requirements. All documents related to current manual system were reviewed.

**Interview** – This method was used to clarify and confirm the identified requirements. Interviews with the staff members of the Rural Road Development Programme are used to confirm the identified requirements.

## 2.3. Current System and the Process

At the beginning of the year according to the allocation amount set apart for the Maganeguma Rural Road Development Programme, requests for the roads are invited from MPs, Electoral Organizers and General Public. The implementation is given to the Road Development Authority where every district is divided into several Executive Engineer divisions altogether 56 Executive Engineer Divisions. After the completion of the roads payments will be made by the Rural Road Development Programme. Regular field visits are done by the officers of both Rural Road Development Programme and the Road Development Authority. Use case diagram for the existing system is depicted by Figure 2.1.

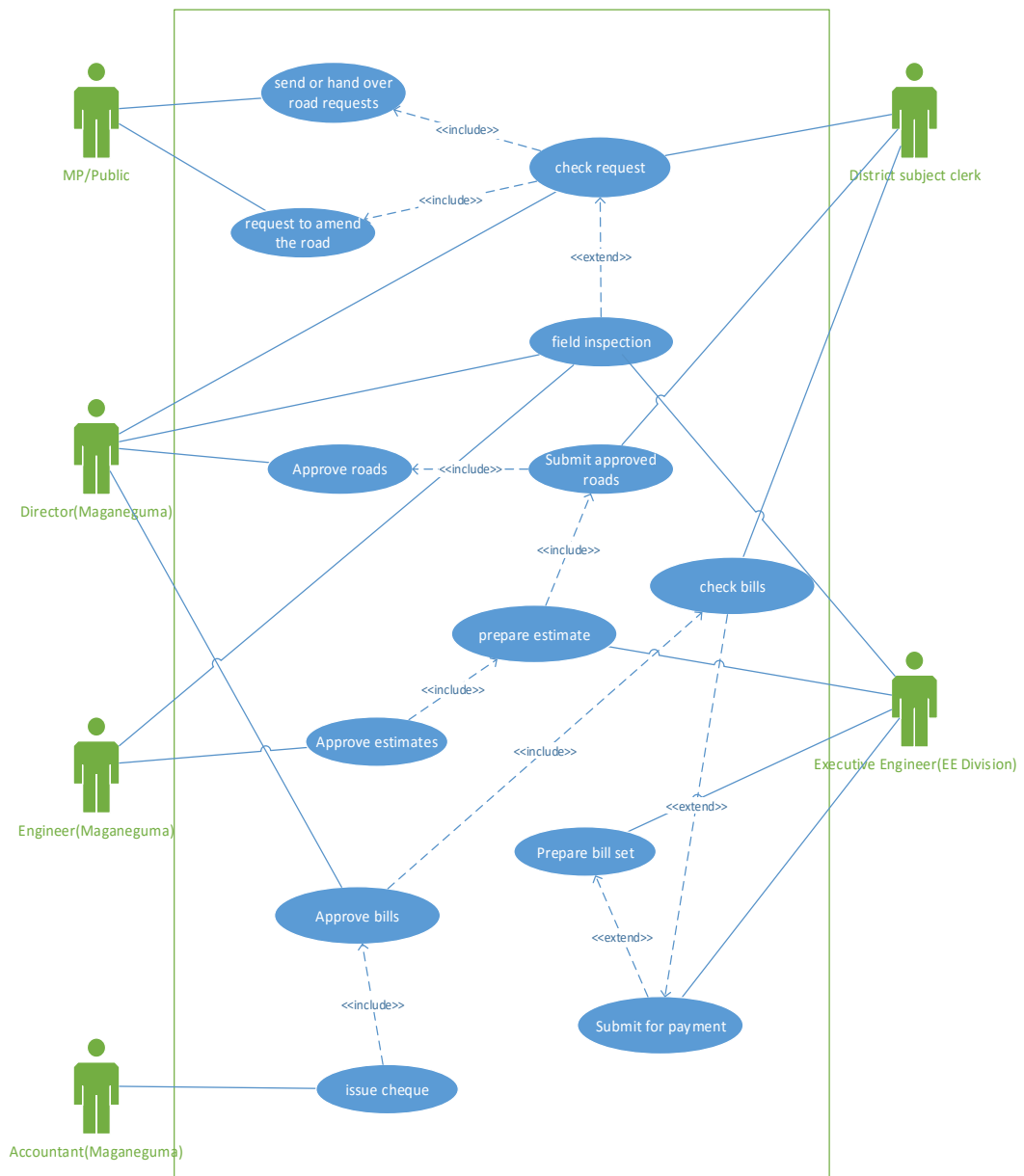


Figure 2.1: Use case Diagram for the Existing System

## 2.4. Drawbacks of the manual system

- There is no proper way to know the total length of roads or no of structures constructed for a particular year accurately.
- Due to the huge amount of request letters are being coming it is very difficult to sort out which road projects are to be offered the priority.
- When allocation is being provided for road projects to the MPs, it is essential to know the amount of allocation a specific MP was given already. Manually it is a very time consuming task to search the files to make the decision even the accuracy cannot be guaranteed because several records are possible to be missed. With the proposed automated system the decision making process will be easily achieved within the total allocation limit, providing an equal and unbiased distribution of allocation among MPs.
- It takes a lot of time for the district subject clerks to search a certain road project information such as approvals or payments when they are asked which results other office work to be put off.
- Final Bill set with mistakes are returned by registered post again to the relevant Executive Engineer division and get corrected which leads to higher postal charges.
- Field inspections are done very often and that cause the office work run into a delay.
- Approval for road projects and payment approvals cannot be accomplished in a timely manner.

## 2.5. Similar Systems and Literature Review

Similar systems should be studied before starting the design to gain an idea of how the required functionalities of the developing system should be presented. Following are few similar systems reviewed o build the system.

- **Autodesk BIM 360 Construction Project Management Software**

Autodesk BIM 360 is a comprehensive project management platform designed for the construction industry. The software is designed to help Project and Field Managers to speed up the delivery of their projects while they are equipped with tools and features

need to better coordinate their actions and resolve issues faster [3]. Figure 2.2 depicts Autodesk BIM 360 Field Management Interface.

The features of this software is not applicable for the Rural Road Development Program since it is consisted with more complicated features suited for a large construction project management system.

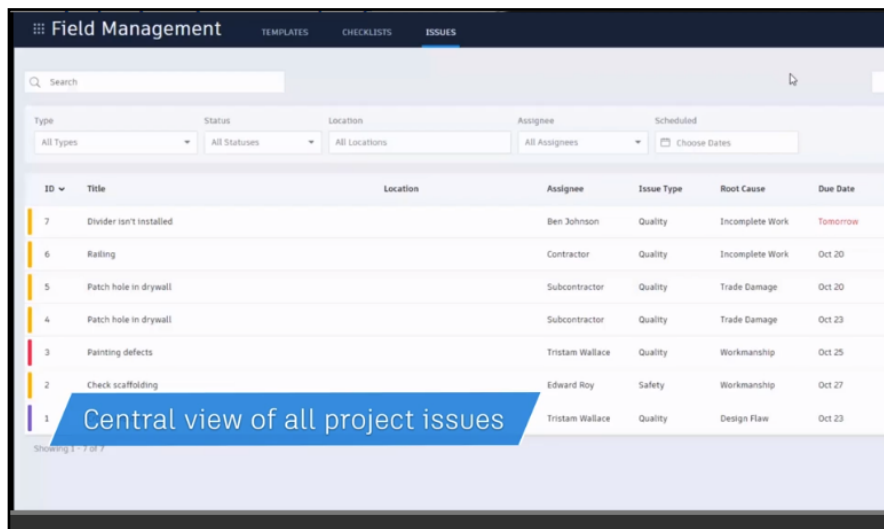


Figure 2.2 : Autodesk BIM 360 Field Management Interface

#### ■ Kalosoft Project Cafe Software

After entering the basic project information and allocating tasks to team members for their execution the manager can monitor the progress of the project. This helps him to take control over the project deadlines and completion. By keeping the priority information of each project and task, manager can make effective utilization of resources [4]. Figure 2.3 depicts an interface of Kalosoft Project cafe software.

Though it is a project management software the required functionalities of the Rural Road Development Program can't be accomplished as it doesn't have features specific to road development such as making an estimate for a rural road project.

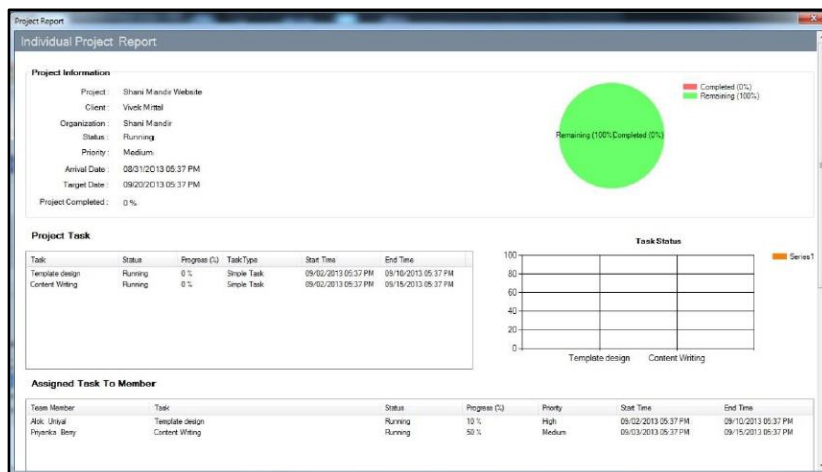


Figure 2.3: Interface of Kalosoft Project cafe software

## ■ GS Roads™ Software

GS Roads is a software is intelligent application software specially developed to cater to the needs of Engineers and Government bodies to who are primarily engaged in executing rural road construction work. It enables preparing Estimates and Bill of Quantities for roads. It can be used for all kinds of construction work like district roads and highways [5].

GS Roads software also can't be applied to the Rural Road Development Program since it has more unwanted features which suited for the large scale road construction projects.

## 2.6. Requirements for the new system

### 2.6.1. Functional Requirements

In software engineering, a functional requirement defines a function of a system or its component. A function is described as a set of inputs, the behavior and outputs. Functional requirements may be calculations, technical details, data manipulation and processing and other specific functionality that define what a system is supposed to accomplish. The functional requirements are captured in use cases. Functional requirements are supported by non-functional requirements [6].

Functional requirements usually describes a system inputs, outputs and the relationship between them. Functional requirements of the developed Rural Road Management System are given below.

- User Management Module

- Users should log into the system securely by validating username and password.
  - Users of the system should be provided with specific access privileges according to their user type.
  - Only the Director (Maganeguma) should be able to access the User Registration and create, update, delete users of the system.
- Project (road) Management Module
- When requests for rural roads are come from MPs, Electoral Organizers and General Public, District Subject clerks should be allowed to enter the details of the rural road request to the system such as rural road name, requester's name, GN division, district, province, required allocation, length, width and current condition of the road.
  - Road Requests can be amended by subject clerk before Approve, Hold or Reject.
  - The system should be provided with the facility only for the Director (Maganeguma) to Approve, Hold or Reject the Road Requests and the status can be viewed by the subject clerk so that the subject clerk can be answered to the requesters regarding the status of their rural road requests.
  - If a rural road request is approved, the project will be assigned a project number.
  - Estimates can be prepared only for the approved rural roads. Executive Engineers should be able to prepare estimates for rural road projects with the system by inserting estimate item description, HSR value, rate and quantity and the system should be able to calculate the amounts and estimate summary details. Approval for the estimates will be given by the Engineer (Maganeguma).
  - Executive Engineer can be able to ask for the extension of time period for the construction work through the system and the Engineer (Maganeguma) will give the approval.
  - Field inspection details can be entered to the system by the subject clerk such as field inspection date, participants, road names, project numbers,

condition of the roads and given instructions. Approval will be given for the field inspection report by Engineer (Maganeguma).

- Bill Payments module

- Having completed the construction of the road Final Bill Set can be prepared by the Executive engineer to submit for the payment. Final bill set is composed of Final bill, Test report and Final bill documents (GN report, agreement, photos of the road before and after construction).
- Final bill can be prepared based on the approved estimate. Executive Engineers should be able to prepare the final bill for rural road projects with the system by inserting final bill item description, HSR value, rate, quantity and surcharges. System should be able to calculate the total amounts, retention value and payable amount. Approval for the payment will be given by the Director (Maganeguma).
- Executive engineer should be able to prepare the Test Reports by entering the details of the concrete blocks such as sample number, received date, cast date, tested date, age at test, weight and compressive strength. Engineer (Maganeguma) will give the approval for the Test report.
- System should be able to get uploaded the documents and photos needed for the final bill payment (GN report, agreement, two photos of the road before and after development).
- System should be able to generate the voucher for the final bill.

- Report generating module

- System should generate reports and charts to evaluate the progress monthly and annually.
- Director (Maganeguma) should be able to make decisions with these reports more conveniently.
  - Total allocation given for a particular MP or EO up to the moment.
  - Total allocation for a particular district/DS division/EE division.
  - Total length of the roads constructed for a specific province/district/ DS division/ EE division/ GN division.

### 2.6.2. Non-functional requirements

In systems engineering and requirements engineering, a non-functional requirement is a requirement that specifies criteria that can be used to judge the operation of a system, rather than specific behaviors. They are contrasted with functional requirements that define specific behavior or functions. The plan for implementing functional requirements is detailed in the system design. The plan for implementing non-functional requirements is detailed in the system architecture [7].

**User friendliness** – Interacting with the system should be easy for the employees of Rural Road Development Programme, Road Development Authority, MPs and General Public. The proposed system will have easy navigation option.

**Availability** – Most of the time the system should be in functioning condition.

**Security** – System provide secure login facility to its users. Access level of the users will be controlled with the proposed system.

**Extensibility** – As the Rural Road Development Programme continue to expand year by year the proposed system should be extensible for future developments.

**Reliability** – Information of road projects, payments etc. in the system should be accurate at any given time.

**Integrity** – Payment details must match with the given road project.

## 2.7. Feasibility Study

Feasibility study is one of the stages in analysis phase which allows the developer to understand the feasibility level of the proposed system. Following feasibility studies were carried out regarding the proposed system:

**Legal feasibility** – The proposed system has been analyzed to ensure that it is under e-commerce law of Sri Lanka.

**Technical feasibility** – The proposed system has been analyzed to ensure that the developer has all resources or technologies and skill need to carry out the development.

**Operational feasibility** – This feasibility study has been carried out to measure how the proposed system will solve the problems in the current manual system and how it satisfies the user requirements.

# CHAPTER 3 - DESIGN OF SOLUTION

In this phase the system and software design is prepared from the requirement specifications studied in the first phase. System design helps in specifying hardware and system requirements and also helps in defining overall system architecture. The system design specifications serve as an input for the next phase of the model.

## 3.1. Introduction to Design

Software design evaluates and translates software requirements (both functional and non-functional) into a collection of design elements that specify structural and behavioral aspects of the major components of the system together with their provided quality and inter-relationships required to support the detailed design and construction of software system; and the product resulting for such activity [8].

According to the definitions, the software artifacts is established in this phase. The design phase starts with the specific requirements delivered by the analysis phase and then maps the certain requirements into the artifact. The software artifact defines the components, their interfaces and behaviors. Therefore the design phase represents the plan to implement identified requirements.

System design is the process of defining the architecture, components, modules, interfaces and data for a system to satisfy specified requirements. The two main design techniques are structured approach and the object oriented approach. The structured approach is an approach used to focus on the processes and software development life cycle as it is. Object oriented approach follows component based development factors such as Abstraction, Inheritance, Modularity, Reusability, Encapsulation and polymorphism which results in reduced development time. To take advantage of the factors mentioned above object oriented approach is selected as the design approach for the proposed system. The UML modeling diagrams were used for the design of the system [8].

- **Use case diagram**

Graphic depiction of the interactions among the use cases, actors and their relationship [8].

- **Class diagram**

Addresses the static view of the system and shows a set of classes, interfaces and relationships between them [8].

- **Activity diagram**

Graphically represent workflows of stepwise activities in a system [8].

- **Sequence diagram**

An interaction diagram that emphasizes the time-ordering of messages and shows the object interactions arranged in time sequence [8].

## 3.2. Software Development Process Models

Software development which produces a software system involves set of ordered tasks, activities, constraints and resources. This development can be seen as a life cycle because it involves several common steps such as conception, analysis and design, implementation, delivery and maintenance. SDLC, described as System Development Life Cycle or Software Development Life Cycle is the name given to this life cycle.

There are several process models that can be used in software development life cycle. Some of the most commonly discussed process models are described in following section.

### 3.2.1. Waterfall model

The waterfall model was the first process model to be introduced. It is also referred to as a linear-sequential life cycle model. It is very simple to understand and use. In a waterfall model, each phase must be completed fully before the next phase can begin. This type of model is basically used for the project which is small and there are no uncertain requirements. At the end of each phase review takes place to determine if the project is on the right path and whether or not to continue or discard the project. In this model the testing starts only after the development is complete. In waterfall model phases do not overlap [9]. The waterfall model phases are depicted by Figure 3.1.

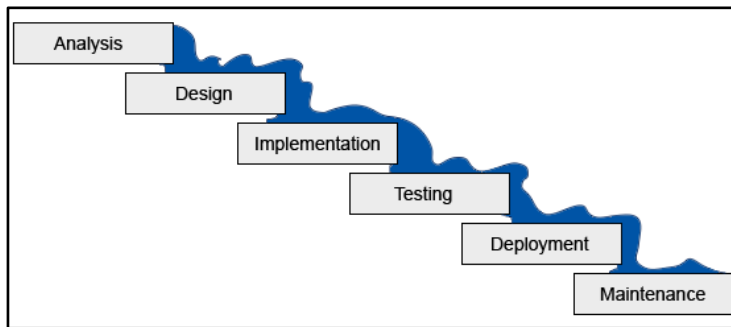


Figure 3.1 : Waterfall Model

Advantage of waterfall model:

- Simple and easy to understand.
- Phases do not overlap.
- Each phase has specific deliverable and review.

Disadvantages of waterfall model:

- Phases cannot be started parallel.
- Waterfall model is not a good method for large scale projects.
- It is not suited for projects which have uncertainty.
- No any single module is to be produced before finish the cycle.
- It is a linear process model hence could not go back to previous stage.

Waterfall model is suitable for projects with requirements are very well known, clear and fixed. Typically longer projects are not suitable for waterfall model.

### 3.2.2. Incremental Development

Incremental development is based on the idea of developing an initial implementation, exposing this to user comment and evolving it through several versions until an adequate system has been developed. Specification, development and validation activities are interleaved rather than separate with rapid feedback across activities [10]. Incremental model is depicted below by Figure 3.2.

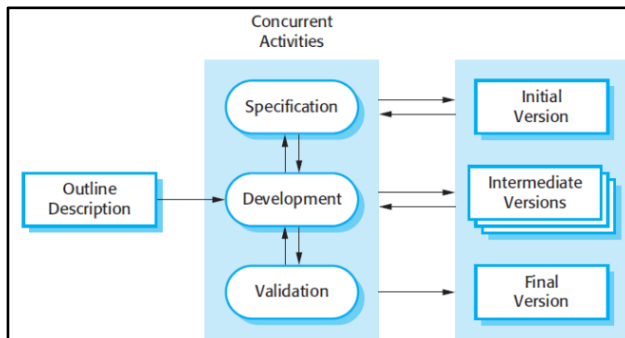


Figure 3.2 : Incremental Development

#### Advantages of Incremental Development

- Generates working software quickly and early during the software life cycle.
- This model is more flexible and less costly to change scope and requirements.
- It is easier to test and debug during a smaller iteration.
- In this model customer can respond to each built.
- Lower initial delivery cost.

#### Disadvantages of Incremental Development

- Needs good planning and design.
- Needs a clear and complete definition of the whole system before it can be broken down and built incrementally.
- Problems might cause due to system architecture as such not all requirements collected up front for the entire software life cycle.
- Rectifying a problem in one unit requires correction in all the units and consumes a lot of time.

This model can be used when the requirements of the complete system are clearly defined and understood. Also if there is a need to get a product to the market early.

### 3.2.3. Spiral model

The spiral model is similar to the incremental development model with more emphasis placed on risk analysis. The spiral model has four phases; planning, risk analysis, engineering and evaluation. A software project repeatedly passes through these phases in iterations (called spirals in this model). The baseline spiral, starting in the planning phase requirements are gathered and risk is assessed. Each subsequent spirals builds on the baseline spiral [11]. Spiral model is depicted below by Figure 3.3.

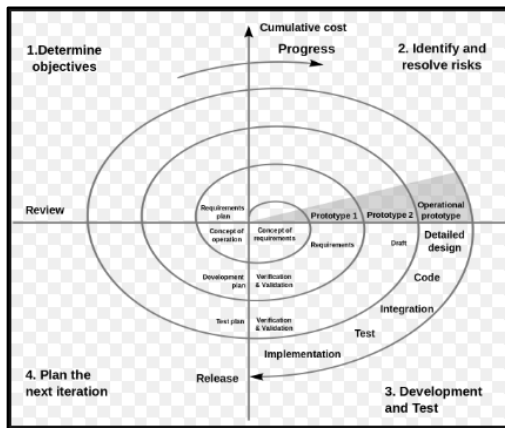


Figure 3.3: Spiral Model

#### Advantages of the spiral model

- High amount of risk analysis hence avoidance of risk is enhanced.
- Good for large and mission-critical projects.
- Strong approval and documentation control.
- Additional functionality can be added at a later date.
- Software is produced early in the software life cycle.

#### Disadvantage of the spiral model

- Can be a costly model to use.
- Risk analysis requires highly specific expertise.
- Project's success is highly dependent on the risk analysis phase.
- Doesn't work well for smaller projects.

Spiral model can be used for medium to high risk projects, when cost and risk evolution is important, users are unsure of their needs and when the requirements are complex.

### 3.2.4. Rational Unified Process

Rational Unified Process (RUP) is an iterative software development framework created by Rational Software Corporation. This methodology can be described in two dimensions; time and process components. The dynamic aspects of the process is represented in the time dimension. Therefore it usually expressed in term of phases, cycles and iterations. The process dimension is described in term of process components, activities and workflows [10]. Rational unified process is depicted below by Figure 3.4.

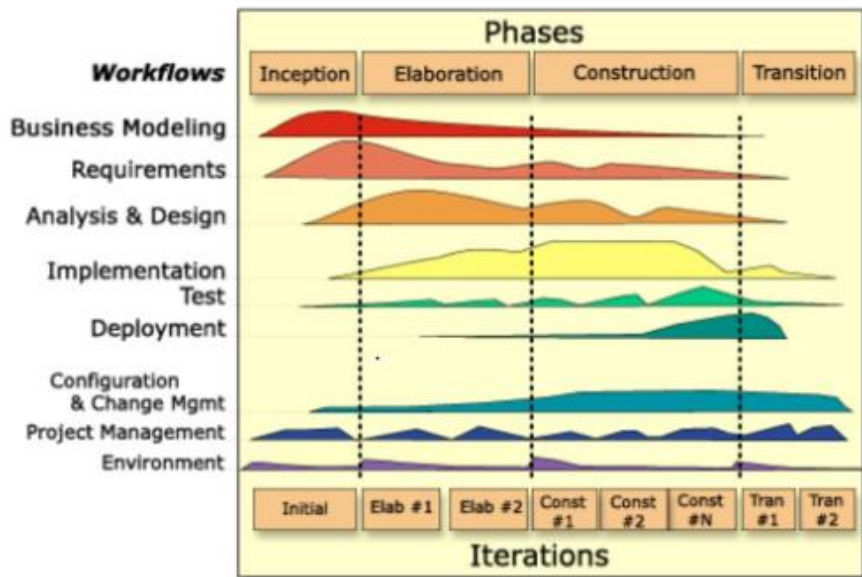


Figure 3.4 : Rational Unified Process

RUP divides the development process into four distinct phases, each involve business modelling, analysis and design, implementation, testing and deployment. The four phases are:

- **Inception** – The goal of the inception phase is to establish a business case for the system. You should identify all external entities (people and systems) that will interact with the system and define these interactions [10].
- **Elaboration** – The goal of the elaboration phase is to develop an understanding of the problem domain, establish an architectural framework for the system and develop the project plan and identify key project risks [10].
- **Construction** – The construction phase is essentially concerned with system design, programming and testing. Parts of the system are developed in parallel and integrated during this phase [10].
- **Transition** – The transition phase of the RUP is concerned with moving the system from the development community to the user community and making it works in all environments [10].

Advantages of the RUP model

- The development time is less compared to other methodologies due to reuse of components.
- Process of integration goes throughout the software development life cycle.

- RUP able to resolve risk which is associated with client's requirements.
- Able to maintain software quality and standards throughout software development life cycle.
- Switching between previous phases easy.
- Requirements can be changed during project life cycle.

#### Disadvantages of the RUP model

- The process is complex.
- Disorganized development; may lead to totally undisciplined form of software development.

### 3.3. Process Model used for the system

The requirements are about to change in Rural Road Development Program so that the iterative development and easy integration of the components will be advantageous. Since the client is a government organization, higher level of competency in information technology can't be expected so that uncertainty could be happened throughout project life cycle. Hence the Rational Unified Process Model was selected for the proposed Rural Road Management System.

### 3.4. Alternative solutions to the system

Following section illustrates the alternate solution evaluation for the developed system and the selected solution description with its justification. The alternate solutions for the developed system can be categorized into few sub topics as follows.

#### ▪ **Web based system**

Web development has been transformed with lots of new features such as responsive design, real time collaboration, usage of Application Program Interface and more efficient compression methods to decrease internet traffic. These new trends along with people getting closer to technology that could be exploited for making web based systems and keep the users involved in using them. Compared to other alternative systems web based systems are easier to develop, more useful for the users, easier to install, maintain and keep secure and easier to extend as the business grow.

- **Purchase commercial stand-alone software**

Installation and configuration of the system should be done in every computer individually and if there is a need to make a single change it should be done in each computer individually. There is no such a stand-alone solution to suit for the requirement functionalities of the Rural Road Development Program. Commercial Project or Construction Management software is consisted with lots of unwanted functionalities and not included the vital functionalities needed for the Rural Road Development Program.

- **Network based system**

Another alternate solution for the developed system was network based system. The main problem with this method is although the system is networked every computer need to be installed the system manually.

### 3.5. System as a web solution

The system is proposed as a web based solution rather a stand-alone system to earn the following benefits.

- The Executive Engineer offices are scattered all throughout the country and a web solution let them to be interacted with the system.
- Access to the system can be performed even Director (Maganeguma), Engineer (Maganeguma) and Executive Engineers are in the field visits.
- The cost of both hardware and software can be reduced by the implementation of a web solution.
- Web systems are platform independent and any different platform can be used.
- Compared to stand-alone systems, maintaining a web system is simple.

### 3.6. Object Oriented Analysis and Designing the system

Object Oriented Design (OOD) is followed during the design phase. OOD encourages main design concepts such as Reusability, Modularity, Abstraction, Maintainability, Inheritance, Generalization etc. Unified Modelling Language (UML) diagrams were used to create the system design because UML provides wide range of diagrams and notations to design every aspects of the system. Use case diagrams, Class diagrams, Sequence Diagrams and Activity diagrams are some common diagrams used in UML.

Database design was also done during this phase. Database tables were normalized up to third normalization in order to reduce redundancy and de-normalized up to certain extent to increase performance. Qualities like user friendliness, easy navigation, performance are considered during the interface design.

### 3.6.1. Use case Diagram for the proposed system

A use case diagram at its simplest is a representation of a user's interaction with the system and depicting the specifications of a use case. A use case diagram can portray the different types of users of a system and the various ways that they interact with the system. This type of diagram is typically used in conjunction with the textual use case and will often be accompanied by other types of diagrams as well. Figure 3.5 depicts the use case diagram for the proposed system.

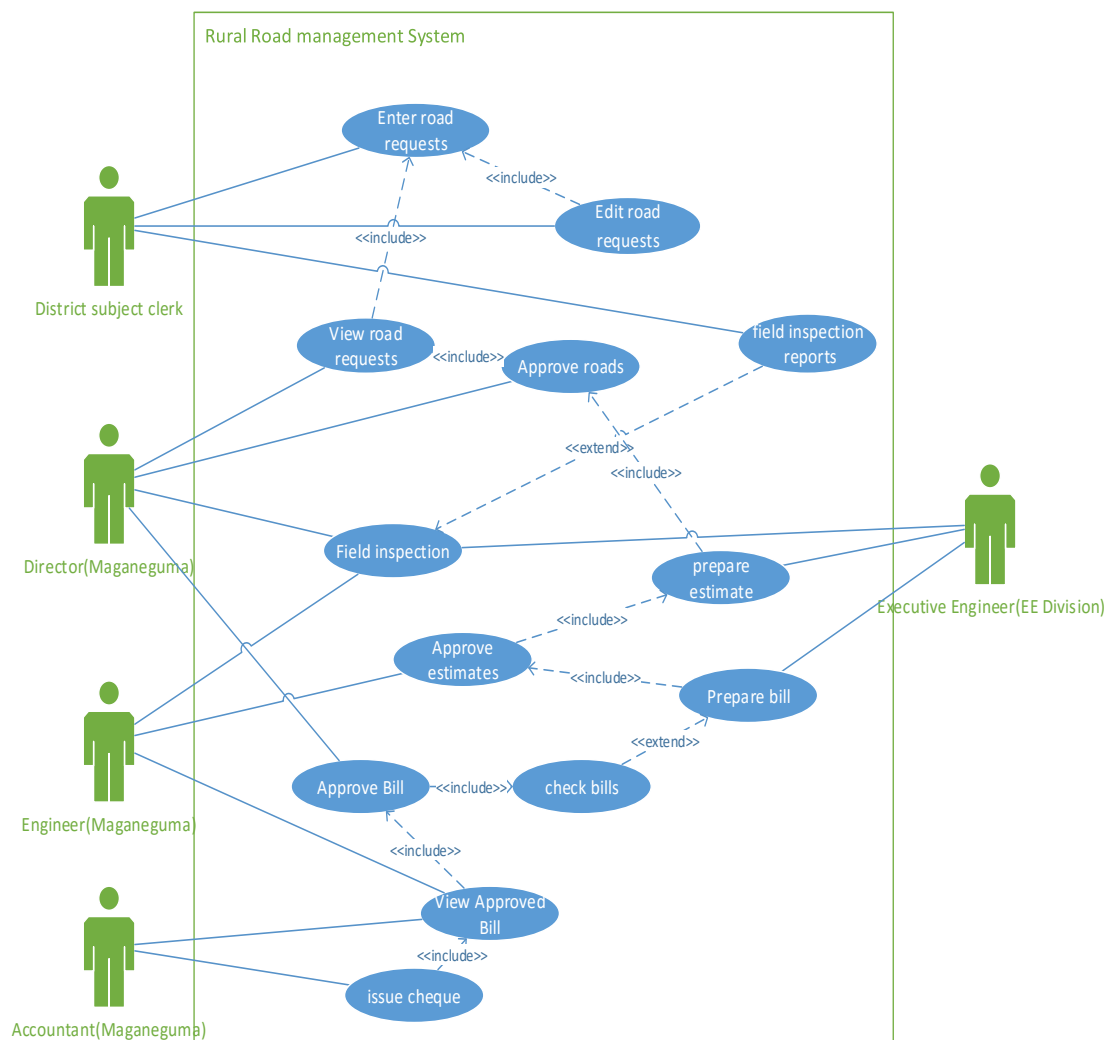


Figure 3.5 : Use case Diagram for the Proposed System

### 3.6.2. Class Diagram for the Proposed System

The class diagram is the main building block of object oriented modelling. It is used both for general conceptual modelling of the systematics of the application, and for detailed modelling translating the models into programming code. Class diagrams can also be used for data modeling. The classes in a class diagram represent both the main elements, interactions in the application, and the classes to be programmed [12].

The purpose of the class diagram is to model the static view of an application. The class diagrams are the only diagrams which can be directly mapped with object oriented languages and thus widely used at the time of construction. Figure 3.6 depicts the class diagram for the proposed Rural Road Management System

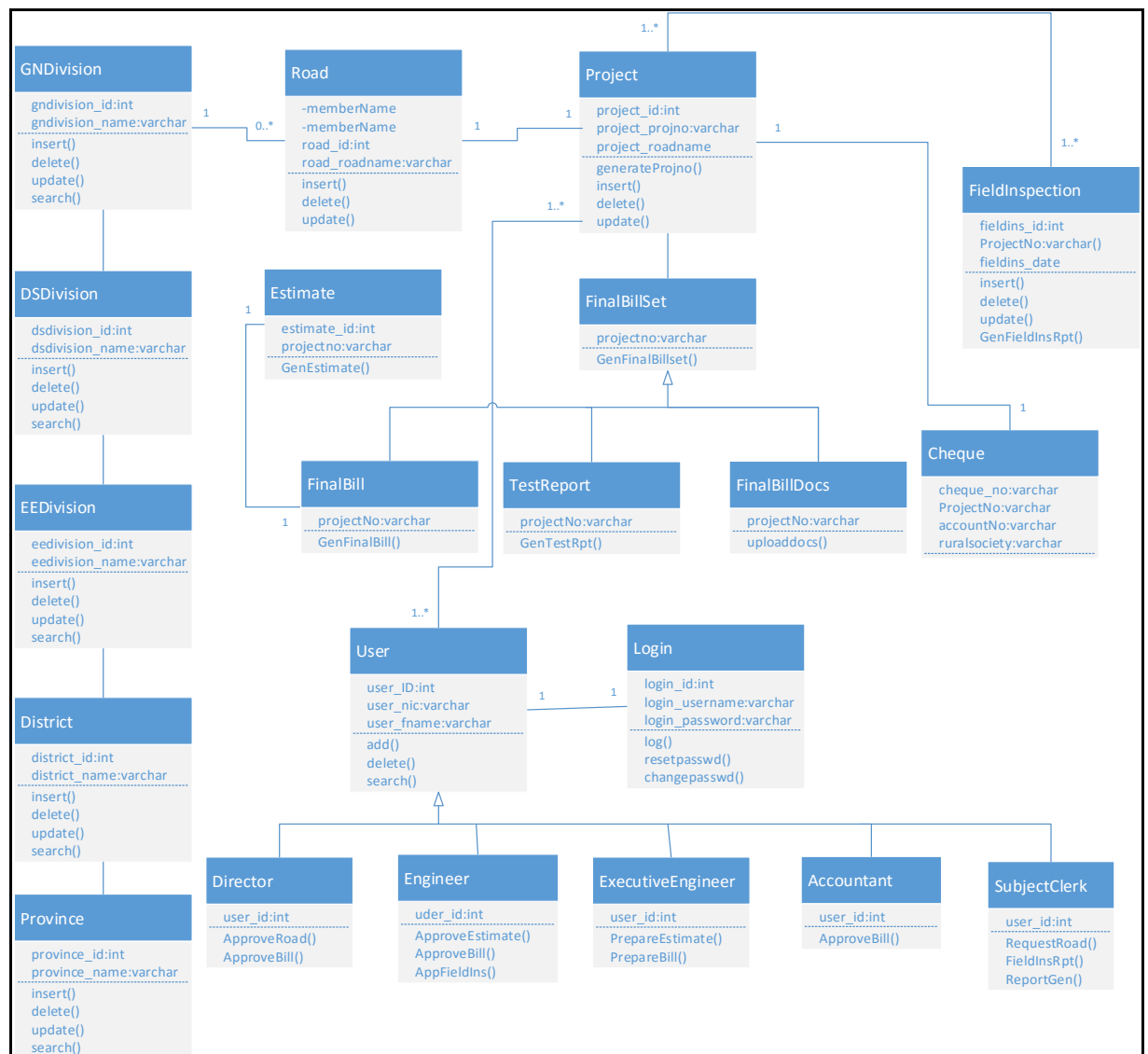


Figure 3.6 : Class Diagram for the Proposed System

### 3.6.3. Sequence Diagram for the Proposed System

A sequence used to capture, specify and visualize system interactions with emphasis on the time-order sequence on messages exchanged [13]. Figure 3.7 depicts the Sequence diagram for the proposed system.

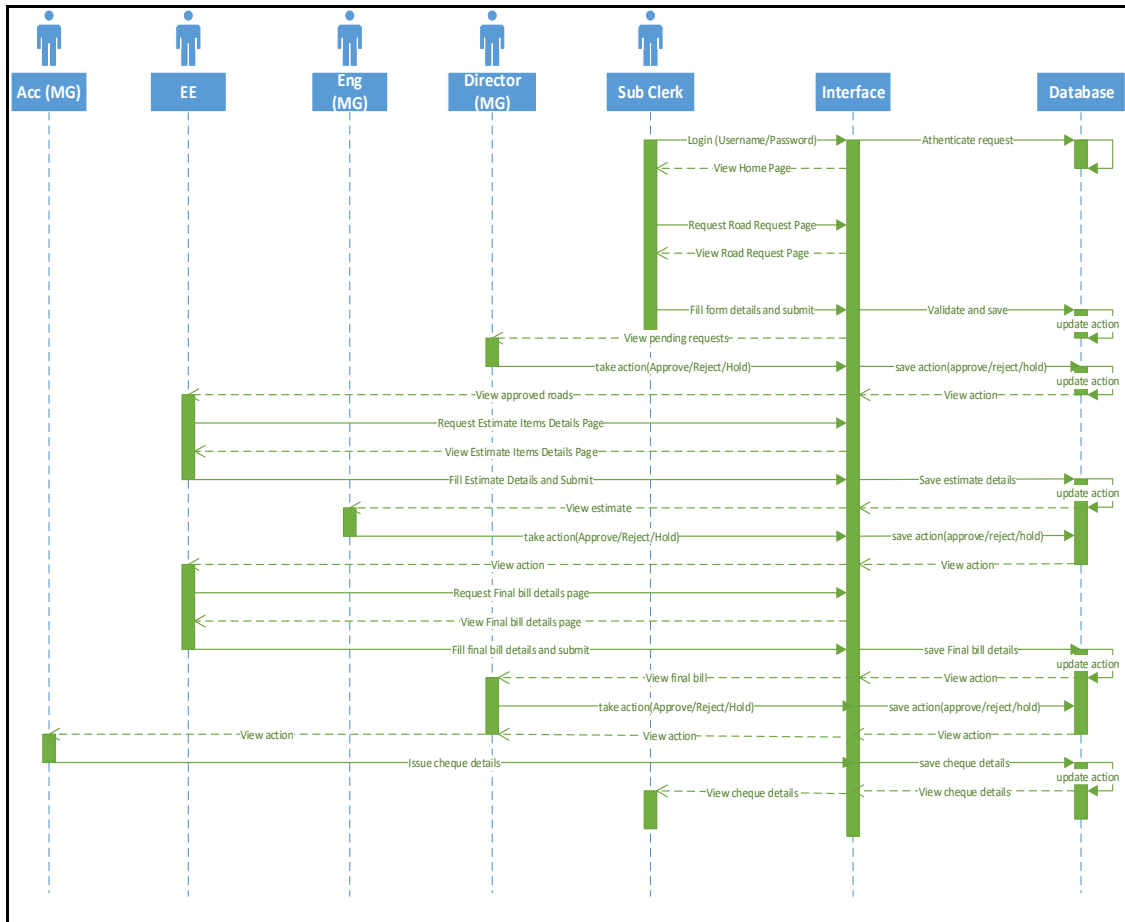


Figure 3.7 : Sequence Diagram for the proposed system

### 3.6.4. Activity Diagram for Road Request Module

Activity diagrams used to capture, specify and visualize system behavior; provide mechanisms for modeling that includes conditional statements, repetition, concurrency and parallel execution and thus can be used at many different levels of abstraction, from modeling business workflows to code [14]. The activity diagram for the Road Request Module is depicted below by Figure: 3.8.

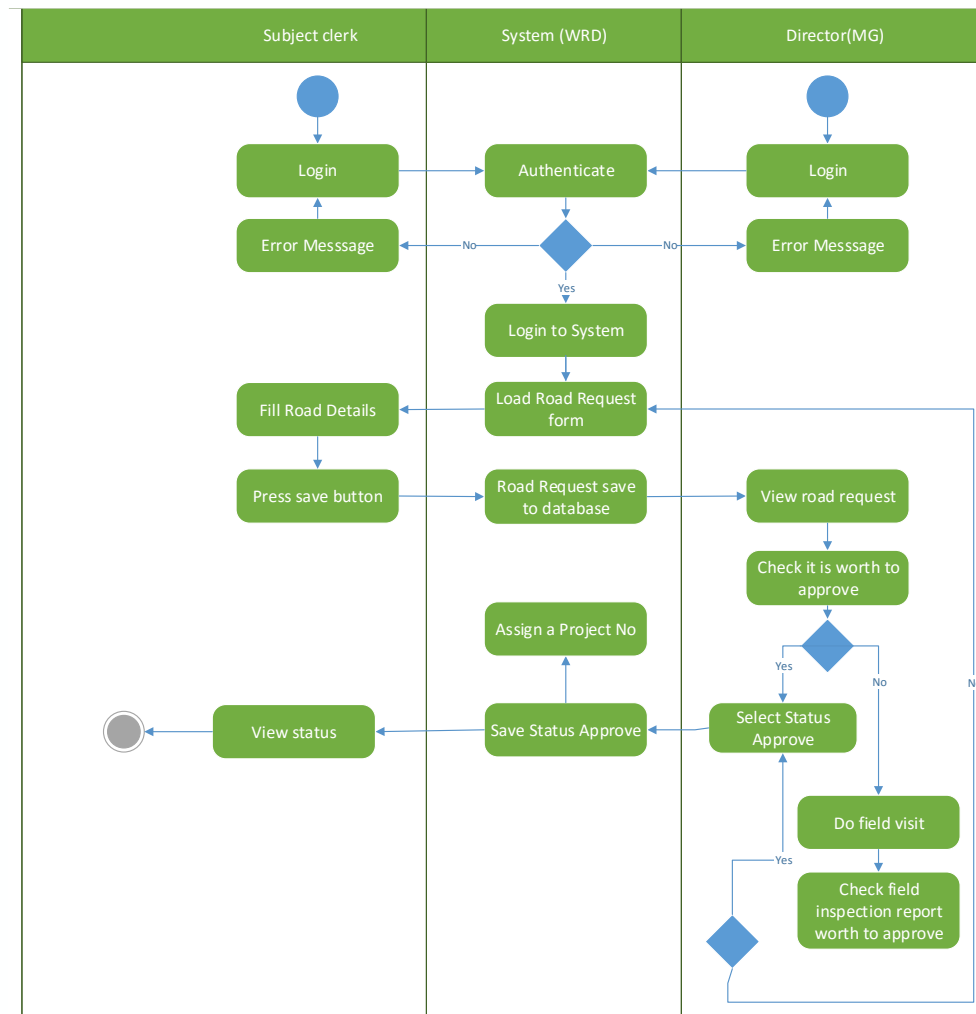


Figure 3.8 : Activity Diagram for Road Request Module

### 3.6.5. Sequence Diagram for Estimate Module

Figure 3.9 depicts the sequence diagram for estimate module. Executive Engineer requests the Estimate items page and Estimate page from system and creates the estimate. Engineer (Maganeguma) will approve, hold or reject the estimate with the Estimate Approval page. If status is hold or reject Executive Engineer can do the required modifications and submit again for the approval.

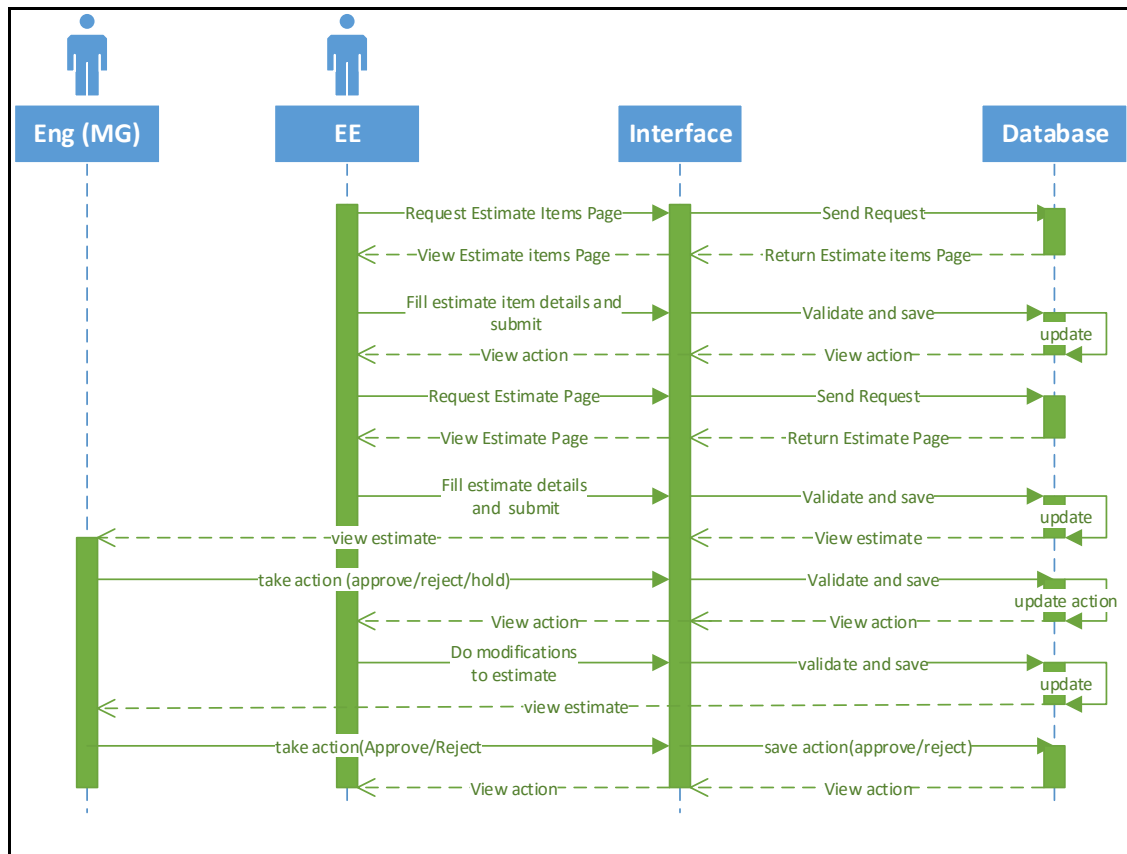


Figure 3.9 : Sequence Diagram for Estimate Module

### 3.6.6. Sequence Diagram for Final Bill Approval

Figure 3.10 depicts the sequence diagram for final bill approval module. Executive Engineer and Director (Maganeguma) involve with this process. Executive Engineer requests the Estimate items page and Final bill page from system and creates the Final Bill. Director (Maganeguma) will approve, hold or reject the final bill with the Final bill Approval page. Executive Engineer can do the modifications and resubmit the final bill if needed.

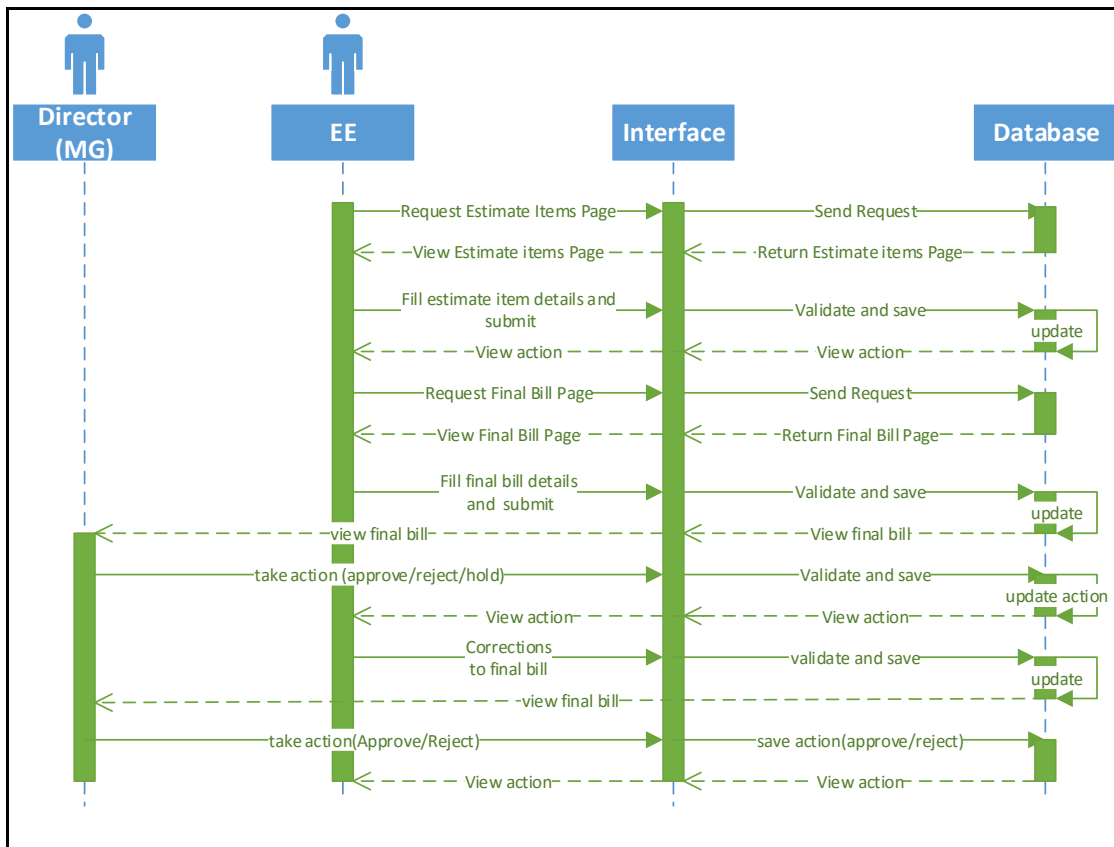


Figure 3.10 : Sequence Diagram for Final Bill Approval

### 3.7. Database Design

Database design is a key factor of system designing. Database anomalies could cause data redundancy and wastage of resources. Hence the database design should be properly done with normalization.

Database design is the process of producing a detailed data model of a database. This logical data model contains all the needed logical and physical design choices and physical storage parameters needed to generate a design in a Data Definition Language (DDL), which can then be used to create a database. A fully attributed data model contains detailed attributes for each entity [15]. Figure 3.11 depicts all the tables of the implemented system with the relationships among them.

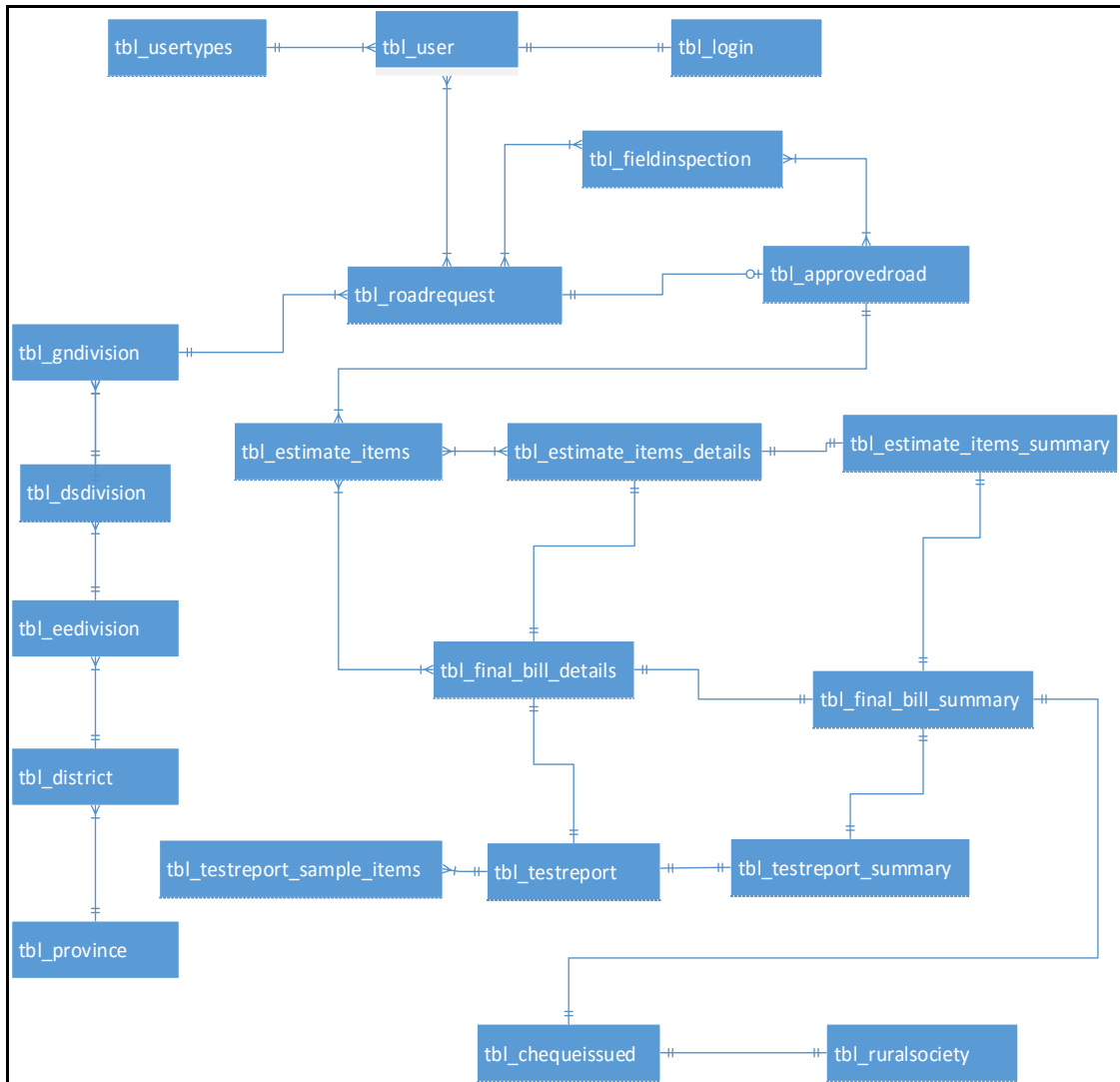


Figure 3.11 : Database Design for the System

### 3.8. Design Architecture

Model View Controller based architecture. The Model-View-Controller (MVC) design pattern assigns objects in an application one of three roles: model, view or controller. The pattern defines not only the roles objects play in the application, it defines the way objects communicate with each other. Each of the three types of objects is separated from the others by abstract boundaries and communicates with objects of the other types across those boundaries. MVC architecture is depicted by Figure 3.12.

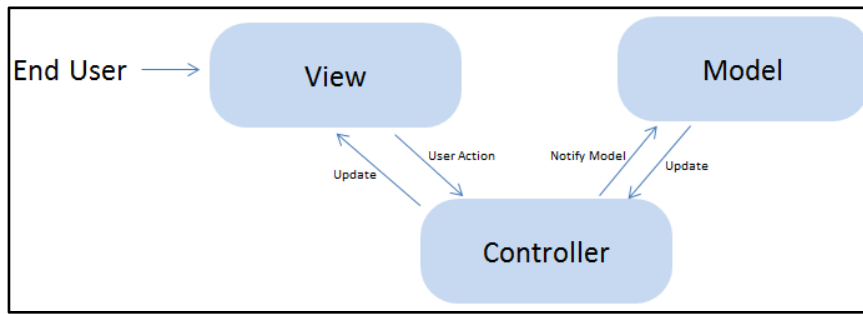


Figure 3.12 : MVC Architecture

The architecture is separated into three distinct parts as:

- **Model:** This is the layer which controls data in the system. It knows all details about data which needed to be displayed. It also governs the rules to access the data of Rural Road Development Management System and perform operations on them. This layer is independent from other system layers such as, View and Controller.
- **View:** This is the layer which uses Model's data querying methods to obtain the data for the purpose of presenting. This layer is independent from application logic. A view must ensure that its appearance reflects the state of the model. Whenever the model's data changes, the model notifies views that depend on it.
- **Controller:** This is the layer which uses Model's data querying methods to obtain the data for the purpose of presenting. This layer is independent from application logic.

### 3.9. User Interface Design

User interface design is a major section of any software development process, because the user interfaces are the intermediate between the user and the system. Nearly most of the software programs use Graphical User Interfaces (GUIs). This means the programs comprised such as menu bars, toolbars, buttons and windows. Therefore a GUI provides a user friendly experience by allowing user to interact with the software in a natural way. Some user interface design principles are given below.

- **User familiarity**

The interface should use terms and concepts drawn from the experience of the people who use the system.

- **Consistency**

The interfaces should be consistent in that wherever possible, comparable operations should be activated in the same way.

- **Minimal surprise**

Users should never be surprised by the behavior of the system.

- **Recoverability**

The interfaces should include mechanisms to allow users to recover from errors.

- **User guidance**

The interface should provide meaningful feedback when errors occur and provide help facility.

- **User diversity**

The interface should provide appropriate interaction facilities for different type of users.

Some of the actions taken to ensure the good and user friendly interfaces for the proposed system are given below.

- Meaningful names and texts and pictures were used for buttons, icons, labels and forms for increased effectiveness of the system
- Eye friendly colors were used.
- Tab indexes were used for easy navigation.
- After saving, updating and deleting a record every form shows the successful or error message.

### 3.9.1. Login Interface

Login form is the initial form user gets once system gets loaded. A valid registered user can enter user name and password in order login to the system. If the user provides correct details the system will direct the user to the home page according to the user type. The login interface is include the logo of the Rural Road Development Program. Figure 3.13 shows the login interface for the system.

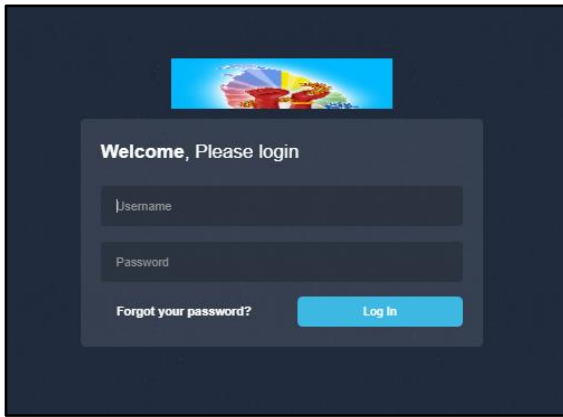


Figure 3.13 : Login Interface for the system

### 3.9.2. Home Page

After successfully login to the system user will see the home page depicted by Figure 3.14. It consists with the processes which can be done with the system. Left Side Bar displays the Main Menu for the system which lists out all the operations that can be done with the system. Those operations are accessible to the user according to the user type. All the key operations are put in short cut icons to enhance the user friendliness and attractiveness. Find Project Info section let the user to find the details of a particular project by selecting project number. News will be displayed on the Latest News section.

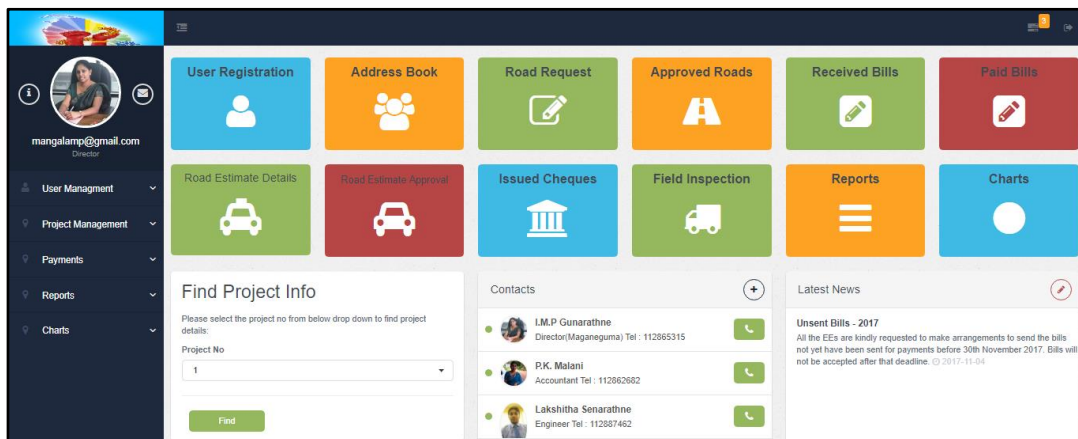
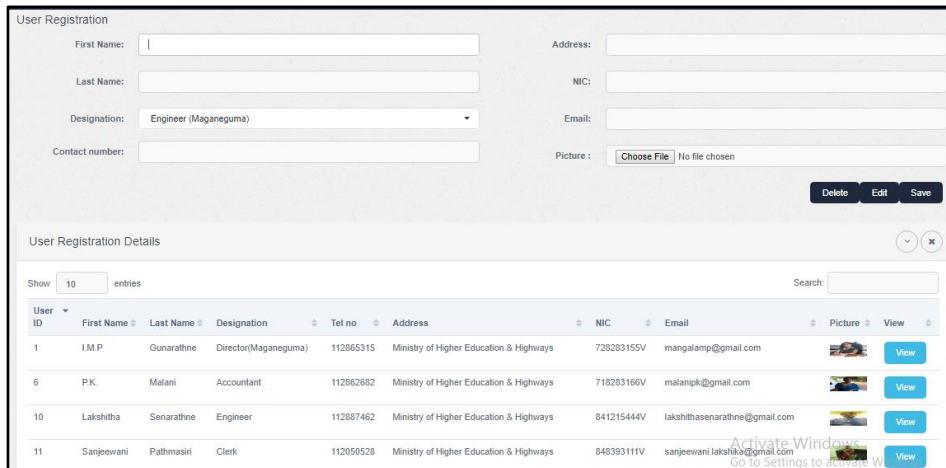


Figure 3.14 : Home Page for the system

### 3.9.3. User Registration Interface

Before a user get registered into the system, user types should be added with the user types page and then users can be registered with below showing Figure 3.15 User Registration Page. User types are loaded to the Designation drop down list. The added

user record are displayed on the grid below which makes the view and update the user details more convenient.



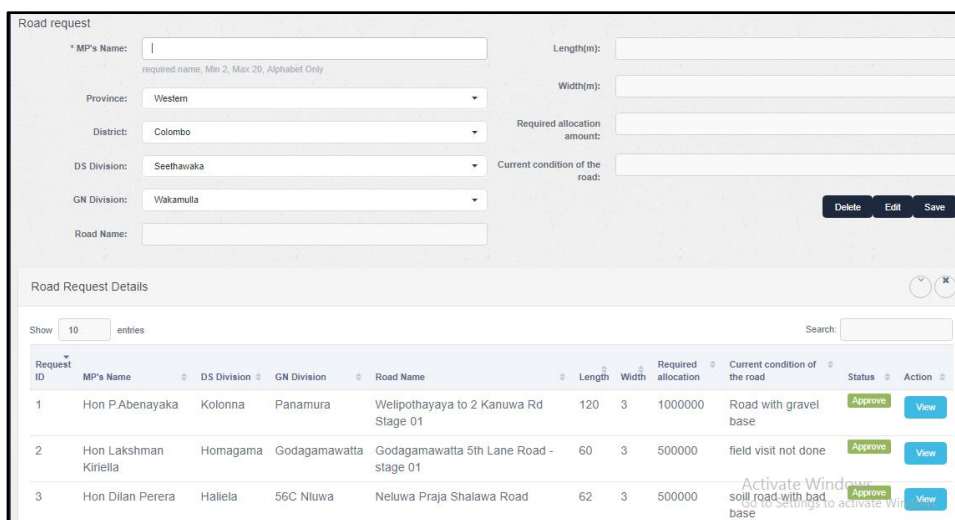
The User Registration interface consists of two main sections. The top section, titled 'User Registration', contains form fields for: First Name, Last Name, Designation (a dropdown menu currently showing 'Engineer (Maganeguma)'), Contact number, Address, NIC, Email, and a Picture field with a 'Choose File' button. Below these fields are 'Delete', 'Edit', and 'Save' buttons. The bottom section, titled 'User Registration Details', features a search bar and a table displaying a list of registered users. The table has columns for User ID, First Name, Last Name, Designation, Tel no, Address, NIC, Email, Picture, and View. Four user records are visible in the table.

| User ID | First Name | Last Name  | Designation          | Tel no    | Address                                 | NIC        | Email                          | Picture | View                 |
|---------|------------|------------|----------------------|-----------|---|------------|--------------------------------|---------|----------------------|
| 1       | I.M.P      | Ounaratne  | Director(Maganeguma) | 112865315 | Ministry of Higher Education & Highways | 728283155V | mangalamp@gmail.com            |         | <a href="#">View</a> |
| 6       | P.K.       | Malani     | Accountant           | 112862682 | Ministry of Higher Education & Highways | 718283166V | malanipk@gmail.com             |         | <a href="#">View</a> |
| 10      | Lakshitha  | Senarathne | Engineer             | 112867462 | Ministry of Higher Education & Highways | 841215444V | lakshithasenanathne@gmail.com  |         | <a href="#">View</a> |
| 11      | Sanjeevani | Pathmasiri | Clerk                | 112050528 | Ministry of Higher Education & Highways | 848393111V | sanjeevani.lakshitha@gmail.com |         | <a href="#">View</a> |

Figure 3.15 : User Registration Interface

### 3.9.4. Road Request Interface

Road requests are made with Figure 3.16 Road Request Interface. Subject clerk enter the road request details into the system. Road request details are loaded to the below grid. By clicking the view button of a particular record the details of the road request are loaded to the relevant fields so that the update and delete operations can be done. When the Director (Maganeguma) approve/reject/ hold a road, the status can be viewed with this interface.



The Road Request interface has two main sections. The top section, titled 'Road request', contains form fields for: MP's Name (with a note 'required name, Min 2, Max 20, Alphabet Only'), Province (dropdown, showing 'Western'), District (dropdown, showing 'Colombo'), DS Division (dropdown, showing 'Seethawaka'), GN Division (dropdown, showing 'Wakamulla'), Road Name, Length(m), Width(m), Required allocation amount, and Current condition of the road. Below these fields are 'Delete', 'Edit', and 'Save' buttons. The bottom section, titled 'Road Request Details', features a search bar and a table displaying a list of road requests. The table has columns for Request ID, MP's Name, DS Division, GN Division, Road Name, Length, Width, Required allocation, Current condition of the road, Status, and Action. Three road request records are visible in the table.

| Request ID | MP's Name             | DS Division | GN Division   | Road Name                              | Length | Width | Required allocation | Current condition of the road | Status                  | Action               |
|------------|-----------------------|-------------|---------------|--|--------|-------|---------------------|-------------------------------|-------------------------|----------------------|
| 1          | Hon P.Abenayaka       | Kolonna     | Panamura      | Welipothayaya to 2 Kanuwa Rd Stage 01  | 120    | 3     | 1000000             | Road with gravel base         | <a href="#">Approve</a> | <a href="#">View</a> |
| 2          | Hon Lakshman Kiriella | Homagama    | Godagamawatta | Godagamawatta 5th Lane Road - Stage 01 | 60     | 3     | 500000              | field visit not done          | <a href="#">Approve</a> | <a href="#">View</a> |
| 3          | Hon Dilan Perera      | Haliella    | 56C Nluwa     | Neluwa Praja Shalawa Road              | 62     | 3     | 500000              | soil road with bad base       | <a href="#">Approve</a> | <a href="#">View</a> |

Figure 3.163 : Interface for Request Roads

### 3.9.5. Road Estimate Details Interface

Before going to create an estimate with this Estimate interface estimate items should be added to the system with Estimate Items interface. Then the system will load the item descriptions, HSR rates and unit price etc. Only the project numbers of approved roads are loaded to the drop down list. To create the estimate, all the user has to do is to select the relevant project number and enter required quantities of items. The system do the calculations and make the summary. Interface for the Estimate is depicted by Figure 3.17.

The screenshot displays the 'Estimate' interface. At the top, a green header bar contains the text 'Created Estimate for:MP/09/17/BP/01'. Below this, the 'Estimate' section includes a 'Project number' dropdown menu (currently showing 'Nothing selected'), a 'Show 10 entries' button, and a 'Search:' input field. A 'Save' button is located to the right of the search field. The main part of the interface is a table with the following columns: 'Details ID', 'Description', 'HSR', 'Unit', 'Rate', and 'Quantity'. The table contains 7 rows of data, each with a corresponding input field for the quantity.

| Details ID | Description                              | HSR     | Unit           | Rate    | Quantity |
|------------|--|---------|----------------|---------|----------|
| 1          | Trimming levelling & compaction          | EWI-009 | Sq.m           | 84.55   |          |
| 2          | Laying Polythine for concrete            | BO-639  | Kg             | 323.2   |          |
| 3          | Suppling & fixing thick planks of timber | STI-057 | Sq.m           | 997.4   |          |
| 4          | Mixing and laying concrete mixture       | STI-046 | Cu.m           | 13542.8 |          |
| 5          | Transport concrete                       | TI-007A | km             | 850.5   |          |
| 6          | Suppling & Placing rigiform              | TI-027B | kg             | 255.25  |          |
| 7          | Curing of concrete                       | STI-053 | Sq.m for 7 dys | 36.25   |          |

Figure 3.17 : Road Estimate Details Interface

# CHAPTER 4 – IMPLEMENTATION

## 4.1. Introduction

Having completed the design stage, implementation starts with the specifications made in the design phase being transformed to an executable system which satisfies the client's requirements. Implementation is a vital stage in software development life cycle hence it is very important to select the most appropriate tools and techniques. This system is developed in a modularized way in which finally integrated all the modules into a complete system.

The main issues discussed in this chapter are the implementation environment, tools and techniques used and the reusable components utilized to implement the system. The key code segments is encompassed to help gain an idea of process functionalities of the system. Comments are included with code segments with the intention of future developments.

## 4.2. Implementation Environment

The System Implementation Environment can be divided into two parts, Hardware Environment and Software Environment which are listed below in Table 4.1.

| Hardware Environment                | Software Environment               |
|-------------------------------------|------------------------------------|
| 3.0 Ghz Intel(R) Core(TM) Processor | Microsoft Windows 7, Windows 8     |
| 1GB RAM                             | XAMPP 3.2.1                        |
| 80 GB Hard Disk                     | NetBeans IDE 8.0                   |
| 1024*768 Display                    | PHP 5.5.15                         |
| Inkjet or LaserJet Printer          | Apache 2.4.10 Server               |
| ADSL Connection (512 kbps)          | HeidiSQL 9.3.0 Database            |
|                                     | Google Chrome, Firefox Web browser |
|                                     | Notepad ++                         |
|                                     | HTML2PDF                           |

Table 4.1 : Implementation Environment

### 4.3. System Developed Tools and Technologies

When the system is being developed the following tools and technologies were used.

- PHP

PHP is a widely used open source server side object oriented scripting language and a powerful tool for making dynamic and interactive web pages. It was the programming language used to implement the system.

- HeidiSQL

MySQL is an open source Relational Database Management System. HeidiSQL is a powerful and easy client for MySQL. It enables to browse and edit data, create and edit tables and export data to SQL files. This is the software used to handle the database of the system.

- HTML

HTML is standard markup language for creating web pages and web applications and it helps to keep the system structure clear and conscious.

- JavaScript

JavaScript scripting language which supports client side validation and help make the system components dynamic.

- Bootstrap

Bootstrap is a HTML, CSS and JavaScript Framework for developing responsive web sites.

- CSS

Cascading Style Sheets is a language that describes the style of an HTML document, how elements should be displayed. CSS is used for the styling of the system.

- JQuery

JQuery is a JavaScript library which can be used as reusable component in system development. It has ability to interact with the browser, provides and easy methods to deal with DOM (Document Object Model).

- NetBeans

NetBeans IDE (Integrated Development Environment) which means, a software application that provides all the tools necessary to develop desktop, web and mobile applications was used as the IDE for the development of the system. It also allows developers to add new plug-ins as needed.

#### 4.4. Module Structure of the system

The System was developed using MVC (Model-View-Controller) architecture which separates Module/View/Control logic from the rest of the user interface. Figure 4.1 depicts the module structure of the system.

Module – Managing all the operations and behaviors.

View – Enclosing all the user interface files

Control – Control is communicating the module and the view.

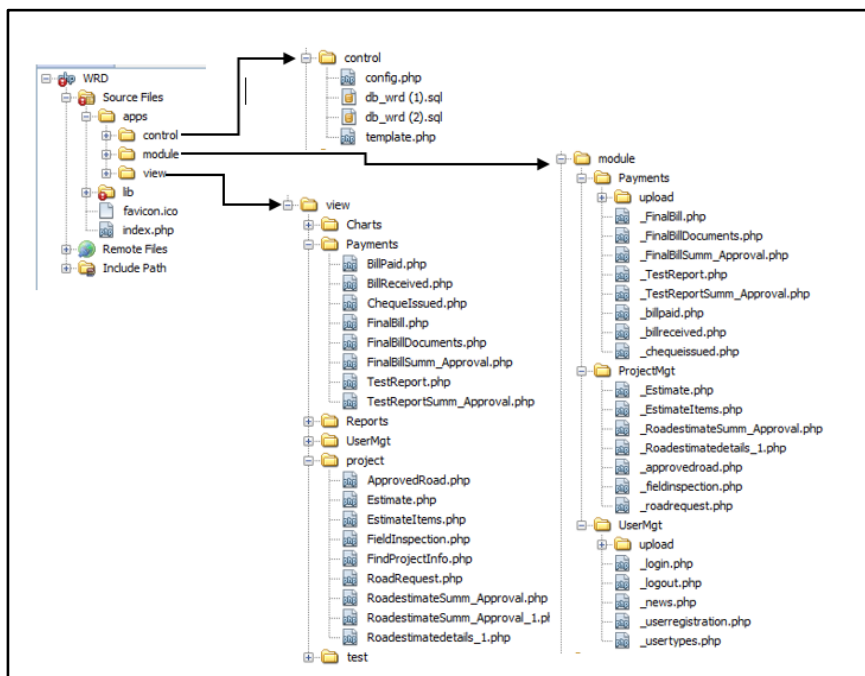


Figure 4.1 : Module structure of the system

#### 4.5. Major Code Segments

The main code modules developed in the system are inserted below with a brief description of their functionalities. Comments are included to make understand the purpose of a specific code line which will be helpful for further improvements of the system.

### ▪ Database Connection Page

Database connection page provides the interface between SQL queries in the system and database management system to exchange transactions. Every standalone system and a web based system has a database to store their information. This system is used PHP PDO (PHP Data Object) to establish the database connection with the system which provides a fully object oriented way for manipulating transactions. Database connection page is depicted in Figure 4.2.

```
<?php
// initiate a session
session_start();

/** DATABASE CONFIGURATION */
define('DB_HOST', 'localhost');
define('DB_PORT', '3306');
define('DB_NAME', 'db_wrd');
define('DB_USER', 'root');
define('DB_PASS', '');

/** DATABASE CONNECTION-STRING connection to a database */
$conn = new PDO('mysql:host=' . DB_HOST . ';port=' . DB_PORT . ';dbname=' . DB_NAME, DB_USER, DB_PASS);
$conn->setAttribute(PDO::ATTR_ERRMODE, PDO::ERRMODE_EXCEPTION); //See the Errors and error

/** SITE CONFIGURATION */
define('BASE_URL', 'http://localhost/WRD/');
define('LOCAL_PATH', 'C:/xampp/htdocs/WRD/');
define('SITE_TITLE', 'Road Management System');

require_once 'template.php';
?>
```

Figure 4.2 : Database connection page

### ▪ Login Handling Page

Registered users of the system are allowed to access the system having entered their email address as username and password. Username and password will be passed to the Module page named as 'login' to validate the user. Depending on the returned results from 'login' user will be redirected to index page or dashboard page. When login to the system the user is given the privileges which defined in the database for each and every module. Code segment that given below by Figure 4.3 illustrates the Login Handling Process.

```

<?php

//db configuration
require_once '../control/config.php';

if (isset($_POST['Login'])) {
    $login_username = $_POST['login_username'];
    $login_password = sha1($_POST['login_password']);

    try {
        //query DB and check user exists or not
        $sql = 'SELECT login_username, login_password, login_usertype, user_pic FROM tbl_login, tbl_user '
            . 'WHERE user_email=login_username AND login_username=:login_username';
        $stmt = $conn->prepare($sql);
        $stmt->execute(array(':login_username' => $login_username));

        $result = $stmt->fetchAll();
        if (count($result)) {
            $row = $result[0];
            $DBPassword = $row['login_password']; // users password saved in DB

            if ($DBPassword == $login_password) { /// check Database password equal to user entered password
                $_SESSION['login_username'] = $row['login_username'];
                $_SESSION['login_usertype'] = $row['login_usertype'];
                $_SESSION['user_pic'] = $row['user_pic'];

                $_SESSION['SUCCESS'] = 'Welcome to Rural Road Management System ! ' . $_SESSION['login_username'];
                header("Location: " . BASE_URL . 'apps/view/UserMgt/home_Director.php');
            } else {
                $_SESSION['ERROR'] = 'Please check your user name and password!';
                header("Location: " . $_SERVER['HTTP_REFERER']);
            }
        } else {
            $_SESSION['ERROR'] = 'Please check your user name and password!';
            header("Location: " . $_SERVER['HTTP_REFERER']);
        }
    } catch (Exception $ex) {
        $_SESSION['ERROR'] = 'Error!';
        header("Location: " . $_SERVER['HTTP_REFERER']);
    }
}
}
?>

```

Figure 4.3 : Login handling page

#### ▪ Logout page

The user can successfully log out from the system, the session gets destroyed and the user will be redirected to the login page. Figure 4.4 depicts log out from the system.

```

<?php

//db configuration
require_once '../control/config.php';

// Delete session
session_destroy();

header("Location: ".BASE_URL);

```

Figure 4.4 : Logout page

#### ▪ Data Validation (PHP, Database, Front end HTML)

Data validation is a most important and critical part of the implementation process, as unwanted values can be entered by the users to the system, so that the accuracy of the

data may be lost. The main objective of data validation is to ensure the input value is in the correct format.

#### - Backend PHP Validation

PHP backend validation is done using ‘try-catch’ block. Code segment illustrated by Figure 4.5 for ‘save’, ‘edit’, ‘delete’ operations are surrounded in a try block to help catch exceptions. If an exception does not trigger the code in the try block will continue and update the database properly. If an exception triggers, the catch block executes and prints a user friendly message.

```
try {
    if (isset($_POST['Save'])) { ...59 lines }

    if (isset($_POST['Edit'])) { ...17 lines }

    if (isset($_POST['Delete'])) { ...11 lines }
} catch (Exception $ex) { // display error occurred in try
    if ($ex->getCode() == '23000') { // This check for unique key constain vilation
        $_SESSION['ERROR'] = $user_fname . " Already exists try another !!"; // print userfriendly msg
        // this will redirect to view page
        header("Location: " . $_SERVER['HTTP_REFERER']);
    } else {
        $_SESSION['ERROR'] = $ex->getMessage();
        // this will redirect to view page
        header("Location: " . $_SERVER['HTTP_REFERER']);
    }
}
```

Figure 4.5 : Code segment for php backend validation

#### - Front end Html validation

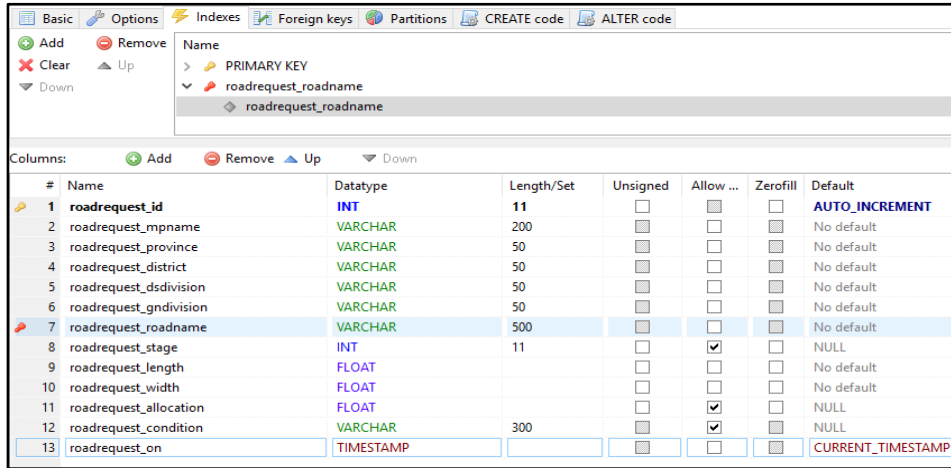
Figure 4.6 Front end html form validation can be performed by the browser. If the MP’s name field is empty, the ‘required’ attribute prevent this from being submitted. The pattern attribute validates the expected format of the value of MP’s name field.

```
<div class="col-md-6">
    <div class="form-group">
        <label class="col-md-3 control-label">* MP's Name:</label>
        <div class="col-md-9">
            <input type="text" autofocus="" required="" pattern="[A-Za-z]{2,20}"
                title="required name, Min 2, Max 20, Alphan Only" name="roadrequest_mpname"
                class="form-control" value=<?php
                if (isset($_GET['roadrequest_id'])) {
                    echo $roadrequest_mpname;
                }
                ?>
            <span class="help-block">required name, Min 2, Max 20, Alphan Only</span>
        </div>
    </div>
</div>
```

Figure 4.6 : Code segment for frontend html validation

## - Database validation

Figure 4.7 depicts the structure of tbl\_roadrequest. All the tables in the db\_wrd database are validated with defining key constraints such as primary key, foreign key and unique key, data types, not null and auto increments.



| #  | Name                   | Datatype  | Length/Set | Unsigned                 | Allow ...                           | Zerofill                 | Default           |
|----|------------------------|-----------|------------|--------------------------|-------------------------------------|--------------------------|-------------------|
| 1  | roadrequest_id         | INT       | 11         | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | AUTO_INCREMENT    |
| 2  | roadrequest_mpnname    | VARCHAR   | 200        | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 3  | roadrequest_province   | VARCHAR   | 50         | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 4  | roadrequest_district   | VARCHAR   | 50         | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 5  | roadrequest_dsdivision | VARCHAR   | 50         | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 6  | roadrequest_gndivision | VARCHAR   | 50         | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 7  | roadrequest_roadname   | VARCHAR   | 500        | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 8  | roadrequest_stage      | INT       | 11         | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | NULL              |
| 9  | roadrequest_length     | FLOAT     |            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 10 | roadrequest_width      | FLOAT     |            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | No default        |
| 11 | roadrequest_allocation | FLOAT     |            | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | NULL              |
| 12 | roadrequest_condition  | VARCHAR   | 300        | <input type="checkbox"/> | <input checked="" type="checkbox"/> | <input type="checkbox"/> | NULL              |
| 13 | roadrequest_on         | TIMESTAMP |            | <input type="checkbox"/> | <input type="checkbox"/>            | <input type="checkbox"/> | CURRENT_TIMESTAMP |

Figure 4.7 : Database validation – Road Request table

## ▪ Assign Privileges to users

Any page in the system can be viewed only authorized users only. So the pages are restricted according to the user type. Code segment given below by Figure 4.8 illustrates how the user privileges are assigned with markup language, here only the Director is given privileges to access the Approved Road Page.

```
<?php
require_once '../control/config.php';
$template = new template();

// Check User logged or not
if (isset($_SESSION['login_username'])) {
    if ((isset($_SESSION['login_username'])) && ($_SESSION['login_usertype']=='Director')) {
        // allow to access page
    } else {
        // direct to error page
        header("Location: " . BASE_URL . 'apps/view/UserMgt/Error_pg.php');
    }
}
?>
<html lang="en">
<h4>Approved Roads</h4>
<form role="form" class="form-horizontal" action="../../module/ProjectMgt/_approvedroad.php" method="POST">
</form>
</html>
<?php } ?>
```

Figure 4.8 : Code segment for assigning privileges to users

## 4.6. Security

The system is contained with very important and confidential information which should not disclose to the outside parties. Hence the system has been provided with strong security features to prevent unauthorized access and modifications. Each and every user type has predefined user privileges given by the system. Every page of the system validate the user to avoid unauthorized access and modifications. User password is stored in the database with SHA1 hash value. System provides backup and restore facility to get regular backups for more security.

## 4.7. Re-usable Components

- Atlant - Bootstrap Admin Template with Frontend

Atlant - Bootstrap Admin Template is a freely available template in internet which can be customized as to the requirements. Atlant is easy to use and has lots of ready to use elements [16].

- JQuery Plug-in - datatables

datatables is a plug-in for JQuery javascript library. It can be used to create, search, sort and view any html table [17].

- amCharts

amCharts is a maker for widely used JavaScript-based interactive charts and maps programming libraries and tools. The main products, JavaScript Charts and JavaScript Maps [18].

- Html2pdf

HTML2PDF is a HTML2PDF converter written in PHP. This library has been made to assist in the creation of PDF files, not to directly convert an HTML page [19].

# CHAPTER 5 – EVALUATION

## 5.1. Introduction

This chapter describes about the evaluation of the project. In the software testing process, the difference between the given input and expected output is evaluated. Testing assesses the quality of the product and it is done during the software development process.

In other words software testing is a verification and validation process. Verification and validation are used to check whether the product, service or system meets requirements and specifications. Validation is the process which assures that the product, service or system meets the needs of the customer. Verification is the process which evaluates the work-products (not the actual final product) of the development phase. It determines whether they meet the specified requirements for that phase. Software testing process can be done in any part of the software development process.

## 5.2. Test Strategies

The Rural Road Management System for the Rural Road Development Programme was tested with a test plan in order to ensure the ultimate product is more reliable. The implemented system was tested using different test cases throughout the development process.

### 5.2.1. System Testing

System Testing is a software testing process which is performed on the entire system in the context of a Functional Requirement Specification and/or a System Requirement Specification. It is also intended to test up to and beyond the bounds defined in the software/hardware requirements specifications. It is performed after Integration Testing by independent testers.

This is a black box type of testing where external working of the software is evaluated with the help of requirement documents and it is totally based on Users point of view. As a rule, system testing takes, as its input, all of the "integrated" software components that have passed the integration testing and also the software system itself integrated with any applicable hardware systems [20].

### 5.3. System Test Cases

A test case has components that describe an input, action or event and an expected response, to determine if a feature of an application is working correctly [21].

#### 5.3.1. Test Cases for User Authentication

Table 5.1 depicts the test cases for user authentication. (Test results are given in Appendix E – Table E.1)

| No | Test Description            | Test Case  | Expected Result  |
|----|-----------------------------|--|--|
| 01 | Validate User Input Details | Enter correct username<br>Enter correct password   | Successfully login into the system                                 |
| 02 | Validate User Input Details | Enter correct username<br>Enter incorrect password | Display error message<br>“Please check your username and password” |
| 03 | Validate User Input Details | Enter incorrect username<br>Enter correct password | Display error message<br>“Please check your username and password” |
| 04 | Validate User Input Details | Enter both username and password incorrectly       | Display error message<br>“Please check your username and password” |

Table 5.1 : Test Cases for User Authentication

#### 5.3.2. Test Cases for User Registration

Table 5.2 depicts the test cases for user registration. (Test results are given in Appendix E – Table E.2)

| No | Test Description                     | Test Case                                      | Expected Result   |
|----|--------------------------------------|--|---|
| 05 | Validate Personal Information adding | Add information with specified correct details | Display message “Created user” with this name                                 |
| 06 | Validate Personal Information adding | Try to add information with all fields empty   | Pop up the error message on the first field                                   |
| 07 | Validate Personal Information adding | Enter all fields except first name             | Pop up the error message “Please fill out this field” on the first name field |
| 08 | Validate Personal Information adding | Enter all fields except last name              | Pop up the error message “Please fill out this field” on the last name field  |

|    |                                      |  |  |
|----|--------------------------------------|--|--|
| 09 | Validate Personal Information adding | Enter email without @ sign                             | Pop up the error message “Please include an ‘@’ in the email address” on the email field |
| 10 | Validate Personal Information adding | Enter existing user                                    | Display message “Already exists try another” with this name                              |
| 11 | Delete user                          | Select a user and click on Delete icon                 | Display a message “Updated user:” with the username                                      |
| 12 | Update User                          | Select a user view details and update user information | Display a message “Updated user:” with the username                                      |

Table 5.2 : Test cases for User Registration

### 5.3.3. Test Cases for Requesting Roads

Table 5.3 depicts the test cases for request roads. (Test results are given in Appendix E – Table E.3)

| No | Test Description | Test Case   | Expected Result  |
|----|------------------|---|--|
| 13 | Request a road   | Insert road request not already in the system                 | Display message “Created Road Request: road name ” with road name and display details in the View Grid |
| 14 | Request a road   | Insert road request already in the system                     | Display message “Already existing road; Try another”   |
| 15 | Request a road   | Insert a road without entering MP name                        | Pop up the error message “Please fill out this field” on the MP name field                             |
| 16 | Request a road   | Insert a road without requested format for MP name            | Pop up the error message “Please match the requested format” on the MP name field                      |
| 17 | Request a road   | Insert a road without entering GN Division                    | Pop up the error message “Please fill out this field” on the GN Division field                         |
| 18 | Request a road   | Insert a road without entering road name                      | Pop up the error message “Please fill out this field” on the Road name field                           |
| 19 | Request a road   | Insert a road without entering Length of the road             | Pop up the error message “Please fill out this field” on the Length field                              |
| 20 | Request a road   | Insert a road without entering Width of the road              | Pop up the error message “Please fill out this field” on the Width field                               |
| 21 | Request a road   | Select a road request from View Grid and click on Delete icon | Display message “Removed Road Request: road name ”   |

|    |                |   |  |
|----|----------------|---|--|
|    |                |   | and remove the record from the View Grid   |
| 22 | Request a road | Select a road request from View Grid and click on Update icon | Display message “Updated Road Request: road name ” and update the details in the View Grid |

Table 5.3 : Test cases for requesting roads

## 5.4. User Acceptance Testing

As the ultimate product obtained, Web Based Rural Road Management System was tested by the client. The user acceptance testing was carried out by implementing the system at the real working environment along with the real test data and available conditions in the actual background. For the evaluation, system users were selected considering privileges they given and they were asked to perform appropriate functionalities. The performance and drawbacks were monitored as well as the test results and the user friendliness of the system.

A survey was conducted with the real users in order to get an understanding of the level of satisfaction of the users. User feedback evaluation questionnaire was given and the results has been summarized. Following Figure 5.1 shows the user feedback evaluation questionnaire.

**User feedback evaluation questionnaire for the**  
**Rural Road Management System**

To improve the proposed system please provide your valuable feedback.

Name: .....

Designation: .....

Rate each of the following evaluating items. (Maximum mark is 12)

| Rural Road Management System |                                 |        |
|------------------------------|---------------------------------|--------|
| No                           | Question                        | Rating |
| 1.                           | Overall reaction                |        |
| 2.                           | Required functionalities        |        |
| 3.                           | System security                 |        |
| 4.                           | System navigation               |        |
| 5.                           | Response time                   |        |
| 6.                           | Interfaces                      |        |
| 7.                           | Easy of usage                   |        |
| 8.                           | Match with the ordinary process |        |

Figure 5.1: User feedback evaluation questionnaire

A pleasant feedback was received having done the user evaluation. Newly developed Rural Road Management System has been increased their regular activity performance rather than continue with the manual system. User feedback evaluation summary is depicted by Figure 5.2.

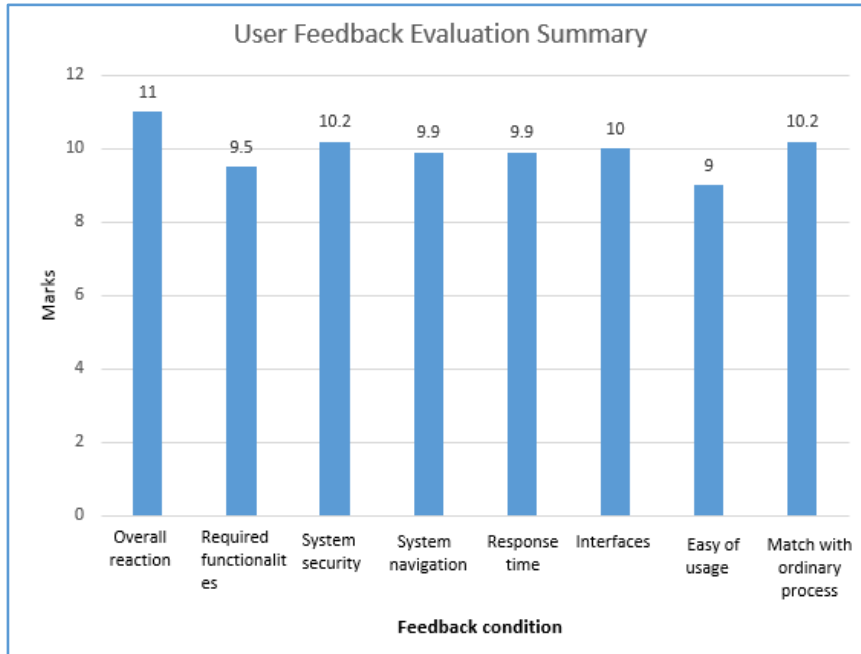


Figure 5.2 : User feedback evaluation summary

# CHAPTER 6 – CONCLUSION

## 6.1. Introduction

With a view to enhance the Rural Road Network of Sri Lanka “Maganeguma” Rural Road Development Programme was initiated under the vision “By establishing a sustainable rural road network suitable for plying the way for the development of other infrastructures, to provide supportive backing for the development of social, economic and all other activities of the rural people while making further increases on the investment for the development of rural roads in next years to come”.

More than a decade had passed but, they were working with the paper, book and file based manual system with lots of difficulties. Almost all the processes from requesting roads to making payments, accuracy of data, and evaluation of the progress had become very slow and time consuming with a considerable wastage of resources. To overcome those drawbacks and make the Rural Road Development Programme to attain its vision, the Web Based Rural Road Management System was developed.

The client’s requirements were properly analyzed from the requirements analysis stage and the system was developed by improving the existing functionalities according to the user requirements in a way that to make the user satisfied and keep interacted with system. By automating the processes the workload of the user was lessen with increased efficiency, accuracy and time saving. User feedback was taken and the system was properly tested to validate the overall system and avoid conflicts to be occurred. However it is difficult to get the client’s expected requirements to be achieved to the 100%. The system has been taken the client’s expectations to a satisfactory level. It is realized by checking the user feedback, test results and comparison between the system functionality with the existing system.

## 6.2. Future Improvements

In future following features are planning to add to the newly built system as further improvements.

- Enhance the System with User-friendliness, Security, Availability and easy Maintenance.

- Improve the usability of the system by adding Sinhala and Tamil languages.
- Develop and add a GIS (Geographic Information System) to identify and capture the spatial locations of all the developed rural roads.
- Develop mobile application using android for the system for easy access to users of the system.

### 6.3. Lessons Learnt

As an undergraduate the knowledge gained throughout the project was really valuable. In addition this gave me an exceptional experience of being in a complete software development life cycle, starting from feasibility studies to the conclusion of the project. From the primary stage of the system development life cycle there were more skills to develop like investigating facts in feasibility studies, effective communicating with people, time management, project planning, report writing, training people to new system environment and many valuable capabilities.

This project gave an opportunity to get extensive knowledge of PHP, MySQL, XAMPP, MVC, NetBeans and many more languages, tools and technologies. And also it helped to test and implement most important theories and technologies learnt throughout the BIT degree program.

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# Appendix A – System Documentation

The system documentation is consisted with a set of steps showing how to install the Web Based Rural Road Management System. The hardware and software environment needed for the installation is also stated below.

## Step – 01

### Hardware Requirements

Table A.1 depicts the hardware requirements.

| Hardware  | Minimum Requirements              |
|-----------|-----------------------------------|
| Processor | 3.0 GHz Intel Processor or higher |
| Memory    | 512 MB or higher                  |
| Hard disk | Minimum 1GB disk space or higher  |
| Display   | Minimum 1024*768 resolution       |
| Printer   | Inkjet or LaserJet                |
| Internet  | ADSL Connection (512 kbps)        |

Table A.1 : Hardware Requirements

### Software Requirements

Table A.2 depicts the software requirements.

| Software         | Minimum Requirements            |
|------------------|---------------------------------|
| Operating System | Windows 7 or higher             |
| XAMPP            | XAMPP 1.8.3 or higher           |
| Web Browser      | Google Chrome, Firefox          |
| Code Editor      | Netbeans or any suitable editor |
| PDF Converter    | HTML2PDF                        |

Table A.2 : Software Requirements

## Step - 02

### XAMPP Installation

- Download and install XAMPP for Windows from <http://www.apachefriends.org>.
- Give installation path to C:\xampp of the computer.

### **Installation of Web browser**

- Install the web browser.

### **Step – 03**

#### **Extraction of Files**

- Open the CD and copy the WRD folder and paste it to the directory path “C:\xampp\htdocs”

### **Step – 04**

#### **Installation of Database**

- Open the web browser and type the URL <http://localhost/phpmyadmin/> and enter username and password if you have set username and password.
- Create an empty database with the name “**db\_wrd**” and navigate to the “**Import**” tab and click “Choose File” button.
- Browse the CD and select “**db\_wrd.sql**” file.
- Then press “**GO**” button at the bottom of the page.

### **Step – 04**

#### **Installation of Database**

- Make sure the XAMPP is running and go to the “C:\xampp\” and open the control panel and verify Apache, PHP, MySQL are running.
- Open the web browser and type the URL <http://localhost/WRD> and press “Enter” button to access the system.

## Appendix B – Design Documentation

Some design diagrams were included in the design chapter and this appendix is contained the other design diagrams such as use case diagrams with detailed information for main modules, sequence diagrams and activity diagrams.

### Use case Diagrams with Detailed Information

#### ■ Use case diagram for Approving Roads

Figure B.1 depicts the use case diagram for approving roads. The Subject clerk can insert and edit road requests. Director (Maganeguma) view and approve/hold/reject roads. Engineer (Maganeguma) do field inspections for the required roads and approve the field inspection report prepared by the subject clerk. Director (Maganeguma) view and take decision to approve or reject.

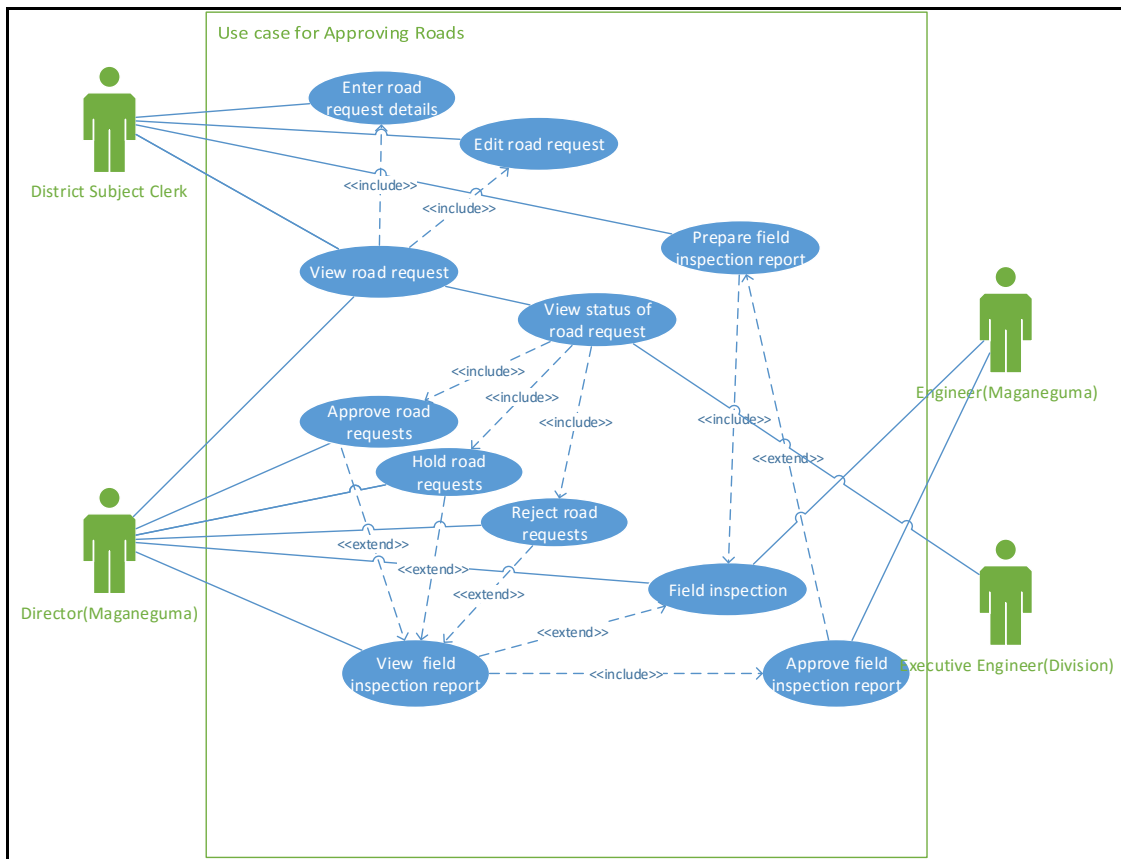


Figure B.1 : Use case for Approving Roads

Table B.1 shows the use case description for approving roads.

|                        |   |
|------------------------|---|
| <b>Use Case</b>        | Approve Roads   |
| <b>Actors</b>          | Subject clerk, Director (Maganeguma), Engineer(Maganeguma), Executive Engineer  |
| <b>Description</b>     | Approve roads   |
| <b>Pre-Conditions</b>  | Subject clerk entered the road request details  |
| <b>Flow of Events</b>  | <ol style="list-style-type: none"> <li>1. Director (Maganeguma) view the road request details</li> <li>2. Check the details</li> <li>3. Do field visit (if needed)</li> <li>4. Approve/Reject/Hold the road project.</li> </ol> |
| <b>Post-Conditions</b> | <ol style="list-style-type: none"> <li>1. Road request details are saved to tbl_roadrequest with the status.</li> <li>2. Approved road details are saved to tbl_approvedroad with assigned Project Number.</li> </ol>           |

Table B.1 : Use case Description for Approving roads

#### ■ Use case diagram for Estimate Approval

Figure B.2 shows the use case diagram for estimate approval. Executive Engineer and Engineer (Maganeguma) involve with this process. EE prepares the estimate and Engineer (Maganeguma) will approve or reject it.

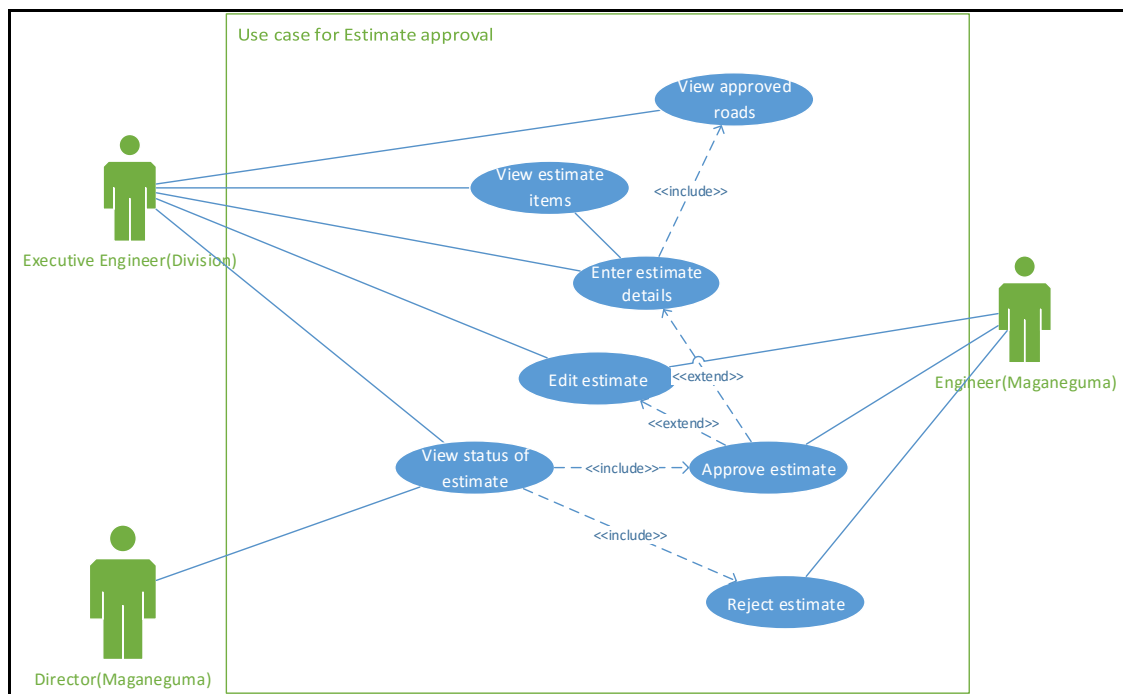


Figure B.2 : Use case for Estimate approval

Table B.2 illustrates the use case description of estimate approval.

|                 |  |
|-----------------|--|
| <b>Use Case</b> | Estimate approval                        |
| <b>Actors</b>   | Engineer(Maganeguma), Executive Engineer |

|                        |  |
|------------------------|--|
| <b>Description</b>     | Prepare and approve estimate   |
| <b>Pre-Conditions</b>  | Executive Engineer views the approved roads  |
| <b>Flow of Events</b>  | <ol style="list-style-type: none"> <li>1. Select the estimate items</li> <li>2. Prepare estimate</li> <li>3. Engineer(Maganeguma) checks the estimate</li> <li>4. Approve/Reject/Hold the estimate.</li> </ol> |
| <b>Post-Conditions</b> | Estimate details are saved to tbl_estimate_items_details table and tbl_estimate_items_summary table.   |

Table B.2 : Use case Description for Estimate approval

#### ▪ Use case for Approving Final Bill Set

After the completion of developing the road EE prepare and submit the Final Bill Set which composed of final bill, test report and the documents and photos. If the whole final bill set is approved Accountant will issue the cheque. Figure B.3 illustrates the use case diagram for Final Bill Set Approval.

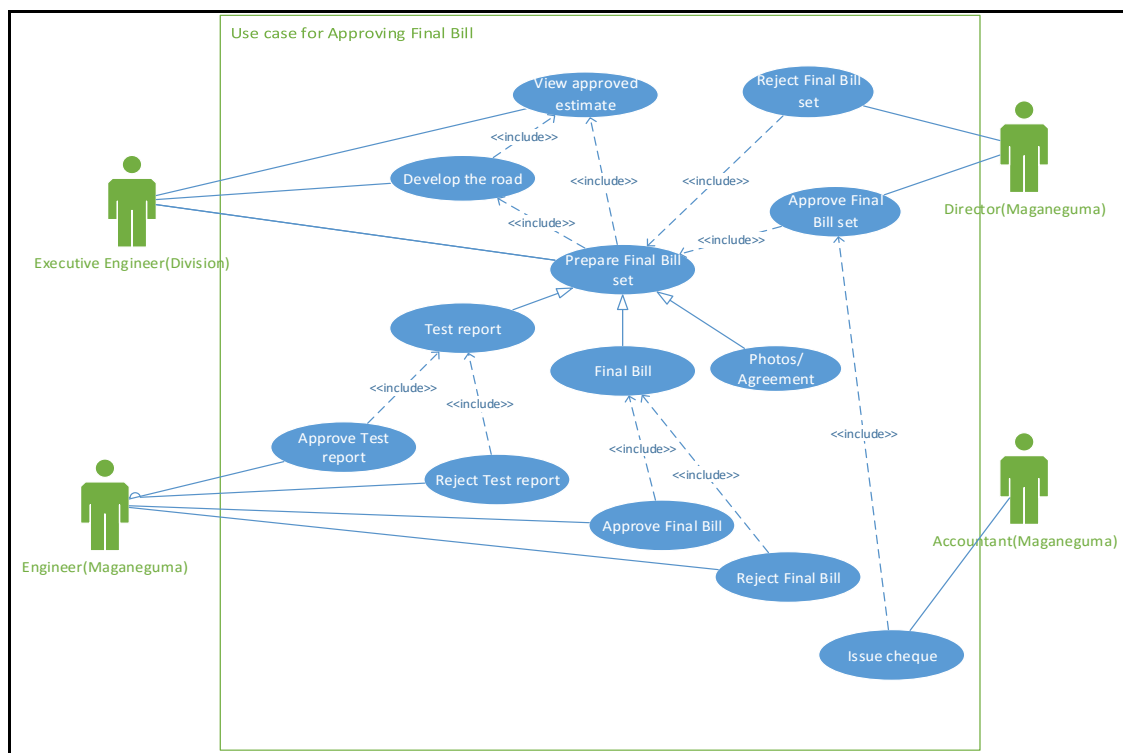


Figure B.3 : Use Case for Final Bill set Approval

Table B.2 illustrates the use case description of Final Bill set Approval

|                 |  |
|-----------------|--|
| <b>Use Case</b> | Final Bill Set Approval  |
| <b>Actors</b>   | Executive Engineer, Engineer(Maganeguma), Director(Maganeguma), Accountant |

|                        |  |
|------------------------|--|
| <b>Description</b>     | Prepare and approve Final Bill Set   |
| <b>Pre-Conditions</b>  | Executive Engineer views the approved estimate and develop the road  |
| <b>Flow of Events</b>  | <ol style="list-style-type: none"> <li>1. Executive Engineer Select the estimate items</li> <li>2. Prepare Final Bill</li> <li>3. Executive Engineer Select Test report items</li> <li>4. Prepare test report</li> <li>5. Upload photos of the road and agreement and GN report</li> <li>6. Engineer(Maganeguma) checks the test report and Approve/Reject the test report</li> <li>7. Engineer(Maganeguma) checks the Final bill and Approve/Reject the Final bill</li> <li>8. Director(Maganeguma) Approve/Reject Final Bill Set</li> <li>9. Accountant Maganeguma issue cheque</li> </ol> |
| <b>Post-Conditions</b> | <ol style="list-style-type: none"> <li>1. Test report items details are saved to tbl_testreport_items_details and tbl_testreport_items_summary tables.</li> <li>2. Final bill details are saved to tbl_finalbill_items_details and tbl_finalbill_items_summary tables.</li> <li>3. Photos, agreement and GN report are saved to tbl_finalbilldocs.</li> <li>4. Issued cheque details are saved to tbl_chequeissued.</li> </ol>   |

Table B.3 : Use case Description for Final Bill set Approval

#### ▪ Sequence diagram for Approve Roads Module

Figure B.4 illustrates the sequence diagram for requesting and approving roads. Subject clerk, director (Maganeguma) and Engineer (Maganeguma) involve with this activity and road request and approve details are saved and updated to the database.

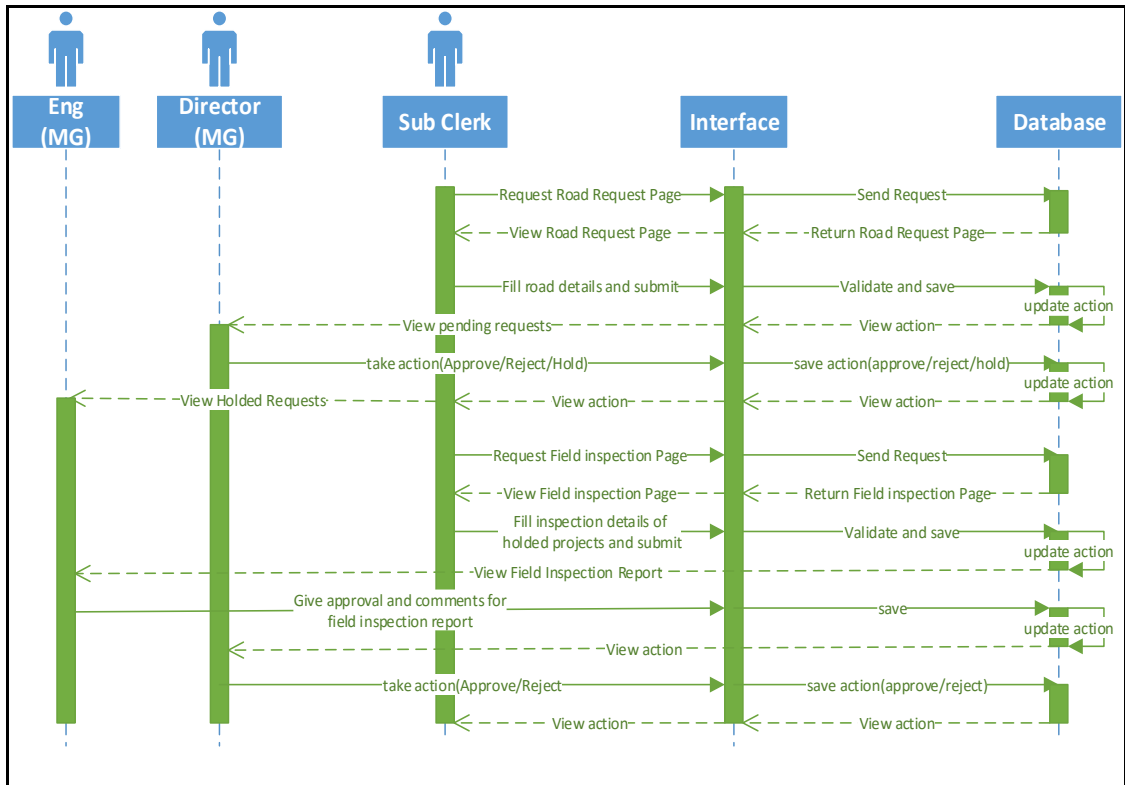


Figure B.4 : Sequence diagram for Approve Roads Module

#### ▪ Sequence diagram for Test Report Module

Figure B.5 depicts the sequence diagram for test reports module. Executive Engineer prepare the test report with the test reports page and Engineer (Maganeguma) will approve, hold or reject the test report with the test report approval page. Test report details and approval status saved to the database.

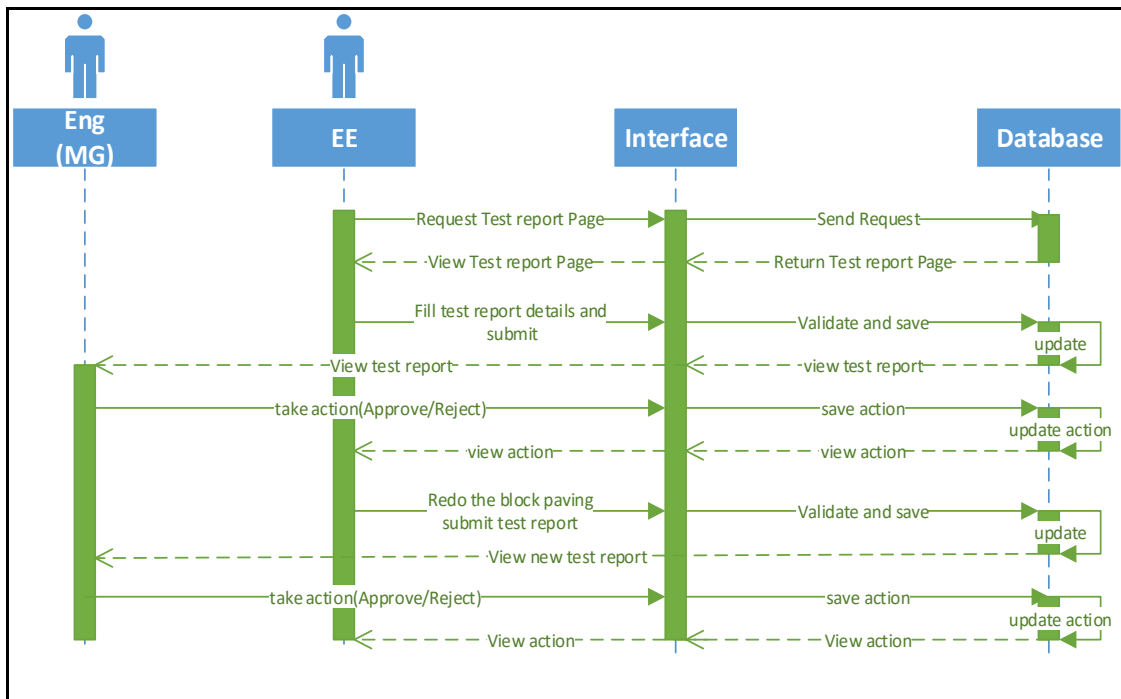


Figure B.5 : Sequence diagram for Test Report Module

#### ▪ Activity diagram for Issue Cheques

Figure B.6 depicts the activity diagram for issuing cheques for the approved bills. Final bill approval status, test report approval status and final uploaded documents and photos will be checked before the cheque to be issued.

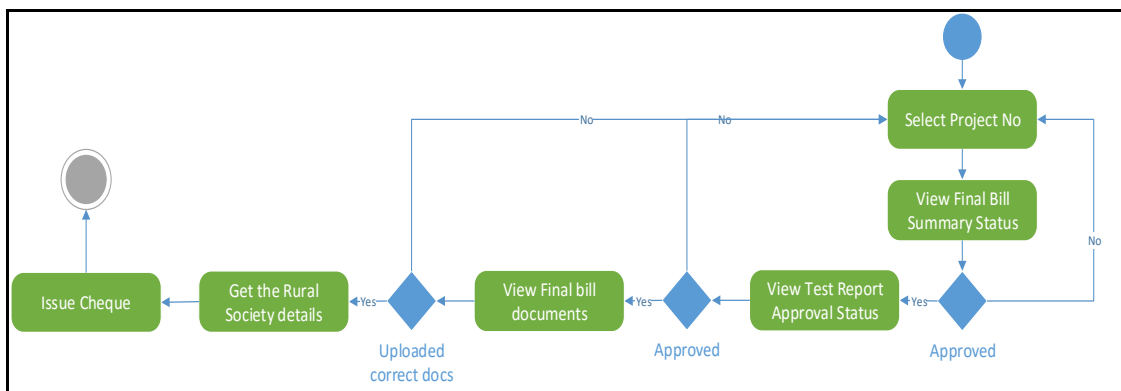


Figure B.6 : Activity diagram for Issue cheques

# Appendix C – User Documentation

Web Based Rural Road Management System for Rural Road Development Programme has been developed with a lot of features to carry out operations smoothly. In order to get the maximum from the developed system, it is very important for a user to identify all the features of the system and know how to use these functions and features efficiently. User documentation provides initial overview knowledge on using the Web Based Rural Road Management System.

## ▪ Login Page

Open the web browser and type the URL <http://localhost/WRD> and enter to the system and the user can find the login page first depicted by Figure C.1. The user should provide the correct username and password to gain authorized access to the system.

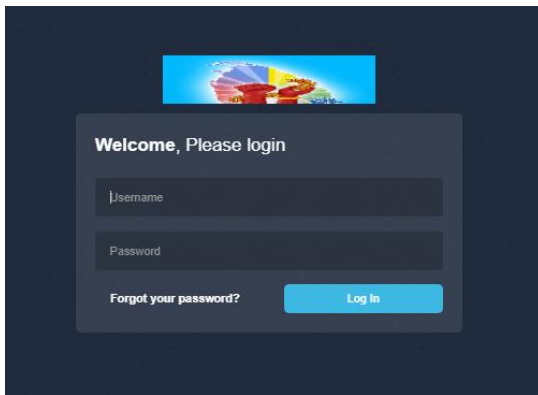


Figure C.1 : System Login Page

## ▪ Home Page

Home page depicted by Figure C.2 consists with Main Menu at left side bar, short cut icons, Find Project Info section and News. Logging out from the system can be done with the arrow icon on top right hand corner of the home page window.

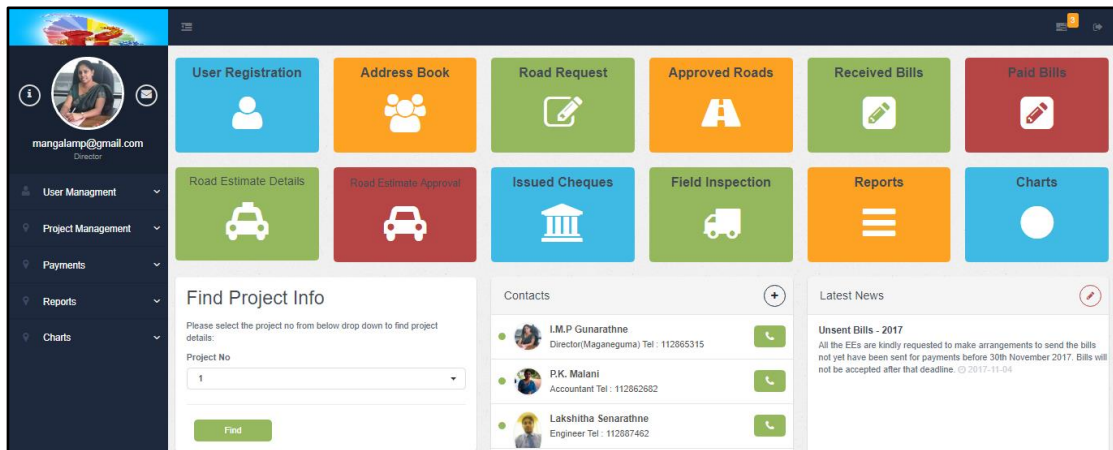


Figure C.2 : Home Page

### ▪ Main menu

Main menu consists User Management, Project Management, Payments, Reports and charts at the left side bar with all the functions which can be done with the system. Main menu pane may differ according to the user privileges. System functionalities can be accessed by clicking on top of the menu items. Once a main menu item is clicked the relevant sub menu will be expanded. See the Figure C.3.

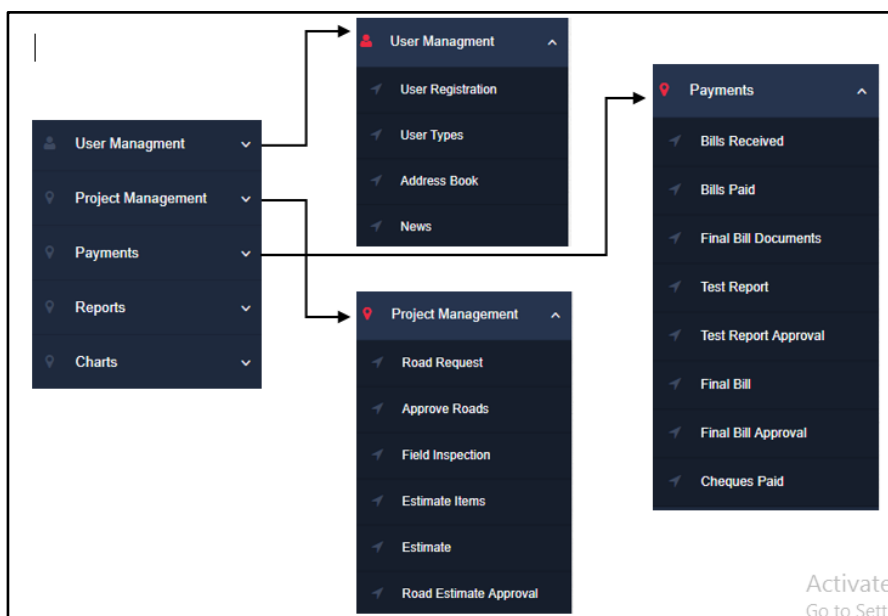


Figure C.3 : Main Menu

## User Management

### ▪ User Registration

Users can be added to the system only by the administrator Director (Maganeguma), hence access as Director (Maganeguma) is needed. To register a user into the system first the user types have to be inserted into the system. See Figure C.4.

1. Log into the system as Director (Maganeguma).
2. Follow the path User Management → User Types.
3. Fill all information.
4. Click save button.

| User Type ID | User Type Name               | User Type Code     | User Type Description                           | View |
|--------------|------------------------------|--------------------|---|------|
| 8            | Engineer (Maganeguma)        | Engineer           | Engineer for Rural Road Development Programme   | View |
| 11           | Director(Maganeguma)         | Director           | Director the Rural Road Development Programme   | View |
| 12           | Subject clerk                | Clerk              | Subject clerk for Hambantota District           | View |
| 13           | Accountant (Maganeguma)      | Accountant         | Accountant for Rural Road Development Programme | View |
| 14           | Executive Engineer (Colombo) | Executive Engineer | EE for Colombo area                             | View |

Figure C.4 : User Types Page

Filling the form and pressing “save” button user types can be added and at the same time the grid below (Figure C.5) will show the inserted user type details. With the “view” button the relevant user details will be loaded and then “update” and “delete” operations can be done.

Then with the Project Management → User Registration page depicted by Figure C.5 users can be registered likewise.

| User ID | First Name | Last Name  | Designation          | Tel no    | Address                                 | NIC        | Email                         | Picture | View |
|---------|------------|------------|----------------------|-----------|---|------------|-------------------------------|---------|------|
| 1       | I.M.P      | Gunaratne  | Director(Maganeguma) | 112865315 | Ministry of Higher Education & Highways | 728283155V | mangalamp@gmail.com           |         | View |
| 6       | P.K.       | Malani     | Accountant           | 112862682 | Ministry of Higher Education & Highways | 718283166V | malanipk@gmail.com            |         | View |
| 10      | Lakshitha  | Senarathne | Engineer             | 112887462 | Ministry of Higher Education & Highways | 841215444V | lakshithasenarathne@gmail.com |         | View |
| 11      | Sanjeevani | Pathmasiri | Clerk                | 112050528 | Ministry of Higher Education & Highways | 848393111V | sanjeevani.lakshika@gmail.com |         | View |

Figure C.5 : User Registration Page

The registered user details are shown in Address Book page depicted by Figure C.6 and Home Page Contacts section. User Management → Address Book

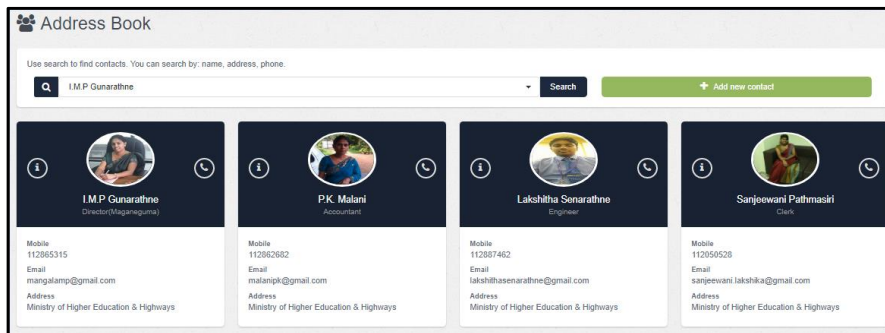


Figure C.6 : User Address Book Page

Home Page - Find Project Info Section (Figure C.7) will search you the all details of a particular project when the Project Number is selected from Project No drop down box.

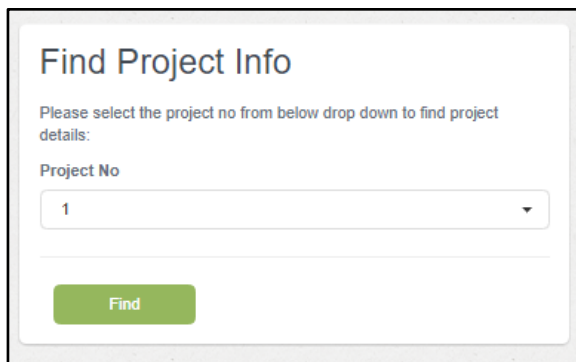


Figure C.7 : Find Project Info

A user can go User Management → News and add news with the News Page (Figure C.8) to be displayed in the Home Page Latest News Section.

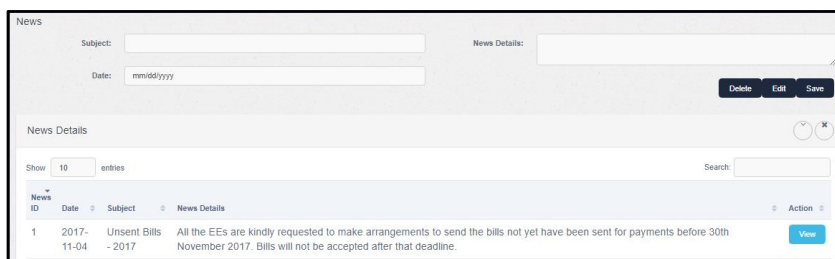


Figure C.8 : News Page

## Project Management

### ▪ Road Request Page

Road requests are made with Figure C.9 Road Request Page.

On the main menu go to

1. Project Management → Road Request.
2. Fill the information.
3. Click save button.

Once the road request saved the record will display on the below grid. By clicking on the view button details of the record will be loaded into the fields. Update and delete operations can be accomplished then.

The screenshot shows the 'Road request' form and a table of 'Road Request Details'.

**Road request form fields:**

- \* MP's Name: [Text input]
- Province: Western (dropdown)
- District: Colombo (dropdown)
- DS Division: Seethawaka (dropdown)
- GN Division: Wakamulla (dropdown)
- Road Name: [Text input]
- Length(m): [Text input]
- Width(m): [Text input]
- Required allocation amount: [Text input]
- Current condition of the road: [Text input]
- Buttons: Delete, Edit, Save

**Road Request Details Table:**

| Request ID | MP's Name             | DS Division | GN Division   | Road Name                              | Length | Width | Required allocation | Current condition of the road | Status   | Action |
|------------|-----------------------|-------------|---------------|--|--------|-------|---------------------|-------------------------------|----------|--------|
| 1          | Hon P.Abenayaka       | Kolonna     | Panamura      | Welipothayaya to 2 Kanuwa Rd Stage 01  | 120    | 3     | 1000000             | Road with gravel base         | Approved | View   |
| 2          | Hon Lakshman Kiriella | Homagama    | Godagamawatta | Godagamawatta 5th Lane Road - stage 01 | 60     | 3     | 500000              | field visit not done          | Approved | View   |
| 3          | Hon Dilan Perera      | Hallela     | 56C Nluwa     | Neluwa Praja Shalawa Road              | 62     | 3     | 500000              | soil road with bad base       | Approved | View   |

Figure C.9 : Road Request Page

Project Management → Approve Road  
Project Management → Field Inspection  
Project Management → Estimate Items

Follow the same thing which the Road Request Page was done

#### ▪ Estimate Creation Page

To prepare an estimate go to Project Management → Estimate

1. Login as EE.
2. Go to Project Management → Estimate.
3. Select the project number of the road to be estimated.
4. Insert the required quantities of estimate items.
5. Press save.

Then the system will create the estimate with calculating estimate summary. Estimate page is depicted by Figure C.10.

| Details ID | Description                              | HSR     | Unit           | Rate    | Quantity |
|------------|--|---------|----------------|---------|----------|
| 1          | Trimming levelling & compaction          | EWI-009 | Sq.m           | 84.55   |          |
| 2          | Laying Polythene for concrete            | BO-639  | Kg             | 323.2   |          |
| 3          | Suppling & fixing thick planks of timber | STI-057 | Sq.m           | 997.4   |          |
| 4          | Mixing and laying concrete mixture       | STI-046 | Cu.m           | 13542.8 |          |
| 5          | Transport concrete                       | TI-007A | km             | 850.5   |          |
| 6          | Suppling & Placing rigiform              | TI-027B | kg             | 255.25  |          |
| 7          | Curing of concrete                       | STI-053 | Sq.m for 7 dys | 36.25   |          |

Figure C.10 : Estimate Page

### ■ Estimate Approval Page

To approve/reject/hold an estimate

1. Login as Engineer (Maganeguma).
2. View the and check the created estimate for the particular project.
3. Go to Project Management → Estimate Approval Details page depicted by Figure C.11.
4. Check the calculated estimate summary items.
5. Press Approve/Hold/Reject button to put the status.

| Project No     | Estimate Approval ID | Amount | RDA Overhead | Phy Contingencies | Total  | Date                | Action                    |
|----------------|----------------------|--------|--------------|-------------------|--------|---------------------|---------------------------|
| MP/01/17/BP/01 | 2                    | 72.5   | 2.175        | 975620            | 975695 | 2018-02-14 23:27:09 | Approve Hold Reject Print |
| MP/09/17/BP/01 | 3                    | 217.5  | 6.525        | 666778            | 667002 | 2018-02-15 11:51:23 | Approve Hold Reject Print |

Figure C.11 : Estimate Approval Page

### ■ Final Bill Page and Final Bill Approval Page

Payments → Final Bill

Payments → Final Bill Approval

} Follow the same steps which the Estimate Page and Estimate Approval Page were done.

### ■ Test Report Page

To prepare a test report

1. Login as EE.

2. Go to Payments → Test Report depicted by Figure C.12.
3. Select the relevant project number.
4. Insert the valid details to the fields.
5. Press save.

System will calculate the compressive strength and prepare the test report. For approve/hold/reject the test report go to Payments → Test Reports Approval and follow the steps taken to approve an estimate.

The screenshot shows a web application interface for a 'Test Report'. At the top, there's a header bar with a 'Test Report' title, a close button (X), and an 'Export Data' button. Below the header, there's a 'Project number:' dropdown menu with 'Nothing selected' as the current value. To the right of the dropdown is a 'Save' button. Below the project number, there's a 'Show' dropdown set to '10' and the text 'entries'. To the right of this is a 'Search:' input field. The main part of the form is a table with 7 columns: 'Sample No', 'Received Date', 'Cast Date', 'Tested Date', 'Age at test', 'Weight', and 'Compressive Strength'. Each column has a small icon next to its header. The table contains 5 rows of data, each with a sample number (TC01 to TC05) and corresponding date fields (mm/dd/yyyy) and empty input fields for 'Age at test', 'Weight', and 'Compressive Strength'.

| Sample No | Received Date | Cast Date  | Tested Date | Age at test | Weight | Compressive Strength |
|-----------|---------------|------------|-------------|-------------|--------|----------------------|
| TC01      | mm/dd/yyyy    | mm/dd/yyyy | mm/dd/yyyy  |             |        |                      |
| TC02      | mm/dd/yyyy    | mm/dd/yyyy | mm/dd/yyyy  |             |        |                      |
| TC03      | mm/dd/yyyy    | mm/dd/yyyy | mm/dd/yyyy  |             |        |                      |
| TC04      | mm/dd/yyyy    | mm/dd/yyyy | mm/dd/yyyy  |             |        |                      |
| TC05      | mm/dd/yyyy    | mm/dd/yyyy | mm/dd/yyyy  |             |        |                      |

Figure C.12 : Test Report Page

## Appendix D – Management Reports

### Some reports and charts generated by the system

This section consists with some management reports generated by the by the new system which support to evaluate the progress of the Rural Road Development Program and make the decision making process easy and more accurate.

#### ▪ Paid Bill Details Report

The following Paid Bill Report depicted by Figure D.1 shows the payment details of the rural roads for a particular month or year. When Director (Maganeguma) opens the Reports Main page the system asks to select the Year and the Month. After selecting year and month the report is generated for the selected year or month.

| මහනගරාලයේ ග්‍රාමීය මාර්ග සංවර්ධන වැඩසටහන-මකනෙගුම කිරාම වේදි අවිබුද්ධි திட்டம் - Maga Neguma Rural Road Development Programme |                |                                       |                |           |           |
|--|----------------|---------------------------------------|----------------|-----------|-----------|
| Paid Bills Report  |                |                                       |                |           |           |
| ID   | Project No     | Road Name                             | Payable Amount | Retention | Surcharge |
| 1  | EO/24/17/BP/01 | Welipothayaya to 2 Kanuwa Rd Stage 01 | 435000.00      | 60000.00  | 2200.00   |
| 2  | MP/22/17/BP/01 | Neluwa Praja Shalawa Road             | 428451.00      | 42845.10  | 0         |

Figure D.1 : Report for Paid Bills

#### ▪ Total length of the Roads Developed in a particular District

Figure D.2 shows the total length of the roads constructed for a particular district. This report can be seen for Province, DS Division and GN Division wise also by selecting needed area. This report will help to make decisions when the Director needs to approve roads for any area.

| මහනගරා මුලීය මාර්ග සංවර්ධන වැඩසටහන-மகநெரும கிராம வீதி அபிவிருத்தி திட்டம் - Maga Neguma Rural Road Development Programme |              |
|--|--------------|
| Total Road Length Developed for a District   |              |
| District   | Total Length |
| Colombo  | 290          |
| Galle  | 185.5        |
| Hambantota   | 125.5        |
| Kandy  | 85           |

Figure D.2 : Total Length of the Roads Developed in Districts

- **Total Allocation given for a specific MP**

The allocation amount set apart for the Rural Road Development Program for the year should be distributed carefully in an unbiased way. Since some MPs EOs requests more rural roads continuously it is really helpful for the Director to have this report generated to know the allocation amount they were already given for the year. This report can be generated selecting the year. The total allocation given for an MP is depicted by Figure D.3

| මහනගරා මුලීය මාර්ග සංවර්ධන වැඩසටහන-மகநெரும கிராம வீதி அபிவிருத்தி திட்டம் - Maga Neguma Rural Road Development Programme |                  |
|--|------------------|
| Total Allocation Given for MP/EO   |                  |
| MP/EO Name   | Total Allocation |
| Hon Dilip Wedaarachchi   | 500000           |
| Hon Lakshman Kiriella  | 1000000          |
| Hon Patali Champika Ranawaka   | 1000000          |

Figure D.3 : Total Allocation given for MPs

- **User Information Report**

Number of users in each user type can be shown by the report depicted by Figure D.4.

மகாநேகமா ரூரல் ரோட் கலர்ஷன் வல்கலன்-மகநேகமா கிராம வீதி அபிவிருத்தி திட்டம் - Maga Neguma Rural Road Development Programme

User Information Report

| User Designation Category | Users in each Category |
|---------------------------|------------------------|
| Clerk                     | 1                      |
| Director                  | 1                      |
| Engineer                  | 2                      |

Figure D.4 : User Information Report

▪ Pie chart for Approved Roads

The pie chart depicted by Figure D.5 shows the percentage of approved rural road projects in year 2017 compared to the year 2016.

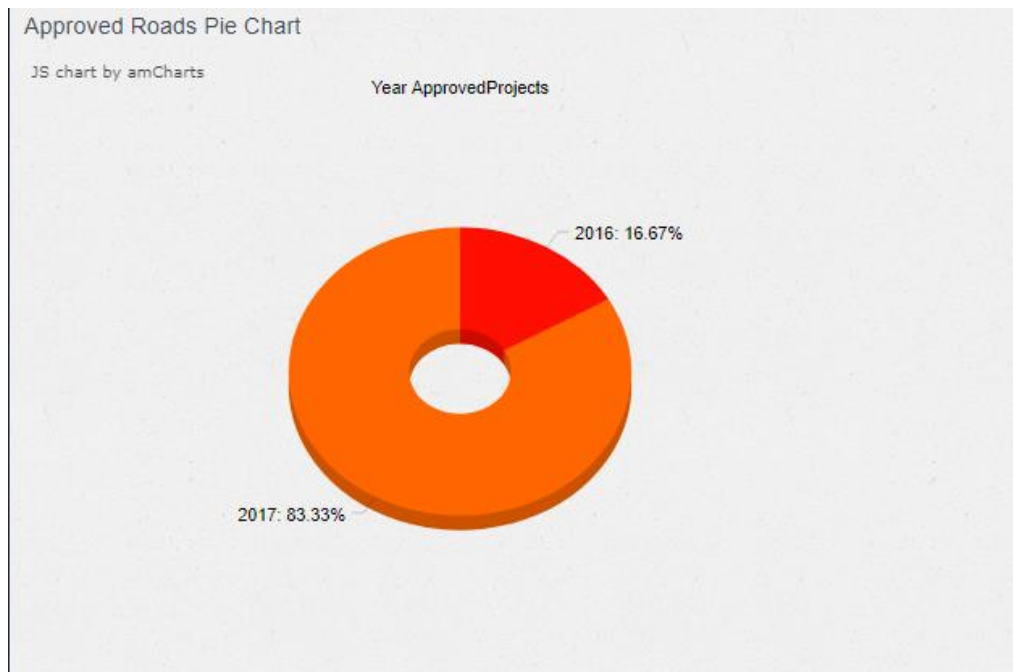


Figure D.5 : Pie Chart for Approved roads

# Appendix E – Test Results

## Test Results for User Authentication

Test results for user authentication is depicted by Figure E.1.

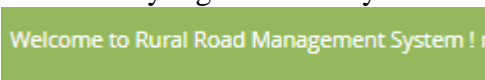
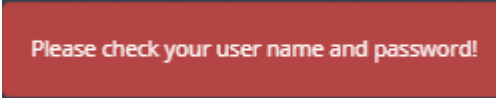
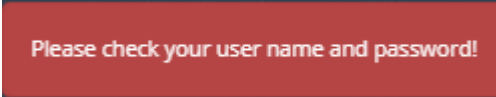
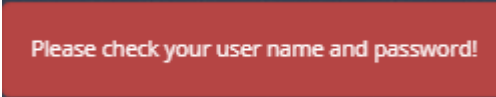

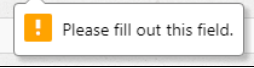
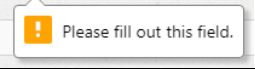
| No | Test Case  | Expected Result   | Status |
|----|--|---|--------|
| 01 | Enter correct username<br>Enter correct password   | Successfully login into the system<br>                                | ✓      |
| 02 | Enter correct username<br>Enter incorrect password | Display error message “Please check your username and password”<br>   | ✓      |
| 03 | Enter incorrect username<br>Enter correct password | Display error message “Please check your username and password”<br> | ✓      |
| 04 | Enter both username and password incorrectly       | Display error message “Please check your username and password”<br> | ✓      |

Table E.1 : User Authentication Test Results

## Test Results for User Registration

Test results for user registration is depicted by Figure E.2.

| No | Test Case                                      | Expected Result  | Status |
|----|--|--|--------|
| 05 | Add information with specified correct details | Display message “Created user” with this name<br>                                | ✓      |
| 06 | Try to add information with all fields empty   | Pop up the error message on the first field<br>                                   | ✓      |
| 07 | Enter all fields except first name             | Pop up the error message “Please fill out this field” on the first name field<br> | ✓      |

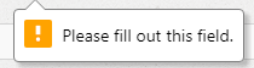
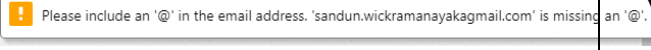


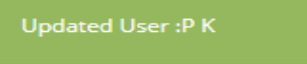
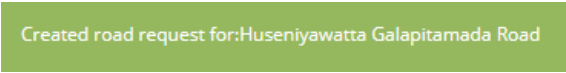
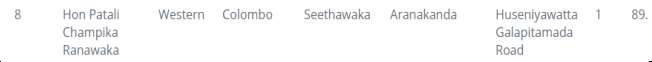
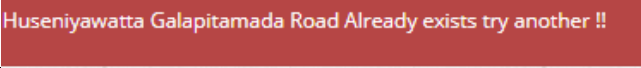
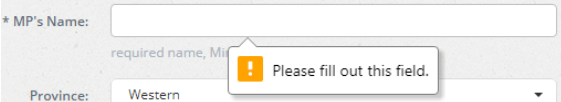
|    |  |  |   |
|----|--|--|---|
| 08 | Enter all fields except last name                      | Pop up the error message “Please fill out this field” on the last name field<br>              | ✓ |
| 09 | Enter email without @ sign                             | Pop up the error message “Please include an ‘@’ in the email address” on the email field<br> | ✓ |
| 10 | Enter existing user                                    | Display message “Already exists try another” with this name<br>                              | ✓ |
| 11 | Select a user and click on Delete icon                 | Display a message “Removed user:” with the username<br>                                       | ✓ |
| 12 | Select a user view details and Update user information | Display a message “Updated user:” with the username<br>                                      | ✓ |

Table E.2 : User Registration Test Results

## Test Results for Requesting Roads

Test results for requesting roads is depicted by Figure E.3.

| No | Test Case                                     | Expected Result  | Status |
|----|---|--|--------|
| 13 | Insert road request not already in the system | Display message “Created Road Request: road name ” with road name and display details in the View Grid<br><br> | ✓      |
| 14 | Insert road request already in the system     | Display message “Already existing road; Try another”<br>   | ✓      |
| 15 | Insert a road without entering MP name        | Pop up the error message “Please fill out this field” on the MP name field<br>   | ✓      |

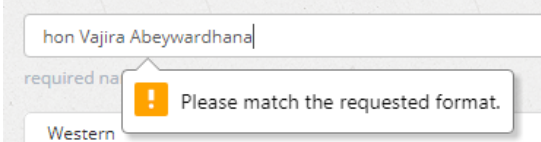
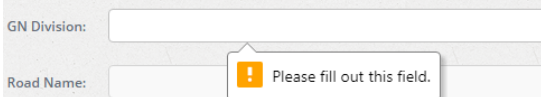
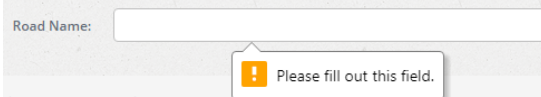
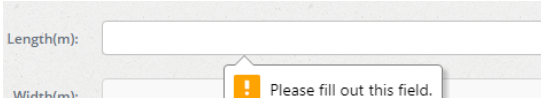


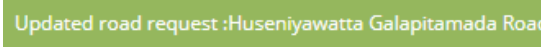
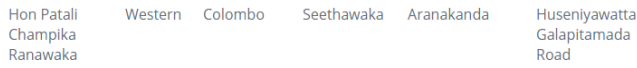
|    |   |  |   |
|----|---|--|---|
| 16 | Insert a road without requested format for MP name            | Pop up the error message “Please match the requested format” on the MP name field<br>  |   |
| 17 | Insert a road without selecting GN Division                   | Pop up the error message “Please fill out this field” on the GN Division field<br>   | ✓ |
| 18 | Insert a road without entering Road name                      | Pop up the error message “Please fill out this field” on the Road name field<br>   | ✓ |
| 19 | Insert a road without entering Length of the road             | Pop up the error message “Please fill out this field” on the Length field<br>  | ✓ |
| 20 | Insert a road without entering Width of the road              | Pop up the error message “Please fill out this field” on the Width field<br>   | ✓ |
| 21 | Select a road request from View Grid and click on Delete icon | Display message “Removed Road Request: road name ” and remove the record from the View Grid<br>  | ✓ |
| 22 | Select a road request from View Grid and click on Update icon | Display message “Updated Road Request: road name ” and update the details in the View Grid<br><br> | ✓ |

Table E.3 : Test Results for Requesting Roads

# Appendix F – Code Listing

Major code segments for anyone interested in getting to know the functionalities of the system are included here in this document.

## ■ Code segment for create estimate

The following code segment depicted by Figure F.1 illustrates how the estimate items are calculated and saved to the database. Calculate the estimate item totals, RDA overhead, physical contingencies and total estimated cost and save the estimate details to estimate item details table.

```
<?php
//db configuratin
require_once '../control/config.php';

// assign to variable, value passed from FORM as POST
$estimate_itemsD_Project = $_POST['estimate_itemsD_Project'];

//// try catch for error handling
try {
    if (isset($_POST['Save'])) { // if user press save button insert executes
        //
        foreach ($POST["estimate_itemsD_ItemID"] as $rec => $value) { /// get values in array
            $estimate_itemsD_ItemID = $_POST["estimate_itemsD_ItemID"][$rec];
            $estimate_items_UnitPrice = $_POST["estimate_items_UnitPrice"][$rec];
            $estimate_itemsD_Qty = $_POST["estimate_itemsD_Qty"][$rec];
            $estimate_itemsD_Amnt = $estimate_itemsD_Qty * $estimate_items_UnitPrice;

            $estimate_itemsS_Amount = +$estimate_itemsD_Amnt;
            $estimate_itemsS_OverHead = $estimate_itemsS_Amount * 3 / 100;
            $estimate_itemsS_PhyCon = $estimate_itemsD_Allocation - ($estimate_itemsS_Total + $estimate_itemsS_OverHead);
            $estimate_itemsS_Total = $estimate_itemsS_Amount + $estimate_itemsS_OverHead + $estimate_itemsS_PhyCon;

            // SQL coomand for insert tbl_estimate_items_details
            $sql = 'INSERT INTO tbl_estimate_items_details(estimate_itemsD_ItemID,estimate_itemsD_Project,
                estimate_itemsD_Qty,estimate_itemsD_Amnt) '
                . 'VALUES(:estimate_itemsD_ItemID,:estimate_itemsD_Project,:estimate_itemsD_Qty,:estimate_itemsD_Amnt)';
            $stmt = $conn->prepare($sql);
            // paass POST variable to DB
            $stmt->execute(array('estimate_itemsD_ItemID' => $estimate_itemsD_ItemID,
                'estimate_itemsD_Project' => $estimate_itemsD_Project,
                'estimate_itemsD_Qty' => $estimate_itemsD_Qty,
                'estimate_itemsD_Amnt' => $estimate_itemsD_Amnt));
        }
    }
}
```

Figure F.1 : Code segment for create estimate

Below code segment depicted by Figure F.2 will save estimate item totals, RDA overhead, physical contingencies and total estimated cost to estimate items summary table.

```

// connect to DB tbl_estimate_items_summary

$sql2 = 'INSERT INTO tbl_estimate_items_summary(estimate_itemsS_ID,estimate_itemsS_project,estimate_itemsS_Amount,
estimate_itemsS_OverHead,estimate_itemsS_PhyCon,estimate_itemsS_Total,estimate_itemsS_Date) '
. 'VALUES(:estimate_itemsS_ID,:estimate_itemsS_project,:estimate_itemsS_Amount,:estimate_itemsS_OverHead,
:estimate_itemsS_PhyCon,:estimate_itemsS_Total,:estimate_itemsS_Date)';

$stmt2 = $conn->prepare($sql2);
$stmt2->execute(array('estimate_itemsS_ID' => $estimate_itemsS_ID,
'estimate_itemsS_project' => $estimate_itemsD_Project,
'estimate_itemsS_Amount' => $estimate_itemsS_Amount,
'estimate_itemsS_OverHead' => $estimate_itemsS_OverHead,
'estimate_itemsS_PhyCon' => $estimate_itemsS_PhyCon,
'estimate_itemsS_Total' => $estimate_itemsS_Total,
'estimate_itemsS_Date' => $estimate_itemsS_Date));

//
//
// print message
$_SESSION['SUCCESS'] = 'Created Estimate for: ' . $estimate_itemsD_Project;
}
} catch (Exception $ex) { // display error occurred in try
$_SESSION['ERROR'] = $ex->getMessage();
}

// this will redirect to view page
header("Location: " . $_SERVER['HTTP_REFERER']);
?>

```

Figure F.2 : Code segment for save estimate summary details

- Estimate approval

Following code segment depicted by Figure F.3 how the approval is given to an estimate. When the Engineer approve, hold or reject and estimate the system will update the status in the estimate items summary table.

```

<?php
//db configuartin
require_once '../control/config.php';

// assign to variable, value passed from FORM as GET
$estimate_itemsS_ID = $_GET['estimate_itemsS_ID'];
$estimate_itemsS_Apprved = $_SESSION['login_username'];
$estimate_itemsS_Staus = $_GET['estimate_itemsS_Staus'];
$estimate_itemsS_Comments = 'N/A';

//// try catch for error handling
try {

    $sql = 'UPDATE tbl_estimate_items_summary '
        . 'SET estimate_itemsS_Apprved=:estimate_itemsS_Apprved,
        estimate_itemsS_Staus=:estimate_itemsS_Staus,
        estimate_itemsS_Comments=:estimate_itemsS_Comments
        WHERE estimate_itemsS_ID=:estimate_itemsS_ID';

    $stmt = $conn->prepare($sql);
    $stmt->execute(array('estimate_itemsS_ID' => $estimate_itemsS_ID,
'estimate_itemsS_Apprved' => $estimate_itemsS_Apprved,
'estimate_itemsS_Staus' => $estimate_itemsS_Staus,
'estimate_itemsS_Comments' => $estimate_itemsS_Comments));

    $_SESSION['SUCCESS'] = $estimate_itemsS_Staus . ' Estimate for : ' . $estimate_itemsS_ID;
} catch (Exception $ex) { // display error occurred in try
    $_SESSION['ERROR'] = $ex->getMessage().$estimate_itemsS_ID;
}

// this will redirect to view page
header("Location: " . $_SERVER['HTTP_REFERER']);
?>

```

Figure F.3 : Code segment for estimate approval

- Code segment to create Final Bill

Figure F.4 code segment illustrates how the final bill item totals and retention amount and payable amounts are calculated and saved to database.

```
if (isset($_POST['Save'])) { // if user press save button insert executes
    //
    foreach ($_POST["final_bill_itemsD_ID"] as $rec => $value) { /// get values in array
        $final_bill_itemsD_ID = $_POST["final_bill_itemsD_ID"][$rec];
        $estimate_items_UnitPrice = $_POST["estimate_items_UnitPrice"][$rec];
        $final_bill_itemsD_Qty = $_POST["final_bill_itemsD_Qty"][$rec];
        $final_bill_itemsD_Amnt = $final_bill_itemsD_Qty * $estimate_items_UnitPrice;

        $final_billS_Amount = +$final_bill_itemsD_Amnt;
        $final_billS_retention=$final_billS_Amount*10/100;

        // SQL coomand for insert
        $sql = 'INSERT INTO tbl_final_bill_details(final_bill_itemsD_ID,final_bill_itemsD_Project,
            final_bill_itemsD_Qty,final_bill_itemsD_Amnt) '
            . 'VALUES(:final_bill_itemsD_ID,:final_bill_itemsD_Project,:final_bill_itemsD_Qty,
            :final_bill_itemsD_Amnt)';

        $stmt = $conn->prepare($sql);
        // pass POST variable to DB
        $stmt->execute(array('final_bill_itemsD_ID' => $final_bill_itemsD_ID,
            'final_bill_itemsD_Project' => $final_bill_itemsD_Project,
            'final_bill_itemsD_Qty' => $final_bill_itemsD_Qty,
            'final_bill_itemsD_Amnt' => $final_bill_itemsD_Amnt));
    }
}
```

Figure F.4 : Code segment for create final bill

- Final bill approval

Figure F.5 code segment illustrates how the final bill approval status is updated into the database.

```
//db configuratin
require_once '../control/config.php';

// assign to variable, value passed from FORM as GET
$final_billS_ID = $_GET['final_billS_ID'];
$final_billS_Apprved = $_SESSION['login_username'];
$final_billS_Staus = $_GET['final_billS_Staus'];

//// try catch for error handling
try {

    $sql = 'UPDATE tbl_final_bill_summary '
        . 'SET final_billS_Apprved=:final_billS_Apprved, final_billS_Staus=:final_billS_Staus
        WHERE final_billS_ID=:final_billS_ID';

    $stmt = $conn->prepare($sql);
    $stmt->execute(array('final_billS_ID' => $final_billS_ID,
        'final_billS_Apprved' => $final_billS_Apprved,
        'final_billS_Staus' => $final_billS_Staus));

    $_SESSION['SUCCESS'] = $final_billS_Staus . ' Final Bill for : ' . $final_billS_ID;
} catch (Exception $ex) {/// display error occurd in try
    $_SESSION['ERROR'] = $ex->getMessage() . $final_billS_ID;
}
```

Figure F.5 : Code segment for final bill approval

- Upload final bill documents

Following code segment depicted by Figure F.6 illustrates uploading the final bill documents. This code segment uploads the GN report to the system.

```

$allowedExts = array("gif", "jpeg", "jpg", "png");
$tmp = explode(".", $_FILES["finalbilldocs_gnreport"]["name"]);
$extension = end($tmp);

if (true) {
    if ($_FILES["finalbilldocs_gnreport"]["error"] > 0) { // chk file size
        $_SESSION['ERROR'][] = "Return Code: " . $_FILES["finalbilldocs_gnreport"]["error"] . "<br>";
    } else {
        $_SESSION['SUCCESS'][] = "Upload: " . $_FILES["finalbilldocs_gnreport"]["name"] . "<br>";
        if (file_exists("upload/" . $_FILES["finalbilldocs_gnreport"]["name"])) { // chk file exist or not
            $_SESSION['ERROR'][] = $_FILES["finalbilldocs_gnreport"]["name"] . " already exists. ";
        } else {
            move_uploaded_file($_FILES["finalbilldocs_gnreport"]["tmp_name"], "upload/" .
                $_FILES["finalbilldocs_gnreport"]["name"]);
            $_SESSION['SUCCESS'][] = "Stored in: " . "upload/" . $_FILES["finalbilldocs_gnreport"]["name"] .
                "<br>";
            $finalbilldocs_gnreport = $_FILES["finalbilldocs_gnreport"]["name"];
        }
    }
} else {
    $_SESSION['SUCCESS'][] = "Invalid file";
    // this will redirect to view page
    header("Location: " . $_SERVER['HTTP_REFERER']);
}

```

Figure F.6 : Code segment for upload final bill documents

## Appendix G – Client Certificate



உயர் கல்வி மற்றும் நெடுஞ்சாலைகள் அமைச்சு  
MINISTRY OF HIGHER EDUCATION & HIGHWAYS

என் அம்மய  
எனது இல.  
My No.

MHEH/HWY/MNG/Gen/01

உமது இல.  
Your No.

**Your No.**

திகதி  
Date

Date: 2017-10-30

Project Examination Board  
University of Colombo School of Computing  
No. 17, Swarna Road  
Colombo - 06

Dear Sir/Madam,


### LETTER OF CERTIFICATION

This is to certify that Ms.M.P.M.Abeyratne (R031902) has successfully developed and presented the Web Based Rural Road Management System for Rural Road Development Programme. This project was undertaken by her as a partial fulfillment of the requirement of the Degree of Bachelor of Information Technology.

I am pleased to inform that the developed system has satisfied the requirements we expected. And also it enables the decision making process for future development of the Rural Road Development Programme.

I would be glad to mention the developed system can be implemented successfully for the Rural Road Development Programme.

Thanking you,  
Yours faithfully,

  
I.M.P.Gunarathne  
Director (Maganeguma)  
(0112865315/ 0712652020)

I. M. P. Gunarathna  
Director (Maga Neguma)  
Ministry of Higher Education &  
Highways

உயர கல்வித் திணிவு : 18, வீதி 18, கொழும்பு 7  
Higher Education Division : 18, Ward Place, Colombo 7  
Tel : +94 (0) 11 2697721 / 2691378 / 2694486 / 2697133 Fax : +94(0) 11 2674768  
Web Site : [www.moh.gov.lk](http://www.moh.gov.lk)

මහාමාත්‍ය ආංශ : "මහලයම් මහජනරජු", 8 වන මහල, වෙස්ට් කොඩ් කොඩ් මාවත, කොඩ්ස්, බත්තරමුල්ල.  
 ධුල්ලාභානායක විශ්ව විද්‍යාලය, 8 වන මහල, මොරටුව, කොඩ්ස්, බත්තරමුල්ල.  
 Highways Division : "Maganegama Mahamechura" 8th Floor, Denzil Kobbekaduwa Mawatha, Koswatta, Battaramulla.  
 Tel : +94 (0) 11 2871821-30 Fax : +94 (0) 11 2863296

Figure G.1 : Client Certificate

# GLOSSARY

- **Apache** – Apache is a free open source web server software that enables to run web pages on top of it.
- **Bootstrap** – Frontend HTML, CSS, JavaScript framework that can be used for creating web sites or web applications.
- **CSS** – CSS stands for Cascading Style Sheets which uses for styling web pages.
- **HTML** – Hypertext Markup Language which is used creating web pages and web browser can understand HTML only. All the other languages should convert to their codes to HTML code.
- **JavaScript** – Most powerful programming language that can used to program client side web environment.
- **jQuery** – jQuery is JavaScript library which has the ability to do tasks easily instead of using JavaScript.
- **MySQL** – MySQL is the most popular free database management software maintained by Oracle.
- **PHP** – PHP stands for PHP: Hypertext Preprocessor is a free open source object oriented server side scripting language.
- **SQL** – SQL stands for Structured Query Language which can be dealt with the relational databases.
- **UML** – Unified Modeling Language is a graphical modeling language used for visualize the design of a system.