WEB BASED PROJECT OPERATIONS MANAGEMENT SYSTEM

FOR

SCHAUPUB TECHNIK PRIVATE LIMITED

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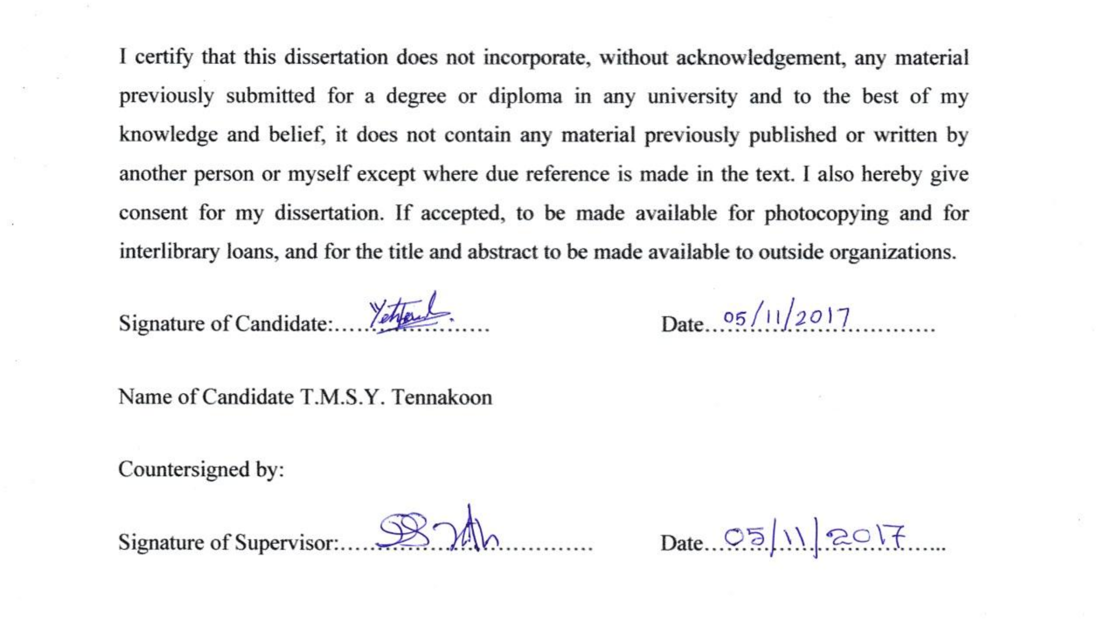
Declaration



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Abstract

‘SCHUPUB TECHNIK’ private limited is one of the leading engineering service providers in Sri Lanka which undertakes a vast range of metal fabrication projects from both the government and private sector organizations. Engineering projects being the organization’s heart, the company’s project operations are managed using a manual paper based approach. Due to the drawbacks of this manual process such as lack of coordination between departments, lack of centralized control and the difficulty to keep track of the status of work, the company hopes to move to a computerized solution in search of a way to make project operations more efficient and effective.

The proposed web based system is built with the aim to overcome the mentioned drawbacks and make the organization’s project operations more effective and efficient. The scope of the system consists of tender management, production management, project employee management, purchasing and supplier management, customer management, expenses and finance management, inventory management, transport and vehicle management, user management and notification management.

The system was developed using object oriented programing principles where the system was designed using the Unified Modeling Language (UML). The programing languages used were PHP (for server side scripting) and JAVA. (for the development of the Android application) HTML and CSS were used for designing the user interfaces of the web based system. Apache was used as the web server and the database was developed using MySQL. The tools used were Net Beans 8.1 Integrated Development Environment and Android Studio Integrated Development Environment (for the mobile component).

The Web Based Project Operations Management System was successfully implemented in SCHAUPUB TECHNIK private limited and received numerous positive feedbacks from the management and the employees of the organization mentioning how the system improved their daily operations related to the engineering projects and how it improved the productivity of employees in the organization.

Acknowledgement

Firstly, the author would like to give sincere gratitude to the University of Colombo School of Computing for providing the Bachelor of Information Technology degree program, and constantly providing guidance for successful completion of the project.

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In addition, sincere gratitude is offered to Mr. Upul Dissanayake for providing the organization document formats, coordinating appointments with the managing director and providing with actual data which were used for testing purpose.

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List of Acronyms

- AJAX - Asynchronous JavaScript and XML.
- CSS - Cascading Style Sheet.
- DEC - Data Entry Clerk.
- EM - Engineering Manager
- ERD - Entity Relationship Diagram
- ERP - Software: Enterprise Resource Planning Software.
- PO - Purchase Order
- RUP - Rational Unified Process
- UML - Unified Modeling Language
- WSM - Workshop Manager

CHAPTER 1 - INTRODUCTION

1.1 Introduction

Managing operations of an engineering project is one of the most challenging tasks that any engineering company has to face, involving a number of tasks and hundreds of employees working on them. A project can often be described as a series of tasks which need to be completed in order to reach a specific outcome [**1**]. Therefore, engineering organizations have to put in a significant effort to manage these tasks to ensure successful completion of projects.

Most engineering companies in the country still use a manual paper based approach for managing their project operations. SCHAUPUB TECKNIK (private) Limited is of no difference to the most of the organizations as they too use a manual paper-based approach to manage their project related operations. This approach causes redundancy of data and introduces several bottlenecks in their operations which lead to losing their customer loyalty and makes it impossible to be among the front runners in this largely competitive industry.

1.2 Motivation for the Project

SCHAUPUB TECHNIK (private) limited, located in Attidiya, Dehiwala Sri Lanka is one of the leading engineering service providers in the country, which has undertaken a various range of metal fabrication projects. The organization is well experienced having being in the industry for the past ten years receiving projects from both the government and the private sector.

The projects that the organization undertake may require in-house production or located in remote locations and it is important for them to ensure that organizational resources such as employees, supplies received and etc. are efficiently and effectively distributed and used for projects.

In addition to the above mentioned, from the time a tender notice is recognized and approved for bidding, until the entire project tasks are completed with necessary payments received and a gate pass is issued; the entire process is managed using a paper based approach.

The above mentioned manual process had several drawbacks which can be listed as follows:

- Lack of centralized control over the documents and processes.
- Difficulty to track the progress and the current status of a task.
- Difficulty of coordination between several departments.
- Difficulty of assigning employees to project in a productive way.
- Unavailability of timely information to make business critical decisions.
- High time consumption to prepare project related financial reports.
- Time consuming approval process.
- Difficulty to measure the costs related to each task of a project.
- Impossible to track the location of vehicles assigned to trips in real-time.
- Difficulty of scheduling vehicle trips to sites and tracking the location of a vehicle during a trip.
- Difficulty to enforce supplier selection criteria for purchasing.

The above listed factors have also made the organization management consider moving to a computerized web based solution that can remove the bottlenecks and re-engineer their business process expecting to give them a massive competitive advantage.

1.3 Objectives of the Project

The major purpose of developing this project operations management system is to provide the organization with a complete solution that will solve the mentioned organization problems related to the current manual process in an efficient and an effective manner.

The objectives that the system aims to achieve are as follows:

- Increase the efficiency of the project operations by reducing time to get approval for critical decisions when directors are away.
- Introducing a centralized storage of information by using a web based approach.
- Enable the ability to keep track of the deadlines, project budget and production status.
- Reduces fraud by enabling the ability to view project related expenses and ensuring that each expense is approved by a higher authority before payments are made.
- Ensuring that project operations are carried out according to the organizations quality management plan (ISO 9001:2015).
- Re-engineer the way employees are assigned for projects to improve the productivity of the workforce and to reduce resource wastage.
- Make information available in a timely manner for necessary organizational reports.
- Ensure that the selection criteria are enforced when selecting suppliers for purchasing.

1.4 Scope of the Project

Based on the requirements gathered from the client, scope of the project ‘Web based Project Operations Management System’ can be divided into the following categories:

- **Tender Management**

Maintain the details relevant to tenders that the organization has agreed to bid. Must keep track of the tender meetings and notify when they are being approached.

- **Production Management**

The system should maintain details related to the production process such as general project details and task details.

- **Employee Management**

Manage the employee assignment to projects in an effective and a productive manner.

- **Purchasing Management**

Manage the purchasing of goods for a project in an effective way preventing bottle necks and fraud associated with the purchasing process and bringing in transparency to the process.

- **Inventory Management**

Keeps track of the company’s inventory details and ensures that inventory items are appropriately assigned for projects.

- **Transport Management**

Maintain vehicle details, transport schedules, track vehicle locations and maintenance schedules of vehicles.

- **Expense Management**

Ensures those general project expense requests are coming from the project supervisor, manages expense request history and manages the approval process for expenses.

- **Finance Management**

Manages the finance details of a project such as adding the payment scheme for the customers, notify on the due dates, managing supplier invoice payments, making payments related to expenses. Generate project reports and perform analysis.

- **User Management**

Manages the user of the web- based solution based on the roles they perform in the organization.

- **Security and Backup Management**

Ensure non–repudiation and the back-up of database containing critical business data.

1.5 Structure of the Dissertation

The purpose of this dissertation is to provide a clear understanding of the web based project operations management system developed for SCHAUPUB TECHNIK (private) Limited. This includes the following chapters.

Chapter 02: Analysis

This chapter focuses on explaining about the existing manual process, the fact gathering techniques used, a review on the existing systems similar to the system being developed, functional and non-functional requirements of the developed system, number of identified users and the selected methodology for developing the system.

Chapter 03: Design

The chapter describes the design strategies used, the development platform, choice of system software, design patterns used to solve the requirements, the system design, database design and the designs of major user interfaces.

Chapter 04: Implementation

The ‘Implementation’ chapter explains the interaction between modules, description of major codes and reusable components of the system, the implementation environment.

Chapter 05: Evaluation

This chapter provides a description explains the test plan used to verify and validate the system, methods of testing and the test cases and the process of obtaining client feedback to evaluate the success of the system.

Chapter 06: Conclusion

This chapter provides a critical evaluation of the system and possible suggestions for future modifications.

CHAPTER 2 – ANALYSIS

2.1 Introduction

Software analysis can be considered as the most crucial stage in software development as it forms the foundation for successful software. More broadly analysis of software can be considered as a general methodology that takes all situations into account to determine the best way to accomplish current and future needs [**2**].

This chapter provides an analysis of the project describing the fact gathering techniques used, the manual process that the organization currently uses in managing project operations, a review of existing similar solutions used in the industry, the functional and non-functional requirements expected and finally the development methodology used for the development process.

2.2 Fact Gathering Techniques

When it comes to the analysis phase, fact gathering is yet another important step. Several methods can be used for fact gathering and certain factors must be considered when selecting appropriate fact gathering techniques.

2.2.1 Factors to Consider when Selecting Fact Gathering Techniques

- The type of information you wish to collect.
- The position and the personality types of people you have to gather data from.
- The environment of the organization.

2.2.2 Selected Fact Gathering techniques and purpose

Taking the above factors and the intense work environment of ‘SCHAUPUB TECHNIK’ into consideration, four fact gathering techniques were used which are namely questionnaires, on-site observations, interviews and existing document and sample reviews. An illustration of how these methods were used is shown in Table 2.1.

Targeted Group	Fact Gathering Method	Reasons to use the Method
Organization Directors	Interviews (structured and open-ended)	Encourages feedback and suggestions
Accountant	Interviews (structured and open-ended)	Require descriptive answers
Operational Employees	On-site observations	To better understand the actual operational process
Operational Employees	Questionnaires	Large group of people and intense work environment causing time limitations in data gathering.

Table 2.1: Fact Gathering Techniques Used Based on Targeted Group

In addition to the above mentioned fact gathering methods, reviewing of existing documents and samples of forms was used as a fact gathering method. The purpose of using this method was to get an idea on the existing document formats, necessary report fields and the document flow of certain critical documents. Some examples of documents reviewed are listed below:

- Material Requisition Notes.
- Supplier Purchase Orders.
- Supplier Invoices.

The mentioned factor gathering techniques which were used served its purpose effectively as it helped to understand the business process of the existing system, vulnerabilities of the existing system and requirements for the web based system.

2.3 Existing Manual Process of Managing Project Operations

The organization’s existing manual process of managing project operations can be described using the use-case diagram presented in Figure 2.1.

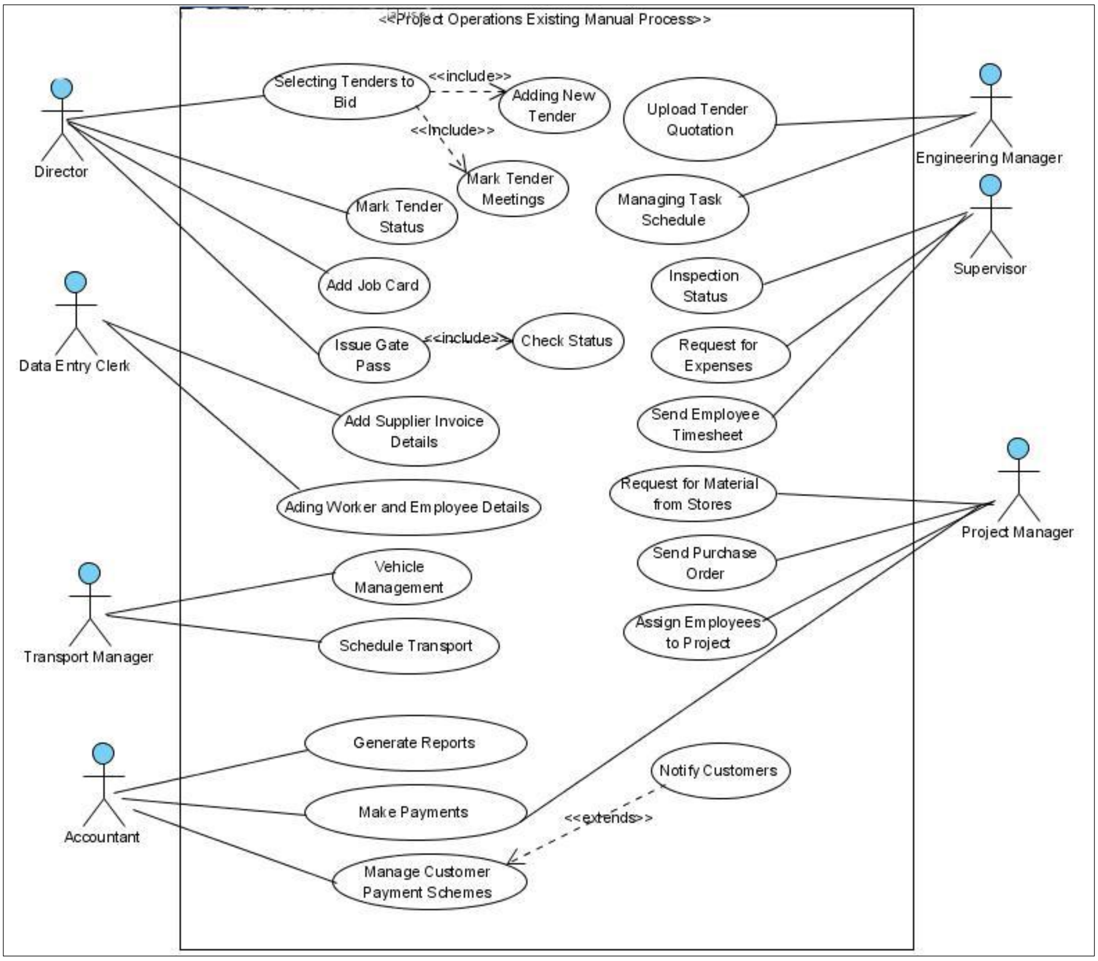


Figure 2.1: Use Case Diagram for Existing Manual Process

2.3.1 Managing Tenders

Most of SCAUPUB TECHNIK’s projects are received by bidding for tenders. However the organization does not currently have systematic process for managing it. The process is managed by the directors themselves where they go through the tender advertisements themselves and select suitable tenders for biding and stored manually.

This process introduces the following drawbacks:

- This is a time consuming process as the organization has only three directors in the board and it causes a massive waste of time and may cause loss of business opportunities as there is a chance of missing out on potential tenders.
- Since tender meetings are noted down manually, tender meetings may be forgotten and not attended as there is no formal notification process.

2.3.2 Managing Production

A manual file based approach is used for maintaining production details such as budget, schedules and task lists and schedules.

This process introduces the following drawbacks:

- The difficulty of tracking the progress of the project (which task is the project currently on?)
- Difficulty to track the sunk cost of the project and compare it against the budget.
- Requires contacting accounts department to know about customer payment status before issuing the gate pass since there is no centralized storage.

2.3.3 Managing Purchasing

A manual process is used to manage the purchasing process which includes requesting items from stores, assigning inventory, managing and selecting suppliers, sending purchase orders and storing invoice details and making payments and managing inventory.

This process introduces the following drawbacks:

- Can cause conflict of interest when it comes to selecting suppliers for purchasing items at the expense of the organization.
- Difficult to track how inventory was allocated to the projects. This may cause financial loss through fraud.

- Difficult to evaluate supplier performances when deciding on future contracts with them.

2.3.4 Worker Management

For managing workers, the organization uses a manual process where worker details are kept on files and also uses a manual process when it comes to assigning employees for project and measuring employee performance.

This process introduces the following drawbacks:

- May cause impractical assigning of employees such as assigning the same employee to two geographically distant projects at the same time.
- Difficulty to have reliable information when assigning the most ideal worker to the project need.
- Difficulty to evaluate worker performances and how much the employee costs bears on the overall cost of the project.

2.3.5 Transport Management

The organization has vehicles belonging to various categories, the management of vehicle details, maintenance schedules, scheduling transport and assigning drivers and vehicles to trips and keeping track of fuel for vehicles are all done manually.

This process has the following drawbacks:

- Inability to track the location of a vehicle without having to contact the driver.
- Lack of Notification on the maintenance dates causing to miss out on allocated maintenance dates by a third party.
- Lack of efficient tracking on fuel giving the opportunity for financial fraud.
- System lacking an efficient way to assigning drivers that may lead to harmful circumstances such as legal action and accidents.

2.3.6 Finance Management

The organizations financial management is organized and carried out using manual processes. These processes include making payment for suppliers, approval of expenses. Keeping track of customer payments and various other costs associated with a project.

Some drawbacks of this manual financial management process can be listed as follows:

- Difficulty to track the financial status of a project. Since projects involve significant financial outflows it is difficult to track them to take corrective action and increase the profit of the organization.
- Difficulty to track the customer overdue payments.
- Difficulty to calculate the total payable for a supplier for multiple projects when making payments.
- Unavailability of a systematic process to notify on pending payments.
- Difficulty to track the distribution of costs across various project tasks.

2.4 Literature Review of Existing Software

In this vastly competitive engineering industry most of the organizations still use manual processes while some of the organizations have started to automate their business processes, due to this rising demand on automated systems; many software vendors have come up with software that helps many engineering ERP companies to improve their efficiency. Two such software in the industry is been described below.

2.4.1 NAVBUILD

NAVBUILD is built on top of Microsoft Dynamics NAV which provides a complete solution for project-centric business requirements [**3**].

NAVBUID built by Cetas Information Technology private limited provides services such as tendering to project completion, handling project billing, view project progress, customer relationship management and etc. A user interface of NAVBILD is presented in Figure 2.2:

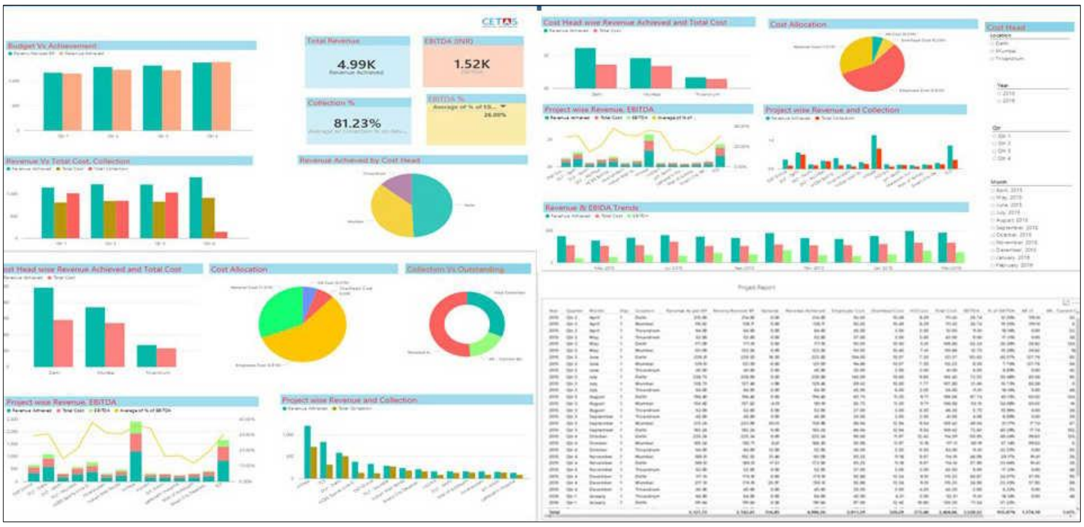

CETAS
Budget Vs Achievement
Total Revenue
4.99K
EBITDA (INR)
1.52K
Collection %
81.23%
EBITDA %
Revenue Vs Total Cost, Collection
Revenue Achieved by Cost Head
Cost Head wise Revenue Achieved and Total Cost
Cost Allocation
Cost Head
Project wise Revenue, EBITDA
Project wise Revenue and Collection
Revenue & EBIDA Trends
Collection Vs Outstanding
Project Report

Figure 2.2: NAVBUILD

Although NAVBUID provides many functionalities and modules that can be used by SCAUPUB TECHNIK it is not capable of providing the optimum to the organization due to the following reasons:

1. NAVBUILD does not incorporate a transport management module, the organization has projects which are carried out at remote sites and as a result the transport costs of employees and material is extensive and can represent a significant part of the project costs. Therefore not being able to represent these costs and schedule transport can lead to inadequate estimates.

2. SCHAUPUB TECHNIK assigns workers to tasks and not directly to the project as a whole and uses the worker residence location as a criterion when assigning. This could result in gaining significant cost savings and performance gains. Since this is a unique requirement and is not supported by NAVBUILD.

The proposed system in the other hand is capable of addressing these situations in the following ways:

1. The proposed system contains a transport management module which is capable of scheduling transport as well as keeping track of costs related to

transport such as fuel management and location tracking. Therefore the system will be capable of representing total project costs more accurately.

2. The proposed system assigns workers to project tasks and not to a project as whole. This will be able to show the availability of employees more accurately and assign workers to projects in more productive ways.

2.4.2 GLOVIA G2

GLOVIA G2 is another project management ERP used by many organizations and focuses on increased on–time project completion and controlling project costs. A user interface of GLOVIA G2 is presented in Figure 2.3:

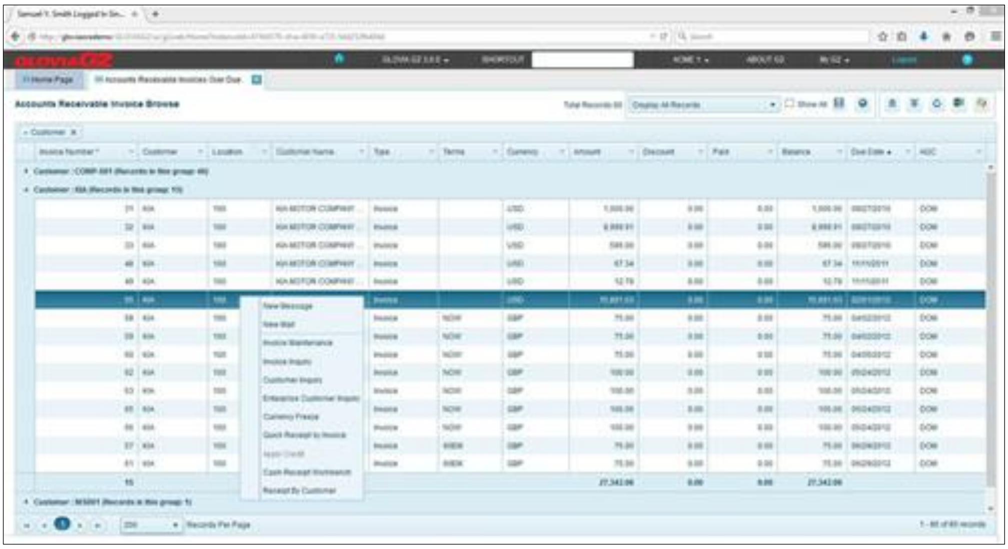


Figure 2.3: GLOVIA 2 Project Management ERP

Although, GLOVIA G2 is used by engineering organizations, it does not suit SCHAUPUB TECHNIK as it does not support employee assigning for projects, as a result it cannot be used for the company as employee costs has a significant impact on overall project cost and not been able to represent it can affect the organization negatively.

The proposed system for the organization can be selected over GLOVIA G2 as it is containing an employee module which facilitates the assigning of employees and shows the costs the organization had to bear on employees for each project.

2.5 Requirements for the New System

2.5.1 Functional Requirements

Functional Requirements of the Project Operations Management System as follows:

Based on the results obtained from the requirements gathering process, system users can be categorized into following roles for their daily operations:

1. Director (Administrator).
2. Purchasing Manager.
3. Workshop Manager.
4. Transport Manager.
5. Accountant.
6. Stock Keeper.
7. Data Entry Clerk.
8. Project Supervisor.
9. Client Coordinator (External to the organization).

The above mentioned system users will interact with the following modules and the requirement for each can be described as follows:

- Tender Management
    - Any user of the system must have the ability to upload tender information such as a tender notice.
    - Directors should be notified when a tender notice is uploaded and go through the information and approve or disapprove for biding.
    - Once a tender is uploaded the DEC (Data Entry Clerks) should be notified to add tender meetings and the workshop manager should be notified to upload the relevant estimates.
    - The directors and the workshop managers should be able to view the status of a tender at any given time.
    - The directors should be notified about schedule tender meeting dates as they approach.

  - Directors should be able to add the final status of the tender indicating whether the tender was approved or not.
  - Should notify the directors and managers to open a job card.

- Production Management
  - A director of the organization or a project manager should have the ability to add a new project which is received directly or through a tender.
  - Once a job card is issued the WSM or the Project manager should have the ability to enter the task schedule.
  - A director or a WSM should have the ability to view the project information at any given time.
  - A director should be notified when a task schedule is uploaded and approve or request changes and add notes.
  - The organization's project supervisor and the client coordinator should be able to add inspection status to a project.
  - Directors should be able to view the timely status of the project including the amount of work done, money spent, time remaining and the payments received.
  - A director should have the ability to issue a gate pass to release the deliverable to the client.
  - A director should have the ability to drop a project.

- Purchasing Management
  - The assigned supervisor or the project manager can create a material requisition note to request items for the production process.
  - The mentioned users must have the ability to view the previous requisition notes.
  - The Data entry clerk or higher authority should have the ability to enter supplier details and the relevant product categories they supply.
  - The added requisition note must be approved by the purchasing manager or a director before inventory or a supplier is assigned.

- Purchasing manager must have the ability to rate supplier performance based on **price, quality of items, delivery, credit facility and warranty period**. The evaluation criteria is shown in Table 2.2:

Category	Evaluation Criteria	Assigned Values
Price	Below the Market Price	05
	Market Price	04
	Over the Market Price	00
Quality	Good	05
	Acceptable Level	04
	Poor	00
Delivery	On Time	05
	One day delay	04
	Over one day delay	00
Credit Facility	From one month to 45 days or more	05
	From two weeks to one month	04
	No credit period	00
Warranty Period	Over 1 year period	05
	1 year	04
	Below one year	00

Table 2.2: Evaluation Criteria and Values for Supplier Performance

- The purchasing manager must have the ability to select suppliers to provide items and material.

  - The suppliers should be selected based on their previous performance evaluated using the above mentioned criteria.
  - The purchasing manager should have the ability to send purchase orders to selected suppliers.
  - The data entry clerk or other authorized users should have the ability to add supplier invoices and send them for payment.
  - View Supplier performance and create the supplier list to work in the next year.

- Inventory Management
  - The stock-keeper or the data entry clerk should add new items to the stock /update stock details.
  - The stock keeper should have the ability to add new item categories/ sub categories.
  - View the availability of items in the stock and assign them to material requisition notes.
  - Mark inspection status of items received from suppliers.

- Worker /Employee Management
  - The data entry clerk or human resource manager should be able to enter the relevant details of employees.
  - The project manager or supervisor must have the ability to assign employees to the project tasks.
  - The following factors need to be considered when assigning workers to the project:
    1. The worker category such as welder, mechanic, plumber and etc.
    2. The worker's past experience.
  - The project manager or other authorized person should have the ability to get an at a glance view of the number of employees of each category assigned to a task.

  - The supervisor should have the ability to enter worker task sheet information to quantify the contribution of a worker to a task and thereby use it to evaluate the worker cost on a given task.

- Transport Management
  - The transport manager must have the ability to schedule transport for various trips.
  - The transport manager should have the ability to cancel transport.
  - The transport manager must have the ability to assign vehicles and drivers for trips.
  - The data entry clerk must have the ability to add maintenance dates for vehicles.
  - Relevant authorities should be notified when maintenance dates are approaching.
  - Transport manager should have the ability to track the location of a vehicle which has been scheduled for a trip to ensure they are on course.

- Expense Management
  - The project supervisor should have the ability to make request for expenses such as lodging, beverages and etc.
  - A project manager or higher authority should have the ability to approve /disapprove the expense requests.
  - The supervisor should have the ability to refund the balance through the system.
  - The project manager or higher authority should be able to view the expense request history and the status of requests.

- Customer Management
  - The data entry clerk or any other authorized authority should have the ability enter new customers to the system and modify the entered details appropriately.
  - The customer's registered coordinator details should be maintained.

    - The directors should have the ability to see the number of completed and incomplete projects with the customer and the total income gained through a specific customer.
    - The directors should have the ability to add notes regarding a customer for future reference.

- User Management
    - The system should facilitate the adding, assigning privileges and removal of internal users of the system.
    - Assign the users to roles and customizing privileges based on the user's nature of work.
    - The adding of external users such as client coordinator accounts.
    - The ability to view the status of each user (both internal and external).

- Finance Management
    - The authorized user (Accountant) should be able view all the approved payment requests.
    - The ability to add payment details for approved expenses and invoices such as the check number, amount and etc.
    - Should have the ability to make a single payment to multiple pending payments distributed across multiple projects belonging to a single supplier.
    - Add the agreed customer payment scheme.
    - The accountant should be notified when customer payments are overdue.
    - The ability to view the distribution of organizational costs within a given project such as the worker costs distributed across multiple tasks of a project.
    - Perform debtor analysis.

2.5.2 Non – Functional Requirements

Non-functional requirements are not directly concerned with the major operations or objectives of the system, but it essential to ensure the smooth and successful usage of the system. The non-functional requirements for the new system can be listed as below:

- Response and Processing Time
    - The users should have the ability to perform their operations efficiently using the system, without unnecessary delays and slow response times.
    - For example the vehicle tracking requires efficient and fast performance as the vehicle locations are tracked in real time, inefficiency in these operations may make it difficult to get the optimum use of such functionality.

- Usability
    - The software should be easy to understand and use by the employees of the organization. The software is expected to be used by non IT users; therefore the interface of the system should be self-explanatory and provide adequate navigation capabilities.

- Reliability and Accuracy
    - Software should be free from failure once it is been put into operational use.
    - The data entered to the system should be accurate and reliable.
    - The outputs generated of the system including reports and displayed information should be accurate and up to date as they are used in making critical business decisions.
    - System's reliability is specifically important in making financial transactions using the system.
- Portability
    - The software should be capable of operating in different environments such as mobile operating systems, different PC operating systems as it is accessed by users from different locations such as engineering sites using different operating systems by the directors and project supervisors.
- Maintainability

  - It should be possible to do future modifications to the system with relevant ease.

2.6 Pre-requisites for Project Success

- Opportunity to have adequate amount of meetings with the client to clarify on interfaces and other designs.
- Client's ability to understand the effect of design decisions of the system.
- Ability to come up with the optimum design for the system (both system and database).
- Excellent competency on relevant technologies needed for development.
- Test cases established prior to implementation.

2.7 Selected Methodology for Development (Rational Unified Process)

The 'Rational Unified Process' (RUP) was chosen as the methodology to develop the project and it can be described as follows:

Rational Unified Process can be described as an architecture centric, incremental and iterative software development model, which can be used as a framework for object-oriented software engineering using UML and focused on the production of high quality software within a predictable schedule.

The iterative nature of RUP has a significant role to play in mitigating the risks associated with a software development project [**4**].

The model can be described using four main phases:

1. Inception.
2. Elaboration.
3. Construction.
4. Transition.

An illustration of the RUP methodology is shown in Figure 2.4:

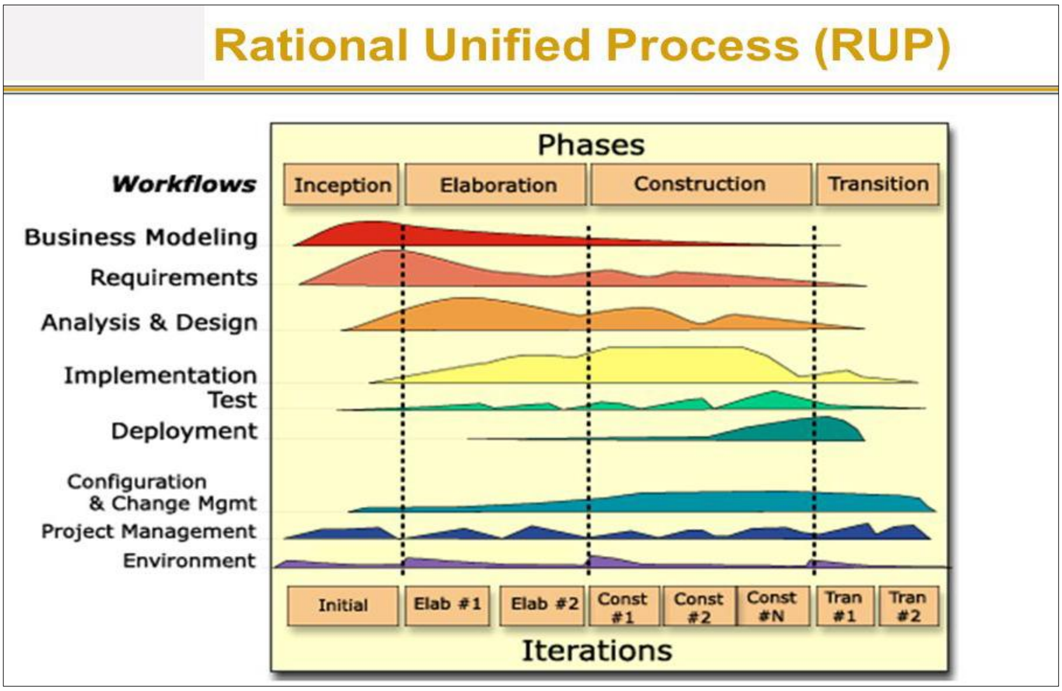


Figure 2.4: The RUP model intensity of workflows through phases

Inception Phase

This phase includes the planning activities and the communication with the clients. This helps in establishing the business requirements and the initial structure of the system.

Elaboration Phase

Elaboration phase encompasses the planning and modeling activities and expands the primary use-cases which were developed in the inception phase. This phase also expands the architectural view of the software.

Construction Phase

Construction phase focuses on the development of components of the system to ensure that each use-case is operational for end-users. Unit tests and test cases are also developed and executed for each component. After the unit tests are carried out, integration tests and acceptance testing take place.

Transition Phase

Transition phase encompasses the later stages of the generic construction activity and also the early stages of the generic deployment activity. The necessary support information is created in this phase such as user manual, installation manual etc. A usable software release is the output of this stage.

Reasons to Choose Rational Unified Process as the Methodology.

As mentioned above the iterative and incremental nature of this model has enabled frequent demonstrations to the client which is contradictory to the waterfall model where customer involvement is less. The focus on a narrow set of use-cases at a time is also facilitated by the RUP model. Both these factors have a significant impact on improving the quality of the software.

The ease of integration is another factor that was considered in selecting RUP over other process models such as throw away prototyping. The process of integration takes place throughout development and will not result in additional time allocation for integrating functions and modules.

UML diagrams are been well utilized by the Rational Unified Process, therefore by using this methodology it would be easier to bring future modifications to the system relatively easily as UML diagrams could be used to get an understanding about the system.

CHAPTER 3 - DESIGN

3.1 Introduction

For any software project, the software design stage is a crucial stage which determines the quality and the success of the software. The design stage transforms the requirements identified in the software analysis phase into meaningful engineering representations by defining methods, objects and the overall architecture of the software.

The aim of this chapter is to describe and justify the design strategies used, explain the overall design of the system including the system structure, the database structure and the user interfaces of the system.

3.2 Alternate Solutions

The alternative solutions for the web based project operations management system can be a stand-alone desktop application or using open source components to build the system.

3.2.1 Stand–Alone software Solution

A stand- alone software can be described as a software that does not require a network connection to function. These systems operate on a single personal computer.

Benefits and drawbacks that a stand-alone solution will introduce to the organization:

Advantages:

- More secure as the organization only have to protect a single personal computer.
- Less cost.

Drawbacks

- The system's users are expected to be located in different geographical locations such as engineering sites therefore a stand-alone system will simply exclude such users from using the system.
- Difficulty of integrating with mobile technology such as android. The software would require interaction from users in remote locations such as coordinators. Some of the business decisions may require authorization from directors who may not have access to a pc at a given time and the system may be accessed via a mobile. Therefore implementing a stand-alone system would make such functionality impossible.

3.2.2 Web Based Software System

A web- based system can be considered as a solution which has utilized a client server architecture, where the application and the database is stored on the server located on the internet. Clients are facilitated to access the server using a web browser.

Advantages

- Using this approach does away with the drawbacks of using a stand-alone software system, as a web based system can be accessed from remote locations.
- Could easily be integrated with mobile technology such as android.

Disadvantages

- Additional security measures can introduce greater costs (tunneling).
- Security issues in allowing users to access the system from remote locations.

The facts furnished above shows why a web based solution is the optimum solution to the project operations management system as it has provided room for greater functionality and availability of the system.

3.3 Design Strategies

The following design strategies were considered when developing the system.

- Develop from scratch using object-oriented methodology.
- Use of Open - Source code.

The benefits and drawbacks of the above mentioned methodologies can be described as shown in Table 3.1:

Developing from the scratch	Develop using open source components
Can be developed to meet the requirements precisely with relative ease.	Requires extra effort to understand and change the components to meet the stated requirements.
Promotes the development of highly cohesive and loosely coupled modules. This would give more control to the developer over the functionality of modules.	Adding new modules can introduce certain interoperability issues with the existing open-source modules which could be difficult to solve.
Since no purchases are required from third parties, can be considered as a cost efficient solution.	Some OS components may only provide a limited set of functionalities free and may charge a considerable fee for other functionalities.
Consumes more time to develop the overall software.	System can be developed in less time.

Table 3.1: Comparison of Developing form Scratch Versus Using Open Source Components

Taking the above factors into consideration, developing from the scratch using object oriented methodology was selected as the suitable design strategy to carry out the development of the web based project operations management system.

3.4 The Proposed System

The proposed system for SCAUPUB TECHNIK can be described using the UML diagrams.

1. Use-Case Diagrams.
2. Class Diagram.
3. Activity Diagrams.

3.4.1 High-Level Use-Case Diagram for the Proposed System

The high-level use-case diagram of the proposed system is shown in Figure 3.1:

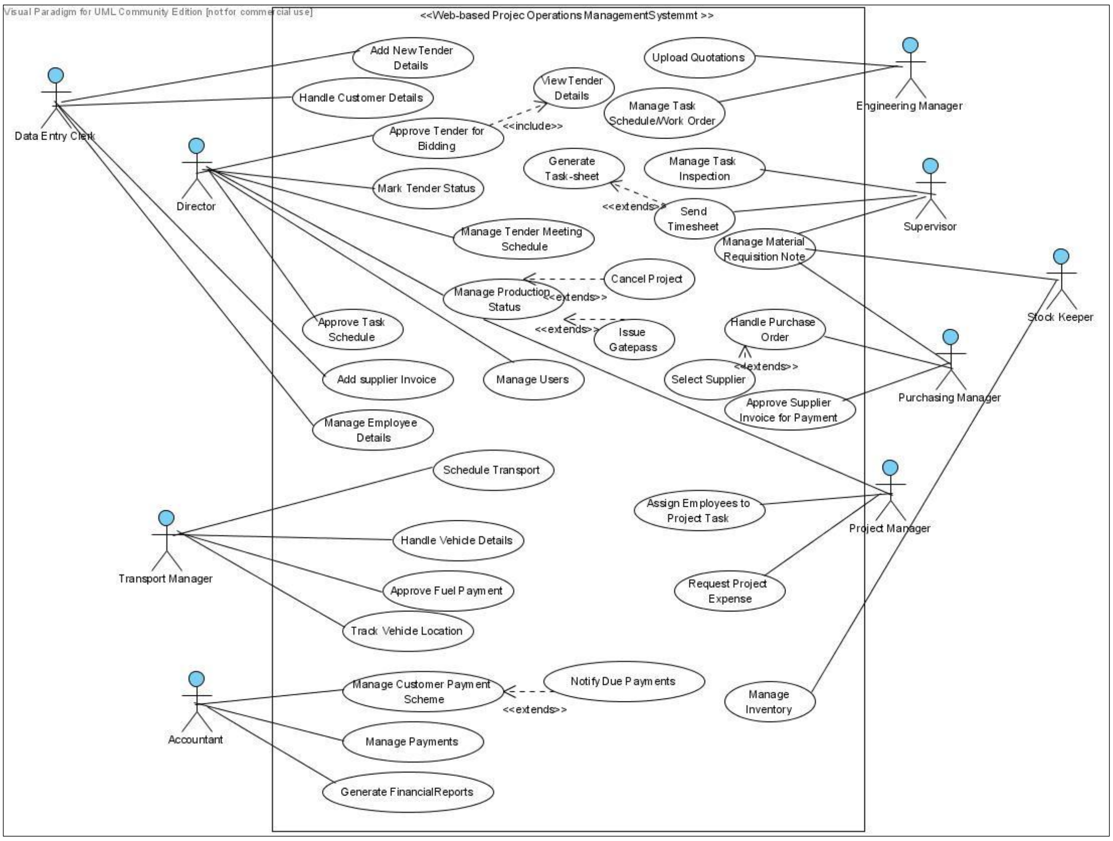


Figure 3.1: High level Use case for the Overall System

The proposed solution is divided into the following modules:

1. Tender Management.
2. Production Management.
3. Employee Management.
4. Transport Management.

5. Expenses Management.
6. Purchasing Management.
7. Inventory Management.
8. Customer Management.
9. Finance Management.
10. User Management.

The use-cases of some significant modules as follows:

Tender Management

The use-case diagram and the use-case narrative for the tender management module is shown in Figure 3.2 and Table 3.2:

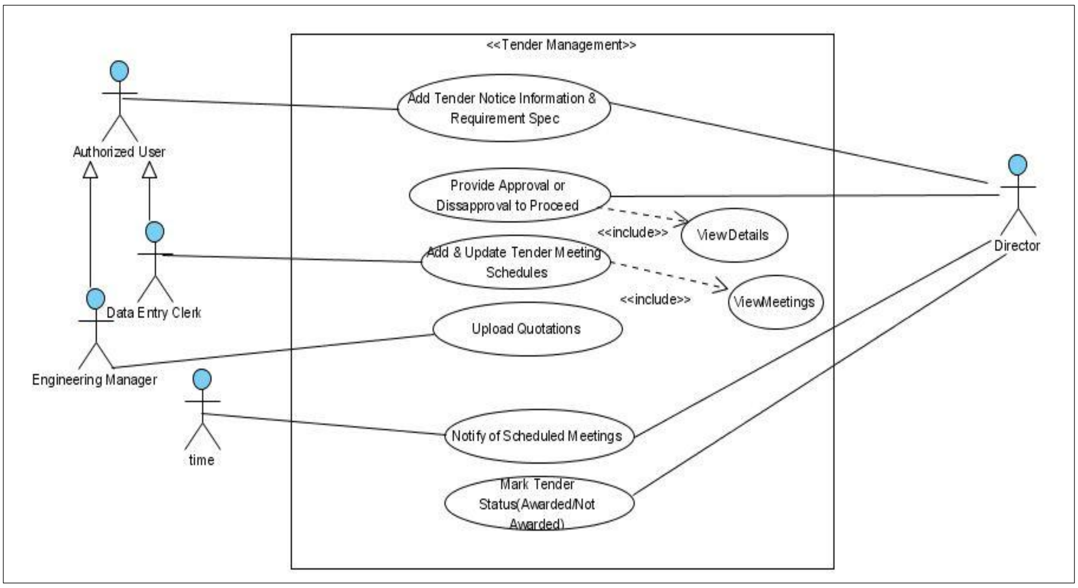

<<Tender Management>>
Authorized User
Add Tender Notice Information & Requirement Spec
Provide Approval or Dissapproval to Proceed
<<include>>
ViewDetails
Add & Update Tender Meeting Schedules
<<include>>
ViewMeetings
Data Entry Clerk
Engineering Manager
Upload Quotations
time
Notify of Scheduled Meetings
Mark Tender Status(Awarded/Not Awarded)
Director

Figure 3.2: Use Case Diagram for Tender Management

Use Case Name	Tender Processing
Actors	Authorized user, Director, Engineering Manager (Workshop Manager).
Description	A new tender is added and goes through an approval process till the tender is awarded or closed.
Pre-conditions	All actors should be in the active state.

Main Flow:

1. A user identifies a potential tender for bidding and uploads the details to the system.

2.A director approves the tender.

3.If tender is approved.

3.1 The DEC adds tender meeting schedule.

3.2 The workshop manager uploads quotations for bidding.

4. System notifies the directors of tender meetings scheduled within the week.

5. Director marks the tender as awarded or closed.

Table 3.2: Use Case for Tender Management Process

Production Management

The use-case diagram and the use-case narrative for the production management module are shown in Figure 3.3 and Table 3.3:

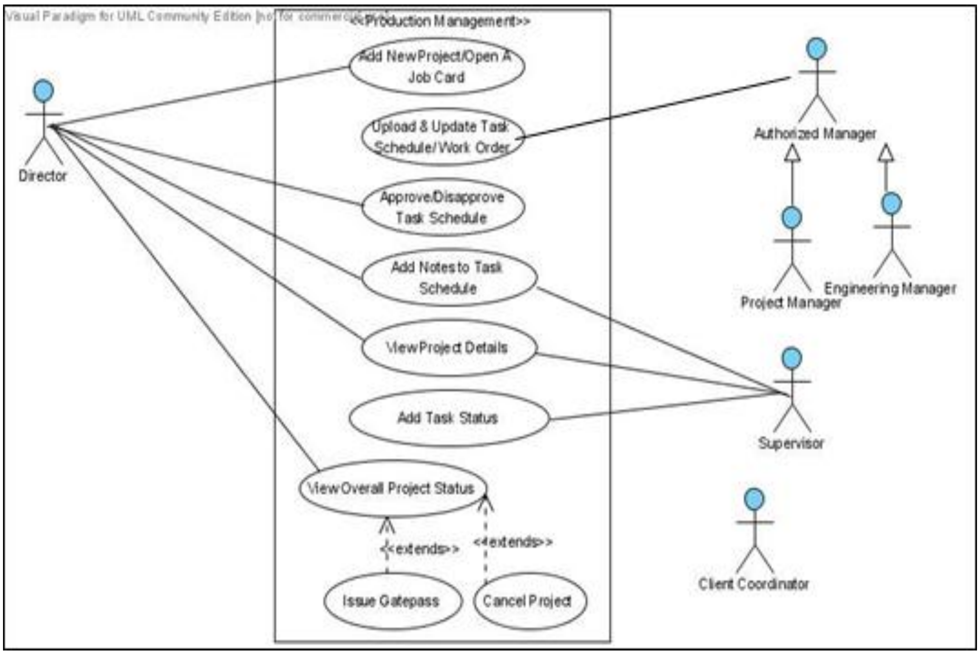

Visual Paradigm for UML Community Edition [not for commercial use]
<<Production Management>>
Director
Add NewProject/Open A Job Card
Upload & Update Task Schedule/Work Order
Approve/Disapprove Task Schedule
Add Notes to Task Schedule
View Project Details
Add Task Status
View Overall Project Status
<<extends>>
<<extends>>
Issue Gatepass
Cancel Project
Authorized Manager
Project Manager
Engineering Manager
Supervisor
Client Coordinator

Figure 3.3: Use Case Diagram for production Management

Use Case Name:	Production Management Process.
Actors:	Director, Engineering Manager, Supervisor, Client Coordinator.

Description:	A new Project is added, the tasks are managed and status and a gate pass is issued.
Main Flow: 1. A director adds a new project to the system. 2. The notified workshop manager creates and adds a task schedule. 3. A director evaluates the task schedule. 4. If Approved 4.1. The supervisor marks the task status. 4.2. The client coordinator marks task status. 5. Director can view overall project details and status. 6. If Satisfied. 6.1. Issue Gate pass. 7. If Not Satisfied. 7.1. Drop Project.	

Table 3.3: Use Case Narrative for Production Management

Purchasing Management

The use-case diagram and the use-case narrative for the purchasing management module are shown in Figure 3.4 and Table 3.4:

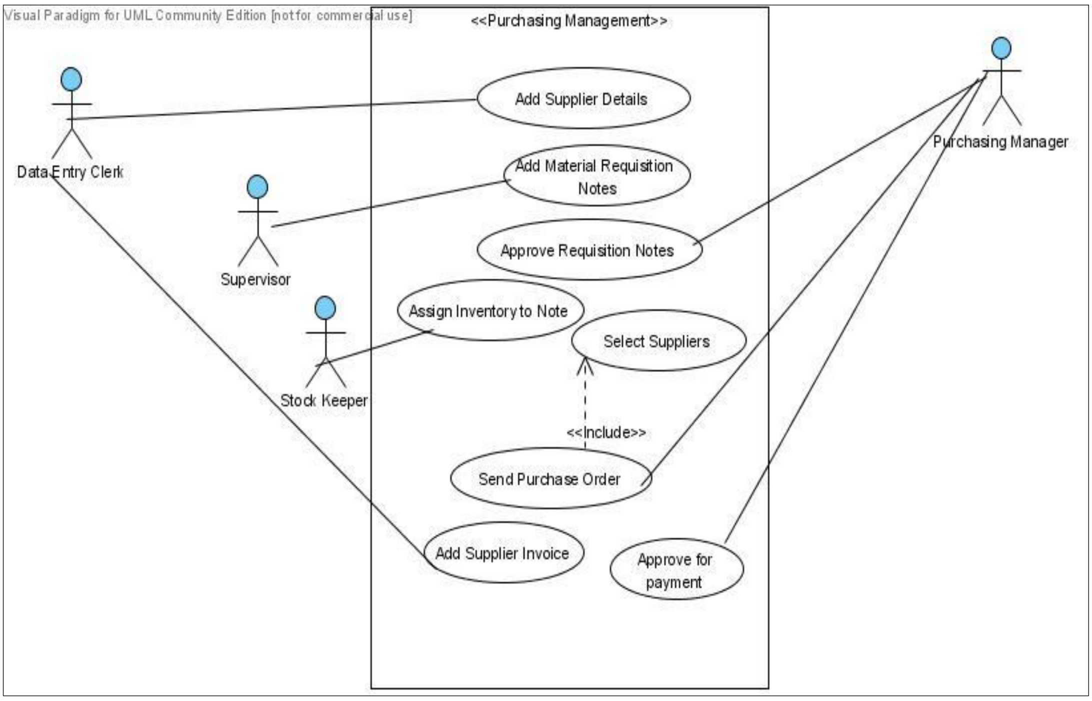


Figure 3.4: Use Case Diagram for Purchasing Management Module

Use Case Name:	Purchasing Management Process.
Actors:	Supervisor, Purchasing Manager, DEC, Stock Keeper.
Description:	A Material Requisition Note is added, and processed till items are received and evaluated.
Pre-Conditions:	The project has to be in active state.
Main Flow: 1. Supervisor requests for material requisition note. 2. The purchasing manager evaluates the note. 3. If approved 3.1. Stock keeper assigns inventory items to note. 4. Purchasing manager selects suppliers for purchasing. 5. Purchasing manager sends purchase orders to selected suppliers 6. Data entry clerk adds a supplier invoice. 7. Purchasing Manager approves for payment.	

Table 3.4: Use Case Narrative for Purchasing Management

3.4.2 The Class Diagram

The system can be broken down into 17 classes and their interactions between each other can be shown using the following class diagram in Figure 3.5.

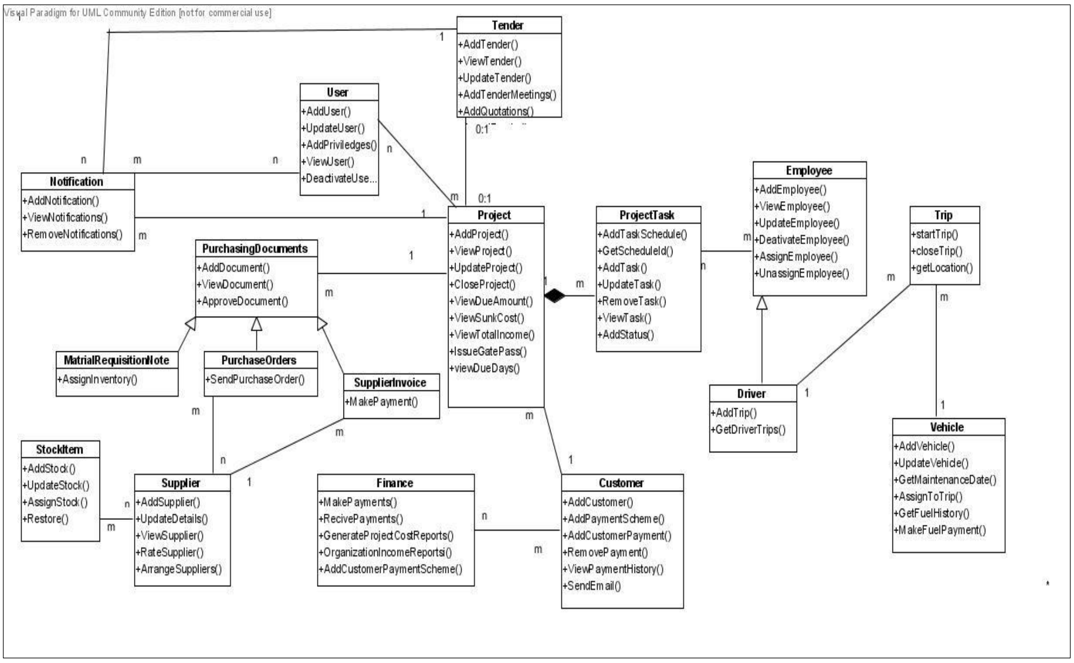


Figure 3.5: The Class Diagram for the proposed System

3.4.3 Database Design

Database Design is an integral part of a software development project's success. The entity relationship diagram of this web-based project operations management system describes the entities and the associations between entities. The database is normalized up to 3rd normal form (3NF) to prevent transitive dependencies and anomalies listed below.

1. Insertion anomalies.
    a. Occurred when an attribute cannot be entered to the system without the presence of another attribute.
2. Update anomalies.
    a. Occurred when not all instances of the data is updated.
3. Deletion anomalies.
    a. Occurred when a certain attribute is lost due to deletion of another.

Therefore normalizing the project operations management system helped to remove these anomalies and maintain the data in a consistent state.

The proposed system's entity relationship diagram is given in Figure 3.6: The internal structure of tables corresponding to the ER diagram of the database is available on APPENDIX B.

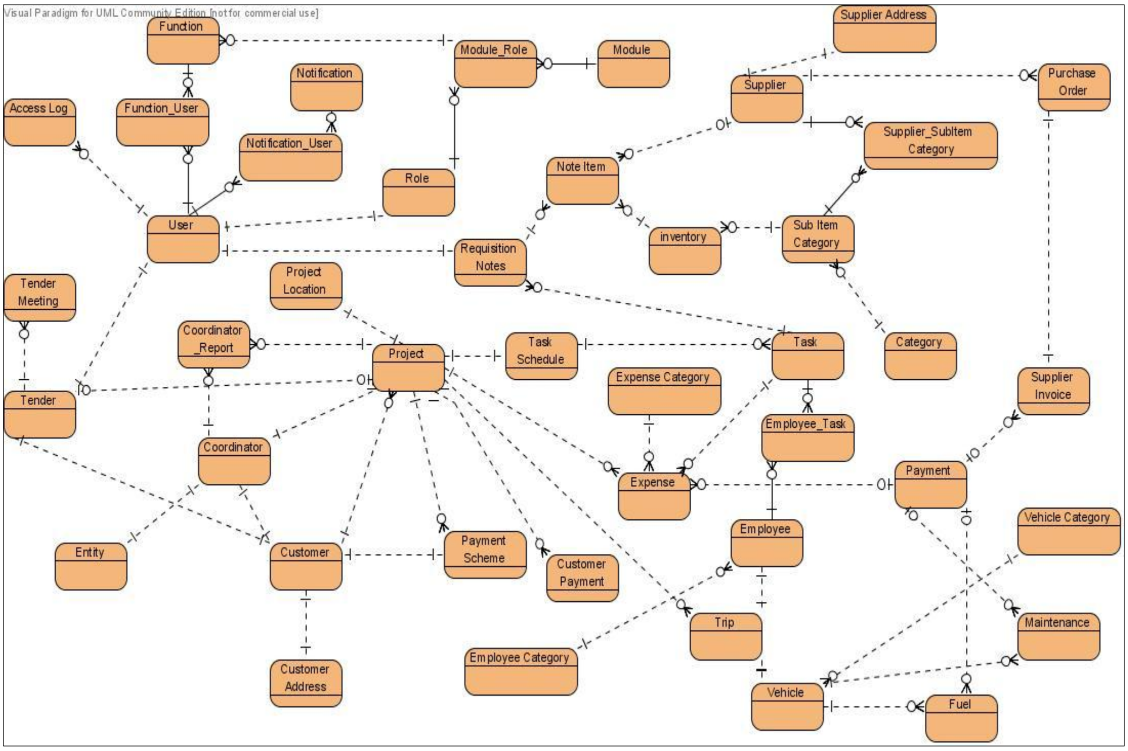
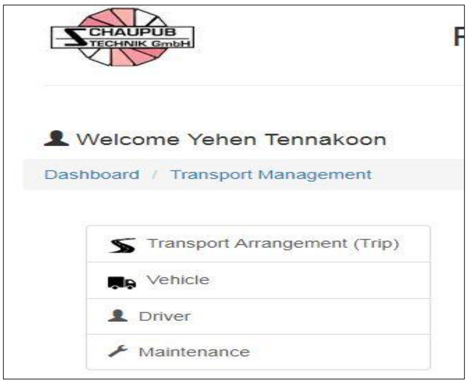


Figure 3.6: Entity Relationship Diagram for the System

3.4.4 The User Interface Design

User interface design can be considered as an important part in ensuring that the system is usable by the authorized users without difficulty. The following factors were considered when developing the interfaces of the system.

- Design to remove mistakes and slips during user interaction by allowing natural mappings (use of commonly used icons to represent processes). An example of the use of natural mappings is shown in Figure 3.7:

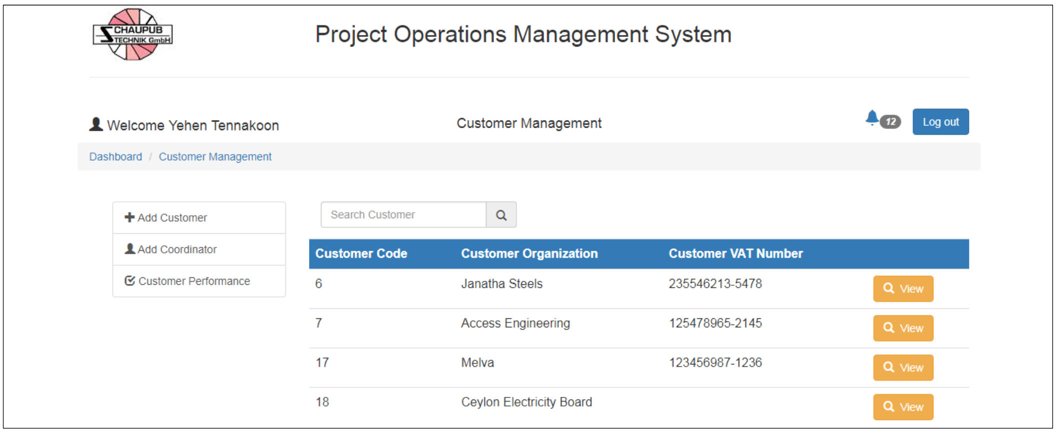


Welcome Yehen Tennakoon

Dashboard / Transport Management

Figure 3.7: Use of natural mappings to remove confusion

- Improve visibility using appropriate color example (use of red color to symbolize irreversible operations, use of cool colors to background). An example is shown in Figure 3.8.



Project Operations Management System

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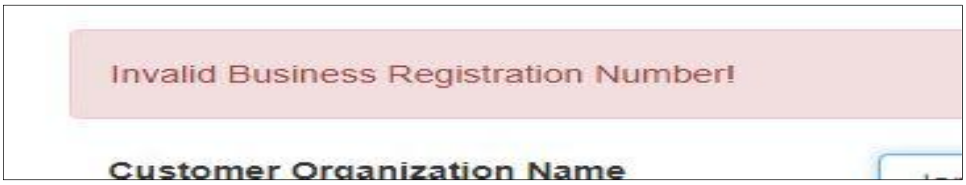
Customer Management

Dashboard / Customer Management

Customer Code	Customer Organization	Customer VAT Number	
6	Janatha Steels	235546213-5478	View
7	Access Engineering	125478965-2145	View
17	Melva	123456987-1236	View
18	Ceylon Electricity Board		View

Figure 3.8: Use of cool colours to backgrounds.

- Use of simple plain language for error messages with precise description. An example is given in Figure 3.9.

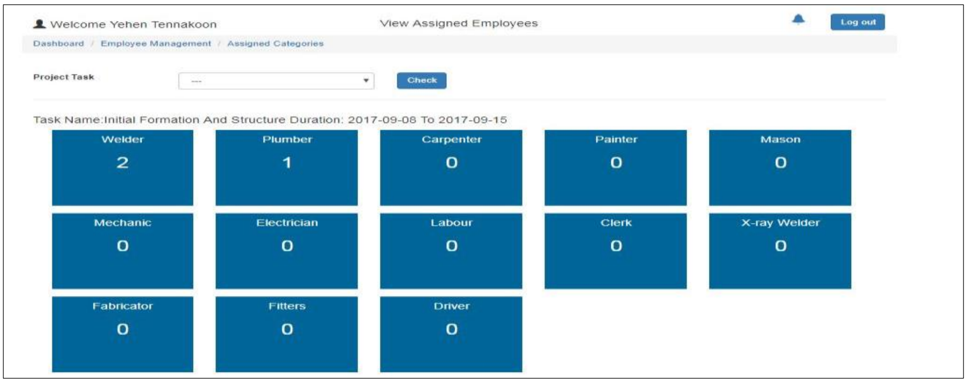


Invalid Business Registration Number!

Customer Organization Name

Figure 3.9: The Use of Plain language in Error Messages

- At-a glance view to increase usability and understanding. The usage of such a view is given in Figure 3.10.



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View Assigned Employees

Dashboard / Employee Management / Assigned Categories

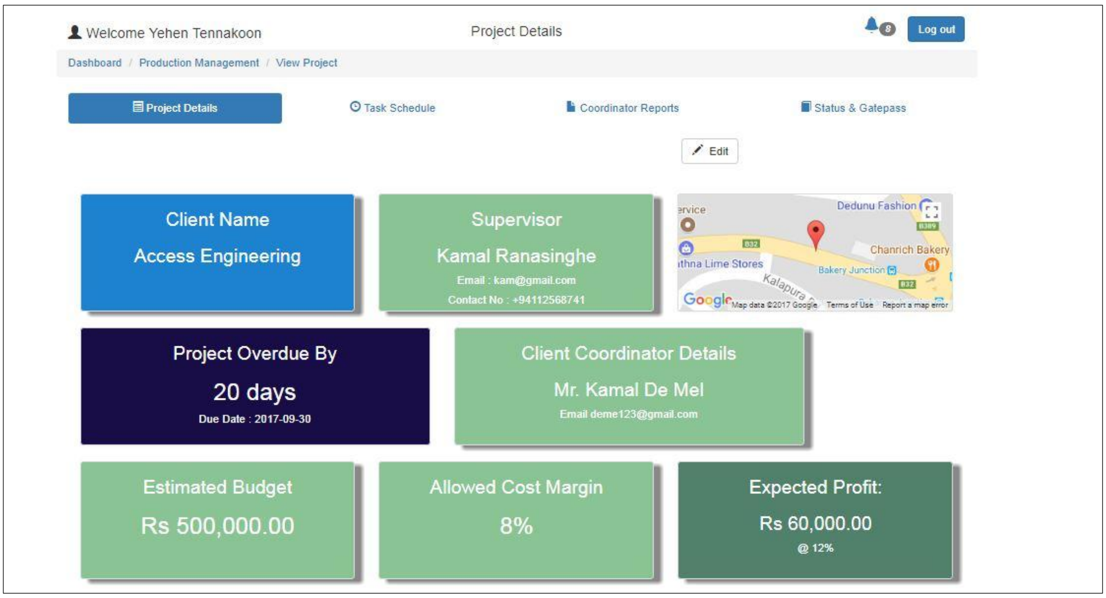
Project Task: ---

Task Name:Initial Formation And Structure Duration: 2017-09-08 To 2017-09-15

Welder 2	Plumber 1	Carpenter 0	Painter 0	Mason 0
Mechanic 0	Electrician 0	Labour 0	Clerk 0	X-ray Welder 0
Fabricator 0	Fitters 0	Driver 0		

Figure 3.10: At a glance view on categories and count of employees assigned

Efficient and timely access to project status information is an important feature required by any construction project. The system has provided an at a glance view on the project status covering the scope, time and cost constraints of the project. An example is given in Figure 3.11.



Client Name

Access Engineering

Supervisor

Kamal Ranasinghe

Email : kam@gmail.com

Contact No : +94112568741

Project Overdue By

20 days

Due Date : 2017-09-30

Client Coordinator Details

Mr. Kamal De Mel

Email deme123@gmail.com

Estimated Budget

Rs 500,000.00

Allowed Cost Margin

8%

Expected Profit:

Rs 60,000.00

@ 12%

Figure 3.11: Project Status and Details at a glance view

CHAPTER 4 -IMPLEMENTATION

4.1 Introduction

The implementation phase of a software project can be considered as the stage where the software design would be converted into an executable program. The effective execution of this phase has a direct influence on the success of the overall software project. The software and the work done become visible to the non – IT people during this period.

The aim of this chapter is to describe the implementation of the system in terms of major code and module structures, the interaction between modules, the implementation environment of the system and the implementation of the design patterns used for the development of the system.

The chapter also provides a description of the reusable components and their use in developing the system.

4.2 Implementation Environment

4.2.1 Software Requirements

Client-Side:

- Operating System: Windows 7 or above.
- Web Browser: Google Chrome web browser.
- Android Operating System (For mobile component)

Server-side:

- Operating System: Ubuntu Operating System for web.

4.2.2 Hardware Requirements

Client-Side:

- 4GB RAM. (2GB Minimum).
- Intel Core i3 (2.4 GHz) or above processor.
- 100 GB free Hard Disk Space.
- Inkjet Printer (for printing reports).
- Android Based Smartphone (Android 5.0 or above).
- Internet Connectivity.

Server-Side:

- 5GB SSD Space.
- 500GB Bandwidth.

4.3 Development Tools Used

4.3.1Software Tools

- Net Beans 8.1 Integrated Development Environment (for developing the front-end and the back-end of the web based system).
- Android Studio (for developing the mobile component of the system).
- Google Chrome Web Browser.
- Apache (as the testing server).
- MySQL (as the database Management System).

4.3.2 Programing Languages

- PHP 5.0 (For scripting the server-side code).
- HTML5 and CSS3 for developing the front-end of the web based application.
- Bootstrap CSS and JavaScript library for styling.
- JQuery (For scripting the client-side code).
- Java (For development of the android application).

4.3.3 Reused Components

- Google Charts [**5**] - An API provided by Google to attractively illustrate a system's live data using various types of chart representations. The project operations management system uses this component to clearly illustrate financial data across various projects and tasks.

- Google Maps [**6**] – Google Maps is an online mapping service provided by Google incorporation via an API that has been providing abilities such as marking locations, measuring traveling distance between two locations and many more [**7**]. This service has been well utilized in the software project, specifically in the transport management module where the destination is marked using the Google maps javascript api and subsequently use the API's feature of calculating the driving distance. This information is important to calculate the fuel cost of transportation. google maps were also used to indicate the current location of vehicle's which are assigned a trip.

- PHPMailer [**8**] – A code library that is been used to send emails. PHPMailer has supported the creation and sending of html emails. The project operations management system has used this functionality to send emails using the Gmail account to required mail recipients. This functionality has been used in area's such as notifying customers of overdue payments, sending of purchase orders.

- FPDF library - FPDF can be considered as a free PHP class library which can be used to generate PDF files using PHP. The described project has utilized FPDF library in generating reports and documents required such as supplier performance reports, purchase orders and etc.

- Bootstrap – A predefined collection CSS and javascript files that enable the creation of attractive and responsive web applications.

- JQuery [**9**] - A small and a feature-rich library that has been designed to support HTML document traversal, event handling and many more functionalities to make web applications attractive and interactive. JQuery is used throughout this system for validations and instant page refreshes that would increase user convenience.

- JQuery-DataTable [**10**] - JQuery DataTable can be considered as a JQuery plugin that can be used to enhance the capabilities of a dynamically generated html table using bootstrap. Datatable has the capability to support easy-searching of records and navigation of records.

4.4 Code Features

4.4.1 MVC Architecture

The software system was based on the MVC architecture

Model-View-Controller also known as MVC is a software design framework which was specifically designed for web applications. The main components of this framework are given in Figure 4.1.

- Model- The actual classes depicted in the class diagram are contained in the model. The methods required to manipulate the data of the system are embedded in these classes.
- View - The responsibility to display the required data to the end users are carried-out by the view.
- Controller- The interaction between the view and the model components are managed by the controller. The requests sent by the view are validated and passed on to the model then the responses received from the model are passed back to the view by the controller.

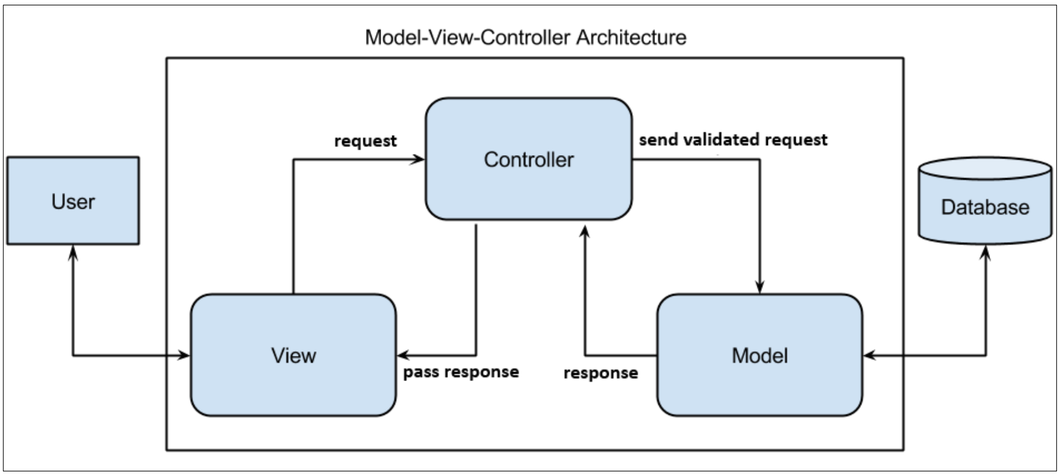
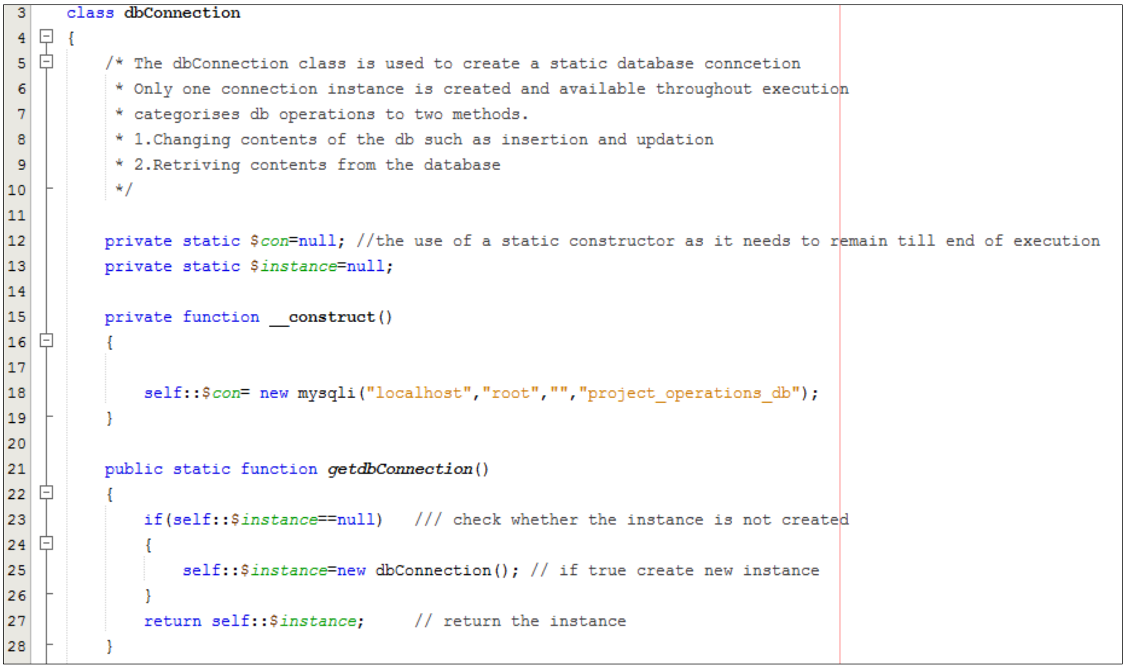


Figure 4.1: Diagrammatic view of the MVC architecture

4.4.2 Singleton Design Pattern for the Database Connection

The database connection of the application is an essential component that has to be available throughout the application's execution period. The web based project operations management system described in this document has accomplished this significant need through the use of a dedicated class known as 'dbConnection' which has been implemented using the Singleton design pattern. A illustration of the use of Singleton design pattern in the system is given in Figure 4.2.



```
class dbConnection
{
    /* The dbConnection class is used to create a static database conncetion
     * Only one connection instance is created and available throughout execution
     * categorises db operations to two methods.
     * 1.Changing contents of the db such as insertion and updation
     * 2.Retriving contents from the database
     */

    private static $con=null; //the use of a static constructor as it needs to remain till end of execution
    private static $instance=null;

    private function __construct()
    {

        self::$con= new mysqli("localhost","root","","project_operations_db");
    }

    public static function getdbConnection()
    {
        if(self::$instance==null)   /// check whether the instance is not created
        {
            self::$instance=new dbConnection(); // if true create new instance
        }
        return self::$instance;     // return the instance
    }
```

Figure 4.2: The use of Singleton Design Pattern in the project

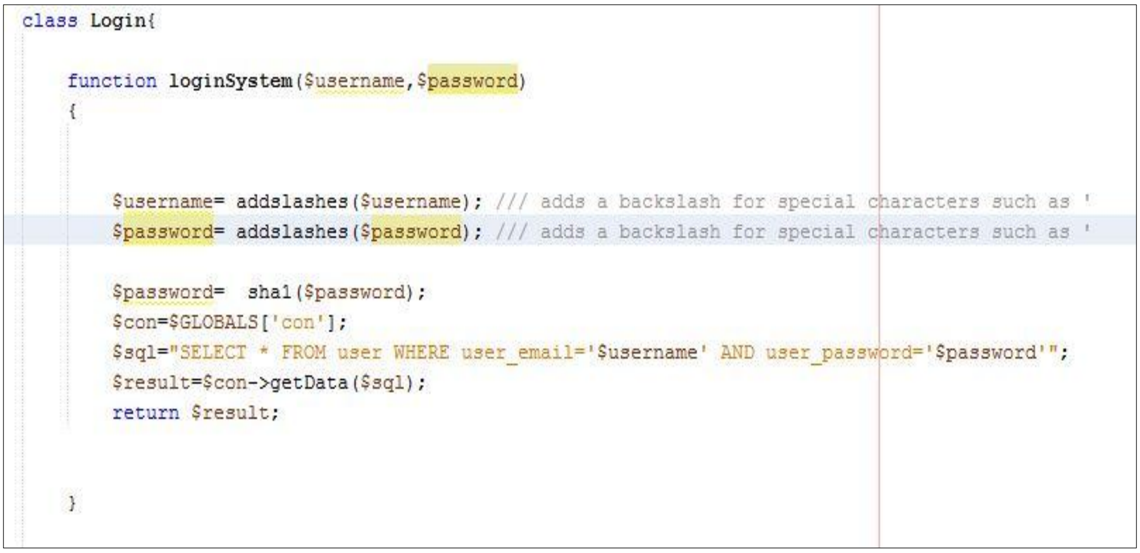
The use of a static connection has ensured that the created connection will remain till the entire application's execution. The static method 'getDbConnection' is called by the class using the connection.

The availability of the static database connection object is checked by the getdbConnection() method and if not available it creates a new connection, otherwise the method returns the available connection.

The major advantage of using singleton design pattern is that memory would be allocated to the instance only on the first call to the instance and thereby subsequently has an impact on the performance improvement of the application.

4.4.3 Preventing SQL Injection through Predefined PHP Methods

Prevention of SQL injection is critical to ensure that the system is not accessed by unauthorized users and thereby ensure the security of the system. Predefined PHP method; 'addslashes' was used to prevent SQL injection. An illustration is given in Figure 4.3.

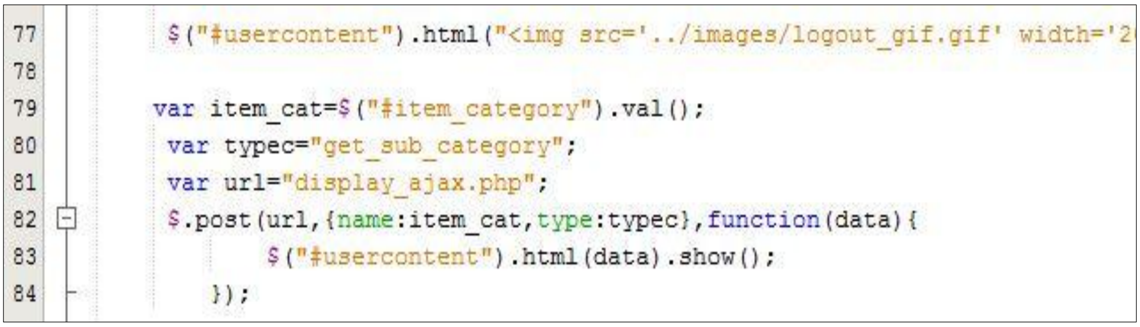


```
class Login{

    function loginSystem($username,$password)
    {


        $username= addslashes($username); /// adds a backslash for special characters such as '
        $password= addslashes($password); /// adds a backslash for special characters such as '

        $password=  sha1($password);
        $con=$GLOBALS['con'];
        $sql="SELECT * FROM user WHERE user_email='$username' AND user_password='$password'";
        $result=$con->getData($sql);
        return $result;


    }
```

Figure 4.3: The Use of 'addslashes' to prevent SQL injection

4.4.4 The use of a Dedicated Page to Manage all AJAX Requests

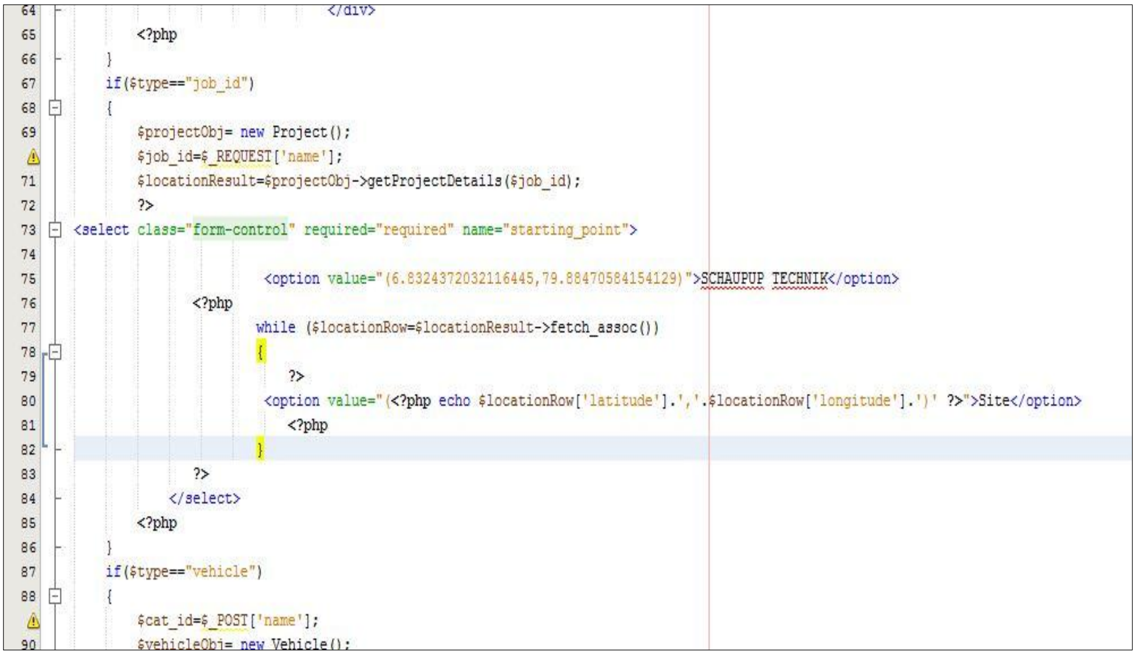
Usability is one of the key non-functional requirements of end-users, therefore the use of AJAX to minimize page refreshes would play a critical part. A larger number of AJAX requests are used by the system; therefore having multiple PHP pages to cater each request would result in the increase of storage space required as well as the difficulty of organizing and managing. Therefore to prevent the problems mentioned, a dedicated PHP page is used to cater the requests sent by different JavaScript pages as required, this is accomplished by passing an additional parameter that would specify the requirements. In addition method reusability is also promoted by this approach. The call to the correct type is shown in Figure 4.4.



```
         $("#usercontent").html("<img src='../images/logout_gif.gif' width='2

        var item_cat=$("#item_category").val();
         var typec="get_sub_category";
         var url="display_ajax.php";
         $.post(url,{name:item_cat,type:typec},function(data){
                $("#usercontent").html(data).show();
            });
```

Figure 4.4: Passing type as an additional parameter to the display ajax page

The 'display_ajax.php' page would evaluate the type of the request sent to it using POST method and display the details appropriately as described in Figure 4.5.

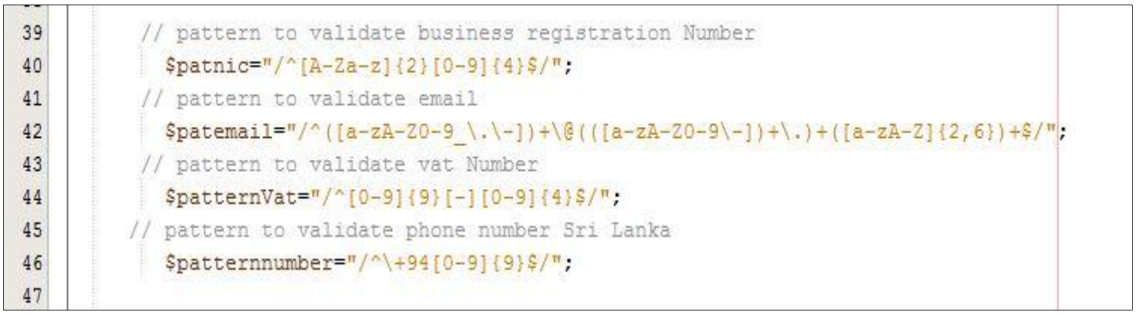


```
                                </div>
        <?php
    }
    if($type=="job_id")
    {
        $projectObj= new Project();
        $job_id=$_REQUEST['name'];
        $locationResult=$projectObj->getProjectDetails($job_id);
        ?>
<select class="form-control" required="required" name="starting_point">

                     <option value="(6.8324372032116445,79.88470584154129)">SCHAUPUP TECHNIK</option>
            <?php
                    while ($locationRow=$locationResult->fetch_assoc())
                    {
                        ?>
                     <option value="(<?php echo $locationRow['latitude'].','.$locationRow['longitude'].')' ?>">Site</option>
                        <?php
                    }
            ?>
          </select>
        <?php
    }
    if($type=="vehicle")
    {
        $cat_id=$_POST['name'];
        $vehicleObj= new Vehicle();
```

Figure 4.5: The 'type' variable is evaluated by the display AJAX page to respond to different requests

4.4.5 Validation of User Input Fields based on Business Domain Requirements

Fields specific to the business domain such as the business registration number, customer organization VAT number and general but, required fields were validated to ensure the consistency of the database through the use of both server-side and client side validation. An example of validating domain specific fields is given in Figure 4.6.



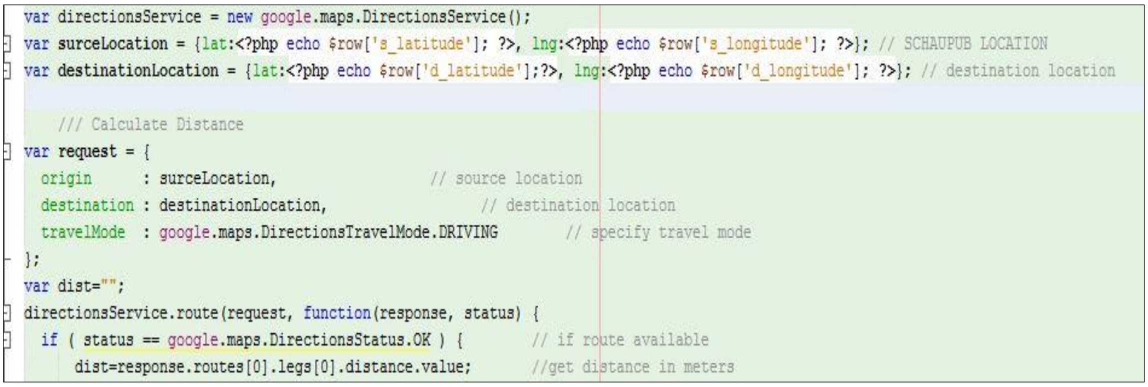
```
    // pattern to validate business registration Number
      $patnic="/^[A-Za-z]{2}[0-9]{4}$/";
    // pattern to validate email
      $patemail="/^([a-zA-Z0-9_\.\-])+\@(([a-zA-Z0-9\-])+\.)+([a-zA-Z]{2,6})+$/";
    // pattern to validate vat Number
      $patternVat="/^[0-9]{9}[-][0-9]{4}$/";
   // pattern to validate phone number Sri Lanka
      $patternnumber="/^\+94[0-9]{9}$/";
```

Figure 4.6: The use of regular expressions to validate both domain specific fields

4.5 Reused Code Segments

The transport management module’s view trip function is required to display the driving distance between the source and the destination locations. This information will be subsequently used to calculate the transport cost of the trip.

Google Map API has provided has defined a method that is capable of calculating the driving distance between two specific locations. The project operations management system has utilized this method when calculating the driving distance which would then be used to calculate the transportation cost. An example is given in Figure 4.7.



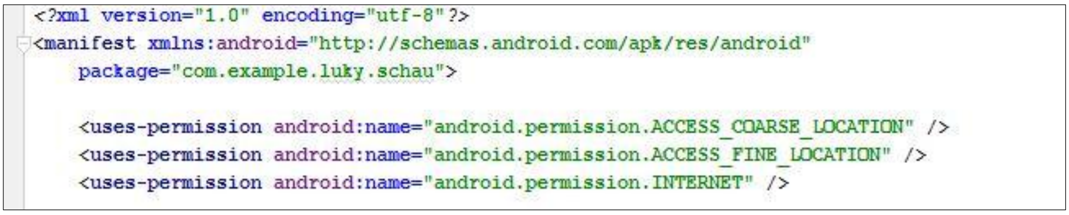
```
var directionsService = new google.maps.DirectionsService();
var surceLocation = {lat:<?php echo $row['s_latitude']; ?>, lng:<?php echo $row['s_longitude']; ?>}; // SCHAUPUB LOCATION
var destinationLocation = {lat:<?php echo $row['d_latitude'];?>, lng:<?php echo $row['d_longitude']; ?>}; // destination location

   /// Calculate Distance
var request = {
  origin      : surceLocation,                 // source location
  destination : destinationLocation,                 // destination location
  travelMode  : google.maps.DirectionsTravelMode.DRIVING       // specify travel mode
};
var dist="";
directionsService.route(request, function(response, status) {
  if ( status == google.maps.DirectionsStatus.OK ) {        // if route available
     dist=response.routes[0].legs[0].distance.value;       //get distance in meters
```

Figure 4.7: The use of the Google's location service method to calculate the driving distance

4.6 Featured Functionalities

- Vehicle Location Tracking

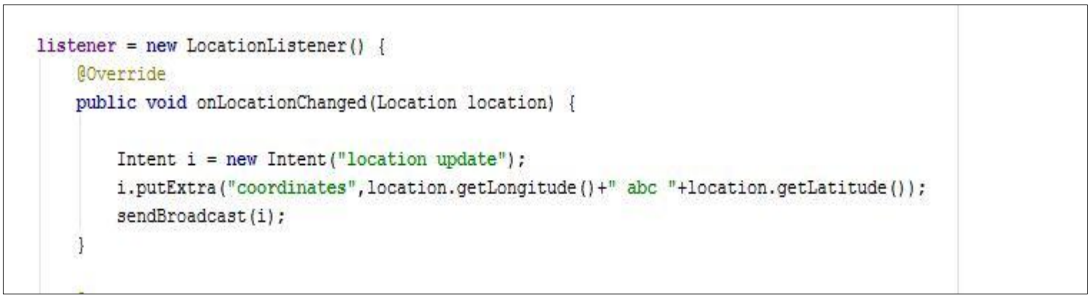
Vehicle location tracking has a critical role to play in the transport management module. The web based project management system has made use of android technology to implement. The code used to request permission from the user is given in Figure 4.8.



```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.example.luky.schau">

    <uses-permission android:name="android.permission.ACCESS_COARSE_LOCATION" />
    <uses-permission android:name="android.permission.ACCESS_FINE_LOCATION" />
    <uses-permission android:name="android.permission.INTERNET" />
```

Figure 4.8: Android Permissions to Specify to use GPS service

Once the permissions are granted, location listener’s defined method ‘onLocationChanged’ can be used to get the latitude and the longitude values of the moving vehicle. The code used to send the latitude and longitude to the server is given in Figure 4.9.



```
listener = new LocationListener() {
    @Override
    public void onLocationChanged(Location location) {

        Intent i = new Intent("location update");
        i.putExtra("coordinates",location.getLongitude()+" abc "+location.getLatitude());
        sendBroadcast(i);
    }
```

Figure 4.9: Accessing the location object to get latitude and longitude

CHAPTER 5 - EVALUATION

5.1 Introduction

Software evaluation can be considered as the process of determining whether developed software has provided the optimum solution to the client's requirements. [**11**] This evaluation is carried out by testing which if executed correctly, is capable of identifying the drawbacks, errors and incompatibilities of components that will hinder the successful use of the system.

5.2 Test Strategies Used

A test strategy is the outline of how testing should be carried out. In the evaluation of the project operations management system, two such testing strategies were carried out, which are namely 'black box testing' and 'white box testing'.

5.2.1 Black Box Testing

Black box testing has been the most commonly used type of testing in the industry. This is largely due to the fact that it does not require the person performing the test to have any knowledge on the internal design of the code. This is performed by taking down system's behaviors which were made in response to the data provided.

A good understanding of the requirements specification of the system and the knowledge on how the system should behave in response to different user actions is required by the black box tester.

5.2.2 White Box Testing

This has been a more complex form of testing as the person performing the test should have good knowledge on the internal structure of the system. These are test methods cover specific elements of the code. [**12**]

When testing the developed Project Operations Management System, white box testing was used as a method of verifying the smooth execution of critical functions such as adding customer payments to the system.

5.3 Levels of Testing Followed

Different levels of testing were used in the evaluation of the project operations management system as shown in Figure 5.1:

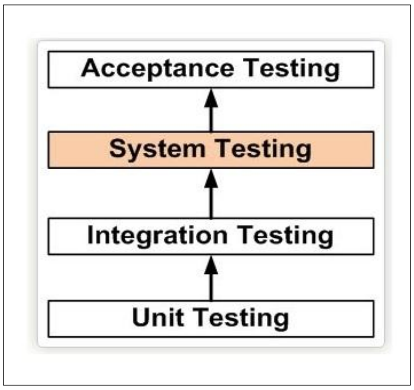


Figure 5.1: Levels of Testing Followed in the Evaluation Phase of the Software

5.3.1 Unit Testing

The process of testing the software in terms of individual functions, carried out as a part of the development process to ensure following about the code being tested.

- Robust- The code should not crash under any circumstances.
- Functionally correct- The code should carry out the task defined in the code design.
- Correct interface- The inputs and the outputs should be as defined in the code design.

All the components of the project operations management system was unit tested to ensure the above mentioned characteristics and found to have given the expected results.

5.3.2 Integration Testing

This could be considered as the process where two unit tested modules are tested for compatibility when integrated with each other using the bottom up approach. Integration testing has been a key testing type in this software similarly to any other ERP software as the modules needed to be integrated to ensure successful flow of the software.

For example: the purchasing management module and the inventory management modules are highly interrelated as the inventory items are assigned to requisition notes generated in the purchasing module. Therefore to ensure the success of the process, integration testing had to be carried out.

5.3.3 System Testing

System testing has been one of the most important levels of testing. All system modules are put together and tested to ensure the successful flow of the system. For a successful system testing, it is important to have performed the unit testing and integration testing phases.

The complete project operations management system was tested from the point a tender was uploaded till the financial payments are made and a gate pass is issued. The system testing used the black box testing strategy as the system's behavior for various user actions were mapped with the required behavior.

5.3.4 Acceptance Testing

Acceptance testing is carried out to ensure that the requirements mentioned in the requirements specification are met. This is a form of testing carried out by the actual system users in the operating environment. This type of testing is also known as beta testing and is capable of giving an idea on how successful the system will be in the operating environment.

The acceptance testing of the software system was carried out by the employees of SCHAUPUB TECHNIK private limited. The operations were carried out by the mentioned users and the feedback on the success of the software was stated on the questionnaires provided.

5.4 Test Plan

A test plan can be considered as the basis for testing a software system which describes the approach, features to be tested, how each test should be carried out and assigning them with priorities [**13**] The test plan should be developed at the beginning of the software development phase.

Two types of test plans are available for testing:

1. Master test Plan.
2. Testing Level Specific Test Plan.

Testing level specific test plans were used for the software mentioned in this dissertation.

The testing levels and their schedules are guided by the test plan which subsequently would lead to the creation of test cases to address the test items mentioned in the test plan.

5.5 Test Cases

A test case can be defined as a set of conditions which can be used to identify whether a system being evaluated has satisfied the requirements. A well planned set of test cases will ensure that all important features are tested and error free. Some of the test cases developed for the major modules are described in Table 5.1 to Table 5.5 (Please refer APPENDIX E for test Results of other modules).

5.5.1 Test Cases for Tender Management Module

Test cases for tender management module are shown in Table 5.1.

Test Number	Test Case Description	Steps Carried Out	Expected Result
1	Add A New Tender	Fill The Required Fields and Click ‘submit’	Tender Successfully Added to the system. User navigated to tender list.
2	Validate Tender	Leave out tender notice, customer organization name blank.	Tender not uploaded, Display an error message.
3	Approve A tender for Bidding	Click Approve button	Tender Approved and further actions become visible.
4	Upload Quotation	Select the file click upload quotation.	Uploaded quotation is visible with up with the person name.
6	Validate Tender Meetings	Fill Meeting title and Meeting Date and click ‘add’	Meeting added and displayed in a list.
7	Award Tender	Click on the award tender button.	Display a mesaage indicating that tender is awarded.

Table 5.1: Test Cases for Tender Management

5.5.2 Test Cases for Project Management Module

Test cases for the production management module are shown in Table 5.2.

Test Number	Test Case Description	Steps Carried Out	Expected Result
1	Validate Project	Fill all required project	Project Added and displayed on the project

	Details.	fields and click submit	list.
2	Validate Project Details.	Leave required fields empty and click submit.	Displays an error message, project not entered.
3	Validate Task Details.	Fill Required task Details click add task.	Task added and displayed on the list.
4	Validate Task Details.	Select an earlier start date than finish date.	Displays error message.
5	Upload Coordinator Report Through Android App.	Fill Report Details, Select Image to Upload and click send.	Displays uploaded report on coordinator reports.

Table 5.2: Test Cases for Production Management

5.5.3 Test Cases for Purchasing and Supplier Management Module

Test cases for purchasing management module are shown in Table 5.3.

Test Number	**Test Case Description**	**Steps Carried Out**	**Expected Result**
1	Validate Supplier Details.	Fill the required fields of supplier.	Supplier Details successfully added and supplier displayed.
2	Validate Supplier Details.	Fill invalid data for supplier contact information, click submit	Display an error message, supplier details not added.
3	Material Requisition Note Task validation.	Select a job Number.	Displays the task s of that job in a dropdown list.
4	Material Requisition Note Validation.	Add job Number, task, required date and click	Navigated to add Note items form.

		‘proceed’.	
5	Material Requisition Note validation.	Add required item details, click add.	Displays added items on left side.
6	Material Requisition Note validation.	Add textual value for requested quantity.	Displays error message, item not added.
7	Supplier Invoice validation.	Fill all fields appropriately click send for payment.	Supplier Invoice Added and displayed on invoice list.
8	Suppler Selection	Select Item Category and Sub Category.	A list of suppliers providing the sub category is listed based on performance.

Table 5.3: Test Cases for Purchasing and Supplier Management

5.5.4 Test Cases for Stock Management Module

Test cases for stock management module are shown in Table 5.4.

Test Number	**Test Case Description**	**Steps Carried Out**	**Expected Result**
1	Checking Stock Availability.	Select ‘Item Category’ and ‘Sub Category’, click ‘check availability’	Displays a list of available item types from inventory corresponding to the selected sub category
2	Inventory validation	Enter textual values to quantity	Items not added to inventory, Display an error message
3	Inspect Receive Goods validation	Mark a quality unmarked invoice	Quality value assigned for invoice.

Table 5.4: Test Cases for Stock Management Module

5.5.5 Test Cases for Finance Management Module

Test cases for purchasing management module are shown in Table 5.5.

Test Number	Test Case Description	Steps Carried Out	Expected Result
1	Customer Payment Scheme.	Select job number, enter valid future due date and job number.	Payment scheme added and displayed, with status as pending.
2.	Customer Payment Scheme.	Add a before due date to the system.	Payment scheme added with status as 'overdue' and a link to notify clients.
3	Supplier Payment validation.	Select Supplier, Select the payable invoices from the list, click evaluate.	Display the total amount, a form to enter payment details.
4	Payment confirmation validation.	Select check as payment type and leave check number empty or enter invalid number.	Display an error message indicating to enter correct cheque number. Payment not added.
5	Payment confirmation validation.	Enter correct data and click confirm button.	Payment Added can pending invoice count reduced.

Table 5.5: Test Cases for Finance Management Module

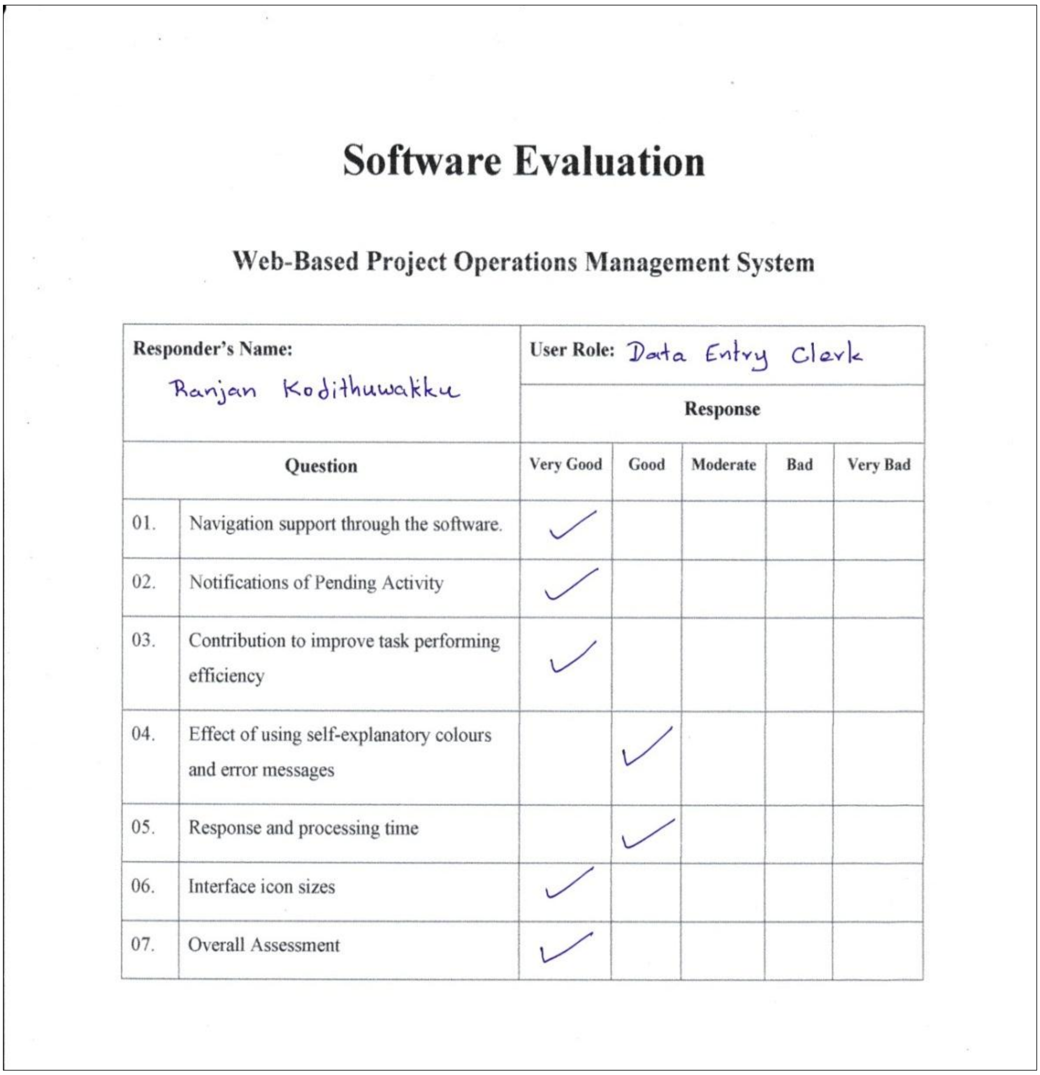
Please Refer APPENDIX E for the test cases of other modules and test results.

5.6 User Evaluation

A critical role has been played by user evaluation in determining the success of the web- based project operations management system. The developed and deployed system was tested in the client organizations operational environment for user acceptance. The user acceptance testing was carried out by employees of the organization belonging to different user levels. The android app component complementing the transport management module and the client user management and coordinator reports functions was also tested after installing the '.apk' file on potential user's mobiles.

Once the user acceptance testing was completed, user feedback of the system from operational levels users was collected using questionnaires. An interview was held with the directors of the organization to get their feedback of the system.

An example of a questionnaire responded by a data entry clerk is given in Figure 5.2.



Software Evaluation

Web-Based Project Operations Management System

Responder's Name: Ranjan Kodithuwakku		**User Role:** Data Entry Clerk				
		Response				
Question		**Very Good**	**Good**	**Moderate**	**Bad**	**Very Bad**
01.	Navigation support through the software.	✓				
02.	Notifications of Pending Activity	✓				
03.	Contribution to improve task performing efficiency	✓				
04.	Effect of using self-explanatory colours and error messages		✓			
05.	Response and processing time		✓			
06.	Interface icon sizes	✓				
07.	Overall Assessment	✓				

Figure 5.2: Format of the Questionnaire provided for Operational Level Employees

The number of users participated for evaluation from each user role is as described in Table 5.6.

User Role	Number of Users Participated
Director	3
Workshop Manager	2
Purchasing Manager	1
Human Resource Manager	1
Transport Manager	1
Supervisor	4
Data Entry Clerk	4
Accountant	1
Stock Keeper	1
Client Coordinator	2

Table 5.6: User Participation on Acceptance Testing By Category

The result of the user evaluation is presented in Figure 5.3.

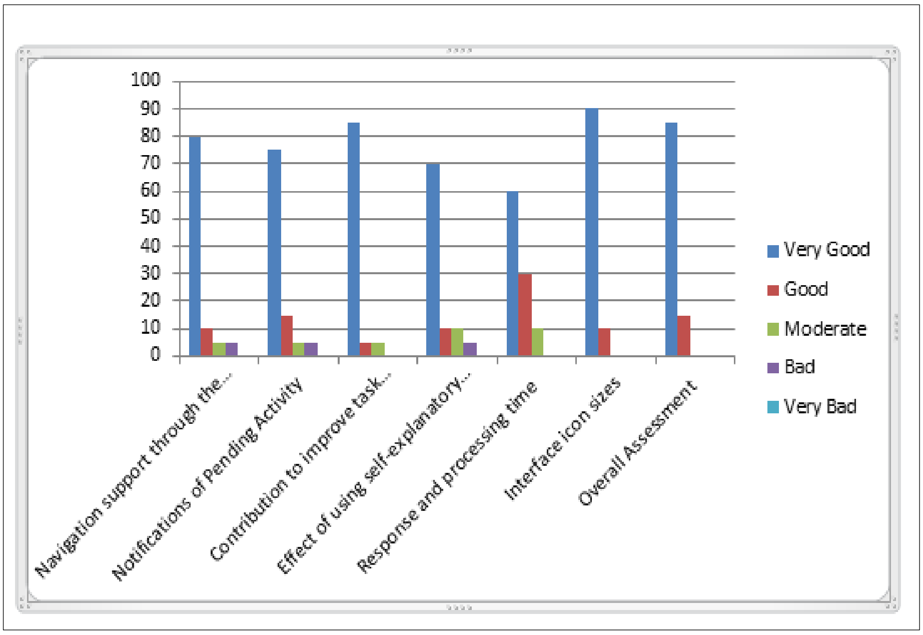


Figure 5.3: Results of User Evaluation Questionnaire as a Percentage

CHAPTER 6 - CONCLUSION

6.1 Introduction

Construction industry in Sri Lanka can be considered as one of the most competitive and challenging endeavors to undertake. SHAUPUB TECHNIK Private Limited has been in the industry for the past decade used the manual file oriented approach in managing their project operations which resulted in bottlenecks and loss of business opportunity. By using their new system described in this dissertation, SHAUPUB TECHNIK has been able to do away with the drawbacks and improve their business processes in such a way that the company is well on its way to be recognized as the most effective and efficient steel construction and Fabrication Company in the nation.

6.2 Assessment of Success Factors

Requirements analysis for the system played a critical role in the success of the system. The formats of the critical business documents were provided by the client upon requests together with their quality management plan prepared based on ISO 9001:2015 standards which in turn helped to give a very good understanding of the business domain and the requirements expected from the system.

As in the case of any software development project, the web based project operations management system too had to cater to the later change requests by the client. The use of the iterative process model; ‘Rational Unified Process’ as the development methodology was effective in responding to such late change requests.

All of the stated and agreed requirements of the client were accomplished by the software system and the test cases were executed successfully.

The developed software was tested by the client and was satisfied with the software’s overall performance and its potential to improve the organization as a whole.

6.3 Lessons Learnt

Being an undergraduate student who has been waiting to enter the software development industry in near future, the software project has had a tremendous impact on me. Many novel experiences and lessons were learnt during this period and some of them can be listed below:

- The software project having strict deadlines and schedules improved my time management capabilities and was certainly a good experience as the real industry scenario is reflected by strict deadlines.
- The process of gathering requirements has helped to improve my interpersonal skills.
- The process of analyzing requirements form unfamiliar domain improved my analytical skills on how to cater software to fulfill their needs.
- The need to combine different technologies such as android and PHP in catering client needs helped significantly to broaden my knowledge on different programing languages and use them effectively to achieve objectives.
- The need to respond to various changes of requirements later in the project life cycle taught me how to adapt to change and the advantage of using iterative process models over linear process models.
- The process of writing system documentation has improved my technical and general writing skills which is essential for the professional carrier success.

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Appendix A – SYSTEM DOCUMENTATION

This section has been developed to demonstrate the installation process of the web based project operations management system. (Linux hosting environment has been used for this demonstration).

A. Step -1 Installing the 'project_operations_db' on web server.

- Access your Control-Panel on Linux web server.
- Click on MySQL Databases link (Given in Figure A.1).

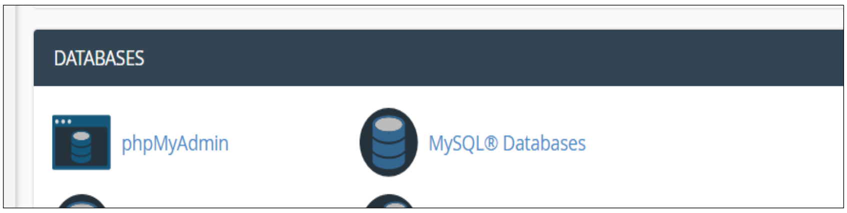
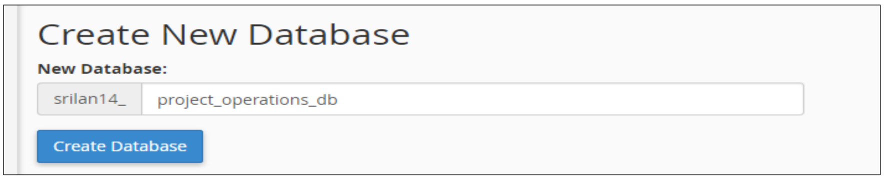


Figure A.1: Select MYSQL Databases option

- Enter Database Name and 'Click Create Database'.
  The interfaceto enter the database name is shown in Figure A.2.

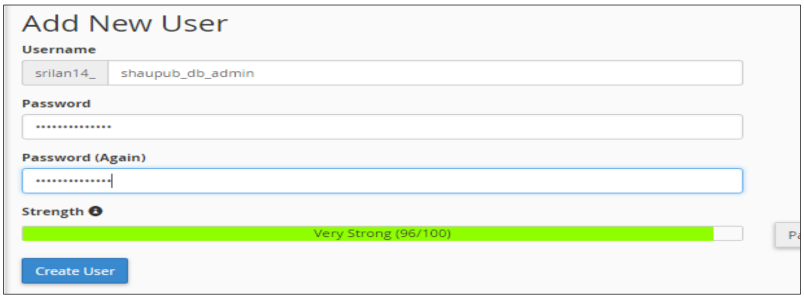


Create New Database

New Database: srilan14_ project_operations_db

Figure A.2: Create New Database

- Create New User. An example of creating a database user is given in Figure A.3



Add New User

Username: srilan14_ shaupub_db_admin

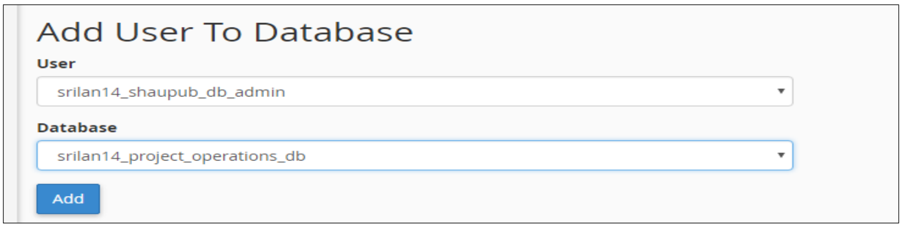
Password: ••••••••••••••

Password (Again): ••••••••••••••

Strength: Very Strong (96/100)

Figure A.3: Create New Database User

- Add the User to database. An illustration is given in figure A.4



Add User To Database

User

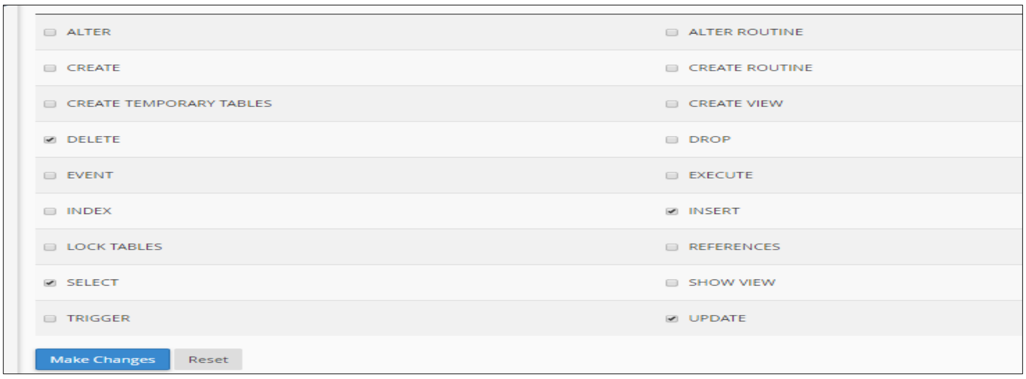
srilan14_shaupub_db_admin

Database

srilan14_project_operations_db

Figure A.4: Add User to Database

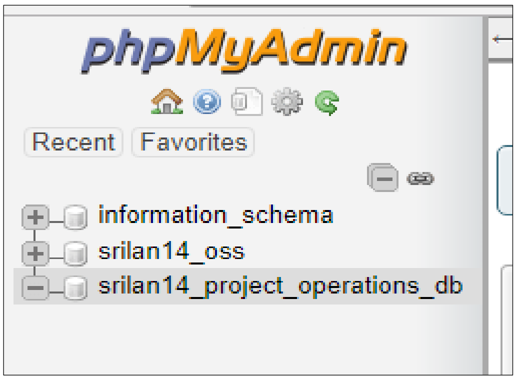
- Assign Data Manipulation Privileges from the list and click make changes. Shown in Figure A.5



□ ALTER	□ ALTER ROUTINE
□ CREATE	□ CREATE ROUTINE
□ CREATE TEMPORARY TABLES	□ CREATE VIEW
☑ DELETE	□ DROP
□ EVENT	□ EXECUTE
□ INDEX	☑ INSERT
□ LOCK TABLES	□ REFERENCES
☑ SELECT	□ SHOW VIEW
□ TRIGGER	☑ UPDATE

Figure A.5: Select Data Manipulation Privileges

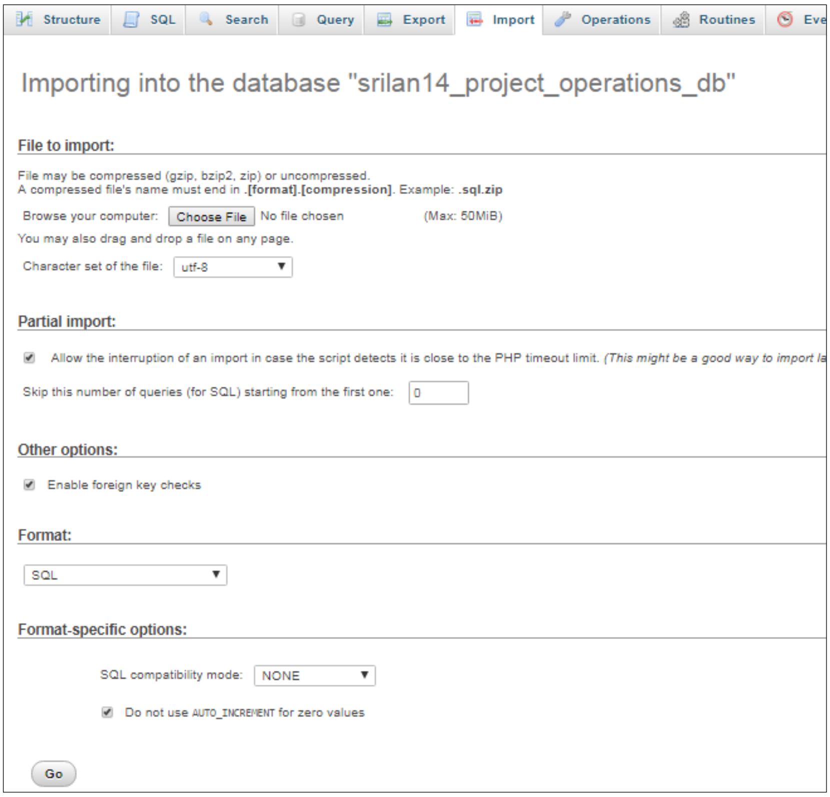
- Go back to Control panel dashboard and select ‘phpmyadmin’.
- Select the added database from the list. Selection process given in Figure A.6



information_schema
srilan14_oss
srilan14_project_operations_db

Figure A.6: Select Database from phpmyadmin

- Select ‘Import’ option and select the database SQL file to upload, then click ‘go’ the database will be uploaded. Figure A.7 shows the interface to import the database.



Importing into the database "srilan14_project_operations_db"

File to import:

File may be compressed (gzip, bzip2, zip) or uncompressed.
A compressed file's name must end in **.[format].[compression]**. Example: **.sql.zip**

Browse your computer: Choose File No file chosen (Max: 50MiB)

You may also drag and drop a file on any page.

Character set of the file: utf-8 ▼

Partial import:

☑ Allow the interruption of an import in case the script detects it is close to the PHP timeout limit. *(This might be a good way to import la*

Skip this number of queries (for SQL) starting from the first one: 0

Other options:

☑ Enable foreign key checks

Format:

SQL ▼

Format-specific options:

SQL compatibility mode: NONE ▼

☑ Do not use AUTO_INCREMENT for zero values

Go

Figure A.7: Importing the Database File

Step 2 – Upload the software folder to the web server.

- Change the database connection details such as username and database name to correspond with the created database name and database user. the file is located in the commons folder in the 'dbconnection.php' file.
- Select File Manager Folder from the cPanel dashboard. A portion of the C-Panel dashboard is shown in Figure A.8

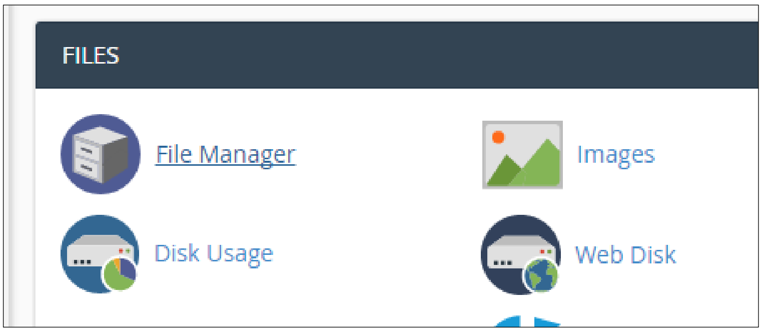
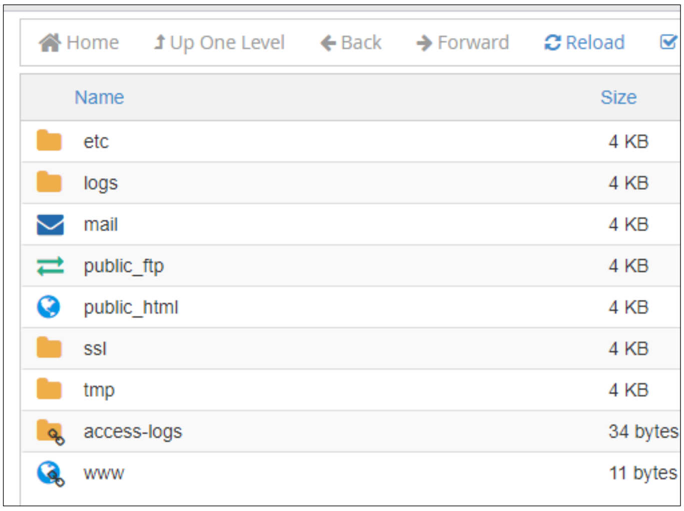


Figure A.8: Select File Manager Option

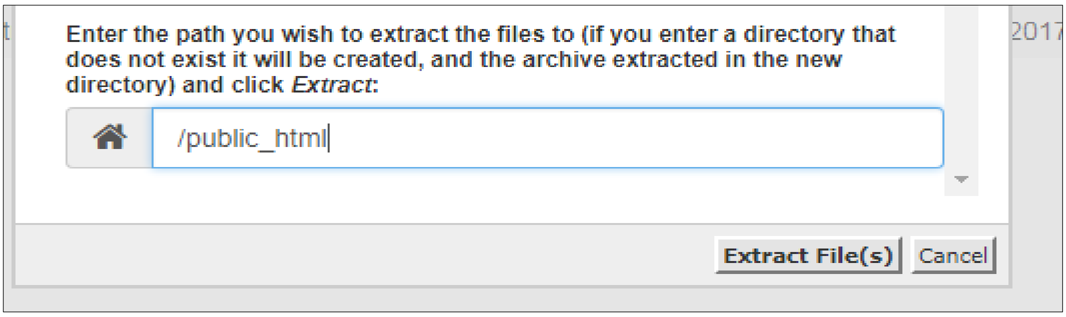
- Access 'public_html' folder. The list of directories is shown in Figure A.9.



Name	Size
etc	4 KB
logs	4 KB
mail	4 KB
public_ftp	4 KB
public_html	4 KB
ssl	4 KB
tmp	4 KB
access-logs	34 bytes
www	11 bytes

Figure A.9: Access ‘public_html’ Folder

- Upload the zipped software folder to the public_html folder.
- Right Click->Extract folder. The dialog box to extract the folder is shown in Figure A.10.


Enter the path you wish to extract the files to (if you enter a directory that does not exist it will be created, and the archive extracted in the new directory) and click *Extract*:

/public_html

Figure A.10: Extract the uploaded folder

Appendix B - DESIGN DOCUMENTATION

Use Case Diagram for Material Requisition Note Processing

The use case diagram for the material requisition note processing is shown in Figure B.1 and the use-case narrative for the mentioned process is shown in Table B.1.

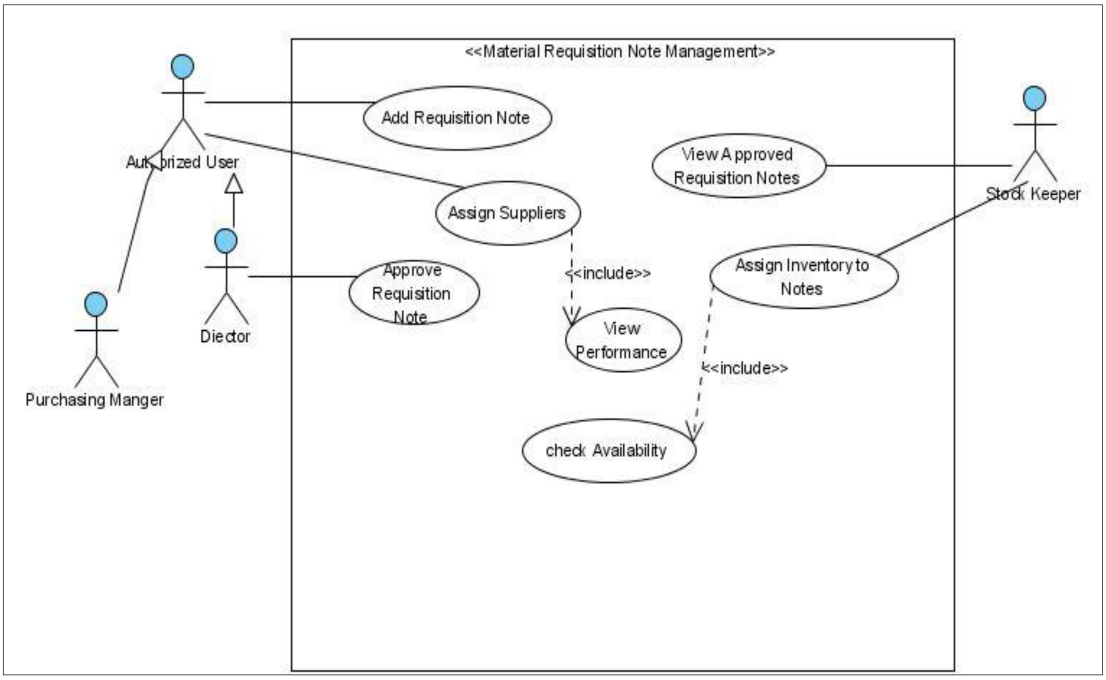


Figure B.1: Use case Diagram for Material Requisition Note Processing

Use Case Name	Material Requisition Note Processing.
Actors	Purchasing Manager, Director, Stock Keeper.
Description	A new material requisition note is added, assigned inventory and suppliers.
Pre-conditions	A project (job) should be in the active state.
Main Flow: 1. The purchasing manager or higher authority adds a new material requisition note. 2. A director approves the requisition note.	

3.If note is approved.

3.1 The stock keeper selects the approved requisition note from the list and checks availability of inventory.

3.2. If matching items are found.

3.2.1 Stock Keeper Assign the items to the note items.

3.3 Purchasing Manager Evaluates the previous performance of suppliers providing the required category.

4. Purchasing manager selects suppliers for purchasing items.

Table B.1: Use Case Narrative for Processing Requisition Note

Activity Diagram for Material Requisition Note Processing

The activity diagram for the material requisition note processing is shown in Figure B.2.

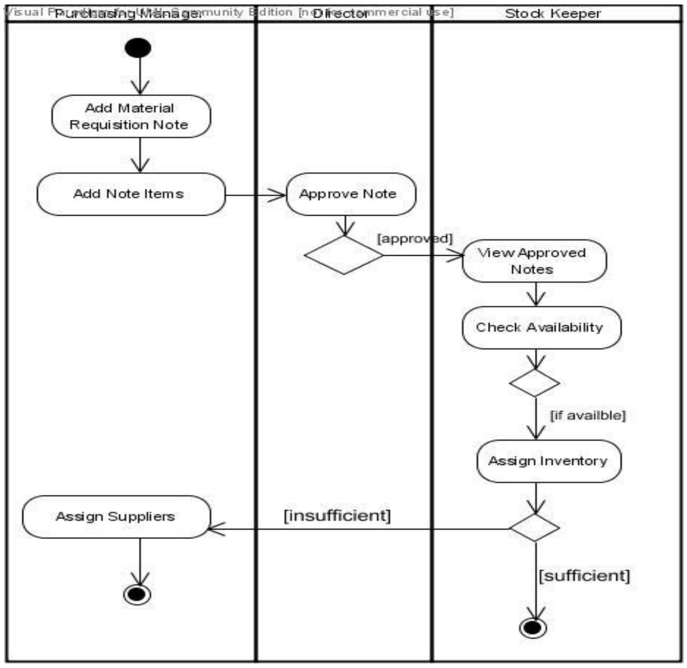


Figure B.2: Activity Diagram for Material Requisition Note Processing

Use Case Diagram for Expense Management

The use-case diagram and the use-case narrative for the expense management module is shown in Figure B.3 and Table B.2 respectively.

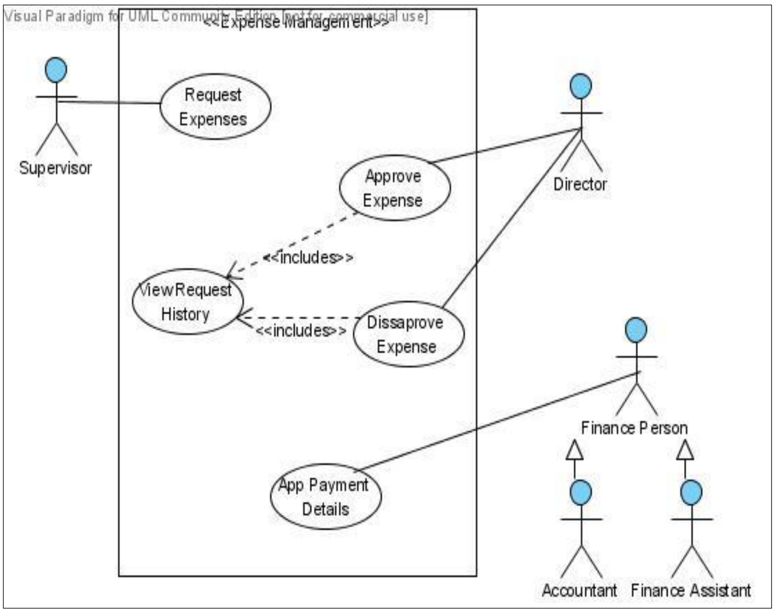


Figure B.3: Use Case Diagram for Expense Management

Use Case Name	Project General Expense Processing
Actors	Supervisor, Director, Finance Staff
Description	An expense request is made, approved and made payment
Pre- Condition	Job should be in the active state
Main Flow: 1. Project supervisor adds an expense request. 2 The director views the expense the expense request history and approves/ disapproves the request. 2.1 If approved 2.2.2 Finance staff adds payment information relevant to the request.	

Table B.2: Use Case Narrative for Expense Request Processing

Activity Diagram for Expense Management

The activity diagram for the expense management process is given in Figure B.4.

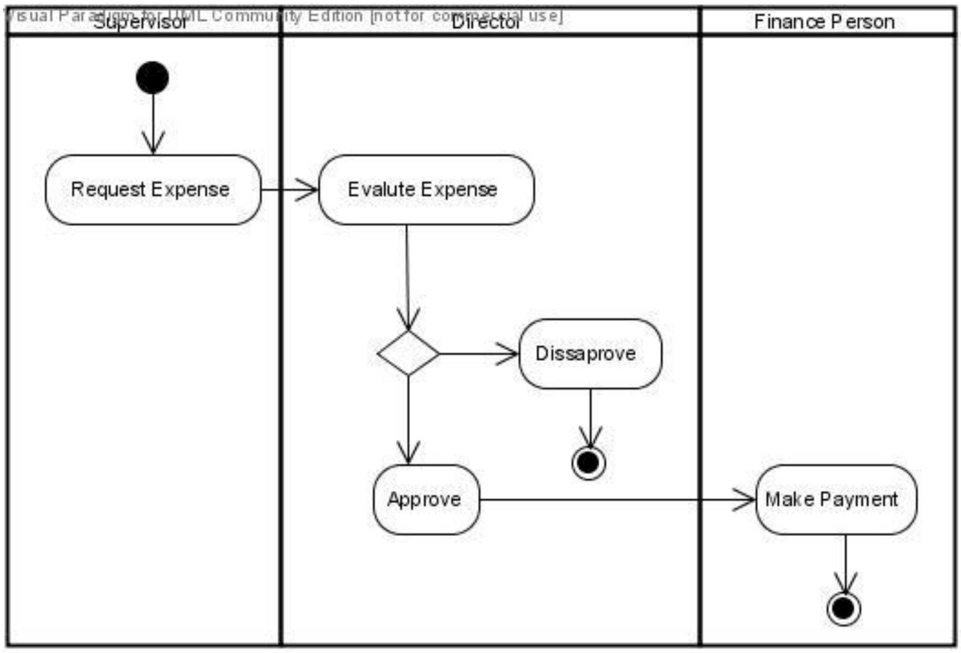
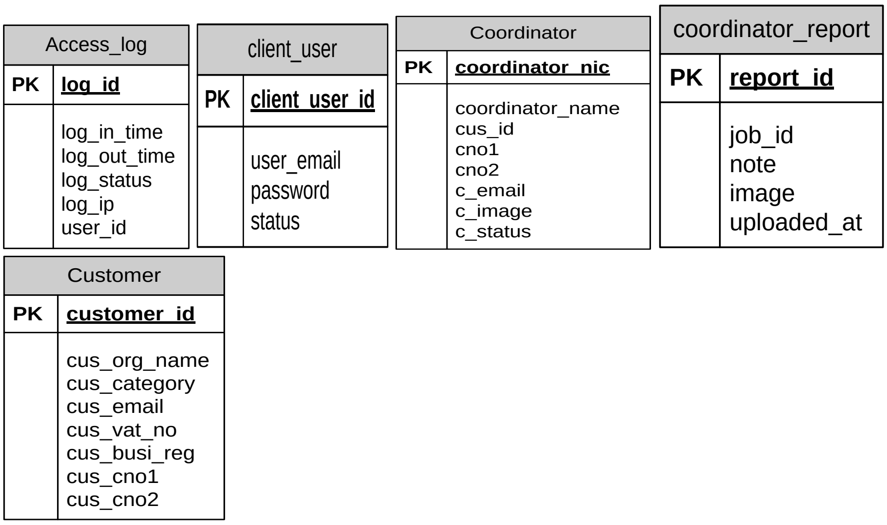


Figure B.4: Activity Diagram for Expense Management

Internal Structure of System Tables

The internal structures of the tables are given in Figure B.5 displayed on pages 68 to 71.



Access_log	
PK	log_id
	log_in_time log_out_time log_status log_ip user_id

client_user	
PK	client_user_id
	user_email password status

Coordinator	
PK	coordinator_nic
	coordinator_name cus_id cno1 cno2 c_email c_image c_status

coordinator_report	
PK	report_id
	job_id note image uploaded_at

Customer	
PK	customer_id
	cus_org_name cus_category cus_email cus_vat_no cus_busi_reg cus_cno1 cus_cno2

customer_address	
PK	cus_address_id
	no street city zip c_id

customer_payment	
PK	payment_id
	amount payment_date payment_type cheque_no bank deposited_by job_id

employee	
PK	emp_id
	emp_fname emp_lname emp_nic emp_dob epf_no etf_no bank_account_no bank category license_no license_class blood_group contact_no email e_contact emp_image emp_status

employee_category	
PK	**category_id**
	category_name hourly_rate

employee_performance	
PK **PK**	**task_id** **rate**
	emp_id hours

expense	
PK	**expense_id**
	job_id task_id expense_category description amount required_by status payment_id

expense_category	
PK	**ex_cat_id**
	ex_cat_name

fuel	
PK	**fuel_id**
	reg_no date fuel_in_ltr amount payment_id

fuel_prices	
PK	**fuel_id**
	fuel_name price

function	
PK	**function_id**
	function_name module_id

function_user	
PK **PK**	**user_id** **function_id**

inventory	
PK	**item_id**
	item_name cat_id sub_id qty market_up_price measured_unit item_status

item_category	
PK	**cat_id**
	cat_name

module	
PK	**module_id**
	module_name module_image

module_role	
PK **PK**	**module_id** **role_id**

note_item	
PK	**note_item_id**
	description req_quantity issued_quantity allocated_item issued_item_cost additional_cost is_assigned_supplier note_id

notification	
PK	notification_id
	noti_title noti_url noti_date

notification_user	
PK PK	notification_id user_id
	status

payment	
PK	payment_id
	payment_date amount type cheque_no user_id

project	
PK	job_id
	project_title ex_start_date com_date budget cost_margin profit_margin tender_no cus_id sup_id type coordinator_nic coordinator_evaluation suppervisor_evaluation status

project_location	
PK	location_id
	latitude longitude project_id

project_payment_scheme	
PK	sch_id
	project_id amount due_date due_amount status

project_task	
PK	task_id
	task_name project_id schedule_id start_date end_date description ins_status_sup

purchase_order	
PK	purchase_order_id
	supplier_id first_issued_date required_date

requisition_note	
PK	note_id
	requested_date required_date job_id task_id status added_by approved_by

role	
PK	role_id
	role_name

sub_item_category	
PK	sub_id
	name cat_id

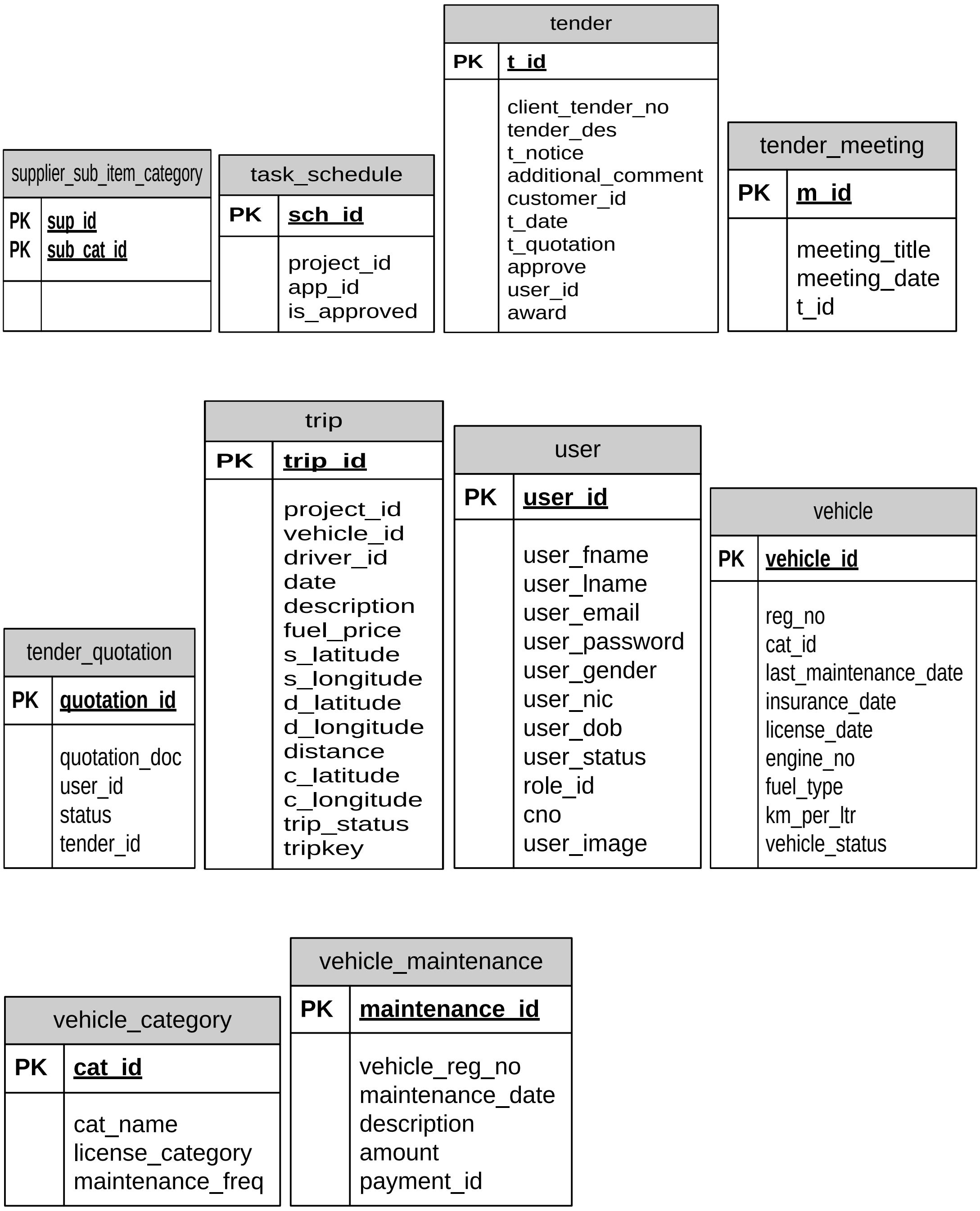
supplier	
PK	supplier_id
	sup_org_name sup_email sup_cno sup_category

supplier_address	
PK	add_id
	no street city sup_id

supplier_assigned	
PK	assigned_id
	note_item sup_id required_quantity unit_price purchase_order

supplier_invoice	
PK	sup_invoice_id
	sup_org_invoice_no due_date total_due purchase_order_id invoice_file additional_note payment_id

supplier_performance	
PK	p_id
	invoice_id sup_id quality price credit warranty



supplier_sub_item_category	
PK PK	sup_id sub_cat_id

task_schedule	
PK	sch_id
	project_id app_id is_approved

tender	
PK	t_id
	client_tender_no tender_des t_notice additional_comment customer_id t_date t_quotation approve user_id award

tender_meeting	
PK	m_id
	meeting_title meeting_date t_id

tender_quotation	
PK	quotation_id
	quotation_doc user_id status tender_id

trip	
PK	trip_id
	project_id vehicle_id driver_id date description fuel_price s_latitude s_longitude d_latitude d_longitude distance c_latitude c_longitude trip_status tripkey

user	
PK	user_id
	user_fname user_lname user_email user_password user_gender user_nic user_dob user_status role_id cno user_image

vehicle	
PK	vehicle_id
	reg_no cat_id last_maintenance_date insurance_date license_date engine_no fuel_type km_per_ltr vehicle_status

vehicle_category	
PK	cat_id
	cat_name license_category maintenance_freq

vehicle_maintenance	
PK	maintenance_id
	vehicle_reg_no maintenance_date description amount payment_id

Figure B.5: Internal Structure of the Tables

Appendix C - USER DOCUMENTATION

Internal User Login

The software system has provided a single login interface for all levels of internal system users. The user is expected to enter their usernames and passwords in the provided interface to login to the system. The login interface is shown in Figure C.1.

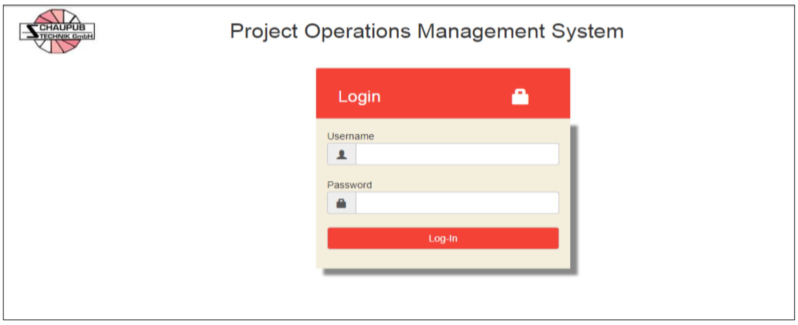


Figure C.1: Internal User Login Interface

Dashboard

The logged in user will be redirected to the dashboard, here the user will be provided with a set of icons indicating the accessible modules for the user such as tender management, production management etc. The user dashboard is given in Figure C.2.

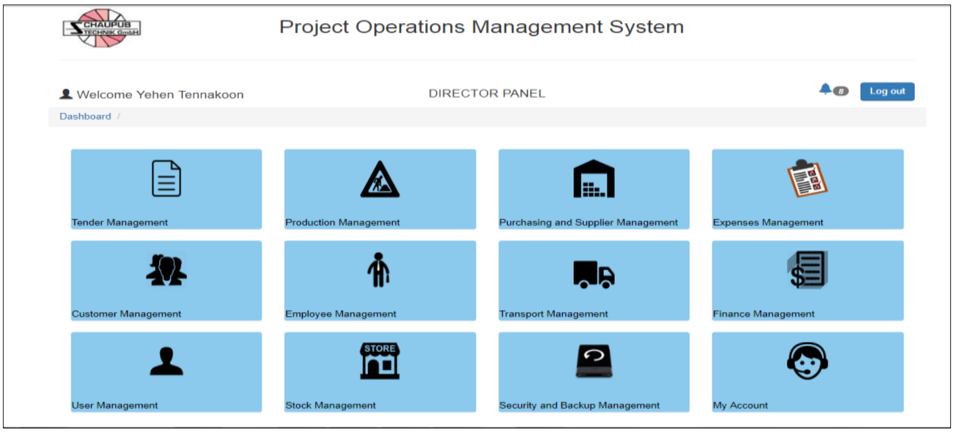
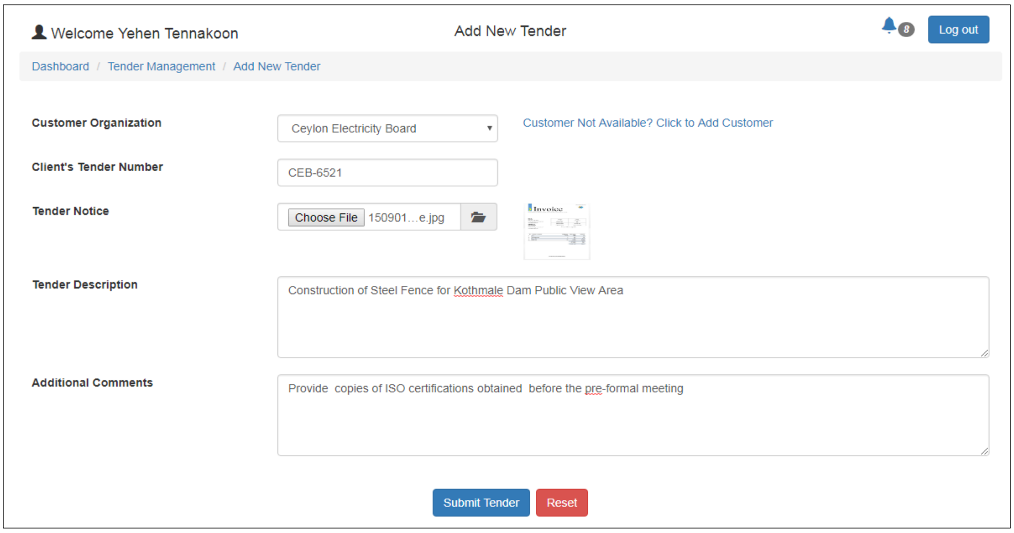


Figure C.2: System Dashboard for the User Role Director

Upload new Tenders

All tender related operations are handled in the tender management module. An identified potential tender can be added using the interface, the selected tender should be uploaded for reference. The interface for uploading tenders is given in Figure C.3.



Welcome Yehen Tennakoon

Add New Tender

Dashboard / Tender Management / Add New Tender

Customer Organization: Ceylon Electricity Board

Customer Not Available? Click to Add Customer

Client's Tender Number: CEB-6521

Tender Notice: Choose File 150901...e.jpg

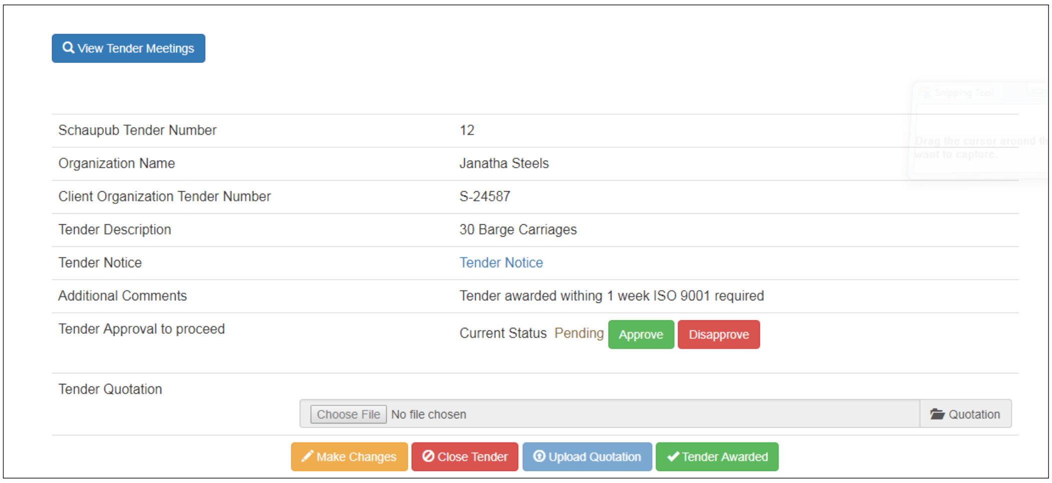
Tender Description: Construction of Steel Fence for Kothmale Dam Public View Area

Additional Comments: Provide copies of ISO certifications obtained before the pre-formal meeting

Figure C.3: Interface for New Tender Uploading

View Tender Status, Manage Approvals and Quotations

The users can select a desires tender from the uploaded tender list and perform their operations such as providing approval, uploading quotations making changes and marking tender status based on assigned privileges. The interface to manage uploaded tenders is given in Figure C.4.

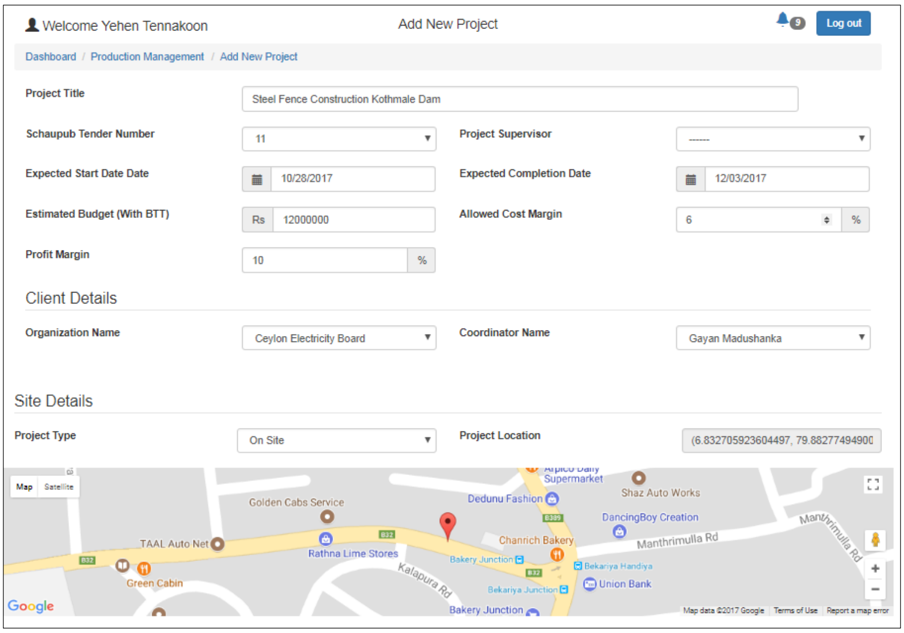


Schaupub Tender Number	12
Organization Name	Janatha Steels
Client Organization Tender Number	S-24587
Tender Description	30 Barge Carriages
Tender Notice	Tender Notice
Additional Comments	Tender awarded withing 1 week ISO 9001 required
Tender Approval to proceed	Current Status Pending
Tender Quotation	Choose File No file chosen

Figure C.4: Interface to Manage a Specific Tender

Add New Project

Adding a new project can be done using the production management module. Director can select from awarded tenders which would auto fill customer details or can add a direct project. All fields of the interface must be filled and the project site location must be selected using the Google map provided. An example is given in Figure C.5.



Welcome Yehen Tennakoon

Add New Project

Log out

Dashboard / Production Management / Add New Project

Project Title	Steel Fence Construction Kothmale Dam		
Schaupub Tender Number	11	Project Supervisor	------
Expected Start Date Date	10/28/2017	Expected Completion Date	12/03/2017
Estimated Budget (With BTT)	Rs 12000000	Allowed Cost Margin	6 %
Profit Margin	10 %		

Client Details

Organization Name	Ceylon Electricity Board	Coordinator Name	Gayan Madushanka

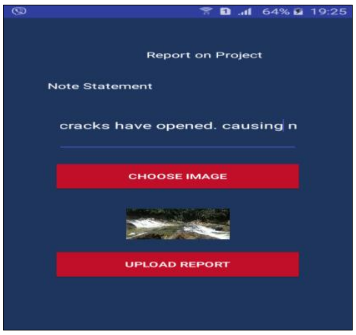
Site Details

Project Type	On Site	Project Location	(6.832705923604497, 79.88277494900

Figure C.5: The interface to Add a ProjectThe interface to Add a Project

Upload Coordinator Notes

Urgent Notes on a project can be uploaded by the client-coordinator using the android app. The android app interface used to upload a report is given in Figure C.6.



Report on Project

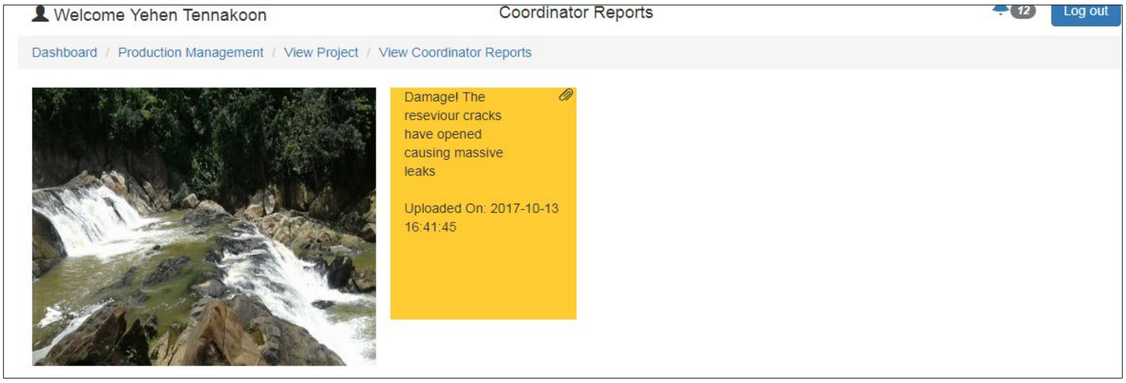
Note Statement

cracks have opened. causing n

Figure C.6: Uploaded coordinator notes using the android app

The uploaded note can be viewed using the web application by a director.

The interface used to view coordinator reports is given in Figure C.7.



Welcome Yehen Tennakoon

Coordinator Reports

Dashboard / Production Management / View Project / View Coordinator Reports

Damage! The reseviour cracks have opened causing massive leaks

Uploaded On: 2017-10-13 16:41:45

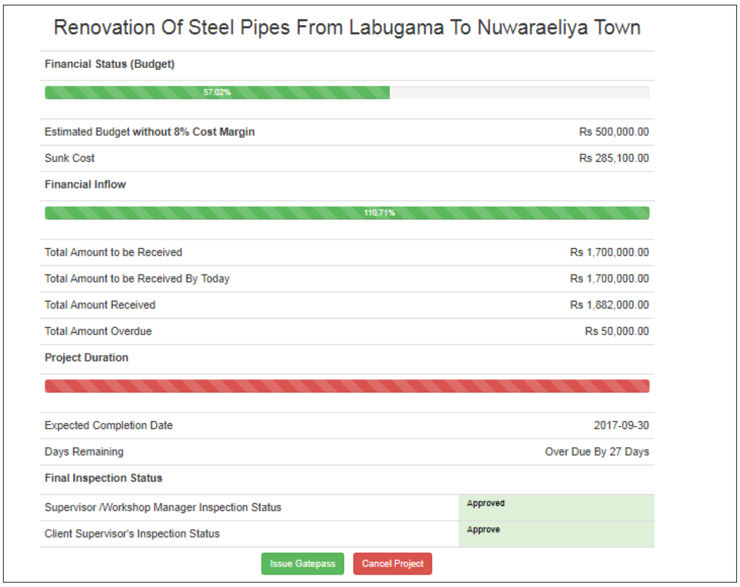
Figure C.7: View Coordinator Reports

View Project Status and Gate Pass

The logged in user can view project details by selecting the desired project and then select status and gate pass (Generally desired for director role users).

The project’s current status is evaluated using the scope, time and budget constraints.

The interface indicating the project status is shown in Figure C.8.



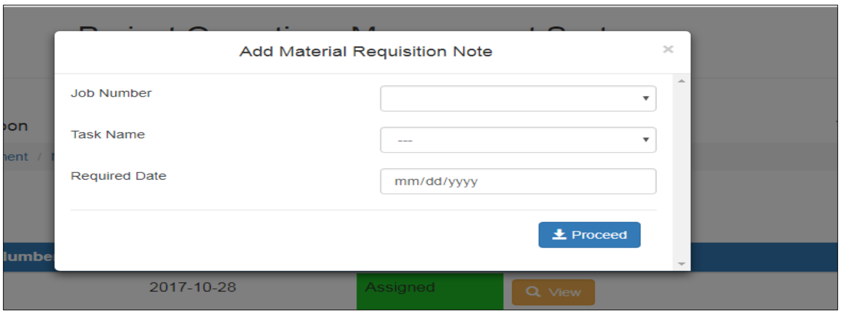
Renovation Of Steel Pipes From Labugama To Nuwaraeliya Town

Financial Status (Budget)	
57.02%	
Estimated Budget without 8% Cost Margin	Rs 500,000.00
Sunk Cost	Rs 285,100.00
Financial Inflow	
110.71%	
Total Amount to be Received	Rs 1,700,000.00
Total Amount to be Received By Today	Rs 1,700,000.00
Total Amount Received	Rs 1,882,000.00
Total Amount Overdue	Rs 50,000.00
Project Duration	
Expected Completion Date	2017-09-30
Days Remaining	Over Due By 27 Days
Final Inspection Status	
Supervisor /Workshop Manager Inspection Status	Approved
Client Supervisor's Inspection Status	Approve

Figure C.8: Project Status and Gate pass Interface

Add Material Requisition Notes

Material requisition notes can be added using the purchasing management module’s ‘Material Requisition Notes section. User has to Specify the job number, the task name to which the note belong and the required date. A requisition note modal is shown in Figure C.9.



Add Material Requisition Note

Job Number:

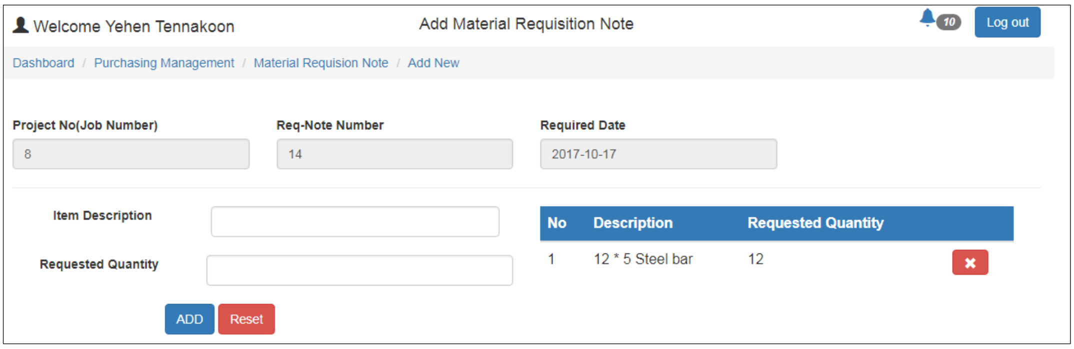
Task Name: ---

Required Date: mm/dd/yyyy

Figure C.9: Add A Material Requisition Note

Adding Items to Material Requisition Note

Once the requisition note is added the required items can be added to the note using the interface shown in Figure C.10.



Welcome Yehen Tennakoon

Add Material Requisition Note

Dashboard / Purchasing Management / Material Requision Note / Add New

Project No(Job Number): 8

Req-Note Number: 14

Required Date: 2017-10-17

Item Description:

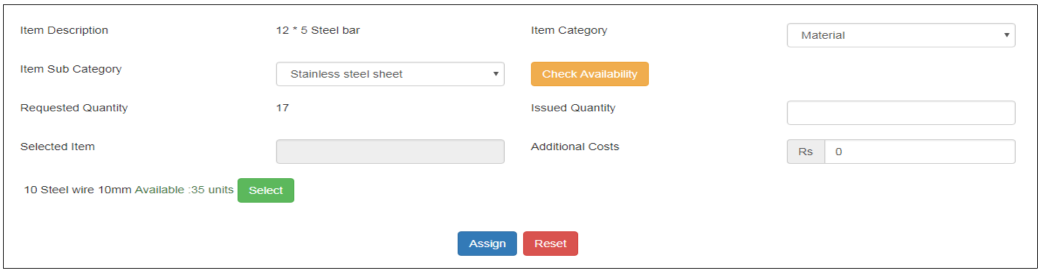
Requested Quantity:

No	Description	Requested Quantity
1	12 * 5 Steel bar	12

Figure C.10: Add Items to Requisition Note

Assigning Inventory to Note Items

Once a note is approved, the stock keeper or authorized uses can assign inventory to note items. User has to select on the note item, this will provide a description of a required item and the required quantity, the stock keeper will then have to select the category and the sub category that the item belongs and click on check availability. If available the user can select the inventory item and then specify the issued quantity. The interface used to check stock availability is shown in Figure C.11.



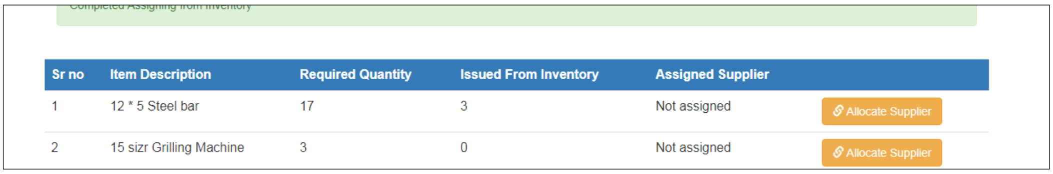
Item Description	12 * 5 Steel bar	Item Category	Material ▾
Item Sub Category	Stainless steel sheet ▾	Check Availability	
Requested Quantity	17	Issued Quantity	
Selected Item		Additional Costs	Rs 0

10 Steel wire 10mm Available :35 units Select

Figure C.11: Assign inventory to Note Items

Assigning Supplier

Once the items have been assigned and completed, the assigning of suppliers to obtain the remaining items can be done by the authorized user by clicking on allocate supplier. The interface showing the items and their assignment is given in Figure C.12.

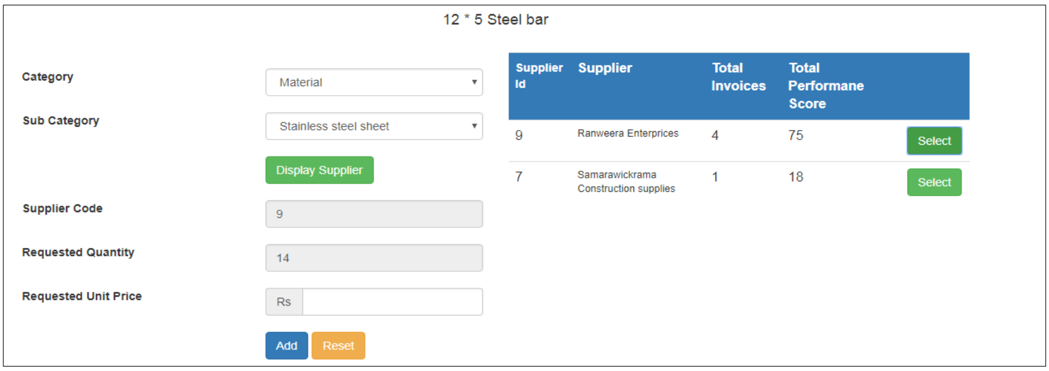


Completed Assigning from inventory

Sr no	Item Description	Required Quantity	Issued From Inventory	Assigned Supplier	
1	12 * 5 Steel bar	17	3	Not assigned	Allocate Supplier
2	15 sizr Grilling Machine	3	0	Not assigned	Allocate Supplier

Figure C.12: Button to Allocate Suppliers

The user will be displayed an interface specifying item details and the remaining amount to purchase. The user will have to select the category and the sub category that the item belongs and click on ‘display supplier’ button, this would display a list of suppliers providing that particular item sub category ordered based on the points obtained from previous invoices. The interface to assign suppliers is shown in Figure C.13.



12 * 5 Steel bar

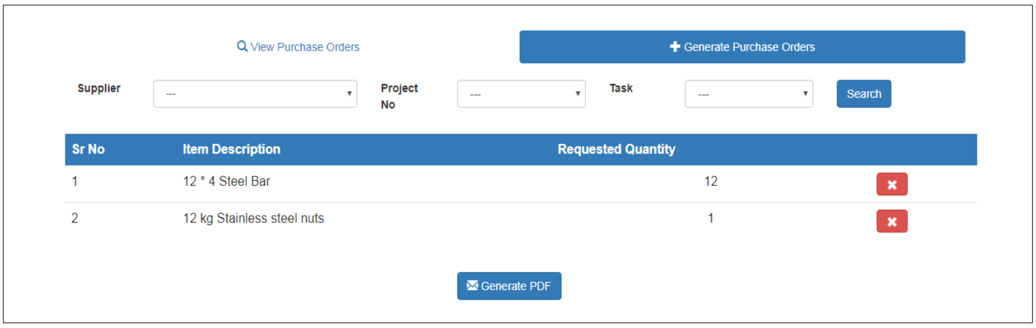
Category	Material ▾
Sub Category	Stainless steel sheet ▾
	Display Supplier
Supplier Code	9
Requested Quantity	14
Requested Unit Price	Rs

Supplier Id	Supplier	Total Invoices	Total Performane Score	
9	Ranweera Enterprices	4	75	Select
7	Samarawickrama Construction supplies	1	18	Select

Figure C.13: Interface for selecting suppliers

Generating and Sending Purchase Orders

Through the generate purchase order interface the user can combine all purchasing requests to one supplier belonging to a task into a single purchase order by selecting the supplier form the allocated list, project no and task and click search. Generation of purchase orders is shown in Figure C.14.



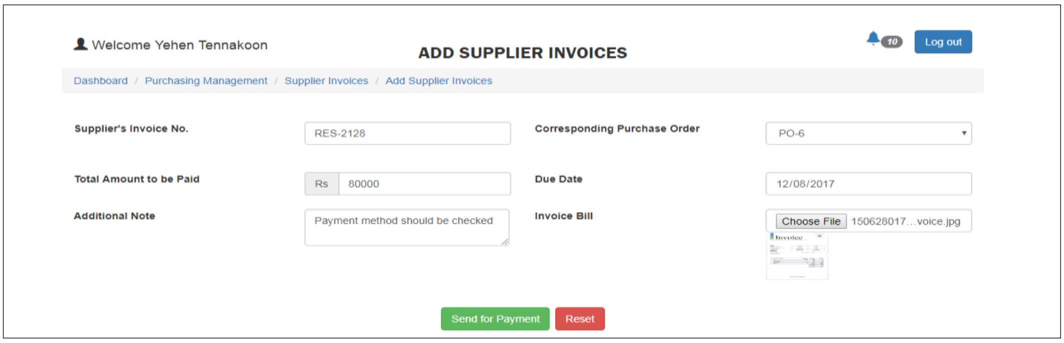
Supplier: --- Project No: --- Task: ---

Sr No	Item Description	Requested Quantity	
1	12 * 4 Steel Bar	12	✖
2	12 kg Stainless steel nuts	1	✖

Figure C.14: Generation of Purchase Orders

Adding and Evaluating Supplier Invoices

A supplier invoice received, corresponding to a sent purchase order can be added using the interface furnished below. The Interface to add supplier invoices is shown in Figure C.15.


Welcome Yehen Tennakoon
10
Log out
Dashboard / Purchasing Management / Supplier Invoices / Add Supplier Invoices
Choose File
Send for Payment
Reset

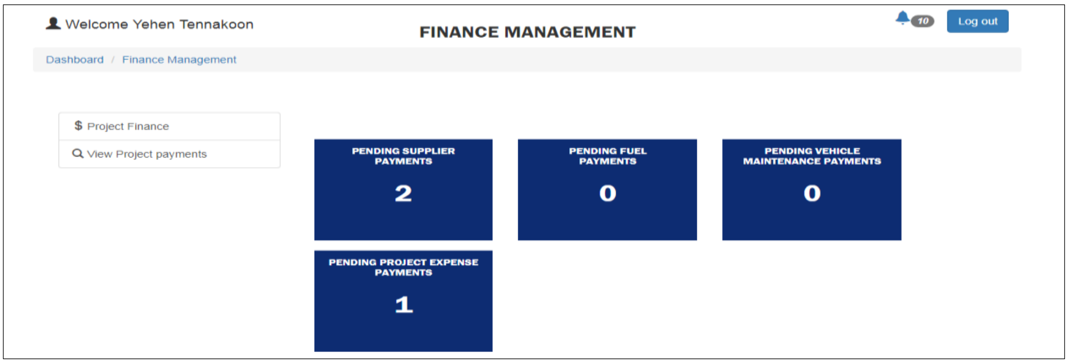
ADD SUPPLIER INVOICES

Supplier's Invoice No.	RES-2128	Corresponding Purchase Order	PO-6
Total Amount to be Paid	Rs 80000	Due Date	12/08/2017
Additional Note	Payment method should be checked	Invoice Bill	150628017…voice.jpg

Figure C.15: Interface to Add Supplier Invoices

Managing and Entering Project Payment Details

Project supplier invoice payments and other payments can be managed using the finance management module. The pending payments are notified in the finance management dashboard. By Clicking on the respective icon payment details are presented. An example is given in Figure C.16.



Welcome Yehen Tennakoon

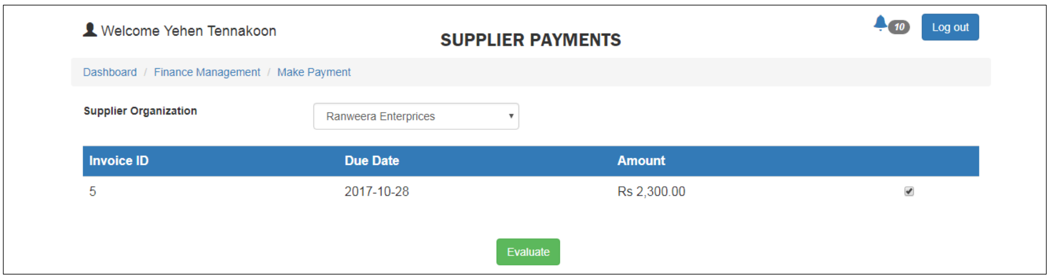
FINANCE MANAGEMENT

Dashboard / Finance Management

PENDING SUPPLIER PAYMENTS	2
PENDING FUEL PAYMENTS	0
PENDING VEHICLE MAINTENANCE PAYMENTS	0
PENDING PROJECT EXPENSE PAYMENTS	1

Figure C.16: Finance Management Notifying Pending Payments

The user has to select the payments made and click 'Evaluate' button shown in Figure C.17.



Welcome Yehen Tennakoon

SUPPLIER PAYMENTS

Dashboard / Finance Management / Make Payment

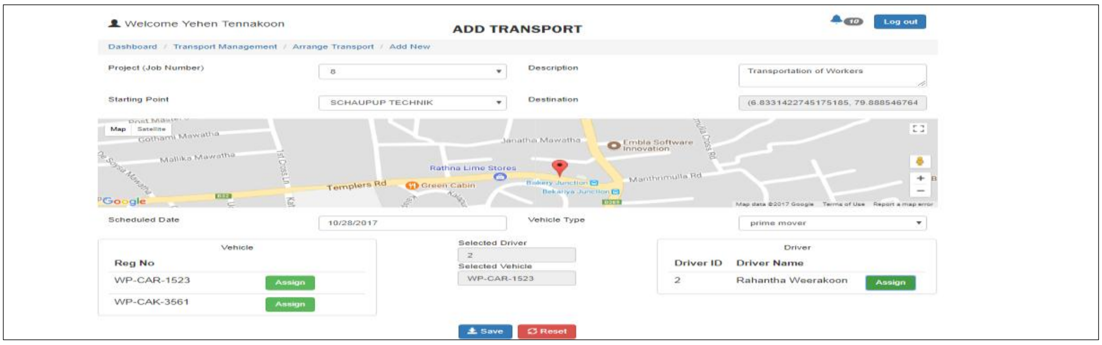
Supplier Organization: Ranweera Enterprices

Invoice ID	Due Date	Amount	
5	2017-10-28	Rs 2,300.00	☑

Figure C.17: Selecting Payments

Transport Arrangement (Trip Arrangement)

The authorized user can schedule a new trip by using the following interface available in the transport management module. The job id should be selected and the destination location should be selected by clicking on the map provided. Based on the vehicle category selected the drivers available and the list of available vehicles will be displayed. After selecting the driver and the vehicle click save. The interface to add a trip is shown in Figure C.18.



Welcome Yehen Tennakoon

ADD TRANSPORT

Dashboard / Transport Management / Arrange Transport / Add New

Project (Job Number): 8

Description: Transportation of Workers

Starting Point: SCHAUPUP TECHNIK

Destination: (6.8331422745175185, 79.888546764

Scheduled Date: 10/28/2017

Vehicle Type: prime mover

Vehicle

Reg No	
WP-CAR-1523	Assign
WP-CAK-3561	Assign

Selected Driver: 2

Selected Vehicle: WP-CAR-1523

Driver

Driver ID	Driver Name	
2	Rahantha Weerakoon	Assign

Figure C.18: Add A New Trip

Track Current Location of Vehicle

A trip can be started using the android app by providing the trip key allocated to a trip in the dialog box. The dialog box to enter the trip key is shown in Figure C.19.

A unique trip a key must be provided to start/stop trip.

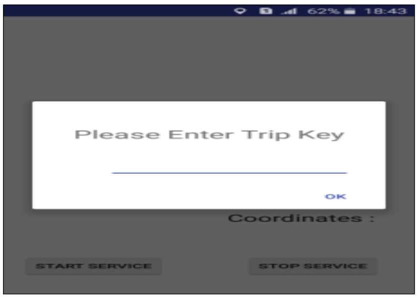
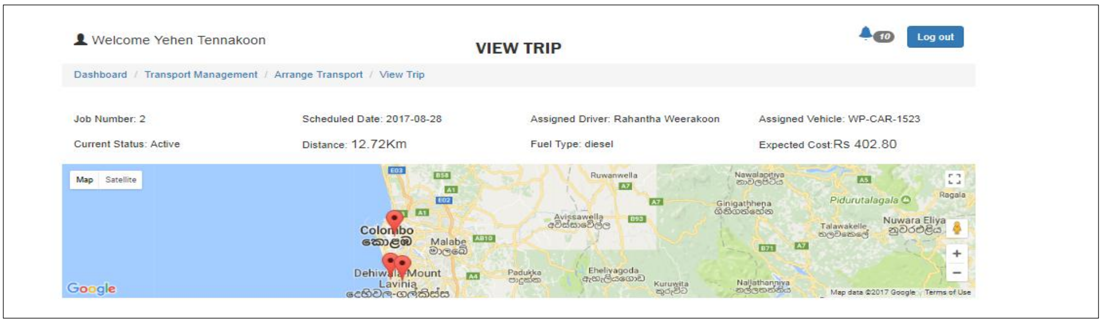


Figure C.19: Android app requesting for trip key to start/stop trip

To track the current location of a vehicle, click on the view of the trip arrangement. The details of the trip including the last updated location of the vehicle gathered using the android device provided is displayed in Figure C.20.



Job Number: 2
Scheduled Date: 2017-08-28
Assigned Driver: Rahantha Weerakoon
Assigned Vehicle: WP-CAR-1523
Current Status: Active
Distance: 12.72Km
Fuel Type: diesel
Expected Cost:Rs 402.80

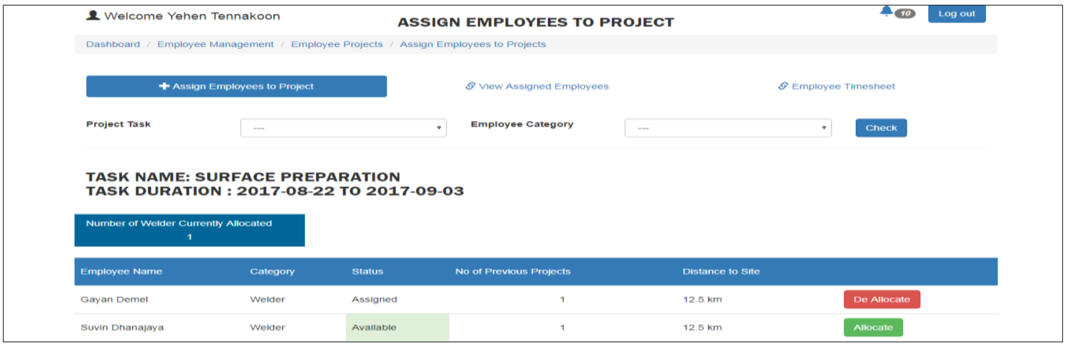
Figure C.20: View Trip

Employee Assigning to Project Tasks

Operations related to employees are managed using the employee management module. Organizational Employees can be added to project tasks using ‘Employees and Projects sub module’ by selecting the desired project. The user will be directed to Assign Employees to project interface. The process is described using Figures C.21 to C.23.

Process- Select project task and the worker category click check button.

System will display a list of workers belonging to that category indicating their availability. User can allocate / de-allocate the workers to tasks by clicking on the respective button. Interface used to assign employees is shown in Figure C.21.



Welcome Yehen Tennakoon

ASSIGN EMPLOYEES TO PROJECT

Dashboard / Employee Management / Employee Projects / Assign Employees to Projects

Project Task: ---

Employee Category: ---

TASK NAME: SURFACE PREPARATION
TASK DURATION : 2017-08-22 TO 2017-09-03

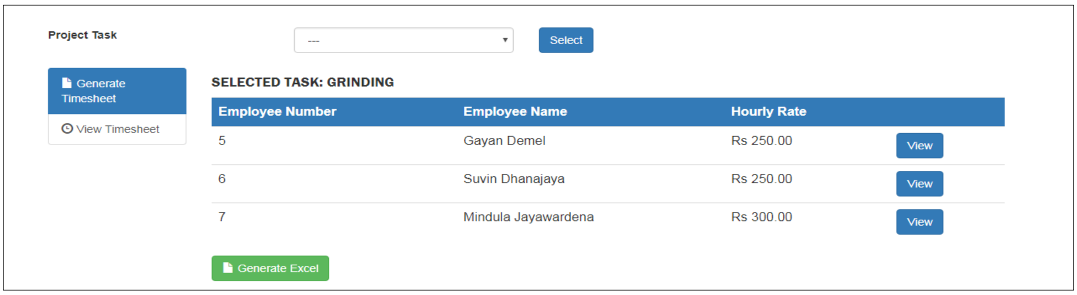
Number of Welder Currently Allocated
1

Employee Name	Category	Status	No of Previous Projects	Distance to Site	
Gayan Demel	Welder	Assigned	1	12.5 km	De Allocate
Suvin Dhanajaya	Welder	Available	1	12.5 km	Allocate

Figure C.21: Assign Employees to Project Tasks

Uploading Worker Task-sheet

Authorized user can generate an excel file containing the list of workers assigned for a given task using the system from employee timesheet section shown in Figure C.22.



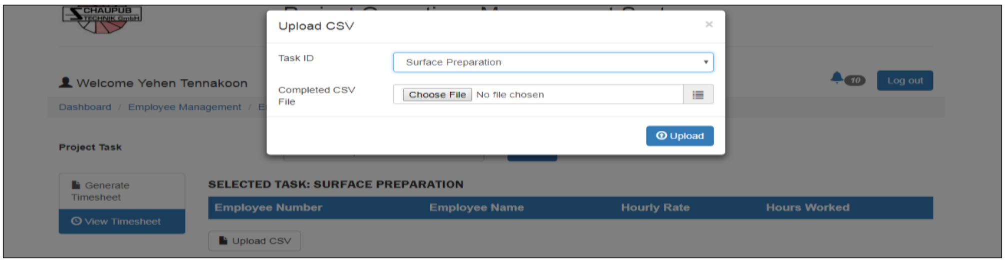
Project Task: ---

SELECTED TASK: GRINDING

Employee Number	Employee Name	Hourly Rate	
5	Gayan Demel	Rs 250.00	View
6	Suvin Dhanajaya	Rs 250.00	View
7	Mindula Jayawardena	Rs 300.00	View

Figure C.22: Generating the Worker Task-Sheet Excel File

After completing the generated excel file by specifying the number of hours each worker spent for a task, the user will have to convert the file to a.csv and upload it to the provided interface in the view task-sheet section. The dialog to upload the CSV is shown in Figure C.23.



Upload CSV

Task ID: Surface Preparation

Completed CSV File: Choose File No file chosen

Welcome Yehen Tennakoon

Dashboard / Employee Management / E

Project Task

SELECTED TASK: SURFACE PREPARATION

Employee Number	Employee Name	Hourly Rate	Hours Worked

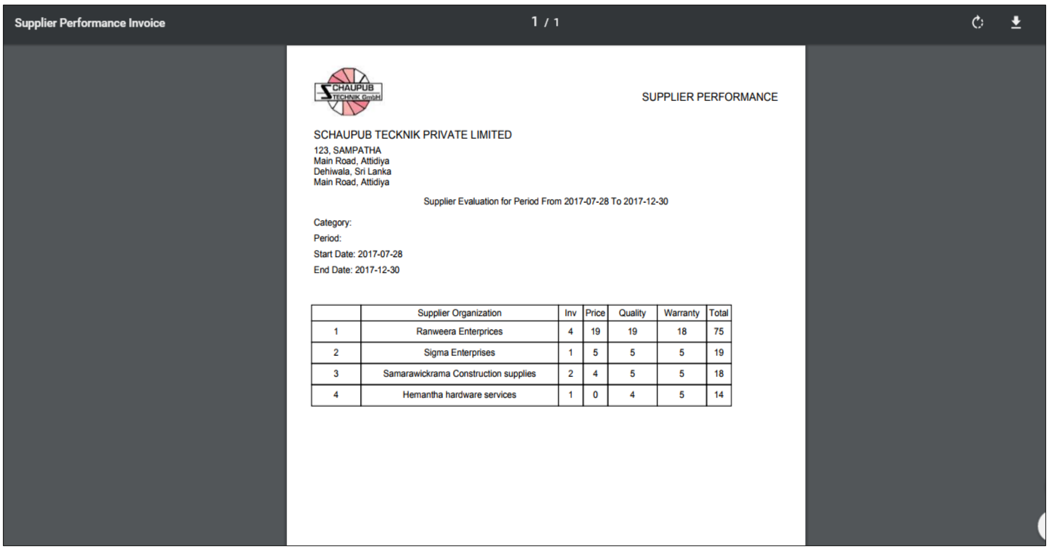
Figure C.23: Interface to upload the task-sheet

Appendix D – MANAGEMENT REPORTS

Supplier Performance Report

The figure displayed below is an example of a supplier performance report for a given period. The total points gained by supplier in warranty, credit, price and quality aspects per their invoices are displayed. This report is used by the purchasing and other management in deciding on the efficiency of suppliers and selecting the suppliers to re-register with in the future. The supplier performance report is shown in Figure D.1.

Can be filtered based on supplier category too.



SUPPLIER PERFORMANCE

SCHAUPUB TECCKNIK PRIVATE LIMITED

123, SAMPATHA
Main Road, Attidiya
Dehiwala, Sri Lanka
Main Road, Attidiya

Supplier Evaluation for Period From 2017-07-28 To 2017-12-30

Category:
Period:
Start Date: 2017-07-28
End Date: 2017-12-30

	Supplier Organization	Inv	Price	Quality	Warranty	Total
1	Ranweera Enterprices	4	19	19	18	75
2	Sigma Enterprises	1	5	5	5	19
3	Samarawickrama Construction supplies	2	4	5	5	18
4	Hemantha hardware services	1	0	4	5	14

Figure D.1: Supplier Performance Report

Project Cost Distribution Report

Project Cost distribution reports are used by finance staff and the directors of the organization to understand three main sectors of project related expenses. They are provided using charts on display. The worker cost distribution report is shown in Figure D.2.

- Worker Cost Distribution.

This provides an understanding of the worker cost distribution across project tasks, thereby the management can identify which tasks of a selected project incurred the highest worker cost and subsequently take action reduce such costs in future.

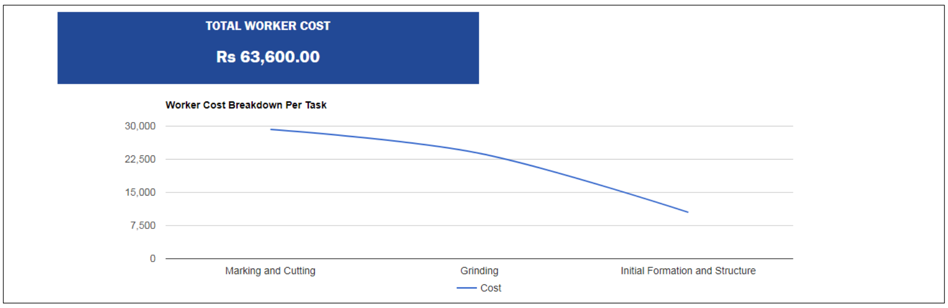


Figure D.2: Worker Cost Distribution Per Task

- Expense Distribution by categories for a project.

Using this column chart representation the management can identify which type of costs; such as lodging, incentive, and etc. has dominated the project expenses and take corrective action to better control project expenses. A project expense distribution is shown in Figure D.3.

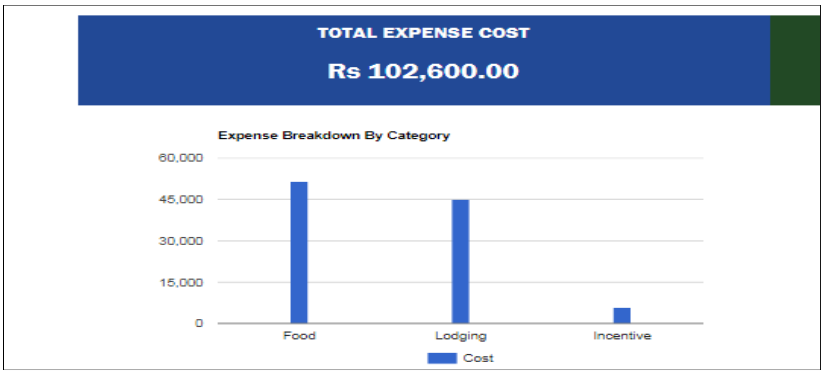
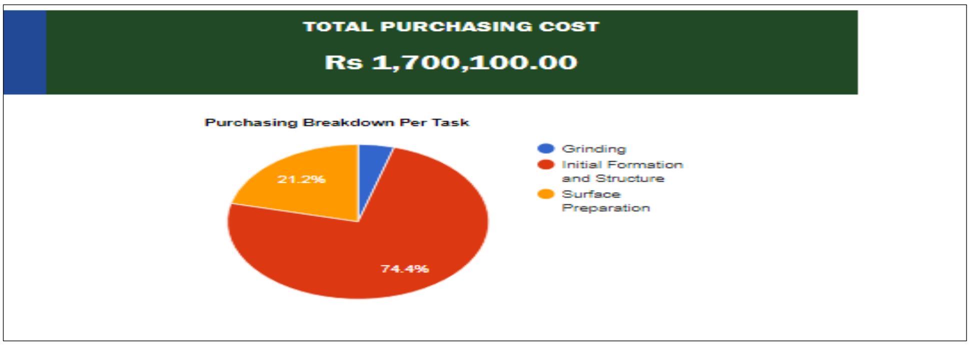


Figure D.3: Project Expenses By Category

- Total purchasing cost distribution across tasks

The purchasing cost distribution across the project tasks of a selected project is displayed using a pie chart. The graph for purchasing cost distribution is given in Figure D.4.



TOTAL PURCHASING COST

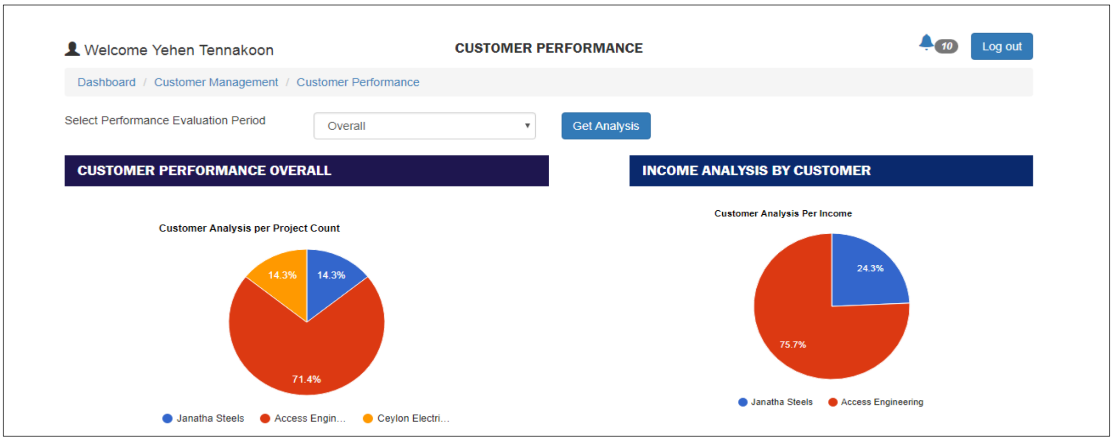
Rs 1,700,100.00

Purchasing Breakdown Per Task
21.2%
74.4%
Grinding
Initial Formation and Structure
Surface Preparation

Figure D.4: Purchasing Cost Distribution Reports Presented Using Graphs

Customer Performance Reports

The customer performance is used by the organizational directors to evaluate the contribution of customers towards the income and growth of SCHAUPUB TECHNIK. This is generated in terms of the number of projects awarded to the organization and the contribution of customers to the project income of the organization. Both graphs are represented using pie-charts. An idea on the potential bargaining power of various customers can be gained through the use of these reports. An example is shown in Figure D.5.



Welcome Yehen Tennakoon

CUSTOMER PERFORMANCE

Dashboard / Customer Management / Customer Performance

Select Performance Evaluation Period: Overall

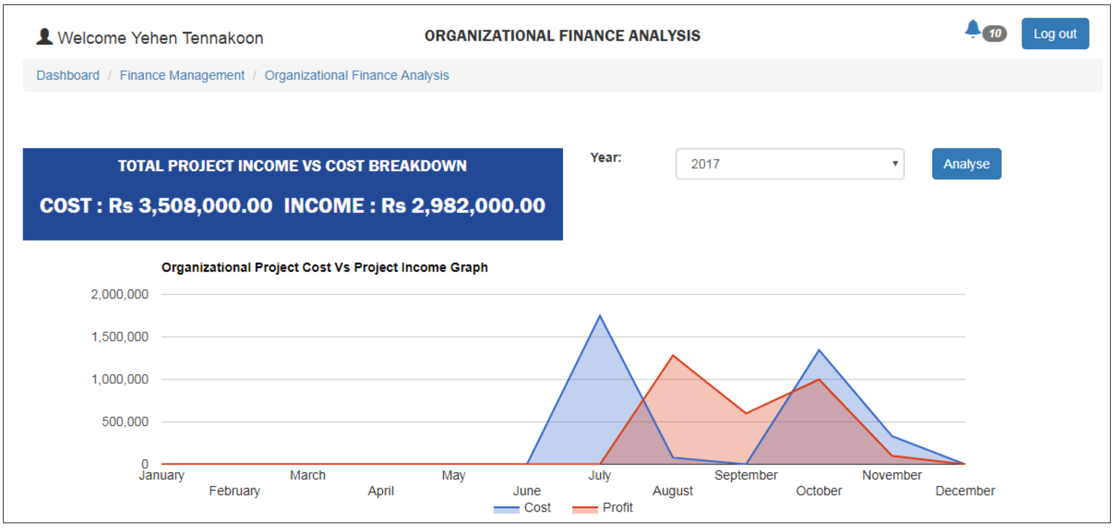
CUSTOMER PERFORMANCE OVERALL

INCOME ANALYSIS BY CUSTOMER

Figure D.5: Customer Performance Evaluation Charts

Organizational Project Income and Cost Analysis

This report is aimed to represent the distribution of costs and income through projects over a selected year. An Organizational finance analysis report is shown in Figure D.6.


Welcome Yehen Tennakoon
ORGANIZATIONAL FINANCE ANALYSIS
10
Log out
Dashboard / Finance Management / Organizational Finance Analysis

TOTAL PROJECT INCOME VS COST BREAKDOWN

COST : Rs 3,508,000.00 INCOME : Rs 2,982,000.00

Year: 2017

Figure D.6: Organizational Finance Analysis

Debtor Age Analysis Report

A report type used by the finance staff to determine the total receivable amount categorized into five baskets based on due date is shown in Figure D.7.

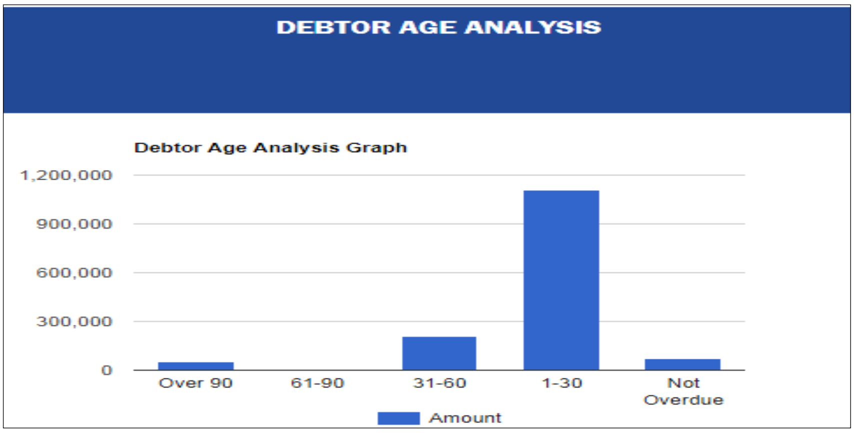
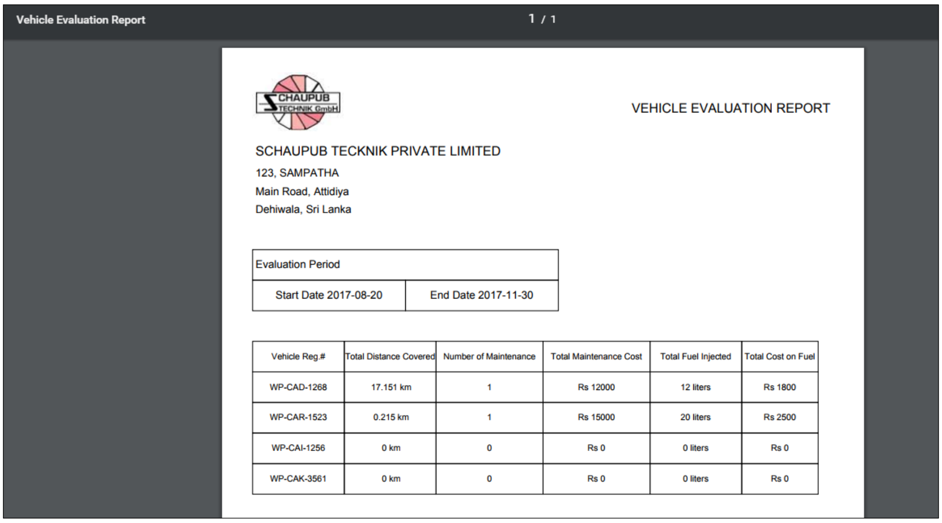


Figure D.7: Debtor Age Analysis Graph

Vehicle Evaluation Report

The vehicle evaluation report is used to evaluate the performance of vehicles in the organization in terms of distance covered, cost of maintenance, cost on fuel and fuel efficiency. An example of a vehicles evaluation report is shown in Figure D.8.



VEHICLE EVALUATION REPORT

SCHAUPUB TECCKNIK PRIVATE LIMITED
123, SAMPATHA
Main Road, Attidiya
Dehiwala, Sri Lanka

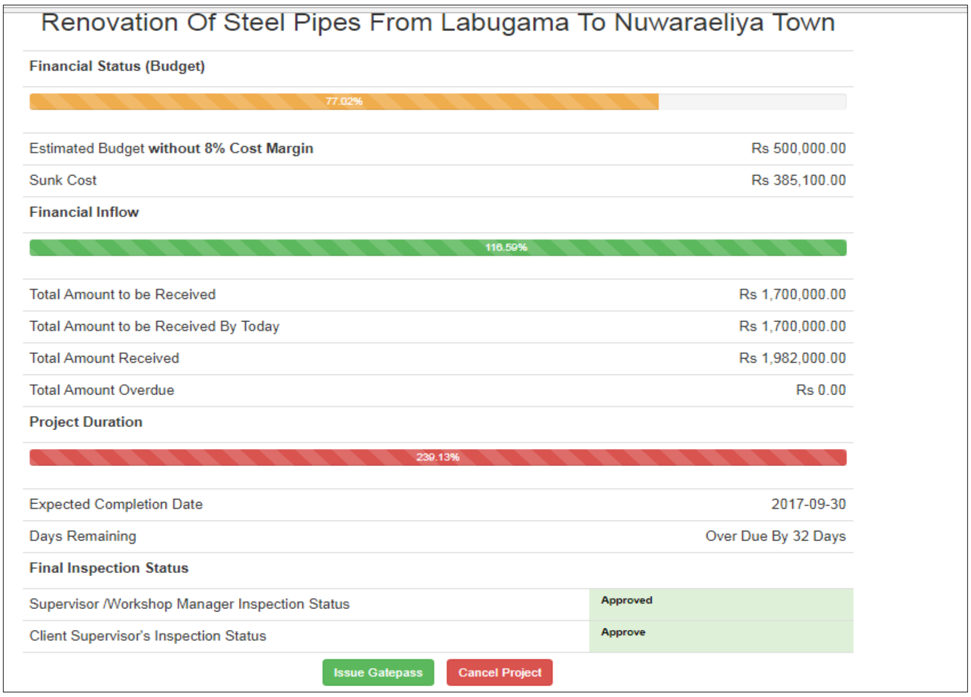
Evaluation Period	
Start Date 2017-08-20	End Date 2017-11-30

Vehicle Reg.#	Total Distance Covered	Number of Maintenance	Total Maintenance Cost	Total Fuel Injected	Total Cost on Fuel
WP-CAD-1268	17.151 km	1	Rs 12000	12 liters	Rs 1800
WP-CAR-1523	0.215 km	1	Rs 15000	20 liters	Rs 2500
WP-CAI-1256	0 km	0	Rs 0	0 liters	Rs 0
WP-CAK-3561	0 km	0	Rs 0	0 liters	Rs 0

Figure D.8: Vehicle Evaluation Report

Project Status Report

A project status report used to evaluate the state of an existing project is shown in Figure D.9.



Renovation Of Steel Pipes From Labugama To Nuwaraeliya Town

Financial Status (Budget)	
Estimated Budget **without 8% Cost Margin**	Rs 500,000.00
Sunk Cost	Rs 385,100.00
Financial Inflow	
Total Amount to be Received	Rs 1,700,000.00
Total Amount to be Received By Today	Rs 1,700,000.00
Total Amount Received	Rs 1,982,000.00
Total Amount Overdue	Rs 0.00
Project Duration	
Expected Completion Date	2017-09-30
Days Remaining	Over Due By 32 Days
Final Inspection Status	
Supervisor /Workshop Manager Inspection Status	**Approved**
Client Supervisor's Inspection Status	**Approve**

Figure D.9: Project Status Report

Individual Supplier Rating Report

A supplier rating report, used to evaluate the supplier performance on past orders is shown in Figure D.10.

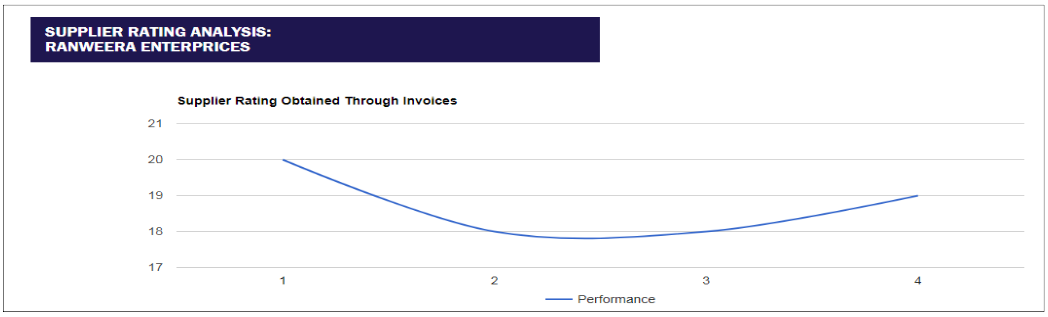

SUPPLIER RATING ANALYSIS:
RANWEERA ENTERPRICES
Supplier Rating Obtained Through Invoices
21
20
19
18
17
1
2
3
4
Performance

Figure D.10: Supplier Rating Analysis through each Invoice

Appendix E - TEST RESULTS

- Test Cases for tender management module is shown in Table E.1.

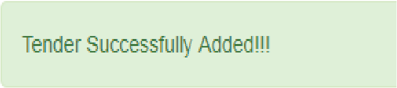
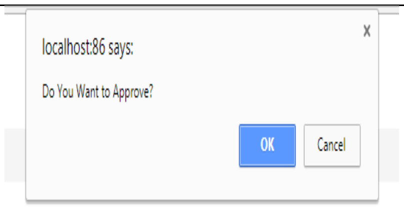
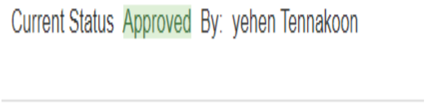
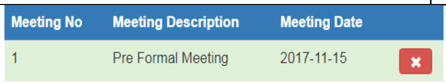
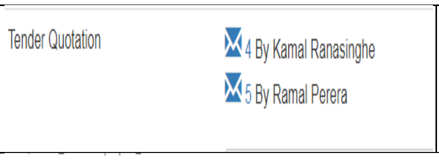
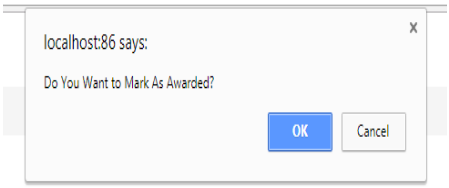
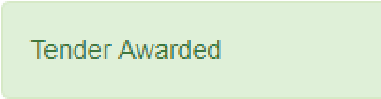
No	Test Case	Expected Output	Actual Output	Status
1.	Fill the tender fields and click on Submit Tender.	Redirected to tender list with a message indicating success.	 Tender Successfully Added!!!	Pass
2.	Approval of Tenders for bidding by clicking approve button.	A confirm box appears, requesting confirmation.	 localhost:86 says: Do You Want to Approve? 	Pass
3.	Click on 'OK' button.	Tender status changes and displays the name of the person who approved the tender	 Current Status Approved By: yehen Tennakoon	Pass
4.	Fill the required fields, click add meeting.	Tender Meeting added to the table on left.	 Meeting No | Meeting Description | Meeting Date 1 | Pre Formal Meeting | 2017-11-15	Pass
5.	Choose Quotation and click Upload Quotation.	Displays a link to the quotation with person name.	 Tender Quotation 4 By Kamal Ranasinghe 5 By Ramal Perera	Pass
7.	Award Tender By Clicking on 'Award Tender'.	Request Confirmation by a dialog.	 localhost:86 says: Do You Want to Mark As Awarded? 	Pass
8.	Click 'OK'.	Alert appears displaying tender awarded.	 Tender Awarded	Pass

Table E.1: Test Results for Tender Management Module

- Test Cases for production management module are shown in Table E.2.

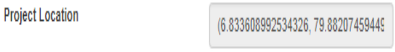
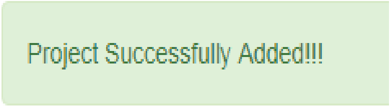
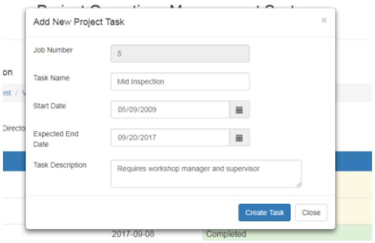
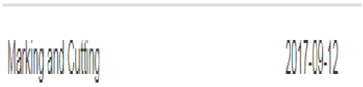
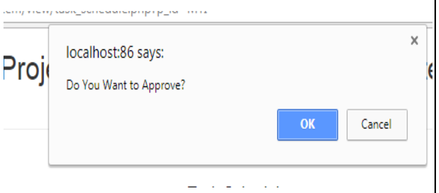
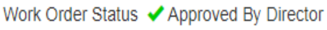
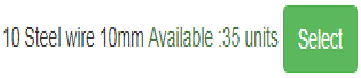
No	Test Case	Expected Output	Actual Output	Status
1.	Click on Map to get Location.	Location textbox filled with location's latitude and longitude.	 Project Location (6.833608992534326, 79.88207459449	Pass
2.	Click on 'Submit' button.	Project added and a message is displayed.	 Project Successfully Added!!!	Pass
3.	Click 'Add Task' button.	A Modal appears to add a task.	 Add New Project Task Job Number: 5 Task Name: Mid Inspection Start Date: 05/09/2009 Expected End Date: 09/20/2017 Task Description: Requires workshop manager and supervisor Create Task Close 2017-09-08 Completed	Pass
4.	Click Create task after filling out the fields.	Task Added and displayed on list.	 Marking and Cutting 2017-09-12	Pass
5.	Approve Work order by clicking on approve.	Confirm box appears requesting confirmation.	 localhost:86 says: Do You Want to Approve? OK Cancel	Pass
6.	Click 'OK'.	Status changes as approved.	 Work Order Status ✓ Approved By Director	Pass

Table E.2: Test Results for Production Management

- Test Cases for stock management module are shown in Table E.3.

No	Test Case	Expected Output	Actual Output	Status
1.	Select item category and sub category and click 'Check	Displays a list of items from the inventory belonging to	 10 Steel wire 10mm Available :35 units Select	Pass

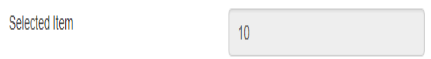
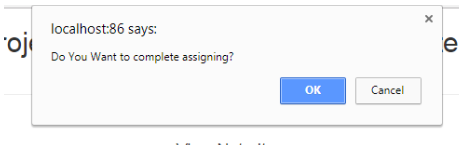
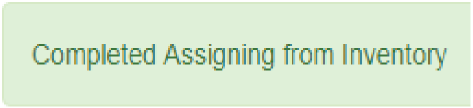
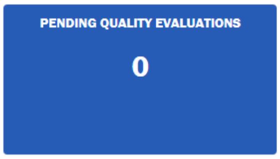
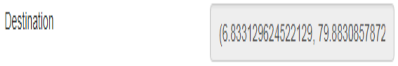
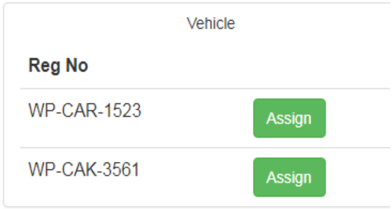
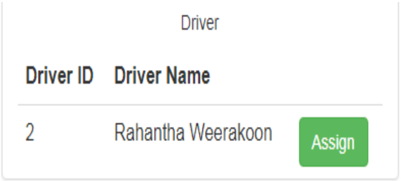
	Availability’	the category		
2.	Click on select button of an item	Item id displayed in the textbox	 Selected Item 10	Pass
3.	Click ‘Complete Assigning’	A confirm box appears	 localhost:86 says: Do You Want to complete assigning? OK Cancel	Pass
4.	Click ‘OK’	Alert appears indicating completion	 Completed Assigning from Inventory	Pass
5.	Click ‘Mark’ on inspect receive goods’	Pending Quality Evaluations count decreases	 PENDING QUALITY EVALUATIONS 0	Pass

Table E.3: Test Results for Stock Management

- Test Cases for transport management module is shown in table E.4.

No	Test Cases	Expected Output	Actual Output	Status
1.	Click on desired map location.	Destination textbox filled with latitude and longitude of the clicked location.	 Destination (6.833129624522129, 79.8830857872	Pass
2.	Select Vehicle Type.	Displays the list of vehicles belonging to that category and not on maintenance.	 Vehicle Reg No WP-CAR-1523 Assign WP-CAK-3561 Assign	Pass
3.	Select Vehicle Type.	Displays the list of drivers.	 Driver Driver ID Driver Name 2 Rahantha Weerakoon Assign	Pass

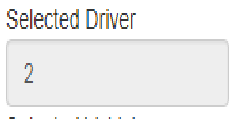
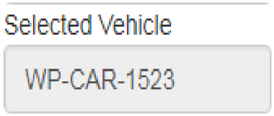
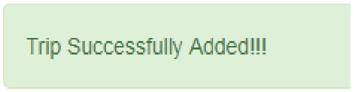
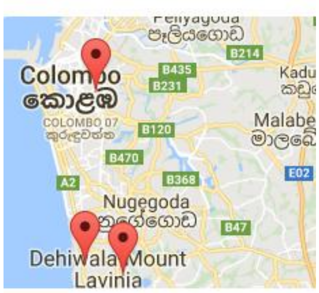
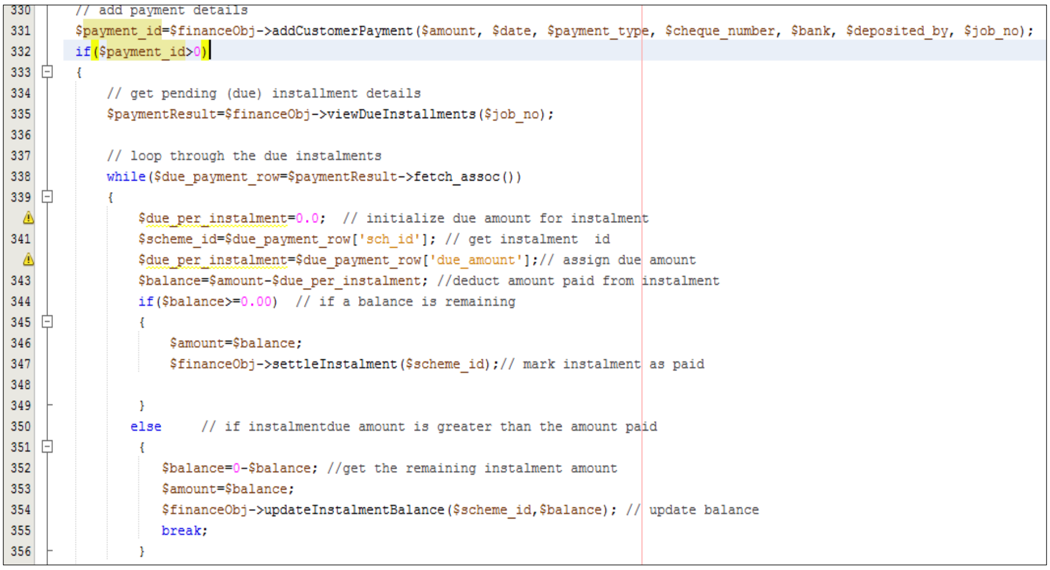
4.	Click on 'Assign' button of a driver.	Driver Number displayed as selected vehicle.	 Selected Driver 2	Pass
5.	Click on 'Assign' button of a vehicle.	Vehicle Number displayed as selected vehicle.	 Selected Vehicle WP-CAR-1523	Pass
6.	Click 'Save'.	Trip Added and displays a message indicating success.	 Trip Successfully Added!!!	Pass
7.	Click 'Start Trip' from android device and enter key.	The last location displayed on the trip map in addition to source and destination locations in web based system.	 Peliyagoda Colombo B435 B231 B214 Kadu Malabe COLOMBO 07 B120 B470 A2 B368 E02 Nugegoda B47 Dehiwala Mount Lavinia	Pass

Table E.4: Test Results for Transport Management

Appendix F - CODE LISTING

In addition to the featured code available in Section 4.4, some of the other program code that was developed is listed as below:

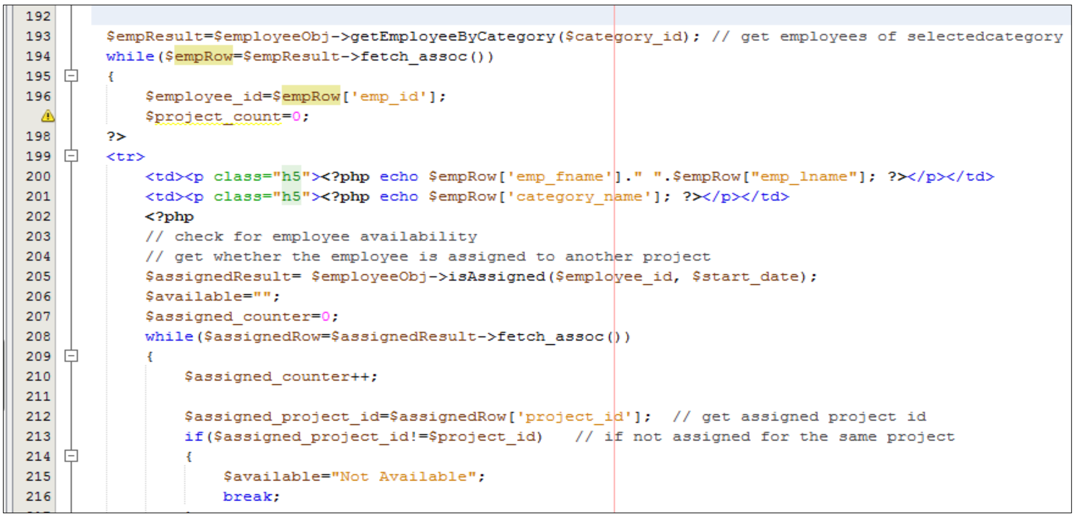
Code for Adding a Customer Payment is shown in Figure F.1.



```
// add payment details
$payment_id=$financeObj->addCustomerPayment($amount, $date, $payment_type, $cheque_number, $bank, $deposited_by, $job_no);
if($payment_id>0)
{
    // get pending (due) installment details
    $paymentResult=$financeObj->viewDueInstallments($job_no);

    // loop through the due instalments
    while($due_payment_row=$paymentResult->fetch_assoc())
    {
        $due_per_instalment=0.0;  // initialize due amount for instalment
        $scheme_id=$due_payment_row['sch_id']; // get instalment  id
        $due_per_instalment=$due_payment_row['due_amount'];// assign due amount
        $balance=$amount-$due_per_instalment; //deduct amount paid from instalment
        if($balance>=0.00)  // if a balance is remaining
        {
            $amount=$balance;
            $financeObj->settleInstalment($scheme_id);// mark instalment as paid

        }
       else     // if instalmentdue amount is greater than the amount paid
        {
           $balance=0-$balance; //get the remaining instalment amount
           $amount=$balance;
           $financeObj->updateInstalmentBalance($scheme_id,$balance); // update balance
           break;
        }
```

Figure F.1: Code Listing for Adding Customer Payment

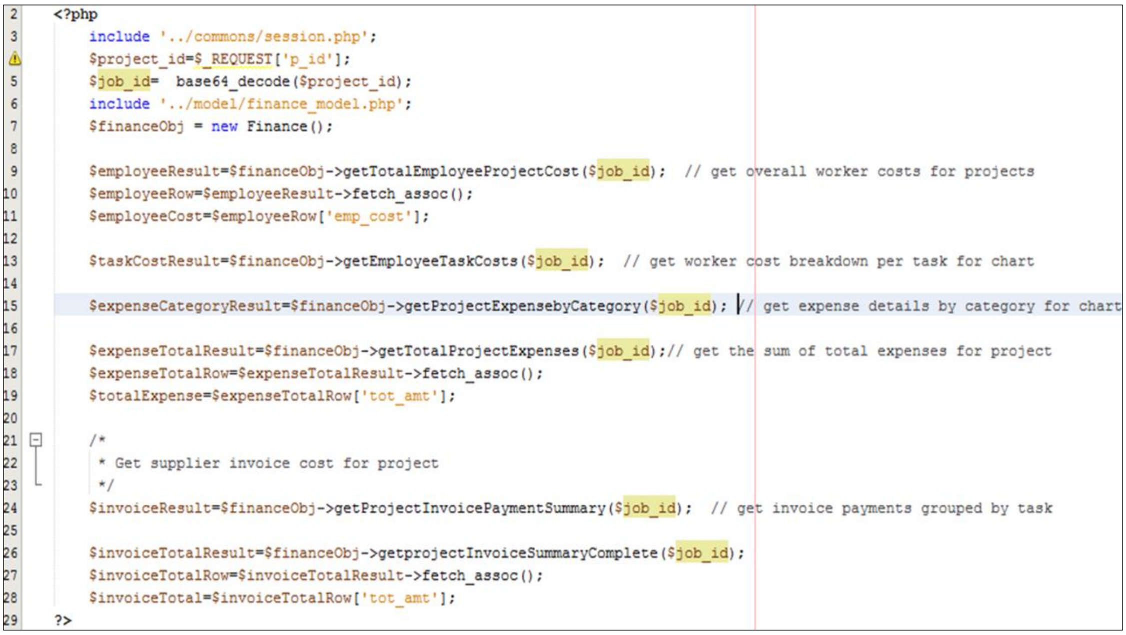
Code for Checking for Worker Availability is shown in Figure F.2.



```

$empResult=$employeeObj->getEmployeeByCategory($category_id); // get employees of selectedcategory
while($empRow=$empResult->fetch_assoc())
{
    $employee_id=$empRow['emp_id'];
    $project_count=0;
?>
<tr>
    <td><p class="h5"><?php echo $empRow['emp_fname']." ".$empRow["emp_lname"]; ?></p></td>
    <td><p class="h5"><?php echo $empRow['category_name']; ?></p></td>
    <?php
    // check for employee availability
    // get whether the employee is assigned to another project
    $assignedResult= $employeeObj->isAssigned($employee_id, $start_date);
    $available="";
    $assigned_counter=0;
    while($assignedRow=$assignedResult->fetch_assoc())
    {
        $assigned_counter++;

        $assigned_project_id=$assignedRow['project_id'];  // get assigned project id
        if($assigned_project_id!=$project_id)   // if not assigned for the same project
        {
            $available="Not Available";
            break;
```

Figure F.2: Code for Checking for Worker Availability

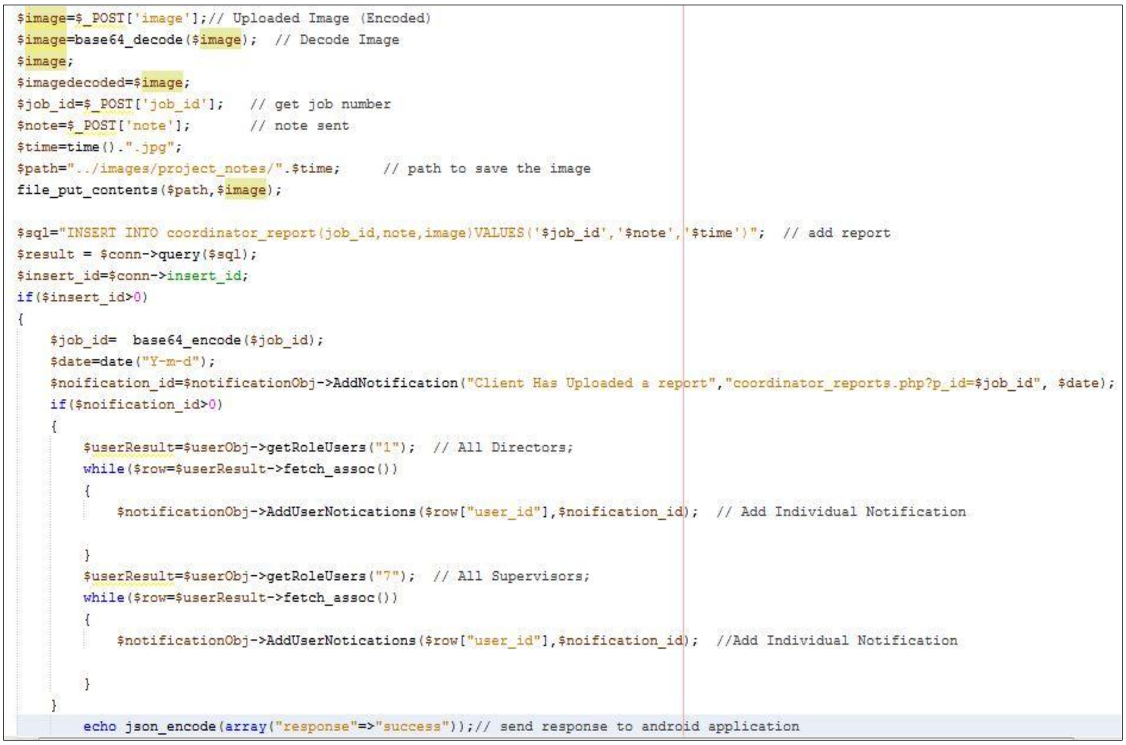
Code Listing for Retrieving Project Expenses for Charts is shown in Figure F.3



```php
<?php
    include '../commons/session.php';
    $project_id=$_REQUEST['p_id'];
    $job_id=  base64_decode($project_id);
    include '../model/finance_model.php';
    $financeObj = new Finance();

    $employeeResult=$financeObj->getTotalEmployeeProjectCost($job_id);  // get overall worker costs for projects
    $employeeRow=$employeeResult->fetch_assoc();
    $employeeCost=$employeeRow['emp_cost'];

    $taskCostResult=$financeObj->getEmployeeTaskCosts($job_id);  // get worker cost breakdown per task for chart

    $expenseCategoryResult=$financeObj->getProjectExpensebyCategory($job_id); // get expense details by category for chart

    $expenseTotalResult=$financeObj->getTotalProjectExpenses($job_id);// get the sum of total expenses for project
    $expenseTotalRow=$expenseTotalResult->fetch_assoc();
    $totalExpense=$expenseTotalRow['tot_amt'];

    /*
     * Get supplier invoice cost for project
     */
    $invoiceResult=$financeObj->getProjectInvoicePaymentSummary($job_id);  // get invoice payments grouped by task

    $invoiceTotalResult=$financeObj->getprojectInvoiceSummaryComplete($job_id);
    $invoiceTotalRow=$invoiceTotalResult->fetch_assoc();
    $invoiceTotal=$invoiceTotalRow['tot_amt'];
?>
```

Figure F.3: Code Listing for Retrieving Project Expenses for Charts

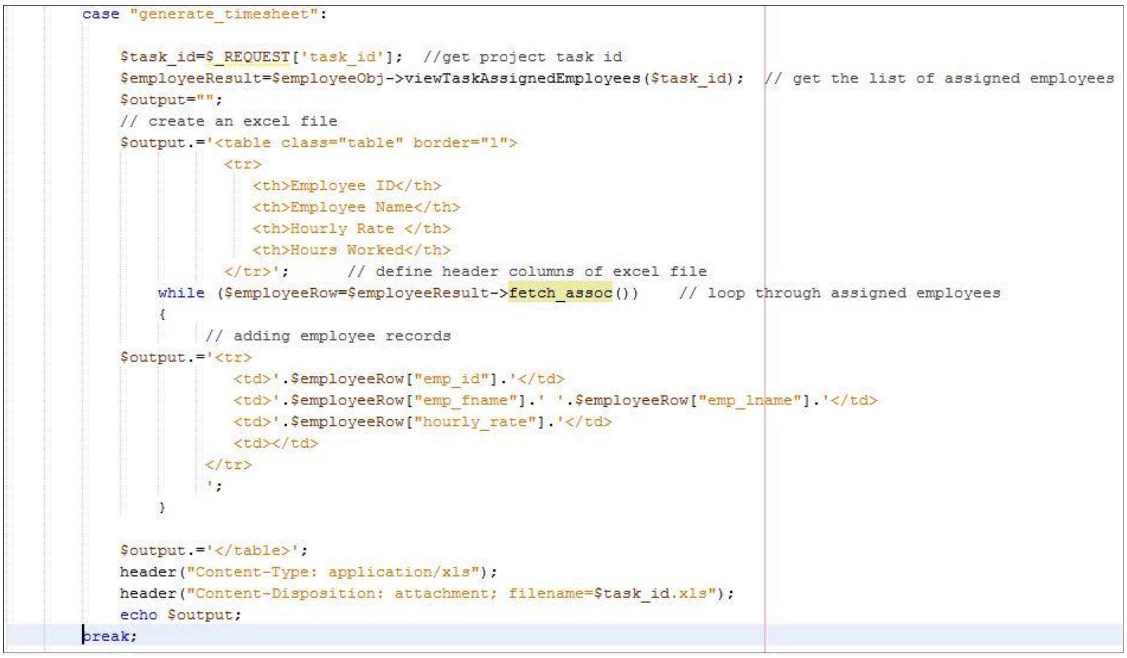
Code Listing to Upload Coordinator Report to Server is shown in Figure F.4.



```php
$image=$_POST['image'];// Uploaded Image (Encoded)
$image=base64_decode($image);  // Decode Image
$image;
$imagedecoded=$image;
$job_id=$_POST['job_id'];   // get job number
$note=$_POST['note'];       // note sent
$time=time().".jpg";
$path="../images/project_notes/".$time;     // path to save the image
file_put_contents($path,$image);

$sql="INSERT INTO coordinator_report(job_id,note,image)VALUES('$job_id','$note','$time')";  // add report
$result = $conn->query($sql);
$insert_id=$conn->insert_id;
if($insert_id>0)
{
    $job_id=  base64_encode($job_id);
    $date=date("Y-m-d");
    $noification_id=$notificationObj->AddNotification("Client Has Uploaded a report","coordinator_reports.php?p_id=$job_id", $date);
    if($noification_id>0)
    {
        $userResult=$userObj->getRoleUsers("1");  // All Directors;
        while($row=$userResult->fetch_assoc())
        {
            $notificationObj->AddUserNotications($row["user_id"],$noification_id);  // Add Individual Notification

        }
        $userResult=$userObj->getRoleUsers("7");  // All Supervisors;
        while($row=$userResult->fetch_assoc())
        {
            $notificationObj->AddUserNotications($row["user_id"],$noification_id);  //Add Individual Notification

        }
    }
        echo json_encode(array("response"=>"success"));// send response to android application
```

Figure F.4: Code to Upload Coordinator Report to Server

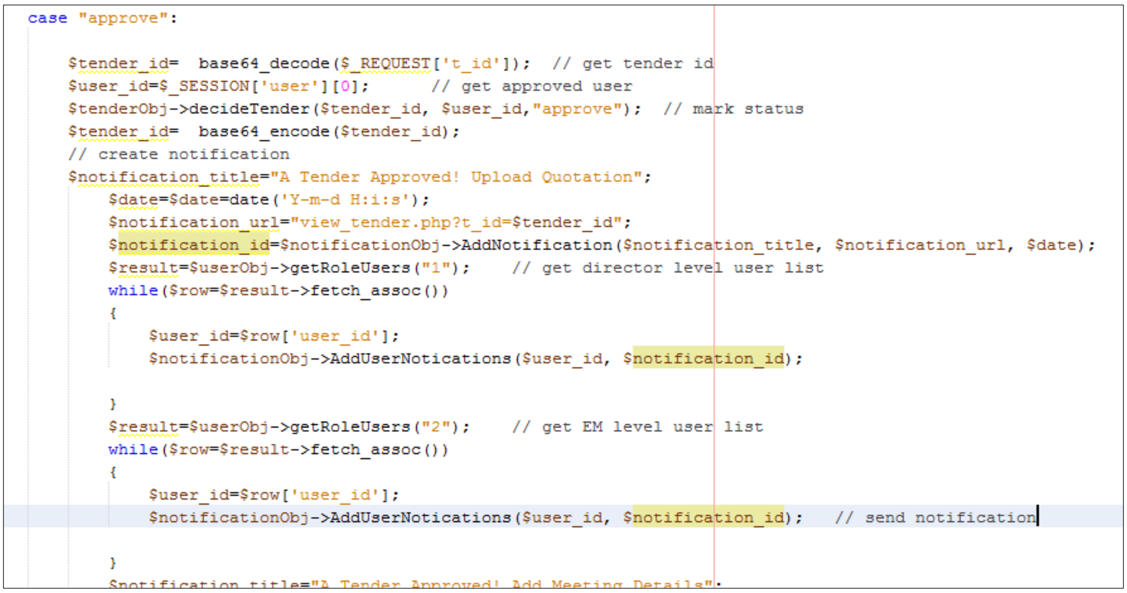
Code Listing to Manage generate the timesheet as an excel file is shown in Figure F.5.



```
case "generate_timesheet":

    $task_id=$_REQUEST['task_id'];  //get project task id
    $employeeResult=$employeeObj->viewTaskAssignedEmployees($task_id);  // get the list of assigned employees
    $output="";
    // create an excel file
    $output.='<table class="table" border="1">
                <tr>
                    <th>Employee ID</th>
                    <th>Employee Name</th>
                    <th>Hourly Rate </th>
                    <th>Hours Worked</th>
                </tr>';      // define header columns of excel file
        while ($employeeRow=$employeeResult->fetch_assoc())    // loop through assigned employees
        {
            // adding employee records
    $output.='<tr>
                 <td>'.$employeeRow["emp_id"].'</td>
                 <td>'.$employeeRow["emp_fname"].' '.$employeeRow["emp_lname"].'</td>
                 <td>'.$employeeRow["hourly_rate"].'</td>
                 <td></td>
              </tr>
              ';
        }

    $output.='</table>';
    header("Content-Type: application/xls");
    header("Content-Disposition: attachment; filename=$task_id.xls");
    echo $output;
break;
```

Figure F.5: Code to Generate the timesheet as an excel

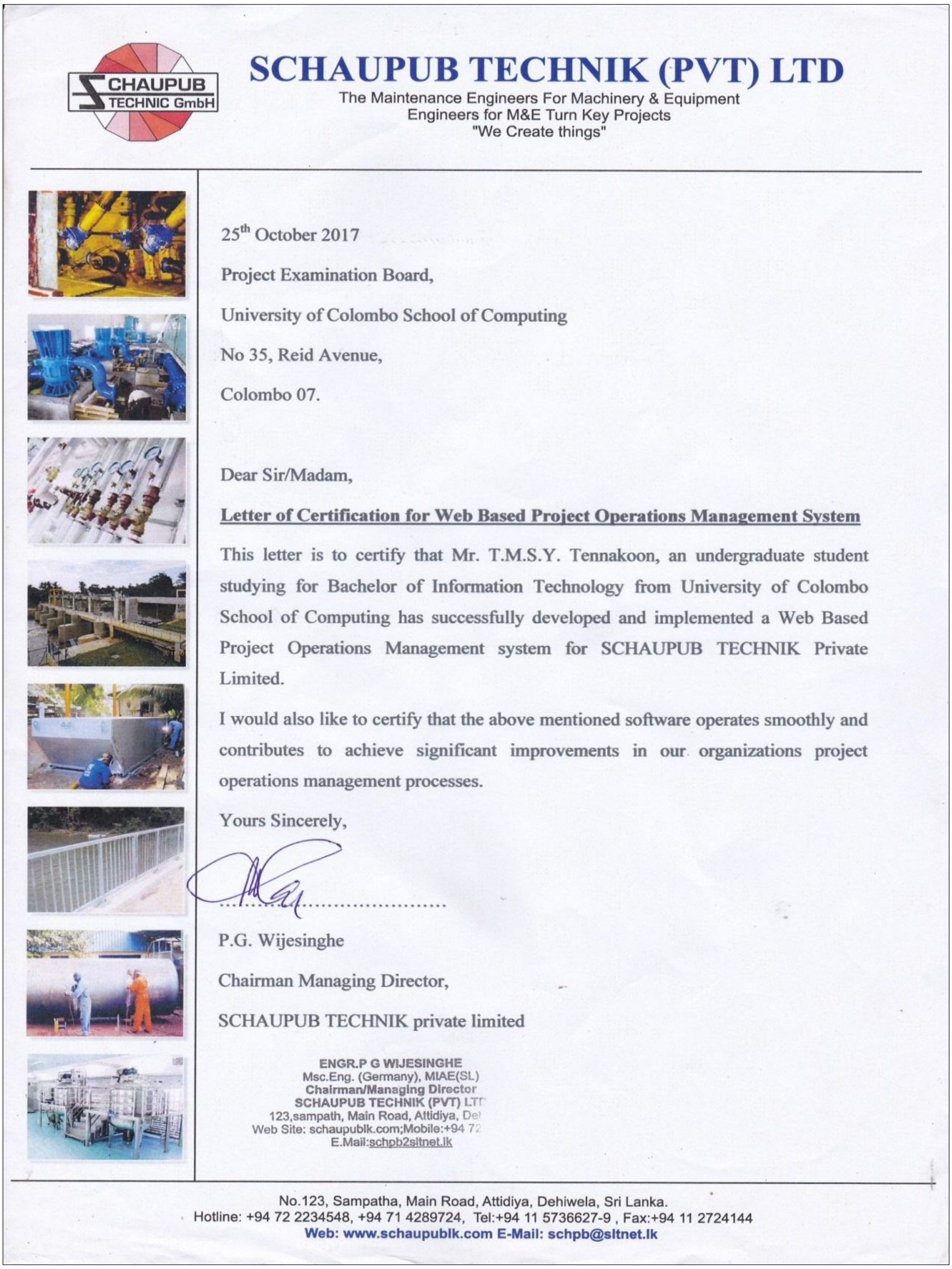
Code to approve an uploaded tender is shown in figure F.6.



```
case "approve":

    $tender_id=  base64_decode($_REQUEST['t_id']);  // get tender id
    $user_id=$_SESSION['user'][0];      // get approved user
    $tenderObj->decideTender($tender_id, $user_id,"approve");  // mark status
    $tender_id=  base64_encode($tender_id);
    // create notification
    $notification_title="A Tender Approved! Upload Quotation";
        $date=$date=date('Y-m-d H:i:s');
        $notification_url="view_tender.php?t_id=$tender_id";
        $notification_id=$notificationObj->AddNotification($notification_title, $notification_url, $date);
        $result=$userObj->getRoleUsers("1");    // get director level user list
        while($row=$result->fetch_assoc())
        {
            $user_id=$row['user_id'];
            $notificationObj->AddUserNotications($user_id, $notification_id);

        }
        $result=$userObj->getRoleUsers("2");    // get EM level user list
        while($row=$result->fetch_assoc())
        {
            $user_id=$row['user_id'];
            $notificationObj->AddUserNotications($user_id, $notification_id);   // send notification

        }
        $notification_title="A Tender Approved! Add Meeting Details";
```

Figure F.6: Code for approving uploaded tender

Appendix G – CLIENT CERTIFICATE



SCHAUPUB TECHNIK GmbH

SCHAUPUB TECHNIK (PVT) LTD

The Maintenance Engineers For Machinery & Equipment
Engineers for M&E Turn Key Projects
"We Create things"

25th October 2017

Project Examination Board,

University of Colombo School of Computing

No 35, Reid Avenue,

Colombo 07.

Dear Sir/Madam,

Letter of Certification for Web Based Project Operations Management System

This letter is to certify that Mr. T.M.S.Y. Tennakoon, an undergraduate student studying for Bachelor of Information Technology from University of Colombo School of Computing has successfully developed and implemented a Web Based Project Operations Management system for SCHAUPUB TECHNIK Private Limited.

I would also like to certify that the above mentioned software operates smoothly and contributes to achieve significant improvements in our organizations project operations management processes.

Yours Sincerely,

....

P.G. Wijesinghe

Chairman Managing Director,

SCHAUPUB TECHNIK private limited

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Chairman/Managing Director
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Figure G.1: Client Certificate

Glossary

- Debtor Analysis -An analysis of the due and overdue payment amounts categorized based on overdue date.
- Gate pass. -A document issued to formally hand over the finished product to client.
- JQuery. -A JavaScript library used for increase dynamic behavior of the website.
- Material Requisition Note -A document issued to requesting the allocation of items to a project task.
- Purchase Order -A document sent to a selected supplier requesting for goods.
- Supplier Invoice -A financial document received from a supplier together with the supplies.
- Tender Quotation -An estimation of the total costs that could incur in the completion of a project.
- Timesheet -A numerical representation of the number of hours a worker spent on a task.
- Trip -A transport Arrangement.
- Work-Order -A list of tasks assigned to successfully complete a project.