

Transport management system to overcome hectic manual intervention

**S. N. Perera
2020**



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A dissertation submitted for the Degree of Master of Information Technology

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Abstract

“BOC reached out to all Sri Lankans through its vast network of 627 branches connected online.

At present the employees of the Bank of Ceylon's head office use a manual process to obtain their transport requests.

Automating the current manual system is an urgent requirement which is being pondered even from the higher management.

Creating a web-based solution within the bank intranet would be the ideal solution to overcome the current difficulties employees face due to the manual interventions.”

Declaration

The thesis is my original work and has not been submitted previously for a degree at this or any other university/institute.

To the best of my knowledge it does not contain any material published or written by another person, except as acknowledged in the text.

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Date: 11/11/2020

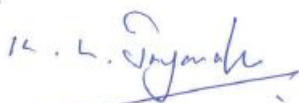
This is to certify that this thesis is based on the work of

Mr./Ms.

under my supervision. The thesis has been prepared according to the format stipulated and is of acceptable standard.

Certified by:

Supervisor Name: Dr. Lakshman Jayaratne



Signature:

Date: 11/11/2020

Acknowledgement

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Like most examination material, this task reflects thoughts of numerous academicians and experts who have added to the advancement of the subject through eras. I consciously respect every single such commitment.

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Abbreviations

BOC – Bank of Ceylon

HCI – Human Computer Interface

UML – Unified Modelling Language

TMS – Transport Management System

HOD – Head of Department

IIS – Internet Information Services

ASP – Active Server Pages

QA – Quality Assurance

FCP – First Contentful Paint

DOM – Document Object Model

TTI – Time to Interactive

GPS – Global Positioning System

DDL – Data Definition Language

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Chapter 1

1. Introduction

Bank of Ceylon (BOC) is a state-owned bank in Sri Lanka. As Bankers to the nation, BOC reached out to all Sri Lankans through its vast network of 627 branches connected online. There are more than 730 BOC ATM networks in number, serving 365 days for 24 hours in all 25 regions of the country. The Bank has 13 Subsidiaries and 5 affiliate companies in its group structure. BOC transformed its operations in the United Kingdom by restructuring its first branch overseas, with the London branch becoming a fully-fledged bank operating as a subsidiary of BOC named Bank of Ceylon UK Ltd. The BOC operates in 03 overseas locations, namely, Maldives, Chennai and Seychelles. BOC represents the worldwide network with over 865 overseas banks and exchange companies. BOC head office is situated in an iconic building on Colombo 01 which has 1500 employees, is the heart of the BOC network island wide.

At present the employees of the Bank of Ceylon's head office use a manual process to obtain their transport requests. The BOC transport department provides a form to fill out details of transport request and the applicants get approval from their respective department admins, head of department and then finally Chief Financial Officer. The transport admin is responsible for arranging the transport of the requester. Upon receiving the approval from the head of department and the Chief Financial Officer, then the request form will be forwarded to the transport department, where the transport admin arranges the transport of the requester. Finally, drivers receive a copy of the transport request from the transport department. As soon as the journey is complete, the admin department's staff manually calculates the meter readings for each trip and calculates the travel costs and distributes them to the relevant departmental admins.

Automating the current manual system is an urgent requirement which is being pondered even from the higher management. Hence creating a web-based solution within the bank intranet would be the ideal solution to overcome the current difficulties employees face due to the manual interventions.

1.1. Motivation

Detail analysis of the problems faced by existing manual system are described as below;

- Difficulty in maintaining records
- Time consuming
- Changing data becomes a tedious job
- No security for the data
- Mistakes occurs in calculations (calculating budget, mileage, etc.)
- Generation of reports
- Lack of efficiency and manpower
- Hassle in data recording
- High data redundancy
- Inconsistency of data

Hence to overcome the drawbacks of the current manual system, I have decided to develop a web-based transport management system. This will help to overcome hectic manual interventions, in order to provide better service for the bank employees. When considering the design and development of a transport management system and pondering on its characteristics as well as its features, there are many solutions worldwide being built to better handle transport services for employees.

But adhering to bank's policies & customizations would cost a fortune for a solution like that to implement on bank's intranet. Thus, when considering my proposed solution, it would basically cover all the requirements of an employee transport management at a cheaper cost.

1.2. Project Overview

Aims

- Research and evaluate existing transport management systems for similar organizations.
- Design a suitable and user-friendly transport management system for the Bank of Ceylon head office employees.

Objectives

- To investigate the drawbacks of existing transport management system in Bank of Ceylon head office & analyse how the new solution could be used to overcome those drawbacks.
- To develop a transport management solution for the Bank of Ceylon head office which would aid its employees to manage their transport with a click.
- To further analyse the findings to determine the additional requirements and the improvements needed for transport management solution for the Bank of Ceylon head office to overcome current hectic manual interventions which leaves employees unsatisfied.

Scope

To define and implement a solution, adhering to bank's infrastructure. Hence identified key features and dimensions of the scope is being pondered below:

- The system will be able to provide information and provide services from web pages to users requesting travel-related questions.
- Allow users to submit their own travel requests.
- Users can view their travel request.
- When submitting a request, approval goes through the following defined levels in the bank.
 - Approval of HOD
 - Approval of Transport Admin
 - Approval of CFO
- Employee notifications and driver notifications with details of expenses via.
 - Emails
 - SMS
- Reports.
 - Generate customized admin reports

Chapter 2

2. Analysis

Following chapter provides an analysis upon the adoption of an intranet system within the bank, and the facilities provided by the transport management system. Moreover, it will ponder upon the basic requirements of similar transport management systems. In addition, this also analyses the problems and strengths of the current system in the bank and its drawbacks.

The scope of this study is constrained by the accessibility of writing and time. As a time-consuming study, it does not present the entire amount of writing about the state of transportation, and yet strives to provide an overview of principle concerns and areas for development. Content and contextual researches are the hallmarks of past work done in this field.

2.1. Adaption of Transport Management system within organization

According to Axero, an intranet-based software development company. Their definition for intranet is; “an intranet is a network where employees can create content, communicate, collaborate and get stuff done.” [1]

Intranets are private, secured networks that are used to share information effectively within a company. The goal of an intranet is to ease communication, collaboration and document sharing for people within an organization. Intranets provide a virtual space for employees to work together, which is great for when people are spread out geographically. Overall, an intranet optimizes exiting business processes to centralize information, reduce complexity and maximize productivity [2].

Intranet can be used within organizations for many reasons. Below explain the other reasons for intranet adoption within organizations:

- It is an easier way to gather all information in one place.
- More secure as data will not be exposed to outside of the organization.

- Increase employee engagement on "used" data which is available within the organization.
- Employees can share information within the organization for a better insight.
- Ability to provide customized data to clients adhering to organization policies.
- Provides easy access to important data within the organization.
- Ability to include data of the organization into a single database.

According to [3], there are main 5 benefits when implementing an intranet within organization.

Those are;

1. Productivity
2. Cooperate communication
3. Streamline communication
4. Spur collaboration
5. Knowledge management

When it's come to transport management system within organizations, many organizations tend to have a track of their day-to-day transports (trips) in a system.

To see the strengths and weaknesses of the current transportation management system, I had to come up with a proper plan for analysing the pros and cons of the current manual system. Hence during the analysis phase, I had to interview business owners with domain knowledge about the current manual process to provide me with more in-depth. When I was preparing for the interview, I came up with a set of questions to raise at business owners which is the transport department of BOC.

1. Define the business requirements this system should address.

2. What are new information you require from the new system which you do not currently have?

3. What are the functionalities you need in the new system?

4. What sort of data will be shared among employees?

5. How much historical data needed to be kept?

6. What do you hope to achieve by developing this system?

7. How will the system change the way you do things now?

8. How will this system help you to become more efficient?

9. What are the drawbacks of this new system should address that is not currently addressed?

10. What problems are you facing today without an automated system?

11. What are the drawbacks this system should solve exclusively?

12. What are the reports currently being used? State whether you need any customized reports.

13. What database management system is currently being used?

MS SQL Server

Postgress SQL

DB2

NA

14. Number of expected users?

25-50

50-100

100-250

More than 250

15. Current windows operating version of the employees?

XP

Vista

Windows 7 or 8

Windows 10 or above

16. What web browsers employees use in their daily tasks?

Internet Explorer

Firefox

Chrome

NA

17. What is the current network architecture?

Centralized

De-centralized

18. Directory services used?

Active

LDAP

Other

19. Who will be using the proposed system?

20. What are the employee levels who will be using this system?

21. What are the levels of expertise of users who will be using this system?

22. What are the training requirements for users and administration staff?

Through this I was able to get an insight analysis of the problems faced and how the developed solution should be changed adhering to the requirements of the business.

2.2. Review of similar systems

When researching for literature about similar type of systems, [4] developed a transport and travel management project which has provided basic functionalities to mainly manage export and import goods anywhere through their solution. Moreover, he has also described that the system is capable of printing tickets and many more. Also, in 2012 [5] developed a similar kind of a project. According to him, his objective is to minimize the routing and scheduling. To minimize this, his objectives were to calculate total route costs, number of costs and distance travelled within the system. The constraints were requester requirement and time availability, vehicle capacity, start and end points.

Most of the transport management systems use set of common functionalities with added features accordingly to the business they are dealing with. Hence, it's quite evident, that facilities provided by a common transport management system would contain common information when it comes to a general request form. A common travel request form should include employee information. It should also provide a section for journey details and necessary approval details.

Travel request system developed [6] is a business management tool which available in office 365. According to their web site description, it has some common features such as;

- Approval workflow
- Ability to print reports
- Notifications
- Multiple currency support
- Customized reporting
- Ability to error handle

Thus, it's always better to ponder upon the common aspects of similar systems when developing a transport management solution. But the main purpose of developing a travel management system for the bank should be to adhere to bank requirements and integrate common useful features considering the long run of the system.

VEHICLE REQUISITION FORM

Please complete this information. Date:

1. Name & Designation of the officer using vehicle :

I
II
III
IV

2. Name & Designation of requesting officer:

3. Number of persons traveling:

4. Starting from:

5. Destination & route:

6. Starting Date & Time :

7. Schedule Time & Date of return:

8. Purpose:

Chief Manager

(For the use of Administration unit only)

* Date :

* Time:

* Received by:

* Time Completed:

Figure 2.2. 1 Sample BOC travel request form

2.3. Alternative design strategies

When researching about the similar transport management systems adopted by different organizations around the world, Iowa State University has a transport management system to their students and staff [7]. For a request initiation he/she needs to login in order to access the system. Then they will be provided with following information which need to be filled for the initiation;

- The type of vehicle requested
 - The employee or the initiator of the application can choose the type of vehicle he/she wants for travel

- Pick-up location, date and time
 - Initiator can define the **from** location and request his/her required date and time

- Destination
 - System has a place to enter details of the destination

- Request purpose
 - Field to enter the reason in applying for transport

- Initiator
 - Details of the initiator and department will be automatically picked

- Driver details
 - The system should simplify the contact details of all drivers as a report

- Telephone number and department name
 - Contact information should be filled

- Number of passengers in the vehicle including driver
 - Field to add any other employee joining the ride

There are many software companies, which provide dedicated transport management solutions. Mobisoft solutions being one of them. Although they provide users with a dedicated mobile app, most of the functionalities they offer, won't differ from the solution I have provided. They offer additional features such as emergency button, trip feedback which are not that essential when it comes to the bank. Moreover, integrating extra features would cost a fortune to the bank. Same additional features can be integrated to my solutions according to the business request as phase two of the project without any additional cost.

Suntelematics, an Indian based software firm also has a similar solution for lower cost. It offers features such as [8]:

- Fully automation of the manual process
- Trip summary sheets
- Dedicated allocation engine for allocations
- Advanced employee security system

When evaluating against the system I have developed, one of the main integrations missing here is the addition of authority levels and flow which is a vital aspect when it comes to the bank, where I have already integrated into my solution. While going for a lower cost solution like Suntelematics seems feasible for the bank, when it comes to the bank policies and requirements, above solution vendors have to develop banks' additional and essential requirement as new features, which will come as change requests. It will be another additional cost and a burden for the bank in the long run.

Few of the additional options which I have observed on all the similar solutions which I have reviewed are:

1. Mobile solution

This will be developed during the second phase, after further analysing the feasibility of providing a mobile solution option.

2. GPS tracking of the vehicle

In order to integrate a GPS tracking module into the current solution, there are few aspects which I need to ponder about. As route planning and optimization will also have to be considered due the fact bank has its own drivers as well as 3rd parties. Hence calculation module will also have to be integrated when fare estimating after finding the shortest route.

In the current solution I have developed, also has the ability to input the distance of the journey to the system without using GPS to calculate the route and distance automatically.

Chapter 3

3. Methodology

This chapter provides an in-depth analysis to expand the technologies, methods and best practices that can be used to design an efficient and convenient transportation management system.

The focus is on design specifications and the design of a transportation management system that describes characteristics and features demonstrates form, fit, and function at a scale estimated to represent the final product in operation.

This segment provides supporting information of the proposed transportation management system used. This will ponder upon the system design, database design and the Human Computer Interface (HCI) design aspects of the system.

3.1. Analysis and Design

Use case Diagrams

Use case diagrams are often referred to as behaviour diagrams which is used to describe a set of actions (use cases) that represent a specific program or system that must perform or perform in association with one or more external users of the program (actors).

Here I have created use case diagrams for each major modules of the project, which will provide more insight for the end-users.

Use case description for **User login**

ID	1
Name	Login to the system
Description	All the users with different user authority levels login to the system by entering their respective usernames and passwords.

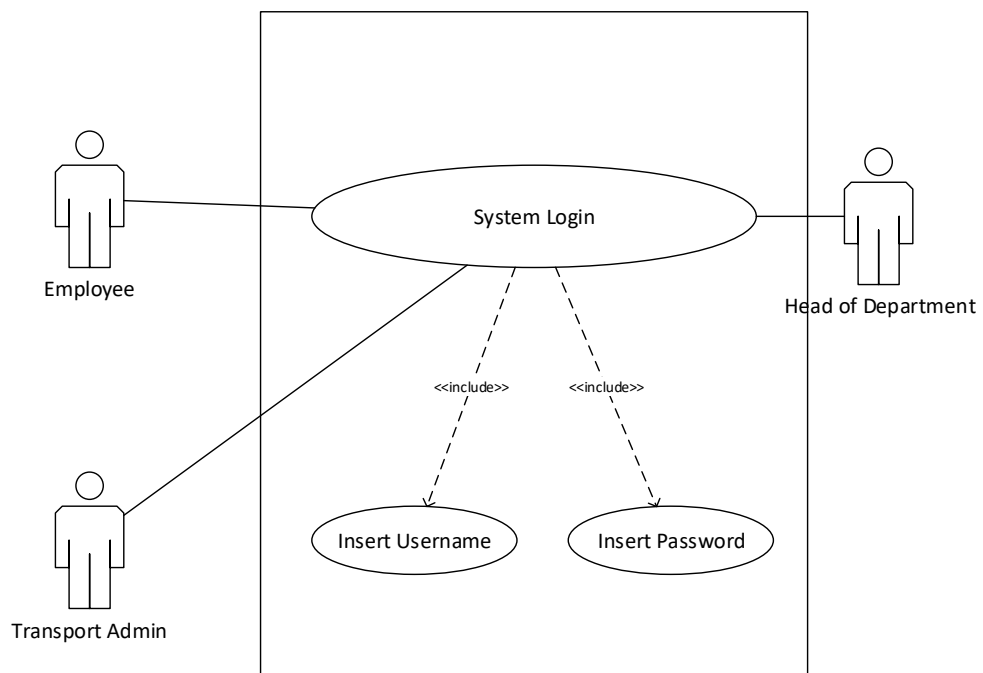


Figure 3.1. 1 Use case diagram - User login

Use case description for **Request initiation**

ID	1
Name	Open new request web page

Description	All the users with different user authority levels login to the system and open new request form by clicking “New request” link on the navigation pane.
--------------------	---

ID	2
Name	Input request details
Description	Request initiator input the request details such as required date, time, location and the reason.
ID	3
Name	Receive notifications
Description	After a successful request HOD will receive a notification on his dashboard.

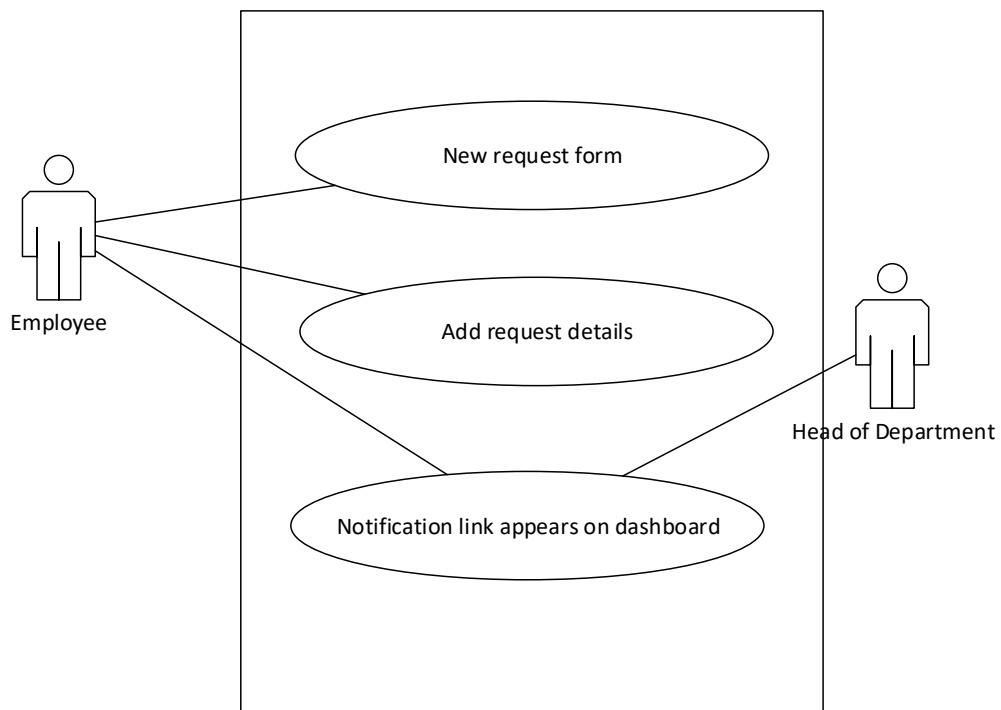


Figure 3.1. 2 Use case diagram - Request initiation

Use case description for **Request approval**

ID	1
Name	View the request from the link appeared on dashboard
Description	Request initiator or HOD will be able to view the submitted request from the dashboard link.
ID	2
Name	Approve/Reject request approval
Description	HOD will either submit the request for approval or reject with a reason by selecting approve or reject
ID	3
Name	Receive notifications via a link appeared on dashboard
Description	After a successful request, both transport admin and request initiator will receive updated status via a notification on dashboard.

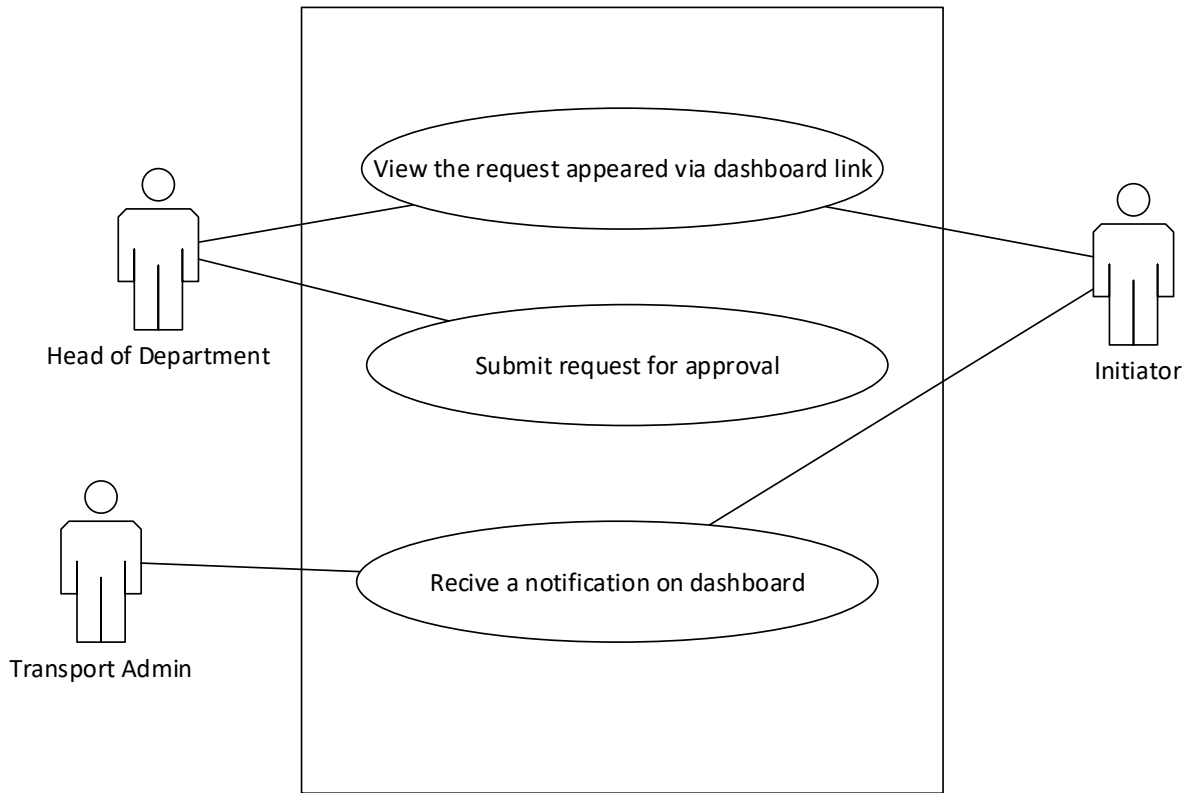


Figure 3.1. 3 Use case diagram- Request approval

Use case description for **Request schedule**

ID	1
Name	View request appeared via dashboard link
Description	Both initiator and transport admin can view the submitted request via the dashboard link.
ID	2
Name	Schedule request
Description	Transport admin will be scheduling the request by entering relevant details on the web form.

ID	3
Name	Receive notifications via a link appeared on dashboard
Description	After a successful submission request initiator will receive notification on dashboard as a link.
ID	4
Name	Receive SMS alerts
Description	After the scheduling the request, appropriate driver will receive SMS alert containing transport details.

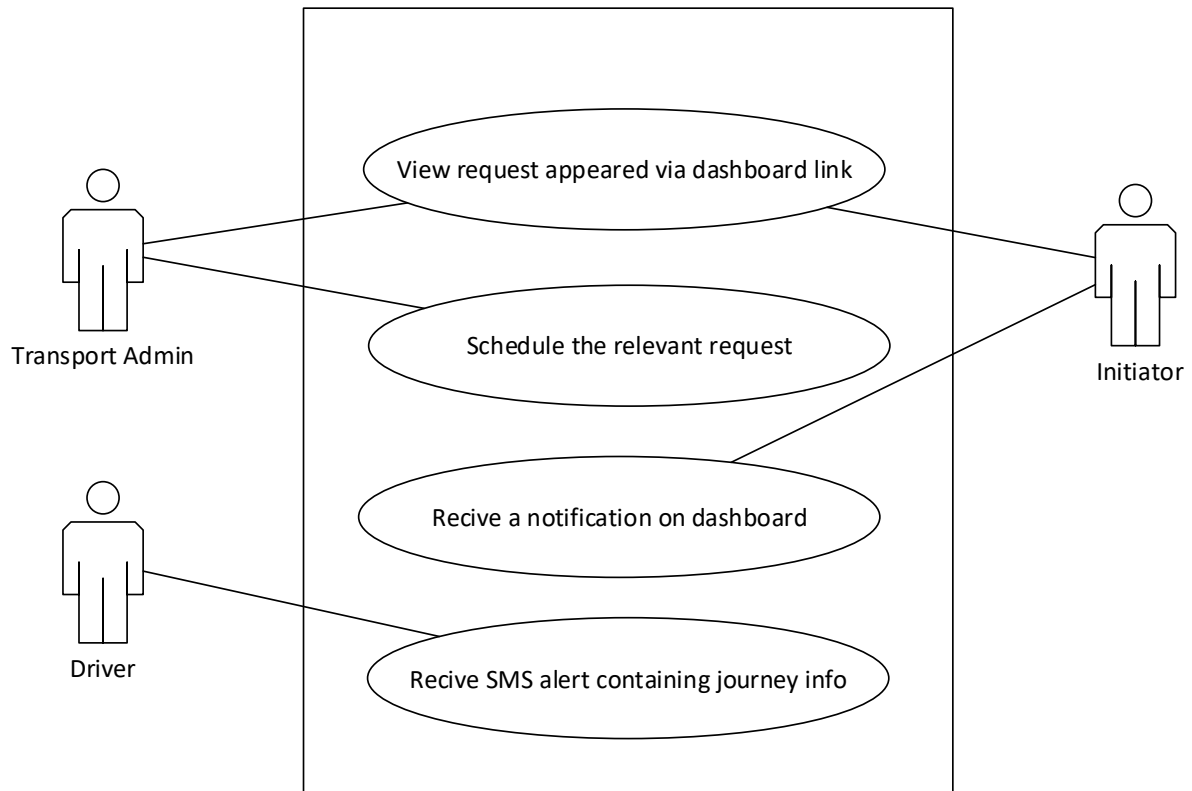


Figure 3.1. 4 Use case diagram- Request scheduling

Use case description for **Request finalization**

ID	1
Name	View request appeared via dashboard link
Description	Request initiator and Transport admin will be able to view the submitted request via a dashboard link.
ID	2
Name	Complete the request by adding the meter readings
Description	Transport admin will finalize the request by inserting total number of kilometres for the journey and the amount.
ID	3
Name	Receive notifications via a link appeared on dashboard
Description	After a successful submission request initiator will receive notification via a link on dashboard.

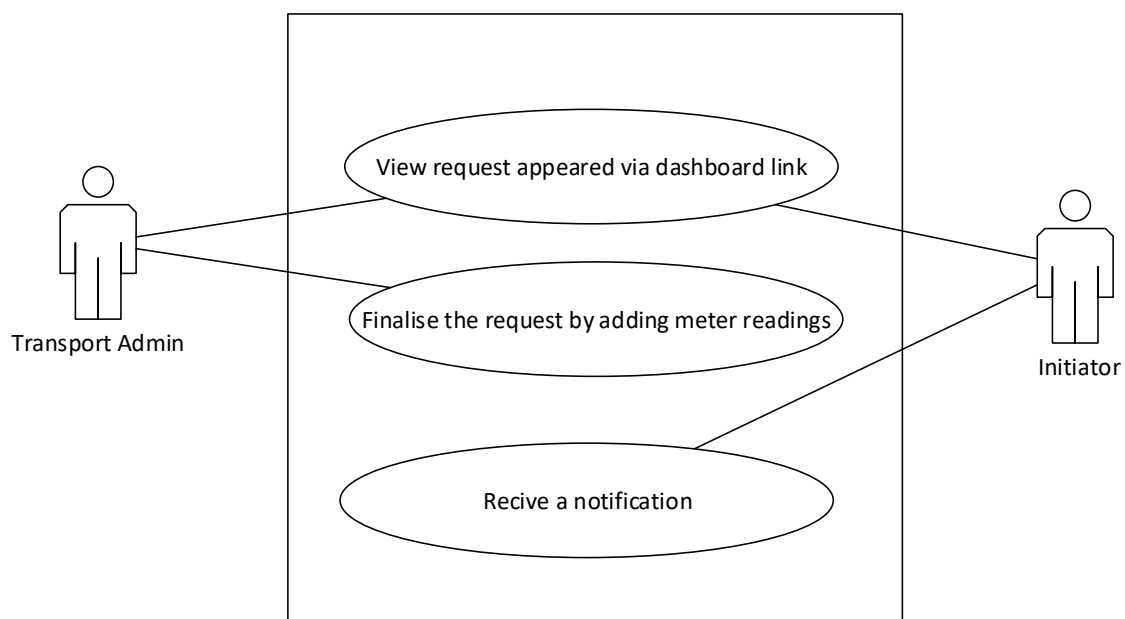


Figure 3.1. 5 Use case diagram- Request finalization

Activity Diagram

Activity diagrams used to graphically represent the dynamic features of a system. It is a flowchart to represent the flow from one task to another task. Here I have used it to describe operations of the system. The control flow is drawn here from one operation to another. Following are few examples to demonstrate the flow of transport management solution.

User login

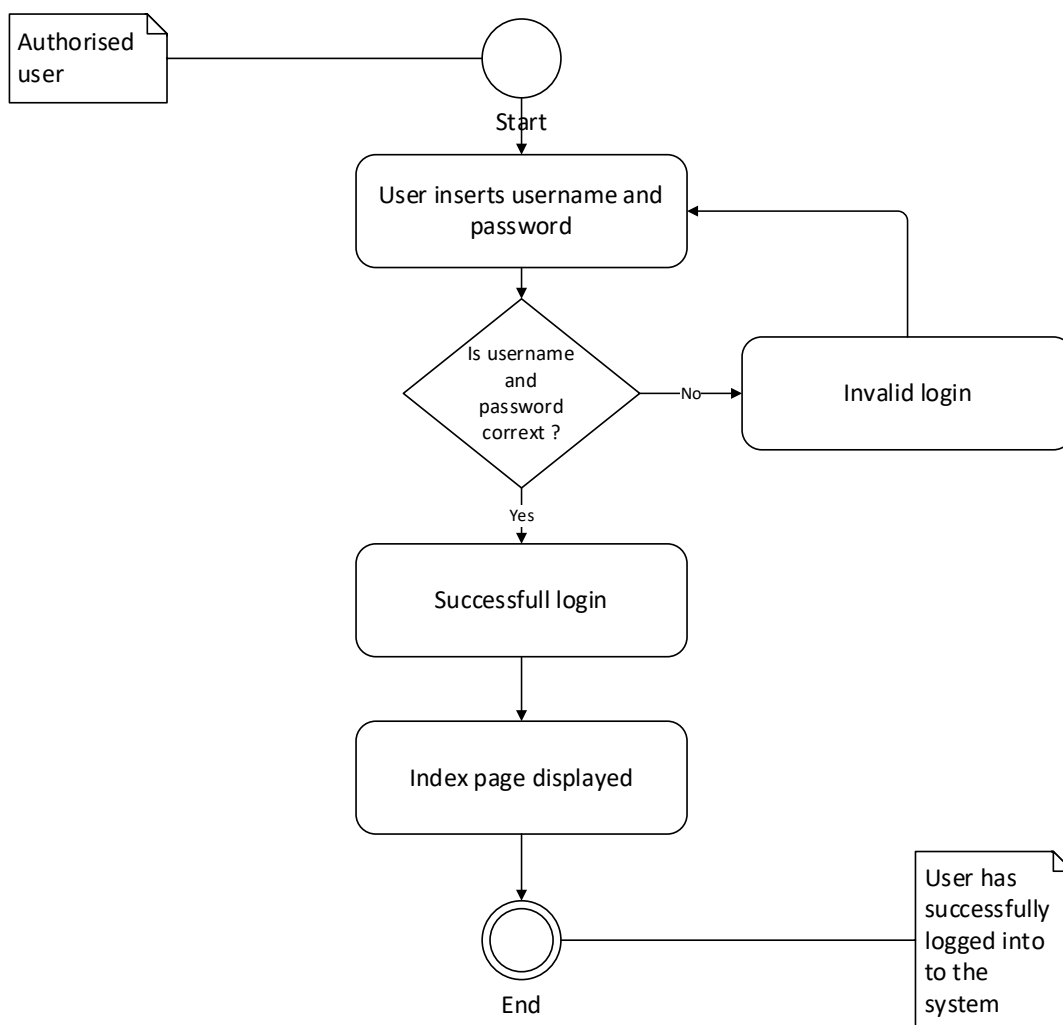


Figure 3.1. 6 Activity diagram – User login

Request Initiation

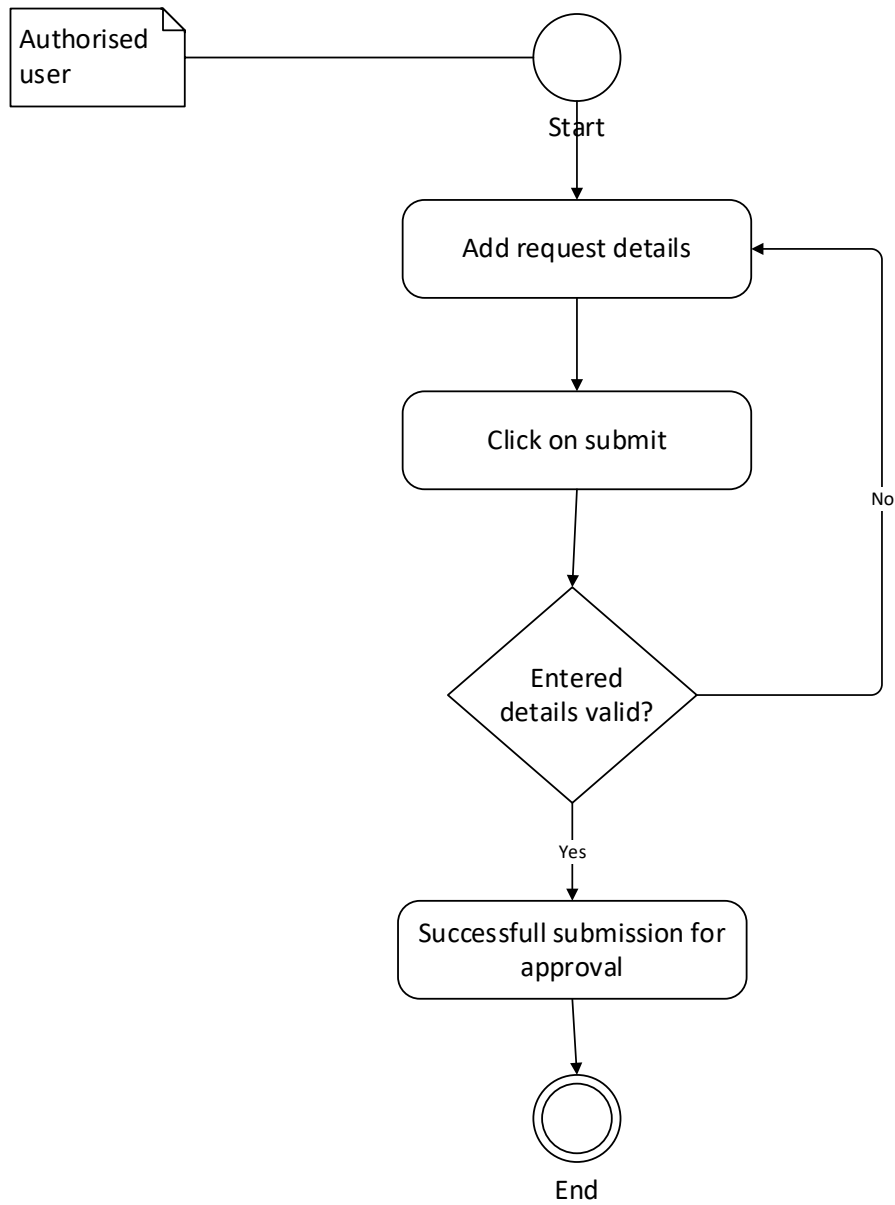


Figure 3.1. 7 Activity diagram – Request initiation

Request Approval

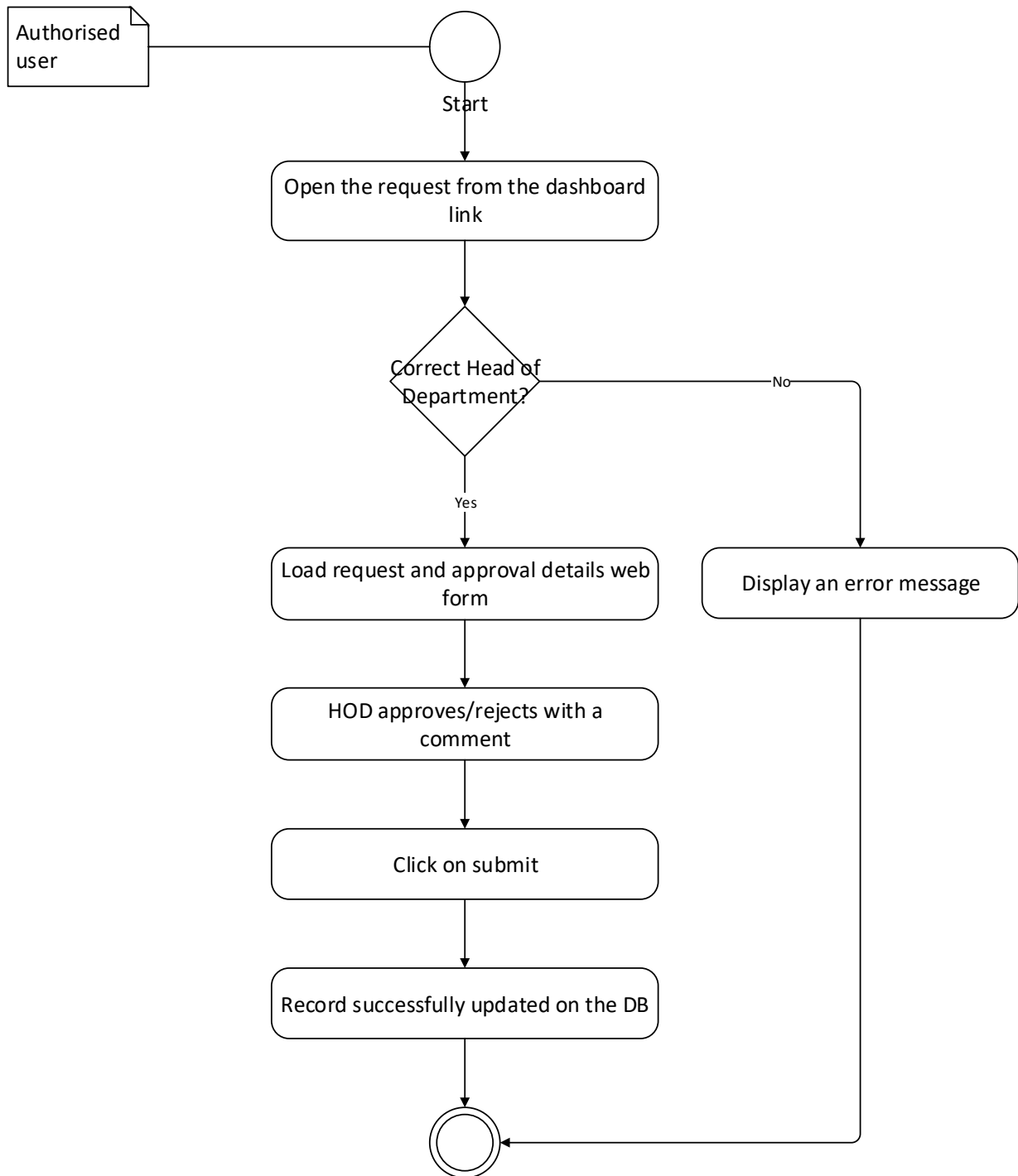


Figure 3.1. 8 Activity diagram – Request approval

Class Diagram

A class diagram is a standard diagram found in object-oriented strategy models. This will enhance the classes identified in the system, the interfaces, attributes and methods of each category, and the relationships within each class.

Following diagram will demonstrate all the classes I have found in designing a web-based transportation management system. I have expanded each class to show all the classes in the drawing.

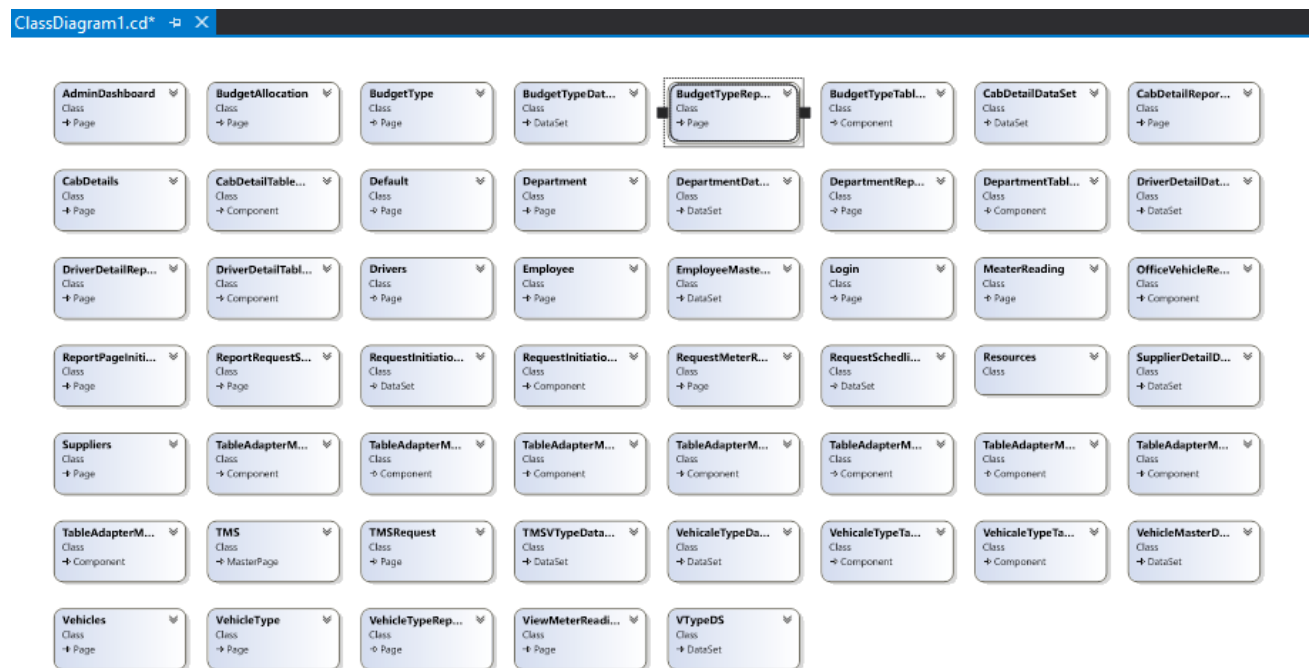


Figure 3.1. 9 Class diagram

Sequence Diagram

These types of drawings will demonstrate the efficiency of the travel management system. This is a type of communication diagram that highlights the time, messages sent and received by each program item.

I have created following sequence diagrams for selected modules in the developed system, to provide an in-depth understanding of the developed system.

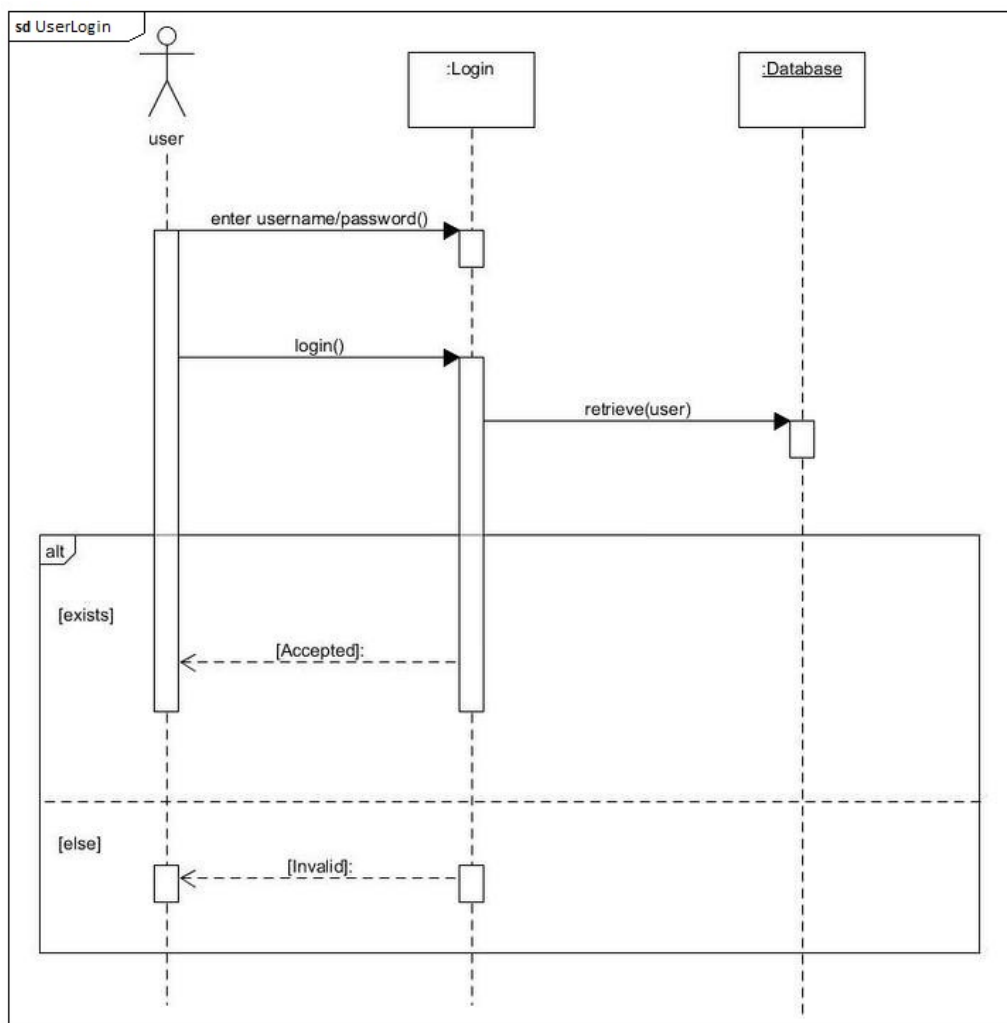


Figure 3.1. 10 Sequence Diagram-User login

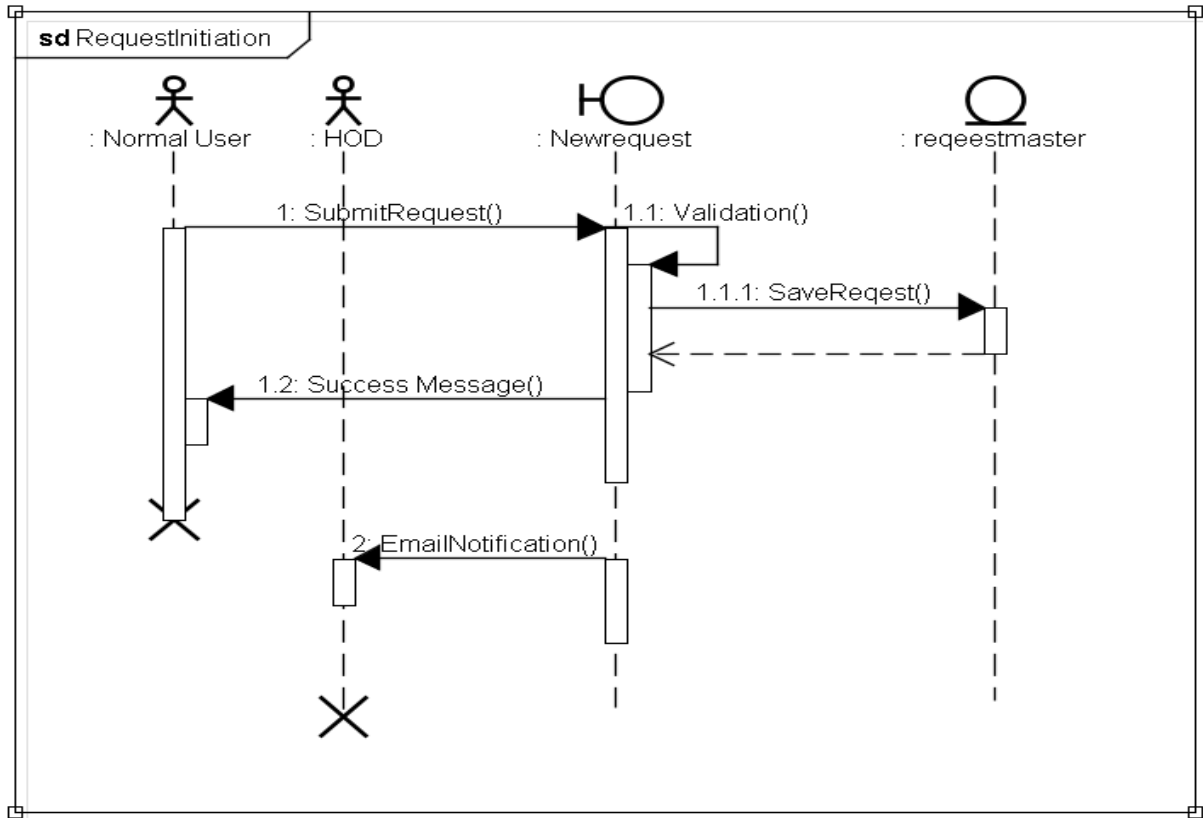


Figure 3.1. 11 Sequence Diagram – Request initiation

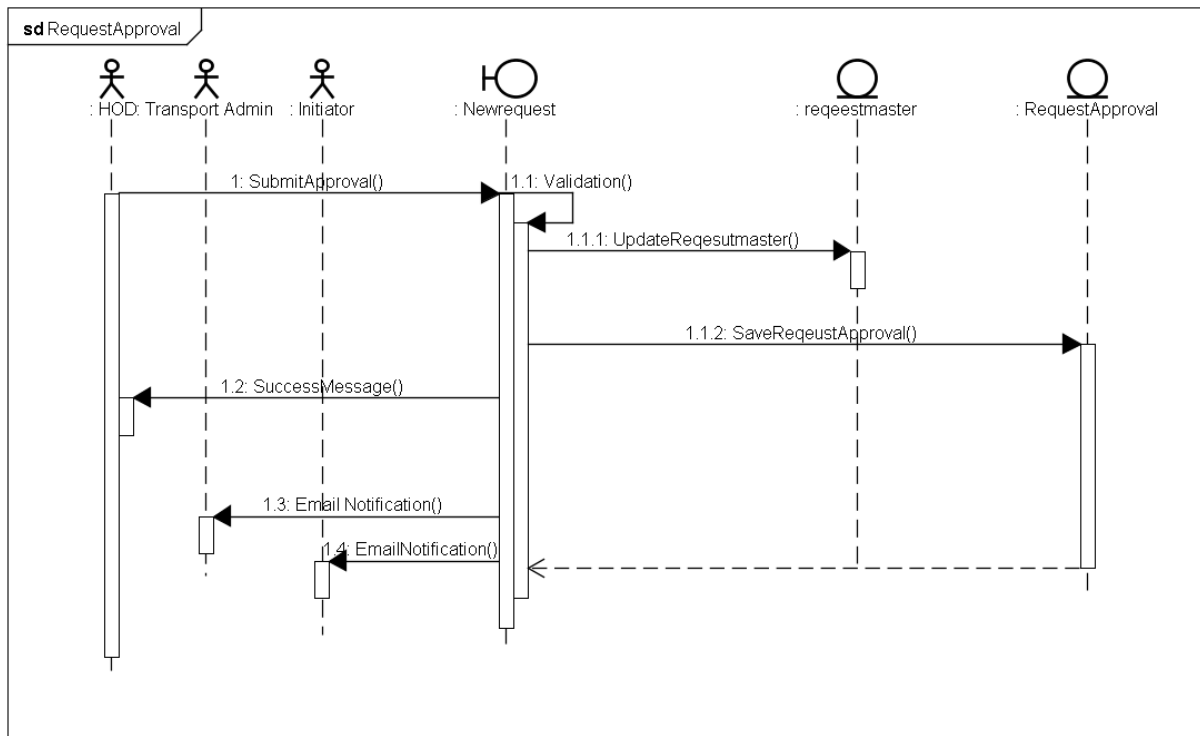


Figure 3.1. 12 Sequence Diagram – Request approval

3.2. Design Strategies

Human Computer Interface (HCI) Design

Following defines the common design principles of a web page. During the development of the transport management system, I have mainly adhered to following design aspects, as design has a major impact on any software solution.

- Relevance for the task – the webpage should be suitable for that task because it supports the user in accomplishing their tasks effectively and efficiently.
- Easy to understand – the web page should be self-explanatory and each step of a web page should be immediately understood by a response from the system or explained to the user by request.
- Easy to navigate – the web page should be easy to navigate and fully controllable to the user, where they can control it to achieve the desired result without a hassle.
- Consistency – the webpage should always meet the user's expectations without any malfunction or crash.
- Error tolerance – the webpage should be able to tolerate user errors even if there are obvious errors in the input, the intended end-result should be achieved by the user.
- Personalization – the web page should be customizable where the user interface can be modified to suit the needs of the job, personal preferences, user capabilities and user authorities.
- Assisting with learning – the webpage should support and guides the user in learning how to use the system without a hassle.

Database Design

The database design should integrate with common factors such as security, performance to produce logical and physical designs models of the proposed database system.

During the creation of the physical model, the data in the relevant tables was created with a better understanding of the identified classes and class diagrams. Moreover, to optimize database performance, I have used stored procedures as they store cached query plans for faster

retrieval. To minimize the redundancy of data, normalization was used. Moreover, third normal form of normalization was used to achieve this.

Following will demonstrate the ERD (Entity Relationship Diagram) which had been created for the web-based transport management system. Moreover, when developing the database views, based on the data that I had identified, I defined the entities and generated the ERD accordingly.

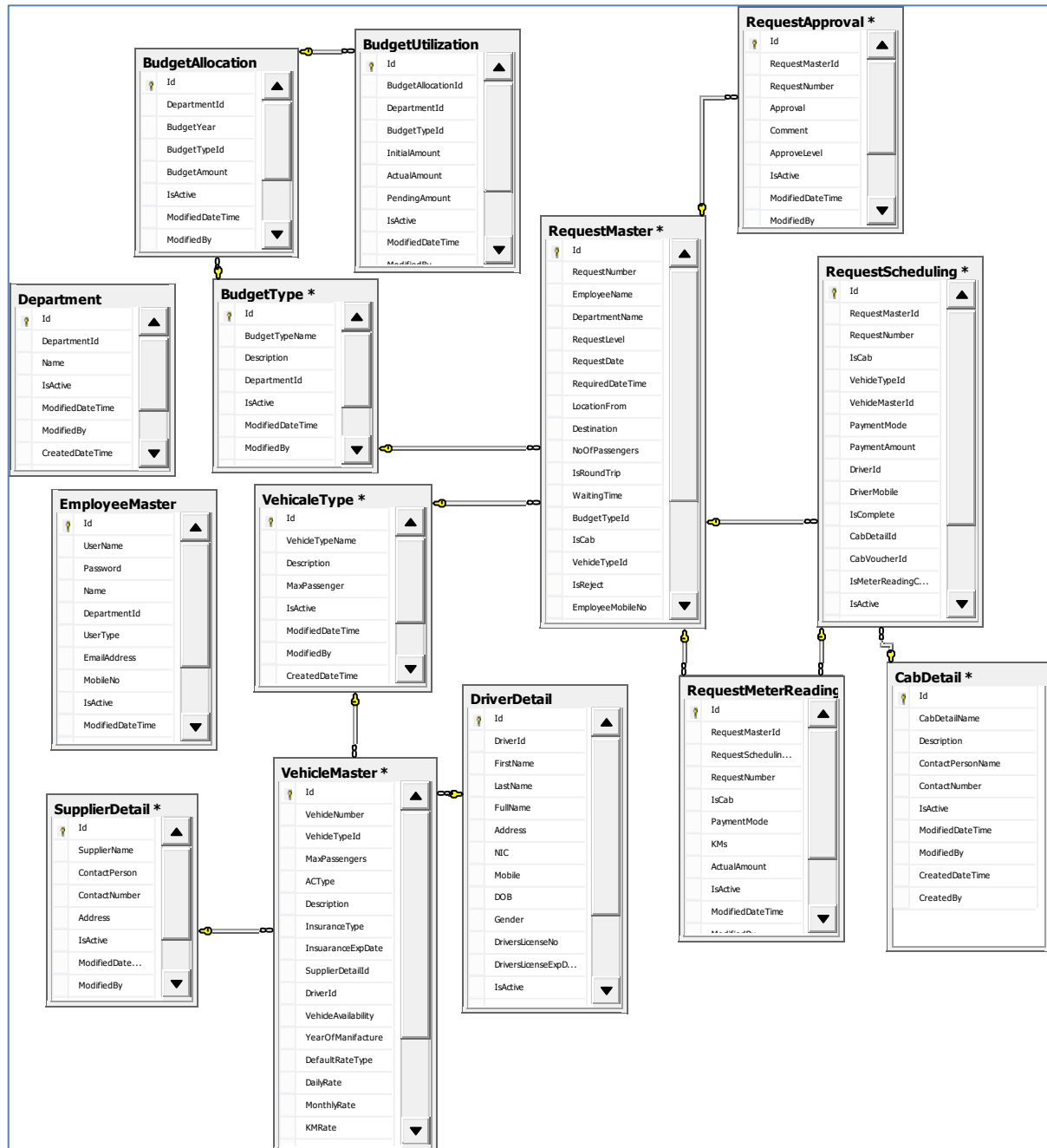


Figure 3.2. 1 ER diagram

Entity relationship diagram shows the relationship of each tables and their attributes stored in a specific database which shows the logical structure of the data. ERD is a blueprint of a database.

Through logical modelling, I have converted the ERD in to relational database. Then, I have structured the database under physical modelling using a DDL (Data Definition Language). Then I have implemented the database via MSSQL.

Module Description

Following section describe about all the main modules implemented on the transport management system. I have categorized them into three main sections here;

1. General module
2. Admin module
3. Reporting module

General Module

Any type of users registered in the system can access these modules. There are four main modules in the web transport management system used.

- Sign in page

From this user can access into the system. The user needs to input his/her username and password. Error and failure messages will be displayed in case of an invalid access.

- Index page

When a user signs into the system they will be redirected to index page. The Index page contains image banners and requests that have been started by system users. The navigation menu bar is also included in the index page.

- Dashboard page

The dashboard page contains summary of information at a glance to the user such as vehicle timeline information, employee details, number of cab suppliers, driver counts etc. All users have access to this module. Users can access this module by clicking on the dashboard in the navigation menu.

- New request web page

If a user wants to create a new request, they should access the new request page by clicking the '**New Request**' link from the menu. All registered users can access the new request page as long as they have successfully logged into the system. Depending on the access rights, request initiation, approval of the initiated request, scheduling and finalization of the request are being done through this module.

Admin Module

This module is accessible to authorised users such Transport Admin. The transport admin can add, update and delete reference page details accordingly. Following are the reference pages which have been implemented on transport management system admin module.

- Reference pages
 - Employee details module – user can add, modify and delete employee details
 - Department details module – user can add, modify and delete department details
 - Vehicle details module – user can add, modify and delete vehicles info
 - Cab details module – user can add, modify and delete cab details
 - Vehicle types module – user can add, modify and delete vehicle types
 - Supplier details module – user can add, modify and delete supplier details
 - Budget types module – user can add, modify and delete budget types
 - Driver details module – user can add, modify and delete driver details

- Budget allocation web page

Only the users with administrative privileges can access this module. To access the budget allocation module, he/she needs to be the transport administrator. By using budget

allocation, they can allocate the budget to the relevant departments accordingly. This option is visible in the main menu to the authorized users.

- Meter reading web page

Transport admin can view pending meter reading requests via this module. He / she can then approve accordingly. This is accessible through the main navigation link.

Reporting Modules

All reporting pages fall under this module. Users need to have admin access rights to view these reports. Users can also download the report as separate formats, such as Excel and PDF. All reporting pages which can be generated are mentioned below.

- Reference reports
 - Vehicle types report
 - Vehicle details report
 - Driver details report
 - Cab details report
 - Supplier details report
 - Department detail report
 - Budget type report
- Transaction reports
 - All employee requests report
 - All completed requests report

3.3. Technologies Used

Visual Studio 2013

To develop the transport management system, I have used Microsoft Visual Studio IDE (Integrated Development Environment), as it is easy to use and the IDE offers easy-to-use features, if you compare it with other IDEs. In addition, it is very easy to work with and provides real time error messages during the debugging process which is convenient.

Microsoft SQL Server Management Studio 2014

SQL Server Management Studio is an integrated platform for configuring, monitoring, and managing SQL Server instances and databases. I have used the SQL server management studio 2014 R2 license version during the physical modelling stage of my database for transport management system.

Use of C# language

Main reason I have used C# is that it integrates well with Windows environment without any special configuration. Moreover, C # programs are easily transmitted to the network, which will make the deployment of transport management system a smooth transition from development to production, once I received the proper approval from the bank.

Use of JavaScript

JavaScript is often executed in a client's browser which means less load on the server with immediate feedback to the visitors. Moreover, it aided me in enhancing the user interface. Hence, I have used JavaScript during the development of transport management system. Below screen shot provides a sample code of JavaScript which I have used to validate the user input of a textbox control in the developed transport management system.

```
function allowOnlyNumbers(evt) {
    evt = (evt) ? evt : window.event;
    var charCode = (evt.which) ? evt.which : evt.keyCode;
    if (charCode > 31 && (charCode < 48 || charCode > 57)) {
        return false;
    }
    return true;
}

function AllowNumbersAndDecimal(evt) {
    var charCode = (evt.which) ? evt.which : evt.keyCode;
    if (charCode != 46 && charCode > 31
        && (charCode < 48 || charCode > 57))
        return false;

    return true;
}
```

Figure 3.3. 1 Sample JavaScript code

Use of Bootstrap

I have used Bootstrap mainly due to browser compatibility and mobile responsiveness. Since I have a plan to extend this to a mobile version, I have used Bootstrap which includes HTML and CSS based design templates which I used for buttons, forms. Etc. Following demonstrate the mobile and browser compatibility achieved via the usage of Bootstrap in my design.

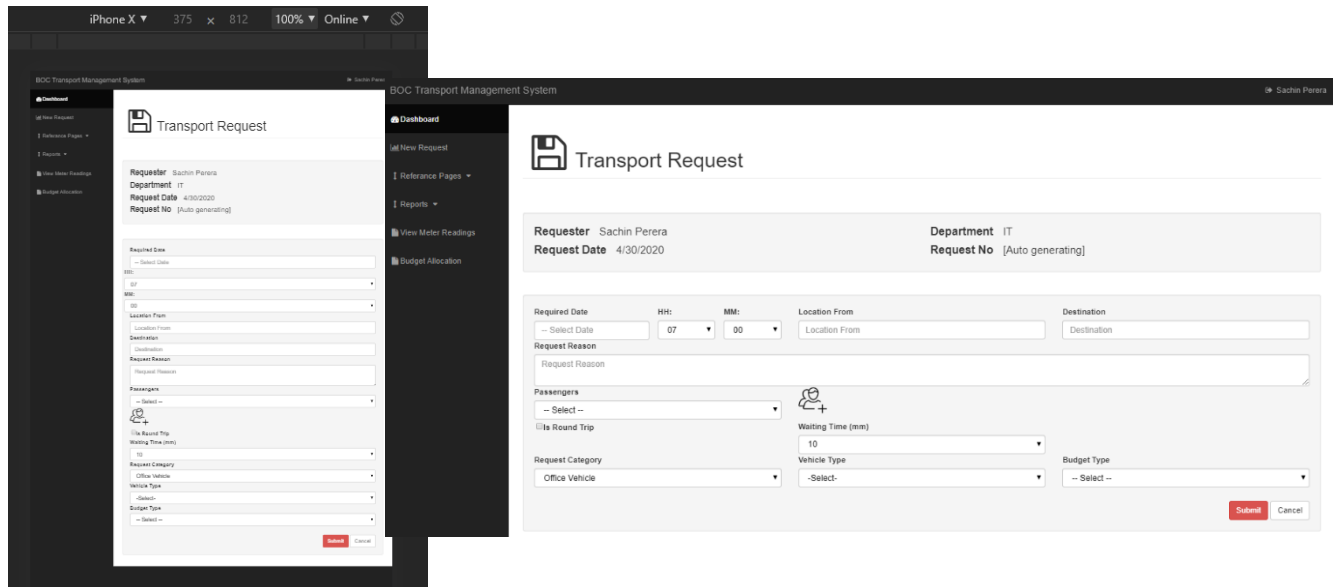


Figure 3.3. 2 Responsive design of browser view and mobile view

3.4. Design Methodologies Used

Waterfall Model

Waterfall software process model has been used mainly for this software project, due to the inherent linear structure of it which is ideal for a milestone- and date-focused project such as this one. I have adopted the linear sequence life cycle of the waterfall model to its full effect when developing the transport management system.

As it allows for early design changes, I have spent more time on design phase during the development of the transport management system.

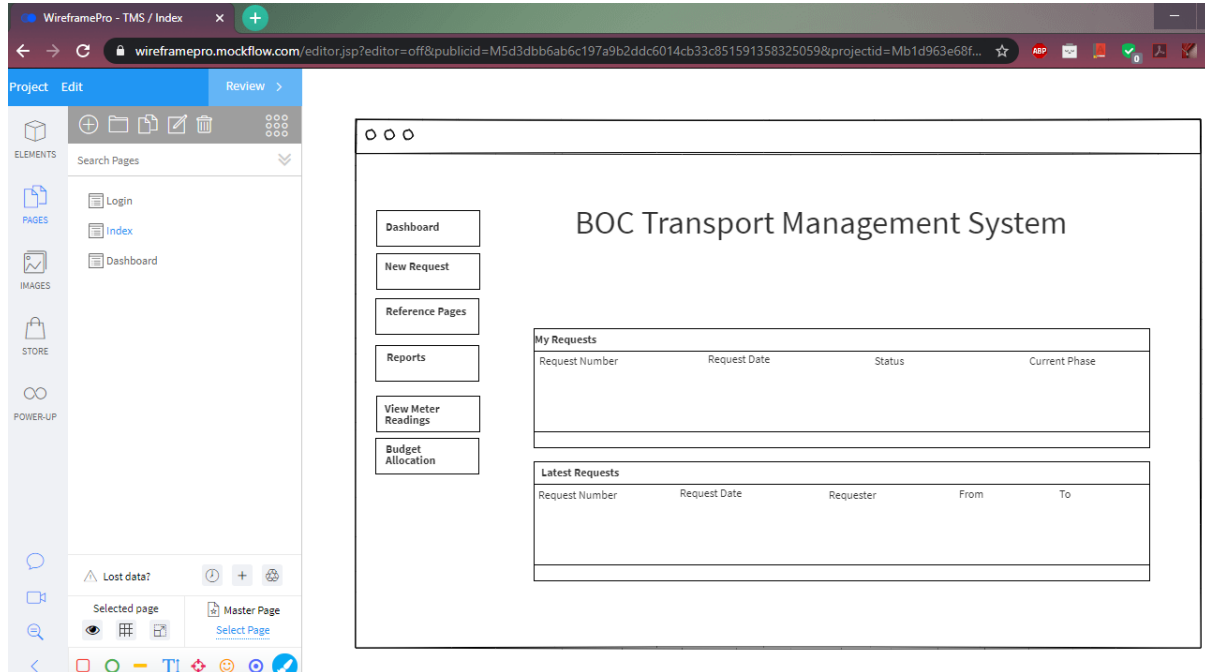


Figure 3.4. 1 Design phase

Since I had to make the design aspects perfect and approved in the early stages of the life cycle, I have created mock interfaces using **mockflow.com**. I have finalised the design stage by getting the approval to the ones I have created via **mockflow.com**.

Hence adopting the waterfall methodology has aided me in finalizing each phase accordingly without a hassle. As there were no ambiguous requirements from the business after finalizing the requirements in the initial stages, I was able to work sequentially as planned. This allowed me to use the waterfall model throughout the project without diverting to another approach such as agile methodology.

Use of Object-Oriented Programming Model

Object-oriented programming (OOP) is a programming model that uses objects and their interactions to design applications. I adopted OOP methods during the development phase as C# provided full support for OOP and made the code easy to maintain, modify and debug. So that allowed me to make a full-fledged application with less code and shorter development time. Following code snippets will provide an idea of OOP methodologies I have adopted when developing the transport management system.

```
[Serializable]
public class SupplierDetail
{
    public int Id { get; set; }
    public string SupplierName { get; set; }
    public string ContactPerson { get; set; }
    public string ContactNumber { get; set; }
    public string Address { get; set; }
    public bool IsActive { get; set; }
    public DateTime ModifiedDateTime { get; set; }
    public string ModifiedBy { get; set; }
    public DateTime CreatedDateTime { get; set; }
    public string CreatedBy { get; set; }
    public string CommandText { get; set; }

    public SupplierDetail() { }
    public SupplierDetail(int id, string supplierName, string contactPerson, string contactNumber, string
    {
        this.Id = id;
```

Figure 3.4. 2 C# OOP class example used

The constructor is a special class method that is automatically invoked every time a class instance is created. It is used to assign initial values to data members of the same class. Usually constructor has the same name as the class name.

According to above sample code snippet, in order to call the **SupplierDetail** class, which stores cab supplier information, following coding pattern should be adhered.

```
SupplierDetails sup1 = new SupplierDetail();
```

Hence user will be able to access **supplierDetail** class simply by typing **sup1** followed by a **dot**.

```

private void BindBudgetTypes()
{
    try
    {
        List<BudgetTypeEntity> budgetTypeEntityList = new List<BudgetTypeEntity>();
        budgetTypeEntityList = SharedBase.BudgetTypeBase.GetEntire();

        if (budgetTypeEntityList != null)
        {
            budgetTypeEntityList.Insert(0, new BudgetTypeEntity { Id = 0, BudgetTypeName = "-- Add Ne
            BudgetTypeNameDropDownList.DataSource = budgetTypeEntityList;
            BudgetTypeNameDropDownList.DataTextField = "BudgetTypeName";
            BudgetTypeNameDropDownList.DataValueField = "Id";
            BudgetTypeNameDropDownList.DataBind();
        }
    }
}

private void BindBudgetTypes(int departmentId)
{
    try
    {
        List<BudgetTypeEntity> budgetTypeEntityList = new List<BudgetTypeEntity>();
        budgetTypeEntityList = SharedBase.BudgetTypeBase.GetEntireByDepId(departmentId);

        if (budgetTypeEntityList != null)
        {
            budgetTypeEntityList.Insert(0, new BudgetTypeEntity { Id = 0, BudgetTypeName = "-- Sele
            BudgetTypeDropDownList.DataSource = budgetTypeEntityList;
            BudgetTypeDropDownList.DataTextField = "BudgetTypeName";
            BudgetTypeDropDownList.DataValueField = "Id";
            BudgetTypeDropDownList.DataBind();
        }
    }
}

```

Figure 3.4. 3 Method overloading example on transport management system

Above code snippets will demonstrate the use of method overloading implemented by defining two methods which have the same name with different parameters, in two classes which are having an inheritance relationship.

Transport management system architecture

The transport management system adopts a three-tier architecture, which runs on local intranet. User will be able to view through a web browser running on a client workstation that resides on bank's intranet and the data is being handled through a database server.

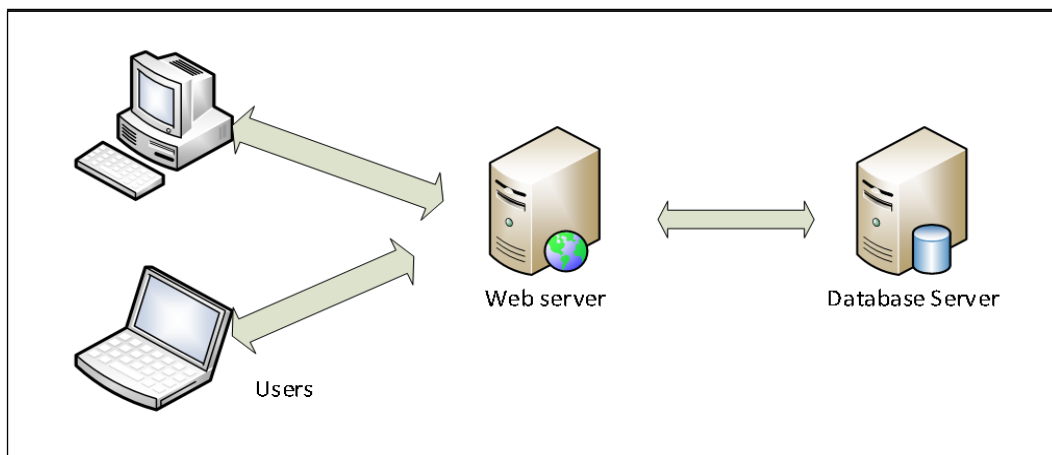


Figure 3.4. 4 System architecture

All head office staffs who use an intranet-based transport management system have access to the program through a web browser. Therefore, only registered users in the BOC domain have access to this transport management system.

They will all interact directly with the intranet web server running at the core of the application, using HTML and Active Server Pages (ASP). ASP enables the server, in this case IIS (Internet Information Services) server to deliver dynamic, database-driven content to the user with minimal effort. MSSQL server will then via Database-only Access permission, connect to IIS server to store and provide data in a persistent manner. Once a user initiates an request through his/her browser, using the request-processing architecture IIS server will then communicate with the database server and send the appropriate response to the user's browser.

Model View Controller Architecture

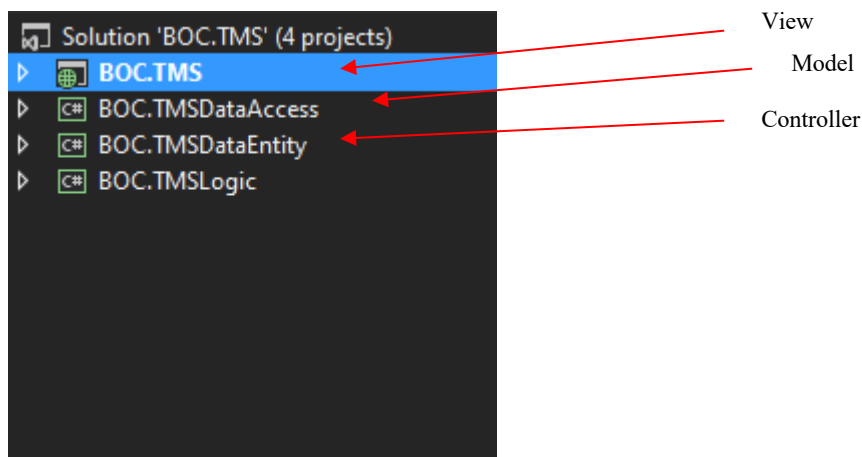


Figure 3.4. 5 MVC architecture

I have adopted MVC (Model View Controller) architecture when developing the transport management system. It allowed me to separate the UI (User Interface), classes and request handlers. Moreover, it allowed me to develop parallelly with a better control over the application I have built.

View

This layer has all the html controls that define the application's UI. This has a significant importance to the intranet-based transport management system as UI logic of the application as well as UI components defined on this layer. All the aspx pages resides on this layer which also validates the user's input. Moreover, rule processing is done in this layer which consists of all the CSS styles and JavaScript files.

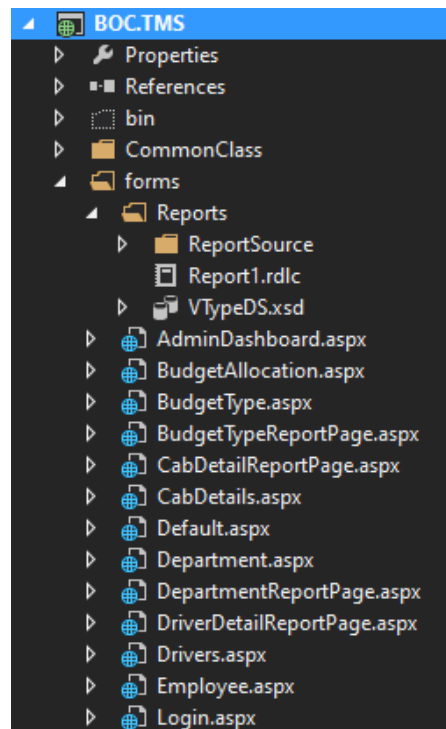


Figure 3.4. 6 View

Controller

Each entity in the controller has its individual repository with simple methods like Get, Delete etc. This layer manages the request and return the response to the user by loading the relevant view and data from the model. This also holds all repositories which are relevant to the transport management system and it's basically an interface between model and view components.

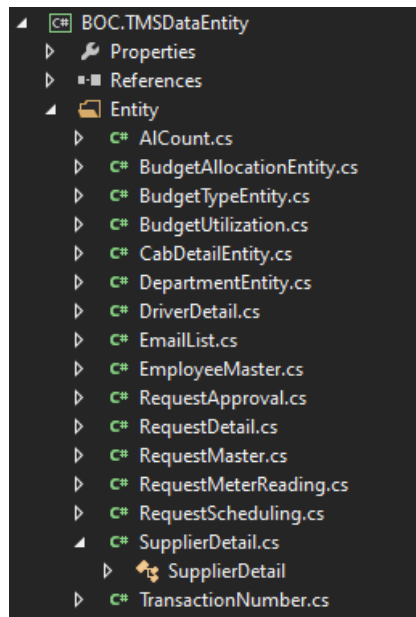


Figure 3.4. 7 Controller

Model

Model contains all the objects and its properties and methods defined in it. Moreover, objects defined in this layer will retrieve the respective information from the database. Then it will manipulate and update it data back to the database or else use it to render data. All the create, delete, update and get methods resides in this layer. Model also consists of the data connection file which is the key in communicating with the database.

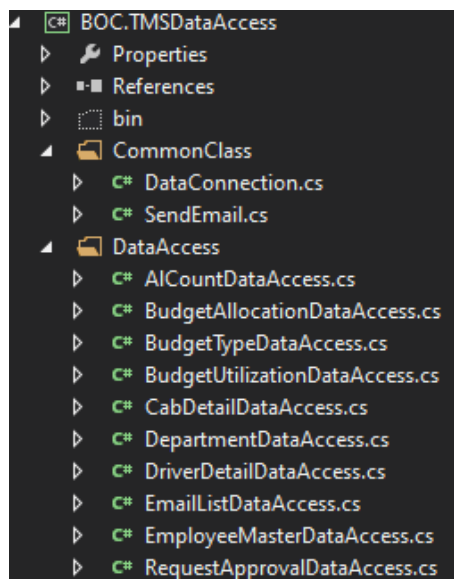


Figure 3.4. 8 Model

Chapter 4

4. Evaluation

When critically evaluating the created transport management system, a lot will depend on how well the system performs under normal circumstances without crashing. Hence the emphasis will be on the testing. Evaluation will be done mainly considering the outcomes of the vigorous testing procedures and the outcomes of them. Hence following will demonstrate some of the testing scenarios which had been done in order to evaluate the transport management system.

4.1. System Testing

Testing the transportation management system before launch is a very important step to ensure that all identified functional and non-functional requirements are integrated into the system without any major issues. System testing can be done in several stages. For the transport management system, I have done unit testing during the development phase. During the unit testing period, each major component has been separated from other components and checked at for their inputs and outputs.

During the actual testing phase according to the waterfall model, I have opted for integration testing where I have combined the individual units and tested as a group. It allowed me to evaluate the compliance of the developed system. Then I have allowed business users to test the system for user acceptance. Following will illustrate the integration testing test cases mapped with user requirements which I have used to evaluate the system.

Test Case	Expected Result	Steps	Test Data	Actual Result
01	User successfully login to the system	Enter user name in the login panel	mark	The user successfully logged in and directed to system's home page
		Enter the password in the login panel	123	
		Click login		
02	User login is unsuccessful and denied	Enter user name in the login panel	mark	Login failed with an error message "Login failed, Username or Password incorrect"
		Enter the password in the login panel	1234	
		Click login		
03	Successful request initiation	User clicks the new request, then his / her name, department	Requester: mark perera	Message displayed "Successfully saved"

	submission – normal user	and date will be captured automatically by the system	Department: Accounts Request Date: 5/1/2020	
		Enter required date and time	5/9/2020 07:00	
		Enter from location and destination	Head Office to Ragama	
		Enter reason	Test request reason	
		Select no. of passengers		
		Select the category	Office vehicle	
		Select the vehicle type	Car	
		Select budget	Accounts Budget	
		Click on submit		
04	Unsuccessful request initiation submission – normal user	User clicks the new request, then his / her name, department and date will be captured automatically by the system	Requester: mark perera Department: Accounts Request Date: 5/1/2020	Error message displayed “Please fill this field”
		Enter required date and time	5/9/2020 07:00	
		Enter from location and destination		
		Enter reason		
		Select no. of passengers		
		Select the category	Office vehicle	
		Select the vehicle type	Car	
		Select budget	Accounts	
		Click on submit		
05	Successful request approval submission –	User login to the system, then his / her name, and date will be captured	Name: Avril Lavigne Date: 5/1/2020	Message displayed “Successfully saved”

	Head of Department	automatically by the system		
		Select approve	Approve	
		Enter an optional comment	Test Comment	
		Click on submit		
06	Unsuccessful request approval submission – Head of Department	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Avril Lavigne Date: 5/1/2020	Error message displayed “Approval field cannot be empty”
		Select approval	-- Select --	
		Enter optional approval comment	Test Comment	
		Click on submit		
07	Permission error for request approval	Normal user logged into the system and click on his/her request for approval		Error message displayed “Access denied contact the administrator”
08	Successful request scheduling submission (cab) - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Message displayed “Successfully saved”
		Select supplier	PickMe	
		Enter voucher Id	N0005	
		Click on submit		
09	Unsuccessful request scheduling submission (cab) - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Error message displayed “Please fill out this field”
		Select supplier		
		Enter voucher Id		
		Click on submit		
10	Successful request scheduling submission (office vehicle) - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Message displayed “Successfully saved”
		Select vehicle	Car	

		Select vehicle number, driver details and payment details will be captured automatically by the system	CBA 8870	
		Click on submit		
11	Unsuccessful request scheduling submission (office vehicle) - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Error message displayed "Vehicle number field cannot be empty"
		Select vehicle		
		Select vehicle number, driver details and payment details will be captured automatically by the system		
		Click on submit		
12	Permission error on request scheduling	Normal user logged into the system and click on his/her scheduled request		Error message displayed "Access denied contact the administrator"
13	Successful request finalization submission - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Message displayed "Successfully saved"
		Insert number of kilometres	25	
		Insert amount	1500.00	
		Click on submit		
14	Unsuccessful request finalization submission - Transport Admin	User login to the system, then his / her name, and date will be captured automatically by the system	Name: Sachin Perera Date: 5/1/2020	Error message displayed "Please fill out this field"
		Insert number of kilometres		
		Insert amount		
		Click on submit		

15	Add a new driver	Authorized user logged into the system		Message displayed “Successfully saved”
		Add first name	Mahela	
		Add last name	Jayawardena	
		Add address	438/b City of Life, Colombo 7	
		Add NIC number	77354335V	
		Add mobile number	077422338	
		Add date of birth	7/25/1977	
		Add gender	Male	
		Add license number	TEST0007	
		Add license expiry date	11/17/2020	
		Click on submit		
16	Define a new vehicle type	Authorized user logged into the system		Message displayed “Successfully saved”
		Define vehicle type	Sedan	
		Add maximum number of passengers	4	
		Add a description	Sedan Test	
		Click on submit		
17	Define a new department	Authorized user logged into the system		Message displayed “Successfully saved”
		Add new department name	Security	
		Add new department’s ID	9000	
		Add a description	Security BOC	
		Click on submit		
18	Define a new Supplier	Authorized user logged into the system		Message displayed “Successfully saved”
		Add new supplier’s name	Ride Taxi	
		Add contact person details	Hotline	
		Add contact number	0112861111	
		Add address	RIDE TAXI (Casons Taxi Company Pvt Ltd)	

			181, Gothami Gardens, Gothami Road Rajagiriya	
		Click on submit		
19	Define a new cab service	Authorized user logged into the system		Message displayed “Successfully saved”
		Add new cab service name	Yogo	
		Add a description	Yogo cabs	
		Add contact person details	Hotline	
		Add contact number	0117177277	
		Click on submit		
20	Define new vehicle details	Authorized user logged into the system		Message displayed “Successfully saved”
		Add vehicle number	CAB-6254	
		Define vehicle type	Sedan	
		Add maximum number of passengers	4	
		Select A/C or Non-A/C	A/C	
		Add a description of the vehicle	Toyota Premio	
		Add insurance type	Comprehensive	
		Add insurance expiry date	12/25/2020	
		Add a supplier	Ride Taxi	
		Add a driver	Mahela	
		Check availability of the vehicle	Yes	
		Add vehicle year of manufacture	2012	
		Add default rate mode	Daily	
		Add daily rate	1500.00	
		Add monthly rate	30000.00	
		Add rate for a kilometre	55.00	
		Click on submit		
21	Define a new budget for a department	Authorized user logged into the system		Message displayed “Successfully saved”

		Add budget type	Security Budget	
		Add the relevant department name	Security	
		Add a description for the budget	Security Budget BOC	
		Click on submit		

Figure 4.1. 1 Test cases

Test Case Results

After implementing the test case for integration testing, I have taken the results of each scenario to further evaluate the transport management system. Following are the final test results of each respective test case.

Test Case	Date	User	Result
01	1/5/2020	Mark Perera	Pass
02	1/5/2020	Mark Perera	Pass
03	1/5/2020	Mark Perera	Pass
04	1/5/2020	Mark Perera	Pass
05	1/5/2020	Avril Lavigne	Pass
06	1/5/2020	Avril Lavigne	Pass
07	1/5/2020	Mark Perera	Pass
08	1/5/2020	Sachin Perera	Pass
09	1/5/2020	Sachin Perera	Pass
10	1/5/2020	Sachin Perera	Pass
11	1/5/2020	Sachin Perera	Pass
12	1/5/2020	Mark Perera	Pass
13	1/5/2020	Sachin Perera	Pass
14	1/5/2020	Sachin Perera	Pass
15	1/5/2020	Sachin Perera	Pass
16	1/5/2020	Sachin Perera	Pass
17	1/5/2020	Sachin Perera	Pass
18	1/5/2020	Sachin Perera	Pass
19	1/5/2020	Sachin Perera	Pass
20	1/5/2020	Sachin Perera	Pass
21	1/5/2020	Sachin Perera	Pass

Figure 4.1. 2 Test case results

Compatibility Testing

In order to further evaluate the system, I have done a browser compatibility test. Since majority of the PCs in BOC has Google chrome pre-installed as a default browser on them, I have analysed the system on chrome web page as it loads. Moreover, it has provided me with suggestions and optimizations to decrease page load time and increase the responsiveness. By completing the browser testing, I had more insight to further optimise the web page which is essential when implementing the solution as well as during the long run of the solution. Following screen captures are for the login page and the request initiation page of the transport management web solution.

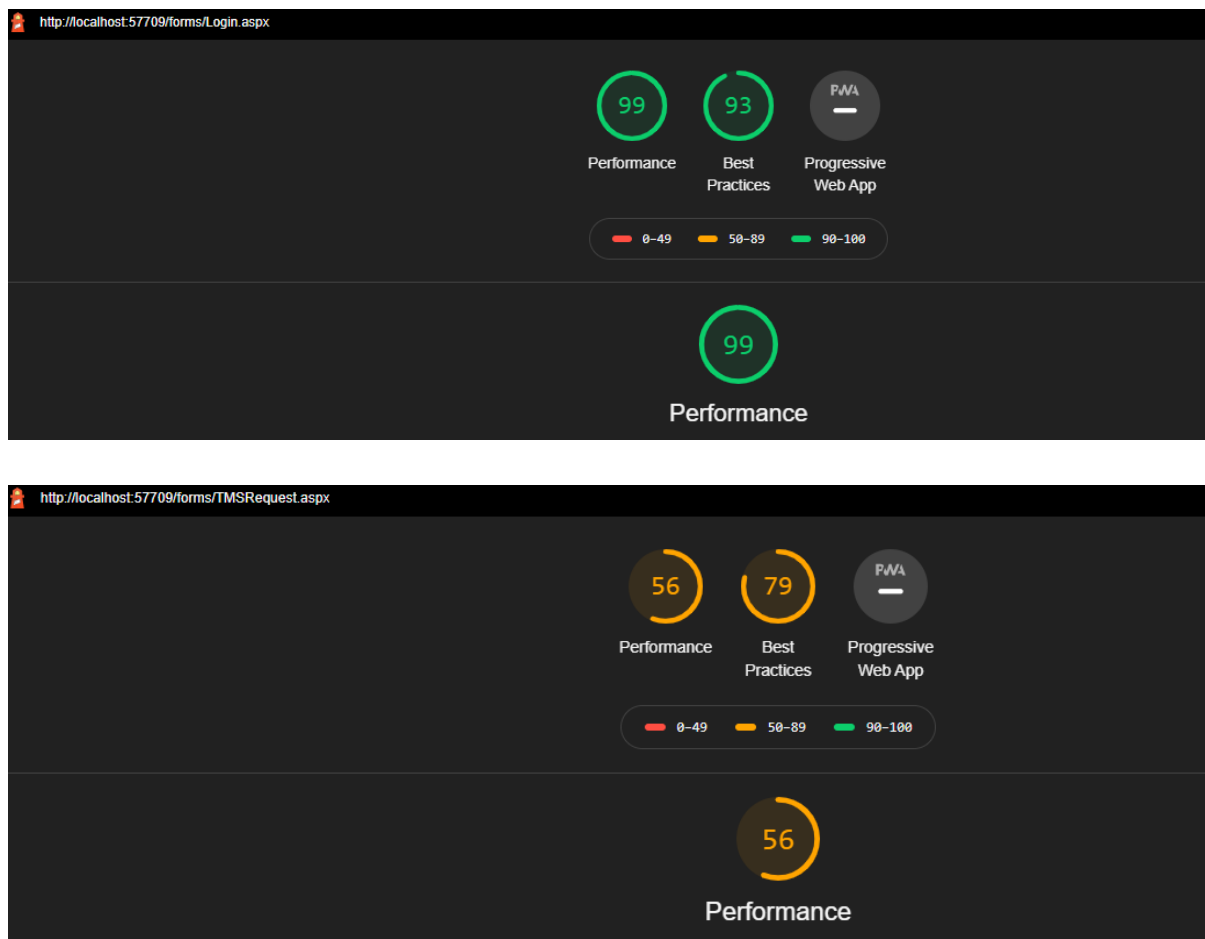


Figure 4.1. 3 Browser test results

4.2. Critical Evaluation

When critically evaluating the transport management system as a whole, it is a success, although there are some areas to be improved. As stated in my objectives, main aim was to develop a transport management system on BOC head office intranet. All the deliverables mentioned in the scope of the project has been delivered, except for notifications, which requires connecting to bank SMS & E-mail gateway which I have already requested for permission and waiting for a full code evaluation by BOC QA (Quality Assurance) team, to move ahead with the implementation of transport management web solution.

Once completed with the development and testing of the built application, it will be moved into the local intranet for final testing before rolling out. Hosting server will be on VM, as most of the banks' local applications. Installation of the application will start with implementing the MSSQL database back-end, and then making necessary VMware connections. Before moving it to the production, essential VMware network ports need to be opened by getting permission from the BOC network team, as all ports will be blocked by default according to BOC security policies.

Moving on to evaluate the testing aspects of the project, unit and integration testing have been completed successfully. When it comes to compatibility testing, there are points which came up unexpectedly, that I should consider in order to optimise my solution for the long run. More research is required to solve these mentioned issues.

1. I had a moderate score for First Contentful Paint (FCP) measure, which measures the time browser takes to render the first piece of DOM (Document Object Model) content after a user navigates to transport management web page.
2. For Speed Index measures, which show how quickly content is displayed during a page load, tested web page took 4.4-5.8 seconds which I need to reduce further.
3. Time to Interactive (TTI) value for my transport management solution, request initiation web page load, was over 7.3 seconds. TTI measures the time it takes a particular web page to become fully interactive when the web page displays useful content. [9]

In general, input delay occurs due to the fact that the browser's main thread is busy involving in another process, hence it can't respond to the user. One common reason this might be happening is due to the fact that the browser is busy parsing and executing a large JavaScript

file loaded by my transport management web solution. Generally, event handlers are registered for most visible page elements, which makes the page responds to user interactions within 50 milliseconds. Hence, I will be further checking the JavaScript files to ensure web pages of my solution loads more smoothly.

Moreover, I will also be researching upon the facts to preload web fonts, to fetch font files earlier which might be the cause of the delay in loading my web pages, although some pages (e.g. login) loaded without a delay.

To evaluate the usability of the developed system, I have selected a set of co-workers as well as business owners to critically evaluate the developed system. Their responsibilities were to complete a set of representative task scenarios presented to them, in an efficient and timely manner as possible, and to provide feedback regarding the usability and acceptability of the user interface. The participants were asked to provide honest opinions regarding the usability of the application, and to participate in post-session subjective questionnaires and debriefing. Their responses were taken into consideration to make necessary modifications.

Age Group * Response Crosstabulation

Count

		Response			Total
		Improve	Negative	Positive	
Age Group	1.00	1	0	5	6
	2.00	1	0	1	2
	3.00	1	0	0	1
	4.00	0	0	2	2
	5.00	0	1	3	4
Total		3	1	11	15

Figure 4.1. 4 SPSS crosstabulation responses

More than 73% positive responses have been received from the evaluation and according to the generated **crosstabulation**. When considering the age group, no negative responses received from the younger audience. Hence, I can make an assumption that the created transport management system is user friendly among the majority of the users.

Chapter 5

5. Conclusion

Objectives vs. Achieved

As stated in my objectives, main aim was to develop a web-based transport management system to BOC. I have achieved all the pre-defined objectives as per the given guide lines. Designing and developing a web-based transport management system adhering to BOC policies was a challenging experience in almost all aspects. Moreover, I was able to complete the project within the given tight time period.

Challenges Faced

One of the main challenges I had to overcome was the to adhere the BOC policies when developing a new system into the banks' infrastructure. Initially I was being asked to consider building the proposed system in AS400 environment. I had to point out the business the lack of GUI support and the mobility in developing a system in the core banking infrastructure. During the project period I had the role not only as a developer but also as an analyst, designer and a QA. In order to successfully develop the transport management system, I have adopted software development methodologies as well as elicitation techniques such as interviews, observations, manual system analysis, review of past data and questioners.

Decisions made during the development of transport management system, were done with the aid of business team. The methods I used to carry out the project were successful and the techniques and strategies used will be beneficial to the bank over time. When reviewing and assessing the system independently, there were few domain related problems which I had faced. However, with the help of business team I was able to overcome those problems. I am very excited to see the new system for transport management in action, which shows the effective results in terms of project plan.

My next objective is to get the necessary approvals from the bank to implement the system in its premises and to improve upon the work what I have done thus far.

5.1. Future Work

Before concluding this dissertation, it is important to define the future improvements of this intranet-based transport management system. Due to limitation of time, I have covered only the basic requirements of this project. As for improvements, I would like to integrate real time vehicle tracking with GPS (Global Positioning System) navigation as well as fuel tracking.

I would also like to build a mobile application for the bank users where they can request, track and view requests and vehicle details which is supported by android, and iOS platforms. Moreover, integrating with bank Active Directory system to populate user details, is another development I'm hoping to achieve in the future.

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Appendices

1.1. User Guide


Getting Started

This section provides a general walkthrough of the transport management system from beginning. This information will allow active users to understand the sequence and flow of the developed transport management solution.

Login to the system

- Enter the user name and password
- Click on sign in

Sign in to BOC Transport Management System



User Name

Password

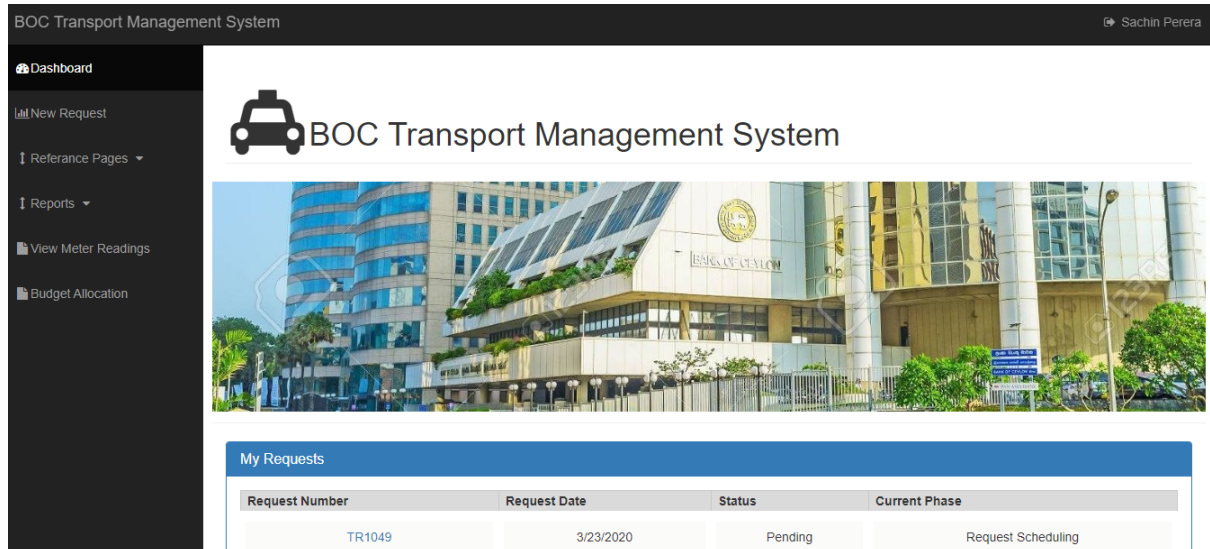
Sign in

Remember me [Need help?](#)

Appendices 1.1. 1 Login screen

Index page

Upon successful login, user will be transferred to the index page where he/she can see the statuses of their requests. Admin users have additional options displayed on their index page.




BOC Transport Management System

Sachin Perera

Dashboard

- New Request
- Reference Pages
- Reports
- View Meter Readings
- Budget Allocation

BOC Transport Management System



My Requests

Request Number	Request Date	Status	Current Phase
TR1049	3/23/2020	Pending	Request Scheduling

Appendices 1.1. 2 Index page

Request initiation

- Go to new request
- Initiator name and department will be captured automatically by the system

Requester mark perera	Department Accounts
Request Date 5/3/2020	Request No [Auto generating]

- Select required date from date & time picker

Required Date: HH: MM:

< May 2020 >

Su	Mo	Tu	We	Th	Fr	Sa
26	27	28	29	30	1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31	1	2	3	4	5	6

- Add request details

Requester mark perera	Department Accounts
Request Date 5/3/2020	Request No [Auto generating]

Required Date	HH:	MM:	Location From	Destination
05/09/2020	17	00	Head Office	Wattala
Request Reason				
Shift				
Passengers				
-- Select --		Waiting Time (mm)		
<input type="checkbox"/> Is Round Trip		10		
Request Category	Vehicle Type	Budget Type		
Office Vehicle	Car	Accounts Budget		
				<input type="button" value="Submit"/> <input type="button" value="Cancel"/>

- Click on submit
- Upon successful submission, successful message will be shown

Required Date	HH:	MM:	Location From	Destination
-- Select Date	07	00	Location From	Destination
Request Reason				
Request Reason				
Passengers				
-- Select --		Waiting Time (mm)		
<input type="checkbox"/> Is Round Trip		10		
Request Category	Vehicle Type	Budget Type		
Office Vehicle	-Select-	-- Select --		
				<input type="button" value="Submit"/> <input type="button" value="Cancel"/>

Successfully saved.!

Appendices 1.1. 3 Add request details

Department wise budget allocation

- Go to budget allocation page
- Select department
- Budget types will be automatically load according to the relevant department
- Select budget year
- Select Budget type
- Enter the budget amount
- Click on submit

Budget Allocation

Department Name
IT

Budget Year
2020

Budget Type
IT Budget

Budget Amount
250000

Appendices 1.1. 4 Department wise budget allocation

Add driver details

- Go to reference pages - driver details from the main menu
- Enter driver details
- Click on submit

Driver Details

User Name
BOC - Mahela

First Name
Mahela

Last Name
Jayawardena

Name in Full
Full Name

Address
438/b
City of Life, Colombo 7

NIC
77354335V

Mobile Number
077422338

Date of Birth
5/1/2020

Gender
Male

Drivers License No
TEST0007

License Exp Date
5/1/2020

Is Active

Appendices 1.1. 5 Add driver details

Add new supplier

- Go to reference pages - supplier details from the main menu
- Enter supplier details
- Click on submit



Supplier Details

Supplier Name	
<input type="text" value="Kangaroo"/>	
Supplier Name*	
<input type="text" value="Kangaroo"/>	
Contact Person*	Contact Number*
<input type="text" value="0117433433"/>	<input type="text" value="0117433433"/>
Address*	
<input type="text" value="No. 31 Duplication Road, Colombo 04"/>	
<input checked="" type="checkbox"/> Is Active	
<input type="button" value="Submit"/> <input type="button" value="Cancel"/>	

Appendices 1.1. 6 Add new supplier

Add new department

- Go to reference pages - department details from the main menu
- Enter department details
- Click on submit



Department Detail

Department Name	
<input type="text" value="HR"/>	
Department Name*	Department Id*
<input type="text" value="HR"/>	<input type="text" value="10004"/>
Description	
<input type="text" value="Human Resource BOC"/>	
<input checked="" type="checkbox"/> Is Active	
<input type="button" value="Submit"/> <input type="button" value="Cancel"/>	

Appendices 1.1. 7 Add new department

Add new employee

- Go to reference pages – employee master from the main menu
- Enter user details
- Define user type
- Click on submit

Employee Details

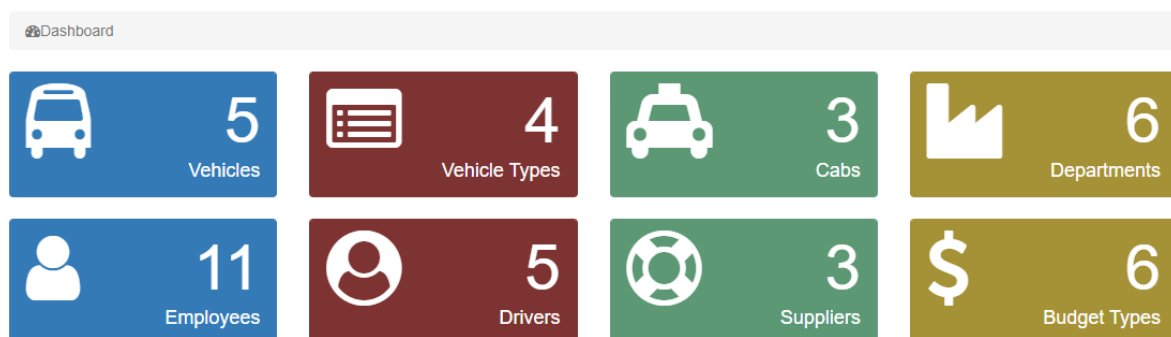
User Name	<input type="text" value="damien"/>		
User Name*	<input type="text" value="damien"/>	Password*	<input type="text" value="Password"/>
Full Name*	<input type="text" value="Damien Perera"/>		
Department*	<input type="text" value="IT"/>	User Type	<input type="text" value="Normal User"/>
Email Address*	<input type="text" value="damien@bocit.lk"/>	Mobile Number*	<input type="text" value="damien@bocit.lk"/>
<input checked="" type="checkbox"/> Is Active			
			<input type="button" value="Submit"/> <input type="button" value="Cancel"/>

Appendices 1.1. 8 Add new employee

View dashboard stats

- Go to dashboard form from the navigation link
- Note: Only the users with admin rights has permission to access the dashboard

Dashboard Statistics Overview



Appendices 1.1. 9 View dashboard stats