Using Data Mining Techniques to Analyze the Best Bus Route Available to Travel in Colombo

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Dissertation submitted to the Faculty of Information Technology, University of Moratuwa, Sri Lanka for the partial fulfillment of the requirements of the Master of Science in Information Technology.

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Declaration

We declare that this thesis is our own work and has not been submitted in any form for another degree or diploma at any university or other institution of tertiary education. Information derived from the published or unpublished work of others has been acknowledged in the text and a list of references is given.

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Signature of Supervisor

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Date:

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Abstract

Sri Lanka is a developing country with mainly two main public transportation systems. Train and Bus system will cover 90% of the transportation routes available across the country. Apart from these two modes other people use private vehicles for cater their travel needs. But, more than 80% of the people use trains and buses as the mode of transportation. With the limited availability of the trains, buses are being used a lot in common environment. But, the biggest disadvantage is passengers who use buses do not have a proper information system to cater their needs.

With the lack of information, we are wasting more time to our transport than our valuable time with loved ones. So, thus to make the work easy people keen to use their private vehicles instead of busses and trains. So, we are wasting our valuable time, health as well as money. So, to reduce these facts, it is crucial to develop a system and improve the efficiency of the time taken for transport in human life. This is a very serious issue that needs to be addressed.

With the development of the technology, information transmission is very easy. Day by day the usage of the mobile devices more specifically smart phone devices increasing and with the help of that the solution is to introduce a user-friendly web system which can be directly get the best possible bus route that need to take to prevent the time wasting on the roads and overcome the discomfort. There are passengers who required more comfort in traveling than the quickness of the travel. But some vise verse. So, in the proposed solution we are focusing both options. So, for the passengers who required more comfort travel can be chosen the busses with a lesser number of passenger density and for the passengers who need to travel fast to their destination can be taken the fastest bus route without thinking of the comfortability much.

Either a passenger or a non-passenger can access the designed web interface without any authentication. Then they need to select the starting and ending locations and the required level of satisfaction. Then the output will suggest the best possible bus routes which satisfy the search needs. So, this development helps consumers to plan the travel more efficiently by choosing the best route available with comfort or quickness.

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Chapter 1

Introduction

1.1 Introduction

With the rapid technological development in the world the transportation system will be more into automate the services day by day which letting the people to get the service without a hassle. In Sri Lanka, the railway department with a joint hand with ICTA, developed a system for train schedules and time tracks for easiness of the passengers who use train as a transportation mode. So, most of the people keen to take trains for day to day travel. Still people can't travel to an exact destination via trains and with the limited availability of the trains people need to use buses as well. So almost all passengers who use public transportation required a good understanding about buses and available bus routes with time details. So, this is high time to develop a bus route identification system for buses. It will provide a lot of advantages like reduced traffic congestion by limited use of private vehicles over public transportation, save lot of time as the time is valuable as gold.

Multiple bus routes often share street segments or run on parallel streets. These bus routes may provide service to the same neighborhood. Users could potentially choose the best route from multiple routes to reach their destination, or complete a segment of their trip [1]. Proposed system will need to more over focus on just selects a route to travel. Users have different needs while travelling. Some users need to travel with more comfort than hurry. Some are hurried to reach the destination. To cater all the needs, we need to consider the traffic and the time required to travel from source to destination for a specific time. Also, different users need to go to different places and they can select multiple bus routes. If A is starting and B is ending point, from A to B there can be 3 to 4 busses available. So, we need to see which bus is most suitable over their expectations.

Therefore, this study focuses on a system which aims at reducing the hassle and time to identify best possible bus route that can be taken to travel around the Colombo district with the desired user expectations.

1.2 Background and Motivation

As a developing country, Sri Lanka has two main public transportation systems. One is trains and other is buses, apart from those other people use private vehicles for cater their travel needs. But, more than 80% of the people use trains and buses as the mode of transportation. With the limited availability of the trains and the low facilities, buses are being used a lot. But, the biggest disadvantage is passengers who use buses do not have a proper information system to cater their needs. Sometimes it is very hard to find the correct bus route directly as multiple buses often share same streets which waste valuable time and money.

With the increasing of number of vehicles on the road, day by day the traffic also being increased. So, if most people keen to use their private vehicles means the entire roads are full of traffic and that leads to waste of valuable time in our lives [2]. Sometimes we spend more time on roads than we spend time with our loved ones. So, with the development of this project, it will reduce the traffic condition on the roads as well as give easy free access to the information required. Purpose of this project is to find a solution for this issue and provide a tool with important information about better bus routes.

1.3 Aim and Objectives

1.3.1 Aim

Develop a tool that helps consumers of the public or private transportation media as buses & trains to help to plan the travel more efficiently by choosing the best route available with comfort or quickness.

1.3.2 Objectives

- Design and implement a decision support system for bus route analysis that can be a great service to the society.
- Help the society by reducing the traffic congestion on the roads.
- Help passengers to plan the future travels with more effective manner.

- Help passengers to reduce the time waste on the roads.
- Route delay prediction to help the passengers to estimate the arrival time.
- Develop the tool that cater the user requirement as either comfortability or quickness of the travel.
- Reduce the time and effort put into search bus routes.
- Help passengers to get accurate information with live traffic. (Future step)

1.4 Solution

The solution is to introduce a user-friendly web system which can be directly get the best possible bus route that need to take to prevent the time wasting on the roads and overcome the discomfort. For the passengers those required more comfort travel can be chosen the busses with a lesser number of passengers and for the passengers those need to travel fast to their destination can be taken the fastest bus route without thinking of the comfortability much.

Also, the solution will provide several route options in which a user can select based on the selected criteria. Then users can plan the future travels by including the time that they plan to travel and the day type that travel happen, so the solution will provide the time taken to arrive to a selected destination.

Apart from the bus consumers, system also provide the train timetable to access for all the users of the system and that will help to decide the mode of transportation for the required journey to increase the effectiveness. This is a very useful way to help all the people in Sri Lanka who need to make the life simple.

The resources required for this research project are identified as follows,

- Research articles on similar analysis tools, web applications, databases and implemented products.
- Website and database development tools.
- Required information from the Sri Lanka Transportation board.

1.5 Structure of the Dissertation

In this report, the chapter two describes the current issues in the public transportation domain and how we mitigate those issues with proposed solution. Then in the chapter three describe the technologies those used for the proposed solution and how they are used against the issues is past. Then in the chapter four describes the how the technology adopts to solve the current transport needs and how the solution design. Then in the chapter five describes the Implementation of the solution so far. Next is the chapter six with the discussion of the overall solution and as the final chapter seven will provide the references.

Chapter 2

Exploring Current Findings in Bus Route Analysis

2.1 Introduction

Reviewing the work done by fellow researches will provide better understanding of the problem domain and mitigate most of the problems will occur in the development and implementation stages. We need to understand the overall image of the problem as we are targeting the humans as the solution owners. So, this chapter will cover the full description about background information of the project. That will cover the work done by other fellow researchers and the approaches used by others to solve similar situations.

2.2 Transportation Domain and Issues

In a developing country like Sri Lanka, understanding the current transport system is very much difficult. Day by day with the increasing of the population and the increasing the number of vehicles in the roads, the chances to predict a best suitable solution for the current transport issues is like a dream. To propose a solid solution, we need to consider a lot of facts.

In the world, there are considerable amount of solutions have built for the public transportation issues. But the lack of knowledge of the solutions and the non-systematic behavior of the transport system makes the solutions not success. But the solutions that propose for one country will be differ from another. That is because of the transportation system is not common among countries.

Lin and Zeng [3] proposed a solution including the set of bus arrival time prediction algorithms for a transit traveler information system implemented in Blacksburg, Virginia. They have introduced four algorithms with different assumptions on input data and were shown to outperform several algorithms from the literature. Their

algorithms, however, did not consider the effect of traffic congestion and waiting time at bus stations.

Kidwell [4] proposed an algorithm for predicting bus arrival times based on real-time vehicle location. He divided each route into zones and recording the time that each bus passed through each zone. However, the proposed algorithm is more suitable for small cities because there can be lesser number of variations in travel time and the waiting time than in a large city. These models are reliable only when the traffic pattern in the proposing area is stable. One of the limitations of both researches are they need bigger number of historical data to develop these algorithms, but the traffic patterns are very much vary over time.

El-Geneidy, Kimple and Strathman [5] proposed a paper of the analysis of the effects of bus stop consolidation on passenger activity and transit operations. They collected the details form the automated system that already online in the location and compare the results on the stop consolidation has implemented and not. So, they find that it's not effect for the passenger activities but the running times improved by that. When it come to the Sri Lankan transportation system, there is no automated setup up to date and we can take few development ideas from the research of them.

Prabhat and Margaret [6] proposed to develop the public transportation by integrating the transportation across buses and trains. They proposed two procedures as routing sub model and the scheduling sub module. In the routing sub model will proposed to provide the bus services for the railway stations as it will efficient the travel needs of the passengers and by scheduling sub model they try to make the scheduling the route selections and the schedule the bus service with parallel to the train schedule. For the research both the systems are automated and up to the systematic standard. So, the researchers can identify the needs to develop the travel needs easily and make the changes effectively. But, country like Sri Lanka, train schedule is close to fix but the bus schedule needs make as a system for integrate the both transportation modes in to single mode.

David Meignan, Simonin, and Koukam [7] proposed simulation and evaluation program for urban bus network using a multi agent approach. They try to see the

attributes that will increase the quality and the benefits from the urban bus system and how it will work. When develop a new system, with the constraints it is hard to develop the system in live environment. So, they used a simulated setup to analyses and plan the new system. They identified that the main interactions of the bus system are passengers, behaviors and the traffic of the roads. The complexity is differing from these interactions. So, they tried to simulate the plan considering the above 3 facts.

M Petrelli [8], proposed in his research paper on the way to design a model with intensive transit network of a new generation characterized by efficiency, integration between routes, and structured to improve the quality and ridership. This is focus on to the urban areas to minimize the overall system cost. He focuses on to heuristic algorithm to generate set of feasible routes, genetic algorithm to fine the optimal sub-set of routes and improve the model. So, he provides the optimal route, vehicle size and the frequency. He fulfilled some improvement on the route prediction for many ways simultaneously.

Owais, Moussa, Abbas and Shabrawy [9], proposed in their research on developing effective solution for the Transit Network Design Problem(TNDP). As this is very important in transit planning and the operation. The overall cost for the transport is depend on the TNDP. So, they proposed to optimize the routed that cover along with the frequencies that took place on the bus routes. So, this paper suggests ways to improve the bus frequencies and the route patterns.

2.3 Summary

With the work done from other researchers, we are unable to apply those full solutions to a country like Sri Lanka and the transportation system is differing from country to country. So, we need to more focus on the changing factors like traffic congestion on the roads, Road conditions and many more factors.

Chapter 3

Technology Adapted in Bus Route Analysis

3.1 Introduction

For a solution to become success the technology that use for the development is very important. There are various types of technologies available, but it is important to choose the most suitable technology at once. In the past researches have used a lot of technologies and we need to analyze them and mitigate the outcome issues of them. This Chapter will cover the technologies which will use to develop this solution. Also, the level of user friendliness that adapt from the technologies.

3.2 How to develop the Best Bus Route

3.2.1 Data Collection and Analysis

For the development of the solution, mainly we need to focus on gathering data from various sources. Some are related to web based and some needs to collect manually. As the project is based on the public transportation mainly buses, I went to the transportation board to collect the available route details that runs in Colombo area and the relevant bus stops.

Then some details are not up to date and went for several locations to collect the correct time details and that focus on to the bus drivers, bus conductors and the time trackers. Once after the required details collected used google maps to map the location according to the longitude and latitude.

For data analyze, we used data mining techniques. We use Rapid Minor software to data mining activities. Reason for choosing the Rapid Minor software for the development is, it contains a rich library of algorithms and functions to build the strongest possible model for any use case. It is very stable and easy to extend for programming. It is very easy to setup and no coding required.

Then we use Microsoft Excel software for analyses the collected data further to make the decisions more accurate. By using Microsoft Excel, one of a very powerful tool to data analysis and validation, I have import all the data for group as required and represent the data as required.

3.2.2 User Interface Development and Programming

The solution contains two systems. System A used web interface interact with the end user and the main development technologies used are ASP.net, Java Scripting. For the System B, use python programing.

For the System A once the data analysis completed, the front-end design was developed using web forms. We use Visual Studio software for the development because it provides very user-friendly development platform. As it gives better control and as we focus on to the web system ASP.net can be used for the web form development. It provides more interactive feeling for the passengers when using the web interface. As the appearance, also very much important for passengers to decide on using the service or not, we need to be more careful on the design.

Java Scripts and the ASP code can be mixed smoothly and dynamic web pages can be generated easily. The deployment also very easy as the availability of the built-in configuration information. It will reduce the line of codes that required to develop a large application. Java Scripts enables interactive web pages and thus is an essential part of web applications. Most websites use it, and all major web browsers have a dedicated JavaScript engine to execute it.

For the System B, we use python programming to develop. Python is a high-level, interpreted and general-purpose dynamic programming language that focuses on code readability. The syntax in Python helps the programmers to do coding in fewer steps as compared to Java or C++. The Python is widely used in many places because of its multiple programming paradigms. They usually involve imperative and object-oriented functional programming. It has a comprehensive and large standard library that has automatic memory management and dynamic features. Using python will increase the

productivity, but as disadvantages, it is very slow when the more data loads and bit difficult in troubleshooting run-time errors.

3.2.3 Data Storing

The data storing will be done with SQL in the future development. Currently, the solution is more focus on the few routes, the data is limited. So, the data is stored inside the program in the System A and in System B, it will retrieve from a data set stored in MS Excel. But in future expansion for all the routes the system uses SQL for storing the data. Main reasons for the selection of the SQL is, SQL queries can be used to retrieve large amount of data from a database quickly and efficiently. It also can view the data without storing the data into an object. We can join more tables and show the result in single object. It required a lesser coding and easy to maintain.

3.3 Summary

So, by using the above-mentioned tools and technologies, either a passenger or a non-passenger can access the designed web interface without any authentication or hassle. Once the Start and the End locations selected, they can select the desired level of satisfaction. Then they need to provide the day type as well as time of travel. Then the output will suggest the best possible bus routes which satisfy the search needs. So, this development helps consumers to plan the travel more efficiently by choosing the best route available with comfort or quickness.

Chapter 4

Approach and Design in Bus Route Analysis

4.1 Introduction

The approach is very important as we need to use the available technology for the best use of the solution. The design is very critical as the success of the whole system will be depend on the design phase. Will more focus on the high-level design of the solution and how they are interacting with each other.

4.2 Best Route by Expert System

As stated in above chapters, the biggest problem using the public transport system as buses is the lack of proper information presentation to the passengers. This is a challenge with the increasing of number of vehicles on the road, day by day the traffic also increased. So, thus most people keen to use their private vehicles. That will cause more traffic in the limited roads available. The main purpose of the proposed solution to provide a solid system that saves time and money.

The solution is to develop a web system which can directly get the best route to travel. The system can be accessed by the passengers or non-passengers. Anyone can plan the future trips using the system. For initial development, I have developed 2 separate systems. The first system will give the ability to locate the user location and the closest bus stop. Then user required to select the destination input. By the system it will analyze the data and provide the best route from the lowest distance and the lesser number of bus routes that will use. In the second system, passenger need to select the start location. Then need to select the trip end location. Then the passenger need to select the satisfaction level. This also divided to 2 main sections. It can be either travel with comfort or quick travel. Then the time of travel and day type.

Once the all mandatory fields filled, the system will analyze the entered data with the data in the backend that initially feed to get the best route suitable for the search criteria. The output will display the best route to travel and the information about the route.

As a separate function, if a passenger need to get any details about the exact route number, then there is a separate section to display all the used route details. The passenger will get the details like, start location, end location and the all the bus halts that cover from that route.

The system architecture as follows;

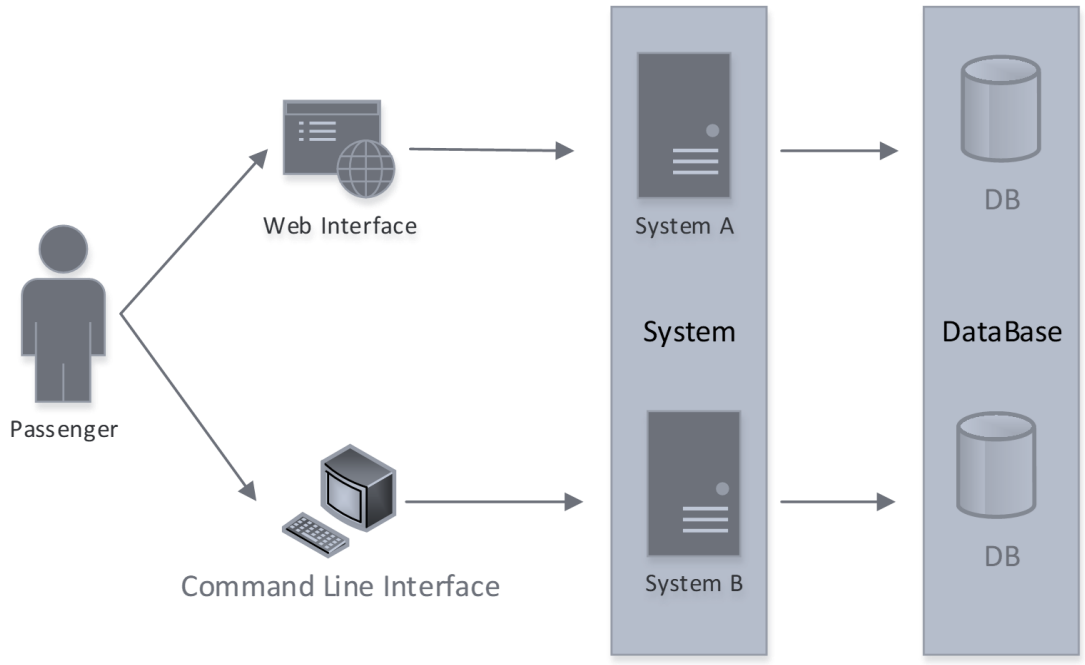


Figure 4.1: System Architecture

In the system user/ passenger has two options. One is use the web interface to access the System A. Other option is use command line interface to access the System B. In the System A, user will get the bus route available from source to destination, user tracking according to the user location, bus route information, train schedule. In the System B, user able to provide the source location and the destination location via command line interface and then user able to select the time of travel, desired satisfaction level (either comfort or quick) and the type of the day (weekday, weekend or holiday). With the information provided the system will suggest the best route details that suits the search need and the time taken for the travel in the peak or off-peak timing.

When the passenger selects the web interface it will direct the passenger to the System A. So, he has the above explained features and once the required fields filled the system will reach the data base with is SQL (future development) and retrieve the required data quickly and efficiently. If a passenger selects the command line interface he will direct to the CLI and passenger need to provide the details manually. Once the all the data typed correctly the system will reach the data base with is SQL (future development) and retrieve the required data quickly and efficiently.

The proposed models of the System A and System B is as below;

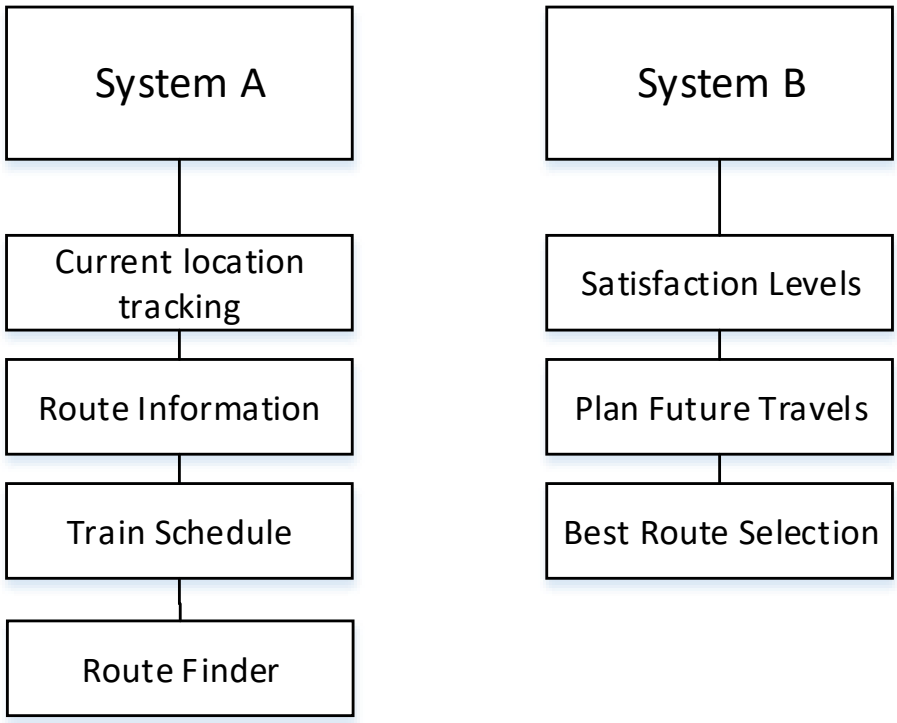


Figure 4.2: Proposed Models of System A and System B

In the System A, you will have following main features as;

- Route Finder and Current Location Tracking

In the Route Finder module, it is integrated with the current location tracking. Passenger required to either select the source location or if the passenger do not know the location or the closest bus stop, by pressing the locate me button it will provide the closest bus stop mapped. Then the passenger need to select the destination location and find the bus route. Th results will show the best bus route and the alternative routes according to the number of routes and less number of routes.

- Route Information details

  In the route information details section, passenger able to get the bus routes and the all the bus stops that cover by that route. In the future development passengers will get the search option by the location or the route number and get the required details.

- Train Schedule

  Train schedule is integrated to the system as the passenger required to use the both public transportation they can easily plan to use both options.

In the System B, you will have following main features as;

- Best Route Selection

  In the best bus route selection it is the integration of the below modules as well. The passenger will get the best bus route according to the selection that he/ she places.

- Plan future travels

  By providing the future travel time and the day, passenger able to get the peak and off-peak time details and able to decide the travel and alternative travel options.

- Satisfaction Levels

Different passengers have different satisfaction levels. Some like to travel with more conform by sit in a seat and with less crowd. But some required to travel fast for their needs. So, depending on the selection it will provide the required level of routes.

4.3 Summary

As the above chapter explained the overview of the problem in the current transport system and the suitability of the solution that proposed. Also, described the functionality of the proposed system as well as how the functions execute by the passengers.

Chapter 5

Implementation

5.1 Introduction

Implementation phase is very important in a development life cycle. We need to focus on the main functionality of the proposed system and how the tasks flow between each other. Also, need to focus on the importance of the functionality and the efficiency of the system.

5.2 Implementation

The implementation of the proposed system is very complex as the factors which need to consider is more. In a country like Sri Lanka, we are unable to predict the changing factors like traffic, condition of the roads, condition of the vehicles easily. But when considering a developed country, those factors are very less and most of the factors are constant for a longer period.

With the increased population day by day the number of vehicles that entering to roads will increase. But the number of roads that can cater the travel need is very limited. With the lack of proper maintenance of the roads the main concern is the prediction of the time to travel between two locations. So, thus we need to assume few factors as constant and then need to move on to the developing phase. One factor is the density of the passengers. We need to keep some constant values for this with two variations for peak and non-peak time intervals. Likewise, we need to identify the specific routes and the passenger density levels.

So, as the first step we have divided the 24-hour time frame in to two main categories like “Peak” and Off-Peak”. The division of the time between peak and off-peak is based on the data collected from different sources and analyze each hour based on the time for the routes. So, the selection as follows;

Type	From (24-hour)	To (24-hour)
Off-Peak	00:00	06:30
Peak	06:30	09:30
Off-Peak	09:30	12:30
Peak	12:30	14:30
Off-Peak	14:30	16:30
Peak	16:30	19:30
Off-Peak	19:30	24:00

Table 5.1: Peak and Off-Peak timing

We have 2 main systems that developed initially. The final(future) system will be interconnected of both systems. In the system A, there are three main sections. The very first one is Route Finder, then the route information and the details of the train time table.

Following are the bus routes that will cover in the system A. As mentioned in the research, I have mainly focused on the Colombo and suburb areas. To map these bus routes there are totally 151 bus stops that mapped across each other. All the routes are mapped from source to destination as well as destination to source. As example if we consider route 100: the bus from Pettah to Panadura is mapped and mapped vise verse. The details of the bus stops with each longitudes and latitudes are included in the Appendix A for further reference.

Route	Source/ Destination	Destination/ Source
138	Pettah	Kottawa
138	Pettah	Homagama
138	Pettah	Maharagama
138/2	Pettah	Mattegoda
138/4	Pettah	Athurugiriya
138/3	Pettah	Rukmalgama
100	Pettah	Panadura
100	Pettah	Moratuwa
101	Pettah	Moratuwa
154	Kiribathgoda	Angulana

154	Kadawatha	Bambalapitiya
120	Pettah	Horana
120	Pettah	Kesbewa
120	Pettah	Piliyandala
141	Narahenpita	Wellawatte
135	Kohuwala	Kelaniya
122	Pettah	Avissawella
122	Pettah	Rathnapura
125	Pettah	Padukka
125	Pettah	Ingiriya
177	Kollupitiya	Kaduwela
155	Soysapura	Mattakkuliya
155	Mount Lavinia	Mattakkuliya
140	Kollupitiya	Wellampitiya
175	Kollupitiya	Kohilawatte
119	Dehiwala	Maharagama
174	Kottawa	Borella
163	Dehiwala	Battaramulla
176	Karagampitiya	Hettiyawatte
103	Narahenpita	Fort
187	Fort	Airport
190	Pettah	Meegoda
336	Kottawa	Malabe
17	Kandy	Panadura

Table 5.2: Route Details

The time table of the train is a straight forward solution as there is a solution that is developed by the Railway department in corporation with ICTA. So, we can directly search railway system through the railways department web system. The reason for integrating the railway system into the solution as user friendliness. The approval is pending from the railway department authority to use their system under the proposed solution and at the same time I have started to build the railway information tracking solution as well. The data is pretty straight forward and routes are not changing like buses. Still I am periodically following-up on the approvals. So, passenger who required to travel via bus or train they can easily use one system for easy access the information. Either they can use both travel modes and plan the travel properly or either they can travel bus or train.

So, we need to more focus on the first two sections. In the very first search criteria are "Route Finder". The flow chart diagram of the function "Route Finder" is as follows;

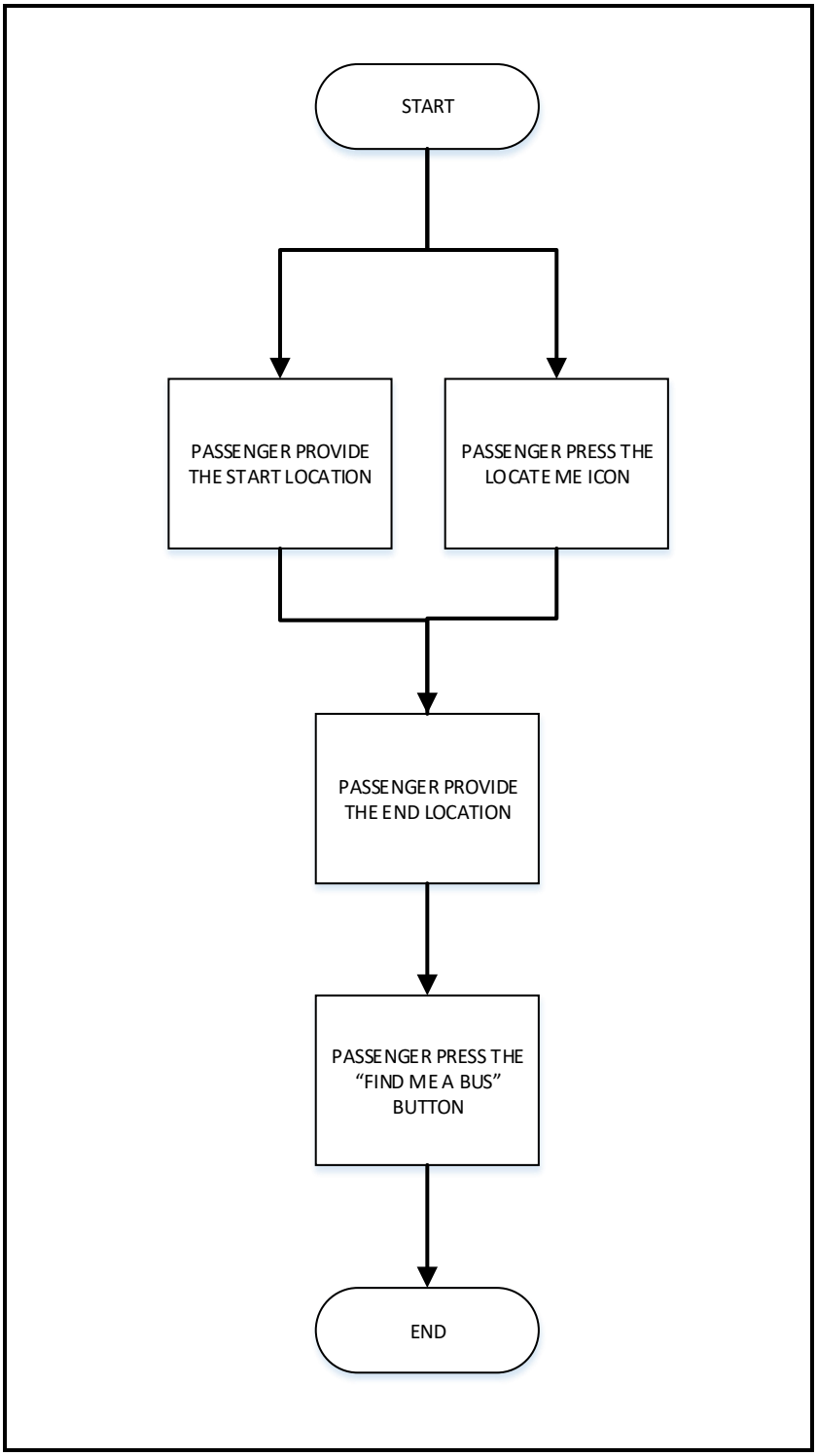


Figure 5.1: Task flow of "Route Finder"

The user interface of the “Route Finder” as follows;

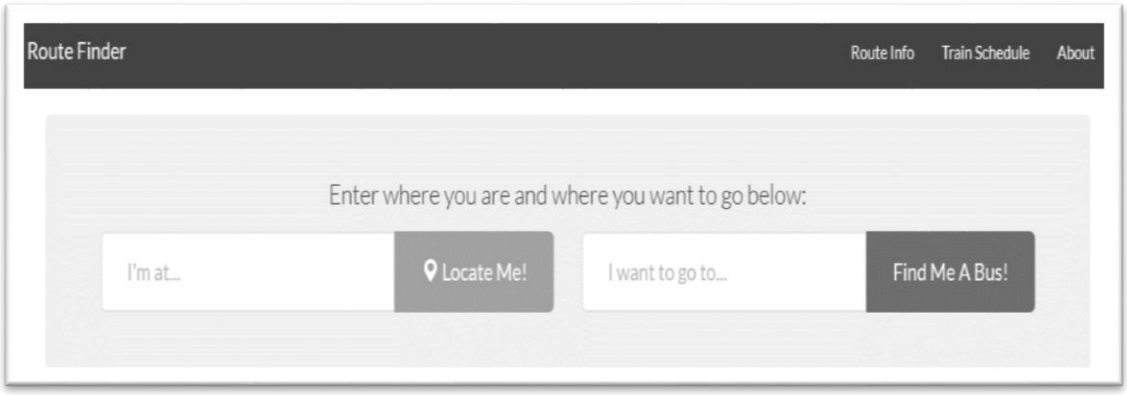


Figure 5.2: User Interface “Route Finder”

When selecting where you are, passenger has 2 options.

- Option 01: Type the location in the text box provided, when the passenger types the first letter it gives the locations that matches the letter.

Figure 5.3: Auto suggestion on the source location

- Option 02: Press the “Locate Me” icon. This will request the working browser to allow access to the current location that you are in and provide the closest location of the bus stop near you.

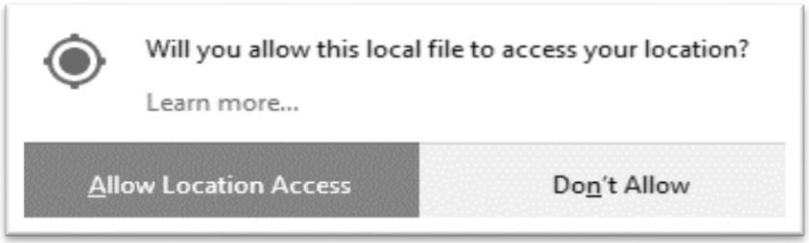


Figure 5.4: Requesting to allow to access your location

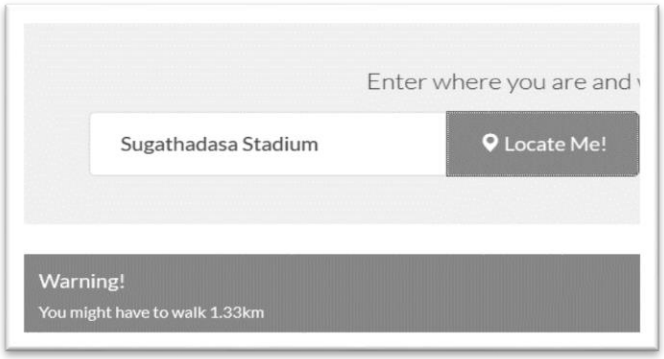


Figure 5.5: Output of pressing “Locate Me” icon

Once you have provided the source location by either option, you need to provide the location that where you want to go/ destination. Same as option 01 above you need to type the destination in the text box provided, when the passenger types the first letter it gives the locations that matches the letter.

Figure 5.6: Auto suggestion on the destination location

Once all the fields filled, passenger needs to press the “Find Me A Bus” icon. Then data will be matched in the backend system with the route details available. The output of the system A;

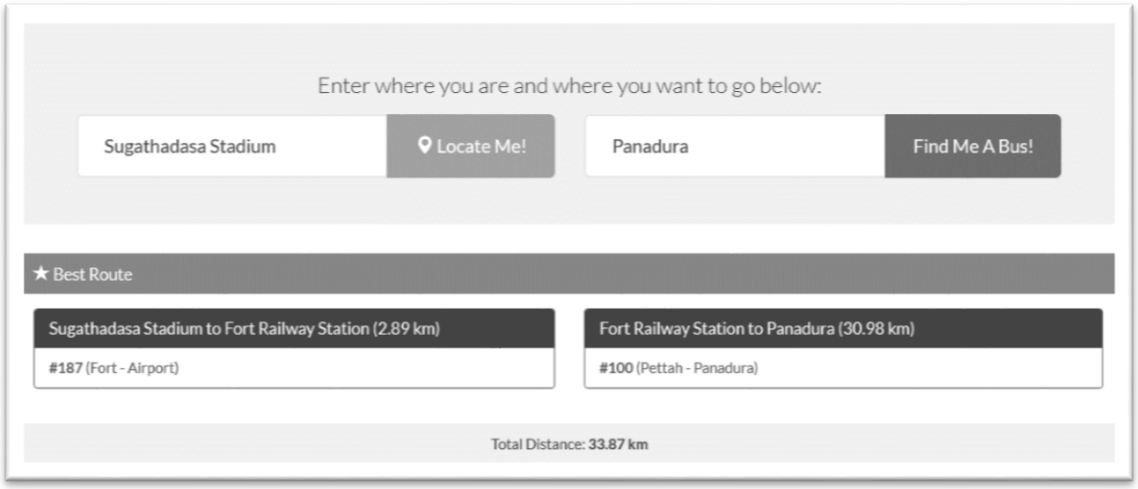


Figure 5.7: Output of the Route Finder

The second section is “Route Information”. As mentioned above this will provide all the details of the routes available. This includes the route number, start location of the route, end location of the route, and all the available bus stops that cover from the route. So, this section includes all the 34 routes and their details.

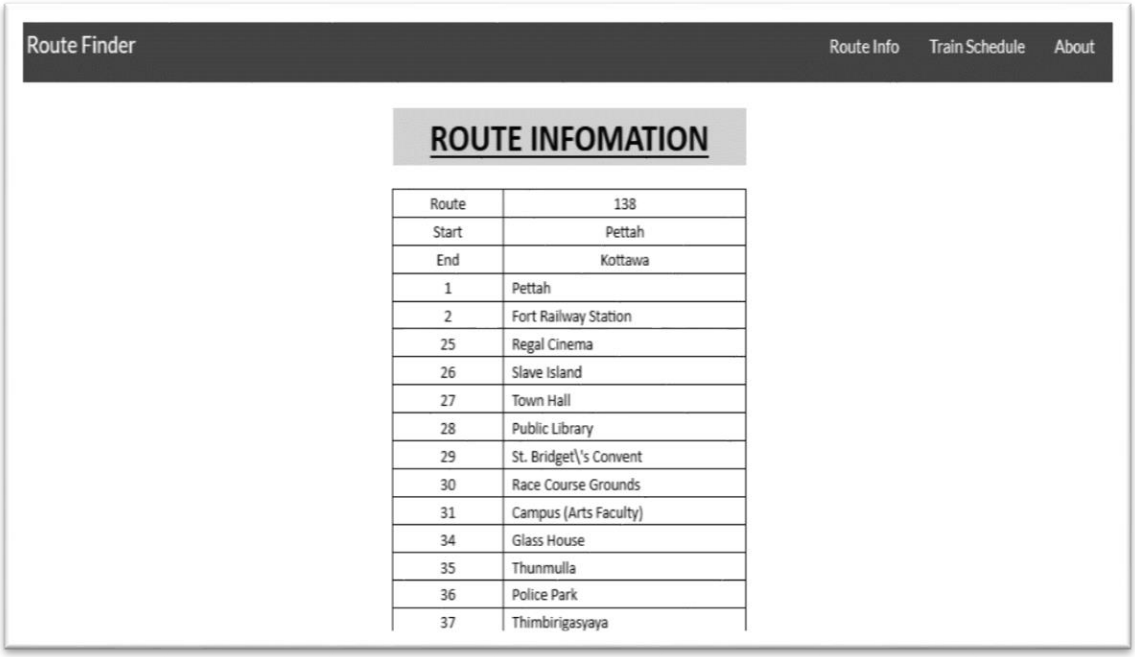


Figure 5.8: Route Information

This section will be developed further by providing the drop-down box to select the route number and retrieve the details according to that. Also, currently passengers lacking the route details when it comes to a specific location. As an example, if we are at “Kollupitiya Junction”, some passengers do not know what are the busses that available from that location. If we get Kollupitiya Junction there are route number 100, 101, 177, 140, and 175. So, will planning to make this more user friendly by adding options to select that the passenger required to do the search via route number, or specific location name. So, this will enable more information for the users as well as easy control to the system.

The flow chart of the function as below;

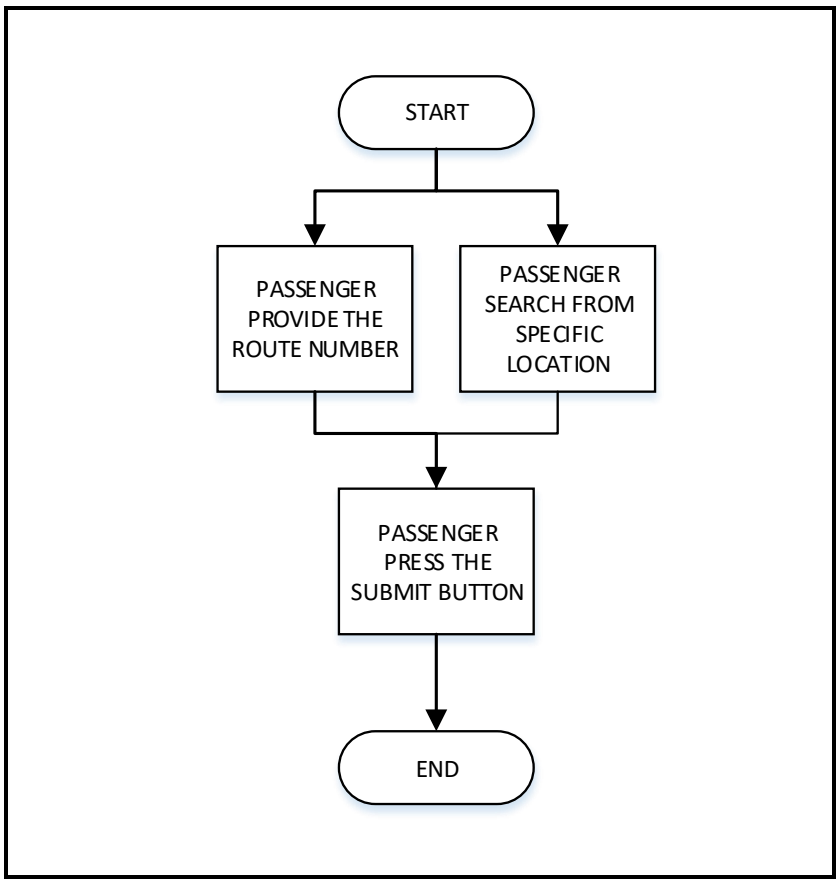


Figure 5.9: Task flow of "Route Information"

As described in the previous chapters, it is very straight forward and user friendly to operate the web system by any passenger. The passenger does not need to have expert knowledge on the system handling and the database work. With the few clicks, passengers will be able to get the desired outcome. With the limited functionality available, passengers will get this more convenient for use as well as keen to use in any phase.

In the error handling, if a passenger enters a source and the destination a same location, or if passenger presses the find bus button without entering source or destination, the error messages will occur saying the required fields are mandatory to fill and source and destination is same.

In the System B, will provide deeper functionality for the passenger to select the satisfaction levels as well as get more accurate details. My main objective of the research is to provide a solution for the passengers with decision support system for bus

route analysis. So, passengers can decide the time of the travel, the day of the travel weather it will be a holiday, weekday or weekend and the satisfaction level as the passenger required more comfort while travel or need to reach the destination immediately. By providing these features passengers can plan the future travels in an effective manner.
In the development of the system B, I mainly focus on to develop a web based system and integrate in to the system A. But with the limitations that come across, I have used python language to develop the outcome.

Python is a very strong interpreted high-level programming language. For the development, I have used the data that already analyzed by the data mining software. The passengers get the feature to select the self-satisfaction level of comfort or quick travel.

The selection is based on the time and density. Time that takes to travel from source location to destination location is considered and took the minimum time to choose the quickest time. This can be from one route or connection of number of routes. In the developing stage, it is very challenging to consider the number of routes and the lowest time as there are many rotes that will cover the same source and destination.

When it comes to the comfort, I have considered the density of the passengers in the bus at each bus stop. In the current stage I have consider the lowest passenger density when electing the comfortable route. But in my evaluation, I have found that I need to consider the number of seats that available in a bus and if the maximum count exceeds then there are no comfortable buses available at that location. This will be developing in my future work.

The entire system B is run in the command line interface (CLI). CLI also a user interface that use to provide output from a console window. Command line interface is a means of interacting with a computer program where the user/ client issues command to the program in the form of successive line of text (command lines).

Before executing a program in command line interface, we need to point the initial command to the location of the program that stored. Then we need to run the python program as below;

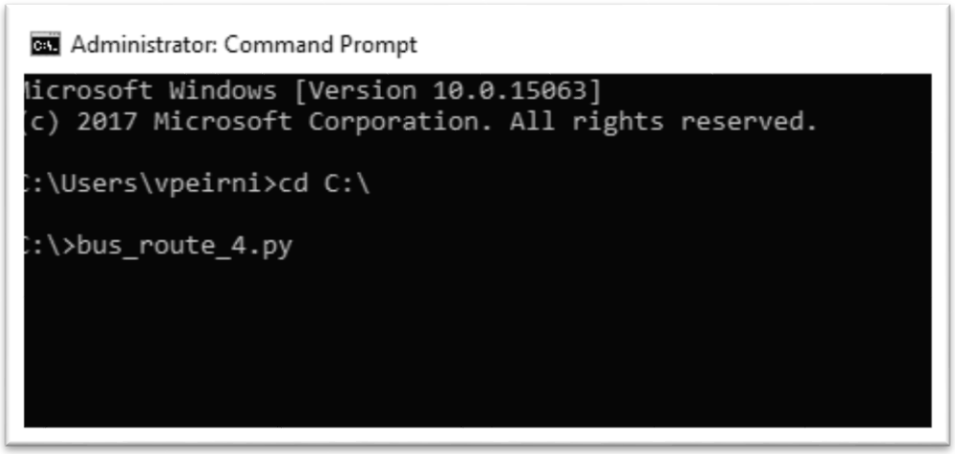


Figure 5.10: Initial setup of the CLI

Once the passenger runs the program, first he need to enter the start/ source location. The location needs to type manually and it can be any case as the system will take all the characters into upper case when the processing. If the passenger didn't provide the source location with the correct spellings then the output will give as none.

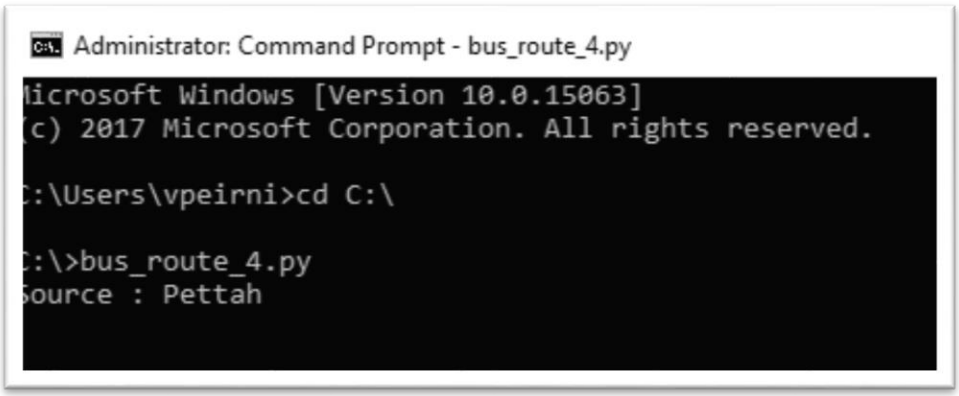


Figure 5.11: Source Input – System B

Then passenger need to provide where he/ she needs to travel. That location also needs to type manually and it can be any case as the system will take all the characters into upper case when the processing. If the passenger didn't provide the destination location with the correct spellings then the output will give as none.

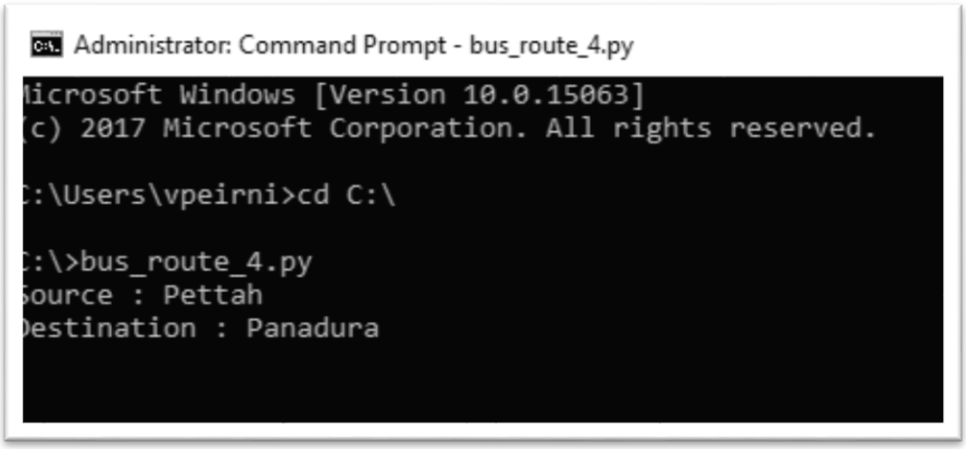


Figure 5.12: Destination Input – System B

Then the passenger will get to provide the time of travel. This will use to implement the future travel needs. Passenger can select the current time or any future time to see the best route to plan their travel. Passenger need to enter the time in 24-hour clock. Ex: 0630, 1330, 2130 etc. If the passenger didn't provide the time in the correct format then the output will be none.

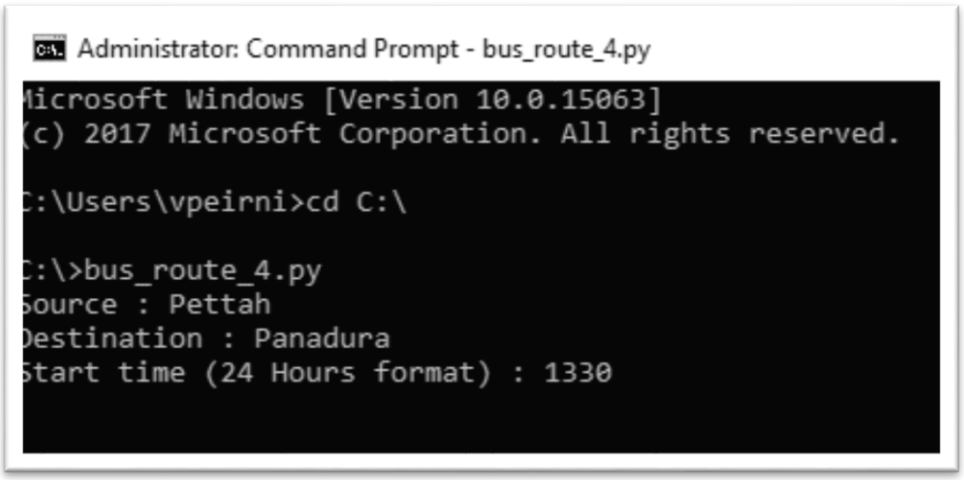


Figure 5.13: Time of travel – System B

Then it will come to the satisfaction level. There are 2 levels available. One is travel with comfort which represent by the "0" and the second level is quick travel without considering the comfort. That will be represent by "1". Passenger can select either one of the satisfaction level and the system will analyze the input and output according to that.

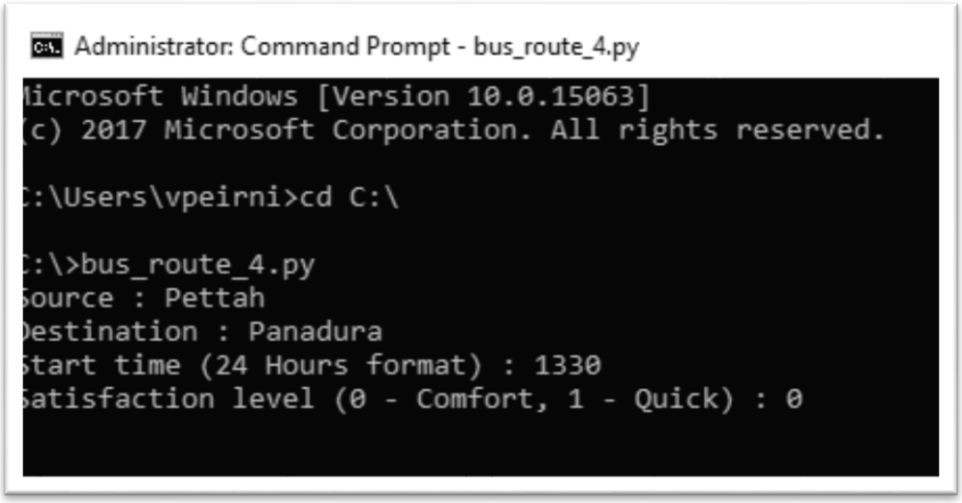


Figure 5.14: Selection of satisfaction level – System B

Then as a final step, passenger required to provide the type of the day. This is mostly used to plan the future rides as they can select either weekday, weekend or holiday. Depending on the type of the day the retrieving data is changed. As an example, if a passenger planning to travel to some destination on next Tuesday. That comes to weekday but it also a holiday. So, he includes as a holiday and he will get the approximate timing that required to travel in the peak and off-peak times depending on the satisfaction level selection. If he selects the comfort then passenger gets the density values of the bus on that time of the day into the best route available.

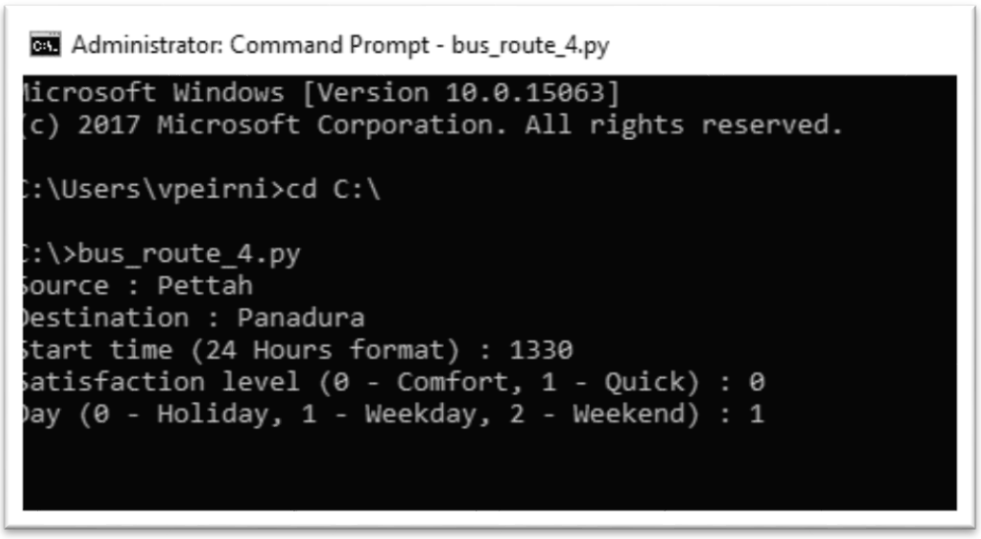


Figure 5.15: Selection of Type of Day – System B

The values of the day type are mapped as if the selected day is a “Holiday” then the passenger required to select “0” as the input. If the selected day is a “Weekday” then the passenger required to select “1” as the input. If the selected day is a “Weekend” then the passenger required to select “2” as the input.

If a passenger miss-typed or didn’t provide all the mandatory fields, the output will come as none. Once, successful input in place the output as follows;

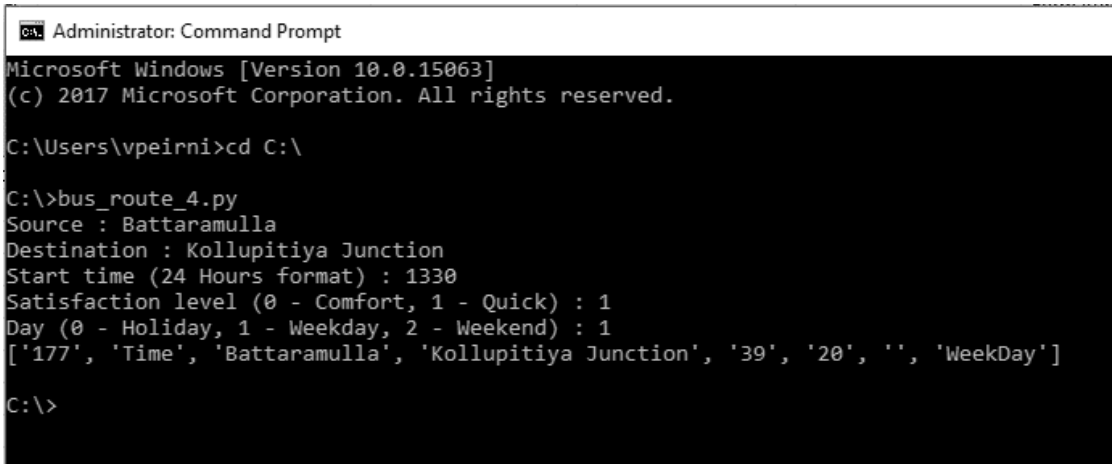


Figure 5.16: Output – System B

From the above output lets analyze the data providing to the passenger.
['177', 'Time', 'Battaramulla', 'Kollupitiya Junction', '39', '20', '', 'WeekDay']

- **'177':** The bus route that will suit the passenger search source and the destination location
- **'Time':** The time indicate the passenger satisfaction level. Passenger selects the 1-Quick as the satisfaction level. So, the data will process from the time taken travel from source to destination. If the passenger selects 0-Comfort then the data will process from the density of the buses.
- **'Battaramulla':** This will show the source location that passenger provided.
- **'Kollupitiya Junction':** This will show the destination location that passenger provided.
- **'39':** This is the peak level time that taking to reach from source to destination

- **'20':** This is the off-peak level time that taking to reach from source to destination
- **'WeekDay':** This is the type of the day that selected by passenger. Passenger selects the 1-WeekDay as the day type. So, the data will process from the weekday. If the passenger selects 0-Holiday, the data will process from the holiday. If the passenger selects 2-Weekend, the data will process from the weekend.

5.3 Summary

As the above chapter explained the overview of the implementation, functionality of the proposed solution and the assumptions made in the implementation phase.

Chapter 6

Evaluation

6.1 Introduction

The previous chapter discussed the details on the implementation, functionality of the proposed solution and the assumptions made in the implementation phase. This chapter justify evaluate the results.

6.2 System Evaluation

Regarding the system A, the functionality that initially proposed to develop is fulfilled and the objects are completed by interconnecting the both systems. For evaluate the system I have provided links of the both systems for few of my officemates and got the feedback on each functionality.

Regarding the system A which is web based solution, almost all the feedback received to integrate both the systems together as the system B is command line base solution and it is giving lot of errors when a passenger manually input the details. Then in the Route Finer functionality, there are lot of duplicate entries suggested by the system when the passenger provides the source and the destination.

With the feedback, I have corrected the issue to some extend as the reason for the issue is identified as the initial solution is basically focus on the few routes and with the increasing number of routes and the details, it will not map the correct route and the location.

Then as a feedback, all proposed to provide a Locate me button then through GPS the location of the passenger is selected automatically and mapped to the closest bus halt and provide the distance that need to walk from the current location to the source bus

halt. The proposed feature is implemented as an added feature than the objectives defined.

Then when it comes to the Route Info search, for the current version I have given all the details in a single web page and passenger who required to see the route details need to manually search the route details by browser default finder. But the feedback is to populate a search box with the route number and the location to track the route details separately as well as if a passenger selects a location then buses that will cover the location separately.

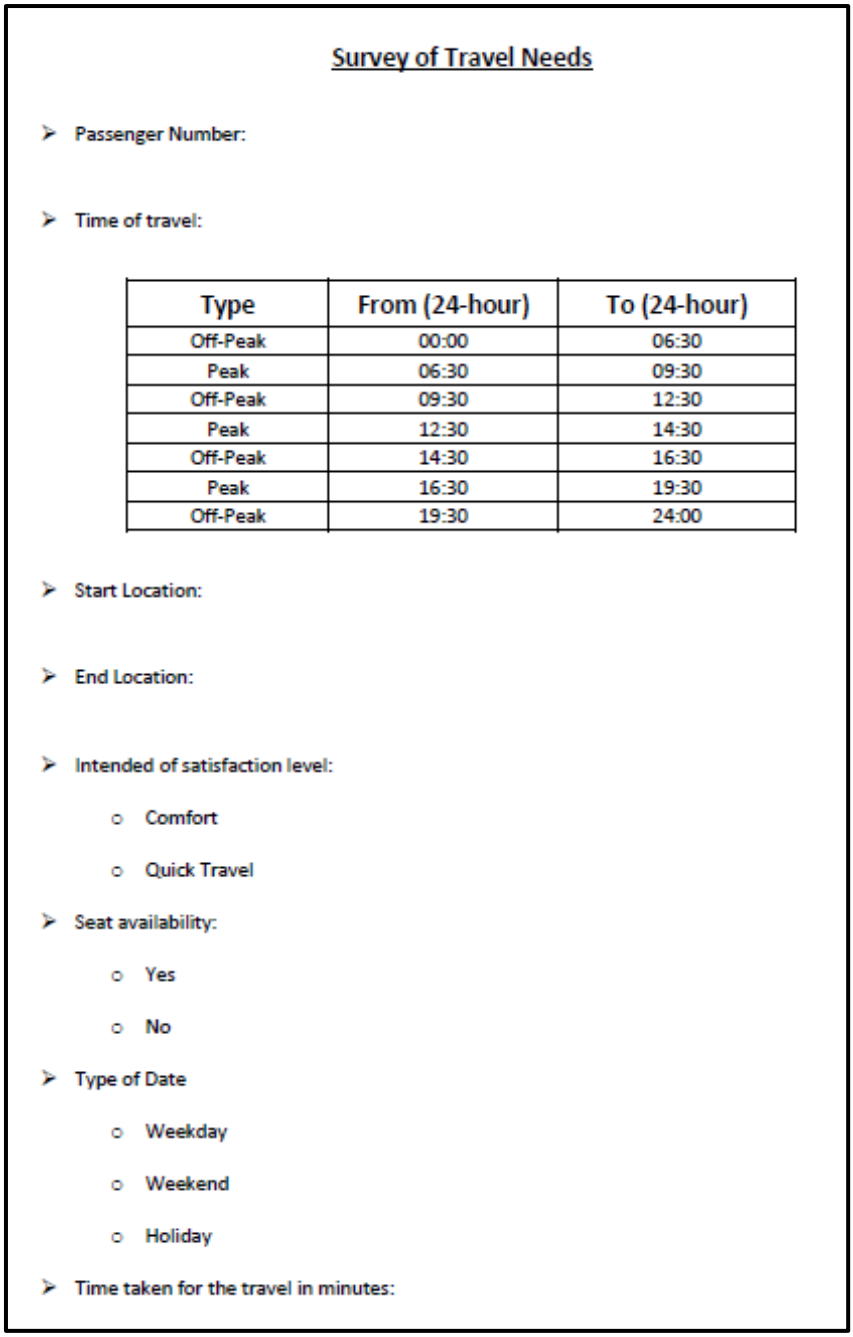
Regarding the train schedule, it is required to obtain the permission from railway department on publishing the same developed site on the current version or else with the proper data collection I need to develop the train schedule as well as all the details of the schedule is constant and not changing like the bus information that change with different variables.

Regarding the System B, the most objectives are covered from this. But the user-friendliness is the most issue that reported by the feedbacks received by the evaluators. If types the data misspelled or, not willing to type the full words the system will only providing the output as none.

So, by integrating the both systems will make the passenger types the few letters and the suggestions will come according to that. So, the issue in user-friendliness will be solved by that.

6.3 Data Evaluation

For evaluating the data, I have created a questionnaire as below. This was provided for few of my selected friends who is travelling on a specific route for their day-to-day activities via bus. I have taken 5 instances from each module for evaluating the system provided data with the real-time data.



Survey of Travel Needs

- Passenger Number:
- Time of travel:

Type	From (24-hour)	To (24-hour)
Off-Peak	00:00	06:30
Peak	06:30	09:30
Off-Peak	09:30	12:30
Peak	12:30	14:30
Off-Peak	14:30	16:30
Peak	16:30	19:30
Off-Peak	19:30	24:00

- Start Location:
- End Location:
- Intended of satisfaction level:
  - Comfort
  - Quick Travel
- Seat availability:
  - Yes
  - No
- Type of Date
  - Weekday
  - Weekend
  - Holiday
- Time taken for the travel in minutes:

Figure 6.1: Questionnaire

For the evaluation purpose, I will take the data from “Bambalapitiya” to “Panadura” on a peak, off-peak time intervals as well as covering weekday, weekend and holidays. With the feedback sheets received I have analyzed the data through Microsoft excel and come across below charts to compare the results.

For the system, the collected data is from different sources. They can list as below;

- From the Transportation Board, bus driver and conductors

- Using Google maps
- Using information from friends and family members
- Using my own data while traveling

The data took for the evaluation is from few of my friends who is traveling daily basis in different times.

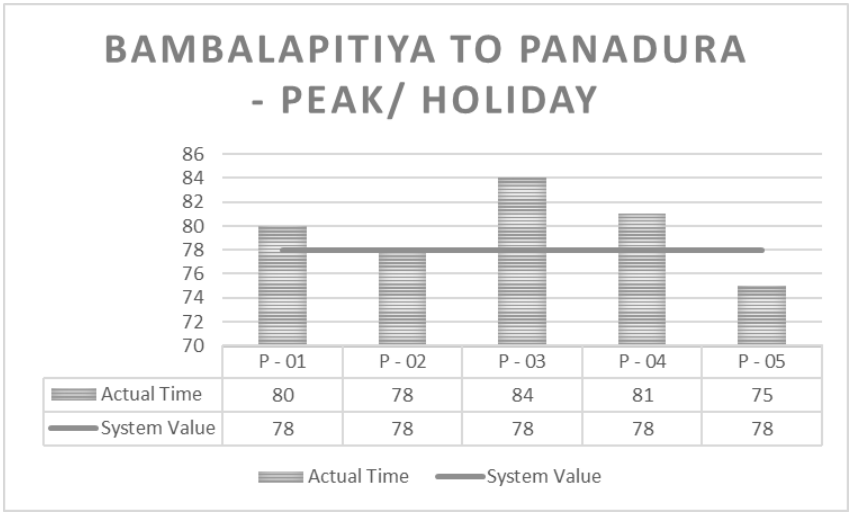


Figure 6.2: Bambalapitiya to Panadura - Peak/ Holiday

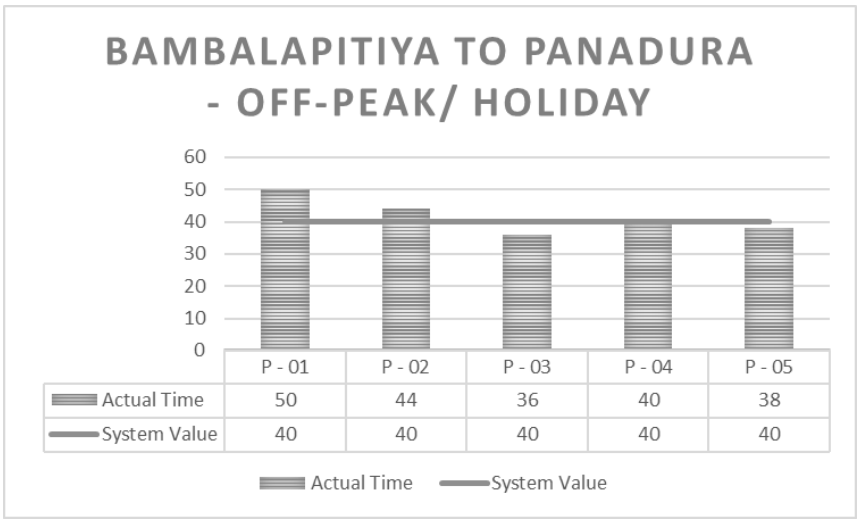


Figure 6.3: Bambalapitiya to Panadura – Off-Peak/ Holiday

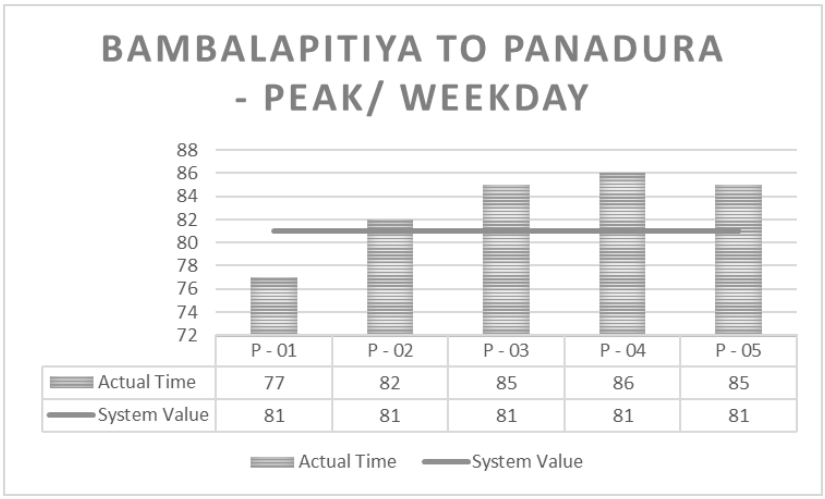


Figure 6.4: Bambalapitiya to Panadura - Peak/ Weekday

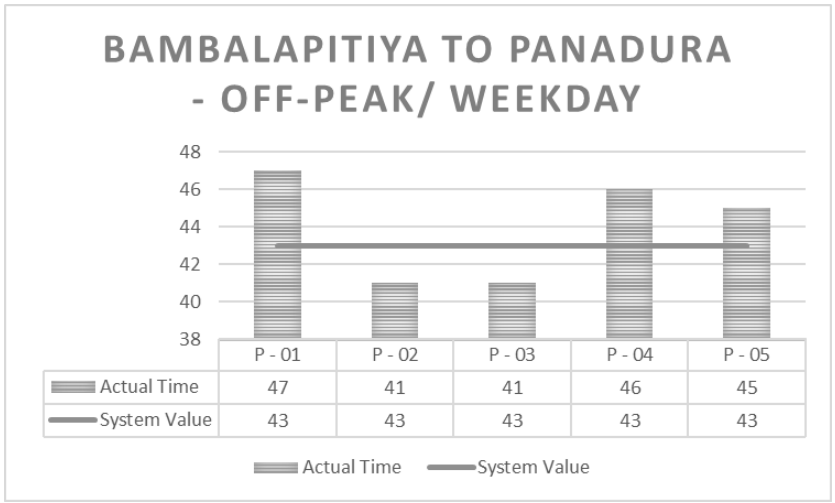


Figure 6.5: Bambalapitiya to Panadura – Off-Peak/ Weekday

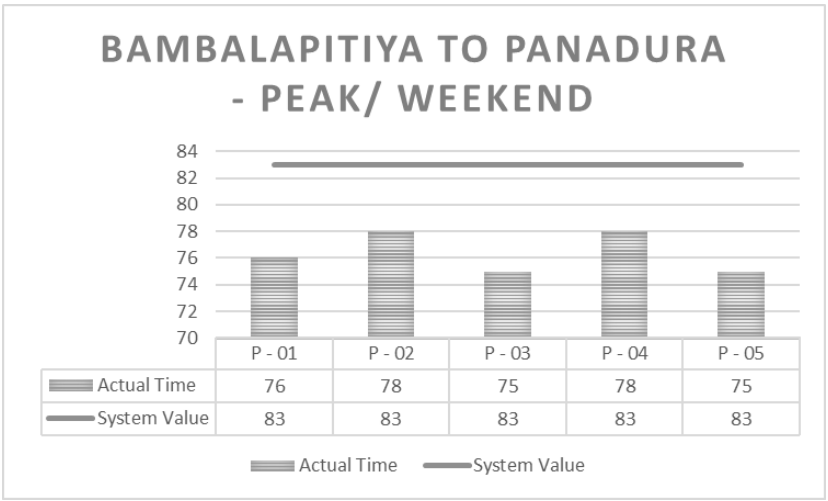


Figure 6.6: Bambalapitiya to Panadura – Peak/ Weekend

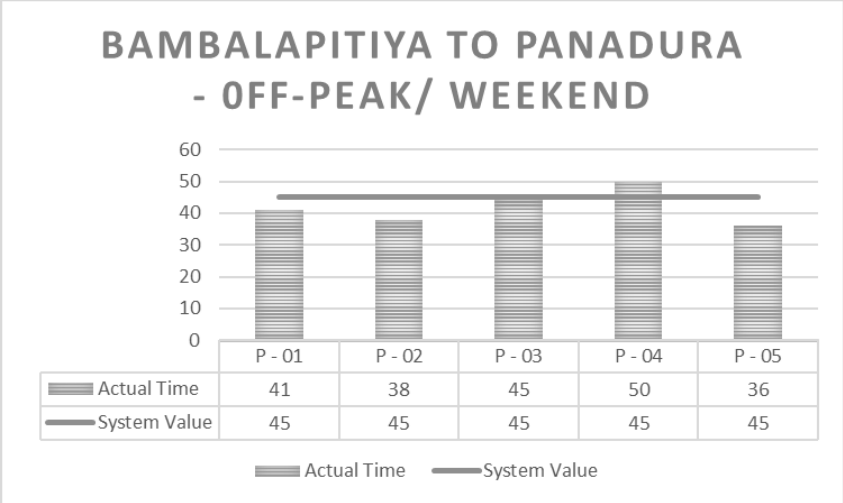


Figure 6.7: Bambalapitiya to Panadura – Off-Peak/ Weekend

From the above graphs, you can see that from the blue bars shows the actual times that received from survey and the red bar is the system value that will receive when a passenger runs the solution.

In the Figure 6.1, the system value is 78min. But the actual user experience is almost beyond that but much closer to the system value. But in the Figure 6.6 and Figure 6.7 values almost less than the system value.

So, I have analyzed the reasons for the changes of the value and found that there was a traffic plan change from local authorities than the previous days now and these changes cause the reduce the time taken for the travels.

When it comes to the number of people in a bus that will refer to the comfort level of the passenger is not a practical fact to collect over the survey as the counting is very difficult. So, with the limitation I have only considered the travel time of the specific routes. Like the graphs above when it comes to the other routes I have found that with unavoidable reasons the timing will vary with the system values.

6.4 Summary

In this chapter, evaluate the methodologies and the results discussed in the implementation chapter. Next chapter discussed some limitations and further improvements for the system.

Chapter 7

Conclusion and Further Work

7.1 Introduction

The previous chapters discussed the problems identified and the proposed solution. This chapter will discuss the achievements of the aim and objectives, limitations of the solution and further work.

7.2 Conclusion

As stated in the first chapter my main aim of this project is to develop a tool that helps consumers of the public or private transportation media as buses & trains to help to plan the travel more efficiently by choosing the best route available with comfort or quickness.

To meet the aim, I have developed two main systems that will cover the efficient travel and the choose the best route available with passenger satisfaction levels. So, the aim is fulfilling according to the functionality as well and the providing efficient information for the passengers that use public transportation for cater their travel needs.

When it comes to the objectives defined when the start of the project is as below;

- Design and implement a decision support system for bus route analysis that can be a great service to the society.
- Help the society by reducing the traffic congestion on the roads.
- Help passengers to plan the future travels with more effective manner.
- Help passengers to reduce the time waste on the roads.
- Route delay prediction to help the passengers to estimate the arrival time.
- Develop the tool that cater the user requirement as either comfortability or quickness of the travel.
- Reduce the time and effort put into search bus routes.

- Help passengers to get accurate information with live traffic. (Future step)

7.2.1 Design and Implement a decision support system

As the first objective, in the developed system it need to be decision support system. As with the functionality of the system, passengers can easily plan the travel needs. If the passenger needs to travel from A to B, but he needs to go with quickly. So, passenger required to provide the satisfaction level as quick and the results will be getting with quickest possible routes to travel to destination. Likewise, passengers can select a future date and time and decide on the travel easily.

7.2.2 Help to reduce the traffic congestion and time waste

Once the people use the system for their travel needs and if a person move from using their private vehicle for day-to-day travel to public transportation needs will result on to reduce the traffic congestion on roads. By that if we can make the public transport more accurate by providing accurate information though we are unable to control other variables we can easily contribute for reduce the traffic congestion on roads. That also will lead to reduce the time waste that happen in the roads.

7.2.3 Help passengers to plan the future travels in effective manner

As stated above passengers able to get decision support system from the developed tool. So, with that the passengers can easily plan the future travels in an effective manner. They can decide to overcome the traffic in the peak intervals and travel with more comfort and more relaxed if they required to travel like their home vehicles.

7.2.4 Route delay prediction to help the customers to estimate the arrival time

In the proposed solution, route delay prediction is one of the major feature. Currently passengers able to predict only the time taken to travel from one location to other depending on the time of the day and type of the day. But it is under the development of the predicting the delay of the buses and the estimate the arrival time according to that.

7.2.5 Cater the user satisfaction levels

As stated above user, there are 2 satisfaction levels available. One is travel with comfort, and other is travel with comfort. Passengers can select either one of them when deciding to search the best route that suit to travel. By this feature the passengers can overcome the traffic congestions, delay in reaching to the destination, reduce the time that waste on roads. If a user travel via their private vehicle for day-to-day work, by using the system they will be satisfy up to some level on travel with public transport as they can overcome the traffic congestion by selecting the off-peak times and selecting the satisfaction level as comfort will give the less congested buses for the need. So, the system will cater for the user satisfaction levels.

7.2.6 Reduce time and effort on searching buses

To identify the correct bus route that travel directly from source to destinations is somewhat difficult with the number of buses available and with the number different streets and different busses cover each street. So, a time for have a system on selecting these details is much more needed for the passengers. With the proposed solution and the system, the need will fulfill up to some level and passengers able to get the required information without a hazel.

7.2.7 Getting accurate information with live traffic

This section is currently in the development phase. Still I am gathering details on how to integrate the developed solution with the live traffic in Sri Lanka. This will be developed in near future.

7.3 Limitation

As the limitations encounter when the development of the system, the transportation modes are all depend on lot of variables. Here we try to provide an effective information system for the passengers. But by changing variables like the conditions of the roads, the conditions of the buses will lead on change the findings of the research. Here the output will be process according to some rough approximation. But if there is a bad

condition road, or bad weather conditions will lead for more time taken for a travel. These facts are not able to control by our self on the development.

With the increasing number of vehicles in to the roads will keep many traffic congestions. When it comes to a weekday, same time and same location there will be different traffic conditions. So, this fact also can't be challenged from the development. Day by day the new roads will create. So, the existing routes is changing to cater the new needs. I faced lot of difficult situations on collecting information for each route. There is no centralized location to get the correct information with the changes in other facts. So, a person providing the details on the bus routes will change one another.

7.4 Further Work

As a future extension for this study we will combine the created two systems in to a web based user-friendly system that will help any passenger to easily access via their mobile devise. Also, in future the enabling the delay prediction will help the passengers to identify the arrival time of the buses and this also need to enable to live traffic details on the route time prediction as with the traffic on the roads are not constant and by enabling the live traffic it will provide more accurate information on the time that takes to complete the travel from source to destination.

7.5 Summary

In this chapter, evaluate the methodologies and the results discussed in the implementation chapter. Next chapter discussed some limitations and further improvements for the system.

Chapter 8

Reference

[1] P. G. Furth and N. H. Wilson, “Setting frequencies on bus routes: Theory and practice,” *Transp. Res. Rec.*, vol. 818, no. 1981, pp. 1–7, 1981.

[2] S. Chandurkar, S. Mugade, S. Sinha, M. Misal, and P. Borekar, “Implementation of real time bus monitoring and passenger information system,” *Int. J. Sci. Res. Publ.*, vol. 3, no. 5, pp. 1–5, 2013.

[3] W.-H. Lin and J. Zeng, “Experimental Study on Real-Time Bus Arrival Time Prediction with GPS Data,” *Transp. Res. Rec. J. Tranportation Res. Board*, no. National Research Council, Washington, D.C., p. 1019, 1999.

[4] W. B. Kidwell, “Predicting Transit Vehicle Arrival Times,” *Geogr. Lab. Bridgew. State Coll. Bridgew. Mass*, 2001.

[5] A. EI-Geneidy, J. Strathman, T. Kimpel, and D. Crout, “Effects of Bus Stop Consolidation on Passenger Activity and Transit Operations,” *Transp. Res. Rec. J. Transp. Res. Board*, vol. 1971, pp. 32–41, Jan. 2006.

[6] P. Shrivastava and M. O’Mahony, “Modeling an Integrated Public Transportation System - a case study in Dublin, Ireland,” no. 41, p. 19, 2009.

[7] D. Meignan, O. Simonin, and A. Koukam, “Simulation and evaluation of urban bus-networks using a multiagent approach,” *Simul. Model. Pract. Theory*, vol. 15, no. 6, pp. 659–671, Jul. 2007.

[8] M. Petrelli, “A transit network design model for urban areas,” *Urban Transp. X*, p. 10, 2004.

[9] M. Owais, G. Moussa, Y. Abbas, and M. El-Shabrawy, “Simple and Effective Solution Methodology for Transit Network Design Problem,” *Int. J. Comput. Appl.*, vol. 89, no. 14, pp. 32–40, Mar. 2014.

Appendix A – Route Details

Details of the bus stops with their longitudes and latitudes;

#	Name	latitudes	longitudes
1	Pettah	6.93321	79.8554
2	Fort Railway Station	6.93408	79.8502
3	Lotus Road	6.93398	79.847
4	Galle Face Green	6.92196	79.8461
5	Kollupitiya Junction	6.91116	79.8497
6	McDonalds Kollupitiya	6.90317	79.8523
7	Bambalapitiya Junction	6.89369	79.8555
8	Holy Family Convent Bambalapitiya	6.88781	79.8573
9	Savoy Cinema Wellawatte	6.88027	79.8596
10	Wellawatte Junction	6.87534	79.861
11	Lake House	6.93261	79.848
12	Gamini Hall Junction	6.92653	79.8618
13	Darley Road/Excel World	6.92166	79.8622
14	Gangarama	6.91811	79.8543
15	Bishop\'s College	6.91459	79.8559
16	Mahanama College	6.90568	79.8536
17	British Council	6.89983	79.8555
18	Regal Cinema	6.93128	79.847
19	Slave Island	6.9233	79.8516
20	Town Hall	6.9168	79.8634
21	Public Library	6.91287	79.8579
22	St. Bridget\'s Convent	6.90965	79.8637
23	Race Course Grounds	6.90618	79.8637
24	Campus (Arts Faculty)	6.90258	79.8622
25	Campus (near Wycherley)	6.90002	79.8595
26	Thurstan College	6.90502	79.8583
27	Glass House	6.91094	79.8583
28	Thunmulla	6.89619	79.8603
29	Police Park	6.89288	79.862
30	Thimbirigasyaya	6.88998	79.8638
31	BRC Grounds	6.88753	79.8645
32	Redimola Junction	6.88363	79.8683
33	Maya Ave.	6.88077	79.8704
34	Kirulapone Junction	6.87858	79.8746
35	Kirulapone South	6.87772	79.8786

36	Balapokuna Road	6.87384	79.8819
37	Anula Vidyalaya	6.87195	79.8843
38	Nugegoda	6.86932	79.8896
39	Seventh Mile Post	6.86686	79.8933
40	Gansabha Junction	6.86511	79.8966
41	Delkanda	6.86282	79.9018
42	Wijerama	6.85764	79.9086
43	Navinna	6.8551	79.9134
44	Arpico M\'gama	6.85243	79.917
45	Wattegedara Junction	6.85123	79.9211
46	Maharagama	6.84608	79.9281
47	Sugathadasa Stadium	6.94666	79.8691
48	Armour Street	6.94343	79.8643
49	Ananda College	6.9245	79.868
50	Maradana	6.92824	79.8646
51	Castle Street Hospital	6.91097	79.8852
52	Devi Balika Vidyalaya	6.91102	79.8821
53	Alwis Place Kollupitiya	6.91264	79.8539
54	Arts Fac. Horton Place	6.91155	79.8687
55	Green Path	6.91173	79.862
56	Stratford Avenue	6.87761	79.873
57	Kirulapone Ave.	6.88269	79.8756
58	Suwisuddharamaya	6.88013	79.8696
59	Sapphire Halt	6.8767	79.8664
60	Pamankada	6.87698	79.8697
61	Vijaya Kumaratunge Mw.	6.88553	79.8767
62	Apollo Hospital	6.88922	79.8769
63	Narahenpita Junction	6.89189	79.877
64	Ibbanwela Junction	6.91879	79.8613
65	Ward Place	6.91721	79.8662
66	Borella	6.91474	79.8776
67	Horton Place - Baseline Junction	6.91126	79.8775
68	Borella Cemetery Junction	6.90859	79.8773
69	Sarana Road	6.90558	79.8735
70	Maitland Place	6.9029	79.8705
71	Delmon Hospital	6.87071	79.8621
72	Ramakrishna Road	6.8659	79.863
73	William Grinding Mills	6.86251	79.8638
74	Dehiwala Municipal Council	6.86103	79.8641
75	St. Mary\'s Church Dehiwala	6.85918	79.8645
76	Holy Family Convent Dehiwala	6.85717	79.865
77	Dehiwala Junction	6.85082	79.866

78	Dehiwala Cemetery	6.84493	79.8662
79	Hotel Road Mt. Lavinia	6.84197	79.8669
80	S. Thomas\' College Mt. Lavinia	6.83775	79.8674
81	Mount Lavinia Junction	6.83296	79.8673
82	Maliban Junction	6.81943	79.8737
83	Belekkade Junc. Rathmalana	6.81474	79.8788
84	Rathmalana Airport	6.81244	79.8811
85	Soysapura	6.80462	79.8867
86	Katubedda Junction	6.79733	79.8885
87	Rawatawatta	6.78803	79.8851
88	Moratuwa	6.77449	79.8824
89	Panadura	6.71138	79.9076
90	Angulana	6.79819	79.873
91	Dutugemunu Street	6.87059	79.8774
92	Kohuwala	6.86707	79.8846
93	Woodlands	6.8623	79.8884
94	Pepiliyana	6.85666	79.8906
95	Raththanapitiya	6.84834	79.8976
96	Boralesgamuwa	6.84124	79.9016
97	Werahera	6.82972	79.9114
98	Bokundara	6.81862	79.9177
99	Piliyandala	6.80122	79.9233
100	Kesbewa	6.79552	79.9408
101	Polgasovita	6.78698	79.9649
102	Kahathuduwa	6.78346	79.9834
103	Horana	6.71662	80.0638
104	Panagoda	6.84827	80.0188
105	Godagama	6.85148	80.0316
106	Migoda	6.84423	80.0467
107	Padukka	6.84146	80.0908
108	Handapangoda	6.79234	80.1426
109	Ingiriya	6.74399	80.1766
110	Teachers\' Training College	6.84471	79.9327
111	Pannipitiya	6.8462	79.9497
112	Kottawa	6.84167	79.964
113	Makumbura	6.83862	79.98
114	Homagama	6.84113	80.002
115	Kottawa Railway Station	6.84401	79.9682
116	Rukmalgama	6.85692	79.9859
117	Walgama Junc. Athurugiriya	6.86495	79.9958
118	Athurugiriya Junction	6.87745	79.9895
119	Pinhena Junction	6.83278	79.9647

120	Mattegoda	6.81158	79.9751
121	Open University Nawala	6.88302	79.8868
122	Nawala Junction	6.88703	79.8872
123	Koswatta Nawala	6.90003	79.894
124	Bellanthota Junction	6.84831	79.8854
125	Nandimala	6.84986	79.8794
126	Karagampitiya	6.85025	79.872
127	Kalubowila Hospital	6.86647	79.8773
128	Nugegoda Supermarket	6.87347	79.8914
129	Pita Kotte	6.8839	79.9019
130	Impala Cinema Rajagiriya	6.91097	79.8907
131	Rajagiriya Junction	6.91012	79.8944
132	Ethul Kotte Junction	6.90551	79.9052
133	Sethsiripaya	6.90244	79.9143
134	Battaramulla	6.90209	79.9181
135	Thalangama	6.90597	79.9262
136	Thalahena	6.90801	79.945
137	Malabe	6.90408	79.9544
138	Pittugala	6.90869	79.9693
139	SLIIT Malabe	6.91471	79.9722
140	Kaduwela	6.9357	79.9842
141	Thalawathugoda	6.87628	79.9353
142	Pelawatta/Isurupaya	6.8906	79.9289
143	Peliyagoda Junction	6.95576	79.8831
144	Nawaloka Junction	6.96068	79.8808
145	Wattala	6.98125	79.888
146	Handala	6.99069	79.8931
147	Welisara	7.02178	79.8996
148	Kandana	7.04783	79.897
149	Kapuwatta	7.06401	79.8932
150	Ja-Ela	7.07824	79.8905
151	Katunayake Airport	7.16564	79.8841