



# **Web Based Travel Assistant**

**A dissertation submitted for the Degree of  
Master of Information Technology**

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**University of Colombo School of Computing**

**2020**



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

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

Certified by:

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Date:2020/11/20

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My sincere gratitude is extended to University of Colombo School of Computing for entrusting on individuals as myself, from zero IT background. UCSC became the kindergarten and the high school of computing simultaneously, because of the effort put on by all the staff members.

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## **ABSTRACT**

Tourism is travelling from the inhabited location to another location by an individual or a group of people. Tourism is a major global industry that produces employment and a major income source to countries. Lot of people engage in tourism for purposes like business, leisure, etc. This includes both travelling within or outside the country of residence.

The travelers engage in tourism both inside his resident country and outside the resident country. Hence during travelling the tourists can face lot of issues due to unfamiliarity of the environment that he will enter and due to lack of information on requirements like cost of living, accommodation, weather, travel routes and travel duration, etc. If the traveler can be provided with travel related data like cost of living, weather conditions, tourist density, etc. it can facilitate the traveler to plan the trip to obtain a safe, cost effective and time efficient one.

There are many applications that have been developed with the above intention, but they all focus on limited scope of the above requirements. The objective of this project is to develop an application that is widely focusing on all the above and more requirements of the traveler. The application that is developed collectively focus on providing the data and analyse them to support the decision-making process on planning the tour by the traveler so that he can have a prolific travel experience.

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# CHAPTER 1

## INTRODUCTION

### 1.1 Project Background

Tourism is a set of interrelated activities, services and industries that supports to deliver a travel experience to the traveler. The main segments are transportation, accommodation, food and beverages, retailing, entertainment and other hospitality services available for travelers that are journeying away from their permanent residents [1]. Along with the improvements of inter and intra continental transportation modes, tourism has become a most favored hobbies of people with an average or above income. Hence tourism is considered as one of the fast-growing industries in the modern world [2]. Parallel to the improvements in travelling and tourism, lot of businesses have been developed associating the growing industry. Among them the most opportunistic businesses are hotels and accommodation, travel agencies and transportation [3]. The key areas that facilitate tourism is accommodation and transportation while travel agents act as the coordinator between the traveler and the parties who provide the above services [3].

When travelling, most of the travelers have common objectives regarding the travel plan. The most important of them next to visiting remarkable destinations are obtaining comfortable lodging facilities, travel using efficient transportation modes and most importantly confidence in individual safety for a bearable cost [4]. Fulfilling the above requirements have become a challenge to most of the travelers due to unfamiliarity of the region that they intend to travel and due to the lack of accurate and efficient sources to obtain details regarding the above parameters [2].

### 1.2 Project Scope

Tourism of any country is divided into two segments, inbound tourism where foreign tourists are travelling to Sri Lanka and outbound tourism where local citizens are travelling to other countries. The information required for a traveler to plan a trip such as travel demand, accommodation, cost and weather data are not available in a consolidated platform [5].

Depending on the data availability the traveler and the travel agents are linked through the proposed solution. There are two groups of end users, namely Traveler and Travel Agent and again subdivided within the group depending on the direction intended to travel related to the base location. The subgroups are inbound and outbound which are segregated as Inbound if arriving to the base location and Outbound if departing from the base location.

The demand is created by the traveler while travel agents act as the supplier [6]. Demand and supply integration are performed through the proposed solution where a platform is provided to enable communication.

Past inbound and outbound travel data are analyzed, forecasts and insights are provided for the users to enable effective planning. Destination based travel data are analyzed and insights are given for the users to plan based on the weather preferences. Cost insights for selected categories of items are analyzed and insights are provided for the users to plan based on the available budget.

Figure 1.1 is a simplified illustration of the above explained project scope.



**Figure 1.1: Project Scope Illustration**

### 1.3 Motivation

Travelling is an activity engaged by many due to different purposes like business, education, leisure where an individual would leave their resident environment and move into a new environment. This become a challenge due to the unfamiliarity in environmental and social backgrounds of the touring region by the traveler [7]. Due to this unfamiliarity the travelers often ended up having an unfulfilling travel experience. The main reasons behind this are, not being able to develop a proper travelling plan due to the lack of availability of information and spending money over matters that won't provide plentiful value back to the traveler. The latter is often encountered by travelers when it comes to accommodation [8]. In addition to the above, travelers often find themselves in irritating situations in picking up suitable travel destinations as they don't have reliable and updated sources on factors like cost of touring, weather conditions, tourism density, duration of travelling from one location to the other that have a direct impact on acquiring an excellent travel experience [9].

When analyzing the past data, tourism is in constant growth hence the demand side is increasing [5]. To facilitate this growing demand in Sri Lankan tourism industry still there are lot of improvements that can be introduced. So far most of the improvements are of the conventional methods. But along with the global improvements, by introducing new technologies to improve, the industry can function with an improved efficiency [10]. The efficiency increases along with proper demand forecasting and planning to meet the forecasted demand. To forecast the demand the previous data should be available with high accuracy [9].

While travelers are being the party that creates the demand, travel agents act as the party that provides for the demand hence be the supplier. Travel agents who have adequate knowledge about the industry and familiar with the intended touring region have answers to most of the above-mentioned common issues that travelers are facing [11]. Travel agents acts as the coordinator between the traveler and primary facilities provider like hotels, lodges, airlines and intra-regional transportation providers. Hence travel agent can facilitate the traveler to have a smooth travelling experience throughout the entire journey by either providing the required services directly or through proper coordination between the demand and supply [12].

In the current industry, there are very few digital platforms that facilitates the traveler to create a smooth travel plan by themselves or to link with travel agents that fulfills the key requirements of the traveler. In available digital solutions the main issue is the lack of required information present in a single platform for travelers to obtain a clear idea on environmental, social and financial status all in one place easily so that they can create their individual travel plans and travel alone without the help of a third party [13]. On the other hand, when looking into the current situation from the perspective of travel agents, there are no combined source that provides them the actual data on demand within the industry for their applicable region/s. If the travel agents can obtain the relevant demand data on time, it will facilitate them to plan the services supply to the forthcoming demand [14]. Also, such digital solution can act as the platform to create interactions among travelers and travel agents facilitating as an effective communication mode to make the travelers aware about the travel agents and the assistance, they provide to the travelers to smoothen out the travelling experience.

#### **1.4 Objectives**

The main objective of this project is to develop a platform that can facilitate both the traveler and travel agents to plan their forthcoming touring related events efficiently. To achieve this final aim, below mentioned objectives should be fulfilled during the project execution.

1. Provide information on cost of accommodation, transportation, location wise variation of weather across the year, tourist density to organize personal travel plans for the inbound tourists during the stay in Sri Lanka.
2. Forecast the trends in tourism using the demand data on variation of tourist arrival during months / seasons, tourist arrival from each region, most favored tourist destinations, demographic details of tourists to create attractive travel packages and create feasible operational plans for travel agents.
3. Support the outbound travelers to select the most appropriate travelling destinations depending on their main selection criteria like intended time and duration of travelling, cost of accommodation, transportation of intended outbound travel regions and weather details.
4. Provide demand information for inbound and outbound travel agents to prepare customized travel packages depending on the demand and share it with the inbound and outbound travelers.
5. Creating a platform to link the travelers and travel agents for inquiries, sharing travel packages and contacting 3<sup>rd</sup> party service providers.

## **1.6 Chapter Breakdown**

This report is consisted of six chapters. Each chapter specifically address and describe about the major activities that were followed throughout the whole project from problem identification to solution providing. The six chapters included in the report are followed by references and appendices.

### **Chapter 1: Introduction**

This chapter address the project background, project scope, motivation of the project which explains about the problem statement and the primary plan of addressing the problem, objectives that has to be fulfilled to achieve the project aim which is providing an solution to the problem mentioned in problem statement.

### **Chapter 2: Background**

The background for the project is described in this chapter with the current status and an analysis of the requirements of the system that are supposed to be developed. This is followed by an analysis of available systems and design strategies. Further implementation techniques are also elaborated in this chapter.

### **Chapter 3: Methodology**

This is the most important chapter of the report. This chapter presents design the suggested solution in detail. The main topics that are focused in this chapter are

requirement gathering for the proposed solution with functional and non-functional requirements, architecture of the proposed system followed by design techniques and implementation process.

#### **Chapter 4: Implementation**

The translation of the software specifications evaluated in the Methodology chapter into an executable program is explained in this chapter. This chapter features the implementation tools and technologies.

#### **Chapter 05: Testing and Evaluation**

Functional and Nonfunctional testing aspect of the application is also elaborated in this chapter.

#### **Chapter 06: Conclusion**

The final chapter of the report summaries the details of the project along with the challenges and the corresponding initiatives that can be adhered to overcome those issues. The lessons learnt during the implementation are also emphasized in this chapter.

## **CHAPTER 2**

### **BACKGROUND**

#### **2.1 Introduction**

Applying big data analytics into tourism can benefit the growth in the industry. This can specifically help for travelling agents to determine predictive and behavioral analysis of the industry [14]. The key area where the travelling agents can use the data analysis is to do a demand research. They can identify the trends of tourist arrival with segmenting on demographic variations. Using the demographic segmentation, they can identify the target market segments. With experience in the industry the requirements of each market segments can be determined hence creating plans to cater the target markets become easier and cost efficient for both parties [15]. Once the major analysis is completed, the travelling agents can use the results of the analysis to promote to the pinpoint markets, offering custom-made travel packages to tourists' identified interests and deciding the countries to focus on captivating customers in. For travelers to determine the travel destination, best season to travel depending on their likings (weather preference, crowded or less crowded, specific cultural events to attend, etc), duration of stay, accommodation type (eg: Hotel, boutique villa, hostel, etc), transportation mode, etc required to be done before initiating the journey. Each traveler has their unique preferences over travelling and the above should be chosen according to them [16]. This cannot be done with blind idea or no information. If the travelers can obtain standard yet simple analytics about information like tourism density, seasons weather details, cost of living, accommodation details they can easily figure out the determinants of their intended journey.

The inbound tourism related past data can be obtained from reports published by Sri Lankan Tourism Authority. The past weather data can be obtained through an API of Openweathermap.org. The data can be used to generate the trends in weather across the year. For outbound tourism, outbound air traffic data are published by Civil Aviation Authority of Sri Lanka. The cost details can be extracted from Numbeo.com. The currency conversion details can be extracted from quantmod API. One of the drawbacks in Sri Lankan tourism industry is that even though all these required data are available there are no proper application to consolidate these data from different reports and give a single output followed by analyzing them and provide demand forecasts to the stakeholders like travel agents and travelers [17].

#### **2.2 Current Settings**

The past tourism related data are published by Sri Lanka Tourism Development Authority. These data are inclusive of information like tourist arrival data, tourist traffic data, accommodation data, etc. These data can be used by demand generating stakeholders and supply providing stakeholders to identify the patterns of tourism in Sri

Lanka. To identify patterns and generate the forecasts these data should be systemically analysed. To do a systematic analysis the main obstacles are that the available data published by Sri Lanka Tourism Development Authority are in the form of raw data and there is no platform to do the data analyzing.

**Table 2.1: Tourism Data Extraction Sources**

<b>Data Source</b>	<b>Type of Information</b>	<b>Frequency</b>
Annual Statistical Report	Tourist arrival data Tourist traffic data Demographic data of tourists Accommodation data	Annually
Monthly Tourist Arrival Report	Tourist arrival by region Top 10 source markets International tourist arrivals by country of residence	Monthly
Quarterly Tourism Industry Report	SLTDA Registered accommodation Restaurants Accommodation distribution Places of attractions visited by tourists	Quarterly
Flight Frequency and Seating Capacity Report	Arrival Flights Frequency per week Seating Capacity by Airline and country	Monthly

All these important data are published by Sri Lankan Tourism Development Authority as raw data in their annual, quarterly and monthly report as shown in Table 2.1. But there is no proper application to share these data with a 3<sup>rd</sup> party in a usable manner. All these data are published in a non-user-friendly manner. As indicated above there are many source documents that are consisted of different type of data which are published at various frequencies. Hence for other stakeholder, when utilizing these data there are some strict limitations. For them to analyse these data to identify past trends and forecast future trends is a resource consuming activity since they have to extract data themselves and analyse it using complex data anlysing applications to obtain information required for their operations. This discourage most of the stakeholders that will lead to inefficient planning of the business.

If these data can be consolidated into a single platform and can be viewed in a simple format it will strengthen the decision-making process of the stakeholders of the industry. Through the same application the upcoming trends can be predicted with high accuracy. Since this can strengthen the planning process, the stakeholders can utilize their resources efficiently. This will lead to a considerable amount of cost saving. If such a facility can be provided that can be used by stakeholders to obtain business advantages.

## 2.3 Review of Similar Applications

There are several applications that are already in the industry that are catering to some of the opportunities listed above but not to all. The main objective of these applications are to facilitate the travelers to plan their trip and to link the traveler with the facility providers. To understand the similarities, variations and depth of usability of the available applications and intended application the below review is targeting. The considered similar applications in this review are ‘TripHobo’ [18] and ‘Pebblar’ [19].

### 2.3.1 TripHobo

‘TripHobo’ is the first travelling application that is reviewed under similar applications. ‘TripHobo’ is an advanced tour planning application that enables the users to plan tours to over one million destinies in the world. TripHobo’s tour planning platform serves an application for destination for all the travel needs exploring attractions, creating itineraries and booking hotels, transportation, and tours [18].

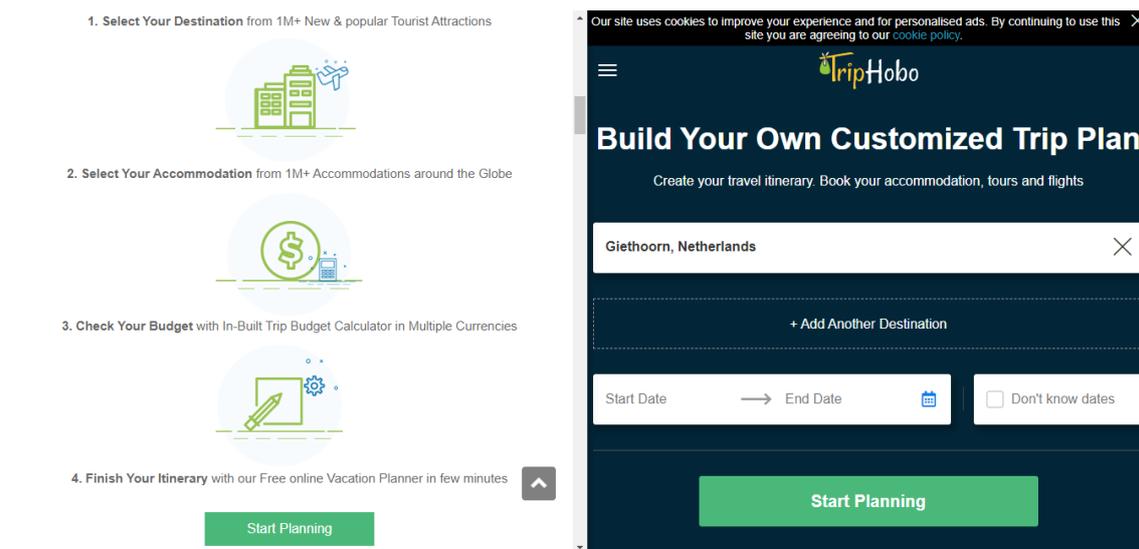


Figure 2.1: TripHobo Home Page

TripHobo provides facilities to the user to select the intended travel destination/s, intended time and duration of travel to use as the basic selection criteria to create the travel plan. This application provides a cost estimation for the intended journey. The additional pros of this application are that it will provide a tour guidance for a traveler in a selected area under the topic ‘Best Things To Do in.....’ [18]. Further it will link the traveler with accommodation facilities through popular applications like ‘Booking.com’, ‘Agoda’, etc and the capability in these applications to compare the different accommodation facilities rates is also embedded into TripHobo. As an added facility, TripHobo will display popular travel destinations and travel itineraries.

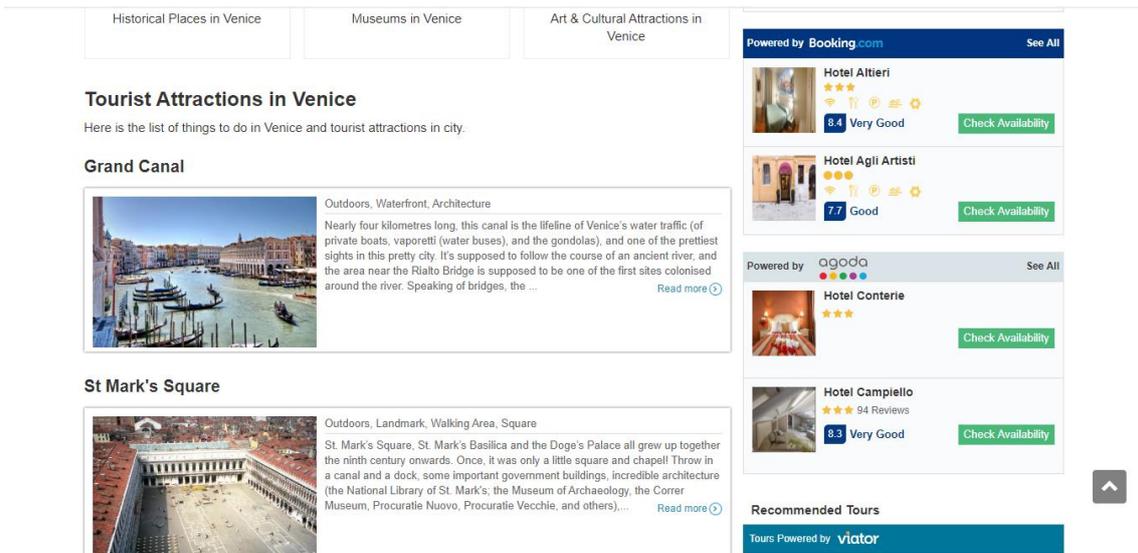


Figure 2.2: TripHobo additional features

Even though ‘TripHobo’ provides lot of facilities to their users, the entire application is a user driven one. The traveler himself must determine the travel destination/s and travel duration to obtain the benefits from ‘TripHobo’. If the traveler wants assistance in determining the above key determinations plus other details like accommodation, travel itineraries depending on parameters like cost, weather preferences, tourist density, etc ‘TripHobo’ doesn’t have the analytical ability to analyse past data and suggest travel plans to the traveler that fulfills his requirements.

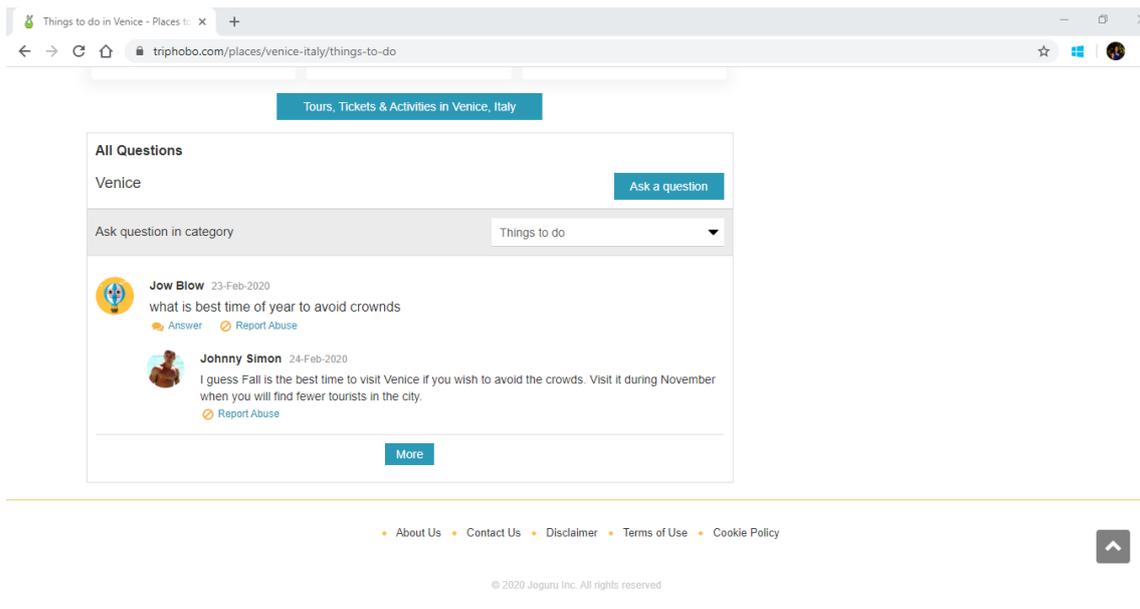


Figure 2.3: TripHobo Limitations

### 2.3.2. Pebblar

‘Pebblar’ is an itinerary planning application available supporting the users to do several travelling related activities from assembling a trip wish list to creating a detailed itinerary; from pre-trip planning to on-trip access to details like accommodation, restaurants, places to visit, etc. This application assists the traveler to create a very detailed tour plan including the above details in the same platform [19].

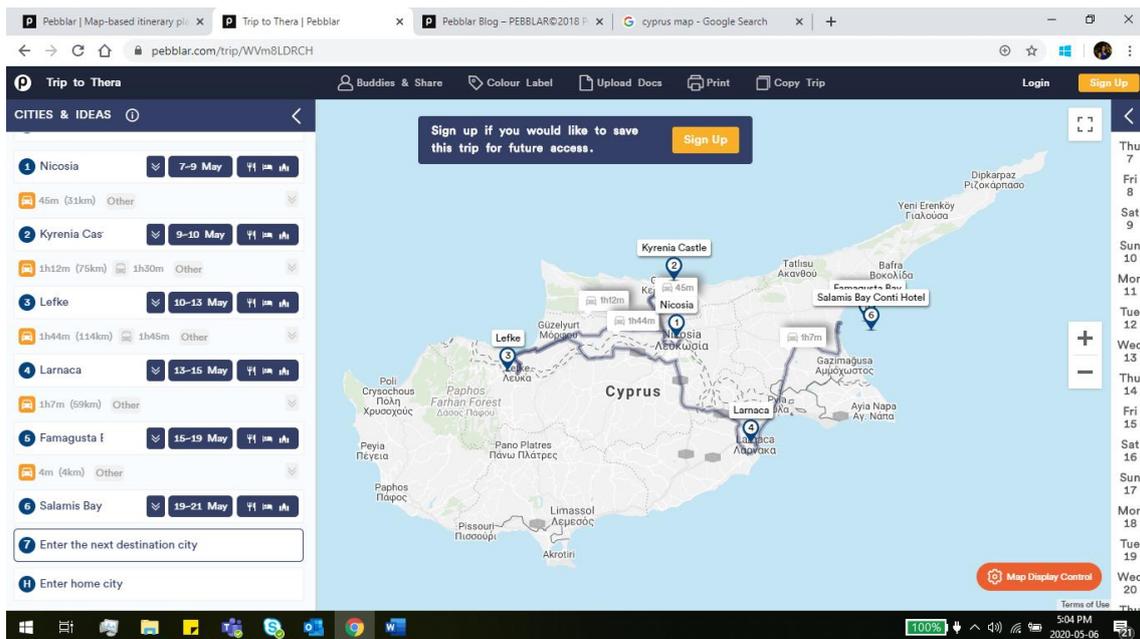
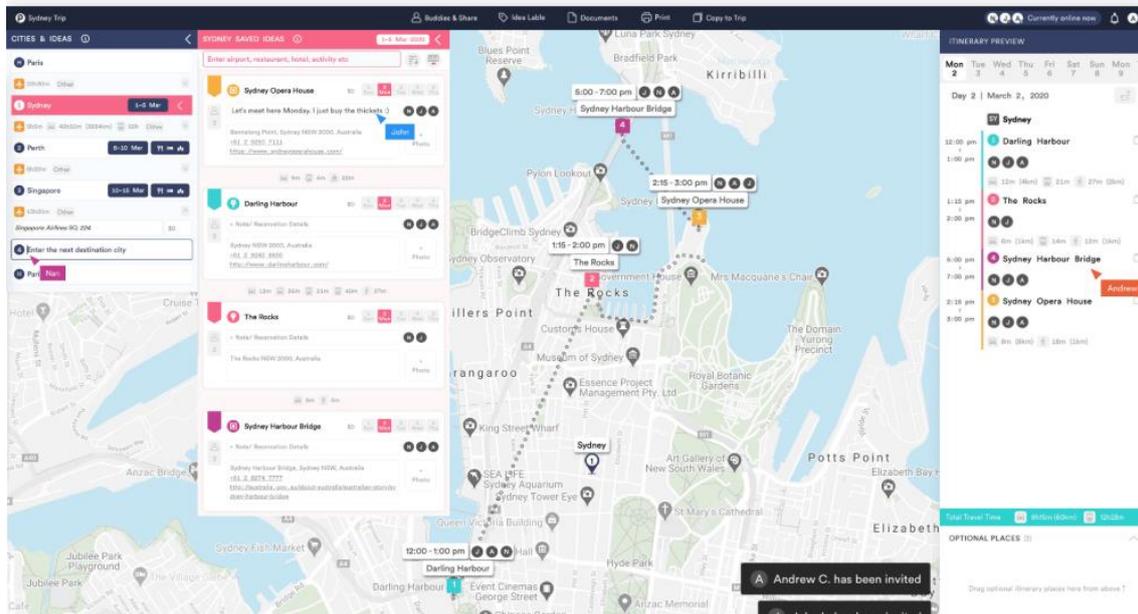


Figure 2.4: Pebblar Tour Planning Map

Pebblar assist the traveler to create a detailed travel plan. Within the app each travel destination can be marked with the duration of stay at each location and automatically it provides the route to be taken from one location to the other location and duration of travel. Pebblar is linked to Google maps from where it will extract the above travelling data. Once the travel destinations and travelling time is marked out in the application, the next step is to create the activity list that can be done in each destination. As an example, if a traveler intends to visit a certain location for 3 days the application supports to create a detailed travel plan by saving the places that can be visited by the traveler during the intended time of stay. This delivers the traveler a more vivid picture since it categorizes the places to visit as restaurants, attractions, shops, etc.

The next advantage that the application providing to the users is that facility to create a detailed timeline of the travel plan for each day. Initially the application assists the users to create a wholistic travel plan but now it is extended into a more detailed plan that details each place that is to be visited and the intended time duration that the traveler is planning to spend there. This allows the traveler to micromanage the entire journey.

## Real-time Collaboration for Group Trip Planning



**Figure 2.5: Pebblar Additional Features**

The drawbacks of this application are even though it assists its users to create a very detailed travel plan, the user can create the plan only if he is aware of the entire plan himself. The user should be aware of the destinations is intended to travel, what are the places that he is planning to visit and for how long he is planning to stay at a given place and what are the dates that he is planning to travel. This simply serves as a high-end planning and record keeping application where the traveler can record the entire travel map that he has built within his head before commencing the tour. The other highlighted major disadvantage of this application is it does not link the user to any other facility like Booking.com or Agoda where the traveler can view the accommodation facilities. Same as deciding upon travel plan the accommodation also must be pursued by the user outside the application by using any other secondary application. Further this doesn't provide any information on cost related data for accommodation, transportation, food and other consumables, etc. 'Pebblar' doesn't provide the users to customize the travel plan according to his personal preferences. As an overall view 'Pebblar' does not provide it's user an end to end guidance on planning the trip, finding the right accommodation, travelling modes, etc but simply a planning application where the user has to align with the context of 'tour planning' of the developer. The success of 'Pebblar' is totally depending on the knowledge of the user regarding the trip that he is intended to journey on.

### 2.3.3 Comparison of Existing Applications with Proposed Application

Below Table 2.2 is the comparison of the above discussed two applications with the proposed application.

**Table 2.2: Comparison of the features**

<b>Characteristic</b>	<b>TripHobo</b>	<b>Pebblar</b>	<b>Proposed Application</b>
Availability	Website	Website & Application	Website
User Ratings	4.6 - Trustpilot	4.6 - Google	
Cost of Usage	Free	Free	Free
Creating overall travel plan	Available	Available	2nd Phase (Chapter 6.4)
Creating DIL plan	Not available	Available	2nd Phase (Chapter 6.4)
Suggesting travel destinations that fulfills User requirements	Not available	Not available	Available
Travel duration between destinations	Not available	Available	2nd Phase (Chapter 6.4)
Cost of living	Not available	Not available	Available
Details on travel destinations	Available	Available	Available
Information on places to visit in each destination	Available	Not available	2nd Phase (Chapter 6.4)
Weather data and weather forecast	Not available	Not available	Available
Information on accommodation facilities	Available	Not available	2nd Phase (Chapter 6.4)
Information about tourist density	Not available	Not available	Available
Information about consumables	Not available	Not available	Available
Information about travel packages	Available	Not available	Available
Networking between travelers and travel agents	Not available	Not available	Available

The uniqueness of the application is the data driven perspective it has provided. The proposed application is currently available as a Web Application only. In the long run it is essential to establish a mobile application to reach more users. As it is analyzed below

the proposed application is lacking in terms of stylish appearance and scalability. Also features like travel distance information and accommodation information are deficient in the proposed application. The figure 2.6 is derived by evaluating the three application on the selected elements in a scale of 0-100.

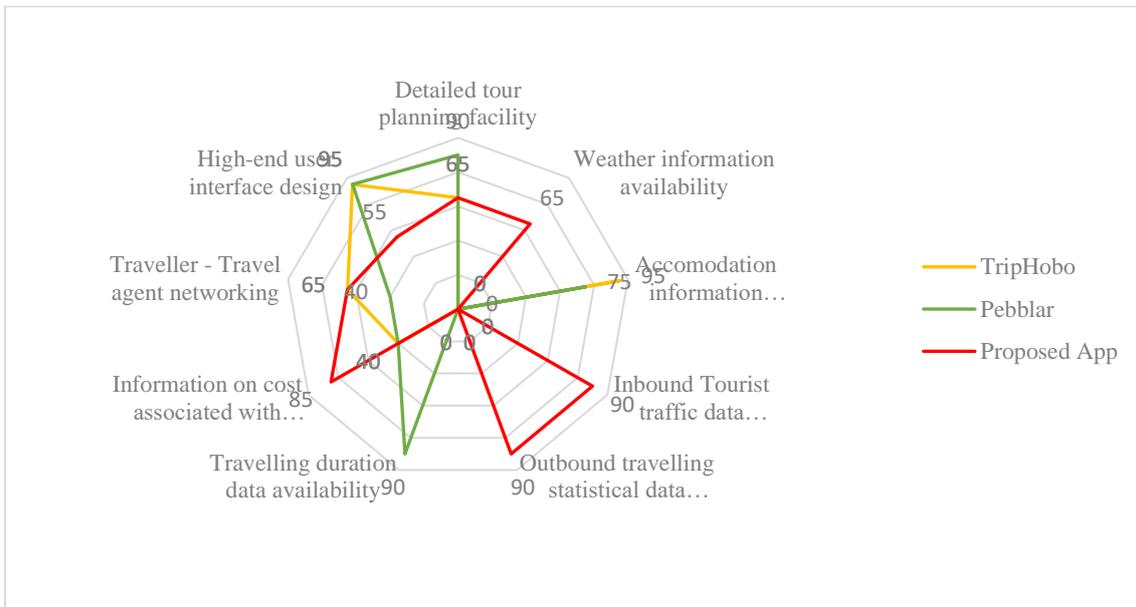


Figure 2.6: Radar chart of the proposed application against TripHobo and Pebblar

## 2.4 Comparison of Alternative Design Strategies

Though multiple application development practices are available there is abstemiously a standard process when developing web applications. The usual development cycle includes the following illustrated phases in Figure 2.7. Incremental development, rapid application development or any other modern development frameworks were not used since the capabilities were limited to follow the traditional life cycle.



Figure 2.7: Application Development Process

Table 2.3 is an evaluation of the development of Traveldatos application based on the standard development process.

**Table 2.3: Development Process Evaluation**

<b>Phase</b>	<b>Area</b>	<b>Traveldatos Application</b>	<b>Remark</b>
<b>Idea</b>	Problem Identification	The application concept was invented following a comprehensive analysis of the current data availability and user requirement.	Followed
<b>Strategy</b>	Competition	The features of the similar systems were thoroughly recognized. Better inspired features were planned in the next phases of development.	Followed
	Monetization	The plan is to sell the web application to travel agents and to incorporate Google AdSense.	Expected to Follow
	Marketing	The marketing strategy to be devised based on UX feedback.	Expected to Follow
	Road Map	The anticipation was to create a product with minimalistic features enough to satisfy early customers.	Followed
<b>Design</b>	UX Design	Wireframe Prototypes were used in UI design. More research is to be done in order to provide a meaningful and relevant user experience.	Partially Followed
	UI Design	Minimalistic UI design aspects were utilized. The application is deficient in this aspect.	Followed
	Handoff	Since the designer and developer are the same there is no design handoff process.	Not Followed

<b>Development</b>	Planning	The structure of the application was intended to perform through optimized reusability of coding.	Followed
	Development	R Shiny, HTML and CSS were used as technologies in the development phase.	Followed
	Testing	Functional and Non-Functional requirements were tested using R test libraries, Shinyapps.io dashboard and Google Page Speed insights.	Partially Followed
	Review	The results of the tests were utilized to enhance the current application and to devise future development opportunities.	Partially Followed
<b>Deployment</b>	Platform	Shinyapps.io as PaaS is used to deploy the web application.	Followed
	Availability	The application is currently available for public to browse through internet.	Followed
<b>Postlaunch</b>	Crashes	The plan is to assess the application using the Shinyapps.io dashboard in terms of the user performance and other related features.	Not Followed
	Analytics		
	Performance		

## 2.5 Implementation Tools and Technologies

Multiple libraries and packages corresponding to R programming was used in this application. Table 2.4 is a summary of the tools and technologies utilized to develop the proposed application.

**Table 2.4: Summary of tools and technologies used**

<b>Area</b>	<b>Tool /Technology</b>
Development Platform	R Studio-Version 3.4.3
Development Language	R Programming Language
Database	RSQLite, Amazon EC2
Web Server	Shinyapps.io, R Shiny Server
UI Development	HTML, CSS
Prototype Development	Edraw Max
Authentication	Shinyapps.io
Automated Testing	Shinytest
Code Testing	Testthat
Performance Testing	Shinyapps.io, Google Page Speed Insights

## **2.6 Requirements of the Proposed System**

### **2.6.1 Functional Requirements**

The functional requirements of the proposed system are illustrated below.

#### Data Management and Maintenance

The proposed system is a data driven application. The data shall be refreshed periodically in view of the type of data. Inbound/Outbound travel data, Cost data and Weather data need to be updated. The travel and cost data are updated manually. Text Mining is used for data cleaning purposes. The main data sources are JSON and CSV files. Weather data and Currency data are updated through APIs.

#### Forecast Modelling

Travel data are made into time series data and forecasted based on Arima forecasting model. The distinct feature of the forecast modelling feature is the ability to obtain forecasts for multiple hierarchical levels. The trend details of the data series are also captured and visualized. Seasonality was derived and viewed through decomposition of trend data.

#### Data Visualization

The manipulated data are visualized for users to take decisions on travel needs. The users shall view data based on the input parameters. The main input parameters are Date Range,

Budget and Weather preferences. The system shall allow the users to download the necessary reports based on the input parameters.

#### User-Agent Communication

The system acts as a link between the travelers and the travel agents. The travelers could request for packages through the portal while the travel agents could share the packages with the travelers. Email communications are triggered based on the requirement.

#### Travel Package Creation and Sharing

Travel packages can be made by Travel agents in the system. The basic information and images are to be uploaded to automatically display the packages. Both inbound and outbound travel agents shall advertise the product packages in the platform.

#### User Management

Mainly there are two types of users namely travelers and travel agents. The system shall allow the administrator to extract user data and change user status as required.

### **2.6.2 Non-Functional Requirements**

Non-functional requirements are related to system capabilities and constraints that improve its functionality. The inability to achieve the required non-functional requirements shall hinder the functionalities of the application. The non-functional requirements of the application could be elaborated based on usability, scalability, maintainability and reliability.

#### Usability

The application shall encompass of user-friendly environment with flexible interfaces

#### Scalability

The application shall be scalable in order to facilitate future expansions since currently the application is applicable for inbound and outbound travelers and agents in Sri Lanka only.

#### Maintainability

The application shall be made maintainable for the administrators since updated data in the application is essential to serve the purpose of the application.

#### Reliability

The information shared in the application shall be accurate and consistent with most updated data.

# CHAPTER 3

## METHODOLOGY

### 3.1 Introduction

This chapter provides an overview of the system analysis and design. The system analysis process refers to assortment of facts and figures, problem identification and disintegration of a system into its components. The objective of the design phase is to ascertain that the incorporation of the system components is effectively apprehending the overall purpose of the system. System design encompasses as to how the proposed system is accomplishing the objectives of the system. The focus in this chapter are in the areas of systems, processes and technology.

### 3.2 Requirement Gathering

The requirements of the travelers and travel agents were brainstormed in order to identify the necessary components of the system. The requirements were conceptualized using a mind map as illustrated in Figure 3.1.

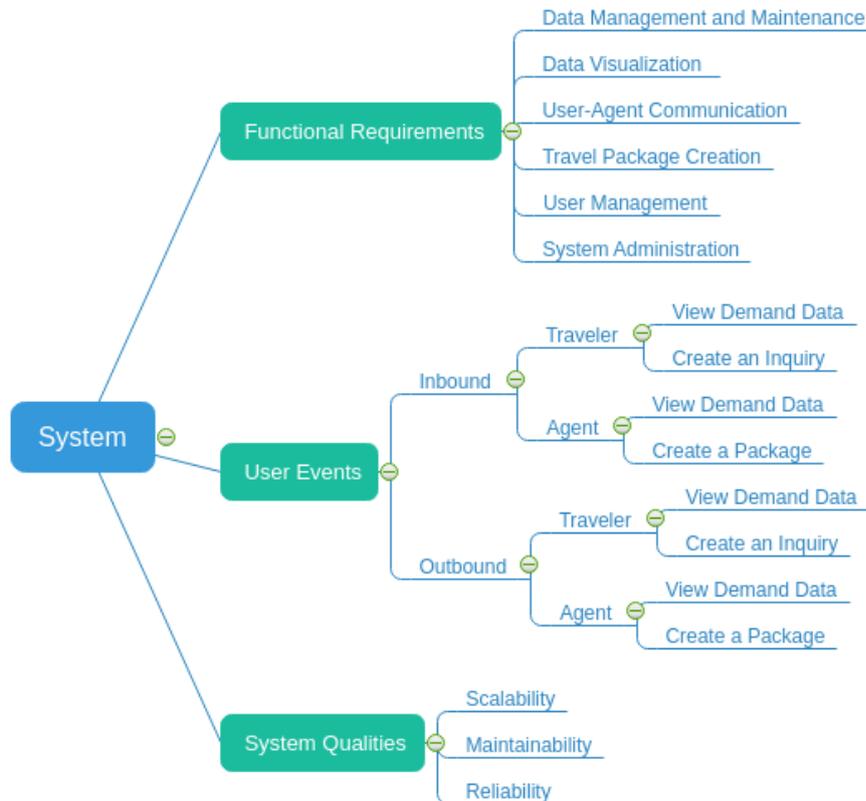


Figure 3.1: System requirement mind map

Three characteristics were recognized in the task of requirement gathering. The functional requirements, user events and system qualities are analyzed in detail.

### 3.3 Proposed Architecture for the System

The application is built using R programming. R shiny dashboard module is used to create user interface side and server-side interactions. The MVC framework is the most widely used web application framework present in the current context. Model-View-Controller is an architectural pattern which fragments the application into different controls as following Figure 3.2.

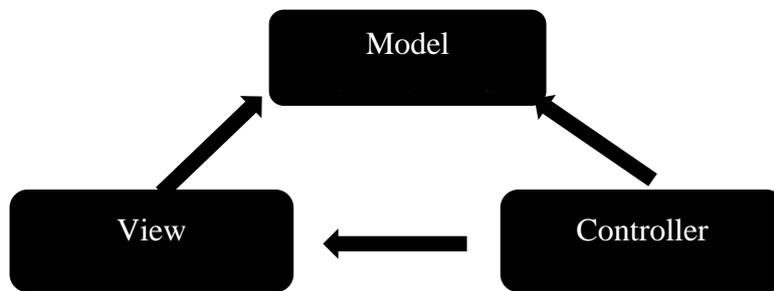


Figure 3.2: MVC Framework

The execution of an MVC application takes place when a request is received from the client. Controller processes the request and create a data model. The Model passes it to the relevant view where the output is rendered as illustrated in Figure 3.3.

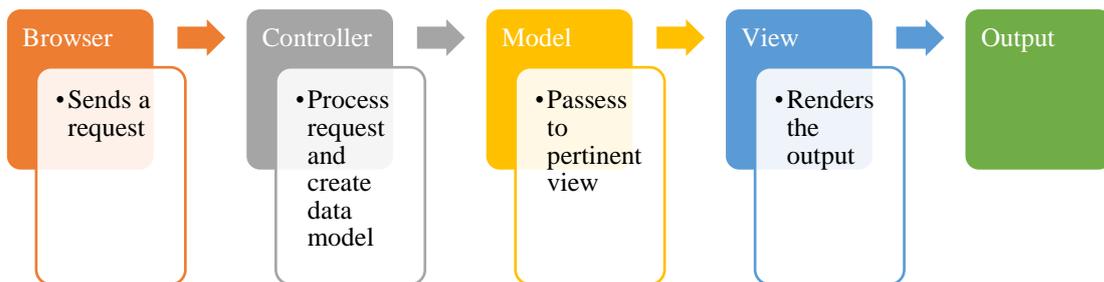
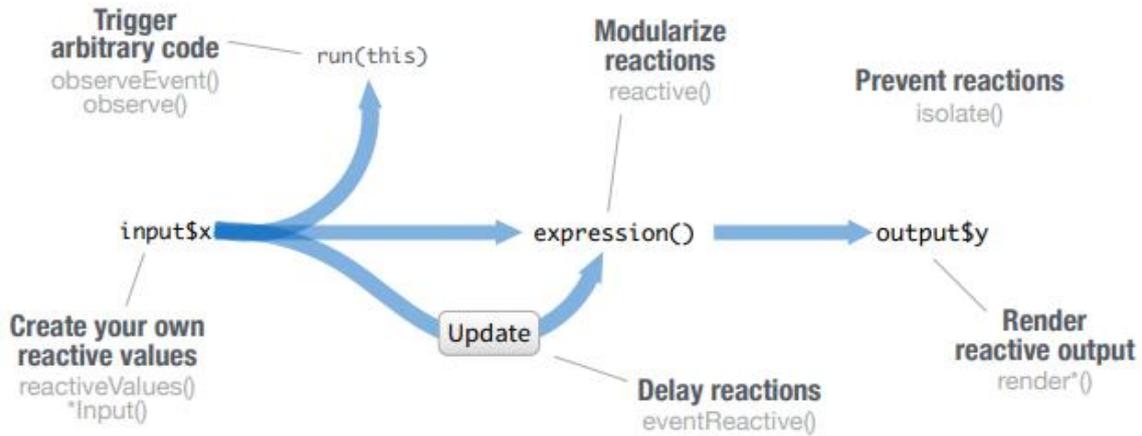


Figure 3.3: MVC application for proposed application

Shiny applications are run in a reactive environment. In the reactivity environment it is not required to apprehend on the order of the processes to create the data model. The Shiny application framework expedites this process while the specifications needed to render the view need to be provided. The controller is concealed in this specific framework.

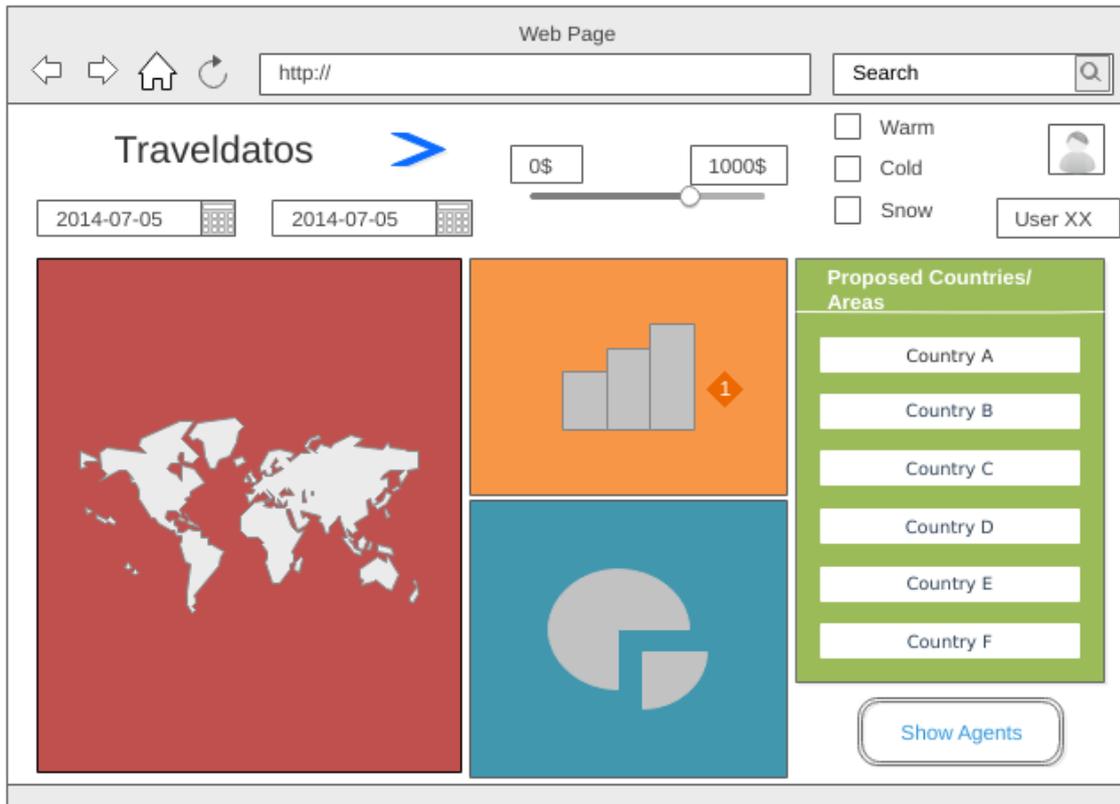
The Figure 3.4 best explains the usage of reactivity in a Shiny application. Reactive values work together with reactive functions. The operations are not allowed without a functioning reactive context.



**Figure 3.4: R Shiny reactive environment**

### 3.4 Design Techniques

Design techniques are the techniques used to model the application which encompasses the specifications of a detailed computer-based solution. The main design techniques are mainly Model Driven Design (MDD), Rapid Application Design (RAD) and Joint Application Design (JAD). Prototyping under the Model Driven Design techniques was used to create the wireframes for each interface. The prototyping enabled clarity in designing and the development steps.



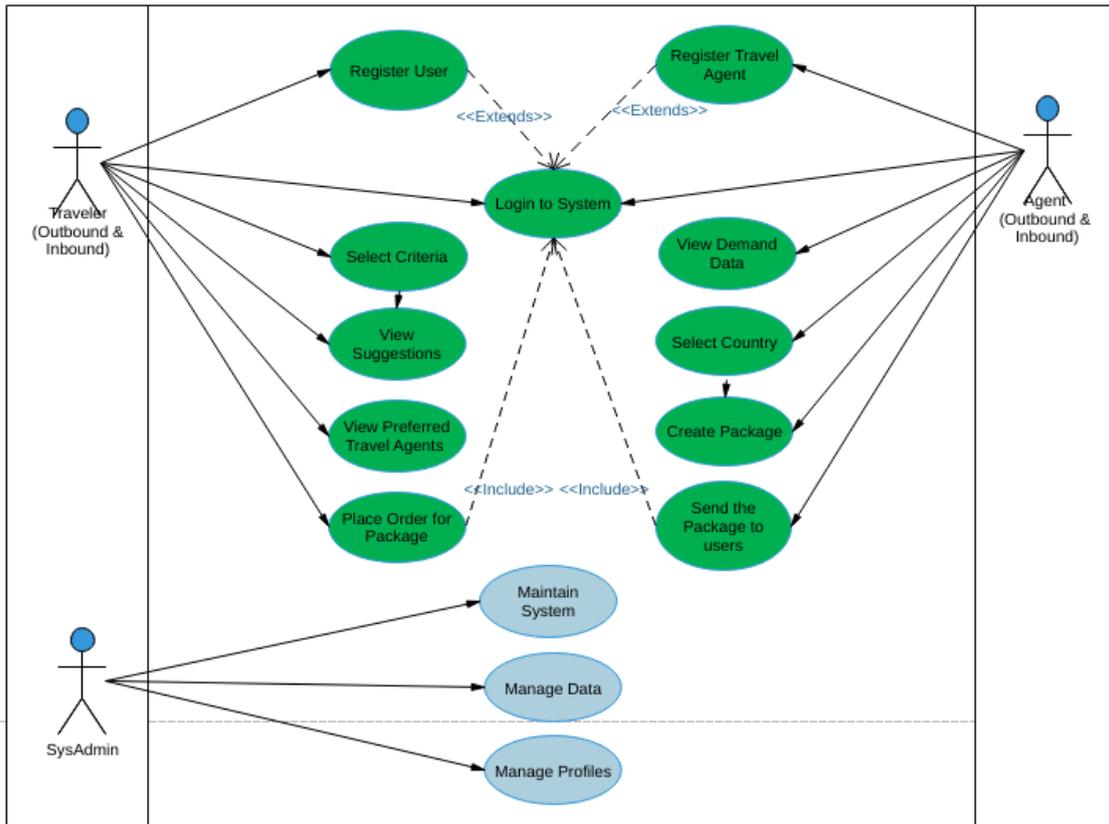
**Figure 3.5: Prototype development**

UML (Unified Modelling Language) diagrams were used to develop the system design. Structure diagrams illustrate the static structure of the application and its components on different abstraction and implementation levels and interconnectivity. These diagrams enable easy understanding of the system. The following are set of some structural and behavioral diagrams used for the design purpose of the system.

- Use case diagram – Illustrates what the system needs to perform.
- Activity diagrams – Illustrates object states at a specific timeframe.
- Sequence diagrams – Illustrates overtime interaction of class objects
- Class diagrams – Illustrates the relationship between objects

### **3.5 High Level Use Case Diagram**

Use case diagrams belongs to the behavioral diagrams of the UML diagrams. Functional requirements of the system are highlighted in a use case diagram. It is an effectual technique to demonstrate system behavior in the perspective of users by identifying externally visible system behavior.



**Figure 3.6: Use Case Diagram**

The Figure 3.6 use case illustrates the main three users: travelers, agents and admin and their basic relationships with the user modules of the application.

The proposed system is fragmented into few modules for the ease of development and comprehension. The modules are as follows.

1. User Login and Registration Module
2. Inbound Travel Demand Data Visualization Module
3. Outbound Travel Demand Data Visualization Module
4. Weather Data Visualization Module
5. Cost Data Visualization Module
6. Demand and Trend Data Forecasting Module
7. Travel Package Viewer Module
8. Communication Module

#### User Login and Registration Module

The users should be able to register and login into the system. Admin users should be able to manage users based on the category.

### Inbound Travel Demand Data Visualization Module

This module is related to inbound-travel data to Sri Lanka. The users should be able to view demand patterns of inbound tourism. The inbound travelers can select the time and places to travel accordingly. The inbound travel agents should be able to view the qualitative parameters of the travel demand and create the travel packages accordingly.

### Outbound Travel Demand Data Visualization Module

This module is related to outbound-travel data from Sri Lanka. The users should be able to view trend patterns of outbound tourism. The outbound travelers should be able to view suggestions based on the entered parameters such as time frame and budget. The outbound travel agents should be able to view the demand data based on the location and create the travel packages accordingly.

### Weather Data Visualization Module

This module facilitates viewing of weather details of any location in the world. The users should be able to select the country-city combination of their preference and view the weather data. The users should be able to view the places based on their weather preference and time of travelling.

### Cost Data Visualization Module

The users shall be able to see cost details of selected items for any country and main cities in the world. The application shall provide the facility to compare any selected countries/cities for all the cost items. As a bonus option the module shall provide the cheapest and most expensive countries for any selected item.

### Demand and Trend Data Forecasting Module

The users should be able to view forecasted data based on the input parameters. The sample queries shall be as following.

- (a) Most unoccupied countries/cities to travel in 2021
- (b) Demand increase in a specific area in Sri Lanka for tourism

This shall be a bonus module apart from the main modules of the application.

### Travel Package Creation/Viewer Module

The travel agents should be able to create travel packages into a standard format by entering basic data. The created travel packages should be viewed in this interface.

### Communication Module

The travelers and agents should be provided the access to communicate. The travelers should be able to contact each travel agent while the travel agents should be able to perform mass communication to all the registered travelers.

### 3.6 High Level Entity Relationship Diagram

ER diagrams demonstrate the relationship among the entity sets. The following diagram depicts the high-level relationship between entity sets. It portrays the logical structure of the database of the main functional elements of the proposed application. The data modelling elements are not indicated below. There is no direct link between the data model and the below relationship entities. The data model enables effective collaboration through provision of data insights.

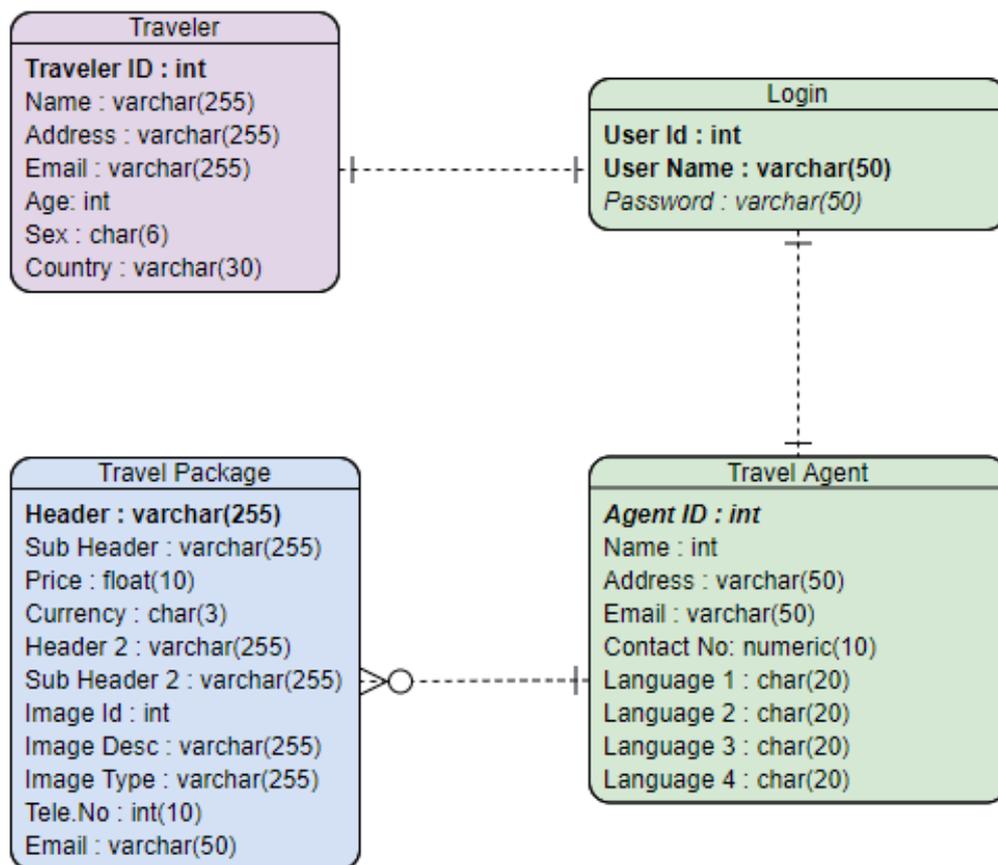


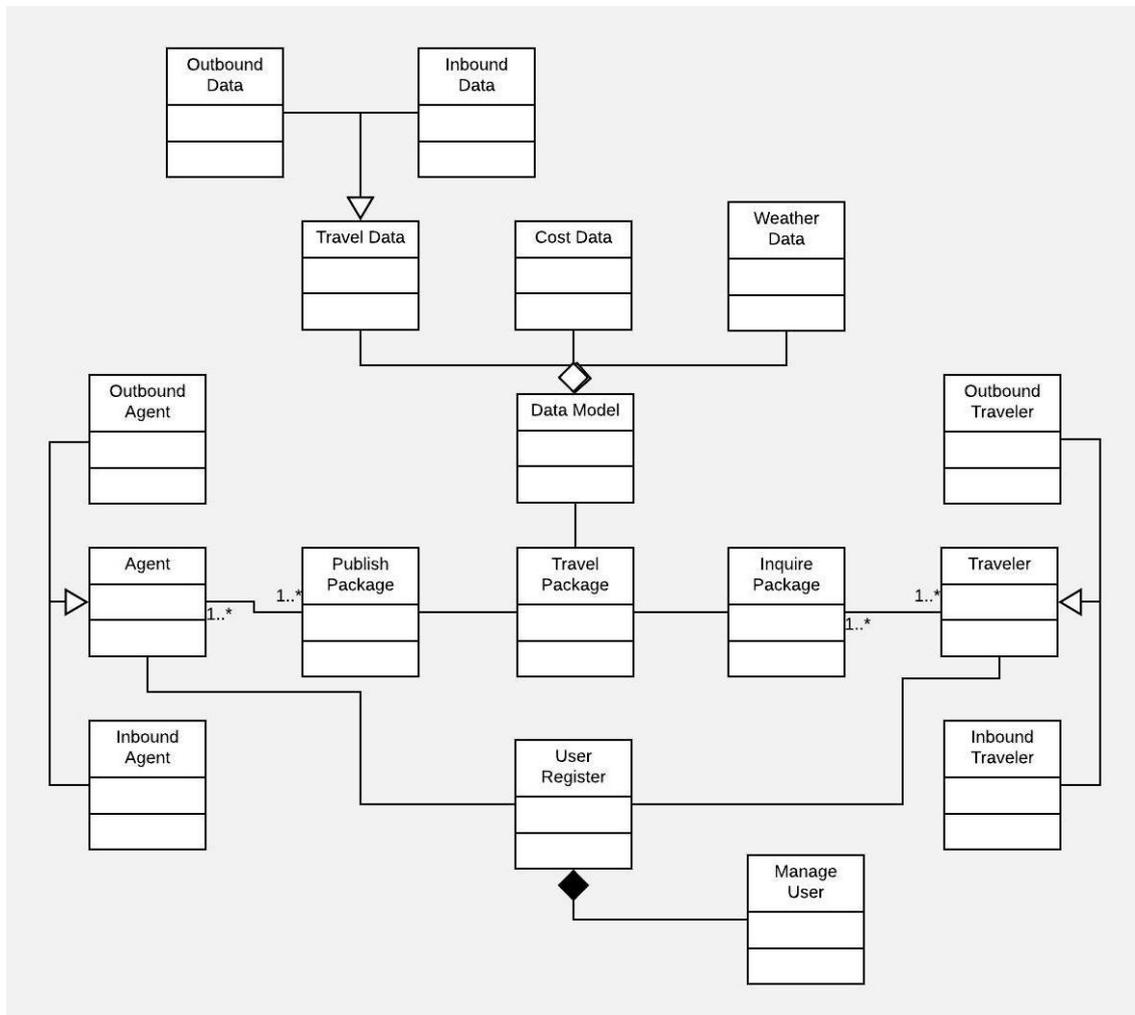
Figure 3.7: Entity Relationship Diagram

The main entities of the application are the travelers, travel agents and the travel packages. The attribute details and type of relationship between the entities are illustrated in Figure 3.7.

### 3.7 High Level Class Diagram

Class diagrams support in understanding the structure of the application depicting the structure, system classes and the attributes of the classes. The key is the relationship

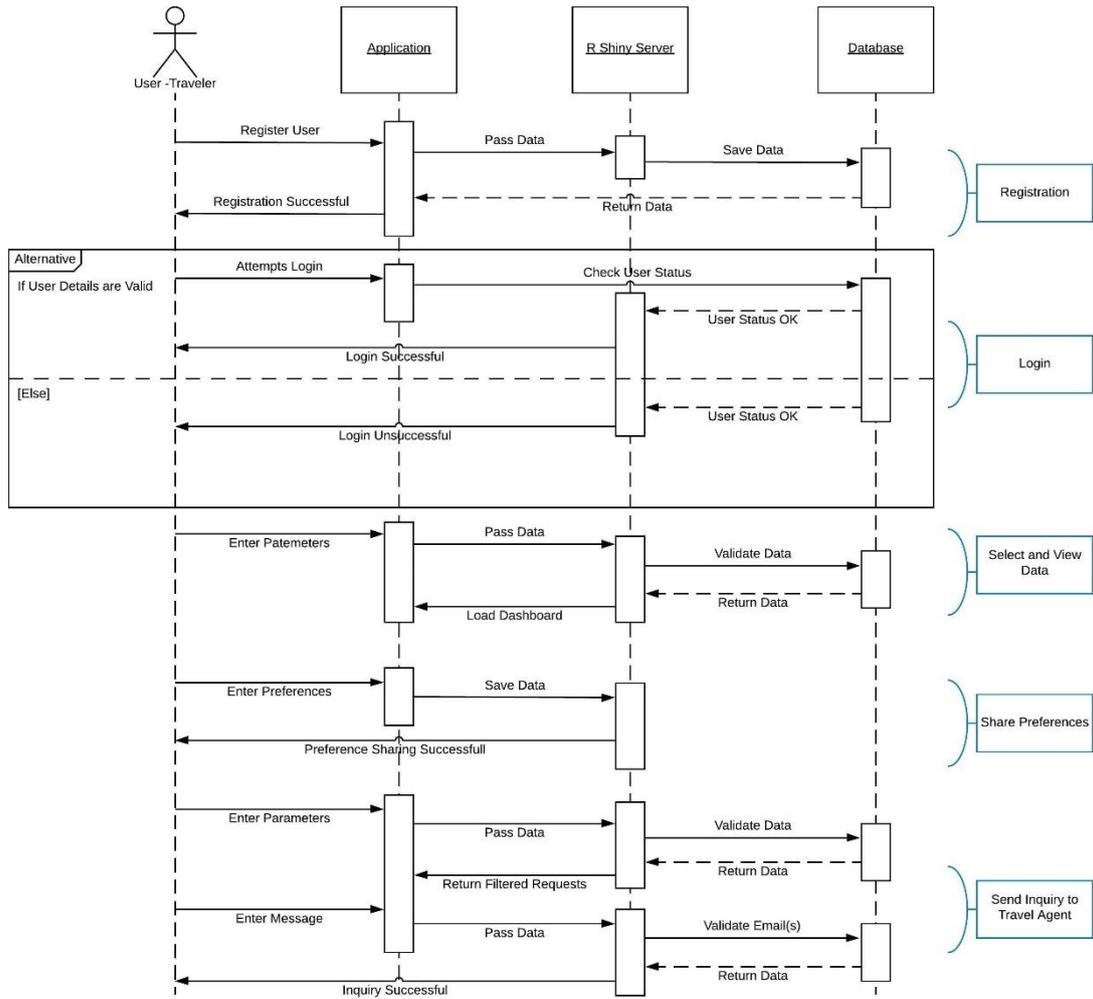
amongst the objects. The following depicted is the high-level class diagram for the proposed application.



**Figure 3.8: Class Diagram**

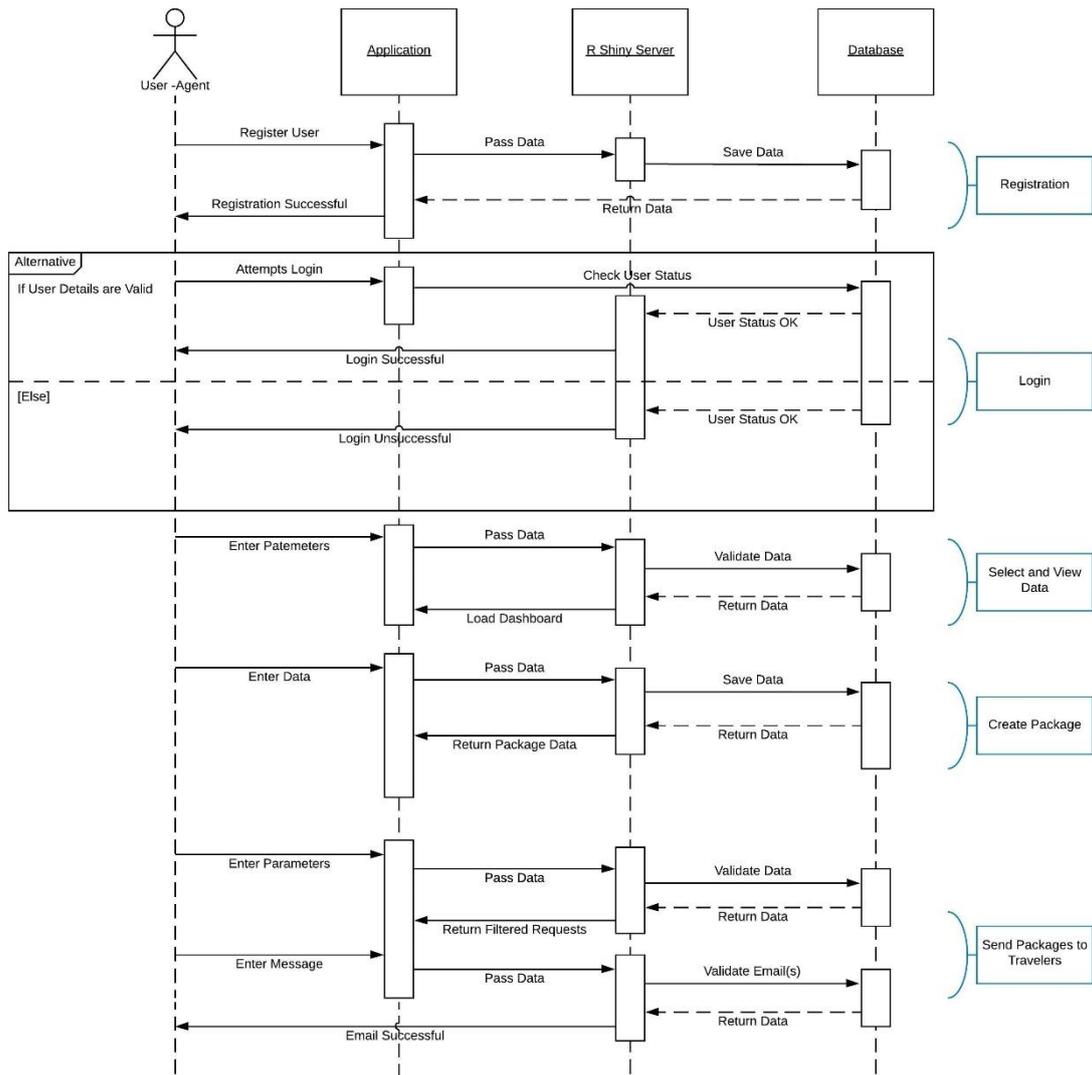
### 3.8 Sequence Diagram

The sequence diagram depicts the interactions between objects in a sequence which helps to understand how the interactions are taken place. The sequence diagram was drawn in two sections for the clarity of information. The two actors, travelers and travel agents were taken independently in different sequence diagrams. The sequence diagrams depict the time frame between the connection of the main class objects. The registration, login, select and view data, place order for package and share preferences are the use cases involved in the Figure 3.9.



**Figure 3.9: Sequence Diagram - Traveler**

The sequence diagram for the Travel Agent actor is illustrated as in Figure 3.10. The registration, login, select and view data and send package to travelers are the use cases involved in the following diagram.



**Figure 3.10: Sequence Diagram - Agent**

### 3.9 User Interface Design

User satisfaction is a necessity in outlining a successful software product. User interfaces were designed critically to abet users to effectively interact with the application. The layouts were made simple and color combinations were essentially deliberated. Java script libraries such as selectsize.js were used to provide much more flexible interface by providing type and search options. The user interfaces were customized using HTML to enable enhanced user interfaces.

## CHAPTER 4

### IMPLEMENTATION

#### 4.1 Introduction

The system specifications were converted into an executable system using back end server-side coding and front-end user interface development. Hence the application is a data driven application, languages and tools were selected in order to accommodate the functionality of the application. The codes were written and put in order in a legible format. Comments were added to aid future scaling of the application.

#### 4.2 Implementation Environment

The proposed application is a web application where the client-side and server-side requirements are considered. The hardware and software requirements of two stated environments are listed below.

##### 4.2.1 Server Environment

The system hosted location and the server architecture is considered in this environment. R Shiny applications can be hosted in through three different ways as following

##### Shinyapps.io

This is a self-service platform to run applications in a protective environment. It is run in the cloud through shared servers which are operated by R Studio.

##### Shiny Server – Open source

This enables the deployment of web applications through a server, which is open source and provides the capability to host multiple apps behind an application firewall.

##### R Studio Connect – Commercial

This enables easy deployment of web applications and better connectivity between the developers and the users.

In the short term the application is hosted in Shinyapps.io which is an online service by R studio to host the application. This enables easier hosting despite restricted active hours.

In the long term the application is hosted in a Shiny Server. RAM and CPU are the main two factors needed to be considered in hardware requirements of a Shiny Server. Minimum RAM requirement is 50MB for a shiny application. Since R is fundamentally a single threaded application, the R process shall run serially on a single processing core. AWS cloud is used as the platform to host the application. The Amazon EC2 on-demand services are used in hosting the application to make sure enhanced service and conserved budget.

### 4.2.2 Client Environment

The basic client environment is to have updated web browsers to avoid browser compatibility issues. The system is abounding with latest technologies and tools hence an updated browser is a must for effective implementation of the application. The system runs on any type of existing web browser.

### 4.3 Development Tools & Techniques

Following tools and techniques were used to develop the application in each level of application development.

#### 4.3.1 Tools

##### R Studio

This is an integrated development environment to function R programming language. It encompasses tools. It includes a console and an editor which is highlighting syntax and supports direct code execution. It comprises of tools which supports plotting, history and debugging. R Studio Desktop version was used to build the application.

Specific libraries for various pretext are available for the usage within the amalgamation of R libraries. Table 4.1 illustrates the main libraries which are used in the application.

**Table 4.1: Utilized R Libraries**

Data Modelling	UI Development	Graphs	Functional
forecast	shiny	plotly	purrr
tidyr	shinydashboard	dygraphs	aws.s3
reshape2	shinywidgets	leaflet	fs
data.table	shinythemes	ggplot2	sodium
plyr	shinyjs		RSQLite
dplyr	randomcoloR		RDCOMClient
xtable	fontawesome		owmr
zoo	RColorBrewer		htmlTable

As illustrated above the libraries were utilized for main four purposes of data modelling, UI development, graph building and system functionality building.

##### Prototype Development – Edrawmax Software

Wireframe diagrams were generated using this software to aid in the development process of the application. The mock user interfaces provided a clear pathway in terms of the user interface building. It has saved abundance of time in trial and error.

### Amazon EC2

This service is used as the cloud service for the database needs of the application. The data management functions are on this server in order to ascertain better performance.

### **4.3.2 Technologies**

#### R as Development Language

R is a primarily a programming language used for statistical programming and graphics. The language was used with assistance of Shiny libraries to develop web applications. It is an open-source programming language.

#### Shiny

This is the main R package that is used in the application build. The user interfaces were built using the `render()` and `output()` functions.

#### CSS

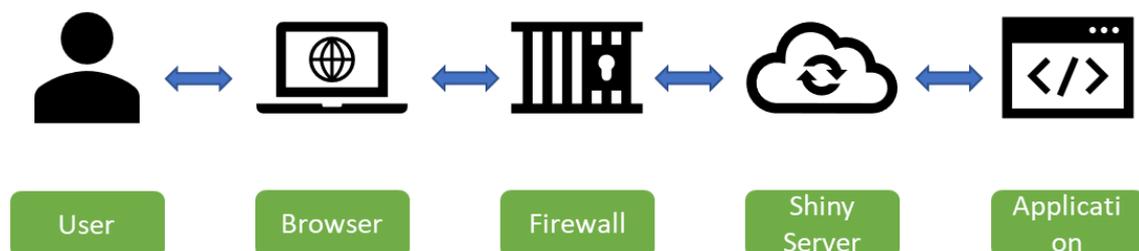
Cascading Style Sheet styles were used to enhance the user interfaces with added characteristics.

#### API

Application Program Interfaces were linked to get real time data for Weather and Currency.

### **4.4 Network Architecture**

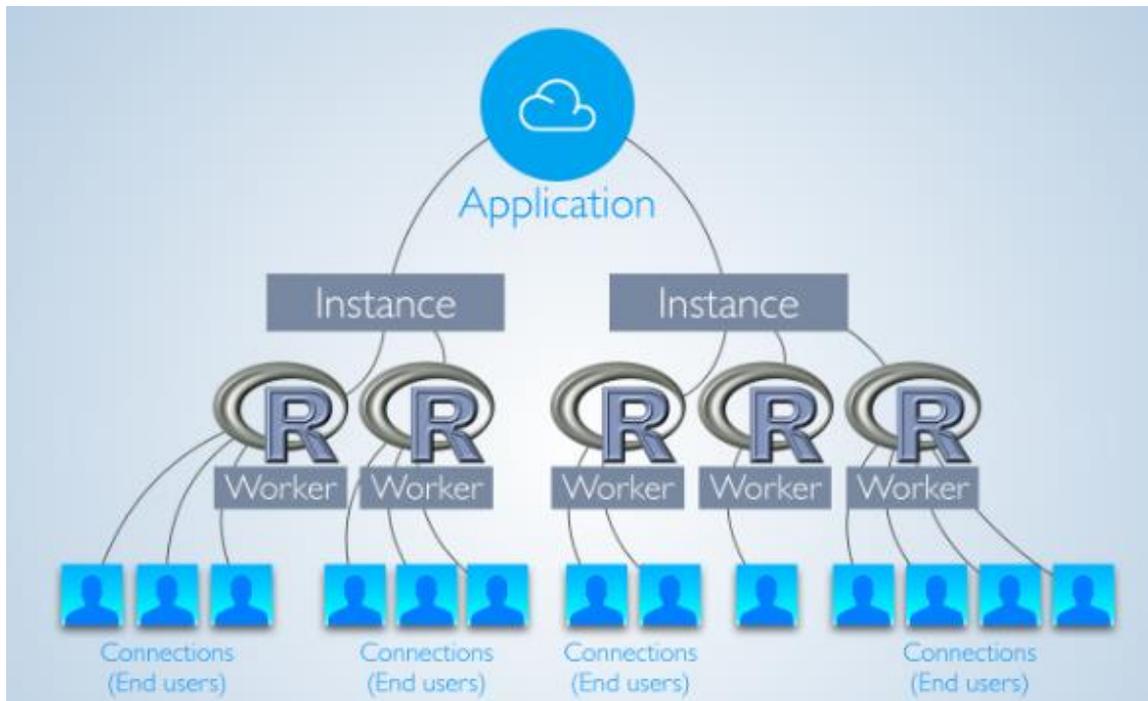
The Figure 4.1 depicts the system implementation. The application hosted in the Shiny server, could be accessed by multiple users through web browsers protected through a firewall.



**Figure 4.1: Application Network**

Since R is a single threaded application, Shiny applications are unable to serve two different users exactly at the same time. It could generally serve 5 to 30 requests/second. However, it could be improved by improving the worker load factor and instance load factor. The application shall start with at least one application instance. Once the number of users increase R workers are added where each application instance could run on

multiple R workers. The browser connection connects the web browser and the application.



**Figure 4.2: R Shiny Application Sequence**

#### **4.5 Application Development Architecture**

As exemplified in the previous chapters the application is developed in a reactive environment, mainly focusing on the server side and the user interface. Mainly two ‘.R’ files are linked with the application.

ui.R – Comprises of elements needed to be added to the user interface.

server.R – Comprises of functions need to be called to derive the output.

```

library(shiny)
ui <- fluidPage(
  numericInput(inputId = "n",
    "Sample size", value = 25),
  plotOutput(outputId = "hist")
)
server <- function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$n))
  })
}
shinyApp(ui = ui, server = server)

```

```

# ui.R
fluidPage(
  numericInput(inputId = "n",
    "Sample size", value = 25),
  plotOutput(outputId = "hist")
)

```

```

# server.R
function(input, output) {
  output$hist <- renderPlot({
    hist(rnorm(input$n))
  })
}

```

Figure 4.3: R Shiny Coding Elements

Furthermore, data and data scripts are managed separately as R files. The images, java scripts and CSS files are saved in a folder named “www”.

#### 4.6 Main User Interfaces

The below section comprises of few of the main user interfaces of the application. As mentioned in the preceding sub sections, minimal characteristics were incorporated to the UX design in order to enhance fluidity and continuity. The users shall first register with the application through the Join TravelDatos modal window as shown in Figure 4.4.

The registration pane is a modal window with the following fields and options:

- Category:** Radio buttons for  Travel Agent and  Individual Traveler.
- Name:** Text input field.
- Email:** Text input field.
- Password:** Text input field.
- Contact No:** Text input field.
- Address:** Text input field.
- Served/Preferred Regions:** Dropdown menu with "South Asia" selected.
- Buttons:** "Cancel" and "Enter" buttons at the bottom right.

Figure 4.4: Registration Pane

The users can login to the system once got registered in the system. Users can view the default data or get a customized view based on the parameters. Figure 4.5 illustrates the user parameter input tab panel.

**Figure 4.5: Input Parameters**

There are 7 main tab panels as following in the application.

1. Travel Sri Lanka
2. Travel World
3. Travel Packages
4. Travel Trends
5. Weather Update
6. Travel Cost
7. Attention!

There are sub panels for each of above tab panels. Based on the insights derived through the application the travelers are given the facility to share the preferences to travel through Share Preferences modal window.

## Travel Sri Lanka

Customized views were given to the travelers and agents with detailed graphics to take decisions on the time and places. The graphics include the seasonality data and demand data of places as illustrated in Figure 4.6. Based on the details inbound travelers and travel agents could take decisions.

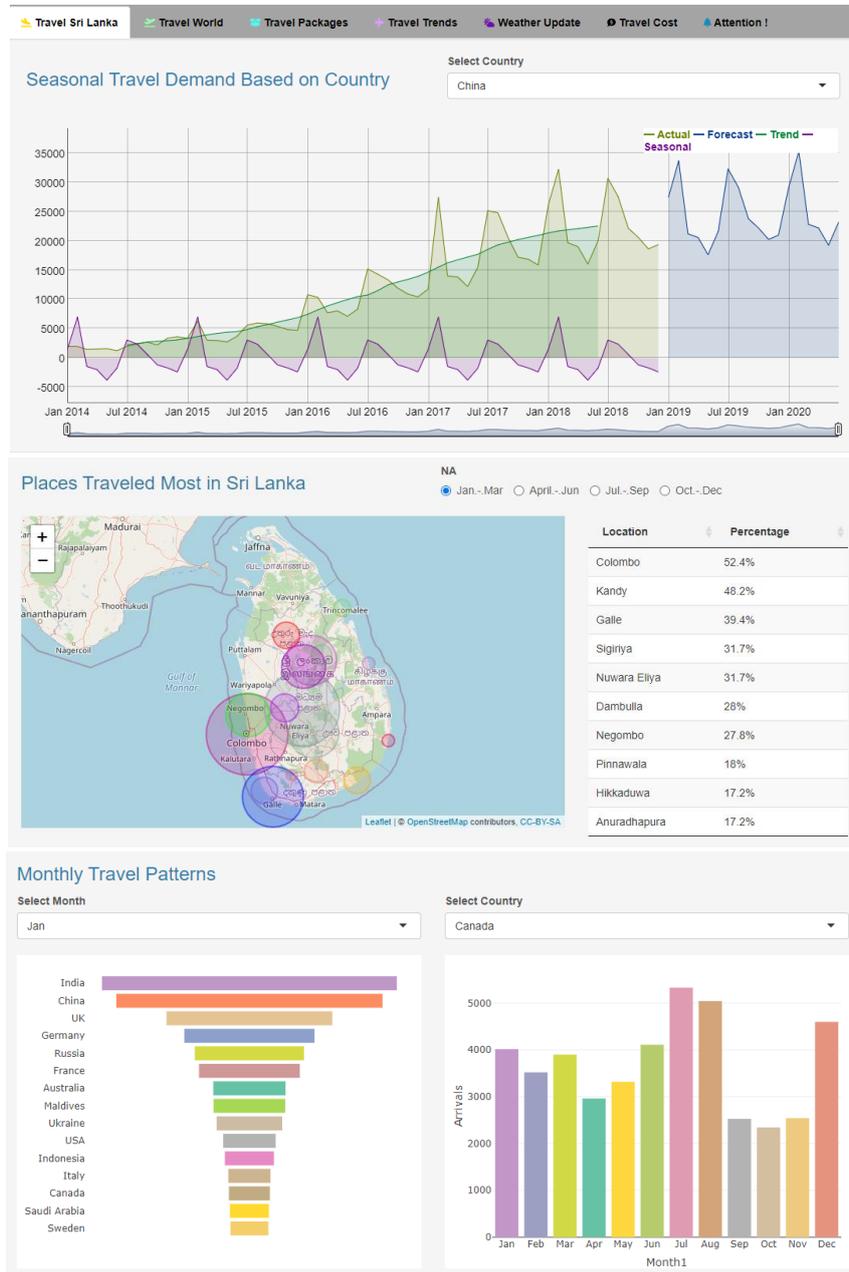


Figure 4.6: Travel Sri Lanka Tab

## Travel World

Customized views were provided on the travel demand data, cost data and weather data for all the countries in the world. The demand data is from Sri Lanka to the other countries. Based on the data the outbound travelers could take decisions on the times and the places. The interfaces are analogous to the above interfaces showcased for Travel Sri Lanka tab.

## Travel Packages

Correspondingly this provides customized views for travelers and agents. The agents could enter details of the travel packages. Flyers of the travel packages are automatically built and showed in the traveler view as packages. This applies for both inbound and outbound travel. The travel is given the ability to select the package and communicate with travel agent through email as illustrated in Figure 4.7.

The screenshot displays the 'Travel Packages' tab in a web application. The navigation bar includes 'Travel Sri Lanka', 'Travel World', 'Travel Packages', 'Travel Trends', 'Weather Update', 'Travel Cost', and 'Attention !'. The main content area is titled 'Travel Packages' and features four package cards:

- 1. Summer Vacations:** Explore Sri Lanka, 900\$, 8 Days, May. Lanka Tours, 49720938, Lanka Tours @gmail.com.
- 2. Best of Sri Lanka:** Explore Sri Lanka, 1000\$, 9 Days, June. Tour Lanka, 49720938, Tour Lanka @gmail.com.
- 3. Feel Sri Lanka:** Explore Sri Lanka, 1200\$, 10 Days, July. Ceylon Tours, 49720938, Ceylon Tours @gmail.com.
- 4. Summer Vacations:** Explore Sri Lanka, 900\$, 11 Days, August. Lanka Tours, 49720938, Lanka Tours @gmail.com.

Below the packages is an 'Add Travel Packages' form with fields for Package Header, Package Sub Header, Cost of the Package, Number of Days, and Month. Underneath is a 'Contact Travel Agent' section with a radio button list for package selection (options 1-7) and a 'Type Message' text area with a 'Send Email' button.

**Figure 4.7: Travel Packages Tab**

## Travel Trends

This is one of the bonus modules of the application in which forecasts based on the travel statistics are provided. The users can view based on the country or region for in depth travel analytics.

## Weather Update

Users can view weather details for any location of choice. Also, it provides interfaces to select the places to travel based on temperature range and time of travel as shown in Figure 4.8.

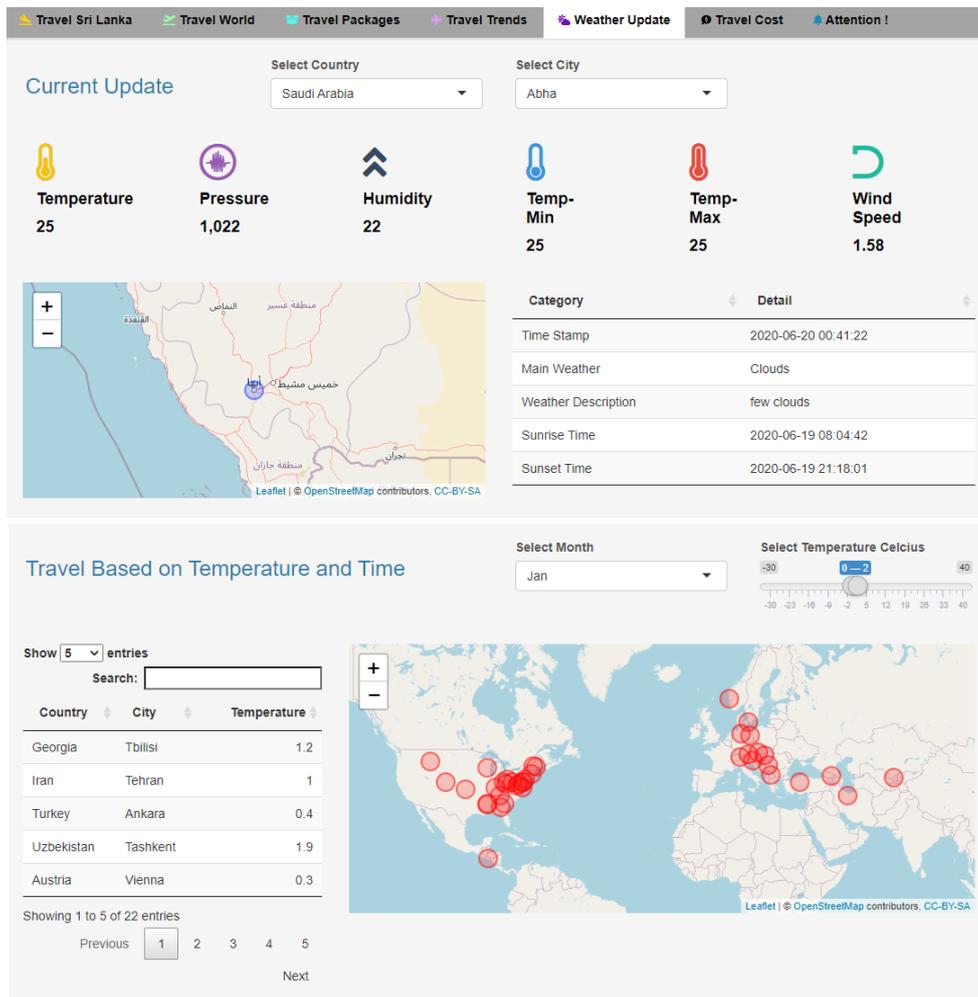


Figure 4.8: Weather Update Tab

## Travel Cost

Users can view costs for different items for any selected place. Also, the facility is given to compare all the items between any selected Country-City combination. The dashboards are provided to view the cheapest and most expensive countries based on item as shown in Figure 4.9.



Figure 4.9: Travel Cost Tab

## Attention!

This tab includes all the package inquiries from the travelers. The travel agents are given the facility to sort the requests based on country, budget range, number of days and month. The travel agents are given the facility to send an email with attachment to the traveler.

**Pending Requests**

Show  entries Search:

	Name	Email	TPNo	Living	Preference	avgBudget	numDays	year	month
1	Gimhani P	thushan444@gmail.com	22726327	Sri Lanka	Thailand	900	8	2020	Jun
2	Thushan Dh	thushandh@brandix.com	23742348	Sri Lanka	Vietnam	1050	14	2020	Jun
3	Thanura P	thushan.dharmawardana@gmail.com	23423433	Sri Lanka	Myanmar	1200	20	2020	Jul
4	Gimhani P	thushan444@gmail.com	22726327	Sri Lanka	Indonesia	1350	26	2020	Jul
5	Thushan Dh	thushandh@brandix.com	23742348	Sri Lanka	Malaysia	1500	32	2020	Aug
6	Thanura P	thushan.dharmawardana@gmail.com	23423433	Sri Lanka	China	1650	38	2020	Aug
7	Gimhani P	thushan444@gmail.com	22726327	Sri Lanka	Thailand	1800	44	2020	Sep
8	Thushan Dh	thushandh@brandix.com	23742348	Sri Lanka	Vietnam	1950	50	2020	Sep
9	Thanura P	thushan.dharmawardana@gmail.com	23423433	Sri Lanka	Myanmar	2100	56	2020	Oct
10	Gimhani P	thushan444@gmail.com	22726327	Sri Lanka	Indonesia	2250	62	2020	Nov

Showing 1 to 10 of 25 entries Previous    Next

**Select Preference**

**Select Budget Range**

**Select Number of Days**

**Select Month**

**Select Year**

Show  entries Search:

	Name	Email	TPNo	Living	Preference	avgBudget	numDays	year	month
1	Gimhani P	thushan444@gmail.com	22726327	Sri Lanka	Thailand	900	8	2020	Jun

Showing 1 to 1 of 1 entries Previous  Next

**Type Message**

We have a package serving your needs. Please find the details

**Figure 4.10: Attention! Tab**

## CHAPTER 5

### TESTING AND EVALUATION

#### 5.1 Introduction

Software testing is a critical component of the software development life cycle. It is generally the process of identifying the gap between the existing and required characteristics of a system. The testing method mainly comprises with verification and validation. Validation refers to whether the functionalities of the system are achieved. Verification indicates whether the system implements the stipulated functions properly.

#### 5.2 Testing Procedure

Iterative model of software development was utilized in the application development. The system was tested while the development is ongoing. Automation and manual testing methods were used in the testing process.

Shinytest package is used to perform automated testing for the deployed application. It allows the recording of tests while running and troubleshooting is performed.

Testthat package was utilized in order to test the code. Selected functions could be tested using the package.

##### 5.2.1 Recording Tests

The recording of the tests was performed through the recording function available in R studio. The main application to be tested can be referred as the 'target app' while the recorder launches a special shiny application which can be referred as the 'recorder app'. Once interactions are done with the 'target app', those are recorded in the Recorded events list. Checking whether the application produces the correct outputs were realized by taking snapshots as facilitated by the tester.

##### 5.2.2 Running Tests

Once the recording is done, consequentially the test scripts are run. Mainly there are three components involved with the running of tests.

1. Test driver – Controls the testing and controls of the web browser
2. Shiny Process/Server – Runs the target shiny application
3. Web Browser/Client – This is a headless web browser, which renders web page internally without displaying the content on the screen.

Subsequent tests were run to evaluate the changes in application performance.

### 5.2.3 Testing Code

Testthat was used as the testing framework to improve the quality of the code. It provides functions to identify errors, warnings and messages. This approach has given the ability to perform formal unit testing rather than ad hoc informal testing.

The simplified testing workflow is as follows. Once the package is set up, the modification of the codes and tests are done. The package could be tested until all the tests are pass.

### 5.3 Testing Non-Functional Requirements

Testing of non-functional requirements is a critical component in terms of the continuity of the application. Shinyapps.io and Google Page Speed Insights were used to assess the performance of the application.

The number of connections, memory usage, worker processes, CPU usage and network usage could be tracked through the Shinyapps.io dashboard.

Google Page Speed Insights enabled with the information specially on the Lab data, Opportunities to improve and other diagnostics. The insights received through these testing helped immensely in improving the application. It was suggested in the initial testing that if the render blocking resources are removed there is an estimated saving of 7.96 seconds.

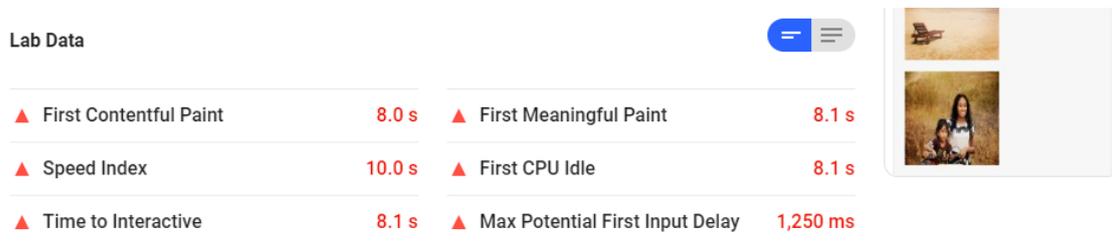


Figure 5.1: Google Insight lab data

Opportunity	Estimated Savings
▲ Eliminate render-blocking resources	7.96 s ▼
▲ Properly size images	2.4 s ▼
■ Serve images in next-gen formats	0.45 s ▼
▲ Reduce server response times (TTFB)	0.41 s ▼
■ Minify JavaScript	0.15 s ▼

Figure 5.2: Google Insight opportunities

### 5.4 User Acceptance Testing

This is the last phase of the software testing process. The application is planned to be tested with prospective users on the performance. To make it lesser complicated a simple survey is created. The survey form is to be shared with the application link in order to assess the user acceptance of the application. Net Promoter Score (NPS) to be used as the methodology to assess the user experience. Figure 5.3 depicts the survey form used in this endeavor.

**Software and Application Customer Feedback**  
Customer Feedback for Traveldatos application  
\* Required

How likely is that you would recommend this app to a colleague ? \*

1 2 3 4 5 6 7 8 9 10  
Not at all likely ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Extremely likely

What explains you better?

Traveler  
 Travel Agent

	Not at all satisfied	Not so satisfied	Somewhat satisfied	Very satisfied	Extremely satisfied
How satisfied are you with the quality of data and insights ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How satisfied are you with the ease of navigation ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How satisfied are you with the functionalities available ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How satisfied are you with the user interfaces ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
How satisfied are you with the usefulness of the application ?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Would you use this application for travel planning ? \*

1 2 3 4 5 6 7 8 9 10  
Not at all likely ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Extremely likely

Would you use this application to communicate with travelers and travel agents ? \*

1 2 3 4 5 6 7 8 9 10  
Not at all likely ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Extremely likely

If you are a travel agent would you use this to create travel packages based on the insights ? \*

1 2 3 4 5 6 7 8 9 10  
Not at all likely ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ Extremely likely

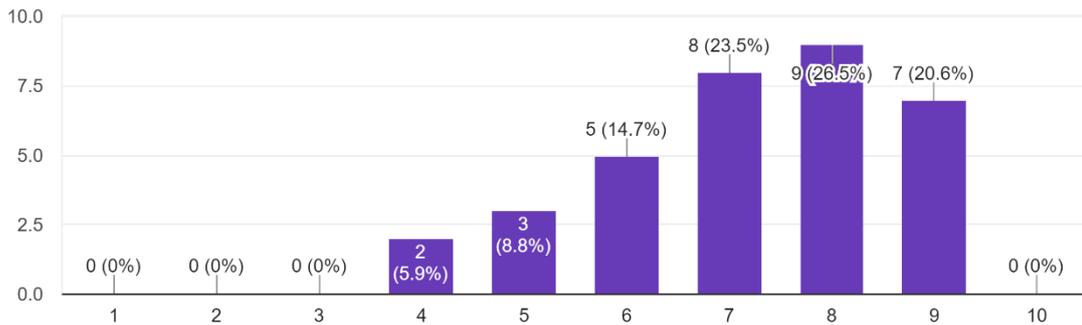
Figure 5.3: Sample Survey Form

The NPS value is derived by subtracting the percentage detractors from the percentage promoters. The promoters are ranks 9 and 10 while the detractors are from 0 to 6. Positive Net Promoter Score is deemed as good [20].

Altogether 34 responses were received and 70.59% has given a rating of 7 or more in terms of recommending the application to a colleague.

How likely is that you would recommend this app to a colleague ?

34 responses

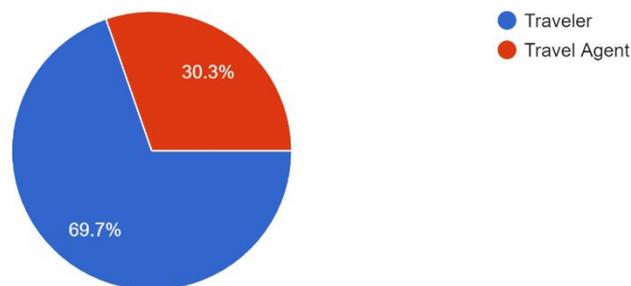


**Figure 5.4: Survey Responses – Recommendableness**

30.3% of the respondents are potential travel agents and the rest are potential travelers.

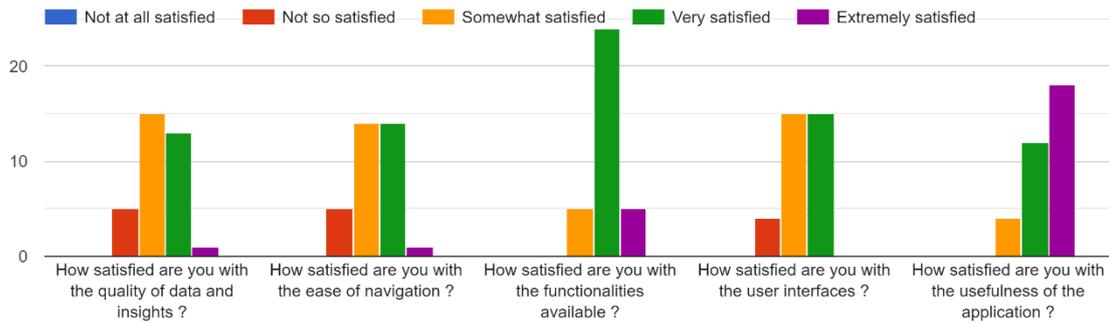
What explains you better?

33 responses



**Figure 5.5: Survey Responses - Type of Respondents**

The Majority are mainly satisfied with the functionalities available and regarding the usefulness of the application. The respondents are moderately satisfied with the quality of data and insights, ease of navigation and user interfaces. However, the least favorable item in the application is the user interfaces. The total NPS is around (-0.21) for the application. Improvements are needs to be planned in order to make it a positive value.

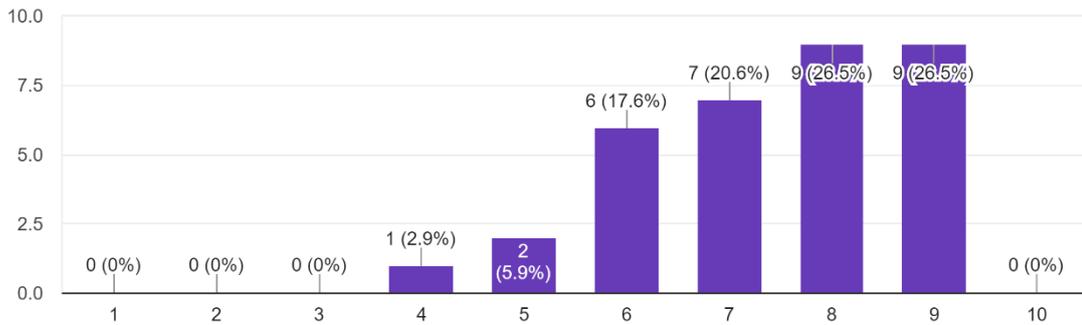


**Figure 5.6: Survey Responses - User Satisfaction**

73.52% of the respondents have rated 7 or more in terms of using the application for travel planning.

Would you use this application for travel planning ?

34 responses

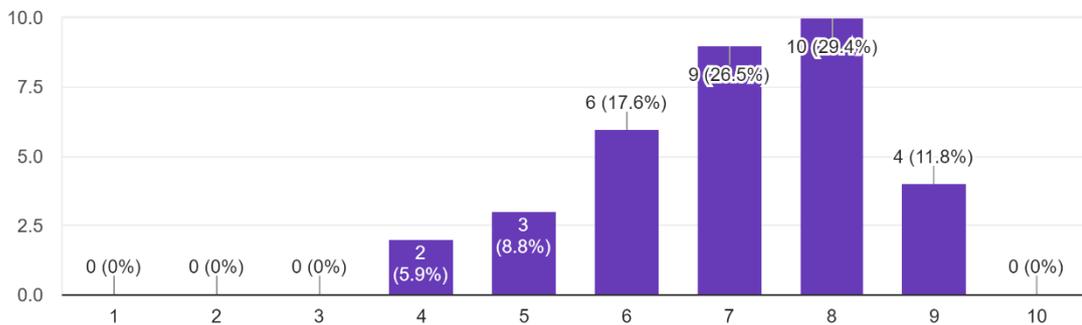


**Figure 5.7: Survey Responses – Usability**

67.65% of the respondents have rated 7 or more in terms of using the application for communication between travelers and travel agents.

Would you use this application to communicate with travelers and travel agents ?

34 responses



**Figure 5.8: Survey Responses - As a Communication Platform**

The least amount of positive responses is received for the potential travel agents to use the application to create the travel packages. Only 64% has approved this statement with 7 or more ranking.

## **CHAPTER 6**

### **CONCLUSION**

#### **6.1 Introduction**

The main objective of the project was to create a platform to enable travelers and travel agents to take better decisions and communicate. The objectives of the application were almost completely achieved using the tools, technologies and frameworks discussed in the preceding chapters. The forethought of the application was to create a data centric travel application. Based on the data sources discovered, the scope of the project altered in diminutive fashion.

The application was created using the open source R programming platform. The libraries and tools available for R assisted in a major portion of the Software Development Life Cycle. The application is trusted to have ignited a distinctive perspective in terms of trip planning.

#### **6.2 Problems Identified**

The application was created using open source tools hence the communities in Stack Overflow, R Community helped immensely in the events of errors and bugs discovered throughout. One of the main problems encountered during the development cycle is the incompatibility of some of the R packages. R is of weak origin which shares the origin with much older programming language “S”. The base packages of R don’t support dynamic visualization or 3D graphics. There are compatibility issues when using r packages developed by the community.

The slowness of data handling when using R was one of the main issues faced. Physical memory is used by R to store objects. Therefore, the data loading of the application was considerably higher. This was captured in the usability tests as well. With the help of data management packages, the impact was minimized.

As mentioned in the background chapter the other competitor applications are richer in user experience. These competitor applications encompass modern and dynamic graphics and widgets. Building such an application is a challenge using R shiny programming. The user interfaces of the application were created with minimalistic features. Conversely minimalism has helped in achieving more affable user interfaces.

### **6.3 Lessons Learnt**

This project turned out to be a great opportunity in the application of the knowledge gained during the MIT degree program. It has turned a non-programmer to a programmer. The technical skills were improved significantly.

The main lesson learnt during this software development endeavor is that a structured approach in software development aids better program development. The requirement gathering and the system design phases of the application enabled critical thinking on application design.

The data were transformed into insights. Insights backed the decisions. The application building phase has imparted the power of data when it is consumed better.

### **6.4 Future Enhancements**

The current scope of the application is limited to linkage between travelers and agents through data insights. During the study of similar systems, it was discovered that many other things could be built into this application to make it one of the best travel applications. As the second phase, the following characteristics shall be built into the application.

- Creating overall travel plan
- Creating a Day in the Life plan of a traveler
- Travel duration between destinations
- Information on places to visit in each destination
- Information on accommodation facilities

Presently the application supports only outbound and inbound travel of Sri Lanka only. The scope of the application shall be gradually increased based on the success of the Sri Lankan undertaking.

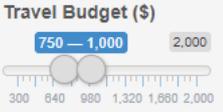
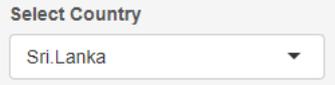
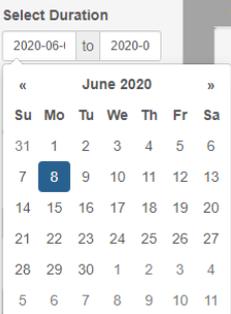
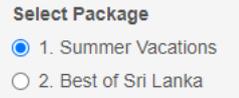
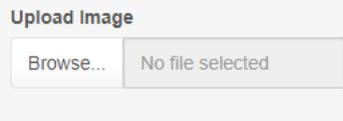
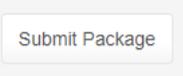
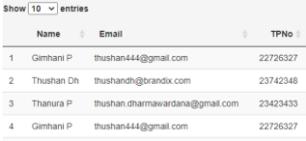
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## APPENDIX A – UI DESIGN ELEMENTS

The user interfaces were mainly designed incorporating several R shiny libraries. Following are the main design elements used for data input and viewing functionalities.

Element	Description	Image
textInput	This was used for basic text entering. Any unstructured text is possible to be entered.	
numericInput	This was used for entering numeric values.	
sliderInput	This was used for entering of value ranges.	
selectInput	This was used for the users to select a value or multiple values from a drop down	
dateInput & dateRangeInput	Users can enter a date or date range through a calendar through this UI element.	
passwordInput	This was used when an entry of password is required.	
radioButtons	This was used when only one input is required, and the total list of options need to be displayed.	
fileInput	The users can input any type of file through this UI element.	
actionButton	This UI element would trigger any kind of action. It enacts an observeEvent where the action will be deployed.	
dataTableOutput	This enables displaying of data tables for selected data frames	

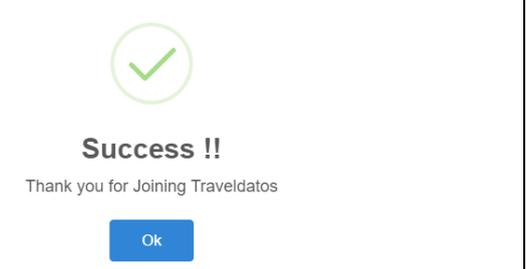
<p>plotOutput , dygraphOutput &amp; plotlyOutput</p>	<p>These UI elements were used to display multiple charts.</p>	
<p>leafletOutput</p>	<p>This was used to display map information.</p>	
<p>tags\$img</p>	<p>This tag was used to display the images in the application.</p>	
<p>tags\$style</p>	<p>This tag was used to display HTML elements.</p>	<p><b>Travel lanka</b></p> <p>travel for british 1999\$ 20 Days</p>
<p>fontawesome icons</p>	<p>This was used to include to start icons to the application.</p>	
<p>SweetAlert</p>	<p>Success and warning messages are displayed as a popup through this UI element.</p>	
<p>infoBoxOutput</p>	<p>This was used to display information as a card with added icons.</p>	

## APPENDIX B – TEST CASES

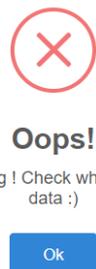
Following are the test cases and results for 5 of the main functional areas of the application.

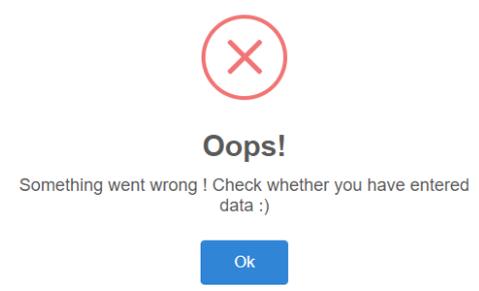
<b>Test Case No</b>		01	
<b>Tested Component</b>		Join Traveledatos	
<b>Test Case</b>		Registration to the application	
<b>Expected Output</b>		Successful registration to the application	
<b>Test Case Description</b>			
<b>No</b>	<b>Test Case</b>	<b>Actual Output</b>	<b>Status</b>
01	Enter the Email	Need to validate only valid email addresses can be put as input	Pass
02	Press OK button with invalid password	A visual message needs to display.  <b>Oops!</b> Something went wrong ! Please check your data  	Pass
03	Press OK button with empty email id	A visual message needs to display.  <b>Oops!</b> Something went wrong ! Please check your data  	Pass
04	Press OK button with any missing value.	A visual message needs to display.  <b>Oops!</b> Something went wrong ! Please check your data  	Pass

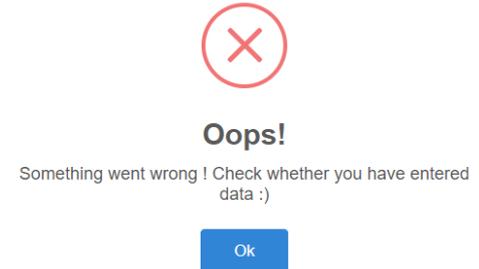
05	Register successfully	A visual message needs to display mentioning success.	Pass
----	-----------------------	---	------

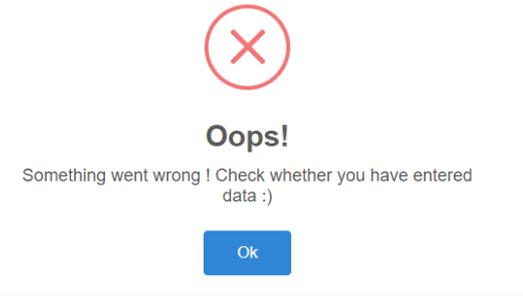
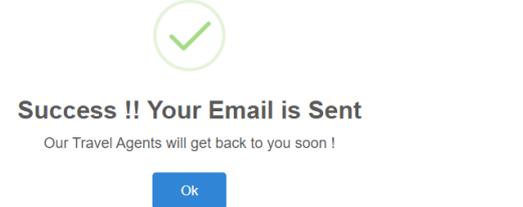


A screenshot of a success message. It features a green checkmark inside a circle at the top. Below it, the text reads "Success !!", followed by "Thank you for Joining Traveldatos". At the bottom, there is a blue button labeled "Ok".

<b>Test Case No</b>		02	
<b>Tested Component</b>		Travel Packages	
<b>Test Case</b>		Add a travel package	
<b>Expected Output</b>		Successful add a travel package	
<b>Test Case Description</b>			
<b>No</b>	<b>Test Case</b>	<b>Actual Output</b>	<b>Status</b>
01	Enter the submit Package action button without package details	If the required details are not available a visual message needs to display.  <div style="text-align: center;">  <p>A screenshot of an error message. It features a red 'X' inside a circle at the top. Below it, the text reads "Oops!", followed by "Something went wrong ! Check whether you have entered data :)". At the bottom, there is a blue button labeled "Ok".</p> </div>	Pass
02	Enter the submit Package action button without an image	If an image is not inserted a visual message needs to display.	Pass

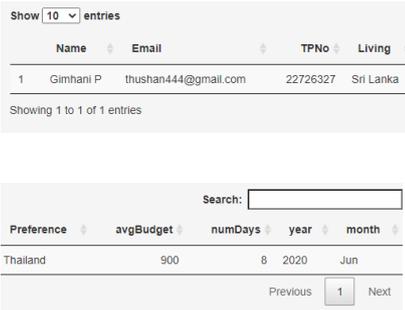
			
03	The added details are successfully displayed in the Travel Packages panel.	The created travel package needs to be displayed without any data missing with the correct image. 	Pass

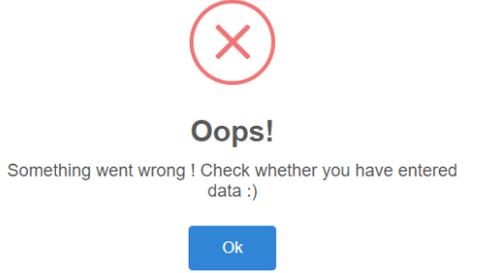
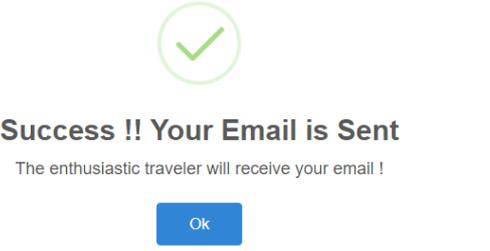
<b>Test Case No</b>		03	
<b>Tested Component</b>		Travel Packages	
<b>Test Case</b>		Contact travel agent	
<b>Expected Output</b>		Successfully contact travel agent	
<b>Test Case Description</b>			
No	Test Case	Actual Output	Status
01	Enter the Send Mail Button without a message	If a message is not entered a visual message needs to display 	Pass

02	Enter the Send Mail Button without selecting a package	If a package is not selected a visual message needs to display  	Pass
03	Successfully send the email message to the intended party after clicking the Send Mail Button.	The email needs to be sent to the intended party. A visual message needs to display.  	Pass

<b>Test Case No</b>	04		
<b>Tested Component</b>	Share Preferences		
<b>Test Case</b>	Input preferred travel attributes		
<b>Expected Output</b>	Successfully share the travel preferences		
<b>Test Case Description</b>			
<b>No</b>	<b>Test Case</b>	<b>Actual Output</b>	<b>Status</b>
01	Enter OK button without entering the Preferred Country	If Preferred country is not entered a visual message needs to display	Pass

		 <p><b>Oops!</b> Something went wrong ! Check whether you have entered data :)</p> <p>Ok</p>	
02	Enter OK button without entering the Budget Range	If Budget Range is not selected a visual message needs to display	Pass
		 <p><b>Oops!</b> Something went wrong ! Check whether you have entered data :)</p> <p>Ok</p>	
03	Enter OK button without entering the Date Range	If Budget Range is not selected a visual message needs to display	Pass
		 <p><b>Oops!</b> Something went wrong ! Check whether you have entered data :)</p> <p>Ok</p>	
04	Successfully share the preferences by clicking the OK button.	A visual message needs to display mentioning success.	
		 <p><b>Success !! Your Email is Sent</b> Our Travel Agents will get back to you soon !</p> <p>Ok</p>	

<b>Test Case No</b>	05		
<b>Tested Component</b>	Attention!		
<b>Test Case</b>	Select requests and communicate with potential travelers		
<b>Expected Output</b>	Successfully select requests and communicate with travelers		
<b>Test Case Description</b>			
<b>No</b>	<b>Test Case</b>	<b>Actual Output</b>	<b>Status</b>
01	Enter Filter Requests button with invalid selected parameters.	<p>The table below shall display a message as the data are not available</p> 	Pass
02	Enter Filter Requests button with valid selected parameters.	<p>The table below shall display the filtered data</p> 	Pass

03	Enter Send Email button without filtered packages	<p>If filtered packages are not available visual message needs to display</p> 	Pass
04	Successfully send an email to potential traveler(s) by pressing Send Email button with filtered packages	<p>If the email(s) are sent to the potential travelers a success visual message needs to display</p> 	Pass

## APPENDIX C – CODE LISTINGS

This section includes the sample codes for mainly three areas. The Travel Sri Lanka section is considered as the example to illustrate the coding for data modelling, Server-side coding and User-side coding. This is one of the tab panels of the total of 7 Tab Panels.

### Data Modelling

```
library("jsonlite")
library("rjson")

json_file <- 'https://datahub.io/nandana/sri-lanka-tourism-statistics/datapackage.json'
json_data <- fromJSON(paste(readLines(json_file), collapse=""))

# get list of all resources:
print(json_data$resources$name)

# print all tabular data(if exists any)
for(i in 1:length(json_data$resources$databus$type)){
  if(json_data$resources$databus$type[i]=='derived/csv'){
    path_to_file = json_data$resources$path[i]
    data <- read.csv(url(path_to_file))
    print(data)
  }
}

# Load the package required to read JSON files.
library("rjson")

# Give the input file name to the function.
result <- fromJSON(paste(readLines(json_file), collapse=""))

# Convert JSON file to a data frame.
json_data_frame <- as.data.frame(result[[6]])

print(json_data_frame)
```

```
library(tidyr)
library(zoo)
library(forecast)

Data2012 <- read.csv("2012-P21.csv", header = T)
Data2013 <- read.csv("2013-P21.csv", header = T)
Data2014 <- read.csv("2014-P21.csv", header = T)
Data2015 <- read.csv("2015-P23.csv", header = T)
Data2016 <- read.csv("2016-P21.csv", header = T)

Data2012 <- Data2012[,-2]
Data2013 <- Data2013[,-2]
Data2014 <- Data2014[,-2]
Data2015 <- Data2015[,-2]
Data2016 <- Data2016[,-2]

Data2012$Year <- "2012"
Data2013$Year <- "2013"
Data2014$Year <- "2014"
Data2015$Year <- "2015"
Data2016$Year <- "2016"

Data2012 <- gather(Data2012, "Month", "Value", -c("Country.of.Residence", "Year"))
Data2013 <- gather(Data2013, "Month", "Value", -c("Country.of.Residence", "Year"))
Data2014 <- gather(Data2014, "Month", "Value", -c("Country.of.Residence", "Year"))
Data2015 <- gather(Data2015, "Month", "Value", -c("Country.of.Residence", "Year"))
Data2016 <- gather(Data2016, "Month", "Value", -c("Country.of.Residence", "Year"))

dataInbound <- rbind(Data2012, Data2013, Data2014, Data2015, Data2016)
```

## Server-Side Coding

```
##### Travel SriLanka | Seasonal Travel Demand | Select Input #####
output$selectCat19 <- renderUI({
  selectInput('input20',"Select Country",choices = as.character(unique(dataInbound$Country.of.Residence)),selected = "China")
})

##### Travel SriLanka | Seasonal Travel Demand | Observe #####
observe({
  if (is.null(input$input20)) {

dataInbound <- dataInbound[dataInbound$Country.of.Residence == input$input20,]
dataInbound$value <- gsub(" ","",dataInbound$value)
dataInbound$value <- as.numeric(dataInbound$value)
dataInbound <- dataInbound[,4]
ts <- as.matrix(dataInbound)
ts1 <- ts(ts)
ts1 <- ts(ts1,start = c(2014,1), frequency = 12)
demand <- ts1
trend<- decompose(ts1)$trend
seasonal <- decompose(ts1)$seasonal
ts1_arima <- auto.arima(ts1)
ts1_arima <- data.frame(forecast(ts1_arima,h = 18))
ts1_arima <- ts1_arima[,1]
f <- ts(ts1_arima ,start = c(2019,1), frequency = 12)
fcst <- cbind(demand,trend,seasonal,f)
} else
  return()
}
```

```
output$dygraph1 <- renderDygraph({
  dygraph(fcst)%%
  dySeries("demand",label="Actual",fillGraph = TRUE)%%
  dySeries("f",label="Forecast",fillGraph = TRUE)%%
  dySeries("trend",label="Trend",fillGraph = TRUE)%%
  dySeries("seasonal",label="Seasonal",fillGraph = TRUE)%%
  dyRangeSelector(height = 20)%%
  dyHighlight(highlightSeriesOpts = list(strokeWidth = 3))
})

##### Travel SriLanka | Places Traveled Most | Observe #####
output$selectQuarter <- renderUI({
  radioButtons("quarter", NA, unique(dataInboundMap$Quarter), inline = T)
})

observe({
  if (!is.null(input$quarter)) {

dataInboundMap <- dataInboundMap[dataInboundMap$Quarter == input$quarter,]
dataInboundMap$lat <- as.numeric(dataInboundMap$lat)
dataInboundMap$long <- as.numeric(dataInboundMap$long)

} else
  return()
}
```

```
output$mymap <- renderLeaflet({
  factpal <- colorFactor( palette = c('red', 'blue', 'green', 'purple', 'orange'), dataInbound$Location)

  leaflet(dataInboundMap) %>%
  addTiles() %>%
  setView(lng=80.5 ,lat=7.8, zoom =7 ) %>%
  addCircleMarkers({
    color = ~factpal(Location),
    radius = ~100*(dataInboundMap$Percentage) ,
    lng = dataInboundMap$long,
    lat = dataInboundMap$lat,
    weight = 2,
    popup = paste(sep = "<br/>",
      "<b>",dataInboundMap$Location,"</b>",
      paste("Place:",dataInboundMap$Location),
      paste("Demand:",round(dataInboundMap$Percentage, digits=2))
    )
  })
})

output$dataTableTraveledMost <- renderDataTable({
  dataInboundMap <- dataInboundMap[order(dataInboundMap$Percentage, decreasing = T),]
  dataInboundMap$Percentage <- paste0(dataInboundMap$Percentage *100 , "%")
  dataInboundMap <- dataInboundMap[,c(1,5)]
  dataInboundMap

},options = list(orderClasses = TRUE, pageLength = 10,"sDom" = "rt"),rownames=FALSE)
```

```
##### Travel SriLanka | Monthly Travel Patterns | Observe #####

observe({

  if (!is.null(input$input21)) {

    dataInbound1 <- dataInbound[dataInbound$Month == input$input21,]
    dataInbound2 <- dataInbound[dataInbound$Country.of.Residence == input$input22,]
    dataInbound1$value <- gsub(",", "", dataInbound1$value)
    dataInbound1$value <- as.numeric(dataInbound1$value)
    dataInboundMonthly1 <- ddp1y(dataInbound1, c("Country.of.Residence", "Month"), summarise, Arrivals = max(Value) )
    dataInboundMonthly1 <- dataInboundMonthly1[order(dataInboundMonthly1$Arrivals, decreasing = T),]
    dataInboundMonthly1 <- dataInboundMonthly1[c(1:15),]

  } else
    return()

  output$inboundMap1 <- renderPlotly({

    inmap1 <- plot_ly() %>%
      add_trace(
        type = "funnel",
        showlegend = F,
        color = dataInboundMonthly1$Country.of.Residence,
        y = dataInboundMonthly1$Country.of.Residence,
        x = dataInboundMonthly1$Arrivals) %>%
      layout(yaxis = list(categoryarray = dataInboundMonthly1$Country.of.Residence), hovermode = 'compare')

    inmap1
  })

  dataInbound2$value <- gsub(",", "", dataInbound2$value)
  dataInbound2$value <- as.numeric(dataInbound2$value)
  dataInbound2 <- ddp1y(dataInbound2, c("Country.of.Residence", "Month"), summarise, Arrivals = max(Value) )
  dataInbound2$Month1 <- factor(dataInbound2$Month, month.abb, ordered = T)

  output$inboundMap2 <- renderPlotly({

    inmap2 <- plot_ly(
      dataInbound2, x = ~Month1, y = ~Arrivals, type = "bar", color = ~Month, showlegend = FALSE )

  })

})
```

## User-Side Coding

```
tabsetPanel(tabPanel(div(fa("plane-arrival", fill = "#ffd500"), "Travel Sri Lanka "),
  wellPanel(fluidRow(column(6, h3("Seasonal Travel Demand Based on Country"), offset = 0, style =
    column(6, uiOutput("selectCat19"), offset = 0, style = "padding: 18px;")),
    dygraphOutput("dygraph1")
  )
),
  wellPanel(fluidRow(column(6, h3("Places Traveled Most in Sri Lanka")),
    column(6, uiOutput("selectQuarter"), style = "padding: 8px;")),
    fluidRow(column(8, leafletOutput("mymap")),
      column(4, dataTableOutput("dataTableTraveledMost"))
    )
  ),
  wellPanel(h3("Monthly Travel Patterns"),
    fluidRow(column(6, uiOutput("selectCat20")),
      column(6, uiOutput("selectCat21"))
    ),
    fluidRow(column(6, plotlyOutput("inboundMap1")),
      column(6, plotlyOutput("inboundMap2"))
    )
  )
)
```

The codes are commented according to the section of the application which are easily discoverable.

## APPENDIX C – PROJECT PROGRESS

Once the initial product is built inputs were gained from the potential users and the supervisor. Based on that following action tracker was created and followed upon.

#	Area	What	Who	Status	Assigned Date	Due Date	Remarks	Revised Date
1	Functionality - Traveler	View based on different type of login - Hide /Show panels based on the user	Thushan	Completed	5/12/2020	5/13/2020	Delayed / Not working	16-May
2	Functionality - Traveler	Create the user login interface	Thushan	Completed	5/12/2020	5/13/2020	Delayed / Not working	16-May
3	Database	Check the EC2 solution and integration with R	Thushan	Completed	5/12/2020	5/13/2020	Delayed / Not working	
4	Functionality - Traveler	Data View to prioritize the countries and areas to travel	Thushan	Completed	5/12/2020	5/14/2020	Not completely achieved	
5	Weather Data	Check the linking with R with Wunderlight API	Thushan	Completed	5/12/2020	5/14/2020	Linking with Owmr	
6	Functionality - Traveler	View the travel packages based on the selection	Thushan	Completed	5/12/2020	5/15/2020		
7	Functionality - Traveler	Create the notification table in the traveler view - Check the possibility of adding notification indications	Thushan	WIP Delay	5/12/2020	5/15/2020		
8	Functionality - Traveler	Send an email to travel agent on click	Thushan	Completed	5/12/2020	5/16/2020		
9	Weather Data	Find city wise temperature data	Thushan	Completed	5/17/2020	5/17/2020		
10	Weather Data	Clean the weather data	Thushan	Completed	5/18/2020	5/18/2020		
11	Outbound Data	Clean Outbound Data	Thushan	Completed	5/18/2020	5/18/2020		
12	Inbound Data	Clean Inbound Data	Thushan	Completed	5/18/2020	5/18/2020		
13	Weather Data	City wise weather update panel	Thushan	Completed	5/12/2020	5/25/2020		
14	Weather Data	Filtering cities based on select input for weather	Thushan	Completed	5/12/2020	5/25/2020		
15	Cost Data	Clean cost data	Thushan	Completed	5/25/2020	5/27/2020		
16	CR1	registration - multiple select region to be facilitated	Thushan	Completed	6/10/2020	6/10/2020		
17	CR2	Sending email based on the selected email .	Thushan	Completed	6/10/2020	6/10/2020		
18	Cost Data	Design the interfaces based on cost data	Thushan	Completed	6/11/2020	6/11/2020		
19	Thesis	Add the library set from rconnect app dependencies	Thushan	Completed	6/12/2020	6/12/2020		
20	Email	Check and confirm on a substitute for RDCOMClient	Thushan	WIP Delay	6/13/2020	6/13/2020		
21	CR3	UK USA data error issue , Travel Sri Lanka	Thushan	Completed	6/14/2020	6/14/2020		
22	CR4	Add number of days & month , add travel packages , currency	Thushan	Completed	6/14/2020	6/14/2020		
23	CR5	submit package Sweet alert	Thushan	Completed	6/14/2020	6/14/2020		
24	Monthly travel patterns	Check on the missing data	Thushan	Completed	6/14/2020	6/14/2020	Error in filtering	
25	CR7	Change the country code to country weather data	Thushan	Completed	6/14/2020	6/14/2020		
26	CR8	Add country filter to weather data by temperature	Thushan	WIP	6/14/2020	6/14/2020		
27	CR9	Add confirm password - join travel dates	Thushan	WIP	6/14/2020	6/14/2020		
28	CR10	Add attachment when sending the email by travel agent	Thushan	WIP	6/14/2020	6/14/2020		
29	CR11	Add master filtering options . Mandatory and not	Thushan	WIP	6/14/2020	6/14/2020		
30	Travel Packages - Entry	Create a modal input for travel packages	Thushan	WIP	6/15/2020	6/30/2020		
31	Travel Packages - Entry	Adjust the text sizes for the travel packages entry	Thushan	WIP	6/15/2020	6/30/2020		
32	Travel Packages - Entry	Add Validations	Thushan	WIP	6/15/2020	6/30/2020		
33	Travel Packages - View	Inbound and outbound package filter	Thushan	WIP	6/15/2020	6/30/2020		
34	Travel Packages - View	Filtering packages based on the input	Thushan	WIP	6/15/2020	6/30/2020		
35	Use access and authentication	Customized views based on access	Thushan	WIP	6/15/2020	6/30/2020		
36	Use access and authentication	Login Button	Thushan	WIP	6/15/2020	6/30/2020		
37	Travel Costs	changes the cost type in the chart	Thushan	WIP	6/15/2020	6/30/2020		
38	Demand and Trend Data Forecasting Module	Most unoccupied countries/cities to travel in 2021 (b) Demand increase in a specific area in Sri Lanka for tourism	Thushan	WIP	6/18/2020	6/30/2020		
39	Demand and Trend Data Forecasting Module	Post Covid Travel Possibilities	Thushan	WIP	6/18/2020	6/30/2020		