2015

ICT 2102: HUMAN COMPUTER INTERACTION

STUDIO 8 ASSIGNMENT: REPORT

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1. Introduction

Travel App is a travel-planner application that will help commuters to find the fastest route from their location to their destination by taking public transport, whilst taking road congestions into consideration. If the shortest route is detected to be congested, whenever possible, the application will suggest an alternative route that would require less travelling time. Additionally, the application can show users when a bus/train is overcrowded, allowing the user to opt for an alternative travelling option instead, if available. This application might be useful for commuters who take public transports daily during rush hour period especially when there is MRT breakdown.

Currently, working adults and students who travel in the morning may lack a convenient medium to find out if there is a traffic jam in the route they are about to take especially with public transport such as bus. They are also unable to see the current capacity load of the bus or train they are about to take.

2. Needfinding

Needfinding helped the team understand the problem better, via the use of task analysis concepts. The task analysis helped the team understand the current approach of the user for a given task.

2.1 Task Analysis

Our main goal of the task analysis is, to find the route to a destination based on user selected preference with the use of a travel application. User are able to choose the shortest route (by distance), fastest route (by time) and walking distance. However, the fastest route to travel could be delayed due to congestion. With the implementation of congestion information, the time and distance will be populated based on the severity of the congestion.

The task analysis is based on our team brainstormed conceptual model of using a map app:

Task 1: **Select current location and desired destination**
Actions:

- Go into the application
- Use GPS to detect current location (Optional)
- Enter location
- Enter destination

Task 2: **Find routes to destination**
Actions:

- Press ‘Search’

Task 3: **Evaluate all available routes generated and select the best option that suits the user**
Actions:

- View displayed routes
- View travelling time for each route available
- Get travelling direction for the most favorable route

Task 4: **Search for current congestion report**
Actions:

- Go into the website
- Search for existing congestion of the day

Currently, there are multiple existing travel applications in the market. We have decided to use the existing applications to do the task analysis as it have the function of routing and it is the data provided is reliable. The existing applications have its benefits and drawbacks.

The existing applications, as observed through the task analysis, are easy to use. Users are able to find the best route, by analysing the traveling time displayed beside the available routes. As per the task analysis, the users are able to fulfil tasks 1, 2, 3 and 4 without any difficulties.

However, the existing applications lack comprehensive congestion data to inform the users if the route or transport is crowded to travel on. This could be analysed from the results, retrieved from the questionnaire. Currently, the Ministry of transport have a few social network platform to inform and update user of the disruption. It also lack in ways to check for the waiting time of the bus/travel arrival, especially when users need to switch/transfer among different transport operators of the same mode, such as SMRT or SBS Transit.

2.2 Implications of Task Analysis

One of the implications that could affect the design is the application may not be able to provide comprehensive and up to date data of congestion, as congestion can be also unpredictable at times. Thus, it heavily depends on us to find the available and reliable congestion data that we could utilize for the web application.

2.3 Elicitation

Our team has decided that an approach consisting of two elicitation methods, where we perform ***Direct Observation*** and provide a ***Questionnaire*** to the participants, would be most ideal. Collectively, both elicitation methods should help us gain a deeper understanding for the user requirements and behaviour.

2.3.1 Elicitation Justification

The reason for conducting a direct observation first is so that we are given the opportunity to observe the users' behaviour, the things done and reactions when they are operating the current system. This allows us to avoid making the same mistakes by highlighting any existing design flaws that could direct users to perform counter-productive actions, which would only hinder and deteriorate the user's experience with the application. We would also like to take the chance to note down key features that are essential for a positive user experience in a travel and make sure that it is not overlooked in our future implementation.

However, performing observations on its own only allow us to study user's physical behaviour and might not help in answering some other doubts we have regarding their thoughts and preferences. Therefore, designing a questionnaire is a quick and easy way for us to wrap up any doubts unanswered. It would be a fairly simple process of setting questions on an online-survey platform and analysing the results after gathering the responses needed. It is also a less time consuming method for our team (which is an important factor given our time constraint), compared to interviews for example, which would require us to invest time and manpower to conduct each one.

2.3.2 Elicitation Procedure

Our approach would have us put our participants through direct observation to begin, by first asking them to simulate the scenario where they are trying to find the quickest way home from where they are now. Participants will be able to choose any website that they would usually use in this scenario, or a suggestion can be provided by us if needed. General guideline for the observation is to have our participants to complete task 1 through 4 that was identified in the Task Analysis. Our team would then take note of their general usage behaviour whilst highlighting anything conspicuous throughout the whole simulation.

Following the observation, the same participants will be given a questionnaire to complete. The questionnaire would pose questions regarding their current practices and thoughts on the existing travelling planner system. This questionnaire will also be offered to our peers outside of the observation participants to complete, in an attempt to garner more response and have a better dataset to analyse with.

2.4 Elicitation Results

During observation, it is identified that our conceptual model is in line with user's mental model. Users did the actions listed in the task analysis. From the observation, most users chose the fastest route which is the first option from the list of routes. While other users, chosen their preferred choice such as Bus, MRT or short walking distance. However, when we proceed with Questionnaire, we understand from the user that it would be better if there is more information on congestion and road block which may delayed their travelling time. The details of the observation result is in appendix 8.1.

Through the survey, we understand that user would want to view information such as congestion, fare cost, current capacity of train/bus and also alternate route when there happens to be a road closure. User doesn't want to route within Singapore only. The information that user want to include may have an impact in the decision they make. The details of the questionnaire result is in appendix 8.2.

2.5 User Needs & Design Principles

Based on our elicitation methods, the following are the user needs and design principles we have identified as fundamentals to our system.

2.5.1 User Needs

1. Find shortest or fastest directions to destination
    - 1.1 Directions should consist of clear and simple steps
      (e.g. what bus to take, where to stop, walking direction and distance etc.)
2. Provide reliable results with congestion in consideration
    - 2.1 If congestion is detected in the regular route, factor that in (e.g. affects time taken).
    - 2.2 Show a better alternative route if available
3. Filter options to list routes generated based on users' preference(s)
    - 3.1 First route option displayed should be the closest option to what the user is finding.
4. Provide alternate route when there is a road closure
    - 4.1 If road block is detected in regular route, show alert message
    - 4.2 Show alternate routes available
5. Find the cheapest route to destination
    - 5.1 Directions should consist of clear and simple steps (e.g. what bus to take, where to stop, walking direction and distance etc.)

2.5.2 Design Principles

Web layout should be simple and uncluttered, bearing only the essentials which is to provide directions and congestion details. The hope is that by reducing the number of unnecessary elements (e.g. meaningless buttons, overwhelming variations of coloured text) in our design, we can reduce false affordance that users might have clicked on in an attempt to perform a non-existent action. With lesser distraction on the webpage, the key elements (actual affordance) should be more visible as well. Step by step through each phase of the task process, we would preferably like to provide some form of mapping to guide the user. We want the flow and structure of the application usage to be clear and simple to follow for the user, so that they can complete the task in the minimal amount of time. Before going out, user have to plan their route like how long will the journey be, how to go to the destination and what are the mode of transport available. User might use a physical map to draw and highlight the route. Hence, our web should provide different list of route available. Different route option should be label when it is selected

2.6 Reflective Summary

Needfinding is an essential part of the product design research process. It is used to identify the fundamental user needs of a group of users that a product aims to satisfy. Understanding the user needs are important as solutions are constantly changing over time. It also leads to better development of the end product.

In this project, our application aims to satisfy the group of people who frequently travel via public transport and may lack a convenient medium to find out about any traffic issues that may affect their travelling. Needfinding required the team to find a group of people who might be the potential users of the application. The potential users then performed the task analysis, which was directly observed. The users then answered a questionnaire to conclude the task analysis process. Once the results were analysed, the team then derived a couple of user needs which would be essential for the application. The user needs also allowed the team to brainstorm design ideas which would fulfil the potential users' requirements.

Needfinding has both advantages and disadvantages. One disadvantage would be, that it is time-consuming. It is time-consuming as the elicitation method, such as direct observation, requires a lot of time to complete the task analysis. However, needfinding is also useful. It allowed the team to gain inspiration and insight into potential research directions which can make a difference to users by satisfying important user needs. It gave the team a sense of empathy towards the user group, as the team faced the original stereotypes and assumptions made about the user group and replaced it with just grounded observations. The team also made an effort to form a relationship with the user group. This could help us for future needfinding processes, such as to support and bounce ideas and prototypes during the iterative design process. In the human computer interaction community, rapid iterative designs with sufficient user testing, feedback and evaluations can be a very fruitful way to make easy-to-use products that people actually want to use.

Overall, needfinding have definitely helped us in shaping a prototype which our potential users would eventually favour and use.

3. Design

3.1 Brainstormed Design Ideas

1. Find all available routes for the user based on given start and end point.
    - When given two specific locations, the application should find all possible routes between the two points before evaluating the results to suggest the best route.
2. Detect congestion on route
    - For all routes found, system should refer back to congestion data and factor in any congestions that are found in the route to reflect a more accurate travelling time.
3. Detect transport's current capacity load (i.e. how full it is)
    - From capacity data, system should reflect and display how full the bus/train is so that users can refer to the information and choose an alternate transport that might be less crowded. However the likely challenge faced for this design idea would be, to obtain relevant transport capacity load data, from the authorities.
4. Crowdsourcing from users for traffic conditions updates
    - Users who find out about certain traffic situation (e.g. traffic jam, train breakdown) can login to their account and post a Traffic Condition Update to the application, to help keep other users informed. However the likely challenge faced for this design idea would be, to obtain reliable traffic information from users. If users submit a report without up to date information or wrong information, it might bring down the value of the application.
5. Bookmark 'Favourite' routes
    - If a user tend to travel on a particular route often, or wishes to save it for future reference, they can bookmark a particular route they found and open the route information in the future.
6. Filter compiled results of routes based on user's preferences
    - There might be a lot of different routes generated based on the user's location inputs, but not all routes might be of value to the user. Filtering the results, to omit the routes that the user would not be interested in will help the user find the most suitable route quicker.
7. Track exact current location of transports
    - Helps user to track the exact location of the bus or train that he/she intends to board, to provide the user with an idea of how far away the transport is from reaching.

Figure 1, User Value vs Technical Complexity, indicates the graph plotted with user values by technical complexity for the design ideas brainstormed, in (numbering). The design idea to 'track exact location of public transport' has high user value and technical complexity, as this design idea is slightly harder to implement as compared to the other design ideas that was brainstormed. Most of the design ideas are in the middle range for user value and technical complexity. The design idea to 'crowdsource' has a lower technical complexity compared to the rest but similar user value.

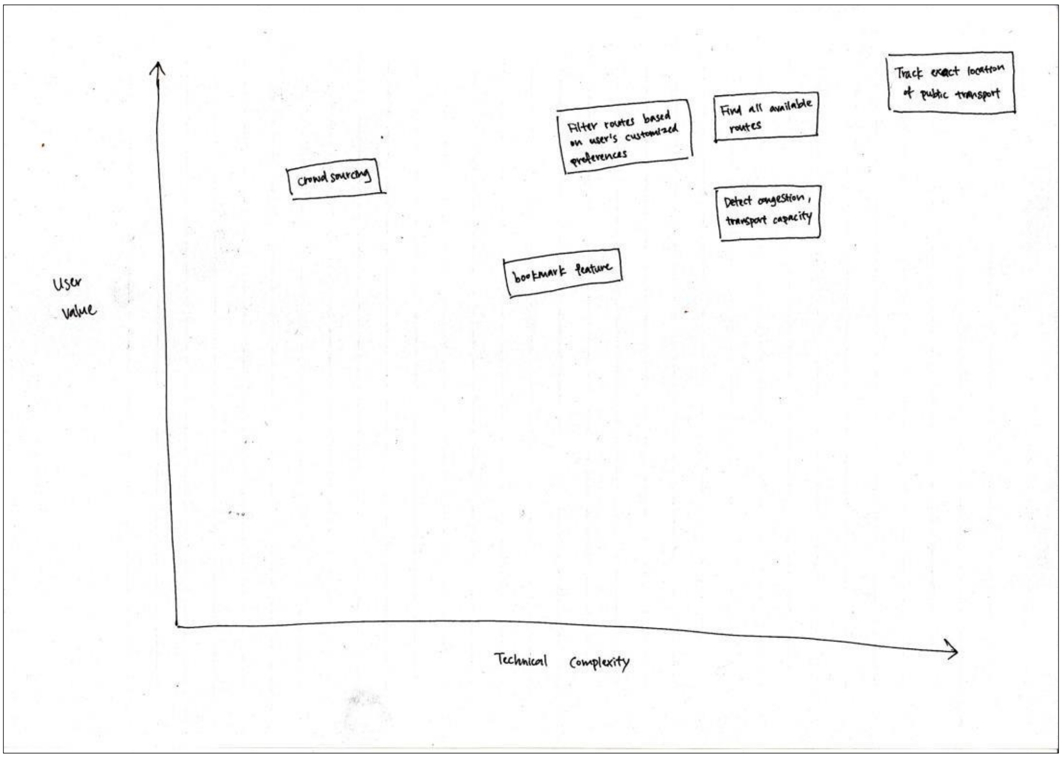


Figure 1: User Value vs Technical Complexity

3.2 Chosen Design Ideas

3.2.1 Design Idea 1

- Find all routes and return results based on user's filter preferences

- Combination of design idea 1 and 6. It is key to the problem that the user is able to find a route that is accurate with congestion data factored in. Not all current travel applications consist of finding a route with accurate congestion data. It would definitely be useful if congestion data is integrated which makes travelling journeys easier to plan. Additionally, the user should be able to choose to see only what they are interested to see. E.g. if a user with bus-concession wants to find directions, routes that requires them to take the MRT will not be their preferred route. If users can't find what they want to see easily, it will definitely affect their user-experience negatively.

3.2.2 Design Idea 2

- Crowdsourcing from users for traffic conditions updates

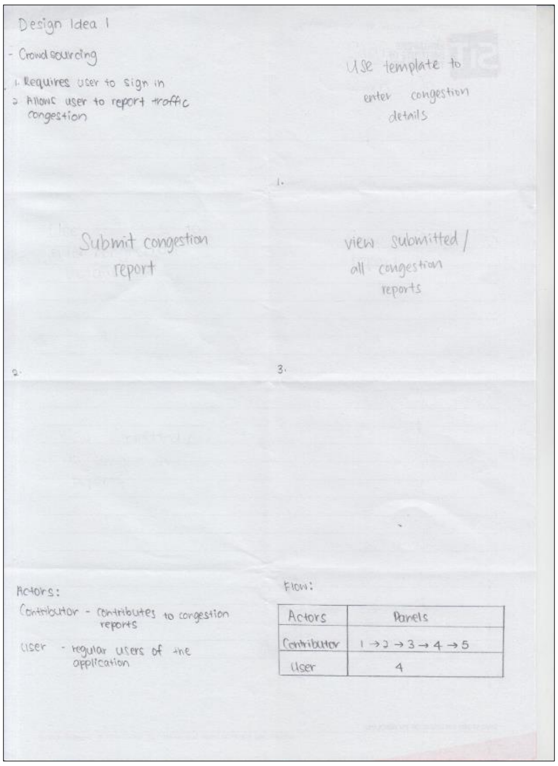
- Relatively easy to implement whilst data gathered from it can be very helpful as well. High user-value compare to the technical complexity it requires. This functionality is also not common amongst current travel applications. Utilizing the congestion data gathered from crowdsourcing, which was contributed by users who has submitted a traffic condition update, it can help inform users when providing directions for routes that are suggested to be congested. This would help the users to find an alternative route or be prepared to take a longer time to travel to the destination.

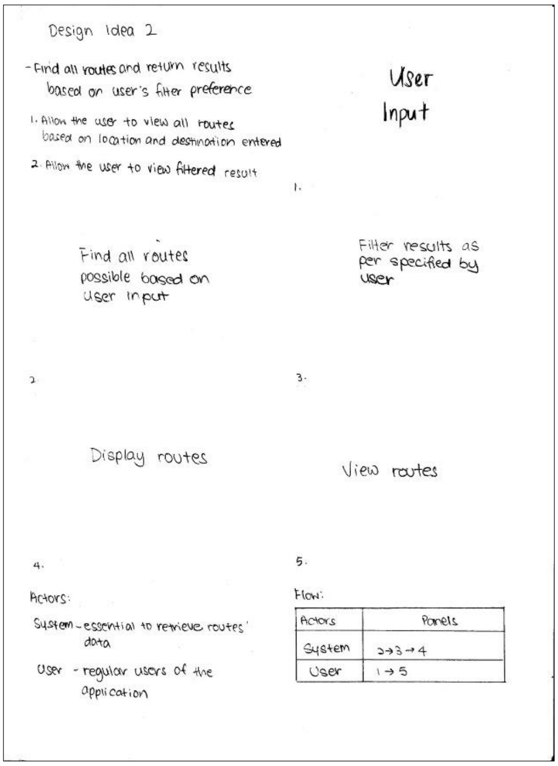
3.3 Storyboards

The storyboards explain the usage scenario of each functionality and what the interface does. The assumption made for the Storyboard 1, would be that the user has a registered account with Travel App and it logged in before submitting a congestion report.

Storyboard 1 explains the step by step sequence to fulfil the crowdsourcing functionality.

Storyboard 2 explains the step by step sequence to fulfil the functionality to find routes and filter is according to user's preference.





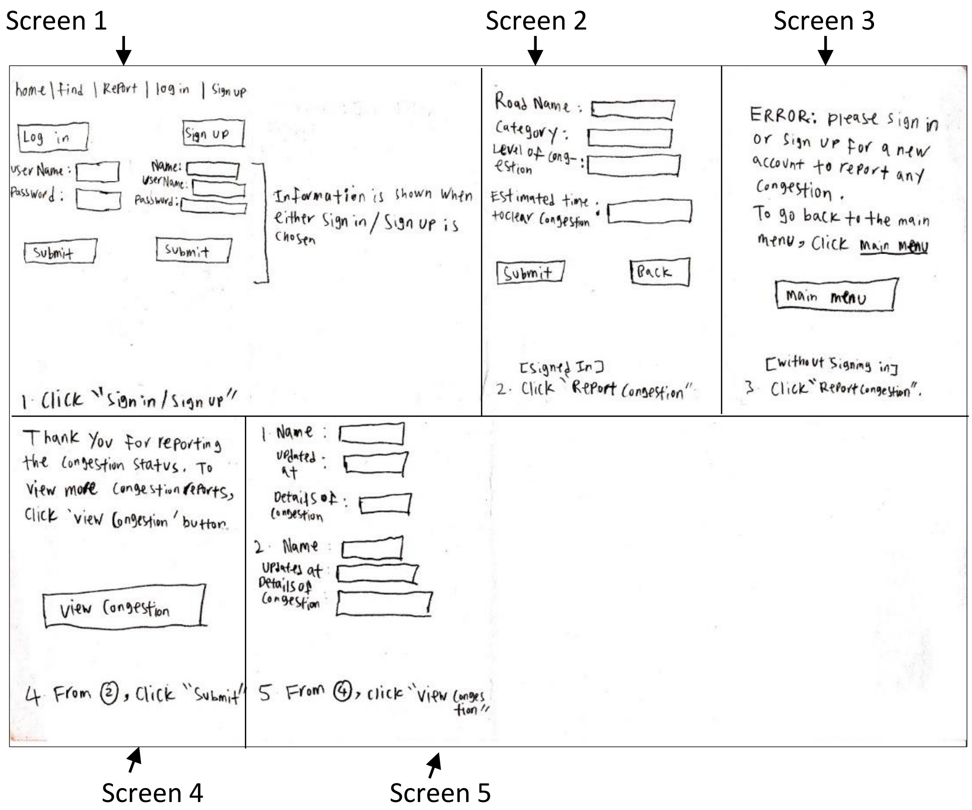
<u>Storyboard 1: Crowdsourcing</u>

<u>Storyboard 2: Find all routes and return results based on user's preferred transport mode</u>

3.4 Prototypes

3.4.1 Design 1 (Low-fidelity)

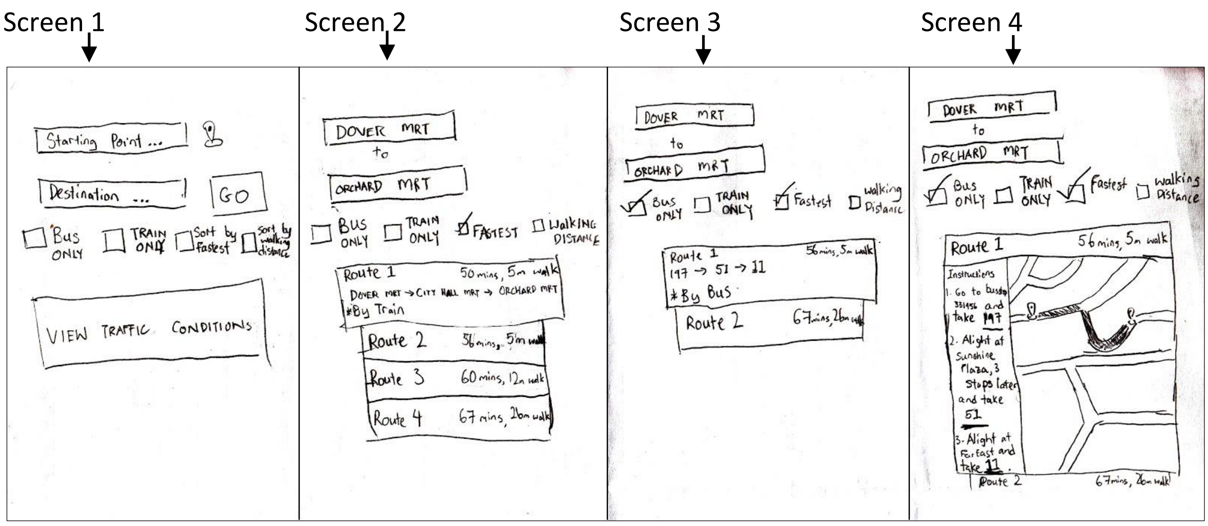
The low fidelity prototype for design idea 1, crowdsourcing, is derived from storyboard 1. Storyboard 1 indicated the layout of the functionality, which is then mapped to the Low-Fid Proposed Prototype 1. The panel 1 is mapped to screen 1, panel 2 is mapped to screen 2, panel 3 is mapped to screen 4 and panel 4 is mapped to screen 5.



Low -Fidelity Proposed Prototype 1: Crowdsource

3.4.2 Design 2 (Low-Fidelity)

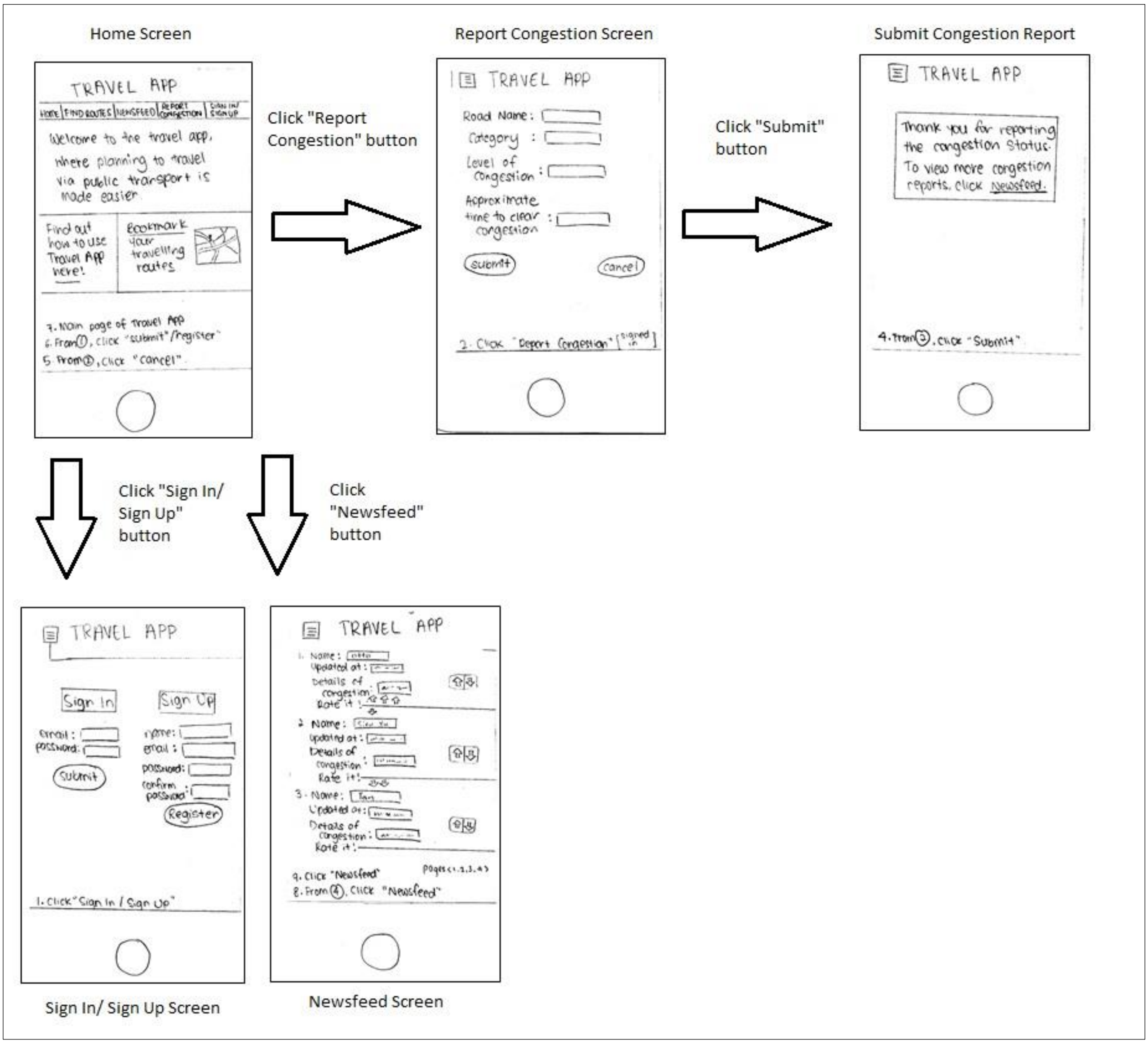
The low fidelity prototype for design idea 2, find all routes and return results based on user's preferred transport mode, is derived from storyboard 2. Storyboard 2 indicated the layout of the functionality, which is then mapped to the Low-Fid Proposed Prototype 2. The panel 1 is mapped to screen 1, panel 2 is mapped to screen 2, panel 3 is mapped to screen 3 and panel 4 is mapped to screen 4.



Low -Fidelity Proposed Prototype 2: Find all routes and return results based on user's preferred transport mode

3.4.3 Design 1 (Medium-Fidelity)

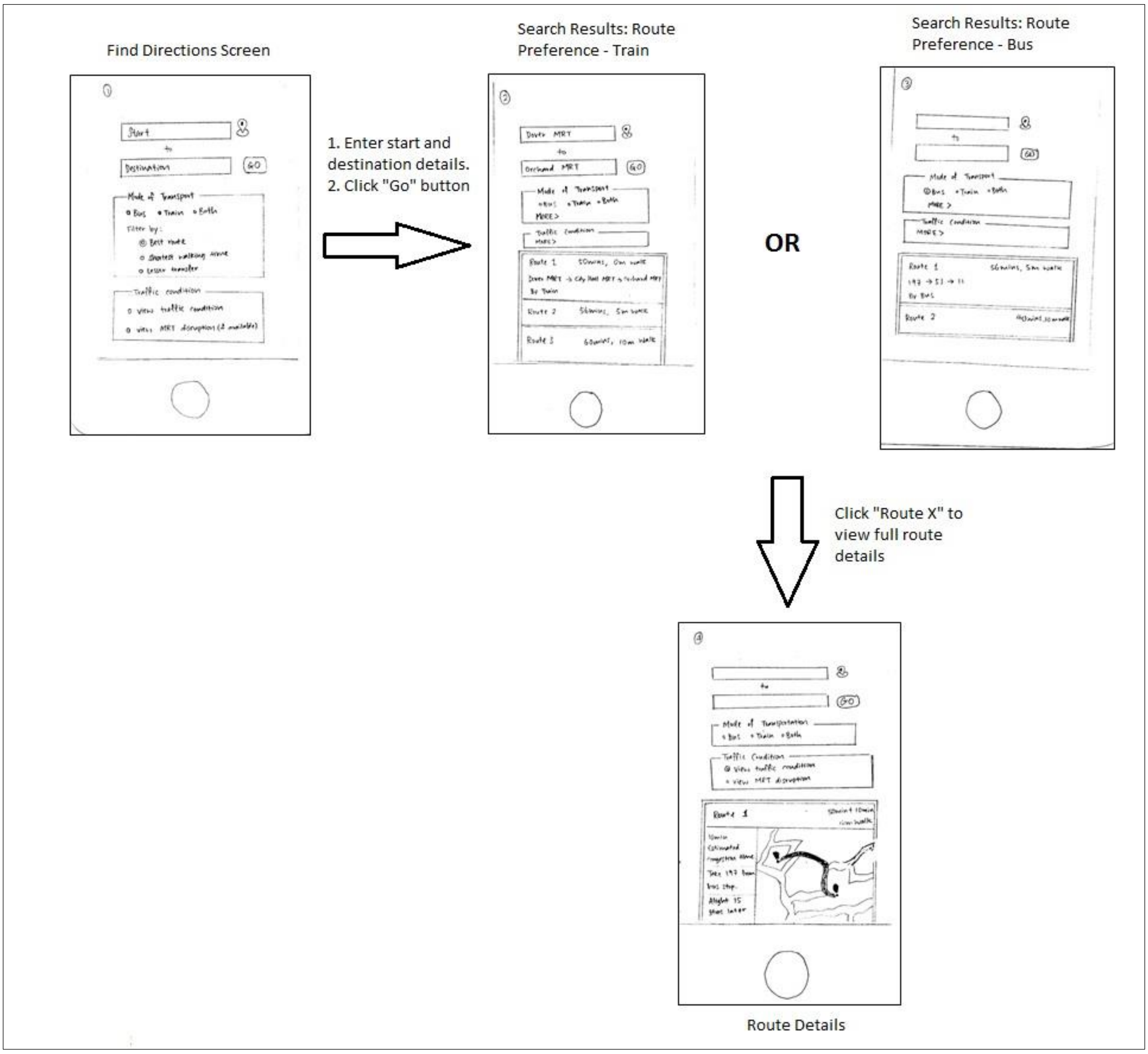
The medium fidelity prototype for design idea 1, crowdsourcing, is derived from low-fidelity proposed prototype 1.



<u>Medium -Fidelity Proposed Prototype 1: Crowdsource</u>

3.4.4 Design 2 (Medium-Fidelity)

The medium fidelity prototype for design idea 2, find all routes and return results based on user's preferred transport mode, is derived from low-fidelity proposed prototype 2.

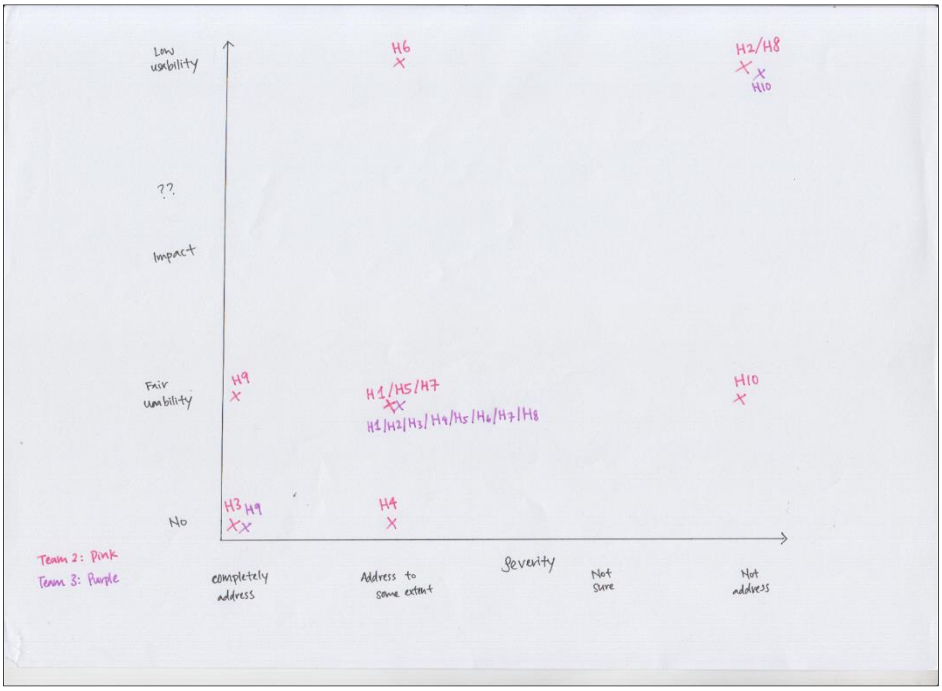


Medium -Fidelity Proposed Prototype 2: Find all routes and return results based on user's preferred transport mode

4. Heuristic Evaluation

Our goal of the heuristic evaluation is to evaluate if users are satisfied with the visualization of our application. If users are found to be dissatisfied, we are then to identify the errors of the specific interface that is hindering the user from navigating through the functions of the application.

4.1 Prioritized Heuristics to be Addressed



<u>Severity Ratings Graph</u>

As shown in the graph above, based on our experts' heuristics evaluations (see from appendix 8.3 and 8.4), we have identified H2 (Familiar Metaphors and Language), H6 (Recognition rather than Recall), H8 (Aesthetics and Minimalist Design), and H10 (Help and Documentation) as our most severe cases of heuristic violations. The positions of these heuristics on the graph indicates that our application has very low usability in these aspects, which is the reason why we need to address them in order to improve our application's design significantly.

Heuristics Identified	**User Interface**	**Raised Issues**	**Suggested Improvements**
H2 Familiar Metaphors and Language	Collapsible Panels ● Each of the various route options returned were initialized to be collapsed (hiding the full route details from the collapsible body).	User did not realize that these were actually collapsible that would expand and show the full route details once the user clicked on it, as the interface was not obvious enough.	We should use buttons instead of panels, or at least make the panels more obvious that it is a collapsible.

H8 Aesthetics and Minimalist Design	We included a large amount of information (text) about the objective of the app.	Users found that our homepage is overly cluttered with text, which affects the overall aesthetics.	We can reduce clutter by replacing text with images, which could be a minimal yet more effective method to present information.
	Directions search form (starting point and destination input boxes) were shown on the display route results page	When displaying route results, the page still has the Search form (starting point and destination input box) which our experts found redundant when viewing the route results, merely cluttering the page instead.	We can improve aesthetics by hiding the search form after returning the route results as user would normally perform only one search each time they use the app.
H10 Help and Documentation	-	There wasn't any help documentation provided regarding what the user should input for the different fields in the reporting of congestion.	It is suggested that we can put up a FAQ page or include a help panel beside each field to aid user.
H6 Recognition rather than Recall	• Rating buttons for congestion reports used an Up/Down arrow which were confusing • Login button was labelled as 'Submit'	Rating buttons were not intuitive enough for the users, who had confused it as a sorting button to move the congestion reports around. Similarly with login button, experts suggested renaming it to "Login" to be more intuitive. When navigating around different pages, our experts noticed there is no page title or header displayed to indicate what page the user is on.	Instead of displaying the rating buttons with arrows, we can opt for the more familiar metaphor using Like/Dislike or Thumbs Up/Down icons for the buttons instead, which should be much less confusing for users. Simple page header should also be included to illustrate the main functionality of each page

4.2 Revised High Fidelity Prototypes (See Appendix 8.11)

Based on the feedbacks we have received from the heuristic evaluations, we have decided that creating a minimalistic design by decluttering our application is one of the key actions of rectification, which is what we have done.

As mentioned, our homepage was overly cluttered, specifically with textual information, and our experts noted that there was also no functionality for the users on the homepage itself. We have since redesigned our interface by removing these information altogether and changed it so that the homepage is where users can find directions straightaway, which is our app's main functionality and therefore very likely the functionality they are looking for, hence the new design to improve its accessibility. We also reduced the number of elements at a particular page and included only the essentials (e.g. page header is added now), so the design is much cleaner, ensuring high visibility of all elements and user's easy understanding of the tasks they are able to perform on that page (see from appendix 8.11 Figure 9.1).

As advised by our heuristic experts, we have hidden away the search input boxes after the user performs a location directions search and is given a set of possible route results. The search form can be redisplayed by the users with a click on the small unobstructive edit button at the top right side of the page (see from appendix 8.11 Figure 9.3). To make it more obvious that the route results are collapsible panels (see from appendix 8.12 Figure 9.4), we added in a signifier (e.g. "Click to see route details") on each panel so that it is clear to the users that the full route details of each route will be shown by clicking on the panel.

Instead of putting up a FAQ page as suggested, our team decided that it would be more straightforward to implement placeholders within the text boxes which will indicate to users what particular information should be inputted at that field (see from appendix 8.11 Figure 9.5). Lastly, we have also changed our rating buttons to incorporate thumbs up and thumbs down buttons for users to rate a particular congestion report (see from Figure 2.3), reason being our team finds that thumbs up and thumbs down is a very universal representation of whether one likes something or not respectively, and therefore should act as a very familiar metaphor.

5. Implementation

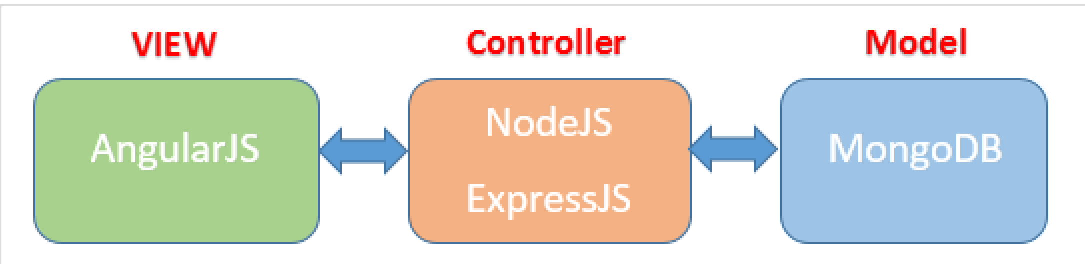
Having finalized the requirements and updated the changes based on the feedbacks we have received after the heuristic evaluations, we list out all the tasks that had to be performed and divided the workload amongst the team (see Figure 2.1 below).

Date	Task	Owner	Due Date	Status	Estimated Hour	Actual Hours	Comments
Week 7	Setup Git Repo	Yeong Chai	19/10/2015		0.2	0.5	Completed.
Break Week	Create MEAN Project	Siew Yu	22/10/2015		0.5	1	Completed.
	Finalize Prototypes	Ashwini	26/10/2015		1	2	Completed.
	Create Views for Search Route	Ashwini	27/10/2015		2	1	Completed.
	CSS for main template pages	Yeong Chai	27/10/2015		2	2	Completed.
	Setup MongoDB	Otto	29/10/2015		0.5	1	Completed.
Week 8	**High Priority:** Implement GoogleMap API to pin location from a user's input	Siew Yu	30/10/2015		5	6	Completed
Main Logic	Create a design template for the pages	Yeong Chai	28/10/2015		2	3	Completed.
	Add data into MongoDB	Siew Yu	28/10/2015		0.5	1	Completed.
	Functionality and dialog for Search Route page	Otto	30/10/2015		2	3	Completed
	Controller logic for log in	Ashwini	30/10/2015		2	3	Completed.
Week 9	**High Priority:** Create a shortest route possible between 2 given location inputs from user's input	Otto	04/11/15		8	10	Completed.
Main Logic	Find all possible routes between 2 given location inputs from user's input	Otto	08/11/15		6	8	Completed.
	Display all routes in angular-material collapsibles.	Yeong Chai	08/11/15		8	8	Completed using hide/show with button instead to simulate collapsible due API restrictions
	Create a working form for Crowdsource traffic reportings by logged in users	Ashwini	08/11/15		4	4	Completed.
	Display all crowdsourced traffic reports with voting ability for logged in users	Siew Yu	08/11/15		4	5	Completed.
Week 10	Test and debug location pinning accuracy - Unit Testing	Yeong Chai	17/11/15		5	5	Completed.
Tuning & Testing	Test and debug routing ability from given location *A* to *B* - Unit Testing	Otto	17/11/15		6	6	Completed.
	Test and debug crowdsourcing reports submission and view - Unit Testing	Ashwini	19/11/15		6	6	Completed.
	Review all bugs found and rectify them	Siew Yu	22/11/15		8	9	Completed.

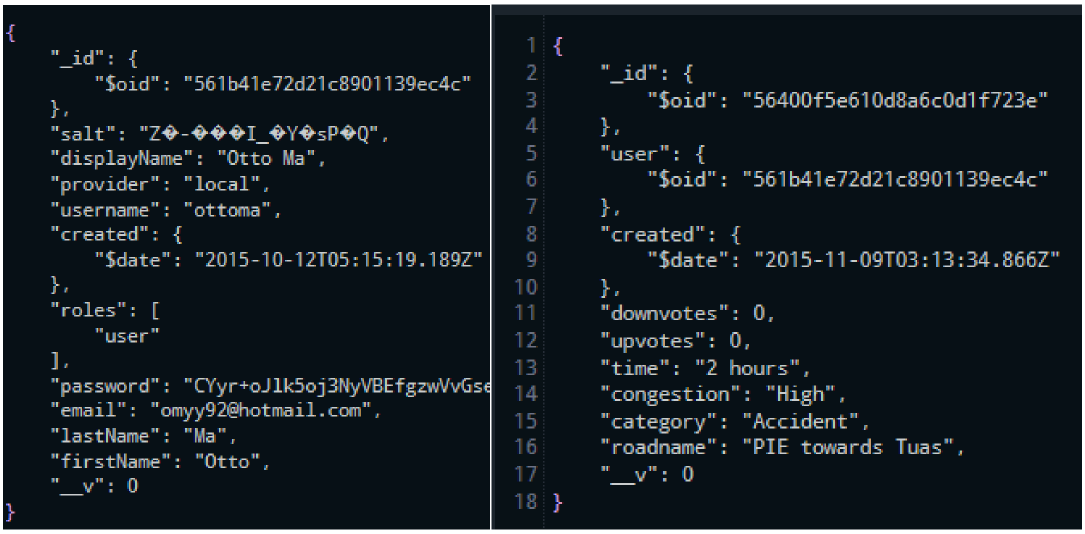
Figure 2.1: Implementation plan

5.1 High level Architecture

We have followed the MEAN Stack with Model-View-Controller (MVC) architecture as taught in our labs (see Architecture diagram below). We have AngularJS taking care of the front-end (View), NodeJS and ExpressJS in the back-end handling commands and requests (Controller) and Mongoose to model our application data and store in MongoDB (Model).



Architecture Diagram

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Data sample within the ‘users’ (left) and ‘reports’ collections in MongoDB

5.2 Key Changes compared to High-Fidelity Prototype

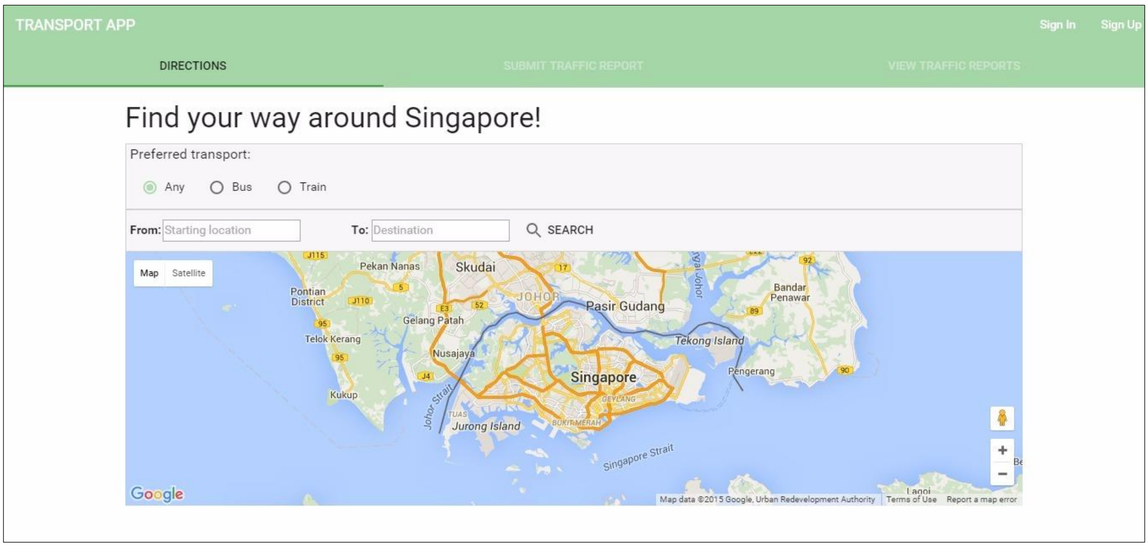


Figure 2.2: Application’s homepage

We have repositioned our home button, as it is likely more familiar and conventional to put a home button with the application’s title branding at the top left corner (see Google and Facebook). If placed at the center, people might not know that it works as a home button and misjudge it as a simple title banner, leading to a hidden affordance (Compare Figure 2.2 to appendix 8.11 Figure 9.1).

We were not consistent in implementing placeholders across our final high-fi prototype as the solution was originally focused on addressing the issues raised during heuristic evaluations regarding the fields of the congestion report form. Our team has since implemented placeholders within the text boxes at the homepage for the directions search form (See figure 2.2).

These changes were made in an attempt to conform to the heuristic design guidelines, specifically to provide familiar metaphors and language (by providing a familiar choice) and ensuring consistency and standards.

5.3 Norman's Usability Principles Incorporated

5.3.1 Affordance

In our implementation phase, one of the key rule we kept in mind was to keep our interface uncluttered. Following that rule, we had only implemented objects that are essential into our application and made their usage terms straightforward and simple to understand. As seen in our homepage (see Figure 2.2), we placed very few objects and each with clear affordance, namely buttons, radio buttons, text-boxes and the interactive Google Map. By omitting elements and objects that has no place in the user's process of completing the task (in this case to find directions), we lowered occurrence of false affordance whilst minimalizing our design.

5.3.2 Metaphors and Signifier

Our team has tried to apply metaphors and signifiers into our application as much as possible, to further ease users in quickly understanding on what they can do with different objects. We did so by mainly using icons that most users would see or interact with in their regular interactions with computers, with icons such as a magnifying glass on the search button, thumbs up and thumbs down for rating traffic reports as well as the commonly used arrow cycle for our refresh button (see Figure 2.3). Additionally, we've also implemented some signifiers using simple placeholders inside text-boxes so users know exactly what kind of information they are supposed to input into the different text-boxes, and also instructions on the returned results panels on how to view full route details (see Figure 2.4).

Figure 2.3: Some examples of metaphors used

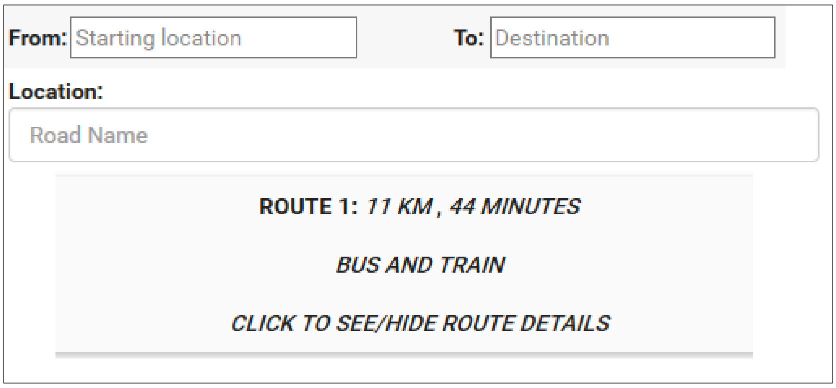


Figure 2.4: Some examples of signifiers used

5.3.3 Constraints

We have limited our search results to specifically process locations within Singapore. Since we have targeted the application's usage for working adults and students who are commuting to work or school, there was no reason to cater for destinations outside of Singapore. If constraints were not in place, it could lead to a returned search results that routes overseas, which is very likely against what the user was expecting (e.g. originally, performing a search to find directions by inputting 'Bishan' will cause Google Maps to find the Bishan district in China instead of the neighbourhood in Singapore). This constraint was implemented by further defining the Google Map API query code to add a region restriction for directions search to be within Singapore only.

Another constraint we had was by imposing a restriction on traffic congestion reports, where only registered and logged in users are able to contribute and rate (See Figure 2.5). This constraint was implemented with controlling quality in mind, as we would like to discourage potential "internet trolls" from spamming traffic reports and affecting the user experience for other users browsing the traffic congestion reports.

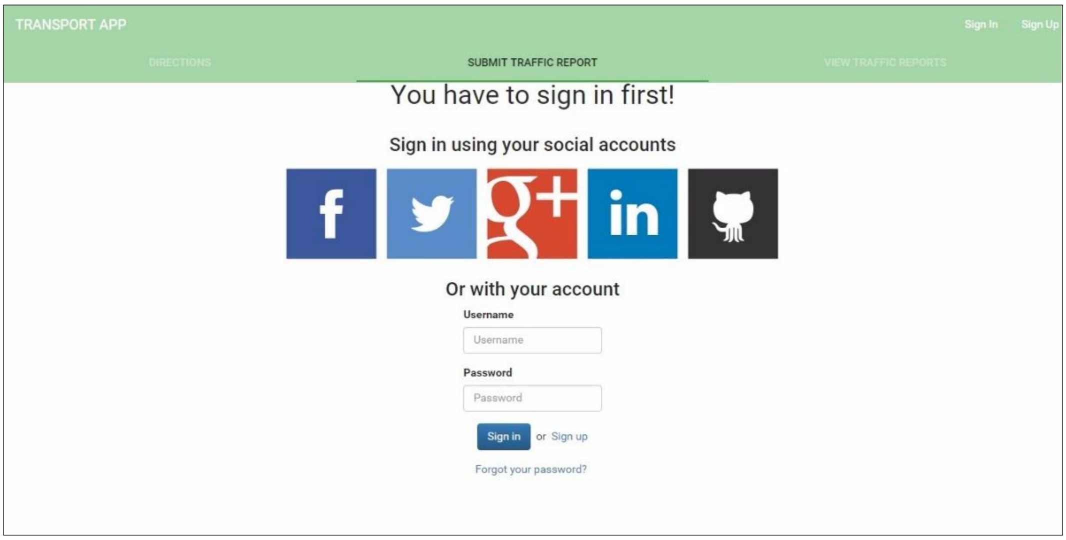


Figure 2.5: Traffic report restriction with log-in required

6. Experimentation

As mentioned, our application combines direction services with crowdsourced congestion reports as its key features. When users are searching for directions, we want them to be able to view congestions reports contributed by other users who might have been affected by certain congestions, so that the former might be able to plan their journey by choosing a route that can avoid said congestions.

However, viewing congestion reports brings about an extra step that user has to make, therefore raising a concern in our team on how it may be significantly more time-exhaustive for the users. If users finds retrieving congestion reports overly time consuming, they might be less inclined to do so and opt to skip that functionality altogether, leading to a reduced value of our application since it will not be used to its fullest. Our objective would hence be to ensure that the congestion information is easily accessible and available for users finding directions on our application

6.1 Hypothesis

We came up with the hypothesis that *viewing congestion reports after searching for directions will significantly increase the time taken when users are finding the optimal route between two locations.* If our hypothesis is proven true, it means that the flow and presentation of our application might need to be optimized in order to ensure users' ease of access to congestion information.

6.2 Experiment Design

We have chosen to conduct our experiment based on a **Between Subject** design, so as to lower the chances that the results would be affected by users having fatigue, practice or carry-over effects whilst also being able to test multiple variables simultaneously. Having each participant to participate only in one of our treatments can lower the chances of the results of our experiment being skewed.

There will be two independent variable in our experiment, namely *Finding Directions* and *Finding Directions then View Congestion Reports*, where the former will act as the control group, and the latter as the experimental group. The dependent variable that we will be measuring is the efficiency (i.e. the time taken to choose the optimal route) of each independent variable.

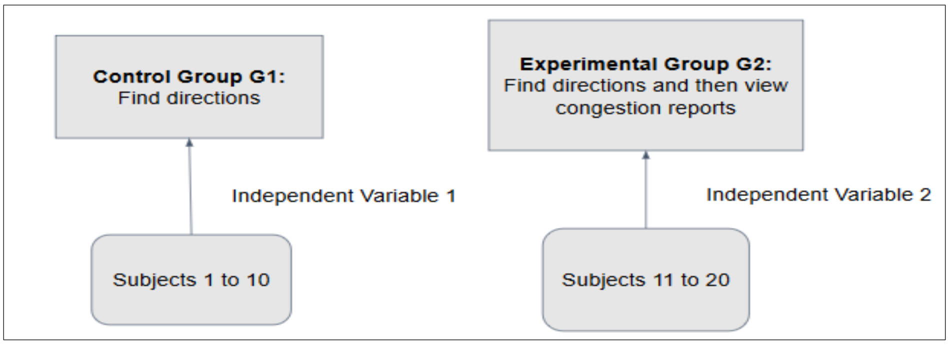


Figure 3: Illustration of our Experiment Design

The control group will help us depict the baseline performance, and from its time we can determine if our new additional feature of viewing congestion reports does increase the total time taken significantly in comparison. We have recruited a total of 20 students from our class to participate in our experiment, and from that split them up to allocate an equal number of 10 participants into each group so as to ensure that the experiment will be fair. Each group will have a different set of tasks to perform (see attached task sheets in appendix 8.6, Figure 4).

To ensure the validity and fairness of the experiment results, we are also implementing two control variables for the experiment. First, all participants will be searching for directions from **"Bishan MRT"** to **"SIT@Dover",** and will key in the inputs as such. This is to maintain consistency and avoid any discrepancy in the time data that might be a result of certain participants inputting a much longer or shorter location input string compared to other participants.

The second control variable is the congestion report list. We do not want the participant's task completion time to be uniquely affected based on how populated the congestion report list currently is, therefore will maintain and populate the number of congestion reports equally for all participants. The content of the congestion report will also remain the same so that all participants in the experimental group will be browsing the same reports.

We will be measuring the time it takes for the control group participants to search for directions and the time it takes for the experimental group participants to search for directions and then view congestion reports. To collect the time, which is an interval/ratio type data, our team has programmed a JavaScript on-click timestamp logger into our application (see appendix 8.10 Figure 8). We will log the starting and ending time of the experiment onto the browser console when the user clicks on the location starting point input box and when the user finalizes and click on a specific route button respectively. Based on each participant's start and end time, we can measure the duration taken and then further examine to see if the time taken by the experimental group is indeed significantly increased.

6.3 Experiment Analysis

We have recorded the time taken for each participant to complete their tasks, which is a ratio/interval type data (see data collection in appendix 8.7 Figure 5.1 and Figure 5.2). Analysing our datasets through the Shapiro-Wilk Normality Test has shown that our data is normal (see appendix 8.9 Figure 7). Given that we have also chosen an Independent design for our experiment, our team decided that it would be most appropriate to perform a parametric test with the Independent T-test.

We have hence come up with the following hypotheses for the statistics test:

Null Hypothesis: There is no statistical significance in the time taken to simply search for directions against the time it takes to search for directions and then view congestion reports additionally.

Alternative Hypothesis: The time taken will be significantly increased if a user chooses to view congestion reports after searching for directions.

Based on our statistical test results (see appendix 8.8 Fig. 6.1), we have a returned p value of 0.011, and therefore must reject the null hypothesis that says there is no significant difference between the data. Looking into the descriptive statistics, we can also see a mean difference of 4.6 seconds between the two dataset, with our control group proving to be the more efficient group in terms of time (average of 13.6 seconds) compared to our experimental group who had to search for congestions as well (average of 18.2 seconds).

Therefore, we can accept the alternative hypothesis based on the statistical evidence, and conclude that viewing congestion reports after searching for directions will significantly increase the time taken when users are finding the optimal route between two locations.

6.4 Experiment Summary

Through the experiment, we have found that our hypothesis was indeed true. Even though the average difference in time taken between the two groups is a mere 4.6 seconds, it actually represents a rough 34% increase in time from the control treatment, which is not negligible and hence should be optimized.

However, the experiment results may not be externally valid as all the participants were gathered from a common student demographics and experiments were all conducted in the same indoor environment.

There are also certain possible confounding variables we had identified. For one, each participant may have a different level of proficiency with operating a navigation application; some will either be more or less familiar with it than others, and hence might take longer or shorter time to perform tasks such as keying in inputs. Secondly, our application is dependent on Google Maps API, and its service time could affect the time it takes for our application to retrieve the directions route (e.g. increase in time if Google's servers are overloaded).

So, whilst the results seems very conclusive, we must take into account that our results might have suffered through the effects on the time taken by participants to complete the given tasks due to factors external to our independent variables, which could ultimately alter the experiment results against our expectations.

7. Conclusion

The assignments, given during studios, allowed us to better understand the flows and steps needed to better understand the user to develop an application that would enhance user experience. We have learned how to conduct needfinding to better understand the problem. Our main objective was, that our product can be used by users to find directions with efficiency and satisfaction so that users would continue to use our product. Our perspective of user needs might differ from the actual needs. Hence, we first gathered the needs of users by drafting the task analysis and decided which elicitation methods would be appropriate to conclude the user requirements.

After understanding the user needs and requirements, we designed our product in a way that suited the user. Then, taking into considerations the design principles, we created the storyboards and prototypes. Elicitation phase allowed us to better understand the users and their needs, thus allowing us to draft design ideas, prototypes and storyboards of the application. We concluded that the design should be simple, uncluttered and it should display the clear functionalities of the product. Thereafter, we got experts to evaluate on the prototype and enhanced the design based on the evaluation results, giving us an opportunity to correct the flaws of our application. During the evaluation phase, we learned to take in criticism and understood that not all applications are perfect after the first creation.

During the implementation phase, we decided on the architecture and made any necessary changes to the design after getting the feedback from experts. Implementation phase allowed us to correct the flaws and perfect our application for our users.

The experimentation was then conducted to help us validate our hypothesis regarding a particular aspect of the application, and allow us to decide the appropriate action to take next based on the experimentation results. Thus, the whole process helped to ensure that the application will be of great use to them after it's being created.

8. Appendix

8.1 Elicitation Observation Results

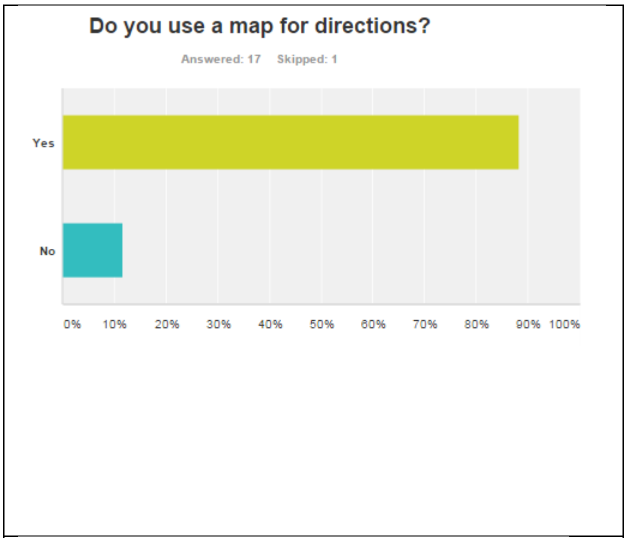
Participants	Observations	Results
1 (Google Map)	• Able to do tasks 1, 2, 3 and 4 without any difficulties • Able to locate current location via GPS setting • Able to identify fastest route from available MRT/Bus options • Able to view desired travelling route • Able to search for congestion data	• Showed frustrations regarding the options shown on the map • Routes shown on google map are based on a • mixture of bus and train • User prefers to view routes with only train services as well
2 (gothere. sg)	• Able to do tasks 1, 2, 3 and 4 without any difficulties • Able to locate current location via GPS setting • Able to identify fastest route from available MRT/Bus options • Able to view desired travelling route • Able to search for congestion data	• Didn't show any extreme emotions • No complaints
3 (Google Map)	• Able to complete tasks 1, 2, 3 and 4 easily. • Did not use GPS to auto detect location, instead opt to type in current location manually. • Filtered to show only directions by public transport. • Evaluated each travelling route generated in detail - Mouse hovered through the travelling time and walking distance for each option - Expanded first route option shown to see full details - Expanded remaining options shown to only see summarized details • Able to search for congestion data	• Seems like first route option caught most of participant's attention, only briefly looked through the other options. • User seems to weigh the walking distance as one of the important factors for a route.
4 (SBS Journey Planner)	• Able to complete tasks 1, 2 and 3 by following steps shown on the website. • Looked around but the application seemingly does not provide GPS auto-detection function, typed in current location	• User had ignored all other directions shown other than the first, assumes that system has accurately filtered the options based on his preferences hence the first is the best.

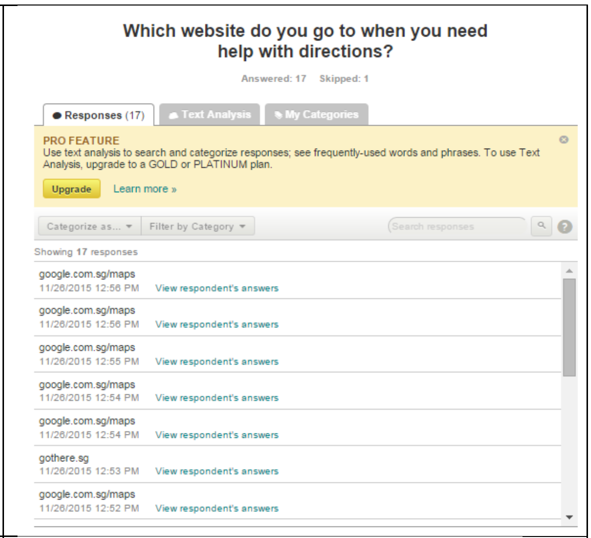
	manually. • Starting/ending points are bus stops which must be selected by user. • Slightly extended process of defining start and end points compared to other web-applications • Between option to filter based on shortest travelling time or walking distance, travelling time option was selected. • When different route options are generated, user evaluates first option and closed the site without even looking at the other options. • Able to search for congestion data	
5 (Google Map)	• Able to do tasks 1, 2, 3 and 4 without any difficulties • Able to locate current location via GPS setting • Able to identify fastest route from available MRT/Bus options • Able to view desired travelling route • Able to search for congestion data	• Seems like first route option caught the participant's attention, only briefly looked through the other options. • User seems to weigh the shortest time as one of the important factors for a route.

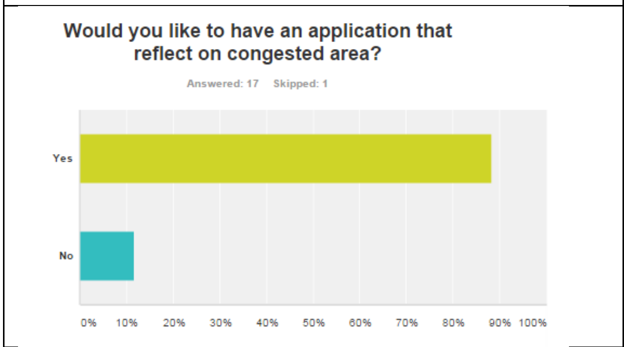
6 (Google Map)	• Able to complete tasks 1, 2 and 3 easily.
	• Did not use GPS to auto detect location, instead opt to type in current location manually.
	• Filtered to show only directions by public transport.
	• Evaluated each travelling route generated in detail
	  ○ Mouse hovered through the travelling time and walking distance for each option
	  ○ Expanded first route option shown
		• The participant analyzed each of the route and chose the route that has less walking distant despite having the longest time.
		• User seems to weigh the shortest walking distant as one of the important factors for a route.

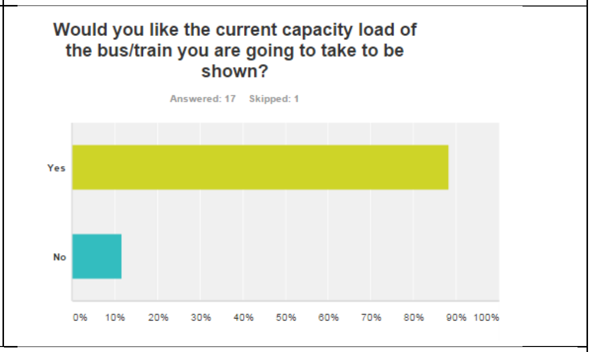
	to see full details ○ Expanded remaining options shown to only see summarized details • Able to search for congestion data	
7 (Google Map)	• Able to complete tasks 1, 2 and 4 easily. • Did not use GPS to auto detect location, instead opt to type in current location manually. • Filtered to show only directions by public transport. • Experienced problems on evaluating each travelling route generated in details.	• Faced some problems in checking for full details of the route • Not aware that by clicking on “Details” will be able to show up the full details of the route • User perceives there may be other things to interact with to check for full details • The participant analyzed each of the route and chose the route that is the fastest to reach the destinations – never look into whether are there any long distance walk required for the chosen route

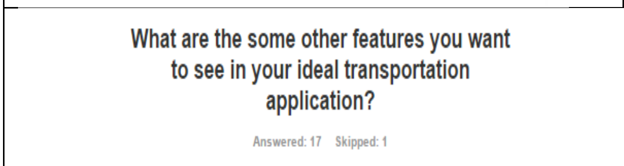
8.2 Elicitation Questionnaire Results



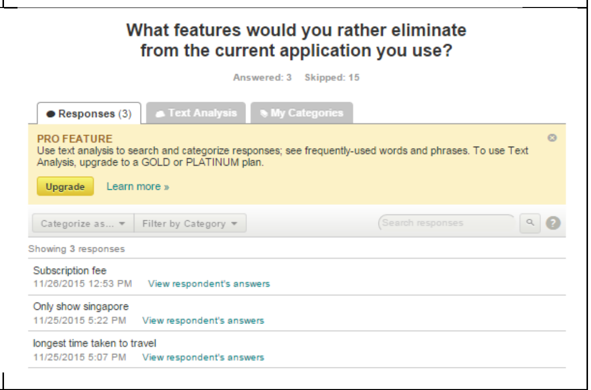


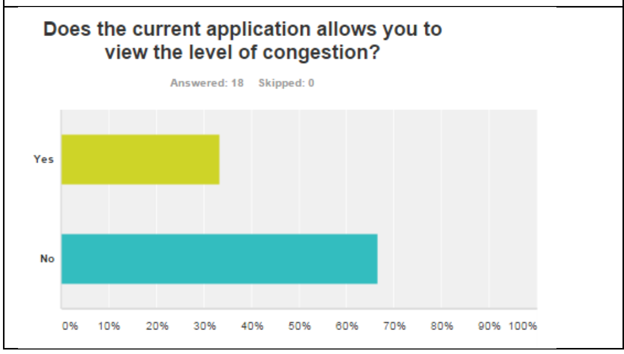






Answer Choices		Responses	
Ans 1	Responses	100.00%	17
Ans 2	Responses	23.53%	4
Ans 3	Responses	11.76%	2
Ans 4	Responses	5.88%	1





8.3 Severity Rating by Team 2

Heuristics	Team Comments	**Severity	**Impact
1. State Of The System	• Since it a mobile app, it should display some loading indicator for certain page that requires form submission to the server. In reality, the page transition would not be so instants and smooth, especially when mobile signal is weak. • After reporting a congestion, there is a message shown to the users and a link to go back to menu, telling the user where to go next.	Addressed to some extend	Fair Usability
2. Familiar Metaphors And Language	• Panels are used instead of buttons to show details of each of the different routes (not obvious enough). • 'Up' button for rating is not a familiar metaphor to interpret. • 'Travel App' is not a clear header to let users know the main functionalities of the app • There should be metaphors for the navigation menu to aid in visual information, because looking at image is faster than reading text. • Fields in form to report congestion is unclear as to what to fill in.	Not Addressed	Low Usability
3. User Control And Freedom	• User can have a choice to edit/delete the congestion entry that they reported in any case that the wrong information is keyed in or it was a false alarm etc. • There is a navigation drawer menu throughout the entire app which is good.	Completely Addressed	No
4. Consistency And Standards	• The navigation menu is horizontal, it should be vertical because in portrait orientation user might not be able to view all menu link in reality.	Addressed to some extend	No
5. Error Prevention	• A home metaphor or back button could be implemented to eliminate inaccurate assumptions and easier navigation for users.	Addressed to some extend	Fair Usability
6. Recognition Rather Than Recall	• The up and down button for rating look like a sort button which was confusing. • No page title/header for every page.	Addressed to some extend	Low Usability

	• For searching routes, the choices that the user has selected are still displayed which prevent users from having to recall what they have done, but as a result there are too many elements on a single screen on these pages and it seems cluttered. (similar to second point in H8)		
7. Flexibility And Efficiency	• Autocomplete function can be implemented. • Once a certain task is completed, there is additional link in the instruction to lead user to the next course of action which is good.	Addressed to some extend	Fair Usability
8. Aesthetics And Minimalist Design	• Design for the screens are minimalistic except for home page – maybe the amount of text could be reduced and replaced by an images instead. • The search route result still retains the search form elements, which is unnecessary although it is understandable that this is convenient for user to perform search again. • A "Back" button would be helpful to reduce the amount of information displayed on the screen. This course of action for user is not as "expensive" as compared to making the screen more cluttered. This is not a search engine where user will perform more than 1 search.	Not Addressed	Low Usability
9. Recognise, Diagnose, Recover From Errors/ Problems	• Error is shown when route that cannot be travelled by public transport is keyed in, but it does not allow the user to select the mode of transport and traffic condition after the error • The recommended course of action is shown when user tried to search using the form without logging in.	Completely Addressed	Fair Usability
10. Help And Documentation	• No help or FAQ section • For the 'Report Congestion' page, it is better to have a little help icon beside each text field to guide user on what is expected to be filled in (if there is no drop down)	Not Addressed	Fair Usability

8.4 Severity Rating by Team 3

Heuristics Evaluation

Team: 3

Heuristics	Team Comments	**Severity	**Impact
1. State Of The System	When the user sign up for a new account, there is no display of register successfully message	Addressed to some extent	Fair Usability
2. Familiar Metaphors And Language	[↑] [↓] This conveys another message such as shifting instead of Like or Dislike	Addressed to some extent	Fair Usability
3. User Control And Freedom	Traffic news feeds should allow users to change based on their preferences	Addressed to some extent	Fair Usability
4. Consistency And Standards	There is no sign out button. Title of the page is not available for all the pages. Instead of Go! button, use find / find route	Addressed to some extent	Fair Usability
5. Error Prevention	There should be * fields for registering account (validation), sign in validation. Some of the pages have no back button	Addressed to some extent	Fair Usability
6. Recognition Rather Than Recall	Terminology of sign in should not be submit, instead it should be login or sign in.	Addressed to some extent	Fair Usability
7. Flexibility And Efficiency	Shows a list of possible road names to the users similarly to autocomplete	Addressed to some extent	Fair Usability
8. Aesthetics And Minimalist Design	Home Page (Too cluttered Suggest to put inside the menu bar. Newsfeeds should not have text boxes.	Addressed to some extent	Fair Usability
9. Recognise, Diagnose, Recover From Errors/ Problems		Completely Addressed	No
10. Help And Documentation	Suggest to put a faq page or a (?) mark beside certain fields to help users understand what ~~fields~~ the purpose of the fields is.	Not Addressed	Low ~~Usability~~ Usability

** Input Options

Severity	Impact
Completely Addressed	No
Addressed To Some Extend	Fair Usability
Not Sure	??
Not Addressed	Low Usability

8.5 Consent Form

PARTICIPANT CONSENT FORM

The consent form is to participate in the ICT 20102 Human Computer Interaction project conducted by second year undergraduate students in Singapore Institute of Technology, as a part of their assessed coursework

The objective of the experiment is to: ensure that the congestion information is easily accessible and available for users finding directions using our application.

Our application combines direction services with crowdsourced congestion reports. The direction services allow users to find directions to and fro preferred locations. The congestion reports allow users to contribute to the traffic conditions that aren't available in our application currently and view existing congestion reports to plan for a journey. We have finished implementing the above applications with all the required functionalities and now are in the stage of evaluating the final software product.

The participants of the control group will be tasked to find the directions from a preferred location to a preferred destination. The duration of the task will take no longer than 5 minutes.

Please note that it is the web application/functionality we are evaluating and not your technical skills.

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The participants of the experimental group will be tasked to find the directions from a preferred location to a preferred destination. The participants will then be tasked to view the congestion reports to plan the journey. The duration of the task will take no longer than 5 minutes.

Please note that it is the web application/functionality we are evaluating and not your technical skills.

DATA PRIVACY

This section contains all relevant information regarding participant data privacy. Participants are strongly advised to read this section carefully.

- All the personal information collected (i.e. the email address) will be stored in a secure server in the Information & Communication department, with the access restricted to only the people involved in this project.
- This data won't be shared with any third-party or used for commercial purposes.
- We won't be recording any personal information, except your email id and demographic information (i.e. gender). The email id will be used to contact you, during the duration of the evaluation and participation in the future research projects. The anonymous demographic information will be used for the purpose of evaluation only.
- The aforementioned information won't be shared with any third-party or used for commercial purposes.

You may withdraw from the experiment at any time without prejudice, and any data already recorded will be both discarded and deleted. If you have any further questions, please feel free to contact the evaluators.

Name: Otto Ma Email: otto.ma_2014@SIT.singaporetech.edu.sg
Name: Tan Yeong Chai Email: YeongChai.Tan_2014@SIT.singaporetech.edu.sg
Name: Tan Siew Yu Email: siewyu.tan_2014@SIT.singaporetech.edu.sg
Name: Ashwini D/O Balachandran Email: Ashwini_2014@SIT.singaporetech.edu.sg

PARTICIPANT SIGNING SHEET

PARTICIPANT: PLEASE READ CAREFULLY

I have read the information provided in pages (1-2) of this document carefully and give all the necessary consent to take part in the evaluation. Please sign in the box, that you agree with the above statements and give your consent.

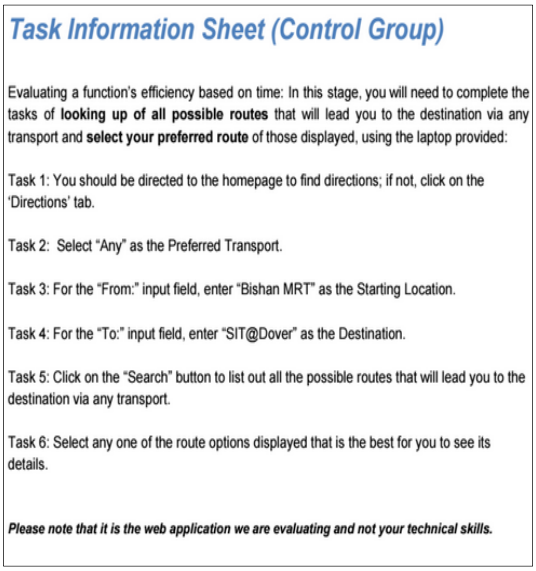
This section is to be completed by the PARTICIPANT.

Full Name of the participant:
Contact Email:
Signature:
Date:

This section is to be completed by the EVALUATOR.

Full Name of evaluator:
Signature:
Date:

8.6 Task Information Sheet



Task Information Sheet (Control Group)

Evaluating a function's efficiency based on time: In this stage, you will need to complete the tasks of **looking up of all possible routes** that will lead you to the destination via any transport and **select your preferred route** of those displayed, using the laptop provided:

Task 1: You should be directed to the homepage to find directions; if not, click on the 'Directions' tab.

Task 2: Select "Any" as the Preferred Transport.

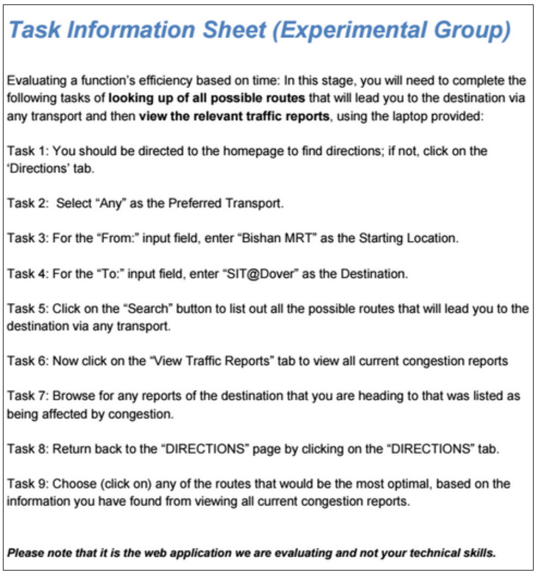
Task 3: For the "From:" input field, enter "Bishan MRT" as the Starting Location.

Task 4: For the "To:" input field, enter "SIT@Dover" as the Destination.

Task 5: Click on the "Search" button to list out all the possible routes that will lead you to the destination via any transport.

Task 6: Select any one of the route options displayed that is the best for you to see its details.

Please note that it is the web application we are evaluating and not your technical skills.



Task Information Sheet (Experimental Group)

Evaluating a function's efficiency based on time: In this stage, you will need to complete the following tasks of **looking up of all possible routes** that will lead you to the destination via any transport and then **view the relevant traffic reports**, using the laptop provided:

Task 1: You should be directed to the homepage to find directions; if not, click on the 'Directions' tab.

Task 2: Select "Any" as the Preferred Transport.

Task 3: For the "From:" input field, enter "Bishan MRT" as the Starting Location.

Task 4: For the "To:" input field, enter "SIT@Dover" as the Destination.

Task 5: Click on the "Search" button to list out all the possible routes that will lead you to the destination via any transport.

Task 6: Now click on the "View Traffic Reports" tab to view all current congestion reports

Task 7: Browse for any reports of the destination that you are heading to that was listed as being affected by congestion.

Task 8: Return back to the "DIRECTIONS" page by clicking on the "DIRECTIONS" tab.

Task 9: Choose (click on) any of the routes that would be the most optimal, based on the information you have found from viewing all current congestion reports.

Please note that it is the web application we are evaluating and not your technical skills.

Figure 4: Task sheets for individual participants of each group

8.7 Data Results Collected

TIME TAKEN FOR PARTICIPANTS TO FIND DIRECTIONS			
#	**Start Time**	**End time**	**Time taken (seconds)**
1.	13:31:44	13:31:59	15
2.	13:46:54	13:47:08	13
3.	15:23:28	15:23:40	12
4.	16:40:50	16:41:01	11
5.	16:56:44	16:56:54	10
6.	16:58:49	16:59:08	19
7.	17:30:02	17:30:13	11
8.	17:31:11	17:31:25	14
9.	17:32:33	17:32:46	13
10	17:35:14	17:35:32	18

Figure 5.1: Data results from Control Group – Find directions

TIME TAKEN FOR PARTICIPANTS TO FIND DIRECTIONS AND VIEW CONGESTION REPORTS			
#	**Start Time**	**End time**	**Time taken (seconds)**
1.	13:42:05	13:42:26	21
2.	15:26:04	15:26:28	24
3.	16:14:16	16:14:35	19
4.	16:51:10	16:51:21	11
5.	16:55:46	16:55:58	12
6.	16:59:57	17:00:18	21
7.	17:31:44	17:32:03	19
8.	17:35:53	17:36:11	18
9.	17:40:14	17:40:30	16
10	17:41:22	17:41:43	21

Figure 5.2: Data results from Experimental Group - Find directions and view congestion reports

8.8 Statistics

Data set statistics

Sample name	Number of samples	Mean	Standard error of the mean	Standard deviation	Median
Find directions only	10	13.600	0.945	2.989	13.000
Find Directions and Congestions	10	18.200	1.306	4.131	19.000

Figure 6.1.1: Descriptive Statistics (Full Results)

Test results

Number of samples	N = 20
Normality of sampling distribution	The Shapiro–Wilk test was conducted on all data sets, and they appear to be approximately normal. Therefore, the assumption of normality is likely to be satisfied.
Levene's test for equality of variance	• *W*=0.791, 2-tailed p-value = 0.386 • The two sets appear to have approximately equal variance (use the green results below)
Independent *t*-test (equal variance assumed)	• *t* = -2.853 • *df* = 18 • Significance (2-tailed) *p* = 0.011 • Based on a significance level of 0.05, there is a statistically siginificant difference between 'Find directions only' and 'Find Directions and Congestions'.
Effect size	• *r* = 0.558 • Cohen's *d* (using Find directions only variance) = 1.539

Independent *t*-test (equal variance assumed)	• *t* = -2.853 • *df* = 18 • Significance (2-tailed) *p* = 0.011 • Based on a significance level of 0.05, there is a statistically siginificant difference between 'Find directions only' and 'Find Directions and Congestions'.
Effect size	• *r* = 0.558 • Cohen's *d* (using Find directions only variance) = 1.539

Figure 6.1.2: Statistical test results (Full Results)

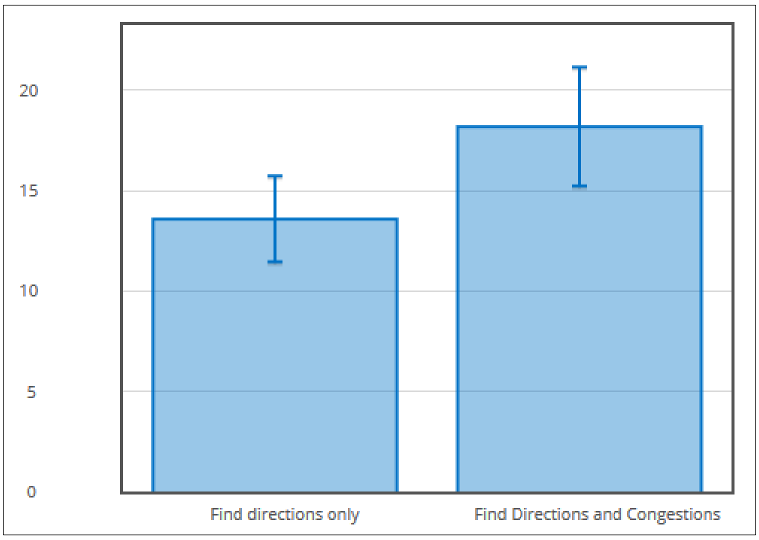


Figure 6.1.3: Statistics Graph (Full Results)

8.9 Normality Test

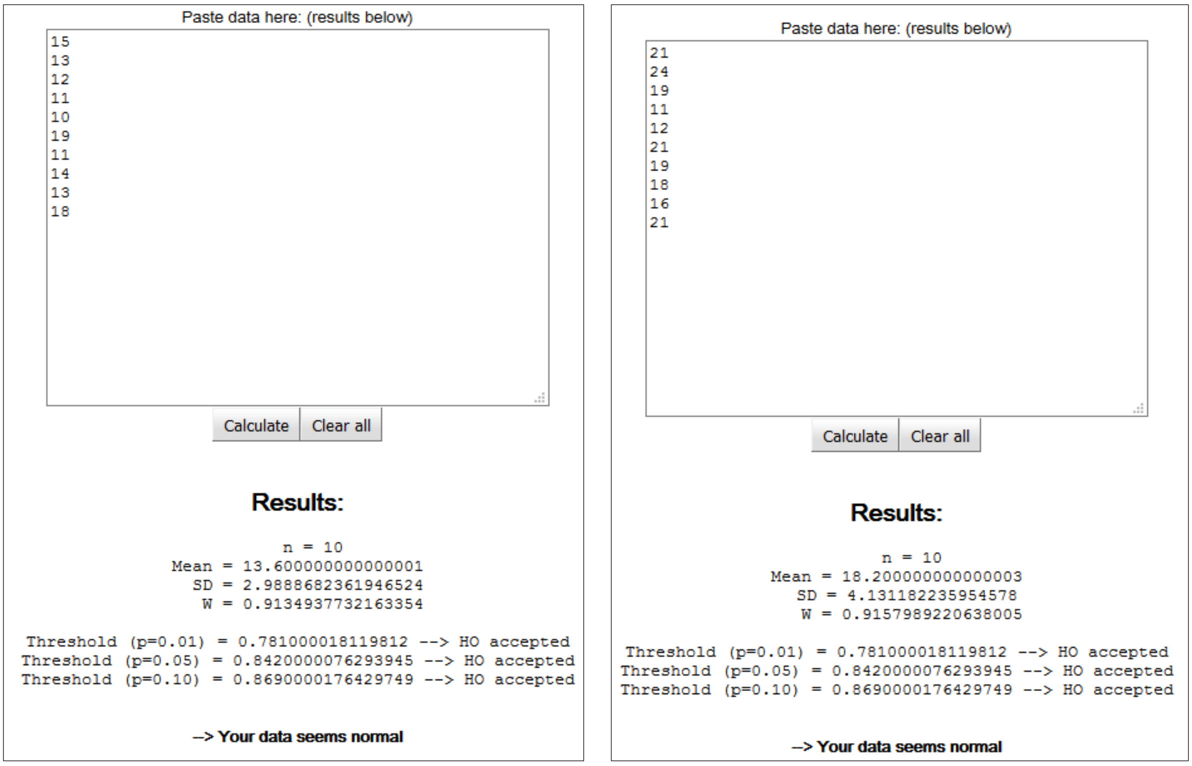


Figure 7: Normality tests for Control (left) and Experimental group's data

8.10 Example

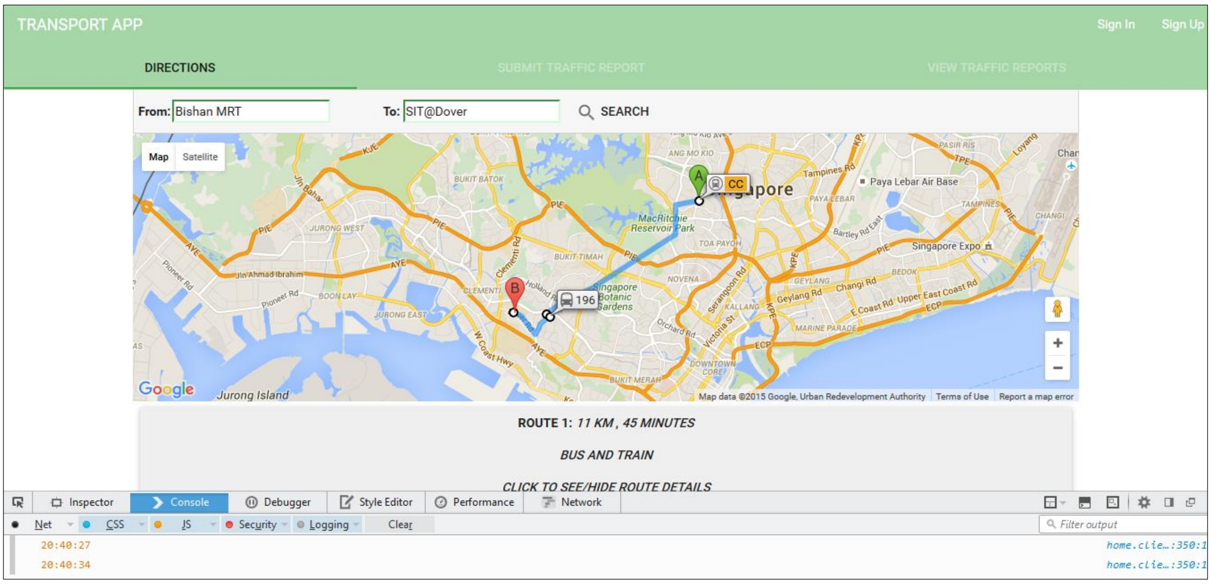


Figure 8: Example of timestamp logged onto browser console (bottom left)

8.11 Revised Prototypes screens (High-Fidelity)

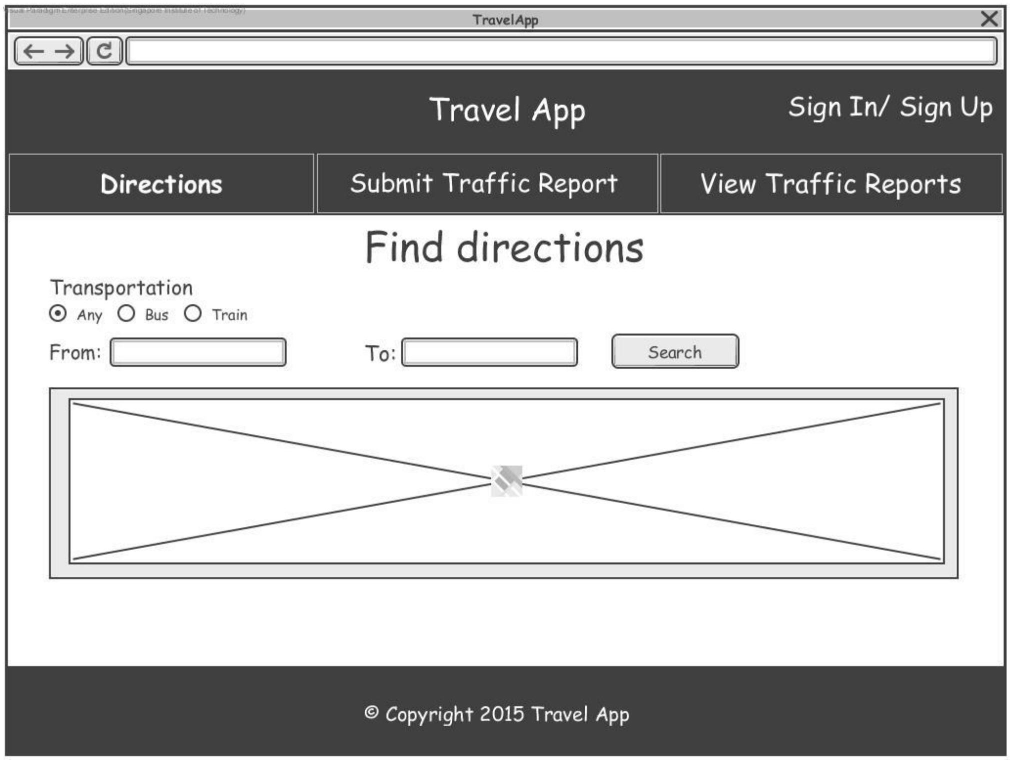


Figure 9.1: Prototyped homepage

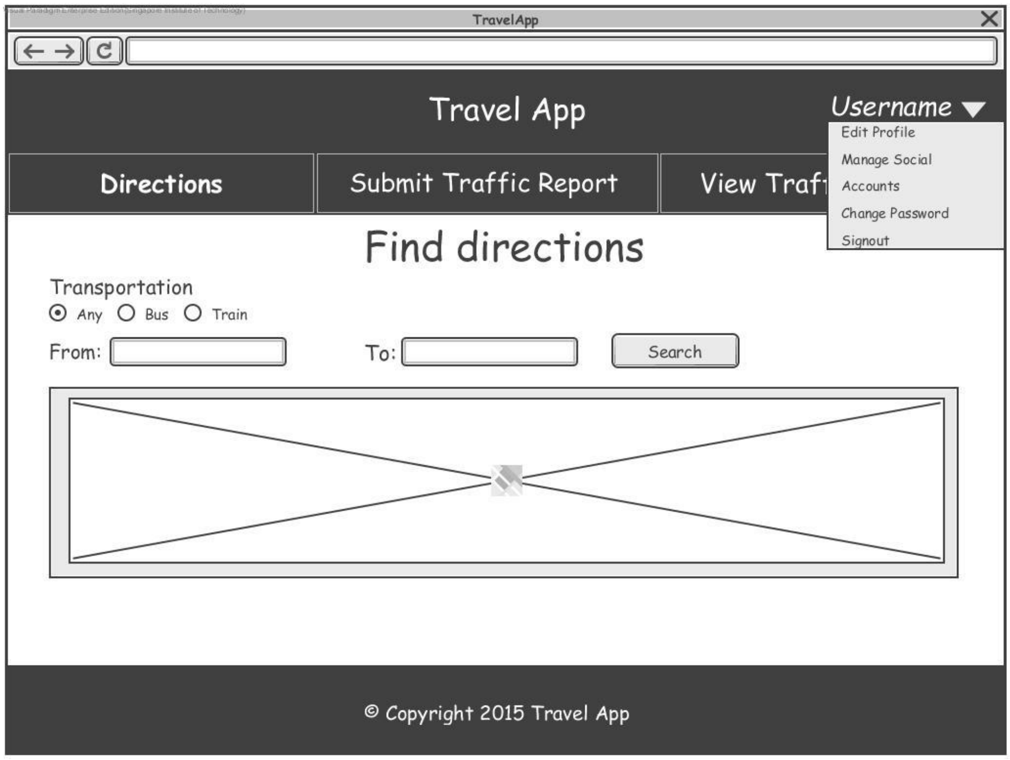


Figure 9.2: Prototyped homepage after login

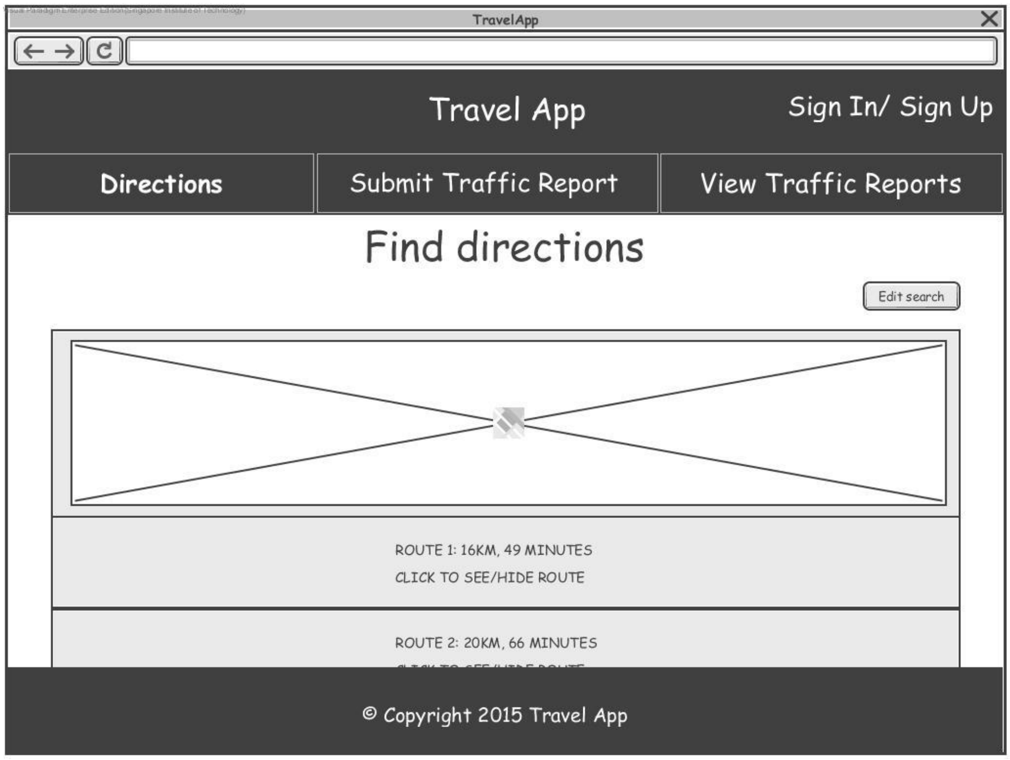


Figure 9.3: Route results after user submit directions search

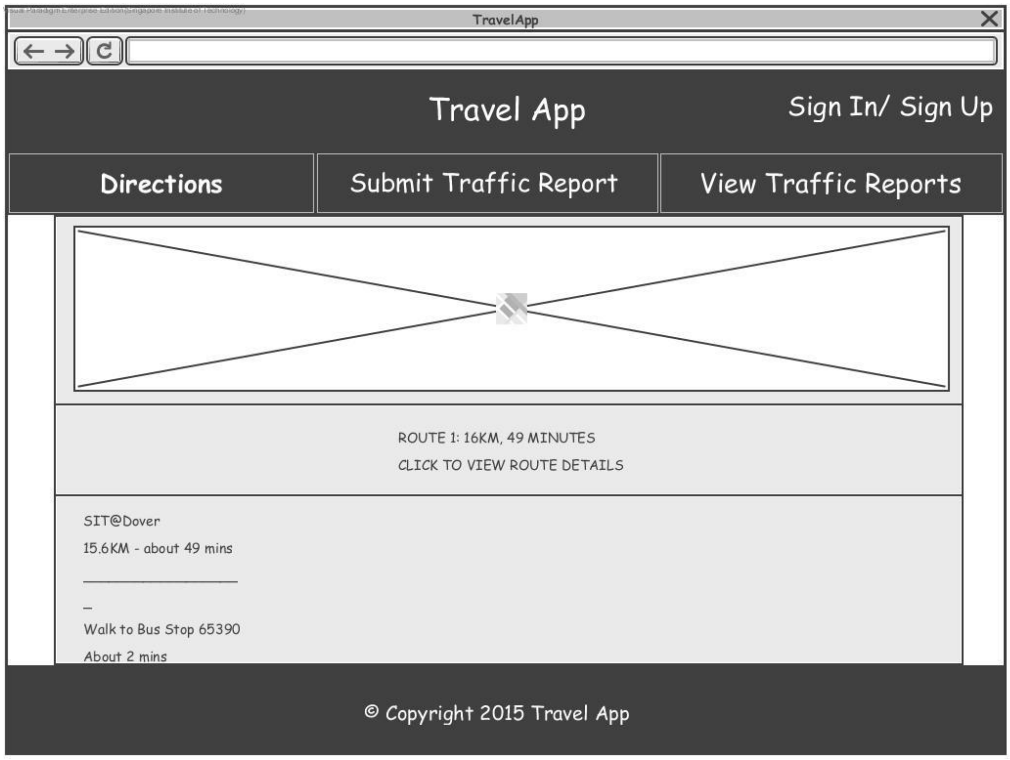


Figure 9.4: Expanded route to display full route details

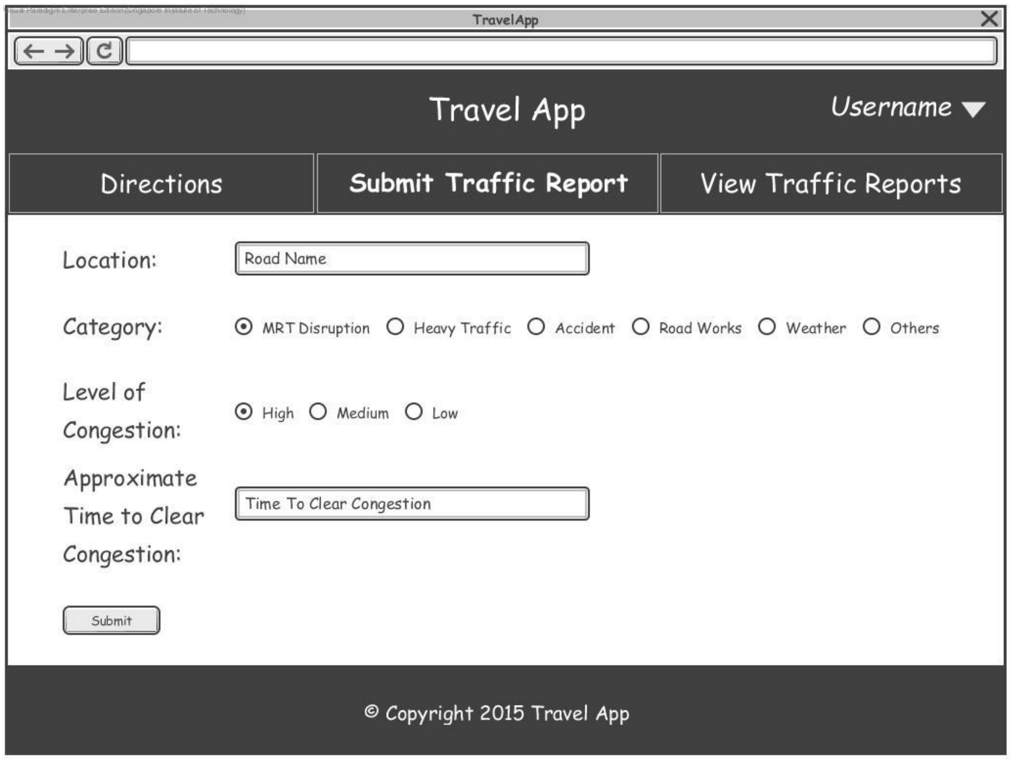


Figure 9.5: Form for traffic congestion report submission

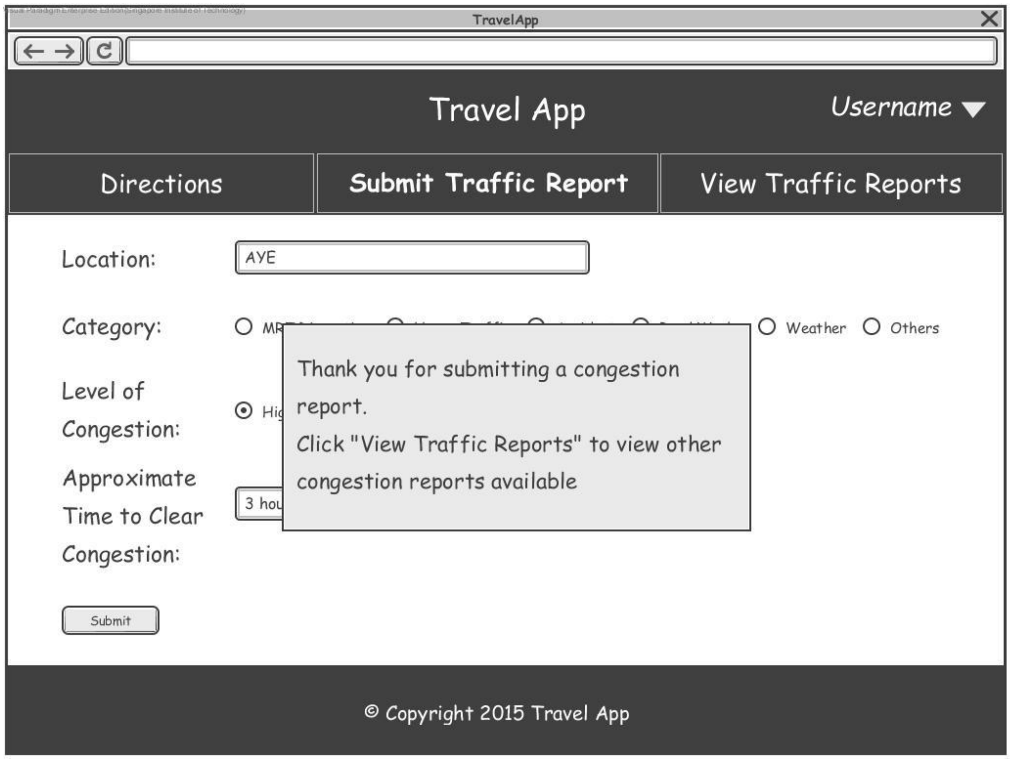


Figure 9.6: Report submitted notification (Feedback)

Figure 9.7: Form submission restricted for login users only

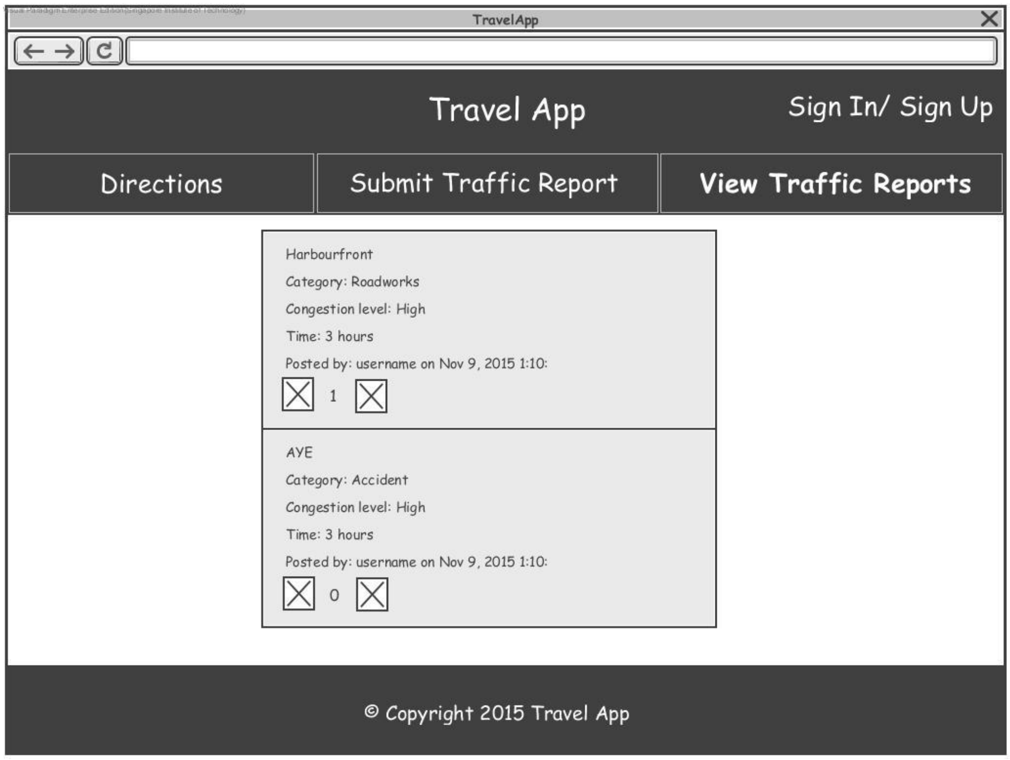


Figure 9.8: List of traffic congestion reports submitted

8.12 Signed Consent Forms

The attached zipped folder contains all the signed consent forms by the subjects who have participated in our experiment.

SignedConsentForms.zip