Software Design Document

Accident Analysis Software

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# System Vision

## Problem Background

A dataset containing data on Victoria State Accidents presents opportunities to discover underlying causes and other statistics surrounding road accidents that occur in Victoria. Currently, the department of transport for Victoria do not have software to train new employees on data analysis. An increase in data has required the Department of Transport for Victoria to seek software that can draw conclusions and present findings, so that the Department of Transport may overcome the challenges associated with data analysis and human error. As data becomes too large, it becomes impossible to analyse the data without errors, misunderstandings, and large amounts of human resources. The intention is for a software that can resolve these issues and enable internal stakeholders of the department to easily access and analyse the data, and present the data to external stakeholders, in the form of an awareness campaign or project.

## System Overview

This system will provide a GUI for the user to visualise the data. The system will accept CSV files and convert them into JSON files. The system will be able to produce results based on the input of the user, and depending on the view, will be able to see the data with the visualisation aid of charts. Different views will include the analysis of alcohol, along with a map based analysis. The system will include features that:

* For a user-selected period, displays the information of all accidents that happened in the period.
* For a user-selected period, produces a chart to show the number of accidents in each hour of the day (on average).
* For a user-selected period, retrieves all accidents caused by an accident type that contains a keyword (user entered), e.g., collision, pedestrian.
* Allows the user to analyse the impact of alcohol in accidents – ie: trends over time, accident types involving alcohol, etc.
* Allow the user to analyse results and filter the result by LGA and/or Region to compare data between different areas with the assistance of charts.

## Potential Benefits

Implementing software in the context of data analysis, alleviates the pressure on humans to avoid producing errors in the analysis. Without software, the Department of Transport may spend countless human and financial resources on producing results that software can produce within seconds. By streamlining long tasks into functions that can be performed by software, the Department of Transport can benefit with increased employee productivity and streamlined processes. Software can discover patterns and statistics that are otherwise impossible for humans to observe from a dataset. With this knowledge, the Department of Transport can benefit greatly with the software’s ability to guide the data analyst to solutions not recognised from just the human’s perspective on the data.

# Requirements

## User Requirements

As the client is the Department of Transport for Victoria, it is expected that it is employees of the Department that are the end users of the program. The end user must first begin with inserting the dataset. Once entered, the user may toggle between variations of the user interface. It is only required that the user enters certain parameters surrounding the nature of the user’s query. Once decided, and entered, the results of the user’s query shall be viewable via the output.

In a sequential list of needs, the above would be translated to:

1. Open program
2. Insert Dataset (if first time using application)
3. Insert Query Parameters
4. View Results

Each function will be available from the main view tree in the user interface, with the required function being run dependant on the user input. A field will be available for users to input keywords, which will limit the data output to accident data only containing those keywords.

Options to limit the timeframe will be displayed, if a user decides to use this function the output will be limited to data from within this function. If no time is specified, then all relevant data from the dataset will be displayed.

All data queries will be returned in table format.

Once the data has been displayed, a button to display a chart for the average number of accidents in each hour of the user specified period will appear above the returned data. If this button is pressed a chart will be generated and will be displayed above the tabulated data.

There will also be a radio button which will allow the user to specify that they wish to analyse alcohol related incidents. If this button is checked, a chart will be displayed showing both alcohol and non-alcohol related incidents over the user-specified period, as well as the tabulated data from both alcohol and non-alcohol related incidents in different tables.

In a separate tab users will be able to view accident data overlayed onto a map of the relevant local government area (LGA). Users will be able to zoom in/out of the map with accidents being displayed as a coloured dot. The colour of each dot is determined by their accident type, a legend will be displayed to the user explaining the colour correlation. Users will be able to filter the data displayed on the map by region/LGA/accident type etc.

In addition to this, the end user should be aware that their query is being processed. To provide this context, for each query a loading prompt (i.e. loading bar, circle etc.) will be displayed to make the end user aware that their query has been accepted and the system is working on displaying their query.

## Software Requirements

1. The program shall have a GUI implementation
   1. The program shall allow for user input through GUI
   2. The program shall accept .csv dataset files from user input
   3. The program will limit returned data by user inputted keyword.
   4. The program will limit returned data by time range
   5. The program shall graphically display data through charts & tables
   6. The program shall output a summary of results
2. The program shall have a back-end server database.
   1. The program shall allow for users to upload .csv dataset files to the database
   2. The program shall allow for SQLite queries
3. The program shall have maths & statistical modules.
4. The program shall have a datetime module.
5. The program shall have a PyPlot module.

In this section you detail what the requirements for the software are. What functionality will it provide? This is usually a formal listing, with requirements often using the word ‘Shall’. IE:

R1.1 The program shall accept multiple file names as arguments from the command line.

R1.2 Each file name can be a simple file name or include the full path of the file with one or more levels.

etc …

Can be primarily functional requirements, though you may include other types if you think of them.

## Use Cases & Use Case Diagrams

In this section you provide some use cases showing how people may use your software.

|  |  |
| --- | --- |
| Use Case | Display all accident information |
| Primary Actor | Client |
| Secondary Actor | Database |
| Description | The user specifies a time-period. The system then retrieves all accident information from this period and displays it in a tabular format |
| Flow of events | User specifies a start date and an end date, after pressing the ‘search’ button all accident data within the user-specified period is retrieved from the database and presented in a tabular format. |
| Trigger | The client requires to view accident data within Victoria during a specific time-period. |
| Pre-condition | The client knows the period they wish to view and data from within this period is within the database. |
| Post-Condition | Data from the database has been queried and displayed by the program. |
| Success Scenario | Accident information from within the user-specified period is successfully displayed within the program. |
| Abort Scenario | Data from within the user-specified period is not in the database. |

|  |  |
| --- | --- |
| Use Case | Display average hourly accident rate |
| Primary Actor | Client |
| Secondary Actor | System |
| Description | From data retrieved within the user-specified time-period the average hourly accident rate is calculated and presented graphically as a chart. |
| Flow of events | The user has already retrieved data from within a time-period they have specified. The user then presses a button which calculates the average hourly accident rate within the period and generates a chart to display the data. |
| Trigger | The user requires to analyse the hourly accident rates within a specified time-period. |
| Pre-condition | A set of data has been successfully retrieved from the database and is currently being displayed within the program. |
| Post-Condition | The hourly accident rates have been calculated and the system has accurately displayed these rates as a chart |
| Success Scenario | The hourly accident rate from within the user-specified time-period has been displayed as a chart. |
| Abort Scenario | There is not enough data within the timeframe to display an average accident rate for a 24hr period. |

|  |  |
| --- | --- |
| Use Case | Display accident data containing user-specified keywords |
| Primary Actor | Client |
| Secondary Actor | System |
| Description | The user enters a keyword which limits the retrieved data to only records containing that keyword within the user-specified period. |
| Flow of events | User inputs a keyword into the relevant text field. The database is queried with this keyword along with the user-specified timeframe and all matching records are displayed in a tabular format/ |
| Trigger | The user requires to view accident data with a relevant keyword and within a specific timeframe. |
| Pre-condition | Data is available from within this timeframe and containing the relevant keyword(s) |
| Post-Condition | The data has been successfully queried and all relevant records have been displayed. |
| Success Scenario | Records within the user defined parameters are displayed |
| Abort Scenario | No records are found with the user defined parameters |

|  |  |
| --- | --- |
| Use Case | Display all alcohol related incidents within a user-specified time |
| Primary Actor | Client |
| Secondary Actor | System |
| Description | All alcohol related accident data within a user-specified period is displayed. |
| Flow of events | The user selects the alcohol related accident tab and specifies a time-period from which data will be retrieved from. This data is then retrieved from the database and displayed in a tabular format. |
| Trigger | The user requires to view all alcohol related incidents within a specified time-period. |
| Pre-condition | The user requires to view all alcohol related incidents within a specified time-period. |
| Post-Condition | Nil |
| Success Scenario | All alcohol related records within the user-selected period are displayed |
| Abort Scenario | No records are found within the user defined parameters |

|  |  |
| --- | --- |
| Use Case | Visually overlay geographical accident data |
| Primary Actor | Client |
| Secondary Actor | System |
| Description | Accident data is overlayed onto a map of the local government area (LGA). Users can filter results by LGA, region or accident type. |
| Flow of events | Accident data is retrieved from the database and visually overlayed onto a region map. This map can be further filtered by the user by accident type, LGA and/or region. |
| Trigger | The user requires to view the accident data visually by geographical location. |
| Pre-condition | Records exist within the database containing geographical location. |
| Post-Condition | Accident data has been retrieved from the database and overlayed onto a region map of the relevant areas. |
| Success Scenario | An overlay of records is displayed on a map of the relevant area. |
| Abort Scenario | No records exist within the database. |

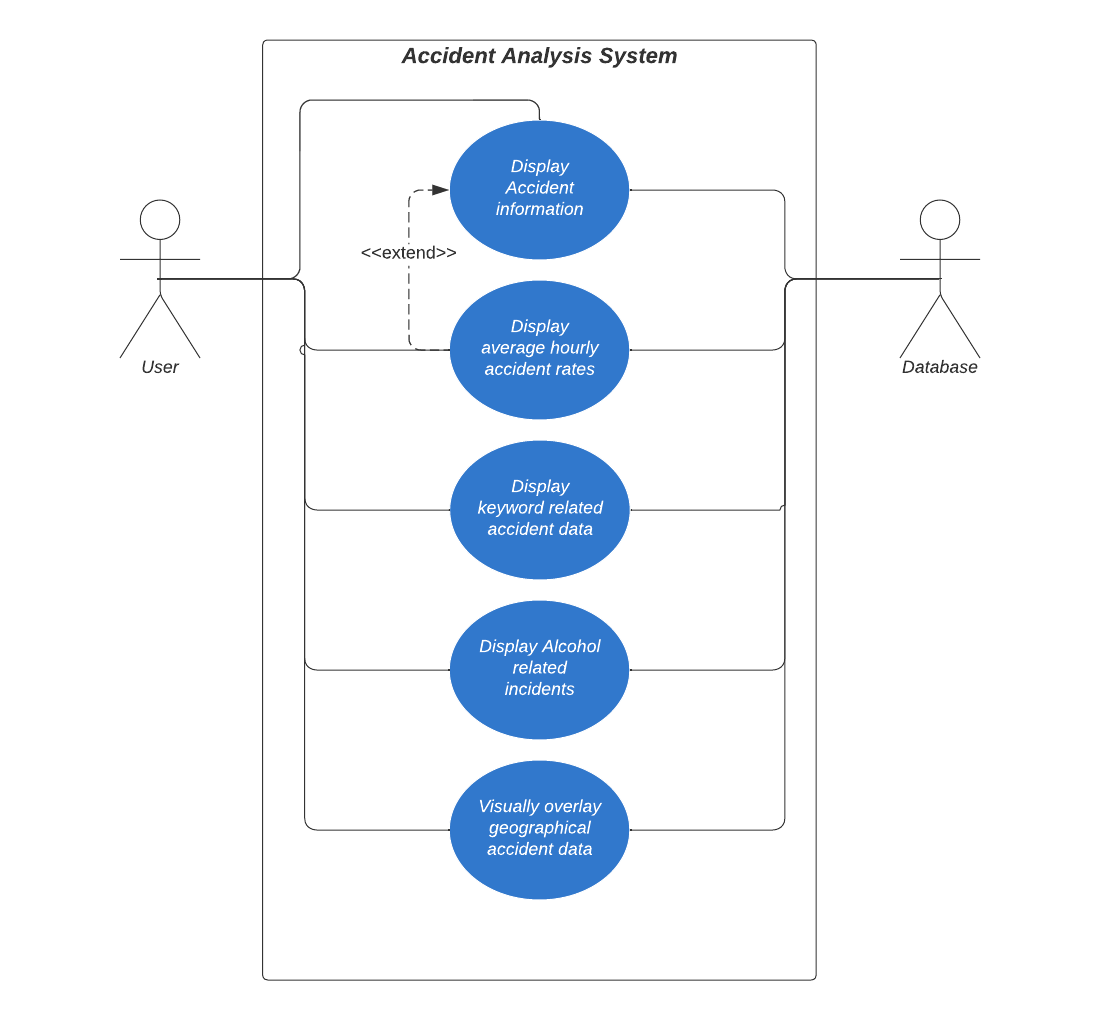


Diagram 1: Use Case Diagram

# Software Design and System Components

## Software Design

## 

## System Components

### Functions

Preliminary list of all functions in the software. For each function in the list the following information is provided:

* a brief description of what it does (1 or 2 sentences);
* a list of the input parameters, and their data types, and what they are used for;
* a list of any side effects caused by the function (ie change global or member variables, changes data passed by reference from calling function etc)
* a description of the function’s return value

#### Import dataset

Reads a selected CSV dataset file and validate if it contains required data fields. Return data

Input Parameter:  
File location (String) to determine path to the file.  
File name (String) to determine the file to read.

Return value: Accidents data (List of Tuple).

Side effect: None.

#### Create database

Connects to SQLite and creates a database and tables.

Input Parameter: None.

Return value: None.

Side effect: Creates a global database object.

#### Save to database

Saves the accidents data to the SQLite database.

Input Parameter: Accidents data (List of Tuple).

Return value: None.

Side effect: Modify database data.

#### Retrieve from database

Reads data from database and return accident data for the defined criteria.

Input Parameter:   
From date (String) to set the date range to search accidents after the date.  
To date (String) to set the date range to search accidents before the date.  
Accident type keyword (String) to search accidents with accident type which include the keyword.  
Accident type (String) to search accidents with the accident type.  
LGA (String) to search accidents only in the LGA.  
Region (String) to search accidents only in the region.  
Output type (List of Int) to determine which field to show.

Return value: Accident data (List of Tuple).

Side effect: None.

#### Calculate hourly average

Calculates the average number of accidents in each hour of the day.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Average for each hour (List).

Side effect: None.

#### Calculate accident type

Calculate the number of accidents in each accident type.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Total number of accidents for each accident type (List).

Side effect: None.

#### Calculate by month

Calculates the number of accidents in each month.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Total number of accidents for each month (List).

Side effect: None.

#### Calculate by day

Calculates the number of accidents in each day.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Total number of accidents for each month (List).

Side effect: None.

#### Calculate LGA

Calculates the number of accidents in each LGA.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Total number of accidents in each LGA (List).

Side effect: None.

#### Calculate region

Calculates the number of accidents in each region.

Input Parameter: Accident data (List of Tuple) to use for the calculation.

Return value: Total number of accidents in each region (List).

Side effect: None.

#### Generate bar chart

Generates a bar chart with legend.

Input Parameter: Labels and values (dictionary) to place in the chart.

Return value: File path of the generated image (String).

Side effect: None.

#### Generate map chart

Generates a map chart to show the locations of accidents on a Victorian map colour coded by fatal or injury accident with legend.

Input Parameter: List of accident kind and geo coordinate(List of Tuple) to place dots in the chart.

Return value: File path of the generated image (String).

Side effect: None.

#### Display main

Creates a main window to display for users to perform data search.

Input Parameter:  
Analysis type (String) to determine which component to place in the window.

Return value: None.

Side effect: Generate GUI components.

#### Display chart

Creates a window to display a chart image with a title.

Input Parameter:  
Title (String) to place in the window.  
File name of chart image (String) to place the image in the window.

Return value: None.

Side effect: Generate a GUI component.

### Data Structures / Data Sources

|  |  |  |
| --- | --- | --- |
| Data | Structure | Description |
| CSV dataset file | CSV Table | This file contains accident data from Department of Transport and saved as CSV file. This will be imported to the software. The dataset file should contain columns of ACCIDENT\_NO, ACCIDENT\_DATE, ACCIDENT\_TIME, ACCIDENT\_TYPE, DAY\_OF\_WEEK, SEVERITY, LONGITUDE, LATITUDE, LGA\_NAME, REGION\_NAME, FATALITY, SERIOUSINJURY, ALCOHOL\_RELATED. |
| JSON dataset file | JSON (Tree) | This file will be created when the software imports the CSV dataset file. Analysis in the software will use this data. The members will be dataset, analyse, alcohol, and location. The keys will include ACCIDENT\_NO, ACCIDENT\_DATE, ACCIDENT\_TIME, ACCIDENT\_TYPE, DAY\_OF\_WEEK, SEVERITY, LONGITUDE, LATITUDE, LGA\_NAME, REGION\_NAME, FATALITY, SERIOUSINJURY, ALCOHOL\_RELATED. |
| Menu | Array | This is to determine which content to display and set different type of analysis to perform. The members will be dataset, analyse, alcohol, and location. |
| Analysis type | Array | This is a list to contain types of analysis which includes general, alcohol, and location. This data will be used to determine attributes for search and which type of chart to generate. The members will be general (default), alcohol, and location. |
| Search attribute |  | This is to determine which search criteria will be available for the analysis functions to search the dataset. Available attributes will be different depending on which analysis type is chosen. From data, to data, accident type keyword, accident type list, and output type will be the members for the general analysis function. |
| Accident type | List | This data will be generated from JSON dataset file referencing the values in the ACCIDENT\_TYPE field. This list will be used by the search attribute to perfume an analyse search. |
| Output attribute | key-value dictionary | This data to store the preference of which fields (attributes) to show in the output of analyse search in the table view. True/False Boolean values will be stored for each output type. The keys will be same as JSON dataset file. |
| Chart type | Tree | This data contains different types of chart and its preference. Each type will define which field from the search result to use, and how to display for generating a chart graphic image to display in the chart windows. |
| Search result records | JSON (Tree) | This data will be generated by the search dataset function and stores result records. |
| Summary values | key-value dictionary | This data contains total values of records, fatality, and injury which are generated by the search dataset function. This will be used to display search result summary. |

List of all data structures in the software (eg linked lists, trees, arrays etc) or eternal data sources. For each data structure in the list the following information is provided:

* Type of structure (tree, list etc),
* Description of where and how it is used
* List of data members, and what each one is for do
* List of functions that use it

### Detailed Design

The following pseudocodes demonstrate how each non-standard function in the software will perform.

#### Import dataset

Import csv and sqlite3 python packages.  
Input file name and location.  
If the file exists, examine the file format and file content of the CSV dataset file.  
Else error: File does not exist.  
If file format is not CSV and it does not contain required fields, error: File type is not supported.  
Connect to SQLite and create a database and tables.  
Insert data into database tables.  
Commit and close database connection.

#### Search dataset

Import sqlite3 python package.  
Connect to SQLite database.  
If date range is set in the search attributes, find records within the date range.  
If accident type is set in the search attributes, find records with the accident type.  
If the found records is more than zero, output values with only output attributes that are defined True.  
Else display a message: No record found.  
Calculate summary values (total records, fatality total, injury total) to display.  
Close database connection.

#### Generate chart

Import library for chart creation (PyPlot library).  
Check which type of chart (chart type) selected.  
Read the search result records generated from the search dataset function.  
Calculate total value for each attribute.  
Allocate colours for attributes and set labels.  
Generate a bar chart.  
Display the chart with legend.

#### Generate map chart

Import library for chart creation (PyPlot library).  
Read the search result records generated from the search dataset function.  
Allocate colours for attributes and set labels.  
Convert LONGITUDE, LATITUDE values in the records to X, Y values to place in the chart.  
Draw circles with the X, Y values with setting colours depending on the accident type.  
Generate a bar chart with a background Victorian map image.  
Display the chart with legend.

Pseudocode for all non-standard / non-trivial algorithms that operate on data structures

# User Interface Design

This is your initial interface design. Describe the tools you used for this design stage and any key findings that informed your design. This introduction is descriptive and should explain what you have completed for the actual design work you will present in the sub-sections below.

<add some intro>

<write about tools used>

## Structural Design

Structural design refers to the navigational and information structure of your product – the structure that supports the interface layout. How will you structure your product? How will you group your information? How will you navigate through your product? Why? This can take the form of a diagram showing structure and hierarchy, supported by a discussion and justification of your choices. Why have you made these design choices? Describe and outline the structure of your interface and of your information.

The software consists of three windows including the main window. The structure of the main window is designed to indicate steps that users follow by placing sections from top to bottom. The estate of main window is limited, thus, charts will be displayed in a secondary window to create more display surface area.

### Main window

The main window of the software contains the following sections. In order to provide the best useability, there are grouped by action which are navigate, search, result (view), summary (view), and chart (view).

**Navigation tool bar**

This section is located at the top of the main window and contains buttons to perform the main functionalities. They are Dataset, Analyse, Alcohol, and Geographical.

**Data search box**

This section is located under the navigation tool bar and contains input fields for users to define search criteria such as dates, and accident type along with a search button to initiate data search.

**Data table view**

This section displays output data in a table view. It is located under the data search box and users can see search result.

**Chart selection bar**

This section is located at the bottom of the main window under the data table view. It shows available chart types which users can view by clicking. This section will not be available when there is no available option.

**Summary view**

This is located at the right side next to the data search box to show summary of result from a search. It can include number of record found, total number of target records, and total number of injury/fatality.

### Chart window

A secondary window will open when users select one of options in the chart selection bar. It displays chars with selected conditions. This window is independent from the main window and can be placed anywhere in users’ screen. Users can close this window without affecting the main operation of the software.

### Dataset window

A window that contains the navigation bar same as the main window. A file selection will be placed in the middle of the window. This window will be shown if there is no dataset imported or selected.

## Visual Design

Detail your visual design: Layout, visual elements, icons, graphics, style, colour, fonts general screen designs. This can be sketches, wireframes, mockups etc, supported by a discussion, explanation, and justification of your choices.

### Layout

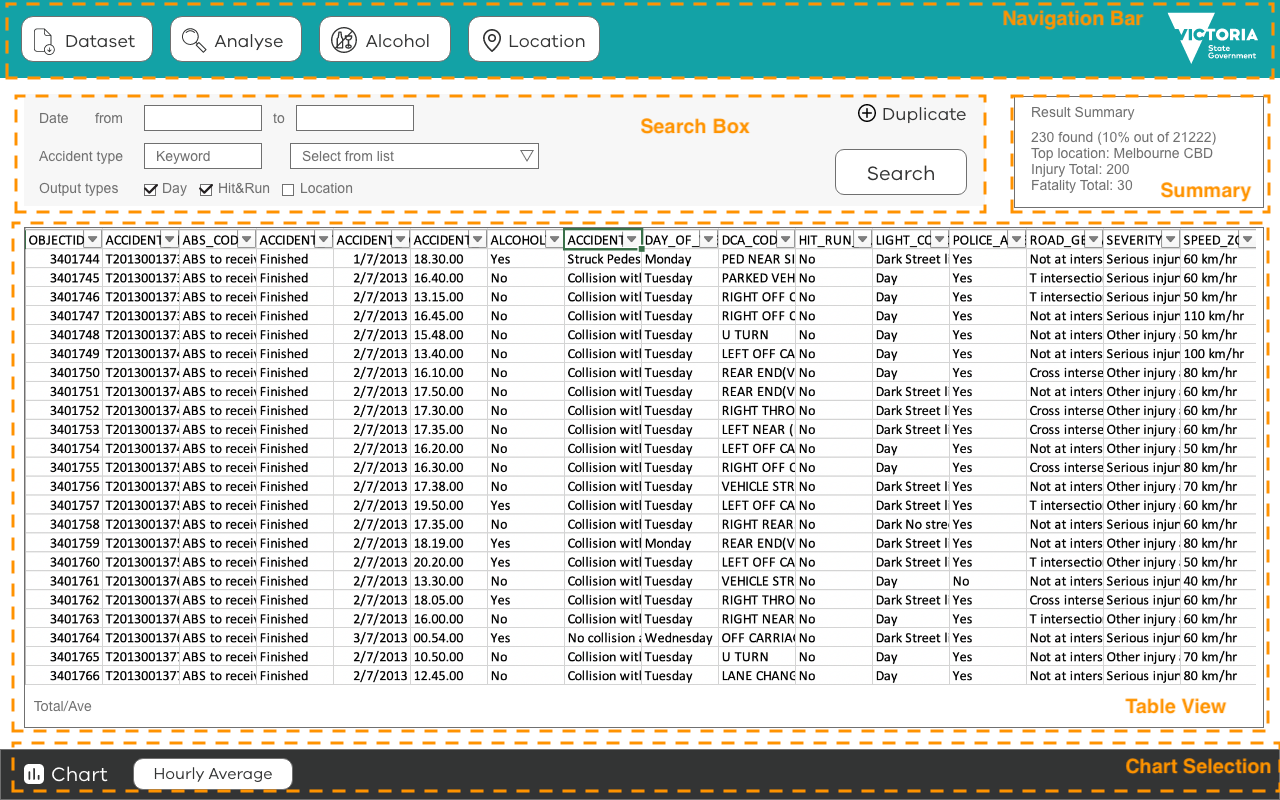


Figure 1 Main Window Layout

### Visual Elements

#### Logo

The client’s logo, Victoria State Government logo, will be placed in the navigation bar sourced from Brand Victoria website (<https://www.vic.gov.au/brand-victoria-using-our-logos>). The colour of the logo will be adjusted to white to have a contrast against the background colour.



Figure 2 Victoria State Government logo

#### Icons and Buttons

|  |  |  |
| --- | --- | --- |
| Graphic | Name | Description |
|  | Dataset Icon | Used in the button for the Dataset menu to indicate importing a file. Open a dialog to select a file to import to use as a dataset. |
|  | Analyse Icon | Used in the button for the Analyse menu to indicate to set search conditions. Displays the standard search box to analyse data. |
|  | Alcohol Icon | Used in the button for the Alcohol menu to indicate the data analysis of alcohol related accidents. Displays the extended search box to analyse alcohol related accidents data. Slashed version is selected to be work environment friendly instead of non-slashed designs. |
|  | Location Icon | Used in the button for the Location menu to indicate the geographical data related analysis using maker which is used in map apps often. Displays the extended search box to analyse accidents data by area or location. |
|  | Chart Icon | Used to supplement the Chart title in the chart selection bar to indicate the section is about charts. |
|  | Search Button | Buttons have round corners to indicate the actions are assigned to them as well as create the soften the impression of the software. |
|  | Navigation menu button | Buttons have round corners and a label with an icon to indicate that they are main menus in the software. They are placed in the navigation bar at the top. The size is bigger than other elements to stand out. |

### Colour

The most key colours for the software are chosen as same as the Department of Transport Victoria website to be cohesive and adhere the client’s corporate ID (see figures below).

|  |  |  |
| --- | --- | --- |
|  | Colour Name (Code) | Description |
|  | Teal (#13a2a6) | The feature colour that is used for the Department of Transport Victoria website. This colour is used for the background of the navigation bar in the software. |
|  | Dark grey (#333434) | The colour is used for the background of the chart selection bar at the bottom of the software. It is the same colour that is used for the client’s website as the footer background colour. It is also used as the text colour of menu buttons and table view body content. |
|  | Grey (#707070) | This colour is used for the secondary text labels such as labels in the search box and the result summary box. Its shade is lighter than the dark grey (#333434) while it holds the decent readability. |
|  | Light grey (#F7F7F7) | This colour is used for the background of the search box to indicate the distinct area and separate from adjacent sections. The shade of this colour is adjusted to keep enough contrast with text elements in the section for maximum readability. |
|  | White (#ffffff) | This colour is used for the background of the majority space in the software to deliver the clean look and feel. It is the same colour which has been used for the background of the client’s website. It is also used for the colour of the buttons in the navigation bar to make a contrast with the navigation bar background colour. |

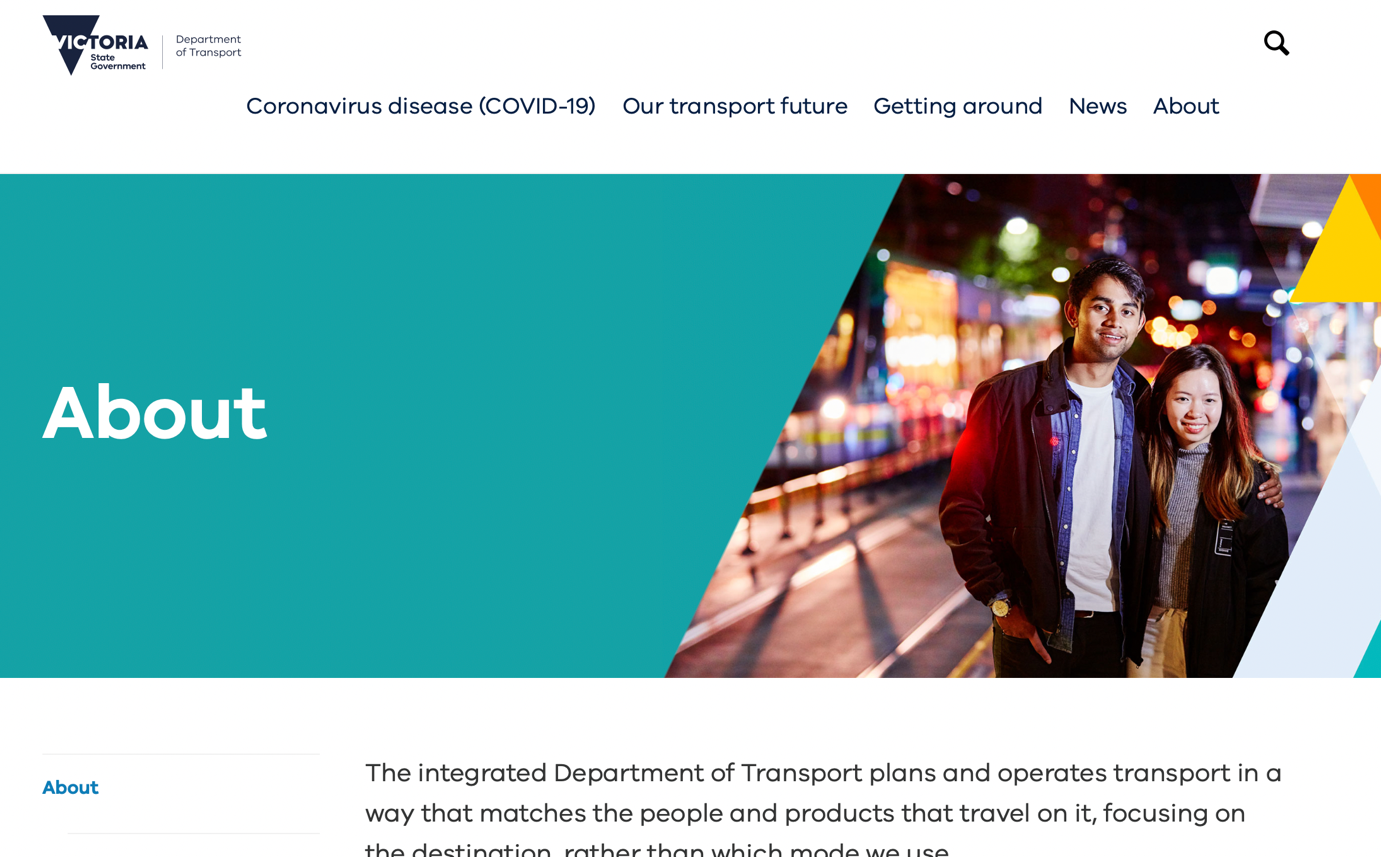


Figure 3 Department of Transport Website

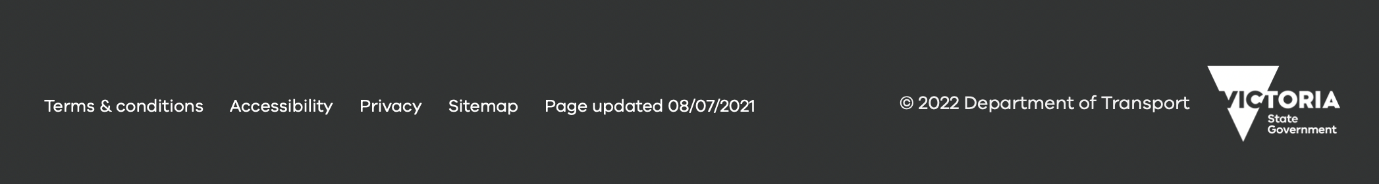


Figure 4 Department of Transport Website Footer

### Font

#### Feature Font

The VIC font will be used for headings and labels of buttons in the software. This is to adhere the design guidelines defined by the client, Victorian Government. The font files are available on vic.gov.au website (<https://www.vic.gov.au/brand-victoria-fonts>) for download to use.

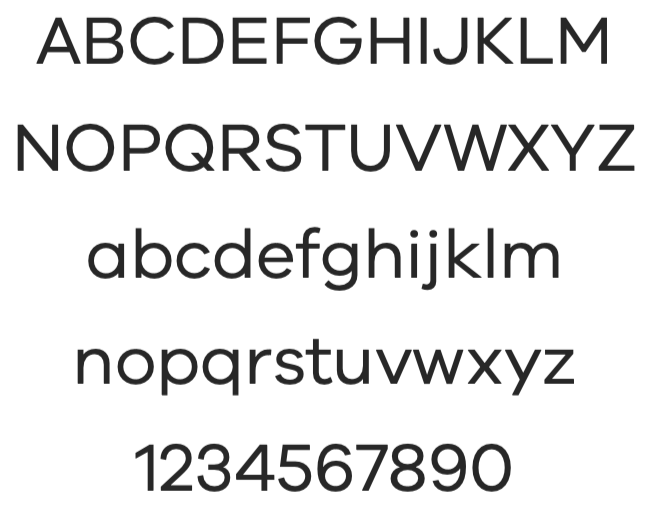


Figure 5 VIC font

#### Body font

Arial font will be used for body text elements as instructed in the font usage guide on the client’s website.

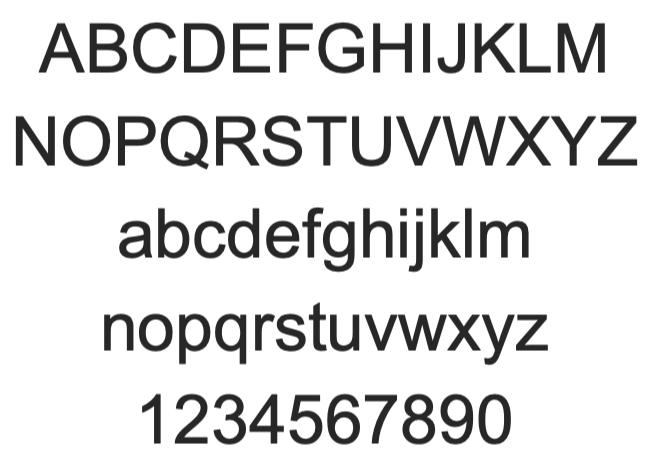
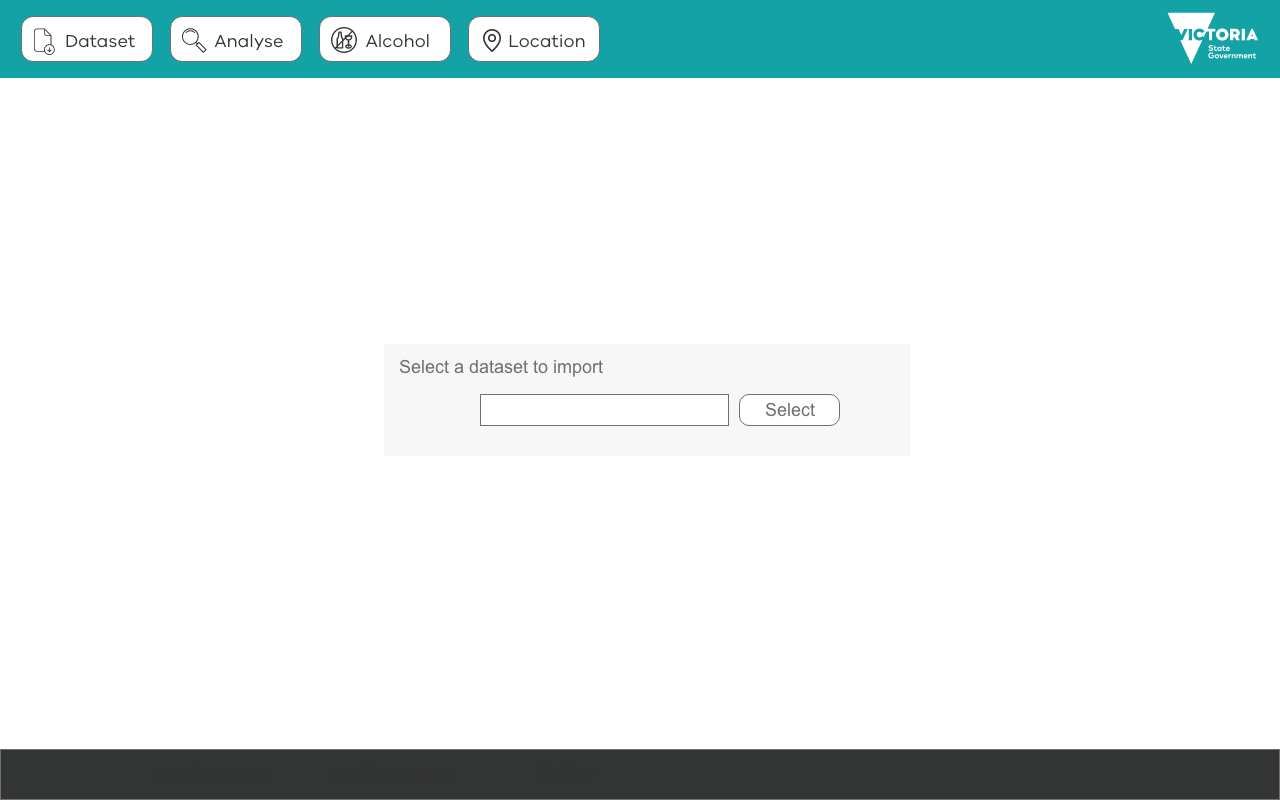


Figure 6 Arial font

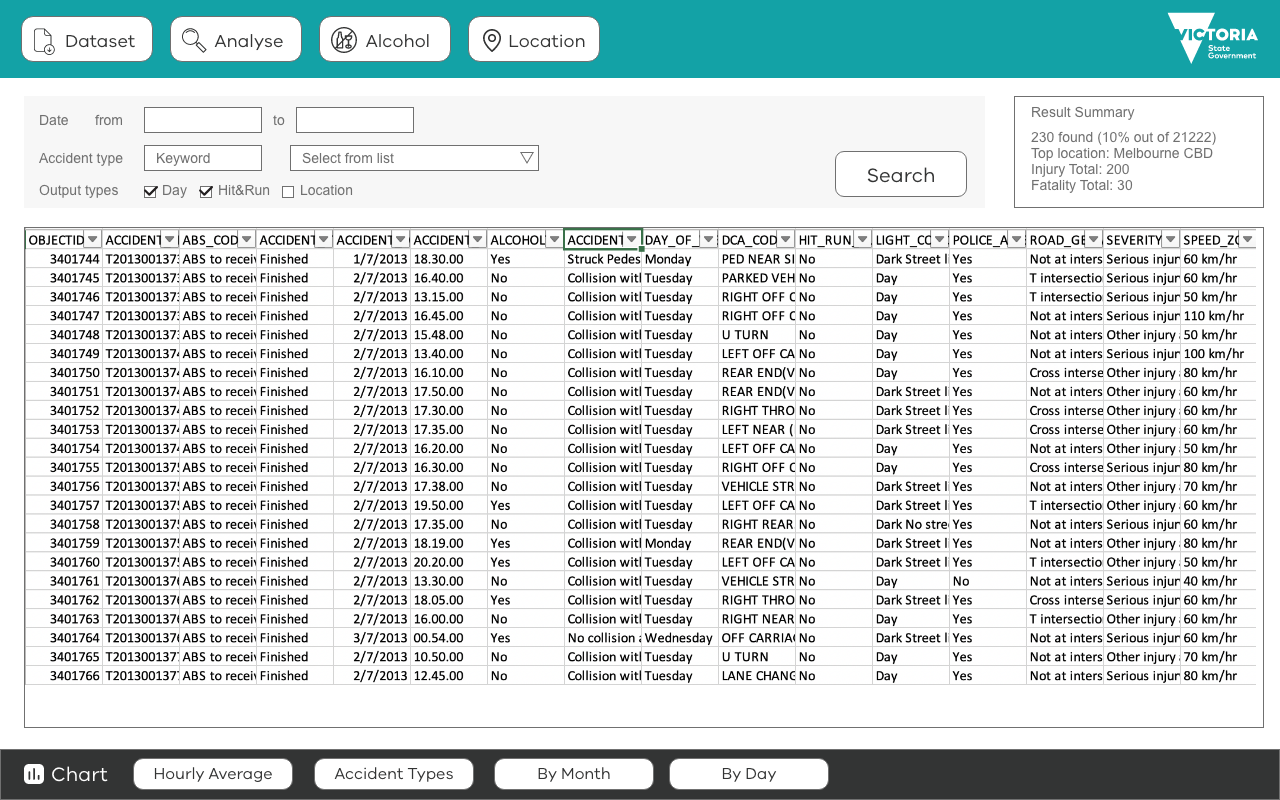
### Mock-up Screens



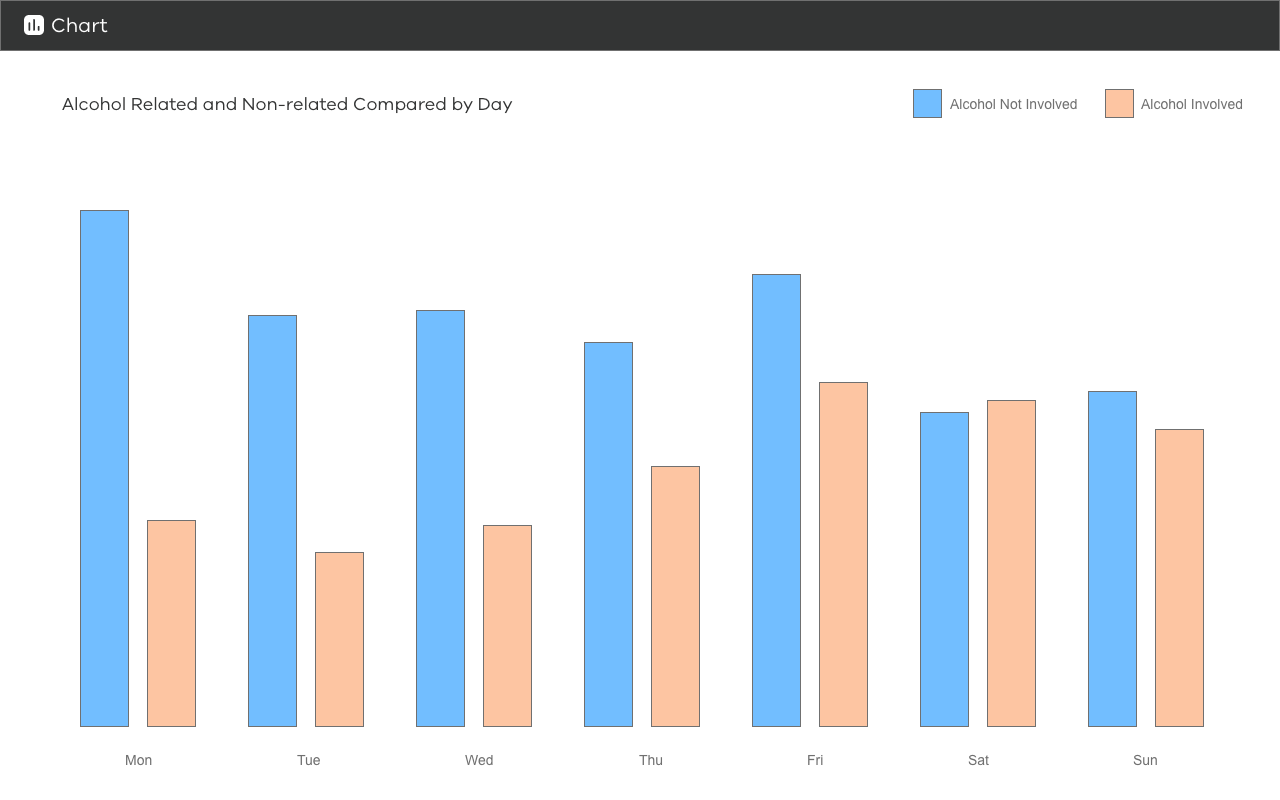
Screen 1 Dataset Selection



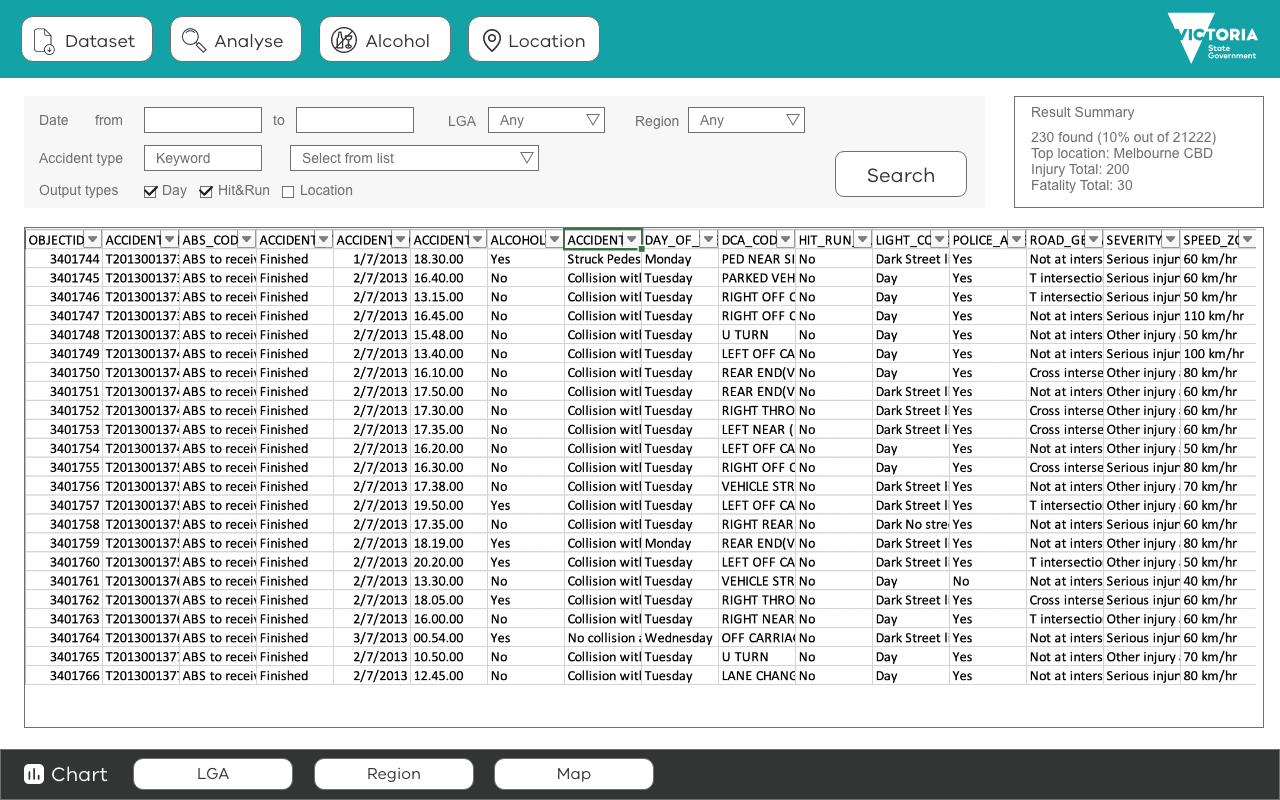
Screen 2 Analyse



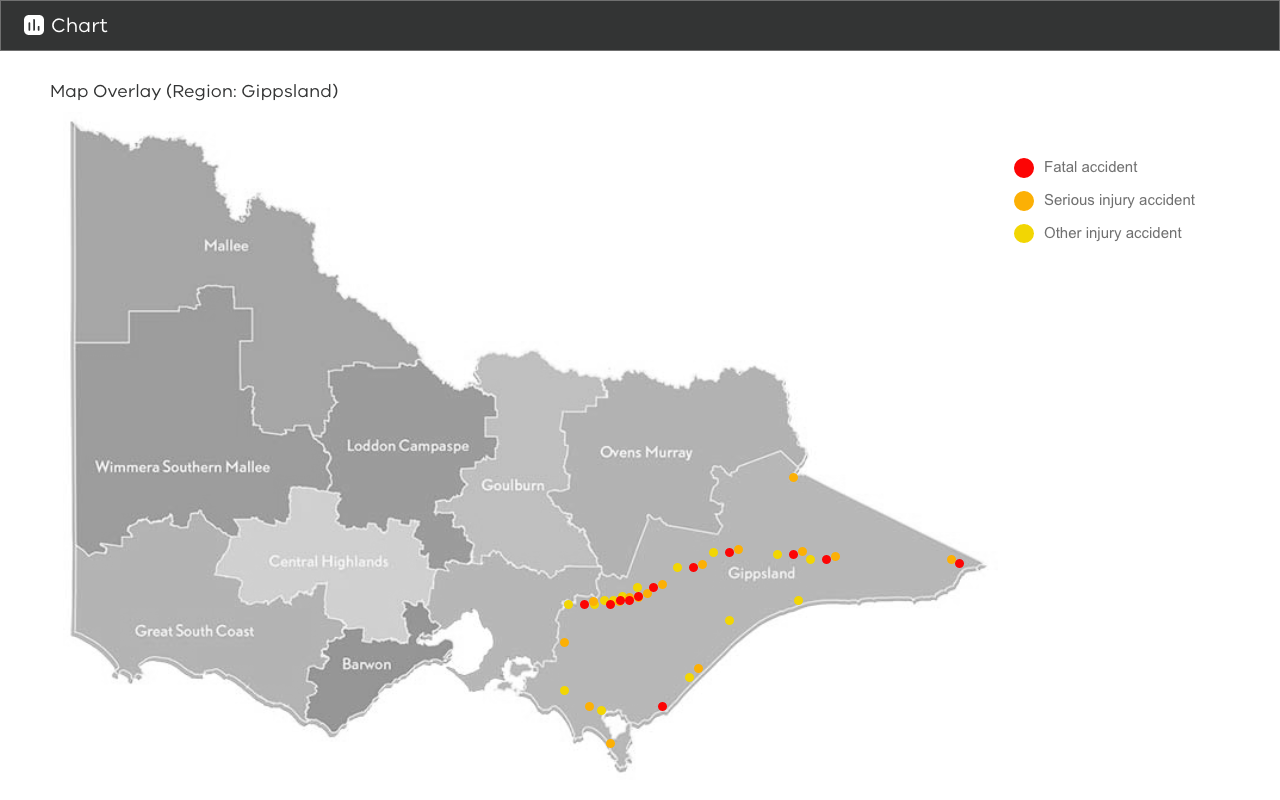
Screen 3 Alcohol Section



Screen 4 Chart Alcohol Related



Screen 5 Location



Screen 6 Chart Map