RailSmart

Technical Report

www.railsmart.patrec.org

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City of Wanneroo

PATREC

Department of Transport

Table of Contents

1   Introduction

The RailSmart Dashboard was developed as a proof-of-concept planning support system. It seeks to demonstrate that academic research can be applied, integrated and disseminated so as to better inform public decision making. This case study allows for testing future development scenarios in terms of employment creation and public transport patronage. The system uses advanced modelling, which had been developed in academia, applied it and integrated the outcomes to better inform the development around three new railway stations in the local government area of Wanneroo in the Perth metropolitan area. The City of Wanneroo specifically wished to develop the new areas in a manner in which they could maximize the use of public transport and to reach a 60% employment self-sufficiency target.

In addition, the Department of Transport wished to implement a Cost- Benefit Analysis tool based on the ATAP (Australian Transport Assessment and Planning) guidelines, which has also been included in the system.

The Dashboard was developed by a large interdisciplinary and multi-agency research team managed by PATREC (Planning and Transport Research Centre). The final product demonstrates, as a proof of concept, that the application of advanced academic research can be applied and presented in an accessible user friendly manner which can help to inform future planning. The Dashboard is flexible and expandable and can be modified to answer a broader scope of issues or geographic areas. This project received grant funding from the Australian Government under the Smart Cities and Suburbs Program.

The dashboard is a proof of concept planning support system which allows users to test alternative scenarios with three aims:

- To best meet employment self-sufficiency targets

- To forecast public transport patronage

- Provide a rapid cost benefit appraisal assessment

The proof of concept was developed for the Department of Transport and the City of Wanneroo to forecast public transport patronage and the potential job creation facilitated by the extension of the northern heavy rail line from Butler Station to Yanchep; this stretch of line includes three new stations: Alkimos, Eglington and Yanchep.

The purpose of the document is to provide a user manual for the Dashboard and an overview of the dashboard; its approach and logic. The report begins with a user manual followed by the Dashboard Overview.

2   User Manual

2.1   Sign Up

In order to access the site you need to sign up with an email address and password. The reason for the sign in is so that the site usage can be tracked to evaluate the usefulness of the dashboard. Work based email addresses are preferred as the dashboard developers can gauge the type of professionals using the site and the government/industry bodies who find it useful. The number of hits per tool is also monitored but this is not linked to users to protect user privacy. The hit count on the various tools seeks to work out the parts of the site which are the most useful to users.

2.2   Structure of the Dashboard

The dashboard consists of three main sections:

1   The Metropolitan Analysis

2   The Scenario Builder

3   The Cost Benefit Analysis

These sections are accessed via the links on the main tool bar.
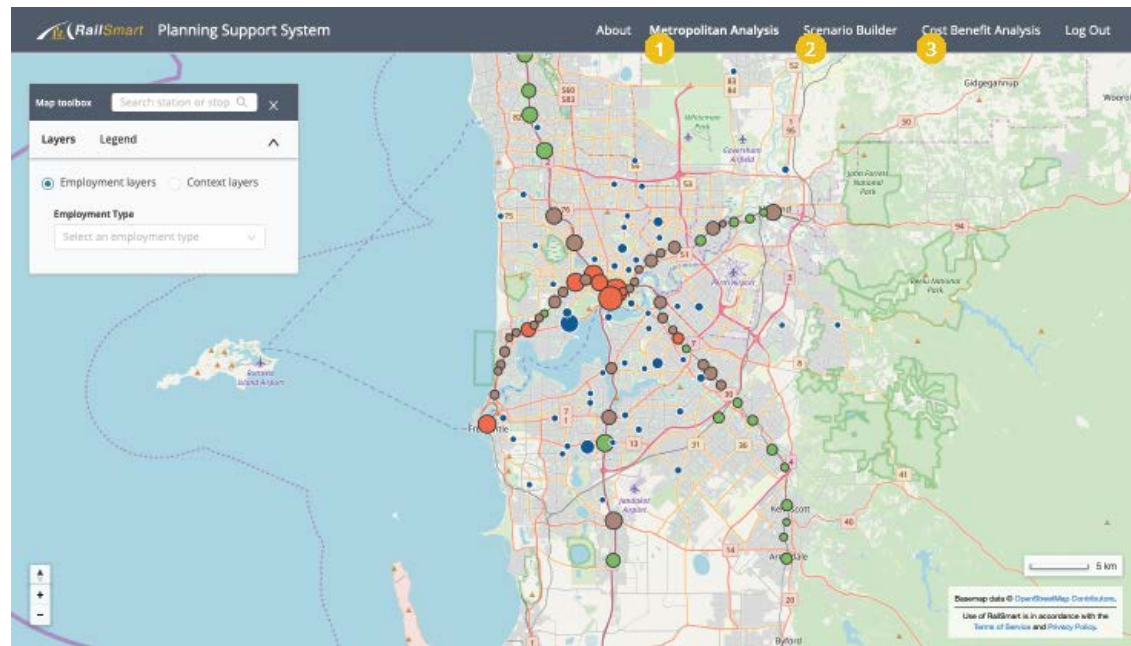
2.3   The Metropolitan Analysis

In order to forecast the design parameters and patronage numbers of stations; a detailed analysis of all the stations in the Metropolitan area is used. As a proof of concept this dashboard analysed Metropolitan Perth.

The analysis is carried out via the application of five analytical tools, and associated GIS context layers. Each of these tools is explained in the Overview section of this report.

1. All of the analysis works off of stations; thus, to open any tool select the station you are interested in.

2. The tools panels open on the right hand side. Up to three tools can be open simultaneously.

3. At the top of the tools window there is a drop down menu which allows you to select the tool you are interested in.

4. The employment tool has a number of map context layers associated with the information in the right hand tool window. The map layers are all accessed via the menu on the left hand side.

5. The maps selection box is divided into the Employment layers and

6. GIS context layers.

7. Once you select either the Employment layers or the context layers the options appear below.

8. The legend may be accessed via the link in the menu box.
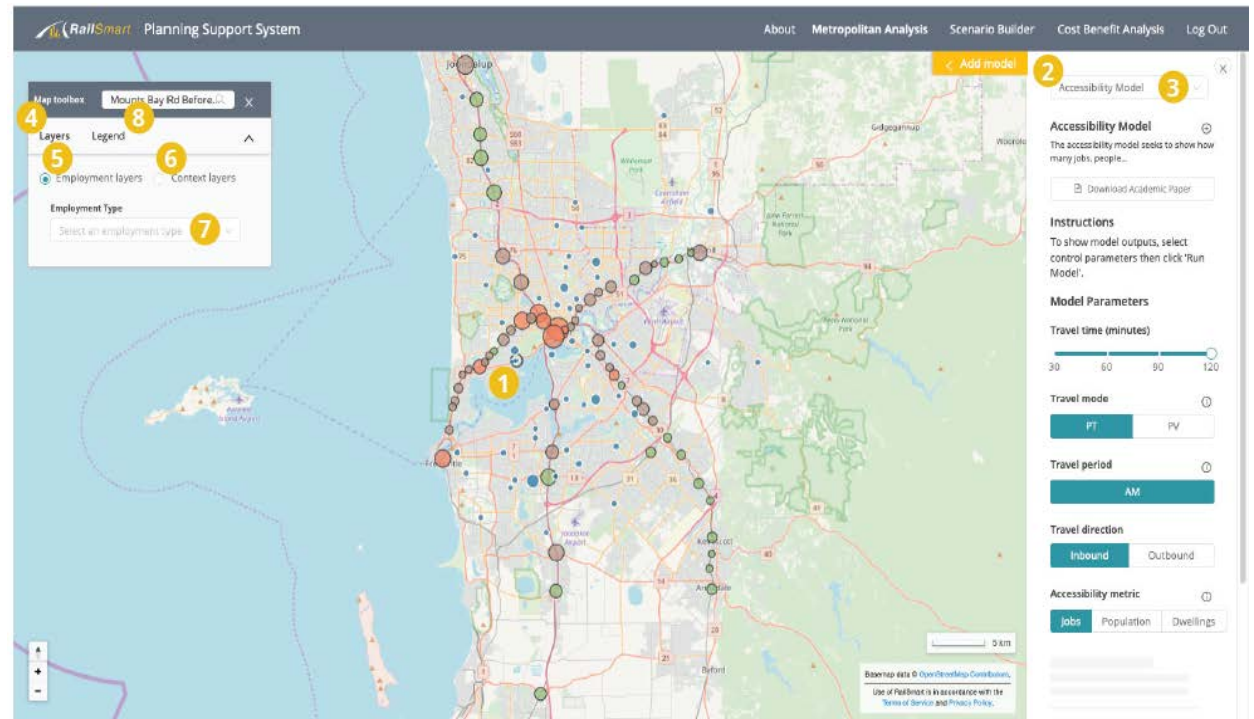
2.4   Scenario Builder

The dashboard was created in order to guide future development as such projections and predictions are necessary. The scenario builder section has purposefully been separated out from the Metropolitan analysis as it is based on forecasting; the metropolitan analysis by contrast is based on actual statistical counts (mainly from the Australian Bureau of Statistics).
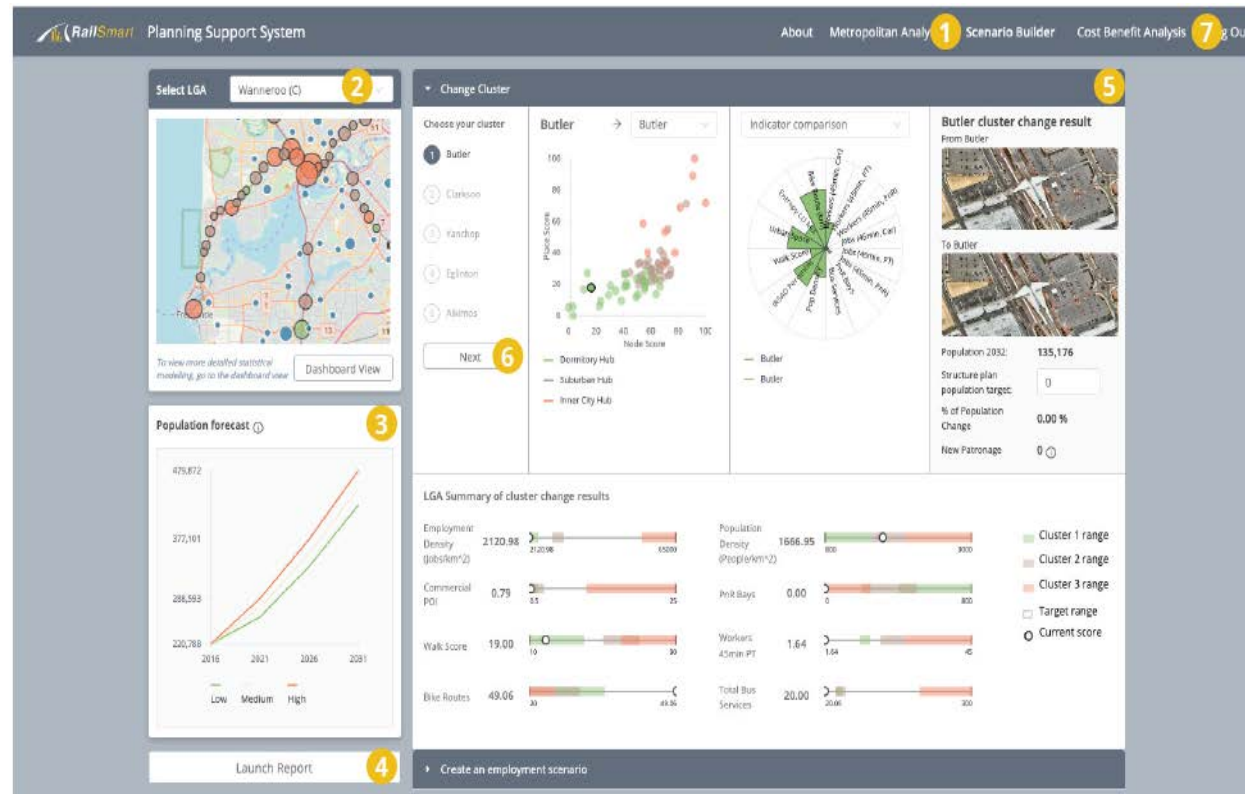
1. To access the Scenario builder select the Scenario tab on the menu bar at the top of the screen. The screen is divided into five areas:

2. The Local Authority selection tool. This proof of concept was built for the City of Wanneroo, all other LGA's are password protected as they are under development.

3. The scenarios are based on the population projections calculated by Western Australia Tomorrow.

4. Once you have run your development scenario you are able to print the results via the Launch Report button.

5. The main scenario builder pane for the calculation of station design attributes and patronage calculation,

6. The link to the second page of the scenario builder which is the employment calculator.

How to use each tool, what they do and how to interpret the results is explained in the overview section of this report.

2.5   Cost Benefit Analysis

The cost benefit analysis is accessed via the link on the top menu bar. This section begins with a cautionary statement. The tool is a rapid analysis; it does not claim to give sufficient detail for a final cost benefit analysis of any project. The two tools are aimed at allowing for the early stage scoping and selection of projects from a number of options.

There are two tools:

- Active Travel
- Your Move

These are accessed via the drop down menu at the top left of the screen. The tools are explained in the Overview Section of the report.

3   Dashboard Overview

The dashboard is a proof of concept digital analytical tool which aims to:

1. Calculate public transport patronage

2. Allow for employment creation testing

3. Allow for the early stage testing of active travel interventions to aid project scoping and selection

The project was built specifically for the City of Wanneroo and as such the proof of concept analyses Metropolitan Perth and the City of Wanneroo, which is a Local Government Area within Metropolitan Perth. The logic of the dashboard, however, could be rolled out to any area, although it may need to be adapted depending on the source data available.

The dashboard is divided into three sections:

1. Metropolitan Analysis

2. Scenario Builder

3. Cost Benefit Analysis
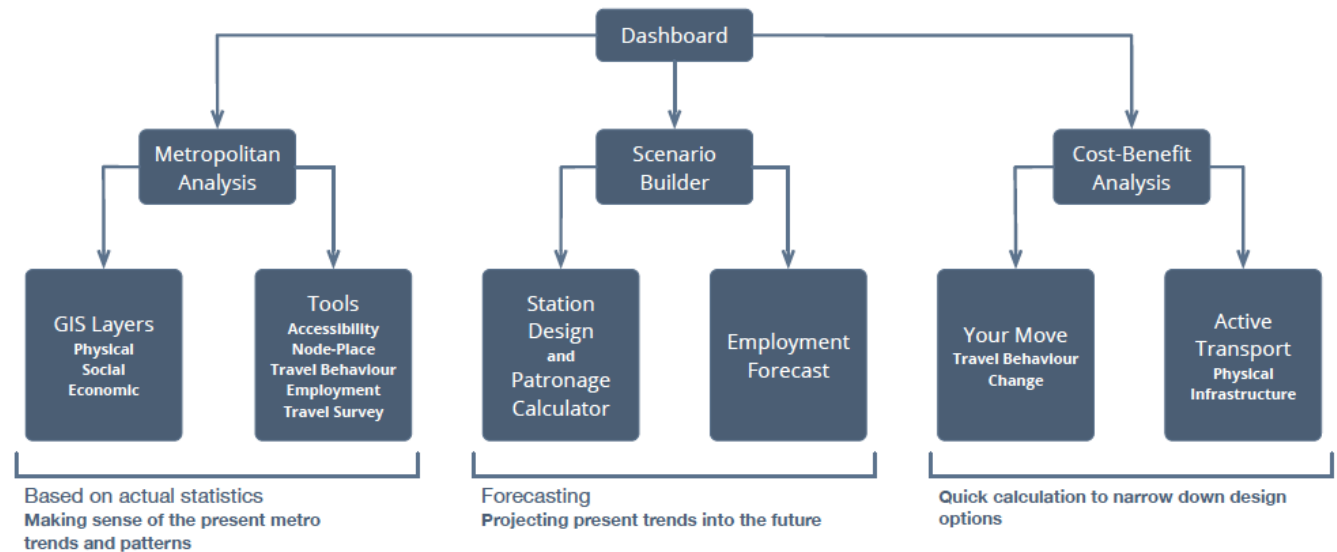
3.1   Metropolitan Analysis

The metropolitan analysis section consists of a rigorous analysis of Metropolitan Perth through the application of five tools, described below, and a series of GIS analytical layers which spatially represent social, demographic, economic and physical information.

The Metropolitan analysis was completed in order to list the design parameters and calculate patronage numbers of all existing stations in the Perth Metropolitan area. The results of this analysis are presented as a web based dashboard. The Metropolitan analysis feeds and informs the Scenario builder.
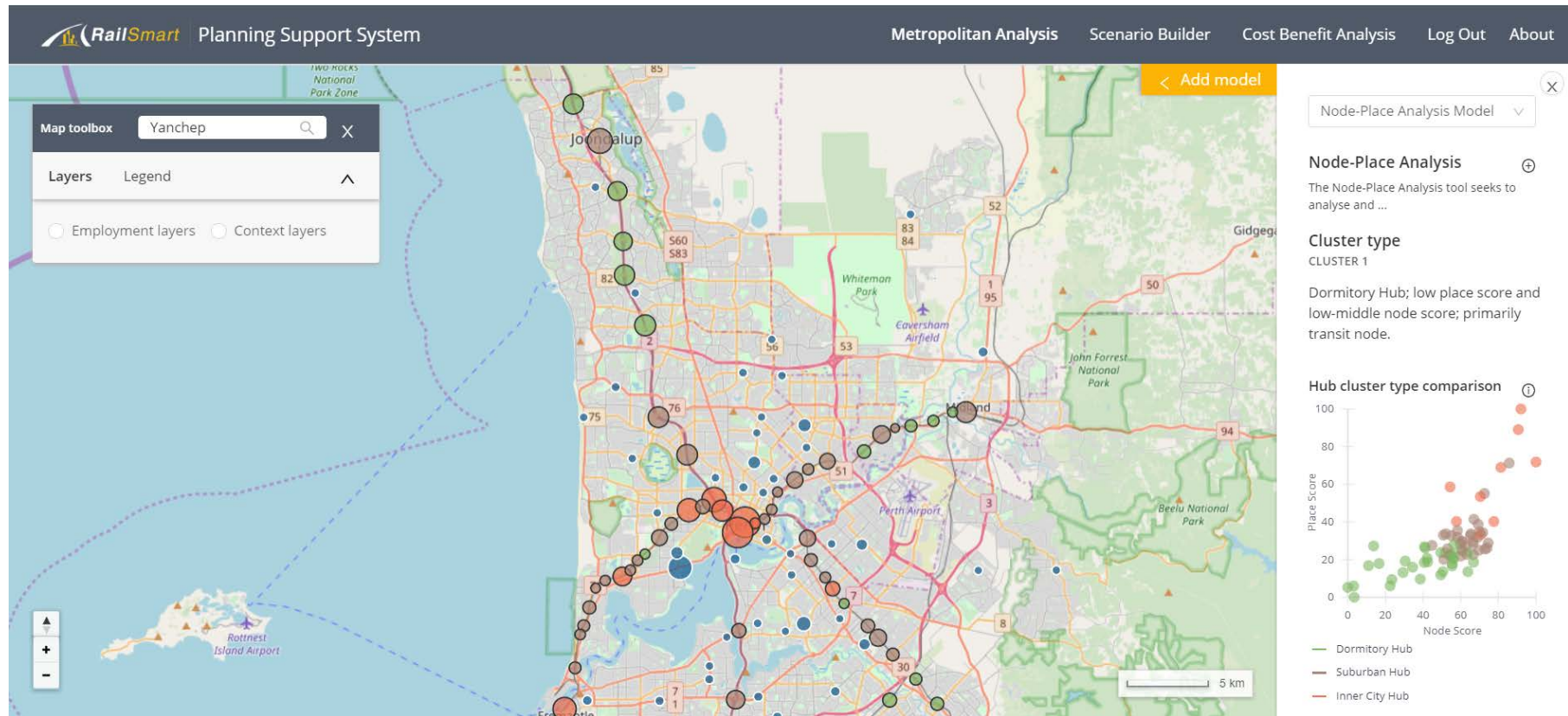
3.1.1 The tools

Tool 1 Activity centre node-place analysis and activation tool

The core of the project is built around the analysis of Metropolitan Perth's existing stations. Tool 1 gives a detailed analysis of the train station precincts with respect to their *Place*, *Node*, and *Background Traffic* characteristics. A full academic explanation of the research, the list of authors of the work and all of the components of the analysis is available in the PATREC Technical Paper: "Addressing Future Uncertainties of Perth at 3.5 Million: 'What-If' Scenarios for Mass Transit "

Place is defined as the area immediately surrounding the station. The place analysis looks at the quality and vibrancy of the built environment around a station. Node is defined as the station area - the through put of passengers, alighting's and boarding's. Background Traffic refers to the accessibility to the station via both public and private transport, aside from the railway line itself, so feeder busses, taxis, etc.

Thus the Node/Place/Background traffic analysis is assessing the station in terms of its functionality as a station moving people through the system (node), the function as a place where people meet and great, shop, work etc. (the place function) and how accessible the station is to other major land uses (what can you reach within a given time from the station?) these are weighted and ranked so that all stations can be compared and contrasted based on standardized measurements.

The tool works via a two-stage analytical process:

Cluster analysis (categorising the stations into groups with similar Place, Node, and Background Traffic characteristics); profiling the clusters and classifying the train station precincts (allocating them to the most likely cluster based on their similarities and dissimilarities with the other station locations).

Regression analysis ('producing equations' to predict station boardings/patronage based on key station and catchment
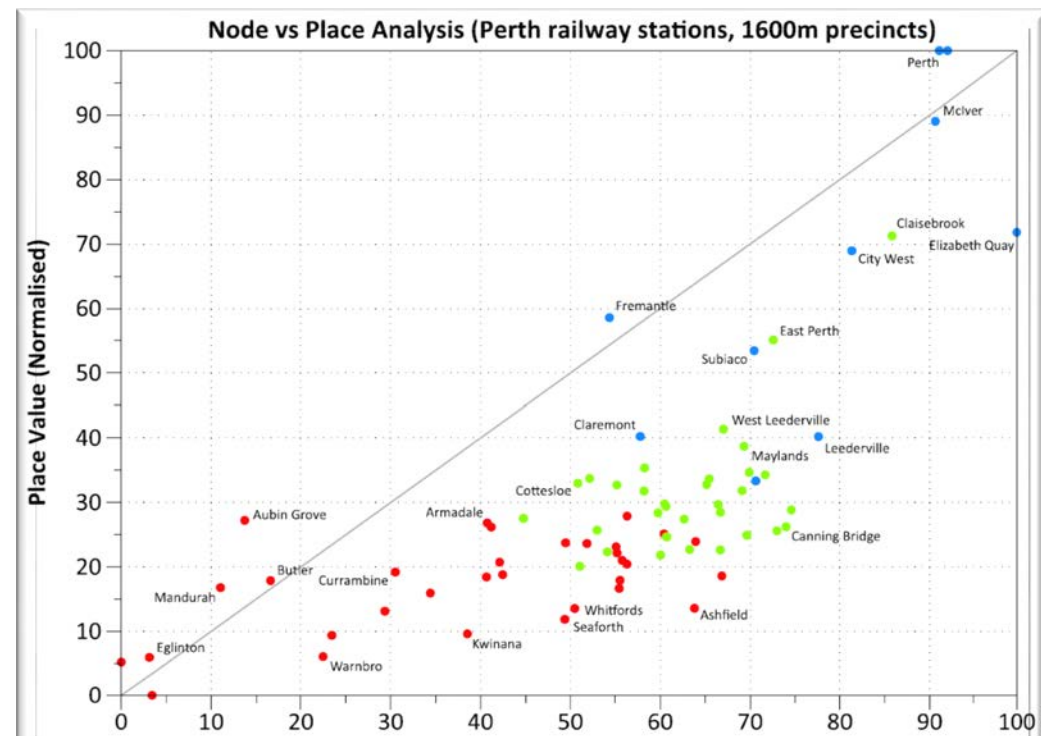
A plot of all of the Greater Perth stations; it indicates that very few stations in Perth have a high place value. Perth is in essence a mono-centric city with the CBD (the two data points –Perth and Perth underground- on the 100 Place line) by far the most diverse.

characteristics). The analysis identifies patterns which are common to various station types and thus, you can assume if you are planning a station which is similar to one of the existing stations then it will share similar Place, Node, and Background Traffic, which in turn become predictors (explanatory elements) of the patronage and mode choice.

Note this model is only available for hubs that contain a train station. The Node-place analysis model applies regression analysis to group each hub into one of 3 categories (dortimary hub, suburban hub or inner city hub) by calculating both a 'node' (function as a transport node) and 'place' (function as a destination place) score.

Users can use this model pane to understand the current primary function and performance of the hub in the metropolitan context. The model pane contains three main components:

Cluster type

CLUSTER 2

Suburban Hub; middle place score and middle node score; balance of Hub usages.

The **Cluster Type** component explains the hub cluster type for the selected hub and uses a scatter plot to show where the selected hub is positioned compared to all other hubs in the metropolitan area. The hub cluster type is shown using colour on the chart.

Hub cluster type comparison

- Dormitory Hub
- Suburban Hub
- Inner City Hub
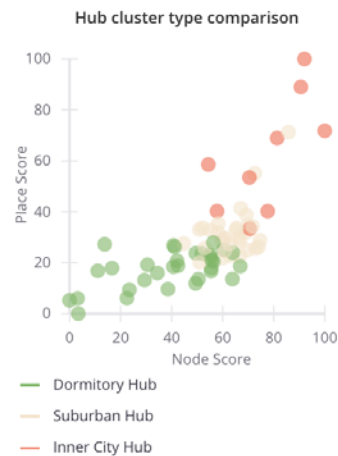
Key Indicators

Place score	Node score
24.94	69.64

The Key Indicators component shows the node and place scores for the selected hub (out of 100) and shows, using a radar chart, the score for the elements that have contributed to the node and place scores.

Key node and place key indicator for hub

— Place indicators — Node indicators
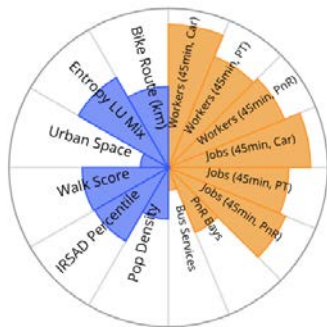
Landuse diversity index

Landuse breakdown for hub
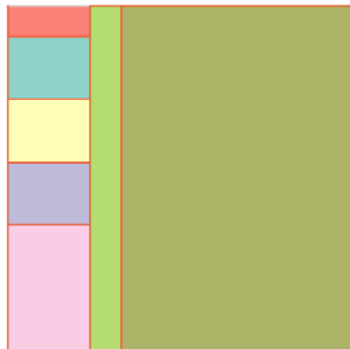
The Landuse Diversity Index component uses a tree map to show the proportion of land within the 1600m station precinct in each land use zone. Landuse entropy is a key measure of the place score.

Tool 2 Railway Usage Analysis and Travel Behaviour

The second tool is an evidence based, data-driven tool centred on the analysis of SmartRider data. It works off of the automatic ticketing system of the railway and bus system and can tell when passengers tag onto or off of a bus or train. Tool 1 looks at transportation from the point of view of the built form, tool 2 does the opposite it analyses the way people move through the system. The two tools together give a very powerful understanding of public transport, land use and the manner in which they interact.

When the Smart Rider data was analysed it became evident that there were patterns which were easy to explain in the time patterns between when a passenger tags off and back onto the system. Patterns such as a 9am – 3pm (school), 9am – 5pm (work), 5pm to 8am (home); this is extremely useful as it tells us about the land uses around the station and the relative public transportation usage. The full academic explanation of the tool as well as a listing of the authors of the work is available in the PATREC Technical Paper: "Travel Behaviour Patterns – Micro Analysis "

The Railway Usage/Travel Behaviour model is based on analysis of SmartRider data. The Railway Usage/Travel Behaviour model pane includes the following elements:

Hub type

HUB

Dormitory

Stay activities

Number of stays per stay type

Stay type	Count
Work	2940
School	81
Sleep	15734
Short	2002
Medium	794
Transfer	1118
Arrive only	22610
Depart only	23921

Hub Type

Each hub is assigned a primary type based on the main purpose of activities at the hub.

Stay Activities

The stay activities are presented in a bar chart showing volume of stay by type.

Stay activities comparison

Number of stays for all stays
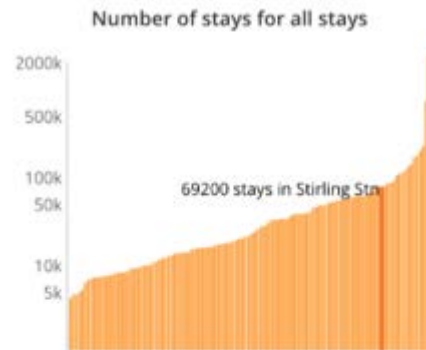
Stay Activities Comparison

Total volume of stays for each hub are shown in a ranked bar chart with the selected hub highlighted. A logarithmic scale is used to enable significant variances in data (from CBD stations) to be shown on the same chart.

Hub catchments

Travel catchment to hub

NOTE: data is a month from Aug 2017
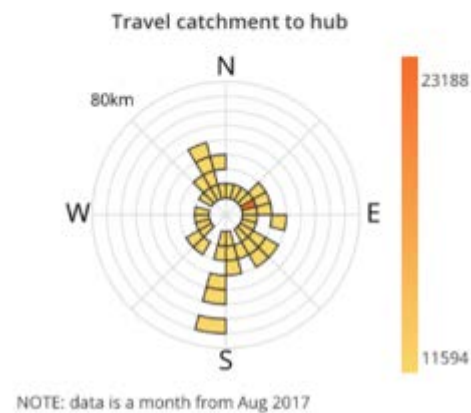
Hub Catchments

Catchments are shown for origins of all stays in a radial bar chart, with direction, distance and intensity (count) of stays shown from the selected hub.

Key Findings

- The analysis of the Smart Rider data gave a number of interesting insights into both the functioning of the public transport system but also the movement of people around Perth.
- When you study the stay patters of stops on the system it becomes evident that there are clusters of stops (mainly bus stops) serving the same land use. The data thus identifies 'hubs', that is, groups of associated bus stops serving one function.
- The hubs clearly show which land uses attract people to the public transport system; most notably universities, hospitals and private high schools.
- Most of these uses attract people travelling on concession tickets such as school children and university students, busy hubs are thus, not necessarily income generating hubs for the public transport system
- The public transport system clearly has a social welfare value as it meets a need for those who cannot use private transport either due to the cost of ownership and parking (university students) or are too young to drive. The hospitals also show an increased usage.

Tool 3 Enhanced Employment Self Sufficiency Tool

Maximising employment potential is one of the main aims of this project, the City of Wanneroo has a target of creating a 100,000 new jobs over 20 years. Where does a Local Government start when calculating employment and attempting to create new jobs? This analysis is an extension of work which has previously been completed by PATREC See Kirsten Martinus & Sharon Biermann (2018) Strategic Planning for Employment Self-Containment in Metropolitan Sub-Regions, Urban Policy and Research, 36:1, 35-47 for details and full list of authors.

Not all employment creation happens in the same manner; there are a number of jobs across the skills levels which naturally occur once the population grows and creates the demand for services. Jobs such as doctors, teachers, shop assistants, etc. naturally form once the population demand exists. Other jobs are created due to a competitive advantage and are more strategic in nature, for example gold mining occurs where gold is discovered or the computer industry evolves where there is a concentration of high level computer skills.

Tool 3 begins by categorizing all of the Australian Bureau of Statistics occupation categories into strategic employment or population following employment by SA2, the dashboard then works out the proportions for the Local Government Area. A Local Government Area's Strategic advantage(s) is calculated by means of Location Quotients using Perth, Western Australia and Australia as analytical bases. National multiplier effects of each employment category are applied to calculate the knock on effect of strategic job creation. These two key data sets work with a clearly reported stratification of the ABS occupations data into Strategic and Population driven employment sets. The strength of this tool is that it allows Local Government Areas to focus their employment creation by removing the jobs which will simply occur (population following) and focusing instead on the key strategic jobs based on the areas competitive advantage. A local Government thus, focuses on providing land, services and infrastructure to support key industries which can best create the employment required.
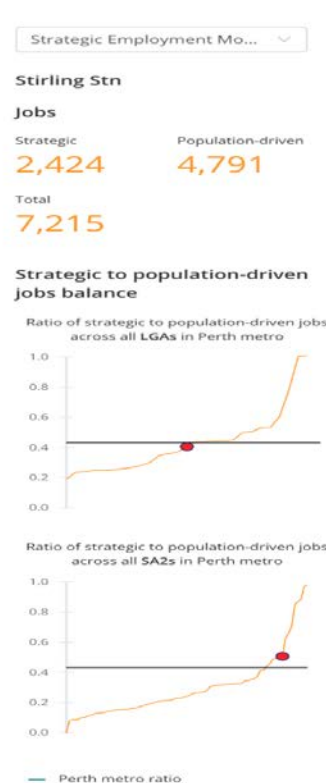
The Strategic Employment Model highlights the number and ratios of strategic-driven or population-driven jobs relevant to the selected hub. Strategic jobs are those determined through location quotients to be locally strategic in the context of the metropolitan, state or national context.

2 line charts show the ratio of strategic to population-driven jobs compared to both the selected hub's LGA and SA2. The Perth Metropolitan average is shown as a baseline on each chart.

Users can use this model pane to understand how strategic the LGA or SA2 is a potential employment centre in the metropolitan context

Key Findings

- Approximately 75% of the Wanneroo employment target will naturally occur as the population grows
- Wanneroo has a competitive advantage in Agriculture, forestry and Fishing; construction and Manufacturing; which is unsurprising given that the local government area is on the peri-urban fringe. It does raise a few cautionary issues however, should development spread into the agricultural areas jobs are likely to go down and jobs in the construction sector are fleeting as once the new areas are developed these jobs will fall away.
- The employment tool is useful at the Local Government scale but it is important to bear in mind that Wanneroo is part of a bigger economic system; the multiplier effect specifically must be used with caution as spin off jobs could very well be international jobs, this would be the case more so in the IT sectors than in something which is location dependant such as agriculture, tourism or construction..

Tool 4 Dynamic Accessibility Planning Tool

Accessibility as it relates to urban and transport planning, measures the ease with which individuals are able to access their most important activities. More detail on the logic behind the tool as well as a list of the authors is available in the Australasian Transport Research Forum 2017 Proceedings " A flexible accessibility analysis tool for enhanced urban analytics"

The tool calculates accessibility from any of the stations to the centre point of all STEM zones (derived from the Department of Transport's Strategic Transport Evaluation Model) to be able to map what is accessible via either public or private transport. In this case accessibility to 'what?' is important, the tool measures accessibility to jobs, houses and population.

The model pane for the Accessibility model includes the following elements within the pane, with the travel time catchments (upon model run) shown on the context map and in the model pane. The model is run on demand by the platform.

Model Parameters

Travel time (minutes)

30   60   90   120

Travel Mode ⓘ

PT	PV

Travel Period ⓘ

AM

Travel direction ⓘ

Inbound	Outbound

Accessibility Metric

Jobs	Population	Dwellings

Accessiblity Comparison

404,686 Jobs accessible within 60 minutes travelling inbound.
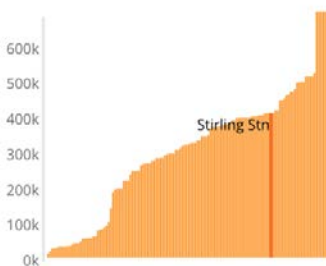
Accessibility Score

36% of Jobs in Perth Metro Accessible

Model input parameters

Travel time (15/30/45/60 minutes)

Travel mode (public transport/private vehicle)

Travel period (currently AM only)

Travel direction (inbound/outbound)

Accessibility metric (jobs/population/dwellings)

Accessibility scoring

Upon model run the accessibility for the selected input parameters is analysed and the results shown in a bar chart. The chart is sorted by overall count of the metric showing the relative position of the selected hub (highlighted in red) compared to all other hubs. The total count of the metric for the selected hub is shown, and the % of the total of that metric is shown at the bottom of the element (e.g. the image left shows that from Stirling station within 60 minutes traveling inbound, a total of 404,686 jobs are accessible which represents 36% of total jobs in the Perth metropolitan area)
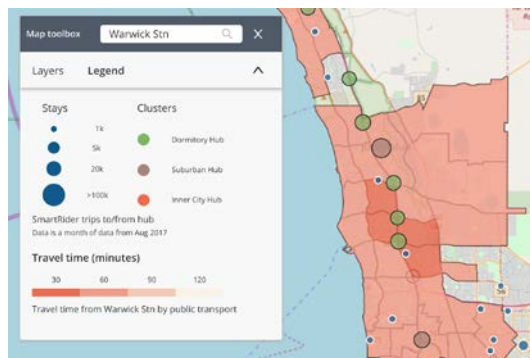
Travel time catchments

Upon running the model the travel time catchments are show on the map for all time permutations (30/60/90/120 minutes) at the SA2 level for the input parameters selected by the user. The catchment legend can be seen in the Map Toolbox Legend

Key Findings

- Perth is a two hour city that is it takes two hours from the outer edges to the CBD via public transport.
- Accessibility varies across the city with some definite marginal areas

Tool 5 Last Mile Tool

This tool is based on a survey to identify households and citizens with a propensity to adopt sharing economy transport options. This is part of a wider "last mile" transport problem that is the problem of connecting suburban areas to the stations. The tool offers insights into the factors that determine a person's propensity to use and adopt sharing economy transport options, including commercial ride sharing (Uber), community car polling, bike sharing, and car sharing.

Gender Demographics
Percentage who identified as gender.

Female	36.89%
Male	59.02%

Age Demographics
Percentage who identified as age.

65-74	7.38%
55-64	15.57%
45-54	16.39%
35-44	23.77%
25-34	15.57%
18-24	6.56%
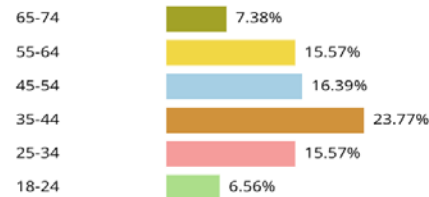
Education Demographics
Percentage by highest education type.

P/Grad	18.03%
Univ	22.95%
TAFE	36.07%
Grad HS	18.03%
Some HS	1.64%
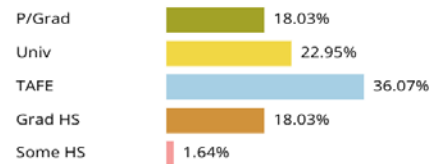
A survey was undertaken to identify the views of Wanneroo residents regarding different transport modes. Including shared transport modes there were approximately 120 full responses to the survey. Majority of these are around the Yanchep Rail Extension precinct.

The Travel Survey Model presents results of a targeted travel survey undertaken by PATREC in 2018. The survey results are shown as bar charts for each of the survey questions which include:

Gender demographics

Age demographics

Education demographics

Employment demographics

Traditional mode use

Sharing mode use

Shared mode segment

Negative train utilisation

Key Findings

- A third of respondents had used ride sharing with 55% of respondents feeling positive about it.
- Other shared modes were used by a smaller amount of respondents, however the sentiment was high (35% to 50% positive).
- Few respondents identified negative issues driving them away from utilising the train (such as distance, safety, parking, cost or timetabling).
- While approximately 95% of respondents had used a car in the last year, 75% had used a train and 41% had used a bus.
- Application Opportunities
- The survey clearly shows the willingness of people in Perth to use ride sharing options.

3.2   The Scenario Builder

The scenario builder section of the site is fundamentally different from the Metropolitan Analysis and has thus deliberately been kept separate to avoid any confusion. Whereas the Metropolitan Analysis is based on actual data and real trends the Scenario builder is future orientated and based on projections; stated another way, the Metropolitan analysis is factual and historic (in the sense that it is only as new as the latest census) whereas the scenario builder is anticipating and forecasting the future. The value of the scenario builder lies in broad trends. The actual numbers are indicative numbers based on modelling.

The system allows for the testing of different development options so that you can compare and contrast different strategies in order to achieve optimal outcomes. The scenario builder directly answers the brief of how to work out optimal employment numbers and how to maximize public transport patronage. In this proof of concept the tool uses the case study of the Local Government Area of Wanneroo, which falls within the northern boundary of Metropolitan Perth. A new railway line with three new stations is being developed in the LGA and the local authority would like to use the opportunity to create employment hubs and thereby also maximise public transport patronage. The scenario builder uses the population projections from Western Australia Tomorrow to provide a target population.

The Scenario builder works by asking what you would like the new stations to look like. The existing approved structure plans for the area state that they would like Yanchep to be like Joondalup; Eglinton to be like Butler and Alkimos to be like Warwick. Given that all of these stations have been analysed in the Metropolitan analysis the attribute data, together with population thresholds and patronage numbers can be fed through into the Scenario builder. This in turn gives you all of the design elements required to make this happen as well as numbers off of which employment can be modelled. What the system allows you to do is to select any station to compare the new stations to as you need to ascertain if the structure plan is optimising development. The bottom line tells you the % population increase required in the 1.6 km station catchments, above that stated in the structure plan required to achieve the desired outcome. In the case of the three new stations in Wanneroo, even if you model the same station aspirations as the Structure plan it is evident that higher population densities are required around the station than listed in the structure plans.
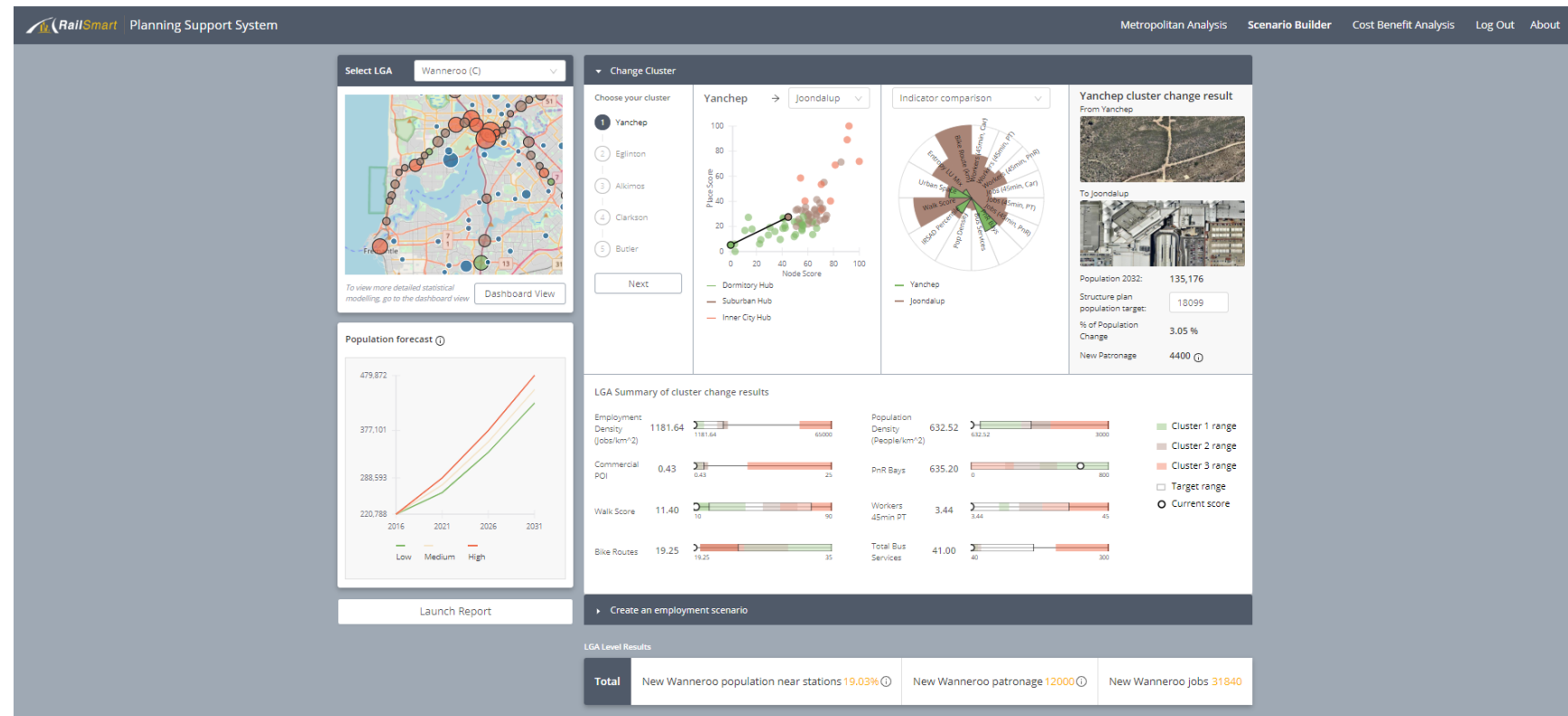
The second task pane of the tool breaks down the employment, firstly the population is converted into required jobs numbers by working out the working age population, subtracting the existing jobs and applying the jobs/housing balance the Local Authority seeks to achieve. The total number of additional jobs required is then split into strategic and population serving jobs based on the existing ratio for the Local Government Areas as of the last census. The breakdown is calculated based on Occupations data.

The right hand side of the task pane lists the top location quotients for the Local Government area in descending order along with their multipliers. Employment multipliers are worked out nationally, and are based on industry so these sectors are slightly different from the occupations used to work out strategic and population serving jobs. The key problem with employment multipliers is that you don't know where the additional jobs are created, they could be off shore, or in the case study of Wanneroo many jobs may have a knock on effect for the Perth metropolitan area but not necessarily be based on Wanneroo. The more location dependant sectors such as construction, agriculture and mining are most likely to have the full multiplier effect in the same location.

The value of this system lies in clarifying where a Local Government should focus its effort. The City of Wanneroo has a target of creating 100 000 new jobs; this is a daunting target, however, as illustrated in the screen shot below 87 000 will naturally occur as the population grows to service their needs, Planners already know how to plan for these jobs as local planning already supplies area for hospitals, schools, clinics, libraries, shopping centres, etc. where these jobs occur. What the local government needs to focus on are the 30 000 strategic jobs; yet if you take into account the multiplier effect what you really need to attract to the area are 5 400 core new jobs; an altogether more manageable feat especially given the system tells you where your areas strengths lie.

The system can also be used in another way, if for example a TAFE collage is planning to locate a new campus in Wanneroo you can input the staff numbers and workout the knock on employment effect for the area.

Select LGA   Wanneroo (C)

▶ Change Cluster

▼ Create an employment scenario

Calculation of number of jobs needed to service population growth

Modelling strategic employment creation for Wanneroo (C) ⓘ

✓ Sector Selection ——— ② Add Jobs
Pick sectors with the highest impact for strategic job creation ⓘ

Population 2032   355964

Add Jobs
Employment multiplier effect

Working age population as a % of total   67.12 %

↻ Reset scenario

Existing jobs   41367

Sector	Current	Multiplier	New
Agriculture, Forestry and Fishing	856	2.951	− 956 +
Construction	6937	2.144	− 9037 +
Manufacturing	4078	2.032	− 4278 +
Other Services	2236	6.916	− 2236 +
Education and Training	5145	7.992	− 5145 +
Retail Trade	5539	8.544	− 5539 +
Accommodation and Food Services	3046	8.879	− 6046 +

Jobs-housing balance (LGA employment self-sufficiency target)   60 %

Additional employment required   118534

Employment created in services for population   87947

Additional strategic employment creation for LGA   30587

Back

Increase in employment   5400

Total additional employment including multiplier effect   31841

Back to Clusters

Population forecast ⓘ

479,872
377,101
288,593
220,788

2016   2021   2026   2031

Low   Medium   High

To view more detailed statistical modelling, go to the dashboard view   Dashboard View

Launch Report

LGA Level Results

| Total | New Wanneroo population near stations 19.03% ⓘ | New Wanneroo patronage 12000 ⓘ | New Wanneroo jobs 31840 |

The power of the system lies in allowing you to test alternatives. Each time you try something new you have the option of launching a report to keep track of the alternative solutions.
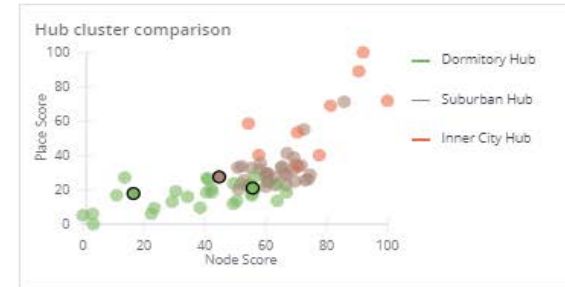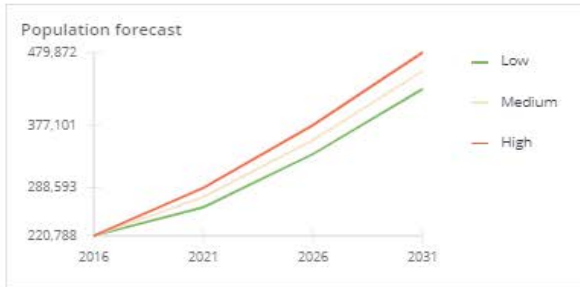
Scenario builder summary: Wanneroo

Population forecast

479,872	Low
377,101	Medium
288,593	High
220,788	

2016 2021 2026 2031

Hub cluster comparison

Dormitory Hub
Suburban Hub
Inner City Hub
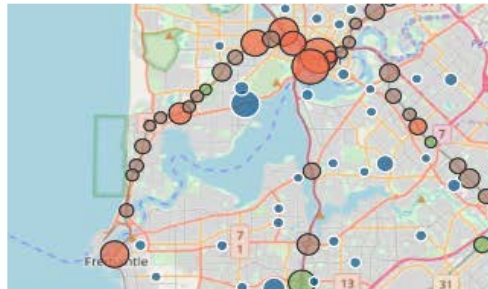
Change cluster	New population	New patronage	Cluster change result
Yanchep → Joondalup	3.05k	4,400k	
Eglinton → Butler	8.21k	2,300k	
Alkimos → Warwick	7.77k	5,300k	

Employment scenario

Sector	Current	Multiplier	New
Agriculture, Forestry and Fishing	856	2.951	956
Construction	6937	2.144	9037
Manufacturing	4078	2.032	4278
Accommodation and Food Services	3046	8.879	6046

Increase in employment — 5400
Total additional employment including multiplier effect — 31841

LGA Level Results

Total	New Wanneroo population near stations	19.03% ⓘ	New Wanneroo patronage	12000 ⓘ	New Wanneroo jobs	31840

Example of printable report

3.3   The Cost Benefit Analysis

The Cost Benefit Analysis quantifies anticipated economic benefits of a travel behaviour change project. Travel behaviour change projects encourage people to change the way they travel through education, providing information and marketing-based approaches. Active travel is any form of travel which requires physical exertion by the traveller for example cycling or walking. Public transport is also encouraged as it requires more activity by the traveller who has to walk to stations, up and down stairs, etc. Active travel and public transportation use is encouraged in order to reduce the car use, lower pollution and to improve general health and fitness levels in the society. The motivation of the travel behaviour change project is to encourage people to choose a more active way to travel and to reduce their car use. This results in reduced congestion, reduced road accident risks and improved health benefits. The tool quantifies these economic impacts using rapid cost-benefit analysis for the purpose of comparing various options of the project. The rapid analysis provides the project proponent sufficient information to decide whether to proceed with more detailed analys. Evaluating a project with respect to its economic impacts ensures that the impacts to the community are accounted for in the decision making of public investments.

Two tools emanate from this philosophy firstly:

Your Move

The 'Your Move' Program is a community-based behaviour change program that is operated by the Western Australian Department of Transport. The Your Move Program supports schools, workplaces and individual participants to reduce their car use by shifting to other modes of transport, such as public transport and active travel, including cycling and walking. By shifting to the modes other than driving, the individuals would benefit from increasing their physical activities, spending more time with friends and family, and saving money. This programme runs via the media and intervention programs which seek to change attitudes and thus behaviour. An example would be running and advertising campaign "why not take the train instead of the car"

Active Travel Infrastructure Initiatives

The active travel tool looks at the impact of providing physical infrastructure to aid active travel, for example providing a dedicated cycle lane. The assessment approach adopted in the analysis is suitable for the initiatives that are self-standing new infrastructure or self-standing infrastructure enhancement. The initiatives that are part of other transport upgrades, such as train station upgrade, are beyond the scope.

The potential range of benefits and costs of active travel is broader than individual health, and include other private and social benefits and costs, such as infrastructure provision and maintenance costs, personal equipment costs and increased crash risk. All of these factor into the model in a broad assessment which calculates the benefits based on the cost inputs provided.

4   Platform architecture

The RailSmart PSS is composed of three components:

- Source data - input source data
- Backend (API) platform - dynamic modelling analysis
- Frontend application - the web application that most users engage with
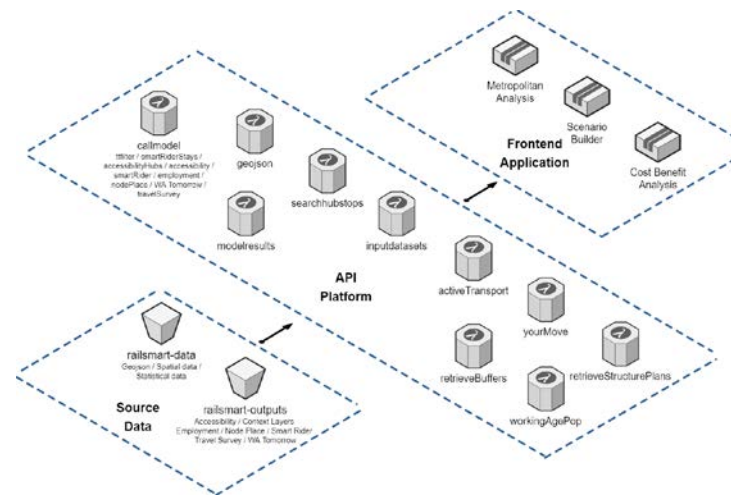
4.1   Source Data

The data is stored in two main AWS S3 buckets named 'railsmart-data' and 'railsmart-outputs', which are explained in detail below. The source data is accessed through the RailSmart Application Programming Interface (API) which is built using Swagger, an open source API framework:
https://swagger.io/

Railsmart-data

Stores primarily raw data from various sources such as the ABS, PATREC and DoP. This data is intended as a modelling 'source of truth', where the latest data is placed when it is updated, such as when a new Census occurs and can be used by any researchers who need access to these types of data.The data is stored in the following structure;

Geojson

- LGA_2016_WA.geojson (LGAs)
- Geo.json (SA2s)
- Perth_sa1.json (SA1s)
- Context_layers

Spatial Data

- ABS
- COW
- LANDGATE
- OSM
- PATREC
- PTA
- STEM

Statistical Data

- ABS
- DOT
- DPLH
- PATREC
- PTA
- Stats

Railsmart-outputs

Has processed output data from the academic models developed by PATREC and is used primarily for visualisation and analysis in the RailSmart dashboard. The data is organised into the following folders;

- AccessibilityModel
- ContextLayers
- Employment
- NodePlace
- RachelModel
- TravelSurvey
- WATomrrow

4.2   Backend (API) architecture

Technology

The back end of of the RailSmart platform is built using the JavaScript programming language utilising the Node.js platform and is running on an AWS Elastic Beanstalk instance using Node.js version 8.11, at the time of writing this document (April 2019). The Application Programming Interface (API) is built using Swagger, an open source API framework: https://swagger.io/ .

The Accessibility model is running on Python 3 on an AWS Elastic Beanstalk instance and using Flask as a web server.

Deployment

We currently use a combination of a Jenkinsfile and Terraform script to deploy the infrastructure on AWS and deploy the code to it.

In the infrastructure folder there is api.tf which describes the infrastructure used to run the API, this sets up the elasticbeanstalk instance running nodejs.

Main.tf currently hosts the local variable setup for deploying, as well as some Arup specific deployment information (Tags used by our IT group).

The jenkinsfile currently is setup to deploy either a production or test environment and does this based on git branches, the master branch will deploy to production and the test branch to test.

1. Check branch and set workspace and version label, endpoint url
2. Run npm install for the downloaded branch
3. Use the Makefile to run both make clean and make build which will generate a deployable build
4. Using the branch , run the terraform script with the necessary version label, endpoint and AWS keys which will create/update the AWS infrastructure
5. Make upload runs to zip up the build and upload it to s3 and then update the elasticbeanstalk environment with this latest build.
6. Make plan and make apply are run to plan and apply the terraform build process

Deployment - Accessibility Model

The Accessibility model follows the same deployment process as above, with the only difference being it runs ElasticBeanstalk with Python and Flask instead of NodeJS.

The repository containing the deployment files and code is available on request.

4.3   API Structure

The API has multiple URL endpoints for accessing different types of data.

/callmodel

https://api.railsmart.arup.digital/api-docs/#/root/callmodel

Used to retrieve the results of the multiple academic models in a structured JSON (Javascript object notation) format, this data is then displayed in the form of tables, graphs and plots in the dashboard.

Options available are:

ttFilter

Travel time information

```
{

    results_param: 'accessResults',

    model: 'ttFilter',

    req_params: {

      zoneID,

      direction,

      time,

      travel_mode,
```

```
        period,

      },

    }
```

smartRiderStays

Smartrider stays and activities (where people are travelling and why)

```
    {

      results_param: 'accessResults',

      model: 'smartRiderStays',

      req_params: {

        format: 'json',

      },

    }
```

accessibilityHubs

Accessibility in terms of jobs, population and dwellings from a given hub

```
    {

      results_param: 'accessResults',

      model: 'accessibilityHubs',

      req_params: {
```

```
                zoneID,

                direction,

                time,

                metric,

                travel_mode,

                period,

            },

        }
```

accessibility

Accessibility in terms of jobs, population and dwellings overall

```
        {

            results_param: 'accessResults',

            model: 'accessibility',

            req_params: {

                zone_identifier: "SA2_MAIN16",

                zoneID,

                direction,

                time,

                metric,
```

```
        travel_mode,

        period,

    },

}
```

smartRider

Grouping of stay activities to each hub

```
{

    results_param: 'accessResults',

    model: 'smartRider',

    req_params: {

      format: 'json',

    },

}
```

employment

Employment ratios (population following vs strategic), location quotients (how the LGA or SA2 compares to Australia) and multipliers (how many jobs are created by this job)

```
    {
```

```
    results_param: 'accessResults',

    model: 'employment',

    req_params: {

      format: 'json',

    },

  }

LGA Level

  {

    results_param: 'accessResults',

    model: 'employment',

    lga: true,

    req_params: {

      format: 'json',

    },

  }
```

nodePlace

Node place information in the form of hubs (train stations) and their associated cluster inputs and outputs

```
    {
```

```
        results_param: 'accessResults',

        model: 'nodePlace',

        clusters: true, // This returns only the 3 cluster results.

        req_params: {

          format: 'json',

        },

    }
```

waTomorrow

WA tomorrow population forecasts by year and LGA

```
    {

        results_param: 'accessResults',

        model: 'waTomorrow',

        req_params: {

          format: 'json',

        }

    }
```

travelSurvey

Travel survey results in a cleaned format

```
{

        results_param: 'accessResults',

        model: 'travelSurvey',

        req_params: {

            format: 'json',

        },    }
```

Example request body (filtered travel time data inbound for AM peak)

```
{

  "results_param": "accessResults",

  "model": "ttFilter",

  "req_params": {

    "zone_identifier": "SA2_MAIN16",

    "zoneID": 503011034,

    "travel_direction": "inbound",

    "time": 15,

    "time_threshold": 15,

    "metric": "Dwellings",

    "travel_mode": "pt",

    "format": "json",
```

```
    "hubID": 0,

    "period": "am",

    "clusters": true

  },

  "lga": true

}
```

/geojson

Returns geojson files stored in the railsmart-data bucket under the geojson 'folder'

/modelresults/{modelID}

Lists model results that are available in the railsmart-outputs within the given modelID folder, this will return a json list of available items including their location/naming.

modelIDs are

- AccessibilityModel
- ContextLayers
- Employment
- NodePlace
- TravelSurvey
- WATomorrow
- RachelModel

/modelresults

Returns a requested model result from railsmart-outputs, based on a given key in the POST request

Example request body

```
{

  "modelKey": "StaysModel",

  "resultKey": "Hubs.csv",

  "format": "json"

}
```

/searchhubstops

Returns a list of hubs that match the given search term, can also include stop data if the 'withstops' flag is true. Matching the search term includes it being found in Rachel's Hub names or IDs or in the NodePlace_Station field.

Example request body

```
{

  "search": "perth",

  "withstops": true

}
```

/activeTransport

Request Active Transport results by sending a request in the format below.

Example request body

```
{

  {

  "lga": "Wanneroo (C)",

  "scenario": "Low",

  "override": true,

  "population": "10000",

  "CAPEX": "3500000",

  "OPEX": "1000",

  "interventionType": "New off-road AT path - inner city location",

  "safetyImprovement": "Complete separation of cyclists and pedestrians from the traffic implemented",

  "sizeOfImpactedPop": "1000",

  "travelTimeImprovementsForPedestrians": "20",

  "travelTimeImprovementsForCyclists": "10",

  "lengthOfProposedInitiative": "2",

  "startYear": "2019",
```

```
    "openingYear": "2020"

  }

}
```

Parameter Options

- lga - ["Low","Medium","High"]
- interventionType - ["New off-road AT path - inner city location","New off-road AT path - outer suburban or rural location","On-road cycle lane","Improved signals and channelisation for cyclists and pedestrians","End-of-trip facilities"]
- safetyImprovement - ["Complete separation of cyclists and pedestrians from the traffic implemented", "Other types of safety measures implemented", "No safety improvement"]

/yourmove

Request Your Move results by sending analysis period, reduction rate, CAPEX, OPEX, number of households and average PT fare

Example request body

```
{

  "AppraisalPeriod": "10",

  "ReductionRate": "25",

  "CAPEX": "3640000",

  "OPEX": "10000",

  "ParticipatingHousehold": "10000",
```

```
    "AveragePublicTransportFare": "6.6"

}
```

/retrieveBuffers

Returns the station buffers areas for 800 metres and 1600 metres in square kms

Example request body

```
{

  "stations": [

    "Yanchep",

    "Joondalup"

  ]

}
```

/retrieveStructurePlans

Returns the forecast populations and dwelling numbers for each of the three new stations in the Wanneroo LGA.

/workingAgePop

Returns working age population as a percentage grouped by LGA

Example request body

```
{

  "req_params": {

    "format": "json"

  }

}
```

Folder Structure

Infrastructure - holds the terraform files responsible for setting up our AWS infrastructure

Processing - holds scripts used to preprocess data included in the models

Routes - this folder contains the code that drives the major API endpoints

Model_routes.js - is the file where each endpoint is described as well as the accepted request types (GET/POST)

We import the small modules that perform each task into model_routes and assign them to a specific endpoint.

.env - When running this locally you need to create a .env file containing your AWS credentials

Technology

The frontend of the RailSmart application is built using React. The application was bootstrapped with Create React App.

Emotion is the main styling library. It is used for writing css styles with JavaScript. Emotion-theming is used to provide consistency across the application.

Ant-design is the main UI library.

Mapbox.gl is the mapping library. An access token is not required as free Openstreetmap tiles are being used.

The application uses redux. Each major feature has its own slice of state, list of actions and action types. Thunks are used within actions to perform async queries to the api. Selectors hold all the business logic.

Deployment

Terraform files in the 'infrastructure' folder details the specific resources required to deploy to AWS. The core information can be found under 'resources' in the 'main.tf'. These include an S3 bucket and a Cloudfront distribution.

The main Jenkinsfile and Makefile are used to step through the deployment process

1. The branch is checked and this determines the workspace, master branch with a tag is production, master or staging with no tag is staging and test branch is test.
2. "make setup" runs and cleans the directory of node_modules or package locking files, then runs an npm install to install the necessary modules
3. "make build" is run which creates a static build of the frontend code in the build folder

4. The terraform script is run with the workspace id which will change/create infrastructure as detailed in the main.tf file (s3 bucket, cloudfront)
5. "make deploy BUCKET=…" is run and copies the contents of the build folder to the s3 bucket
6. The site is now deployed, depending on the workspace from step one the url will be x or x-staging or x-test

Folder Structure

Below is a list of the folders/files found in the repository and a description of their function:

Infrastructure - holds the terraform files responsible for setting up the AWS infrastructure

Public - holds assets outside of the module system, such as images

.env.local - holds environment variable for the API url

Src

- Actions - list of actions named according to the feature it applies to
- Assets - images and custom icons
- Common - reusable components that are styled with emotion
- Components - main react component list
- Config - legend items, colors and other configurations that are reused across the application
- Constants - redux action types, list of context layers and global color theme
- Containers - components which have been connected to the store.
- Data - core dataset that is used to relate smart rider, node place, SA2 and LGA datasets
- Hoc - higher order components
- Queries - list of queries used to query the api, named according to the feature it applies to
- Reducers - slices of state according to feature it applies to
- Selectors - list of selectors
- Store - generates the redux store
- Stories - storybooks have been set up in the repo, use this location to test UI components

- Utils - reusable utility functions
- Index.js - entry point for the app. The global styles are set here

4.4   Model implementation

API Platform

The model's main functions are contained in a single JavaScript (.js) file in the routes folder, the whole API is run using node-express and therefore each model must accept a request and provide a response object.

The request object is what the API receives when the endpoint is called using a GET or POST request (other HTTP request types exist, but are not used for this project), for a POST request to the API the request will have a body which is the JSON passed in the body of the request made to the API.

You can use this to pass data from the frontend (if you are calling the API from there) to perform calculations on it

When you have finished whatever calculations or data retrievals you need to do you need to use the response object to send it back.

```
(request,response) => {

        const {body: {params}} = request;

        // DO SOME WORK ON params

        response.set('Content-Type', 'application/json');

        response.send(results);

}
```

Look at employment.js for an example of reading excel files from amazon s3 and then returning the results of some data manipulation as a JSON response.

1. Create a new files in routes called yourModel.js
2. Add an entry in model_routes.js
   a. `const yourModel = require('./yourModel');`
   b. `app.get('/yourModel', yourModel);` or
   c. `app.post('/yourModel', yourModel);`
3. As described above create a function that accepts a request and response object and export it from yourModel.js
4. Make sure your function runs fast enough to not timeout, if it doesn't you will need to use something called a Promise or async / await

Frontend

To create and add a new model to the Metropolitan Analysis view perform the following steps;

1. Create your new model component
   a. Add a new folder in the components directory named according to the new feature.
   b. Wrap this component in the ModelPanel higher order component found in the hoc directory. Use the Behaviour component as an example.
2. Set up the redux pattern
   a. Create a new set of action types in the actionTypes file found in the constants directory.
   b. Create a new slice of state in the reducers directory. Make sure it's imported into the index.js.
   c. Add a query file in the queries directory
   d. Create a new action file with all the actions you require, including the thunk to retrieve any model data via the query you just created.
   e. Create the container and connect it to the actions and reducer state.
   f. Create any selectors you require to transform data or run any business logic.

3. Add to ModelContainer
    a. Import your new model into the ModelContainer component.
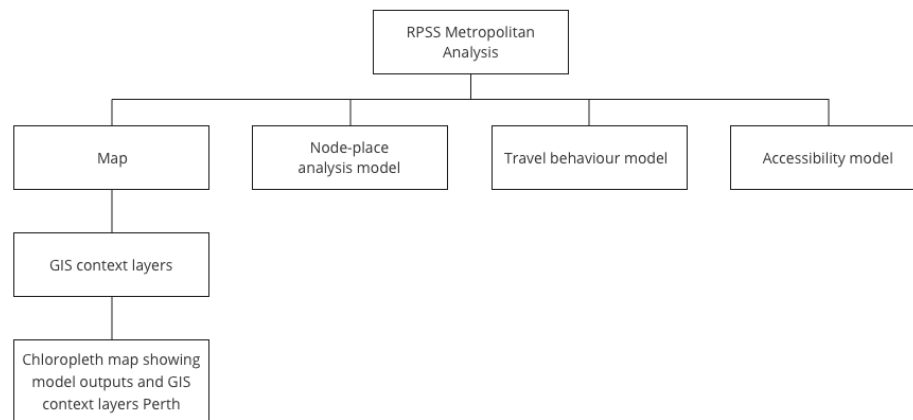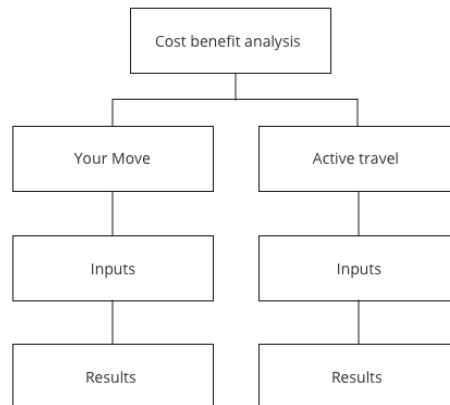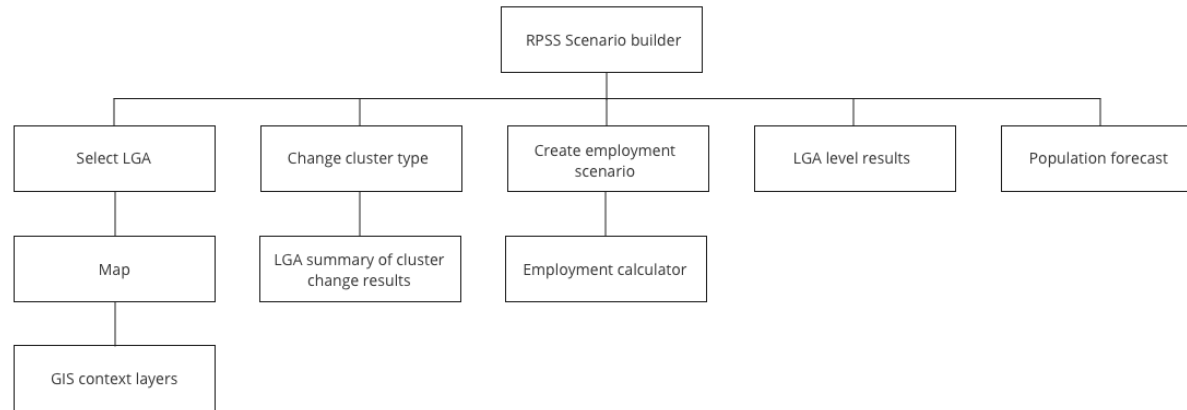   b. Add it to the modelLookup object with corresponding name.
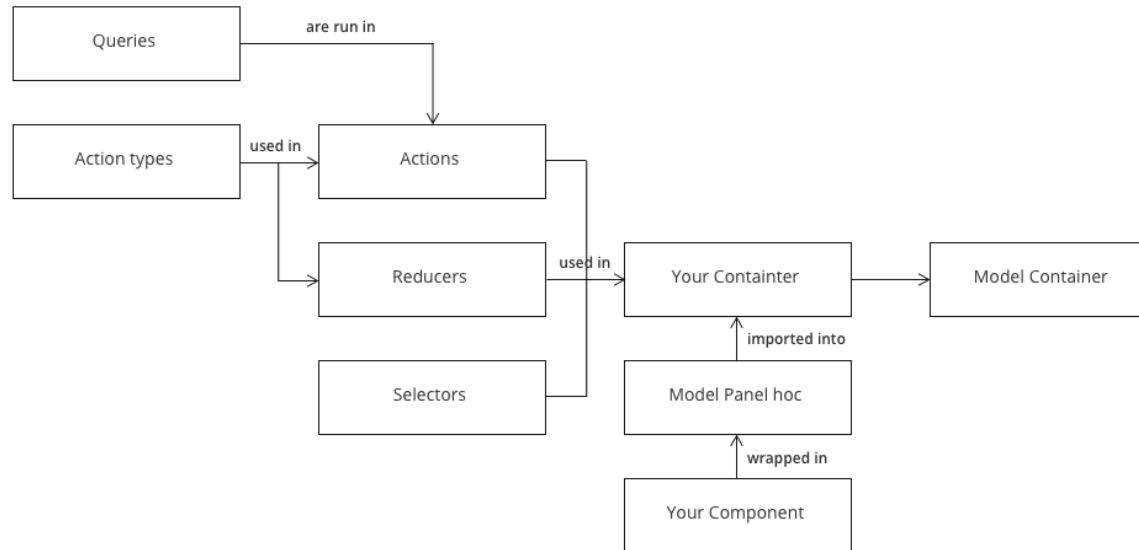
Design approach

The RailSmart PSS is split across 3 pages:

- Metropolitan Analysis
- Scenario builder
- Cost Benefit Analysis

The information architecture for each for each of these pages is detailed below.

5   Conclusion

The RailSmart Dashboard was developed as a proof of concept interactive dashboard which sought to use existing data to better test options for maximising the creation of employment in Wanneroo and the use of public transport. The dashboard allows a user to run through multiple scenarios to test the optimal solutions. The Dashboard also provides a sound Metropolitan analysis of the Greater Perth rail system.

The project has been presented to a wide range of audiences in the planning and transportation field and has been received with enthusiasm. Most interesting is that it obviously inspires reflection; as every presentation has seen suggestions for further analysis and additions to the system. The research team have identified a number of new projects which will grow the system in the future. The system is thus, not only a successful proof of concept but is on track to grow and expand. A number of presentations to the wider field of government and professionals have been programmed.

The dashboard is the combined effort of a huge team of researchers and a number of discrete pieces of academic research. Strategic Planning management theories have informed the application of all of this research to the Perth Metropolitan area and to integrate the results into a system which provides more than the sum of its parts.

The value of the system lies in the strength of the analytical tools which inform the system, the visual interface which allows for the display of multiple layers of data in a user friendly and easy to understand manner and the strategic integration of discrete data sets. The data used behind the system is mostly public information yet it has taken considerable effort, design and thought to extract pertinent information and to model and display this in a user friendly informative manner.

5   Acknowledgements

Research Team

Main Project Team (a number of the models have been produced by research teams; only the lead contact people are listed below, the full list of researchers appears on the detailed reports for each tool):

Name	Designation and Organization	Email	Role in Project
Dr Linda Robson	Research Fellow - PATREC and Lecturer- University of Western Australia	linda.robson@uwa.edu.au	Strategic planning, platform design and integration of project components and project management
Professor Sharon Biermann	Director PATREC	sharon.biermann@uwa.edu.au	Project tender and Employment Analytics
Tristan Reed	Research Associate - PATREC, and PhD Student -Curtin University	tristan.reed@curtin.edu.au	GIS, programming and IT support
Associate Professor Rachel Cardell-Oliver	Head of Department of Computer Science and Software Engineering, University of Western Australia	rachel.cardell-oliver@uwa.edu.au	Lead researcher - Travel Behaviour Modell
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Dr Kirsten Martinus	Senior Research Fellow, University of Western Australia	kirsten.martinus@uwa.edu.au	Lead Researcher – Employment
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