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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 GIS context layers.

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

7. 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 LGAs 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.

Transport Orientated Development (TOD) is a policy concept that has spread around the world with the objective to generate/create compact, mixed-use developments that facilitate walking, cycling and use of public transport (PT) through their urban design (Cervero, 2002; Curtis et al., 2009). Consequently, they are seen as a pathway to environmental sustainability by conserving resources and energy, using urban land better, reducing vehicle-km travelled and shifting the balance towards more environmentally-friendly transport modes (Nahlik and Chester, 2014; Attard and Shiftan, 2015; Appleyard et al., 2019; Caset et al., 2019). Despite clear aspirations and unceasing interventions over the past few decades, the success of TOD in Australia has been patchy (Curtis, 2008; Kamruzzaman et al., 2013). Two main reasons are affecting this: (1) transport and land-use have distinct rhythms of evolution; and (2) integration of train stations within the surroundings requires substantial land assembly, urban development and planning expertise.

Measuring TOD performance has mainly focused on increased patronage and active travel (AT), while reducing car use. In terms of characterising TODs, a frequently applied framework draws on the Node-Place (N-P) model proposed by Bertolini (1999) and enriched since through application in various contexts (Peek et al., 2006; Chorus and Bertolini, 2011; Chen and Lin, 2015; Singh et al., 2015; Vale et al., 2018). We apply this framework to understand the levels of maturity of TODs across the city and what makes some TODs more successful than others and suggest solutions for a new rail corridor built in a ‘greenfield’ area. To achieve these we needed:

- a typology that is inclusive of indicators of sustainability,
- a model that connects mobility effects with TOD features and
- a smart approach and technologies to visualise and monitor the changes.

This is the essence of the broader RailSmart project.
Relying solely on secondary data obtained from government departments in WA and the Australian Bureau of Statistics (ABS) Census, this project offers an extension to the Node-Place model, by developing a classification of railway precincts based on 43 indicators (Babb et al., 2016; Falconer et al., 2016) and then cluster analysing travel patterns of PT users from logs of SmartRider travel cards. Whereas the extended N-P analysis highlights three clusters, the travel data identified several types of ‘activity hubs’ (e.g., residential or dormitory precincts, big commercial centres, universities or other education precincts, hospitals and social services, as well as combinations of activities). We compare these types of clusters and then measure the association between patronage and station precinct features using multiple linear regression models, where boardings and alightings at various times represent the response variables.

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.
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 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 (dormitory 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.
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.

<table>
<thead>
<tr>
<th>Place score</th>
<th>Node score</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.94</td>
<td>69.64</td>
</tr>
</tbody>
</table>

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

The regression analysis helped to identify which factors have the greatest impact on patronage and along with these, the most appropriate application opportunities.

The results identify three clusters for Perth:

- Dormitory hubs
- Suburban hubs
- Inner City hubs
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.

Public transport is a critical aspect of any modern city. Many cities are moving to using paperless smart-card ticketing systems which provide a wealth of data about how the system is being used. This tool uses SmartRider data from Perth’s ticketing system to develop an understanding of how passengers are utilizing the system. The tool queries, analyses and uses data mining, to support a knowledge discovery process centred on passengers, hubs, and journeys. The objective is to be able to generate evidence-based answers from SmartRider ticketing logs to queries such as:

- What are the different types of passengers using the TransPerth network?
- How frequently and at what times do they travel?
- Where are the activity hubs in the Perth network?
- How intensively and with what stay patterns are the Perth hubs used?
- What are spatial catchments for different hubs?
- Which journey segments are heavily utilised during particular time periods?

Using TransPerth SmartRider ticketing logs and stop information, new data mining techniques have revealed latent information about passengers, activity hubs and heavy utilization of certain journey segments. Highlights of the findings of this project include:
• A total of 130 hubs were identified, 120 of which are located in the Perth metropolitan area, from Rockingham in the south, to Butler in the north.

• There were also hubs in Mandurah (4), Busselton (3), Albany (1), Geraldton (1) and Port Hedland (1). It was found that approximately half of all stays were at a single hub in Perth city, which covers Perth and Elizabeth Quay train stations.

• Identification of 5 distinctive ways in which hubs are used. Each of these uses is characterised by passengers’ arrival time and length of stay. The five usage patterns suggest: work day, school day, overnight stays, and variable arrival times followed by either a long or short stay.

• Description of each hub region by its unique mixture of the five activities. Dominant hub activities correlated well with points of interest such as schools, universities, business and shopping centres.

• Discovery of a new and flexible typology for passengers. We found several significant passenger types that are not considered in traditional transport models viz. ad hoc travellers, and one-way-only commuters.

• Creation of databases and visualisation software for automatically generating reports on hubs, passengers and journeys, as well as textual narratives for the discovered patterns.

Perth’s SmartRider system was launched in 2007, and within a year, over 70% of public transport transactions were conducted through a SmartRider (PRIA, 2012) increasing to approximately 77% in 2014-2015 (PTA, 2015). As Perth plans growth towards a population of 3.5 million, the importance of reducing car trips and increasing active and public transport trips is critical. An aspirational target for Perth is 11% public transport patronage, well above the current 7% level. Perth’s SmartRider logs offer a valuable, but largely untapped, source of knowledge on the patterns of use of Perth’s public transport network. Previous studies using passenger smart card data from cities around the world (Hasan 2013, Kieu 2014) have focussed on extracting explanatory statistics of global behaviours such as frequency and scale of travel. Another line of research uses feature extraction algorithms to discover hidden features in data (Poussevin 2016, Yuan 2014). RailSmart has utilised the latest computing techniques in automated knowledge discovery to reveal latent information about passengers, activity hubs and utilization of certain journey segments using the SmartRider logs.
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 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
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
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
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.

NOTE: data is a month from Aug 2017
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.

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**Tool 3 Enhanced Employment Self Sufficiency Tool**

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 patterns 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.
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.
Location Quotients for the LGA’s are shown in a number of associated map layers accessed via the drop down box in the top left hand side of the screen.

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 ‘Accessibility Analysis Tool’ (AAT), which was developed by Sun et. al. (2017) has been modified and incorporated into the RailSmart system.

The purpose of the AAT is to provide an extensible modelling platform that determines the accessibility, by both private transport and public transport, of a particular metric (in this case, jobs, dwellings and population) throughout the metropolitan area of Perth.
In this context, accessibility can be considered a “measure of spatial separation of human activities” (Morris et al., 1979). Hence, it is a measure of the ease of reaching destinations, which enables individuals and firms to conduct their activities; a function of both land use and transport characteristics (Handy & Niemeier, 1997).

To determine the accessibility of geographic areas (termed zones) through the Perth metropolitan area, a variety of data sources are used, including:

- Census 2016 data (Australian Bureau of Statistics, 2018), to determine the number and location of population, dwellings and jobs;

- General Transport Feed Specification (GTFS) of Transperth services (Public Transport Authority of Western Australia, 2018), to determine the time taken to reach a location via public transport;

- Strategic Transport Evaluation Model (STEM) travel time matrices from the Department of Transport of Western Australia (DoT), to determine the time taken to reach a location via private transport;

- Statistical Area, Level 2 (SA2) boundaries (Australian Bureau of Statistics, 2018) as well as STEM boundaries from the DoT, to georeference the above data.

These are analysed by a bespoke software program, as well as using the OpenTripPlanner tool in the case of public transport. While the original AAT determined the overall accessibility of each zone, the tool was modified to be ‘hub-centric’.

In this case, it was the accessibility from individual transit hubs that was calculated, analysed and visualised, rather than the accessibility of each zone to every other zone.

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 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 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. Suburban areas are characterised by low density and thus long transport routes with low ridership numbers often leading to infrequent services due to the cost of transport provision. 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.

The sharing economy has garnered a great deal of media attention in recent years and it has had a significant impact on the transport sector. Despite the substantial growth in shared services its influence on shared transport behaviour and decision-making is unclear. The purpose of this project and
The report is to examine the current impact and potential of the various forms of transport sharing, concluding with recommendations for the City of Wanneroo, Western Australia. Transport sharing modes covered in the study and this report, include ride-sharing, car-sharing, carpooling and bike-sharing, and defined as follows:

**Ride-sharing**

- **Standard ride-sharing (such as Uber)**
  An on-demand peer-to-peer service¹ where the owner of a vehicle takes online requests for rides through an app, and is paid a fee. Drivers respond instantly to requests for rides, and members are able to track their request. Payment is also made via the app.

- **Dynamic ride-sharing (such as UberPool)**
  Is where a ride can be booked at short notice and the journey is shared with others taking a similar route.

**Car-sharing**

- Schemes such as Avis-owned Zipcar, or Hertz 24/7, by which members are able to rent and drive a car for short time intervals before returning it to the designated collection and drop off point.

**Car-pooling**

- Blablacar is an example of a long-distance peer-to-peer car-pooling service. Car-pooling lets you share a journey and the associated costs with everyone taking the journey. Users of car-pooling often need to travel when other transport is unavailable.

**Bike-sharing.**

- An example is Urbibike who have introduced bike-sharing hubs at certain train stations and several other urban locations within the Perth metro area. Bike sharing schemes have been in operation for many years, are very much set to continue into the future.
Using a tailored questionnaire, residents within the City of Wanneroo were asked about their use of various transport sharing mechanisms, their future sharing intentions and their thoughts with respect to the benefits, and barriers to adoption.

Residents were also asked about their use of transport sharing to access rail stations. Indications overall are that respondents feel optimistic about the use of transport sharing for travelling to and from the rail station:

- 41.8% of respondents had used ride-sharing, and 23.77% had used car-pooling
- Over 50% of all respondents regardless of age group, income, job type, gender and household size expressed they felt positive about transport sharing and would use it in the future
- Transport sharing is mostly used for social and work related activities
- A main barrier to transport sharing is a perceived lack of child safety features Survey feedback suggests that the City of Wanneroo could optimise transport sharing by:
  - Proactively supporting car-pooling schemes
  - Collaborating with ride-sharing firms to enhance services
  - Working with local employers to encourage car-sharing; and
  - Allocate parking at rail stations for car-sharing participants

For local city councils, transportation planners and government transportation departments, it’s important to gauge developments in transport sharing in order to assess potential impact on public transport demand and road use. Along with the regulations that govern and control these developments, transport sharing has implications for transport policies and revenue streams. Technology enabled forms of transport sharing are in their infancy, yet it is apparent they have already had a disrupting effect on government policies and transportation regulations. For example, the disruption of the taxi industry and resulting policy changes caused by the arrival of Uber in Australia.

Governments invest heavily in long-term transport infrastructure, as such developments with a potential impact on future demand require research and monitoring. Transport sharing options have increased travel mode choice and can have an impact on vehicle ownership decisions, yet the extent of the impact remains unclear.
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.
- The following suggestions draw upon the survey’s findings and are made for the City of Wanneroo and transport authorities in Western Australia.
  - The sharing economy has impacted travel behaviour and will continue to evolve as technology develops. These developments require integration in transportation planning, balancing the need for modality choice and equality of service provision.
  - That transport and planning authorities collaborate with commercial car-sharing providers to structure pilot schemes which can be monitored and evaluated to extract user data patterns.
  - The willingness of citizens to join car sharing and car-pooling schemes can be supported and encouraged by City of Wanneroo policy.
  - Facilitate awareness campaigns to educate the public about car-sharing and car-pooling - and provide incentives for participation. For example:
    - Road lane restrictions for vehicles carrying less than two passengers in peak hours.
    - Car-sharing and car-pooling framed as creating independence and are effective means of accessing other transport options.
  - Although few people had used bike-sharing schemes there seems to be interest in this transport sharing modality from a significant portion of residents. These schemes may require more promotional support and further development of bike lanes/zones for rider safety.
3.1.2 GIS Layers

The purpose of the GIS Layers is to provide spatial-statistical analysis of sub-regions of the Perth metropolitan area, which can be used in tandem with the other models, tools and analyses to determine spatial correlations between the two. While some GIS layers were purely descriptive, others contained demographic analysis based on data from the ABS.

The sub-regions (or spatial resolution) primarily used within the layers is that of the Statistical Area, Level 1 (SA1) of the Australian Statistical Geographic Standard (ASGS) of the Australian Bureau of Statistics (ABS, Australian Bureau of Statistics, 2018b).

This was due to the fact most data sourced was from the ABS, and as such minimal spatial aggregation and de-aggregation would be required to geo-reference it. The SA1 level was chosen as it is the smallest resolution with the data that could be cross-referenced.

Specifically, the data sets used were the following:

- Census 2016 data (Australian Bureau of Statistics, 2018a), to derive descriptive demographic statistics regarding areas in the Perth metropolitan area;
- ASGS geographies at Statistical Area, Level 1 and Level 2 as well as State Suburb and Local Government Area levels (Australian Bureau of Statistics, 2018b), to geo-reference the above statistics;
- Medium scale topographic data (Landgate, 2018a) for the location and attributes of cultural features and facilities;
- Large scale topographic data (Landgate, 2018b) for the location and attributes of buildings;
- House price data, to determine average house sale prices and volumes by area;
- SmartRider transactional dataset, to determine statistics surrounding the usage of public transport by stop and area;
- Strategic Transport Evaluation Model (STEM) travel time matrices from the Department of Transport of Western Australia (DoT), to determine distance isochrones for travel times in 2051;
- STEM geographies, to geo-reference the above data.
These are analysed using a bespoke software program, written for this purpose. Besides these analyses, spatial data was processed and added to the system to simply provide context by its shape or pre-existing analysis. This included:

- General Transport Feed Specification (GTFS) of Transperth services (Public Transport Authority of Western Australia, 2018), to provide descriptive context of the location of public transport stops and routes;

- Activity centre, regional road and railway location data (Department of Planning, 2018), to provide descriptive context to locations within the metropolitan area.

The GIS layers component of the RailSmart PSS is straightforward to use. To begin, locate the box on the left-hand side of the PSS. You will see there are two options under ‘Layers’: ‘Employment Layers’ and ‘Context Layers’. Select ‘Context Layers’ to access the GIS layers.

Once you have selected ‘Context Layers’, you are able to use the select box underneath to select the layer of interest. These are grouped by theme. Some layers require no further configuration once selected; others will require you to select further options. These are indicated below the select box as groups of radio buttons – for each group, you must select one and only one of the radio buttons.

Once this has occurred, the layer will be displayed on the map in the PSS. If the ‘Legend’ button is clicked a legend may be displayed, depending on the content of the layer, which will show what each colour in the map corresponds to as a value. Maps that are not a choropleth in nature will not have this legend.
To remove the layer, select ‘None’ in the select box. Other layers can also be selected, however only one can be viewed at a time.

Percentage change of estimated resident population in area surrounding Yanchep station.
Accessibility of Girrawheen and surrounds (lighter coloured area) with PT routes overlaid.
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 college 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.
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

Change cluster | New population | New patronage | Cluster change result | Employment scenario
--- | --- | --- | --- | ---
Yanchep → Joondalup | 305k | 4,400k | | |
Eglinton → Butler | 821k | 2,300k | | |
Alkimos → Warwick | 777k | 5,300k | | |

LGA Level Results:

<table>
<thead>
<tr>
<th></th>
<th>New Wanneroo population near stations</th>
<th>New Wanneroo patronage</th>
<th>New Wanneroo jobs</th>
</tr>
</thead>
</table>
Total | 19.03% | 12000 | 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 analysis. 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)
- Geojson (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
- WATomorrow

4.2 Backend (API) architecture

Technology

The back end 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**

A combination of a Jenkinsfile and Terraform script is used 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.
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 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):

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