PATREC

Planning and Transport Research Centre (PATREC)

Executive Summary

Addressing Future Uncertainties of Perth at 3.5 Million: 'What-If' Scenarios for Mass Transit

Submitted to	Steering Group
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EXECUTIVE SUMMARY

1. Study Overview

This report presents the results of a detailed analysis of the train station precincts with respect to their Place, Node, and Background Traffic characteristics. This is stage 1 of the project, which has as a key overall objective to determine what actions/interventions should be undertaken (and at which stations), to improve the stations precincts as high quality TODs and to increase train patronage.

A secondary objective relates specifically to stations with current low patronage levels, i.e. less than 1,000 boardings per day. Responding to the recommendations formulated by the Steering Committee, this report explores the levels of additional residential development likely to be required within the catchment areas of the stations to raise patronage above the set threshold.

The project considers various spatial resolutions, but the final output presents results aggregated at the precinct level (buffers of 0.8 or 1.6km radius around train stations).

2. Analytical Methodology

This study therefore uses a two-stage analytical process:

1. Cluster analysis (dividing the stations into groups with similar Place, Node, and Background Traffic characteristics);
2. Regression analysis ('producing equations' to predict station boardings/patronage based on key station and catchment characteristics).

A third analysis is also presented. This is an estimator (spreadsheet calculator) developed specifically for the low-patronage stations to estimate the additional population/dwellings that may be required to achieve the minimum daily boardings threshold of 1,000 for Place-dominating precincts. The estimator is based on findings from the regression models (linear associations between patronage and density).

2.1 Cluster Analysis

Cluster analysis is simply a way to group station precincts with similar characteristics together (see section 3.2). Three components/dimensions are considered: Node (the station itself), Place (the area surrounding the station), and Background Traffic (the impact cars and buses accessing the station are likely to have on non-station traffic). Within each component, a large number of variable or indicators were included to characterise as completely as possible the station precinct (see Tables 8-13).

Clustering has been done for each component individually and for the three components combined (Section 5.4). The combined results indicate four key clusters/groups of stations (Table 14):

1. Low accessibility / Node function / PnR / further from city;
2. High Place and Node functions / close to the CBD;
3. Interchange stations / feeder buses / generators (i.e. primarily residential catchments);
4. Medium functions (i.e., moderate performance on all three components).

The cluster profiles suggest different interventions required to improve their patronage and role in the whole PT network (Section 5.5). Whereas cluster 1 would benefit from densification (lowest population density and employment), the actions/strategies which would bring higher benefit include offering bus services of flexible access solutions. Cluster 2 is the best performer, yet improving city-wide access is a desiderate for all clusters. Adding jobs would be required if population increases. For cluster 3, increasing access/egress functions and separating station and road traffic are the main interventions. PnR, BnR, and other local access solutions would improve the ridership until sufficient densification would enable transition to a quality TOD precinct, with pedestrian and cyclist orientation, well connected to the whole city. Cluster 4 needs adding jobs, but more importantly a variety of land uses (offices, retail, recreation, cultural, public open space, etc.), with densification outside the 0.8km buffer.

2.2 Regression Analysis

The primary objective of the analysis (results in Section 5.6 and Appendices 8.7 and 8.8) was to develop linear equations that can estimate potential train station boardings/patronage based on a range of quantifiable characteristics at the station (e.g. the number of parking bays), on the level of access from the station (the number of jobs than can be reached in 45 min), and within the station catchment area (e.g., the number of residents or the land-use mix).

The equations are of the general form:

$$\text{Patronage} = \text{Constant} + \beta_1 \times V_1 + \beta_2 \times V_2 + \ldots.. + \varepsilon \qquad (0)$$

where V_1, V_2, … are characteristics measured for the station precincts; β_1, β_2 are coefficients (numbers) that reflect how important that variable may be in predicting patronage or boardings, when accounting for influences of the other variables.

Regression analysis works well when most of the things being considered are independent of each other and there are no outliers. Regression calculates patronage based on 'averaging' over all stations within the sample, therefore, some stations would have patronage lower than 'expected' (estimated) and other than have patronage higher than 'expected'. Given that train stations have distinct profiles and different variables affecting daily boardings, a single equation may not be adequate and conceal the differences in determinants.

Consequently, models were obtained for stations with high Node functions, with balanced functions, and low patronage mostly residential catchments with high Place functions (Tables 20-22). Obviously, residential stations/generators are expected to have higher boardings and fewer alightings in the morning, whereas those with mostly non-residential catchments to have low boardings and high alightings in the AM peak.

The regression analysis helped identify the characteristics that have the greater impact on patronage and hence the most fitting actions to undertake. The key findings are:

- Access from the stations to the whole network and access to the station are the strongest
  predictors of patronage at all stations; this means that Places with good PT access could deliver maximum value for patronage, as confirmed by other cases in Australia (e.g., Yeerongpilly, Wolli Creek, Footscray);
- Increasing PnR and feeder bus services works well for stations further from the CBD and these Node dominant stations would benefit from densification if aligned with greater city-wide access to employment;
- Densification alone is unlikely to offer desired patronage levels, both in exceeding the daily threshold of 1,000 boardings and the min 11% mode share by 2050.

A number of outliers were found in the analysis. They are: Carlisle, Warnbro, Thornlie, Welshpool, Rockingham, Midland, but depending on the model, others may be relevant.

These outliers are very useful, as they can indicate what elements lead to attracting patronage and what doesn't seem to work well. They indicate where to do what and will be investigated further in the next stage of the research project.

2.3 Low patronage station population estimator

A simple, Excel based, calculator is provided to quickly estimate the potential increases in population required at a number of stations on the heritage lines with low patronage levels, in order to reach the minimum threshold of 1,000 boardings per day. This estimator relies on linear associations between patronage and population. The results indicate that in average 12% of the labour force living within the 0.8 km buffers around the stations travel to work by train, but there is substantial variability by station. For example, this percentage is only 2% for Karrakatta and goes to 37% for Victoria Street. Using the proportions and the assumption that non-commuting trips are at least equal to commuting trips, the additional population necessary within station catchment areas to reach the set threshold varies between less than 1,000 (Armadale) to more than 30,000 (Karrakatta), with an average of about 5,800. Even with optimistic modal share twice the current level, density alone is unlikely to provide the 1,000 boardings threshold levels. We see this quick calculator, based on linear assumptions and without accounting for other determinants of patronage, as a first testing tool to filter out infeasible or extremely costly densification solutions, such as for Karrakatta; thus the quick estimator provides a "reality lens" to the relations between patronage and density, which can show what is achievable using only density levers, in the absence of complementary planning measures.

The results show that a number of stations would require extensive design changes to allow for the densification (e.g., Karrakatta, Challis, Daglish, Loch St., Maddington, and Queens Park), which further confirms that density by itself is not sufficient to support high rail patronage.

3. Potential Actions

Based on cluster profiles and regression, there are several main actions that could be undertaken to achieve the key objective of increased patronage:

1. Densification by increasing population within the station catchment;
2. Increasing the number of jobs within the station catchment (developing activity centres);
3. Increasing accessibility of the generator stations by public transport by providing additional PnR;
4. Improving access/egress facilities of the stations by adding new feeder bus routes, increasing service frequencies, or creating more flexible local transport solutions.

Actions 1 and 2 are expected to increase the total number of people travelling to and from the station precinct and therefore the station patronage.

However, from a TOD perspective, it would be preferable to add jobs to station precincts that are mainly residential and to add dwellings to those that have mainly employment/non-residential uses. This would create more balanced TOD, not only with higher density, but also more diversity of land-use mix (in this report the diversity is calculated using an entropy measure – see section 3.4).

While developing better TODs enables creation of good activity centres and leads to higher quality amenity and liveability (appropriate scale for pedestrians), they may not be associated with substantial increase in transit ridership. This is because in a good TOD, the balance between workers and jobs within a station catchment means more trips can be satisfied internally, particularly by using active transport modes. Hence, self-containment and self-sufficiency are likely to be higher, with fewer trips required outside the precinct, potentially resulting in a reduction of the patronage for train, which is primarily enabling city-wide access.

If, on the other hand, population densification would occur in residential precincts (generators) and employment concentration around station precincts that are primarily attractors, i.e. increasing the land- use imbalance, this would likely result in more trips to/from the precincts and hence a greater potential for increased rail patronage. This 'job-housing imbalance' was highlighted in the meta-analysis by Ewing and Cervero (2010) as having the highest elasticity of transit trips (p. 292). Nevertheless, it would result in lower levels of self-containment and self-sufficiency, poorer land use outcomes, amenity and TOD features.

Hence, distinction must be made between the **primary** (liveability and sustainability and reduced dependence on car use) and **secondary** benefits of TODs (increased patronage), and the dilemma between balancing Nodes and Places. Should planning seek to balance workers and jobs or look to maximise the potential for higher train patronage? The former would result in lower overall access costs for users and reducing the demand on the transport systems (thereby reducing infrastructure requirements and costs for government), but with lower fare revenues.

The challenge is therefore to increase the train mode share by offering services superior to car travel for trips external to the precincts, while aiming for a more balanced land-use mix within the station precinct. The implications of this will be further considered in the next stage of the project.

Actions 3 and 4 complement the measures suggested above on the quality of door-to-door public transport services. The goal of increased access measures is to attract a higher proportion of existing travellers to the train (while 1 and 2 seek to increase the total demand with more people travelling, i.e., growing the market), which means diversion from car travel.

The increase access is likely to conduce to three potential outcomes:

a) Encouraging those currently driving all the way to transfer to catching the train, thus increasing patronage. This specifically relates to adding PnR as it is currently full at most stations.

b) Diversion from other modes such as KnR and active travel to PnR or to BnR and a small increase from any travel mode to BnR + train, supported by a better "first mile & last mile" transport solution. This would likely result in a modest increase in train patronage, but there are expected benefits for the individuals that change their access and egress mode

c) By adding PnR bays at one station or changing feeder buses coverage and frequency, current users at adjacent stations may change their boarding station, again resulting in no increase in overall patronage. Thus, the benefits of actions 3 and 4 may be "diluted" somewhat by this change in access/egress mode, or change in boarding station, and the actual increase in train boardings may be lesser than anticipated.