Veitch Lister Consulting Pty Ltd

Optimising Australia's public transport

THOUGHT LEADERSHIP SERIES

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Many Australian cities are investing in public transport (PT). This investment can take many forms, from new infrastructure and extra services through to lower PT fares. This paper presents concepts and tools to inform discussions about the optimisation of PT investment in Australia.

Why public transport?

Calls for better public transport (PT) feature regularly in mainstream media and in the policy platforms of state governments. PT enjoys relatively widespread public and political support because it simultaneously helps to address multiple strategic urban objectives, including:

- *Economic efficiency,* by improving mobility and accessibility, and reducing congestion;
- *Environmental sustainability,* by improving urban amenity and reducing emissions; and
- *Fairness and equity,* by providing a wide-range of people with access to the city.

PT appeals precisely because it helps to address multiple objectives at once. Notwithstanding PT's multi-pronged contribution to urban liveability, we suggest cities reflect on the strategic urban objectives that underpin their PT investment.[1] We make this suggestion for three main reasons, as follows.

First, the relative weight assigned to objectives will vary from place to place. Cities grappling with entrenched social inequities, for example, may attach more weight to investment that serves disadvantaged communities. In contrast, cities struggling with growing travel demands and congestion may invest more in rapid, frequent PT that serves dense, inner-city areas.

Second, the choice of objectives determines how we measure success. Economic and environmental outcomes tend to be more strongly linked to ridership. In contrast, fairness and equity relates more to the availability (and price) of service, somewhat irrespective of ridership. By reflecting on their strategic urban objectives, cities can gain insight into how to define success.

Third, tensions often exist between different objectives. Investing in PT to prioritise fairness and equity will lead towards a different PT system from one where we invest to maximise environmental sustainability. Transparently acknowledging these tensions helps find an appropriate balance between different strategic objectives.

Even once objectives, measures, and tensions have been identified, decisions about PT investment are not straightforward. Indeed, the fiscal constraints placed on state governments make prioritisation unavoidable; hard decisions need to be made about what to fund and when.

[1] Walker, J. "Purpose-driven public transport: creating a clear conversation about public transport goals." Journal of transport geography 16.6 (2008): 436-442.

And notwithstanding its benefits, PT comes with a hefty price tag. In Australian capital cities, PT fares cover around 25% of operating costs, creating a billion-dollar annual shortfall. PT infrastructure is also expensive, with costs that are generally not recouped through increased fare revenue. Fiscal constraints mean that PT competes with other government priorities, such as health and education.

In this context, we suggest there is value in ensuring that our PT systems operate as efficiently as possible. Here, we consider how to optimise PT systems, by which we mean taking a series of steps designed to increase benefits (however defined) for a given cost. The following sections explore processes and tools that can help cities optimise their PT system.

PT optimisation as a process

"We view PT optimisation as a process, for the simple reason that success depends not just on what is proposed, but also how proposals are developed."

We view PT optimisation as a process, for the simple reason that success depends not just on what is proposed, but also how proposals are developed. Process matters because we are considering changes to services that people depend on. Community interest is both a blessing and a curse: a blessing because it means people want better PT; a curse because it can make change more difficult.

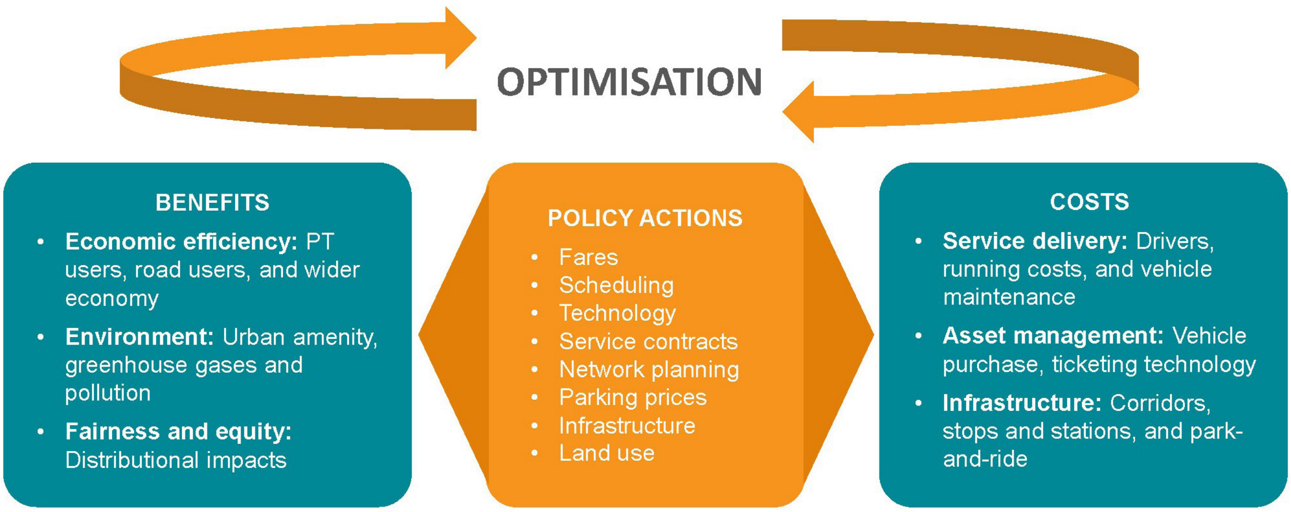
Four characteristics are, in our experience, common to successful PT optimisation processes.

First, good governance recognises the need for clear value judgments. All PT optimisation processes have a political dimension, if only because identifying strategic objectives and performance indicators requires value judgments. Effective governance seeks to make these value judgements clear from the outset, providing direction to subsequent technical analyses.

Second, an iterative approach supports technical analysis and community input. An iterative approach to PT optimisation allows time for options to be proposed, designed, evaluated, and refined prior to and after implementation. Where options have direct implications for passengers, allowing for timely community input can help to expedite implementation.[2] Less haste, more speed!

Third, PT optimisation processes often integrate a wide range of multi-disciplinary skills. The PT systems of most major cities are influenced by many factors. The figure below presents various policy actions that can be used to optimise PT systems, which differ vastly in their technical content.

[2] Auckland's "New Network" and South East Queensland's "Fairer Fares" are two recent examples of iterative processes that allowed for timely community input and which led to refinements prior to implementation.



Responsibility for policy actions are unlikely to fall entirely within one government agency and may instead be spread across several public and private organisations. This technical and organisational complexity means PT optimisation processes benefit from a wide range of multi-disciplinary skills.

Fourth, PT optimisation requires a whole-of-network, high altitude perspective. Given the complexity of the PT system, it is tempting to focus on specific details too early in the process. An effective process, however, must seek to identify and address issues in the context of the wider network, before drilling down into details. Adopting a whole-of-network, high altitude perspective helps identify the most effective policy actions and how they can be efficiently integrated.

These characteristics are necessary but insufficient for a successful PT optimisation process. In addition, there is a need for effective analytical tools to inform our choice of policy actions.

Analytical tools to support PT optimisation

Having established some core concepts that underpin PT optimisation processes more generally, we now consider analytical tools to support evidence-based decision-making.

Ideally, analytical tools would provide relatively consistent, like-for-like comparisons of benefits and costs over time. Strategic transport models, such as VLC's Zenith model, are well suited to this task. These models take land use patterns, demographic profiles, and transport networks as inputs into behavioural algorithms, which predict the travel choices people make, specifically destination, mode and route choice, now and in the future. Various aspects of PT infrastructure and services, such as fares, frequencies, capacities, speeds, and station quality, are represented within strategic models.

"Strategic transport models allow us to analyse how PT policy actions affect the wider transport system in multiple alternative scenarios."

Strategic transport models allow us to analyse how PT policy actions affect the wider transport system in multiple alternative scenarios. Options can then be evaluated and refined to maximise their effectiveness. Conventional evaluation frameworks typically consider economic efficiency, i.e. the total benefits and costs of policies, as well as distributional effects, i.e. winners and losers. Strategic transport models readily generate metrics and visualisations to support both analyses.

In the sections that follow, we use Zenith to analyse the performance of Perth's PT system and how it responds to changes in PT fares. Notwithstanding this specific application, we try to emphasise the general nature of the analyses and their relevance to the wider PT optimisation process. And while we focus on strategic transport models because they provide network-wide insight into potential issues and opportunities, we also consider the potential need for additional analytical tools, which can complement analyses of policies under consideration.

Finally, our analysis here focuses on PT optimisation in a relative, intra-urban sense. We avoid commenting on "optimal" levels of PT investment, which will change over time. Nor do we comment on inter-urban performance. Instead, our focus is on improving what individual cities currently do.

Zenith is a set of multi-modal transport models for major city regions in Australia that is owned, developed and maintained by VLC. Using Zenith, VLC can simulate transport system performance under a range of future scenarios. VLC's clients routinely use Zenith to understand the effects of transport projects and policy / pricing initiatives. Unlike some strategic models, Zenith models the effects of crowded PT services in detail, which in turn can influence the travel choices people make.

Case study: changes to PT fares in Perth

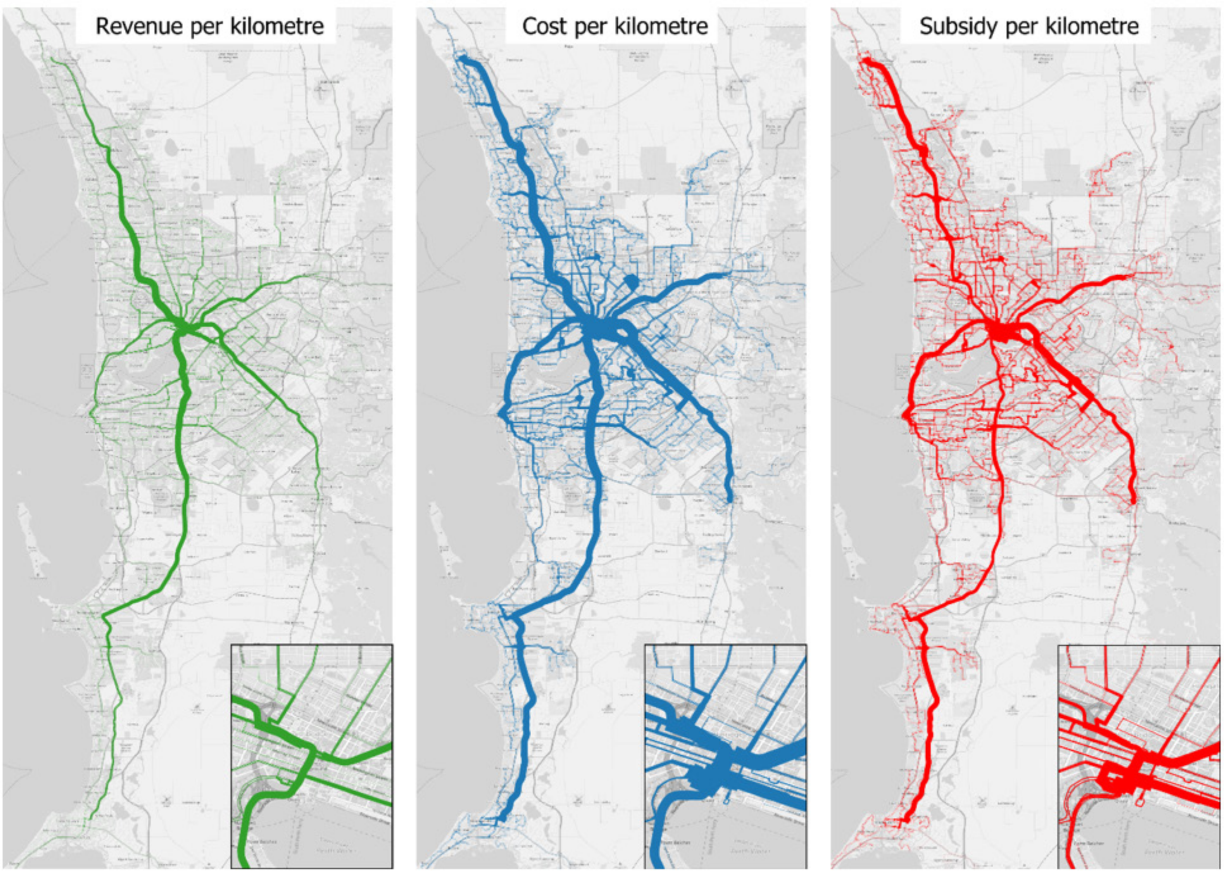
We illustrate analytical tools to support PT optimisation processes using PT fares in Perth as a case study. Compared to other capital cities, PT fares in Perth have three notable characteristics:

(1) Long-distance fares are higher than most other capital cities,
(2) Fares remain constant across the day, i.e. no peak surcharge / off-peak discount, and
(3) Perth has a comprehensive free travel zone in the CBD.

In the following sections, we first characterise the operating performance of Perth's PT system before considering the effects of possible alternative fare structures.

Current performance

To understand the current performance of Perth's PT network, we first assign fare revenues and operating costs to the network, from which we can calculate operating subsidies. Revenues are allocated on a per passenger-kilometre basis, whereas costs are assigned using a cost allocation model. This model considers the total operating costs of Perth's PT system by mode, which is then assigned to individual bus and train services using unit cost rates (cost per vehicle-hour and per vehicle-kilometre). Costs can then be aggregated by link, as illustrated below for 2016.



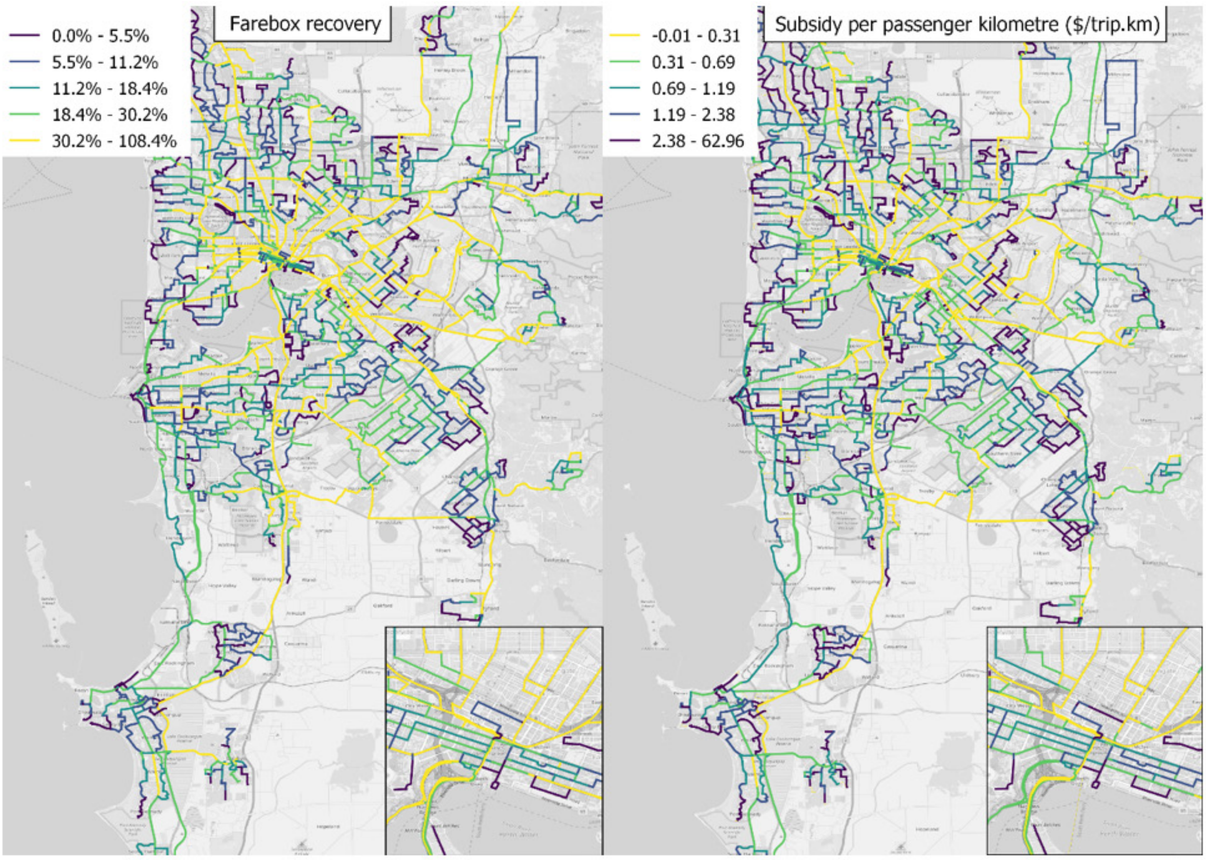
> *"...while the rail network stands out as a major source of revenue it also incurs high costs."*

The three panels illustrate per kilometre revenue, cost, and subsidy (cost minus revenue) for individual links in the network. What do we learn from this analysis?

First, while the rail network stands out as a major source of revenue it also incurs high costs. Also, we find large variation in operating subsidies across the rail network: inner sections of the Mandurah line and Joondalup lines, for example, incur lower subsidies than outer sections. The Fremantle and Armadale lines are relatively highly subsidised, which likely reflects their age and slow speed compared to the newer sections of Perth's rail network.

Second, the absolute operating revenue and cost data presented above can be converted into complementary fiscal performance metrics. The two panels below, for example, illustrate cost recovery (revenue divided by costs) and subsidy per passenger (subsidy divided by loading). A relatively common theme emerges from both fiscal performance metrics: PT services operating in central areas performs better than outlying areas.

That said, we do find that some PT links in Perth city centre perform relatively "poorly", in the sense they receive relatively high subsidies. The latter are, in our view, prime candidates for review during network planning exercises, because their performance occurs in a context that is (1) conducive to PT; (2) where they do not contribute much to fairness and equity objectives; and (3) where infrastructure capacity constraints often exist. For these reasons, poorly-performing routes in central areas warrant as much—if not more focus—than those operating in suburban areas, in our view.



Case study: changes to PT fares in Perth

The whole-of-network perspective gained from strategic transport models provides useful insight into where to target PT optimisation processes to the greatest effect. In doing so, these results highlight our earlier comments on multiple strategic objectives: many of the PT routes in Perth that perform poorly in terms of fiscal performance appear to be providing coverage in suburban areas, which—as discussed above—is usually motivated on fairness and equity grounds, rather than economic efficiency. Understanding these objectives is thus critical to our ability to evaluate the relative performance of different parts of Perth's PT network.

PT fare scenarios

Perth's PT system has recently experienced falling patronage, resulting in spare capacity on some services and increasing opportunities to implement policy actions that serve to optimise the PT system. In this section, we consider three scenarios for changing Perth's PT fares, specifically:

- Free fares, the purpose of this scenario is to understand the degree to which fares suppress the demand for PT across the network.

- Peak charging, in which we set peak fares equal to 25% more than the off-peak fares.[3] The purpose of this scenario is to reduce peak-period demand and encourage off-peak travel.

- Flat fares, in which we reduce the number of fare zones from 9 to 5. Fares remain the same in zones 1 and 2 but decrease in all other zones. The purpose of this scenario is to simplify the fare system and attract more long-distance journeys to PT.

[3] This is the same peak / off peak ratio as in Brisbane, which has a fare structure broadly similar to Perth.

Results for each scenario are summarised in the table below for a normal weekday, where we compare their performance to the 2016 base analysed in the previous section.

Metric		Scenario			
		Base	Free	Peak	Flat
PT trips	Total	339,800	404,900	333,100	343,400
	% change from base	-	+ 19.2 %	- 2.0 %	+ 1.1 %
Passenger km	Total	5,338,000	6,764,000	5,181,000	5,520,000
	% change from base	-	+ 26.7 %	- 2.9 %	+ 3.4 %
Revenue	Total	895,000	0	986,000	846,000
	% change from base	-	- 100 %	+ 10.2 %	- 5.5 %
Farebox recovery	[%]	30.7 %	0.0 %	33.8 %	29.0 %
Subsidy per pass.km	$ / km	$ 0.38	$ 0.43	$ 0.37	$ 0.38

Results for the 'base' suggest Perth's PT system carried approximately 340,000 trips on a normal weekday, with 5.34 million passenger kilometres, yielding an average PT trip length of 15.7km. In terms of our scenarios, we find:

- 'Free fares' results in a 19.2% and 26.7% increase in trips and kilometres, respectively, for a cost of approximately $900,000 per day.
- 'Peak charging' results in a 2.0% and 2.9% decrease in trips and kilometres, respectively, while increasing revenue by almost 10%.
- 'Flat fares' results in a 1.1% and 3.4% increase in trips and kilometres, respectively, while reducing revenue by approximately 6%.

Taken together, these results suggest the demand for long-distance PT travel in Perth is relatively sensitive to fares. We also find free fares are a relatively expensive way to grow patronage: each additional passenger kilometre travelled costs approximately $0.63. By way of contrast, in the flatter fares scenario each additional passenger kilometre travelled costs only $0.27. By this measure, 'flat fares' provides greater value for money than 'free fares'.[4]

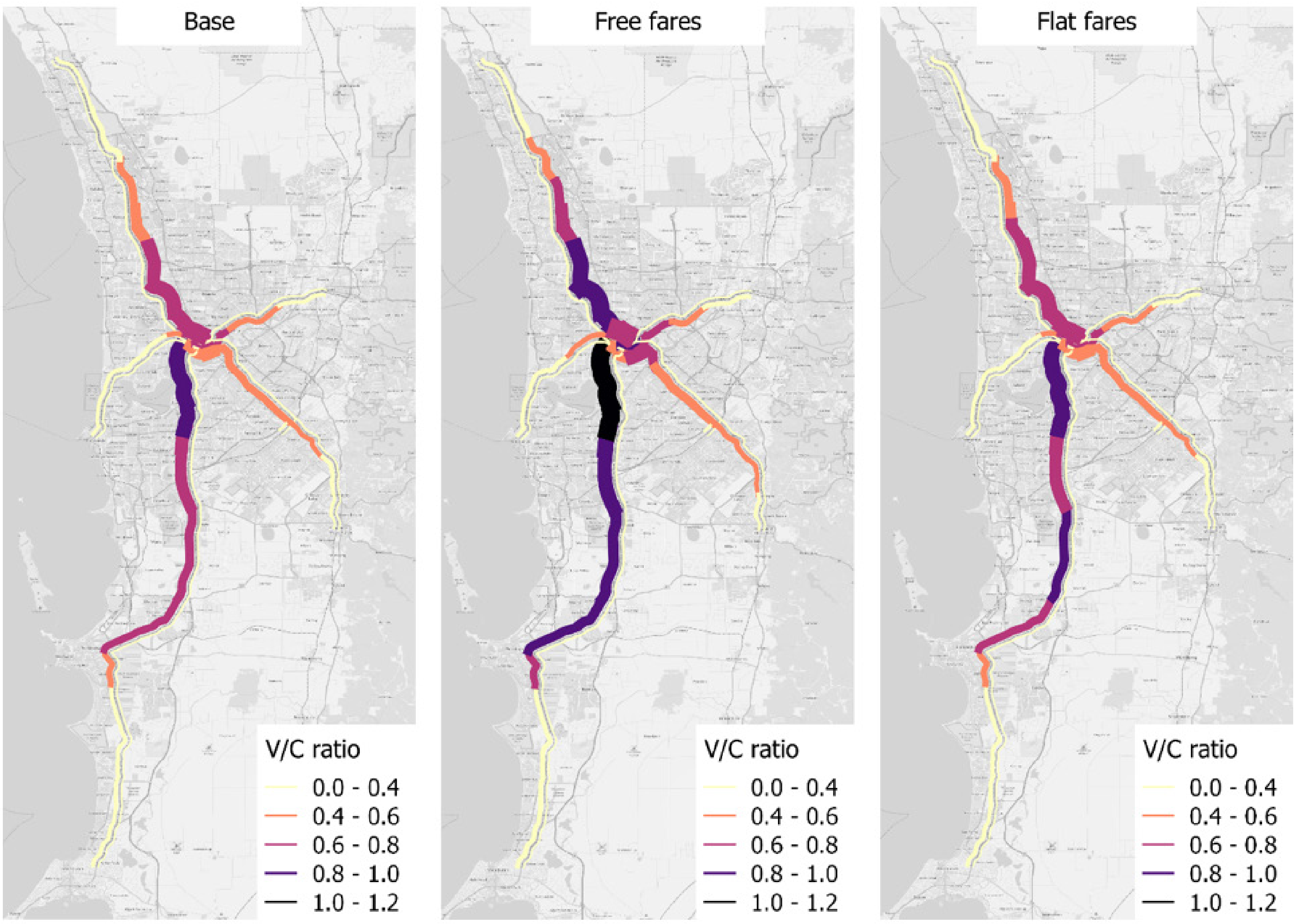
[4] Here, we consider only the direct effect of free fares on the demand for PT. A more comprehensive analysis would need to consider indirect benefits to bus dwell-times and avoided costs of ticketing and compliance.

"Strategic transport models can help understand why 'free fares' do not yield as much additional ridership as is sometimes envisaged."

Strategic transport models can help understand why 'free fares' do not yield as much additional ridership as is sometimes envisaged. The reason is that during peak periods many of Perth's PT services already operate at or near crush capacity, such that increases in demand are unable to be accommodated without displacing other passengers. The maps below, for example, show crowding on the rail network during the AM peak period in the 'base,' 'free,' and 'flatter fares' scenarios.

In the 'free fares' scenario, we find that sections of the Mandurah line experience volume to capacity ratios in excess of 1.0. The additional demand stimulated in the 'free fares' scenario is likely to cause passengers to be left behind for some services at inner-city stations. In contrast, the 'flatter fares' scenario maintains volume to capacity ratios less than one, while stimulating increased demand in outer sections of the Mandurah and Joondalup lines.

This analysis serves to highlight how the demand response to one specific policy action, in this case changes to PT fares, can have wider implications for the PT system, in this case exacerbating existing capacity constraints. In turn, these results underscore our earlier call for PT optimisation processes to adopt a whole-of-network, high altitude perspective.



Conclusion and next steps

> *"... fiscal constraints mean cities face hard decisions about what to fund and when."*

PT offers a powerful policy tool to improve the liveability of Australia's cities. At the same time, fiscal constraints mean cities face hard decisions about what to fund and when.

In this context, there is value in PT optimisation processes that maximise benefits for a given cost. The success of such processes depends not just on what is proposed, but also how proposals are developed. Process matters because we are considering changes to services that people depend on. A transparent conversation about values is a critical precursor to PT optimisation processes, which also benefit from good governance, iterative development, multi-disciplinary skills, and a whole-of-network perspective. Addressing such procedural elements early on can help save time later.

PT optimisation processes also benefit from effective analytical tools. In this paper, we focus on strategic transport models. While strategic transport models are only one part of a broader analytical toolbox, they offer two main advantages. First, they help to highlight potential issues and opportunities. Second, they provide a consistent basis for evaluating and refining options. In the case of Perth's PT system, our preliminary analysis suggests a combination of peak fares and flatter fares may yield benefits by, for example, attracting long-distance car journey and spreading peak demand. Strategic transport models can provide insight into the magnitude of these diverse effects.

Where to next? In our view, Australian cities could benefit from a sustained commitment to PT optimisation. Given the scale of current investment in PT, and the sustained growth of Australia's cities, we consider that such processes are likely to be worthwhile.

Daniel Veryard

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Daniel has 12 years of experience in transport economics, forecasting, policy and planning. He has led the assessment of major transport infrastructure projects across Australia. At VLC he is responsible for managing forecasting projects by fostering collaboration between clients and the VLC team of technical staff.

Prior to joining VLC, Daniel was a project manager and economist at the International Transport Forum at the OECD in Paris. He has also worked as an economist for PwC, GHD, Mouchel (now WSP) and the Reserve Bank of Australia. He has worked on projects in all Australian capitals, and in southeast Asia, the UK and France. Daniel offers an experienced international perspective on economic appraisal, policy, strategic planning and transport business cases.

Daniel holds a first-class honours degree in Economics from Curtin University and a Master of Transport from Monash University.

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At VLC, Stuart provides consultancy services to public and private sector clients across Australia, often in the role of project manager and/or technical lead. In his work, Stuart relishes the opportunity to work closely with clients to help solve their challenging transport problems.

Stuart has more than 10 years of experience working in the transport and energy sectors in Australia and New Zealand. In this time, he has managed several high profile projects, including the redesign of Auckland's bus network, major changes to public transport fares in South-East Queensland, and comprehensive reforms to parking policies. Stuart's core areas of technical expertise include integrated transport and land use planning; spatial, transport, and urban economics; public transport infrastructure and service planning; and data analysis and modelling. He is comfortable both developing complex economic models and presenting to general audiences.

Stuart has a Master of Philosophy (Economics), Master of Science, and Master of Engineering (Engineering science). He is also currently working on his Ph.D. in transport economics.

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About Veitch Lister Consulting

VLC was founded in 1986 with one objective: build the tools and insights that help our clients plan the cities of the future. This remains our singular purpose today, driven by a culture grounded in independence, the pursuit of excellence and the desire to innovate. Our team of transport planners, engineers, modellers, economists and analysts deliver transport solutions that facilitate growth and prosperity for our clients and our communities.

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