The dead end of demand modelling: supplying a futures-based public transport plan

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This paper discusses the transport planning issues that are exposed when new accessibility tools have been employed, designed to address the challenge of providing accessibility by public transport as a serious alternative to car use. Research from case studies in Perth and Brisbane is reported. The paper discusses the benefits of focussing on metropolitan-wide supply side modelling as opposed to simply applying demand forecasts; the need to, and challenges of, setting benchmarks that define quality public transport and accessibility; the need for iterative review by setting long term visions and back-casting as well as looking forward from current city structures. The analysis has raised some interesting questions. It is evident that the past practice of incremental and ad hoc changes to the public transport network will not meet Australia's transport challenges in a timely fashion. What is needed is a step-change, but this requires both a long term view of future city size and structure (a challenge for land use planners who have thus far not planned in this way) and considerable public funding in the short term (where public transport has traditionally been underfunded relative to private transport). It is questionable whether the required rate of change can be achieved.

Introduction

Australian cities are in the midst of a significant change in transport infrastructure provision, acknowledging the need to provide accessibility by public transport as a serious alternative to car use. This has raised new challenges for land use and transport planners. It has become evident that there has been an absence of policy tools that usefully inform key decisions about the extent of future public transport networks and their location in relation to accessibility improvements. It is apparent that traditional strategic transport demand modelling, with its weaknesses in considering induced demand and travel time savings, cannot serve this challenge alone. Traditionally, strategic transport modelling tools have been based on extrapolation of past

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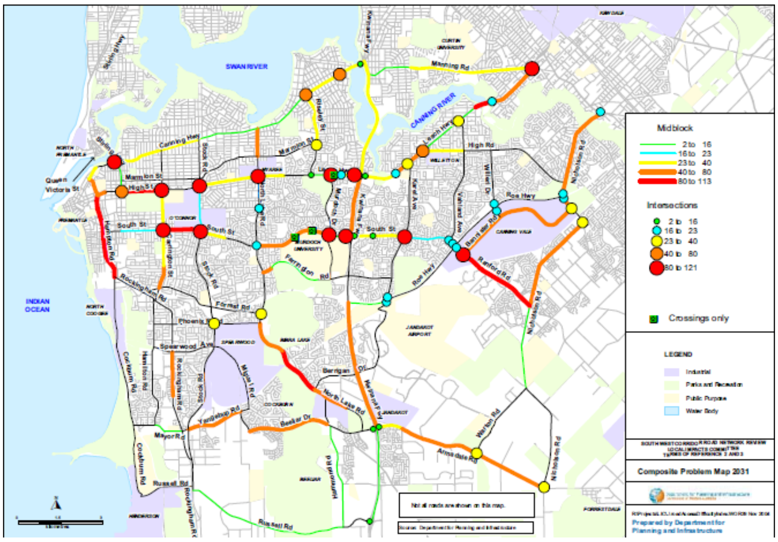
trends, focussed on planning for private car travel, and the dominant policy response has been demand satisfaction by private car travel.

Urban transport planning continues to rely heavily on positivist, analytical frameworks to assist decision-makers in 'solving' transport problems (Banister 2002:22). Vigar's (2002; 2006) work shows how technical assessments are often used to focus transport policy onto specific infrastructure 'schemes' and 'hard' engineering projects, producing appraisals of network capacity, congestion and travel speeds. Mees and Dodson (2007) show how studies using these frameworks have been used to shape and distort political and public preferences and transport policy. This has been the case in Perth, Western Australia, where strategic transport models are commonly employed to forecast future demand for private car and road freight travel. The standard outputs show maps of road links becoming increasingly congested over time (Figure 1a). The metric for congestion is most often what is termed as 'level of service C' where vehicles are minimally impeded. By improving specific road infrastructure, the level of service can be improved and congestion relieved (Figure 1b).[4]

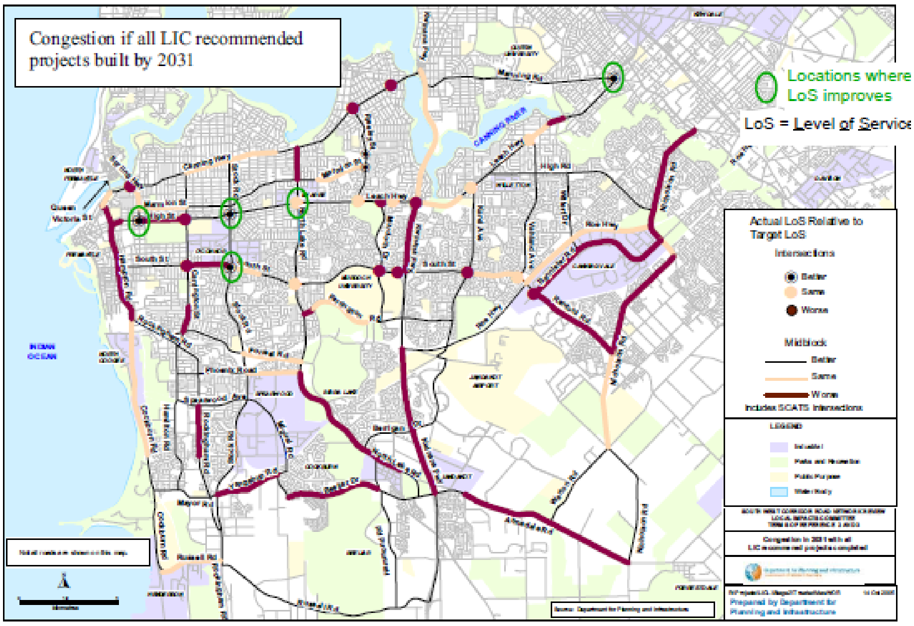
Figure 1a: Perth sub-region showing forecast traffic congestion and problems in 2031



Source: DPI (2004)

[4] Level of Service C is defined as "stable [traffic] flow, but most drivers are restricted in their freedom to select desired speed and to manoeuvre", and at intersections "Operations with higher delays, fair progression and/or longer cycle lengths. Individual cycle failures may begin to appear at this level. The number of vehicles stopping is significant at this level, although many still pass through the intersection without stopping [overall delay .20-35 seconds per vehicle" (DPI, 2004, citing U.S. Transportation Research Board, Highway Capacity Manual 2000, as adapted by DPI).

Figure 1b: Perth region showing extent of congestion and problems in 2031 after intervention



Source: DPI (2004)

More recently, transport analysis has broadened from conventional strategic (four-step) models and disaggregate models of network performance to incorporate many other approaches. Such advances as the rise of geographic information systems (GIS) has allowed for new methods to explore questions of equity and access (Halden, 2002), oil vulnerability (Dodson and Sipe, 2007), climate change (Hickman, Ashiru and Banister, 2010) and other emergent concerns. Activity- or destination-based accessibility modelling has expanded rapidly thanks to the recent coalescing of advanced GIS, comprehensive spatial datasets, exemplar projects and skills development in the planning and transport professions. Examples include accessibility assessments of food and alcohol retailing (Coveney and O'Dwyer, 2009; Hay et al., 2009; Sharkey, 2009), accessibility models of job opportunities (Geurs and van Eck, 2003; Weber, 2003), accessibility models of travel behaviour and energy (Titheridge, Hall and Banister, 2000) and accessibility models that explore social justice and social exclusion (i.e. Preston and Rajé, 2007).

Public transport focused accessibility models are also becoming more common. Amongst others, Hsiao et al. (1997) developed methods to measure pedestrian access to public transport stops. Murray and Wu (2003) developed an accessibility model aimed at reducing stop numbers and increasing population coverage, to reduce the costs of service provision. Liu and Zhu (2004) created accessibility surfaces for the Singapore MRT system using their 'Accessibility Analyst' framework. In Australia, Yigitcanlar et al. (2007) produced the first working model that produced accessibility surfaces and population coverage of public transport networks for South East Queensland's bus and rail services.

This paper describes two new accessibility tools developed and used in separate Australian cities designed to assist in decision making around future cities, where the objective is to achieve more sustainable urban travel where the dominant travel modes are walking, cycling and public transport. The application of each tool has intersected with transport and land use decision-making, attempting to reveal insights that would influence decision-makers to at least consider alternative transport futures. In this paper, the way in which the tools have been applied is briefly described, but the focus is reflective – considering the wider issues for strategic land use and transport planning. These are seen not only in the debates about specific design parameters for any tool used, but in the way this highlights more fundamental issues of path dependence in institutional and professional practice. The paper is structured as follows. First, conventional strategic transport models are reviewed with a focus on what they offer and on criticisms of the way they have been applied in practice. Second, the two accessibility tools are briefly described with a focus on planning issues being considered and the issues raised by the particular application. The final discussion section reflects on the broader issues for planning practice.

Traditional transport demand modelling tools

Conventional strategic transport models (commonly known as 'four-step' models) have been in use since the 1950s. These models have been improved in recent decades to include, for example, the consideration of public transport networks (in some localities) rather than simply their dominant focus on planning for private car travel. These models are still the mainstay in transport planning, used as a way to test scenarios at corridor and network levels for transport and land use arrangements. They focus on measures of efficiency such as vehicle-kilometres-travelled (VKT), mode share and travel time savings.

There are a number of criticisms of the measures used in such strategic transport models. A focus on 'travel distance saving' as a measure of efficiency certainly has merit in the pursuit of more sustainable travel. The UK's Planning Policy Guidance Note 13 -Transport (DoE & DoT, 1994) indicated that sustainable travel required both a reduction in car use and a reduction in distance travelled by car. But the merit of the focus on travel time savings and the way in which this is assigned a monetary value have been criticised by others. Metz (2008:8-9, 30) suggests travel time savings have short- but not long-run benefits due to societies generally having constant travel times, per person, per year, despite significant changes in cities over time, such as major road network expansion. He notes that people often react to road improvements by travelling greater distances at higher speeds, changing their origins and destinations, rather than reducing their travel time (Metz 2008:13). Added to this research, studies of travel demand management programmes have found that individuals will in fact accept a time impost when switching from car to public transport travel, instead valuing the relaxation benefits or opportunity to work while travelling offered by public transport (James and Brög, 1998). Metz (2008:42) argues that whilst 'conventional transport economics supposes that people seek to save travel time, whereas what they actually want is additional access.'

Traditional transport demand forecasting models extrapolate the future from past trends. They operate primarily by replicating existing conditions, testing future demand and effects and assessing the outcome of policy options from this premise (Litman, 2009, 1). This approach not only suffers from assumptions made about the future availability of resources (often it is assumed that the future will continue as in the past), but such trend-based transport demand forecasting acts as a potent constraint on policy formulation. In Australia the norm is to cater for increasing travel demand by increasing road capacity (the predict and provide paradigm). This solution is claimed to reduce congestion and therefore fuel use and air pollution. However, the dynamic impacts of travel time savings on mode choice and land use activity are not considered in the models. Furthermore, policy options for travel demand management or the use of congestion as a lever for mode change are rarely acknowledged.

Another area of criticism of the use of conventional transport models has been about the limited range of their application in exploring future transport and land use relationships. Such models are usually weak in their capacity to explore industry-occupation matching, and therefore the accessibility of jobs and housing by occupation type, as in the manner of Cervero and Wu (1998). An additional accessibility analysis is required, using supplementary census data. Similarly, conventional strategic models, as well as the normative network planning and transit-scheduling models, are not well-suited to exploring questions of transit accessibility.

The emergence of new public transport accessibility tools

This section describes the application of two new accessibility tools designed to assist in decision making for cities where the objective is to achieve more sustainable urban travel. These have been developed and used in separate Australian cities, in Perth the ‘Spatial Network Analysis of Multimodal Transport Systems’ (SNAMUTS) tool developed by first two authors and in Brisbane the ‘Modular Urban Land Use and Transport Tool’ (MULUTT tool developed by the third author and colleagues. These tools were developed in isolation from each other, but underpinning each was a realisation that transport planning has mostly moved away from comprehensive approaches towards a focus on specific projects and policies (see Banister 2002:131) and the addition of new tools, that unpack new dimensions and realise alternative possible ‘solutions’, are a profitable way forward. In our practice we are also aware that transport policy decisions are political and most transport planners have remained wedded to a technocratic role in advising decision-makers. These matters and their implications for future transport are reflected on in the final section of the paper. It is evident from the application of these new tools that there is a need to start with a clear vision of the future and view outputs against this set of clearly articulated end goals.

Case Study: Perth

There have been several applications of the SNAMUTS tool (see Curtis and Scheurer, 2010). This paper focuses on a recent application where SNAMUTS was employed to evaluate the proposals by the State

Public Transport Authority (PTA) for the next 20 years investment in public transport for greater metropolitan Perth. The PTA in developing their strategy wanted to test how well the proposed network and service performed in relation to enhanced public transport accessibility to key activity centres. We do not report in detail the actual proposals; instead in this paper our interest is in reflecting on the strategic implications of both the proposed approach and on observations made during discussion and debate with PTA officers when we presented our SNAMUTS findings to them.

SNAMUTS is a GIS-based tool designed to measure the accessibility provided by existing or proposed urban public transport networks in their current and proposed land use context. In particular, SNAMUTS endeavours to identify and visualise in a coherent mapping exercise a land use-public transport system's strengths and weaknesses of geographical coverage; the ability and efficiency to connect places of activity; the strategic significance of routes and network nodes, and the speed competitiveness between public transport and car travel. Careful consideration is made of how the analysis of public transport networks diverges, and requires different assumptions and definitions from the analysis of movement networks for individual transport (ie. pedestrians, cyclists and motorists). This led to the development of an impediment measure based on properties most closely related to users' experience: that is, travel time, journey transfer and frequency of service rather than geographical distance. For the sake of brevity and because our paper focuses more on the wider transport planning issues raised, we do not report the assessment of the PTA strategy for all SNAMUTS indicators in this paper.

The PTA supplied the proposed public transport network for the 2031 reference year. They also requested changes to three of the standard SNAMUTS measures. First, use of the inter-peak service was changed to the morning peak. Second, the 'contour catchment' measure was increased from 30 minutes to 45 minutes, thus extending the potential accessibility of the area 'on paper'. Third, only accessibility to 14 key activity centres was assessed, not the full set of 94 public transport-accessible activity centres identified in the earlier metropolitan strategy (WAPC, 2004). These were important changes, which will be discussed in the final section since there are far reaching implications for the competitiveness of public transport to the car for the individual traveller.

The evaluation of the PTA network focussed on the following objectives, based on the metropolitan planning aim of improving public transport access (WAPC, 2009):

- The extent to which potential accessibility of quality public transport was expanded to a larger proportion of metropolitan residents;
- The extent to which accessibility was enhanced across the fourteen key activity centres.
- The public transport 'effort' (performance of different transport modes and across corridors).

Table 1 summarises the basic assumptions for the construction of the scenario. The number of residents, jobs and students in metropolitan Perth is projected to increase by 39% between 2009 and 2031; in each reference year, only a small and roughly unchanging proportion of these (4%) is outside the walkable catchment area of public transport services during the morning peak. In practice, this mainly concerns activities in the rural outskirts of the city. Between 2009 and 2031, it is proposed to extend one rail line in line with city expansion plans and to develop a rail branch line linking the existing rail network to Perth Airport; several additional stations are proposed along the southern suburbs rail line. In addition to rail, a number of initiatives in the bus network are proposed to improve service levels, the most prominent of which is the establishment of a priority busway running into the Perth CBD and the provision of high-frequency express services between the CBD and a key activity centre. In total, the requirement for operational input in 2031 is between 58% and 60% higher than in 2009. Thus between 35 and 36 extra trains are needed (workings operated by multiple units are counted as a single train in this definition) while the number of buses is required to grow by between 328 and 344.

Table 1: Land use assumptions and service input per scenario (2009 = Status Quo, Scenario 2031)

Assumptions	2009	2031
Service Intensity[5]: Train	44	80 (+81%)
Service Intensity: Bus	587	915 (+56%)
Service Intensity: Ferry	1	3 (+118%)
Service Intensity: Total	**632**	**997 (+58%)**
Number of Nodes	46	49
Activities in metropolitan area	2,629,497	3,655,399
Activities in serviced area	2,528,198 (96%)	3,513,548 (96%)

Extent of accessibility improvements across the metropolitan region and in key centres

The Composite SNAMUTS Accessibility Index allocates between 0 and 7.5 points for each of the seven indicators: Degree Centrality, Closeness Centrality, Contour Catchment, Congested Speed Comparison, Nodal Betweenness and Connectivity to generate a single measure. Higher figures indicate better accessibility, up to a theoretical maximum of 45. Table 2 shows the scores for each of the 14 key centres and the average. Note that the figures are based on an arbitrary system of conversion and weighting; they are not suitable to calculate percentage increases or declines in accessibility, but rather to compare centres against

[5] The measure for service intensity in Table 2 is defined as the number of revenue service hours per hour per mode offered across the network during the morning peak.

each other, and to develop benchmarks of public transport accessibility standards. As such, absolute increases in this index are used as a scale for measuring accessibility improvements. On average, composite accessibility across the network goes up by about 3 points on the 45-point scale between 2009 and 2031.

Table 2: Composite Accessibility Index for key activity centres

Key Activity Centres	2009	2031
AC1 (outer region)	12.5	15.4 (+2.9)
AC2 (middle region)	16.5	19.5 (+3.0)
AC3 (inner region – major employment centre)	16.3	20.5 (+4.2)
AC4 (inner region)	19.6	21.9 (+2.3)
AC5 (outer region)	20.0	24.0 (+4.0)
AC6 (outer region)	16.0	17.8 (+1.8)
AC7 (outer region)	17.0	19.0 (+2.0)
AC8 (middle region – large employment centre)	24.9	28.8 (+3.9)
AC9 (Airport)	7.3	19.9 (+12.6)
AC10 Perth Central	33.5	37.7 (+4.2)
AC11 (outer region)	16.2	18.6 (+2.4)
AC12 (middle region – major employment centre)	25.6	29.0 (+3.4)
AC13 (inner region – major employment centre)	17.1	22.4 (+5.3)
AC14 (outer region)	-	15.4
Average Key Centres	**18.7**	**22.1 (+3.4)**
Standard Deviation Key Centres	*6.5*	*6.1*
Average Network	**14.9**	**18.0 (+3.1)**
Standard Deviation Network	*6.2*	*6.5*

Expansion of 45-minute travel time contour across the metropolitan region and in key centres

Important centres with a metropolitan-wide function have not benefitted from the proposed measures to the extent necessary to ensure they are very well served by public transport. This can be seen in Table 3 where the ‘contour catchment’ index shows the percentage of total metropolitan activities (residents, jobs and students) within the defined walkable catchment area of activity nodes that can be reached from the reference node within a public transport travel time of 45 minutes or less and a maximum of one transfer. The average contour catchment improves significantly in 2031 over the status quo, but this effect is not even across the centres - as the standard deviation measures suggest, the centres are becoming more unequal as a result of the network and service improvements by 2031. The greatest improvement can be recorded for AC9, owing to its integration into the new rail network. Two outer region centres (AC5, AC1) benefit from greenfield growth in their vicinity. Inner urban densification in combination with some faster services and a reduced transfer time assumption makes itself felt, particularly in three large employment centres (AC3; AC8, AC13) but to a lesser extent almost universally across the network. However two of these centres (AC3 and AC13) perform a particular metropolitan-wide function where one would desire a superior 45-minute catchment to these centres from across the metropolitan area, to match or come close to that at AC10 Perth Central or at least AC12, but this is not achieved.

Table 3: Contour catchment change for key activity centres

Activity Centres	2009	2031A
AC1 (outer region)	17.1%	26.6%
AC2 (middle region)	28.2%	31.9%
AC3 (inner region – major employment centre)	36.1%	46.1%
AC4 (inner region)	45.2%	45.9%
AC5 (outer region)	35.2%	49.4%
AC6 (outer region)	14.1%	15.9%
AC7 (outer region)	37.8%	40.1%
AC8 (middle region – large employment centre)	62.0%	80.0%
AC9 (Airport)	12.2%	56.8%
AC10 Perth Central	77.8%	83.6%
AC11 (outer region)	23.3%	26.4%
AC12 (middle region – major employment centre)	66.8%	72.9%
AC13 (inner region – major employment centre)	35.9%	59.9%
AC14 (outer region)	-	15.8%
Average Key Centres	**37.8%**	**46.5%**
Standard Deviation Key Centres	*20.5%*	*22.2%*
Average Network	**30.0%**	**40.2%**
Standard Deviation Network	*19.4%*	*21.7%*

Public transport network efficiency

It was found that the proposed measures roughly doubled the global efficiency of the network, while requiring additional operational input in the order of 60%, so there is a net synergistic effect. 'Global efficiency change' is the comparison of the entire network before and after a series of interventions, in this case the transformation from the status quo to the 2031 target network. In relation to 'Local efficiency change' (refers to the same comparison on a node-by-node basis)[6] **-** the essence of this index is to assess how well a particular network performs in comparison with historic or future land use-transport configurations – or: by how much does ease of movement across the network improve/deteriorate? We found that across the key centres, an efficiency gain of 49% can be recorded. The finding of a net gain of this magnitude is encouraging and indicative of a positive synergy effect of the measures proposed for 2031. The figures in Table 4 show an anomaly for AC9 as a result of a reallocation of land use activities from one activity centre to this, thus the defined land use catchment of AC9 grows substantially at the expense of the other.

Table 4: Local Efficiency Change for key activity centres

	2031
AC1 (outer region)	+67%
AC2 (middle region)	+41%
AC3 (inner region – major employment centre)	+77%
AC4 (inner region)	+60%
AC5 (outer region)	+24%
AC6 (outer region)	+69%
AC7 (outer region)	+75%
AC8 (middle region – large employment centre)	+24%
AC9 (Airport)	+2,319%
AC10 Perth Central	+38%
AC11 (outer region)	+38%
AC12 (middle region – major employment centre)	+30%
AC13 (inner region – major employment centre)	+61%

[6] This index is defined as the ratio of the actual inverse average shortest path length between the node in question and all other nodes in 2031 over the same measure in 2009. The measure is weighted by the product of the defined catchment size of the pair of nodes in question (measured in residents, jobs and students); following the logic that connectivity between larger nodes has a greater bearing on the efficiency of the network than between smaller nodes. Since the total number of metropolitan residents, jobs and/or students in 2031 changes over 2009, this index is also corrected accordingly by multiplying the results by the square of the increase/decrease ratio in metropolitan activities. The efficiency change measures have been designed to deliver a meaningful assessment of network reconfiguration or expansion scenarios.

AC14 (outer region)	-
Global Efficiency Change	**+49%**

In detail, it was found that these efficiency improvements were largely achieved by increased service frequencies: the basic structure of the network in existing areas is not altered significantly, with the exception of the Airport rail link and to a lesser degree the new dedicated busway. This is illustrated by the network property indicators: across the network, closeness centrality, a measure of ease of movement incorporating speed and service frequency, is enhanced significantly, while degree centrality, a measure of the prevalence of transfers, remains at similar levels in 2031 as in 2009. The 45-minute public transport contour catchments of strategic nodes are significantly improved across the network; this is primarily due to land use intensification in existing urban areas, more efficient transfer facilities and times, and to a lesser extent network extensions and greater travel speeds on existing routes. Similarly, speed competitiveness of public transport over road travel improves in 2031 over 2009, though primarily from the (unproven) assumption of less time-consuming and more efficient transfers between routes.

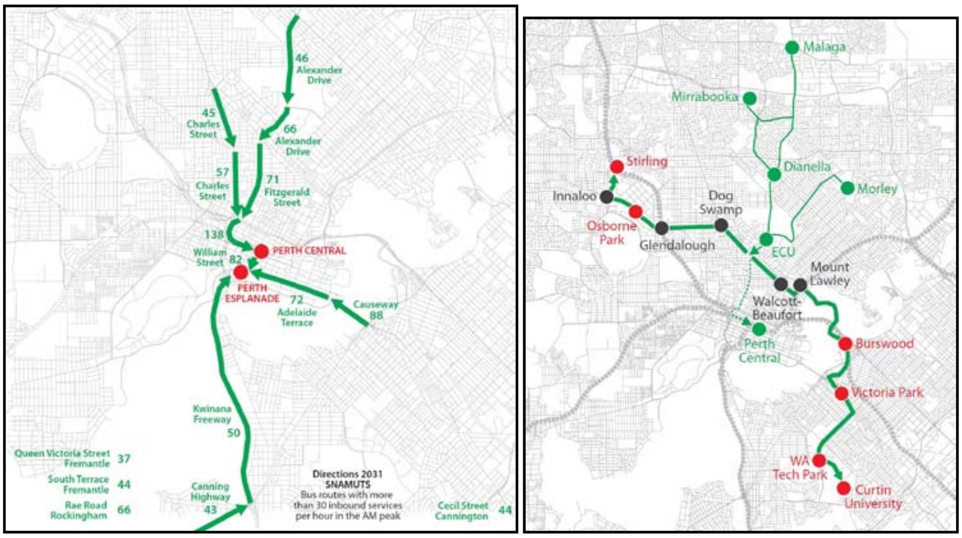
The rail system consolidates its domination over the geographical distribution of travel opportunities, even though only two to three rail extensions are proposed by 2031. These rail extensions are located in areas where they cannot play a role that would relieve existing rail routes from network significance and thus spatially redistribute their tasks more evenly. The busway adds a radial corridor of critical significance, though it is doubtful whether the limited performance and capacity of a bus system is suitable for servicing it efficiently. For this reason, the bulk of the 'movement economy' on the network, or the ability of nodes to benefit from passing traffic (Hillier, 1996), remains concentrated to a limited number of strategic centres.

Discussion

The analysis shows that as a result of the PTA proposals public transport accessibility in 2031 will improve over 2009 in Perth's metropolitan region if the proposed measures are implemented, in absolute terms as well as relative to population and employment growth. The concern is whether the rate of growth is sufficient for the requirements at 2031 of likely mandatory standards for accessibility and carbon emissions, as well as possible constraints in the availability and affordability of transport fuels. In 1995, the Metropolitan Transport Strategy (DOT, 1995) set a mode share target for public transport of 13% of all trips in 2029, up from 5% in 2000. The figure for global network efficiency change between 2009 and 2031 discussed above and amounting to 49% (relative to population and employment growth) needs to be regarded within a policy context that has consistently and for many years emphasised the need for mode shift from the car to public transport in metropolitan Perth. Even following a tangible (though not monumental) mode shift towards public transport during the 2000s, the aspirational 13% mode share in 2029, representing an increase of public transport journeys per person in excess of 100% during the next two decades, will not be achievable if the rate of growth remains at a percentage level in the vicinity of the efficiency gain found in this indicator. While acknowledging that these figures are not necessarily in a linear and proportional relationship, they still pose a critical question as to whether a public transport system that improves by less than 50% can be realistically expected to attract more than 100% of additional passengers. The authors harbour doubts about this capability.

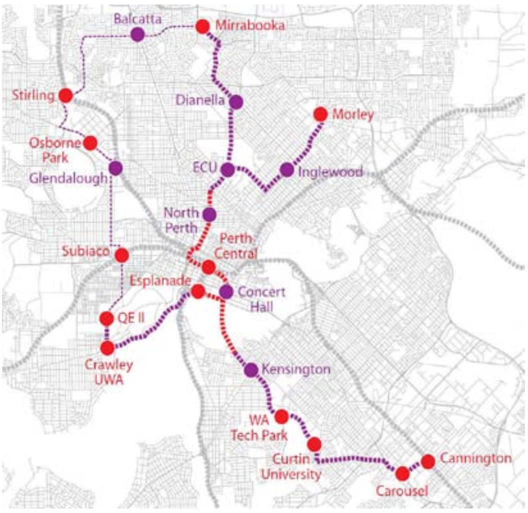
One key concern is the focus of the PTA proposals on incremental improvements to the existing radial, mono-centric network. This results in lost opportunities where additional orbital links could help link strategic centres more directly and take pressure off the central city. Furthermore, this approach results in new constraints emerging on some radial bus routes with very high service density. An example of this issue is shown in Figure 2A showing those bus routes in the metropolitan area that carry in excess of 30 buses per hour during the morning peak in the peak direction. The threshold of 30 buses, equivalent to a 2-minute frequency, is critical in several respects. For the passenger, such frequency marks the level at which average waiting times have reached their practical minimum; additional services are unable to reduce this measure further if dwell times at bus stops and traffic signals are taken into account. For the operator, this is the frequency at which buses will begin to run in bunches even where on-street bus priority has been maximised (where it has not been maximised, this effect will make itself felt at much lower frequencies). Service frequencies higher than every 2 minutes on surface modes are thus inefficient for both passengers and operators and should be avoided wherever possible. Wherever the physical capacity to move a certain number of passengers supplied by the high frequencies is excessive, this can be achieved by rerouting some services away from the high-frequency corridor and to other destinations. This has two benefits: it creates new transfer-free links that may relieve pressure from the central area; it addresses the need to improve polycentric accessibility. Wherever the physical capacity is required, an upgrade to a higher-performance mode that can move greater number of passengers with fewer, larger vehicles should be considered (ie bus to light rail). A demonstration of these solutions is shown in Figure 2B, re-routing some services from radial corridors with excessively high frequencies to provide transfer-free connections to key suburban centres instead.

Figure 2: A (left): Bus route segments with more than 30 services per hour in the peak directions in 2031, showing actual number of services per hour; B (right) Network changes



While the above proposals offer a range of uncomplicated opportunities for improving network coverage, connectivity and operational efficiency, reliance on such optimisation of the bus network alone may not yet deliver the overall magnitude of network performance required to meet strategic targets for the desired role of public transport in the passenger transport market. For this purpose, the gradual introduction of a higher-performing mode such as light rail (LRT) on critical corridors in metropolitan Perth needs to be considered for the 20-year time horizon. In earlier work (Curtis and Scheurer, 2009) it was shown that an integrated network of bus, LRT and heavy rail modes in conjunction with a public transport-oriented urban growth strategy can increase network efficiency by up to 167% in 2031. This would address two significant shortfalls in the 2031 network proposal: the need for high-performance access to the two key activity centres (university/business centre clusters) as well as a vital performance upgrade for an important (currently bus-based) radial corridor (Figure 3). This would provide an alternative for travel through the CBD for access to and from inner urban destinations, to relieve the CBD area from network congestion and to increase public transport mode share across the inner suburbs where road congestion is most acute.

Figure 3: Two-route radial LRT network. Red segments are underground, purple segments are above ground. Bold lines indicate stage 1, fine lines indicate stage 2.



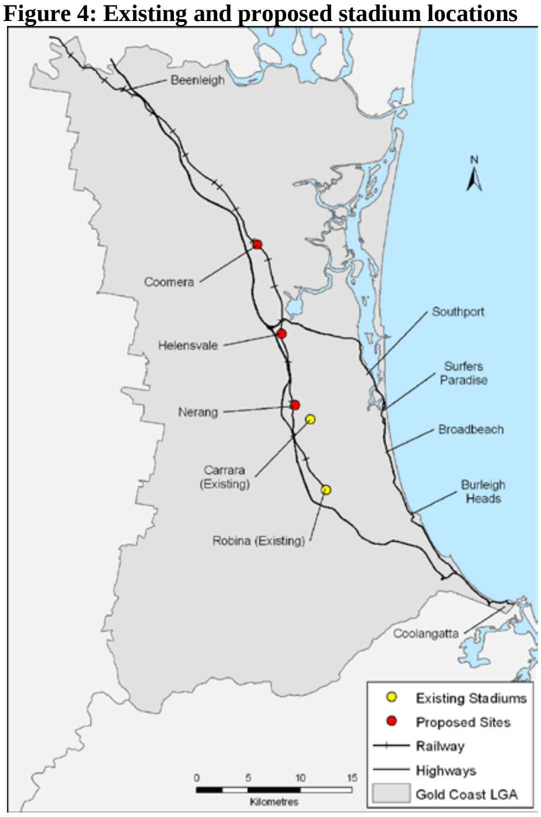
As these issues were discussed with PTA officers it became apparent that much broader institutional issues were acting as barriers to the achievement of a future vision. It was clear that the PTA proposed network for 2030 was tempered by views on the preferred mode, by a vision based on the existing city and public transport network structure. It was also clear that while the above ideas for light rail were being discussed, these were considered to be the '2050 Plan'. Two factors appeared to constrain the future thinking, both influenced by the traditional ways of transport modelling and forecasting: first that these proposals would be costly and would not be funded by Treasury; second, that while these proposals would offer public transport accessibility for residents in line with policy objectives, the current demand (6% mode share across the metropolitan area) meant it would be difficult to justify finance. This demonstrated clearly the way decision makers rely on traditional models, transport forecasts based on past demand, and these act as a serious constraint to developing and delivering a future vision. Furthermore, while recognising the need for the new proposals, delaying their implementation to 2050 may well be too late. What is needed is a step-change rather than continued incremental change, both in developing visions and in the tools used to support decision making.

Case Study: South East Queensland

The second accessibility model presented here is a component of a broader transport and land use planning framework known as the 'Modular Urban Land Use and Transport Tool' (MULUTT) which has been used to explore accessibility on Queensland's Gold Coast. This framework has seen the development of modules for exploring jobs-housing balance, carbon and oil vulnerability impacts, but the focus here on its assessment of public transport and walking accessibility. The model is essentially a destination-based accessibility model run using Arc-GIS software. It makes use of data layers for the available road network, the scheduled public transport network, and the walking path networks for the city. Ease of access is defined in the model in terms of travel time, considering all the legs of the public transport journey. This includes time spent either walking to and from transit stops, or waiting to interchange between services.

The model has been used, amongst other tasks, to examine public transport access to proposed stadium locations on the Gold Coast. Stadiums are an excellent example of a land use heavily reliant on public transport and walking access for bringing patrons to and from games and events. Indeed, in Australia most stadia are now subject to very strict travel demand management measures (see Burke and Woolcock 2009). The proposal to develop a new Australian Football League (AFL) stadium in Queensland's second largest city led to considerable debate over whether the existing site, at Carrara, would be suitable or whether an alternative site should be pursued. A map showing the stadium locations, and the competitor, Skilled Park rugby league/soccer stadium at Robina, is included in Figure 4. Accessibility by public transport was a critical planning dimension, given that non-car access was to be heavily curtailed. The Carrara site was likely to be cheaper, but had perceived weaknesses in transport and land use terms. Prior to a location being selected, the research team used the MULUTT accessibility model to assess four of the key sites being considered, as well as the site (see Figure 4). The analysis sought to determine the number of Gold Coast residents that could access each of the stadium sites easily by public transport.

Figure 4: Existing and proposed stadium locations



Conventional strategic transport modelling was unable to contribute much to this problem. Conceptually it required a series of catchment analyses, based on walking and public transport access. The MULUTT accessibility model was used to assess accessibility, for the whole Gold Coast population, based on all stages of a journey from home to the stadium, including: walk access from home to a public transport stop; waiting time for the public transport vehicle; travel time on the vehicle; interchange with other public transport services (if necessary); and the walk access from the final public transport stop to the proposed stadium site. The model was applied to the existing scheduled public transport network, the Gold Coast population, and the available road network. The study area was defined as the Gold Coast Local Government Area (LGA) as of June 2006 (to match the Australian Bureau of Statistics 2006 census). Data on sports traveller preferences was not available. As such, two accessibility measures were developed: access within 45 minutes door-to-door from home to the stadium was defined as “high accessibility” (this roughly equates to a half hour public transport journey plus walking time); access within 75 minutes door-to-door was defined as “reasonable accessibility” (this roughly equates to an hour’s public transport journey plus walking time). The model calculated which parts of the road network were accessible, via the public transport network, within these parameters. The model then calculated the number of residents in these locations, providing a meaningful insight into the potential public transport catchment of the stadium if located in each site (see Burke and Evans forthcoming; Burke, Evans and Hatfield 2008 for further information).

Spatial mapping of ease of access to the site eventually selected, Carrara, is presented in Figure 5. This shows that the stadium site, located away from the city’s only rail line, failed to provide high levels of access to the key growth corridor of Coomera and Beenleigh. Comparisons with other locations on the rail line, such as at Helensvale and Nerang, showed that these sites could service a much greater proportion of the existing population, and also to these growth corridors. The map for the Nerang site is shown in Figure 6.

Figure 5 Public transport accessibility to Gold Coast Stadium, Carrara

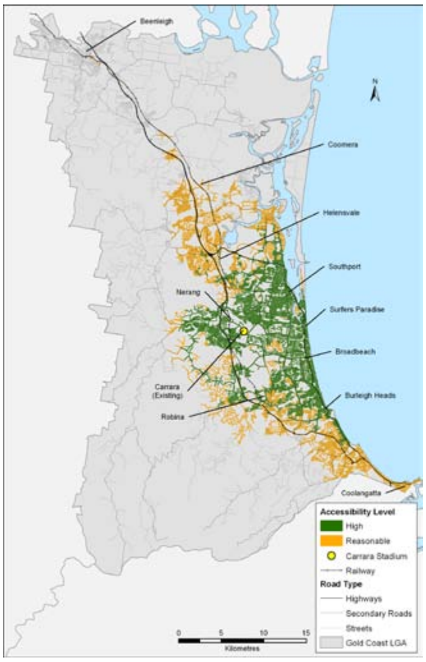
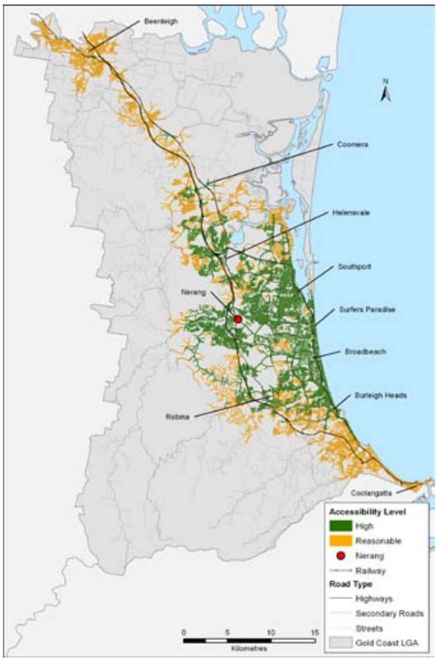


Figure 6: Public transport accessibility to the proposed Nerang stadium site



In eerie parallel to the issues raised in the Perth case, the information underpinning the site-selection processes of the stadium funders and developers were based on models of demand that gave little attention to accessibility, ensuring transport access was given limited importance in decision-making. Demand analyses were based on rough catchment estimates only. The MULUTT mapping outputs, provided late in the decision-making process, were the first to show the catchments based on access via the transport modes future stadium patrons would be able to use. Alas, despite evidence-led advocacy, the cheaper Carrara site was selected, partly due to the global financial crisis occurring at the same time the decision had to be made. An opportunity for transit-oriented development has been lost and there will need to be significant effort (and probably state subsidy) in creating feeder bus services from the rail line to the stadium. But just as important, locating at Carrara may have been to the detriment of the stadium, its tenant club and the sporting code of Australian Rules football. Even in a case as obvious as a new sports stadium, land use decision-makers rely on models and evaluation frameworks that are largely ignorant of accessibility, and struggle to bring transport and land use dimensions to the fore. This leads to constrained visions, compromised built environment outcomes and quite probably a weaker economic future.

The MULUTT accessibility model is being used to explore other questions of urban structure, including examining the transport impacts of government sector employment relocation in Brisbane. For such different trip purposes, distinct accessibility measures are being used. As it is being further tested and revised it is hoped that this model, as part of a broader transport analysis framework, can help improve our understandings of transport-land use relationships and lead to more optimal decisions in future. Furthermore, by producing outputs in formats decision-makers can understand, transform their thinking.

New demands and challenges

Benefits of focussing on metropolitan-wide supply side modelling as opposed to simply applying demand forecasts

Traditional strategic transport models clearly have their place, but how much decision makers (and here we include the practitioner's using these tools and advising government) should invest in the tools' outputs is a key question. Of interest is the mindset that modelling processes may create. All too often the authors have experienced a mindset characterised as introverted, rather than outward looking at the bigger picture. Does the modelling process limit or in some way constrain the futures thinking? Does the problem lie with the tool or the operator (and so the institution)? Can the addition of new tools, which ask quite different questions and take new angles, such as accessibility modelling, transform this practice?

In the Perth case, limits were set into the existing transport models in several ways. Firstly, in setting the measurement parameter at a 45-minute public transport journey, this mode was immediately positioned as uncompetitive to the car, so reducing its patronage potential. Secondly, by weighing infrastructure investment against forecast demand for public transport (indicative of the traditional mindset that the future will be like the past) rather than attempting to deliver on a future objective including an increased level of investment, strategies that ensure patronage growth are not pursued. We saw this in the reluctance to entertain a bid for a light rail network by 2030 (when it was evident that this was the solution needed), instead delaying that proposal for the 2050 plan. In the Brisbane case, the business case for the stadium site gave little attention to public transport access despite it being fundamental to shaping the future catchment and probable patronage.

The need to and challenges of, setting benchmarks that define quality public transport and accessibility

Another challenge lies in improving accessibility models and their parameters, so as to define logical benchmarks. The 'levels of service' used in by transit operators regarding travel times (Kittleson & Associates, et al. 2003) have flaws, but do at least in part reflect passenger preferences. Suggested improvements, such as Racca's (2004) attempt to develop measures that include whether a trip is direct or includes interchange across services, as well as transit travel time, do not seem to entirely equate with the research of Mees (2010) on the real-world experiences of cities with highly networked public transport systems, which require interchange but experience high patronage. Obtaining some clarity, and making those measures readily understood by decision-makers, could go some way in raising the profile of accessibility modelling, and its importance in decision-making frameworks.

The need for long term visions and the need for a step change:

It is evident that the past practice of incremental and ad hoc changes to the public transport network that we will not meet transport challenges in Australian cities in a timely fashion. What is required is a step-change, but this requires both a long term view of future city size and structure (a challenge for land use planners who have thus far not planned in this way), attention to detail in re-designing public transport services, and considerable public funding in the short term (where public transport has been the poor cousin relative to private transport). It is questionable whether the pace of change necessary can be achieved.

Both Perth and Brisbane are relatively well placed to move forward on parts of this agenda. Each have dramatically improved their public transport management arrangements in recent years with TransPerth and Translink (covering South East Queensland) both being the type of single agency that can 'carry out the tactical planning necessary to provide an integrated network of routes and services' (Mees 2010: 153). The Queensland Government has commenced use of accessibility modelling to support its own decision-making processes. Yet elsewhere there are problems, with roads agencies tending to be stronger and more self-assured in their methods, which are generally accepted all the way to the Treasury Department, and the public transport agencies unconfident and often aiming low. Land developers are wary of transit-oriented development, for a multitude of often sound reasons, and may not adequately take public transport access into account, even in the case of a large football stadium. This suggests that it is not just new tools that are needed, nor even exemplar projects such as those described above. New spaces for dialogue and engagement, and the collaborative development of new approaches, may all be needed to create pathways to improved transport and land use planning.

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