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Abstract

**“Quantitative Approaches to Needs Based Assessment of Public Transport Services
– The Hobart Transport Needs Gap Study”**

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This paper describes a new approach to assessing the performance of public transport networks in meeting the needs of transport disadvantaged people in the community. It describes how the approach has been developed and applied using Hobart Tasmania as a study area.

The approach aims to identify gaps in the public transport network where travel needs are high but services are poor or non-existent. It involves the use of readily available socio-economic statistics to quantify the distribution of needs in the community. A public transport network model identifies the quality of service offered by the public transport system to these groups and a Geographical Information Systems approach is used to display the distribution of gaps between service and needs which are identified.

The technique is highly relevant for cities where the justification of public transport subsidies is largely social needs based i.e. where congestion and environmental benefits of transit are less critical

The views expressed in this paper are those of the authors and do not necessarily represent those of Monash University, the Department of Infrastructure Energy and Resources or Booz Allen Hamilton.

1. INTRODUCTION

Catering for the needs of the transport disadvantaged remains an important objective and justification for the provision of public transport throughout the world. In Australasia's smaller capital cities and in rural and regional settings, this objective is the principal rationale for the provision of public transport subsidies. In these circumstances road congestion relief and the environmental impact reduction effects of public transport are relatively minor.

Despite the apparent importance of addressing community needs in public transport system design, comparatively little quantitative work has been undertaken to ensure our public transport systems have been designed in relation to these needs. In particular the allocation of services geographically tends to be based more on historical precedents than on a rationale assessment of the distribution of potential users in the community.

This paper presents the results of a research project undertaken in Hobart Tasmania to :

- measure the geographical distribution of transport need in the community ;and
- to assess the distribution and quality of public transport service provided geographically; and
- to identify 'need-gaps' between community needs and service provision

The research project was a consultancy undertaken for the Infrastructure Policy Division of the Department of Infrastructure Energy and Resources (DoIER) by Management Consultants, Booz Allen Hamilton (Booz Allen Hamilton 2003).

This paper is structured as follows

- Transport Needs Gap Measurement – A Review
- A New Approach to Needs Gap Measurement
- Key Findings
- Conclusions

2. TRANSPORT NEEDS GAP MEASUREMENT – A REVIEW

A literature review of quantitative approaches to measuring the geographical distribution of people facing transport needs was undertaken in Currie and Wallis (92). This identified a range of approaches from the literature, however key components of the methodologies applied included:

- A population measure, which values the size of need relative to the size of the number of people in a defined target population
- Socio-economic measures, which consider the size and distribution of social groups who are considered to be in need of transport services
- Measures of transport supply which assess the availability of transport so that needs can be assessed relative to supply
- Measures of distance, cost or accessibility to facilities e.g. work or shopping. These measures reflect the difficulties (or impedance) in gaining access to desired facilities and help to identify situations where accessibility is poor.

Perhaps one of the more 'refined' approaches identified in the literature was that adopted by Searle (87), MVA, (81) and Moseley, (79) which is often termed the 'Lewes Approach'. In this case the focus of analysis was rural settlements in East Sussex in the UK. The scale of transport needs was identified by examining census records for the number of persons in social groups which were considered to be 'needy' e.g. people living in households with low car ownership. The quality of supply was measured by examining public transport schedules to classify access to particular trip purposes e.g. shopping, as impossible, poor, medium or good. Needs gaps were identified by comparing settlements with high concentrations of persons in needy groups which have poor or no access to public transport.

Currie and Wallis (92) proposed an Australian based methodology for needs gap assessment by firstly measuring needs :

- Using readily available census and social services information to identify socio-economic indicators which would measure the scale of transport needs faced by residents in a local area. These indicators were sourced from an analysis of the Adelaide Household Travel Survey, Travers Morgan (1990) by comparing socio-economic groups demonstrating low trip making behaviour
- A measure of accessibility (in this case travel distance to the CBD) was adopted to include in the needs indicators since this identifies 'locational disadvantage'
- The generation of a single 'need score' which combines the socio-economic and accessibility indicator to give each location a score between 0 and 100 (with 100 being the location with highest of the combined indicator values of all the areas analysed).

Needs gaps were identified by measuring the quantity of the supply of transport including:

- A public transport indicator (the density of vehicle kilometres provided in the daytime interpeak per km²)
- The number of community transport vehicles supplied by area
- The number of persons in the community who are members of the taxi subsidy scheme
- Again a single supply score is generated by combining the component indicators and generating an index valued between 0 and 100 with the highest score representing the highest level of supply.

The above approach was applied in Adelaide and reported in Travers Morgan (1992). Needs gaps were identified where the needs scores were high but supply scores were low. Other applications in NSW, West Australia and New Zealand were also identified (Travers Morgan 1988, 1989 and 1990).

Table 1 shows more recent applications of these techniques. A key focus of the recent work has been:

- The comparison of needs gaps between settlements (including regional cities in Queensland)
- The adoption of the more detailed 'Lewes Approach' to supply side assessment of the quality and quantity of public transport service provision. This is in the Mornington Peninsula study (1997).

Table 1 : Applications of the Australasian Public Transport Needs Gap Analysis Approaches

Application	Source	Notes
Potential Initiatives for Improving Public Transport in Regional Queensland	Booz Allen Hamilton (98)	<ul style="list-style-type: none"> • Needs measurement approach used to identify concentration of needs in Queensland's main regional cities • Supply indicator was bus km p.a., community transport and taxi vehicle fleet size • Analysis compared needs and supply between cities rather than within cities
Mornington Peninsula Public Transport Strategy Study	Booz Allen Hamilton (97)	<ul style="list-style-type: none"> • No transport need indicators used, rather population size used to identify size of regional settlements • A 'Lewes Approach' used to quantify the quality of public transport, walk and taxi travel to 15 trip purpose destinations • Analysis identified needs gaps between regional rural settlements rather than within these settlements

3. A NEW APPROACH TO NEED GAP MEASUREMENT

3.1 REASONS FOR CHANGE

Public transport in the form of scheduled route bus services is supported by the State Government of Tasmania in Hobart, Launceston, Burnie and Devonport. Subsidies of some \$22M p.a. are provided to support these services. To ensure value for money in the provision of these subsidies the State Government must ensure the service is designed to meet the needs of the community. This is the central justification for the subsidies supplied. None of Tasmania's major cities faces significant traffic congestion (compared to Mainland cities). Hence the rationale for provision of public transport subsidies for congestion relief is only a minor basis. Also the share of travel by bus is low hence any environmental justification for Government support of bus services is only of moderate importance. Social needs remain the major driver of service justification.

The DoIER Tasmania was seeking methods to assess the performance of the public bus services provided in relation to the distribution of travel needs of the community. In 2002, management consultants Booz Allen and Hamilton were commissioned to use the methods developed by Currie and Wallis (92) to investigate needs gaps in Hobart.

There are some specific issues regarding the Hobart needs gap project which required further development of the methodology:

- A local area assessment of a major urban area was required. This contrasted with more recent applications of the methodology which compared needs gaps between settlements
- The 'supply side' focus of the analysis was on the public bus service. Hence a more detailed methodology was required to measure the quantity and quality of the service provided

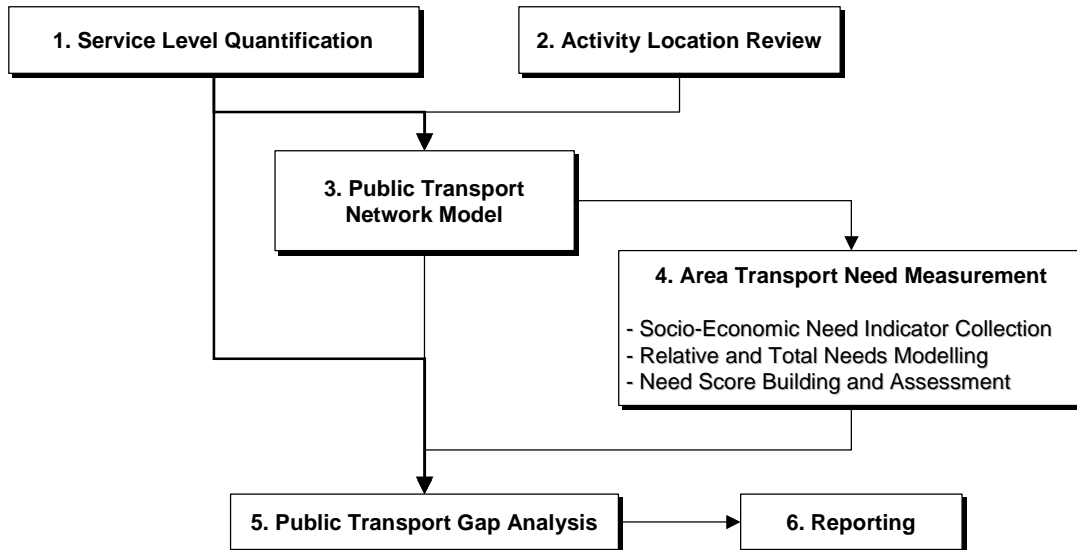
- It was hoped to apply more recent developments in Geographical Information Systems (GIS) to display the results of the analysis graphically such that results may be more readily understood.

3.2 REVISED APPROACH

3.2.1 Overview of Approach

In general the proposed approach combined the needs indexation approach suggested by Currie and Wallis (92) and a more detailed assessment of transport supply measurement based on the 'Lewes Approach'. The latter involved the development of a public transport network model which measures the quantity and quality of public transport provision to a high level of detail. The TransCad transport modelling system (Caliper, 2003) was adopted to undertake the network modelling. The same system was adopted to display the results of the analysis using GIS. Figure 1 shows the key steps in the analysis.

Figure 1 : Revised Needs-Gap Analysis Approach



3.2.2 Network Supply Modelling

A public transport network was constructed from an analysis of the bus routes, stops and timetables in Hobart. In summary the modelling process involved:

- Definition of the location of facilities/shops etc for 14 trip purposes (see Table 3)
- The transport model measured the quality of travel by public transport for 5 time periods including:
 - A.M. Peak (0700:08:59)
 - Interpeak (09:00 to 14:59)
 - Evening (18:00 to end of service)
 - Saturday P.M. (12:00 to 18:00)
 - Sunday P.M. (12:00 to 18:00)
- The analysis generated a matrix of travel cost results for 14 trip purposes by 5 time periods and for 387 travel zones (some 27,000 trip cost outputs)

- For each time period the transport model measured walk access time to bus stops, wait time, fare and travel time on buses and walk egress time. Table 2 shows the key assumptions for generalized cost modelling included in this analysis.
- Where more than one option was available for travel, the lowest cost path was chosen. Where it was possible to walk directly to the nearest destination (without using a bus) this was considered to be preferable up to a distance of 800 meters. Some origin zones were very large and hence walking to and from buses was considered too far given the provision of routes within these areas. Distances above 400m were identified as the threshold for feasible walk access to/from buses.

Table 3 shows the trip purposes used in the analysis. Figure 2 shows an example of the distribution of facilities for the 'Pharmacies' trip purpose. It also illustrates the generalised travel costs output from the model. The shading on Figure 2 shows the level of travel costs from light shading (low cost) to heavy shading (high cost). The darkest shade identifies where travel using bus (or direct walk) was not possible.

Table 2 : Generalised Cost Assumptions – Bus Travel Quality Modeling

Element of Travel	Assumptions
Walk Access/ Egress Time	<ul style="list-style-type: none"> • Measured between residential zone centroid and stop or from a stop to the facility destination. • Walking is made along the streets of Hobart rather than as the crow flies • A walking speed of 4.32 kph is used. A weighting of 2 was applied to walking time to model passenger perceptions of walk quality
Fare	<ul style="list-style-type: none"> • Based on an analysis of revenue and boarding data from the Hobart ticketing system. Included an average fare for travel between zones including higher fares for Hobart coaches routes and also consideration of concession fares for particular passenger groups
Wait Time	<ul style="list-style-type: none"> • Based on half the effective headway of routes operating between on and off stops. Headways based on an analysis of bus schedules. • A weighting of 2.0 was applied to wait time to model passenger perceptions of waiting.
Value of Time	<ul style="list-style-type: none"> • Time was valued at \$8.69/hour (or 14.48c per minute) based on values used elsewhere in the transit planning industry
Transfer Time	<ul style="list-style-type: none"> • A transfer penalty of 20 minutes was added to the time of those transferring between bus routes

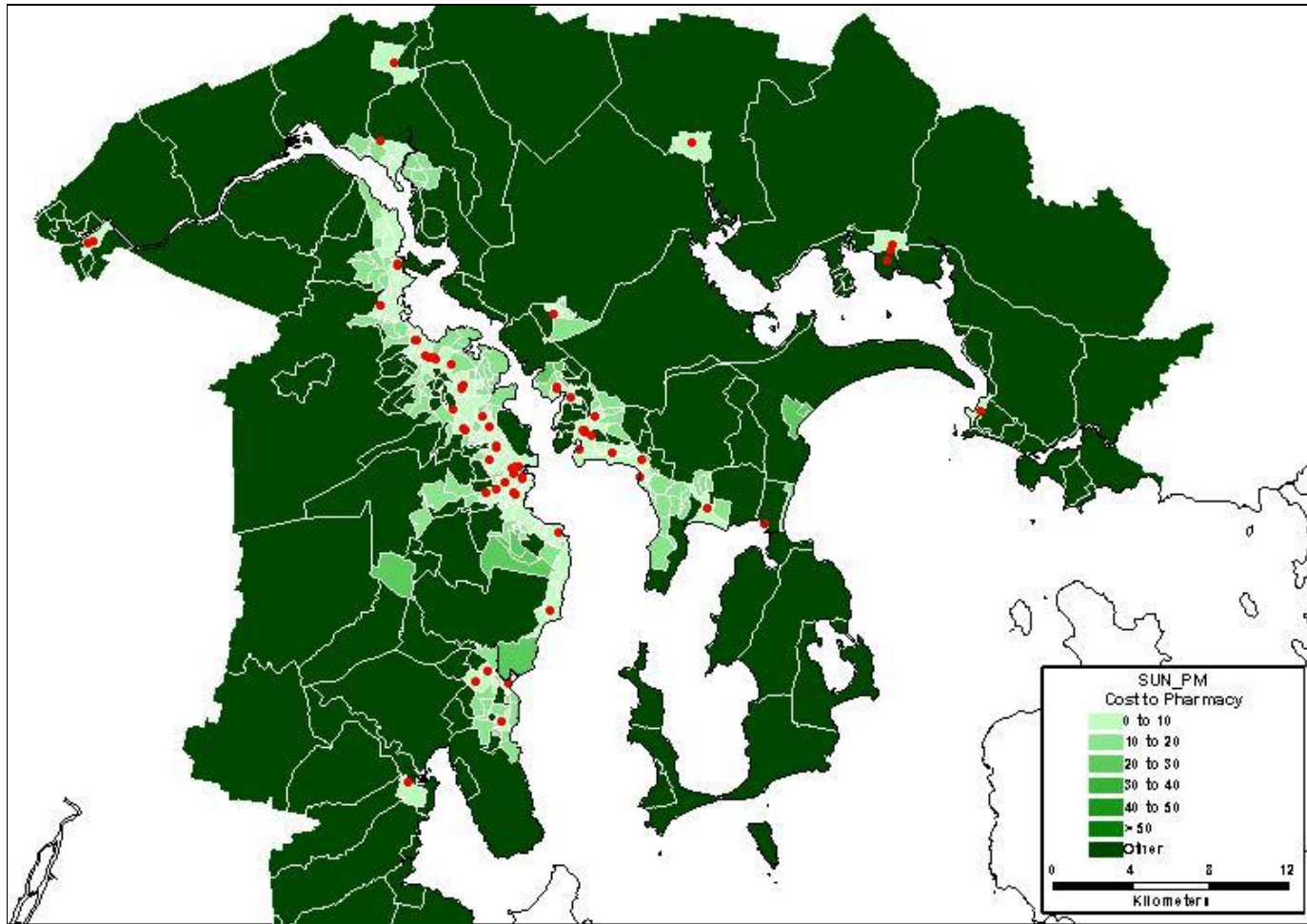
Source: 'Public Transport Modelling Results' Hobart Transport Need-Gap Analysis Working Paper - April 2003

Table 3 : Trip Purposes Adopted – Bus Travel Quality Modeling

Trip Purpose Destinations Used	
4	CBD – Hobart CBD
4	Pools – public swimming pools
4	Shops – major groups of shops
4	Universities – major tertiary education facilities
4	Sports – key recreational sporting facilities
4	Pharmacy – chemists
4	Regional – larger regional shopping centers
4	Employers – larger scale employers main location
4	Schools – major primary and secondary schools
4	Hospitals – major clinics and hospital sites
4	Food Stores – convenience shopping/ local stores
4	Cinema – movie houses
4	Child Care – site for a child care center or crèche
4	Doctors – individual surgeries or clinics

Source : 'Public Transport Modeling Results' Hobart Transport Need-Gap Analysis Working Paper - April 2003

Figure 2 : Example Trip Purpose Locations (Pharmacies) and Bus Travel Quality (Total Generalised Cost) Modeling Results



Note: Red Dots indicate the location of pharmacies in the Greater Hobart Region. Shading shows the quality of travel by bus in categories of generalised travel cost (\$). The Darkest shade is trip not possible

Analysis was undertaken for Hobart's 387 (2001) Census collector districts (CCDs). This is the smallest unit of analysis where census data could be collated for the needs analysis.

3.2.3 Area Transport Need Measurement

In outline the methodology for measuring needs involves:

- Assembling transport need indicators for a series of areas
- Defining a single need score for each area based on the relative indicator values

Transport need indicators used in the analysis are identified in Table 4.

Table 4 Transport Need Indicators and Weights Applied

Need Indicator	Source	Weight
Adults without cars	Census 2001 and BAH analysis ^(a)	0.22
Accessibility	BAH analysis ^(b)	0.17
Persons aged over 60 years	Census 2001	0.16
Persons on a disability pension	Centrelink and BAH analysis ^(c)	0.14
Adults on a low income	Census 2001 and BAH analysis ^(d)	0.11
Adults not in the labour force	Census 1996 and BAH analysis ^(e)	0.10
Students	Census 2001 ^(f)	0.10

Notes:

(a). Based on the number of cars per household and the number of persons aged over 16 (Census 2001).

(b). Based on the distance to Hobart central business district (GPO) traveling on public roads (Australian Bureau of Statistics 2001).

(c). Based on the number of persons on a disability pension in a postcode grouping (Centrelink 2001). This was then spread across CCDs based on number of persons aged over 60 (Census 2001).

(d). Based on household income < \$200pw (Census 2001) and Hobart statistic of on average 2 persons aged over 16 in each household (Census 2001).

(e). Based on persons not in labour force in 1996 for the 1996 CCDs (Census 1996). This was spread across the matching 2001 CCDs. When a one to one mapping did not exist, the data was spread in equal proportions – bounded above by the number of people in the 2001 CCD (Census 2001). As the population of Hobart did not grow in the period 1996-2001 (Australian Bureau of Statistics 2001), the total number of persons not in the labour force in 2001 was assumed consistent with that estimated in 1996.

(f). Based on persons enrolled in an educational institution – including primary and secondary school, university and Technical and Advanced Further Education.

Source: Currie & Wallis(92) and Booz Allen Hamilton analysis.

Accessibility is the only indicator that is not readily available from government statistics. Accessibility measures the natural convenience or difficulty that a person is faced with when traveling to basic services, due to proximity of their home. The accessibility measure used was the distance travelled along public roads. This was sourced from a road network model for Hobart using the TransCAD modelling system.

A single need score is derived the indicators by firstly 'standardising' each value. This involves re-setting the scores to a value of between 0 and 100 based on the relationship of the score to the highest in the series. Each standardised value is then added together and a finalised need index generated by standardising the final scores.

3.2.4 Need Gap Analysis

The needs gap analysis is undertaken by comparing the need scores with the network supply scores for each time period and trip purpose. To assist in understanding the considerable quantities of data this analysis produced, all values were classified into categories; very low, low average, high and very high. Hence an area with very high need could be identified and its quality of supply measured.

Supply measures included a categorisation of 'trip not possible' where the public transport service did not enable travel for most residents within a zone.

4. KEY FINDINGS

4.1 QUALITY OF BUS ACCESS

Figure 3 shows the total generalised cost of travel measured for the Hobart network by time period and trip purpose. This indicates that:

- The cost/time of travel using bus varies considerably by trip purpose as well as by time period
- Trip purposes with a greater number of facilities and also more localized facilities are easier to get to. Food stores for example are consistently the easiest to get to. There is also little variation in the travel time/cost to get to Food Stores by time period. This is suggestive that walk access is a key feature of access to these more localised facilities (rather than bus access)
- Trip purposes with consistently easier (lower cost) access are (in order):
 - Food Store
 - Schools
 - Doctors
 - Pharmacy
 - Child Care
- Trip Purposes with the most difficult (longer time/higher cost) are (in order of difficulty):
 - Hospitals
 - CBD
 - University
- With few exceptions, this pattern of access is replicated by time period but with an overall decline in access quality for all trip purposes at weekends.

Analysis also indicated that the bus network could not provide a service to all areas. This was because some zones were very large and had dispersed low density development. It was impractical to service these areas with a bus. Hence up to 19% of zones in the A.M. Peak had no service. This increased up to 35% on Sundays. Interestingly the share of areas without bus access was more variable by time period than it was by trip purpose. This demonstrates the expansion and contraction of the bus network by time period is more significant than its connectivity to local and regional destinations.

4.2 DISTRIBUTION OF TRANSPORT NEEDS

Figure 4 shows the distribution of Hobart transport needs. This includes a 'blow up' of the areas in inner Hobart. Needs are illustrated in Figure 4 by the use of choropleth shading; darker shades are areas with higher need (very high need group) and lighter have lower needs.

In general the distribution of needs is 'patchy' suggesting a scattered distribution of high and low scores with no particular trend towards inner vs outer areas being either high or low scores. There are some fringe areas with clear concentrations of very high and high scores including the following areas:

- New Norfolk area
- Developed parts of Bridgewater and Gagebrook

Figure 3 : Bus Travel Total Generalised Cost Shown by Equivalent Travel Time by Time Period and Trip Purpose

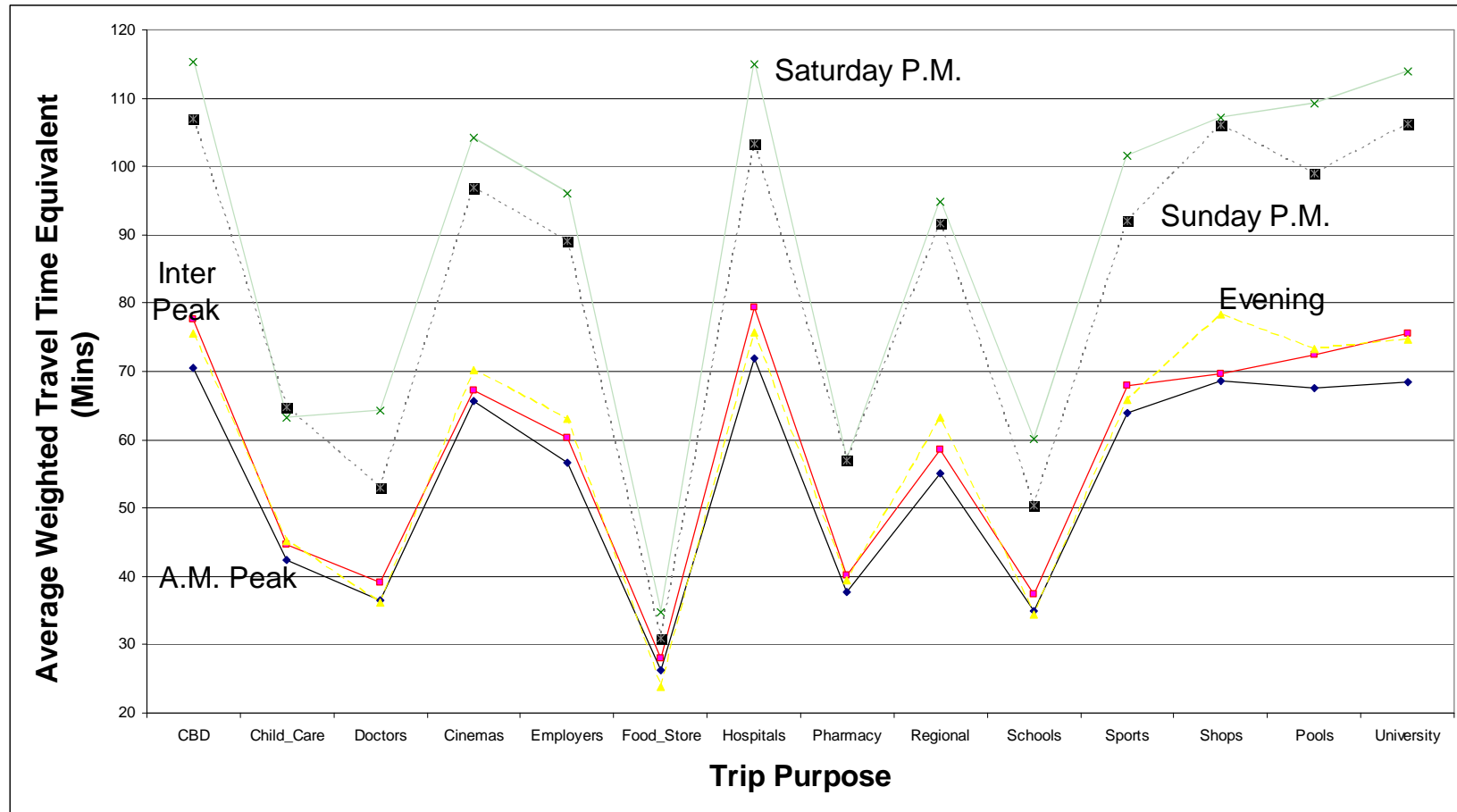
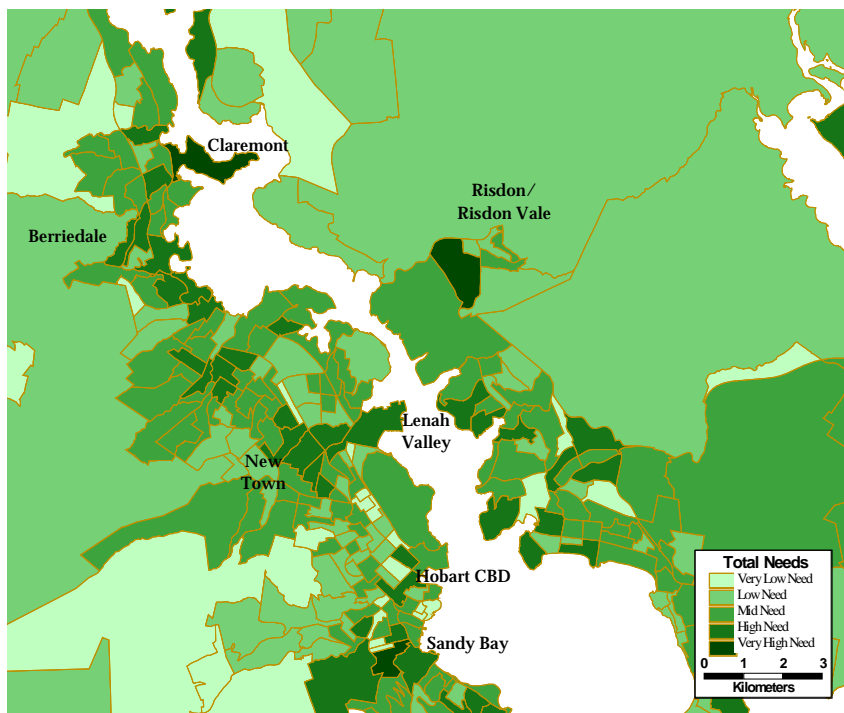
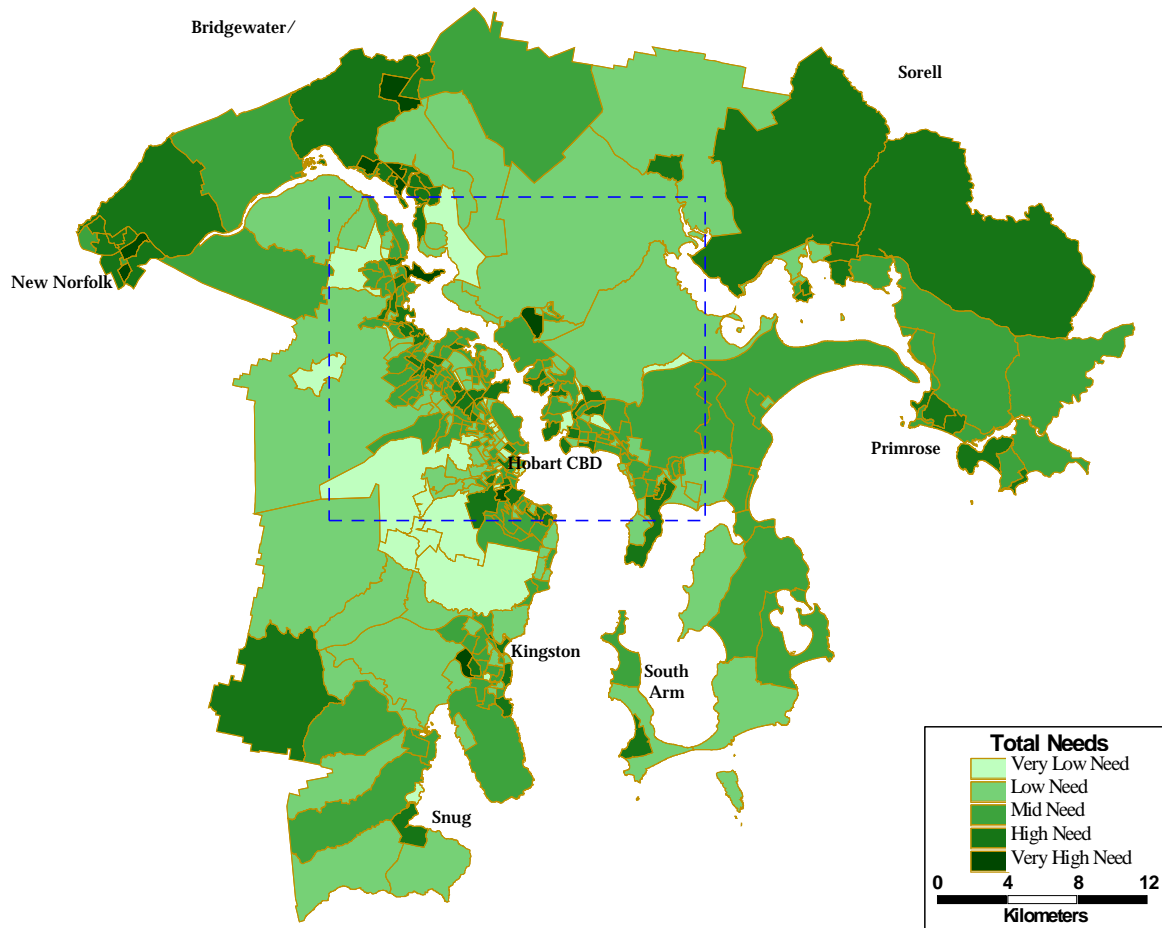


Figure 4 Spatial Distribution of Total Transport Need Score Categories



Fringe areas with concentrations of high need scores include;

- Kingston
- Sorell
- Parts of Snug, Primrose Sands and the South Arm/Opossum Bay peninsula

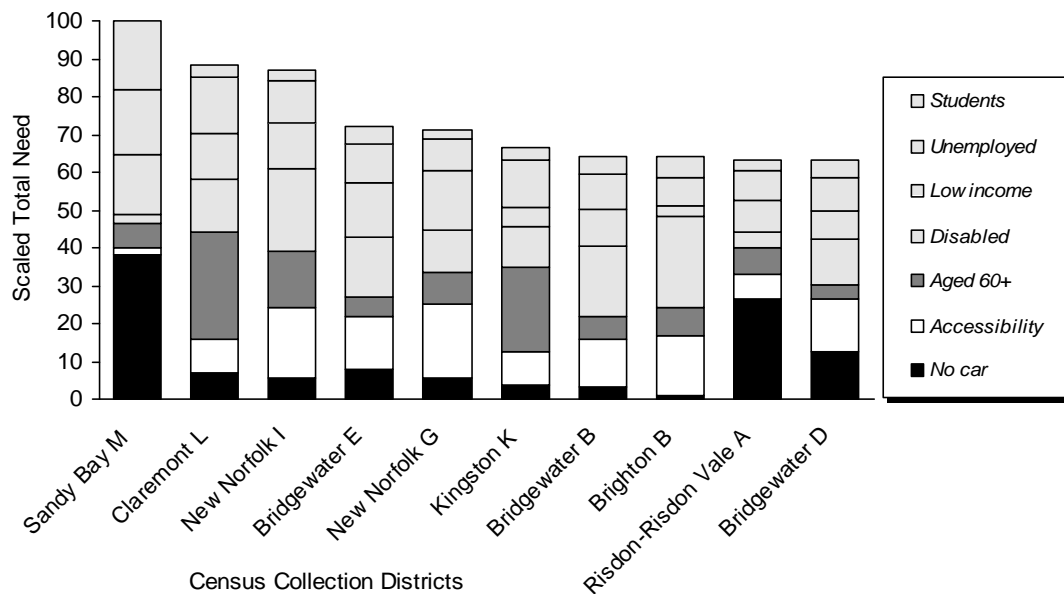
In the more metropolitan areas there are mostly high category scores in :

- A band between New Town and Lenah Valley
- Risdon/Risdon Vale
- The Berriedale and Rosetta area
- Glenorchy
- Sandy Bay
- Parts of Claremont

In general undeveloped areas have very low need scores. This is to be expected given low total population levels.

Figure 5 shows the size of component indicator scores for the highest rated need areas.

Figure 5 Component Indicator Share of the Total Need Score (Very High Category Areas)



Notes:

(a). The component indicators shown represent the true contribution to the Total Need. These component values have already been multiplied by the associated weights, and standardised between 0 and 100, so that the CCD Total Need score is simply the sum of these components.

Source: Booz Allen Hamilton analysis.

This indicates that:

- Sandy Bay M and Risdon-Risdon Vale A, both inner metropolitan areas, owe a large part of their Total Need score to the low car ownership indicator
- Claremont and Kingston owe a reasonably high proportion of their scores to high numbers of persons aged 60+

In general the other very high Total Need score areas have high scores due to high values in all the remaining indicators. This is a significant conclusion particularly for the fringe areas consistently mentioned so far.

It is also significant that fringe areas score highly not only due to being less accessible (as may be expected). They also have high scores due to high concentrations of persons with low car ownership, high levels of disability etc. **We can conclude that in fringe localities, persons most vulnerable to transport disadvantage live in areas where public transport is more likely to be limited relative to inner city areas.**

4.3 NEED GAP ANALYSIS

Figure 6 shows the important needs gaps identified in the analysis. The heavy shaded areas are those with identified high needs but relatively poor quantity and quality of public transport (i.e. where costs of using buses are very high). This analysis presents results for the weekday a.m. peak. It is also a summary of access to all trip purposes. Figure 6 has 7 sets of need-gap shading categories. These represent the cases of needs gap identified in Table 5.

Table 5 Transport Need Gap Categories

Rating	Transport Need Rating	Public Transport Quantity/Quality
Worst Case 	Very High	Service Not Available
	Very High	Very High Cost
	High Need	No Service
	Mixed High/Very High	Very High Cost
	Medium Need	No Service
	High Need	High Cost
Less Worst Case	Mixed Very High/Medium	Mixed Very High/Medium Cost

Key conclusions from this analysis are:

- There are no areas with the worst case combination of needs and service i.e. the very high needs and no service.
- The need gap areas have a distinctly urban fringe flavour
- The most 'severe' needs gap score category is mostly rural fringe and includes (in order of priority):
 - Kingston K
 - New Norfolk H
 - Primrose Sands C
 - Risdon - Risdon Vale A
 - Primrose Sands A
 - New Norfolk E
 - Brighton Region D
- In all of the 'higher' needs gap score group the following regions are mentioned on a significant number of occasions across all trip purposes:
 - Brighton
 - New Norfolk
 - Sorell
 - Bridgewater
- Several large rural zones feature in the 'Medium Need – No Service' group. This is because they are too large to be effectively serviced by a bus. This group is interesting in terms of needs gap assessment since it is unlikely that

conventional bus routes will ever be able to effectively service these areas. Nevertheless the analysis identifies medium travel needs which seek some form of public transport

The main urban areas identified in the analysis are (in order of priority):

- Risdon/Risdon Vale A – in the highest needs gap group of the data (High Need – No Service). This is a satellite community including many persons in the high transport needs group. This is a large zone lying to the West of Sugarloaf Road including Risdon Gaol. Access distances to bus services in this area are too long to walk making buses unavailable for the average resident of this area
- Claremont L – in the Mixed Very High/High Need and Very High/High Cost group. This area has significant development including retirement homes around a peninsula with poor bus service levels
- Dynnyrne-Tolmans Hill B – also in the Mixed Very High/High Need and Very High/High Cost group. This zone straddles the 'Southern outlet' highway in hilly terrain. There are pockets of residential development along short 'cul-de-sac' side roads which would be very hard to service by bus. Walk distances to services in these areas is too far for reasonable access to bus stops
- Geilston Bay A – in the Medium Need – No Service Group. A large Derwent side zone with essentially a rural residential distribution. Includes remoter settlements like Store Point without any bus access

Interestingly the analysis revealed that there was little difference in the distribution of need gap occurrence by time period. Although public transport service levels fall on weekends and evenings, this does not affect the locations which have need gaps. Rather it affects the severity of needs gap. Hence a severe need gap area may have a better service in the peak, but it is still poor relative to other areas.

The distribution of need gaps did vary by trip purpose. The main factor was the distribution of trip purpose land use locations. For more localised facilities such as access to a local store, it was less common to identify need gaps. For trip purposes with single or a few sites e.g. the CBD, universities or hospitals, the travel task was more onerous and hence need gaps were more likely to occur.

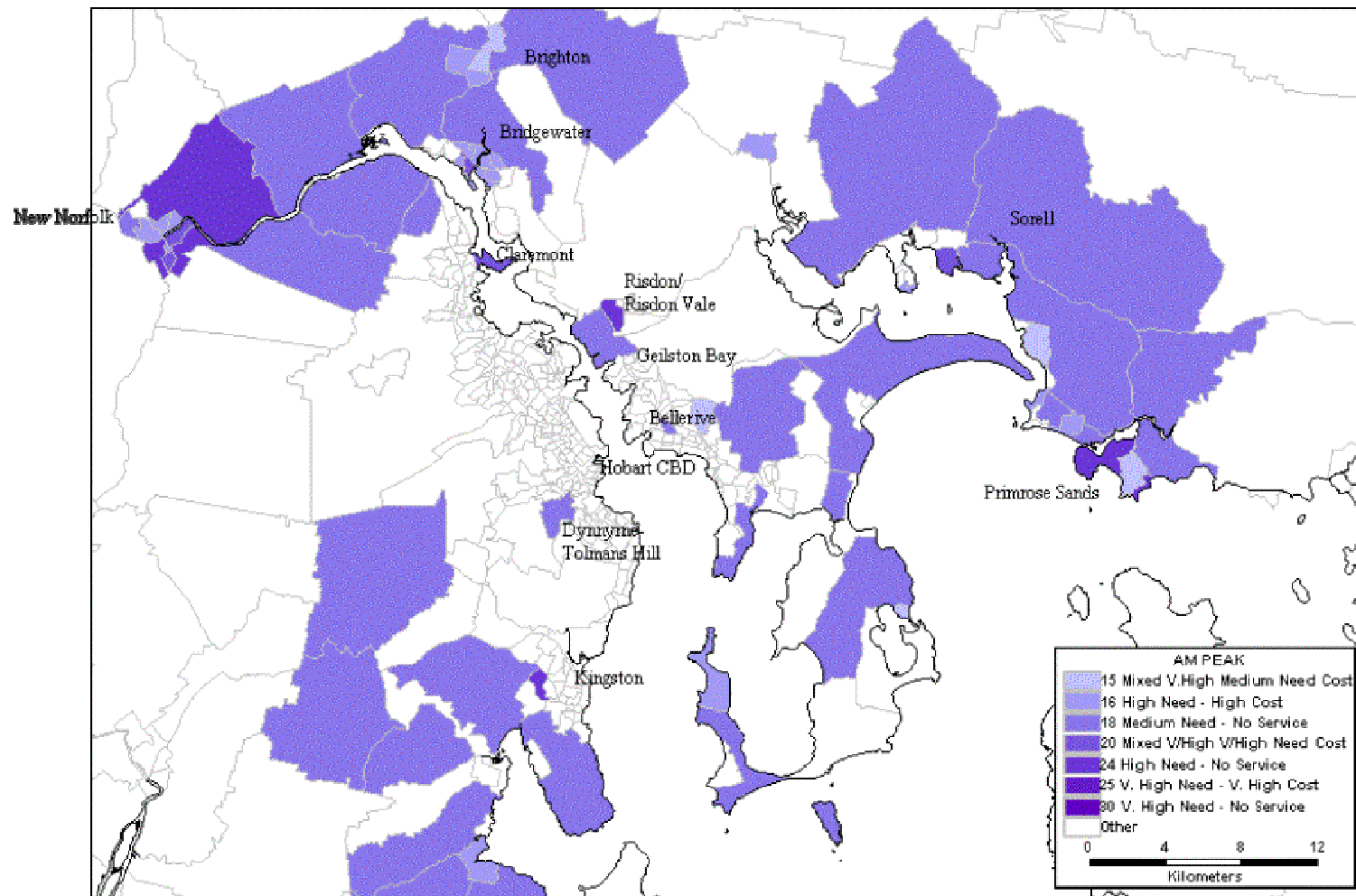
5. CONCLUSIONS

This paper presents the results of study aimed at measuring the geographical distribution of transport need and comparing this with the distribution of public transport service quantity and quality. The analysis has developed the concepts of travel need measurement identified by Currie and Wallis (92) by undertaking a more in-depth measurement of public transport service levels using a public transport network model and in the use of a geographical information system to display results

The results provide an interesting insight into the distribution of travel need in the Hobart community. In general areas of high need with poor public transport service lie on the fringe of urban areas. It is of a particular concern that the analysis has identified fringe settlements where large groups of people known to have difficulties with transport (e.g. low income and low car ownership groups) live in areas located further away from urban facilities and where public transport access is relatively poor. Put another way, large numbers of people known to have travel issues are located in places that have relatively poor public transport options.

The analysis provides a reliable and defensible basis for identifying priorities to adjust public transport services to better meet travel needs in the community.

Figure 6 : Areas with High Need Gap - A.M. Peak (Average of All Trip Purposes)



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