Travel Time Performance Programme: A Step toward Congestion Management System

Terry Brown, *Director (Resolve Group)*
Matt Ensor, *Technical Director, Transportation (BECA Infrastructure)*
Chris Vallyon, *Traffic Analyst (BECA Infrastructure)*
Leon Wee, *Travel Demand Project Manager (Transit New Zealand)*

Executive Summary:

To make wise decisions about the road network we need good traffic information. Without clear and consistent information, we can't tell what's actually happening on the road network; we can't see what errors have been made in the past, what trends might be developing, or what actions need to be taken or behaviours changed in response. If we are serious about moving from the traditional predict and provide concept to the operations management concept, collection of clear and accurate information should be a top priority. We can't manage what we don't know.

One of the data collection programmes implemented by Transit New Zealand and Councils around New Zealand that was initiated Year 2002 is the Austroads Travel Time performance programme. This programme provides travel time performance information on strategic routes along state highways and arterial roads. A performance indicator known as the "Congestion Indicator" (CGI) was adopted to allow a comparison of the performance of the monitored network with New Zealand's other main centres, as well as Australian centres. Currently this programme is implemented in Auckland, Wellington, Tauranga and Christchurch.

This paper reports on the resulting trends uncovered by the congestion monitoring programme and suggests applications of these performance information to improve the efficiency of road network.

1. Why conduct Travel Time Surveys:

Although congestion is an experience that many people encounter on a daily basis, the scale and effects of congestion across a network are impossible to quantify through simple observation.

The combination of GPS and GIS technology enable Transit and Councils to create a quantifiable measure of the time that is lost as a result of congestion. This aids Transit and Councils to gain an appreciation of where congestion occurs, trends in the performance of the strategic roading network, as well as being able to report on specific route travel times.

Travel time surveys provide an important and useful step in monitoring congestion, and in doing so aid government authorities in meeting the objectives of the Land Transport Management Act. The surveys provide a snapshot of congestion twice per year, which can be used to:

- Identify trends in travel times (both for the region as a whole, as well as routes)
- Identify congested routes (or sections on routes) as well as pin point recurring congestion
- Provide information on the variability of travel times for the same trip on different days of the week and different years
- Plan for roading investment
- Assess the effects of major roading projects and also land use development changes

Complementing this travel time performance programme and other traffic data collection programme, Transit and Council, with consultancy expertise, is able to better target congestion management and better tackle what is, without doubt, a billion dollar issue.

2. Data Collection

The Travel Time Surveys are conducted using the international Austroad 'floating car' methodology. Vehicles drive at set times along set routes and the speed of traffic is measured using GPS devices that give the location of each vehicle every 3 seconds. This data is then analysed using computer software.

The travel speed data is collected over five weekdays, separated into six sections: morning,peak, business interpeak and afternoon peak in both inbound (toward relevant CBD) and outbound. Separating inbound and outbound traffic provides a better idea of where congestion occurs, allowing key chokepoints on the network to be pinpointed more exactly. Travel time surveys are also planned during weekends in cities such as Auckland where weekend traffic is becoming an issue.

Providing business interpeak data enables a comparison of peak and interpeak traffic flows and provides and understanding of how the network responds to the peak loading caused by the effect of school and commuter traffic.

3. Data Analysis

The Austroad Travel Time Performance programme calls for the data to be analysed to provide the following outputs:

a) ***Average Travel Speed*** which is calculated as follows:

*Average Travel Speed (Km/hr) = L / T*60 *60*

Where:

- L = Length of road section driven (these are based on predetermined GPS nodes);
- T = Mean travel time in seconds to travel the road section.

b) ***Congestion Indicator (CGI)*** which is calculated as follows:

*CGI = ((T / 60) /L) - ((L / S)*60)/ L)*

Where

- CGI = Congestion Indicator;
- T = Mean travel time in seconds to travel the road section;
- L = Length of road section driven;
- S = Speed Limit for the road section.

c) ***Variability*** (VTT) which is calculated as follows:

VTT = 1.44x (SD/T)

Where:

- VTT = Variability;
- SD = Std deviation;
- T = Mean travel time in seconds to travel the road section.

4. Data Analysis

GIS system is used to calculate the required output and results are presented onto maps as shown below. Such presentation of the results enables areas of major travel time delays to be identified graphically through the use of colour.

Figure 1: Example of Auckland CGI Map for an AM Peak

The use of GPS and GIS technology makes the data collection more accurate and cost effective while also enabling user-friendly presentation of the results.

5. "Congestion Indicator" the Travel Time Delay Performance Indicator

Placing a 'floating car' in traffic with onboard GPS devices provides the travel speed of traffic for a travelled route. However, this on its own does not give an idea of delay in travel time as it does not take into consideration the difference between the actual speed and the ideal speed. For this reason, a formula has been developed called CGI (Congestion Indicator).

The delay is calculated on the basis of the measured time of travel taking into account both congestion and intersection delays compared to the theoretical travel time at the posted legal speed limit without constraints. CGI is derived by comparing the actual speed travelled to the nominal speed of the section of road being travelled on. CGI is a means of comparing delay in travel time on roads despite differing speed limits. For instance, traffic travelling at average speed of 40km/hr on a 50km/hr speed limit is experiencing a very high Level of Service, where as traffic travelling at average speed of 40 km/hr on a 100km/hr motorway is experiencing poor Level of Service. If the speed of traffic were being compared without considering speed limit, the two roads would appear to have the same level of service.

6. Travel Time Variability

The Travel Time Performance programme also provides a measure of the variability of journey times experienced by road users. This gives an idea of the difference that a driver will experience in terms of travel times by travelling along the same stretch of road on different days (such as commuting to work). Variability of travel times can be a source of

frustration for road users, and can have a significant economic effect due to the uncertainty of trip duration, for instance, on freight movements and deliveries.

7. Year 2006 results for Auckland

The average traffic speed in Auckland has improved marginally across all time periods, bringing them back to March 2004 levels. The highest congestion indicator continues to occur in the AM peak, with the March 2006 congestion indicator of 0.72 minutes delay/km. Although this represents a high degree of congestion, it is 0.08 minutes delay/km less delay than the results for March 2005.

As in previous years, there is a significant drop in the congestion indicator during the interpeak period.

Auckland continues to have the highest level of travel time variability with a high degree of uncertainty of travel times experienced by road users. PM peak variability for March 2006, at 35%, is the highest figure recorded for any city since the surveys began.

In 2006, the travel survey results for Auckland included, for the first time, information regarding congestion on the city's strategic freight network. Of interest for freight operators, is the significant difference between peak and off peak travel speeds on the strategic freight network. The average speed difference between AM peak and interpeak for the freight network is 25km/hr. This means that a freight operator travelling at the average travel speed for a distance of 100km along the monitored freight network during AM peak will take 154 minutes, where as the offpeak time would take 94 minutes. This would amount to an average off-peak time saving of one hour, or 0.6 minutes per km travelled.

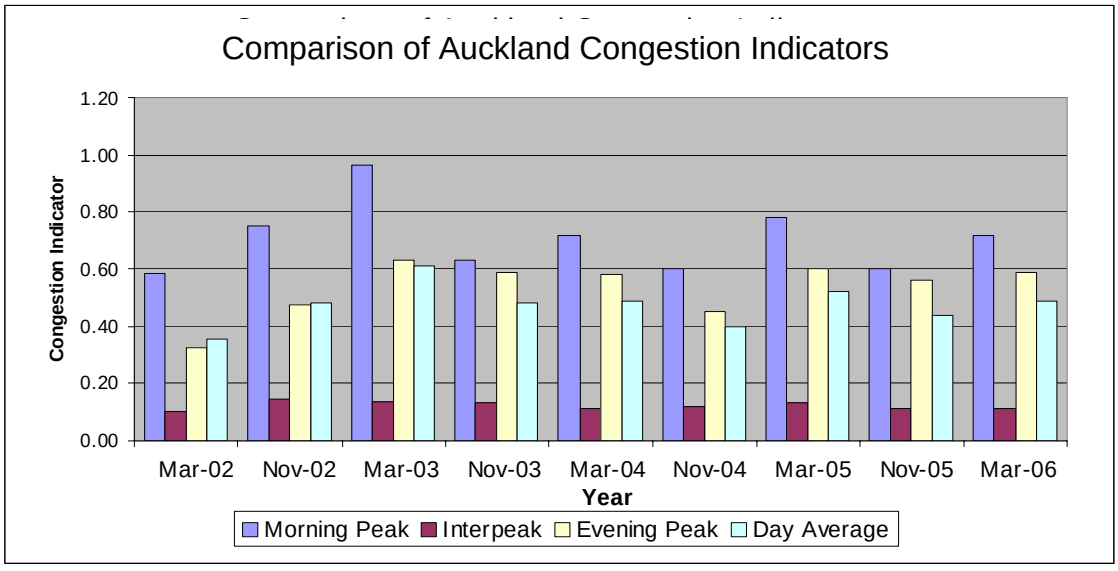


Figure 2: Congestion Indicators for Auckland[1]

[1] The GPS/ GIS collection methodology was first adopted in November 2003. The March 2003AM peak data was affected by adverse weather.

8. Year 2006 results for Wellington

Traffic speeds have increased across all time periods for March 2006 compared to previous March surveys.

The lowest average actual travel speeds continue to occur in the AM peak period, however there has been significant improvement, with a 5km/hr increase from average speeds in March 2005, and 4km/hr higher than March 2004.

Congestion indicators have decreased for all time periods for March 2006 compared to previous March surveys. The most significant decrease has been during AM peak congestion, with the amount of delay caused by congestion reducing by 0.13 minutes delay/km compared to March 2005.

The highest variability in Wellington continues to be in the PM period, with 21% variability in travel time. However, variability for the PM peak period has reduced steadily since the peak of 30% in March 2004.

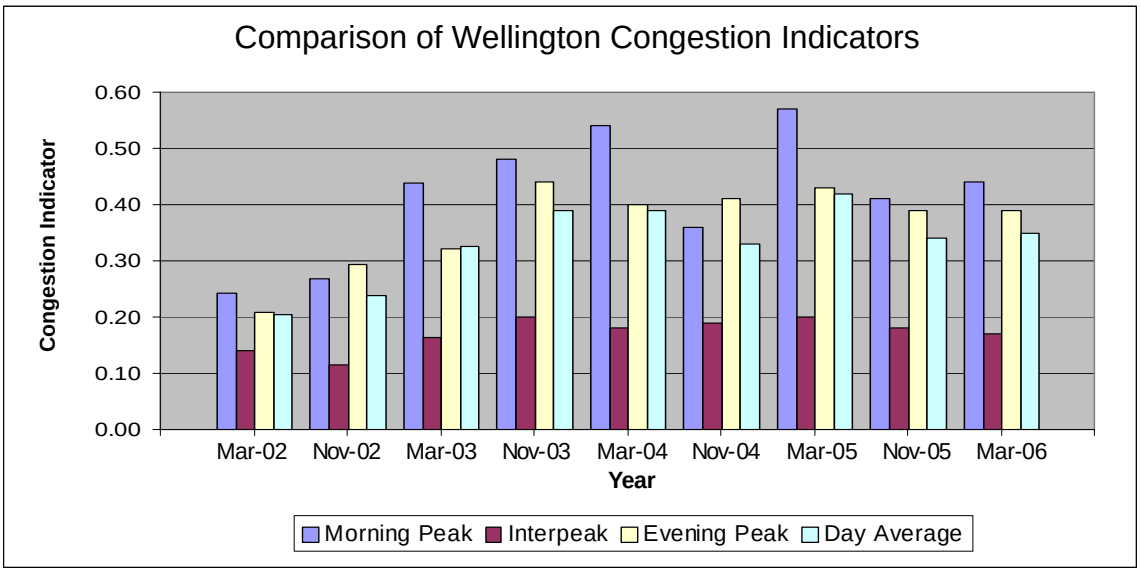


Figure 3: Congestion Indicators for Wellington[2]

9. Year 2006 results for Tauranga

The March 2006 survey average actual travel speeds for all time periods remaining the same or show an increase from the March 2005 results. However it is too soon to tell if this reverses the trend of increasing congestion in Tauranga.

Congestion indicators have improved for the AM peak, interpeak, and weekend periods. The PM peak period remains constant.

[2] The GPS/ GIS collection methodology was first adopted in November 2003. The routes surveyed in Wellington were adjusted in November 2003.

AM Peak congestion for March 2006 has dropped to 0.36 minutes delay/km, compared to a March 2005 result of 0.47 minutes delay/km. This is the lowest AM peak congestion recorded for Tauranga since 2003.

Travel time variability during March 2006 has decreased for AM, interpeak, and weekend interpeak, but has increased for the PM peak period.

A key feature of Tauranga is that congestion is an all day occurrence, and is not confined to peak periods. The difference between peak and off-peak travel time and CGI for Tauranga is less than for any other city surveyed.

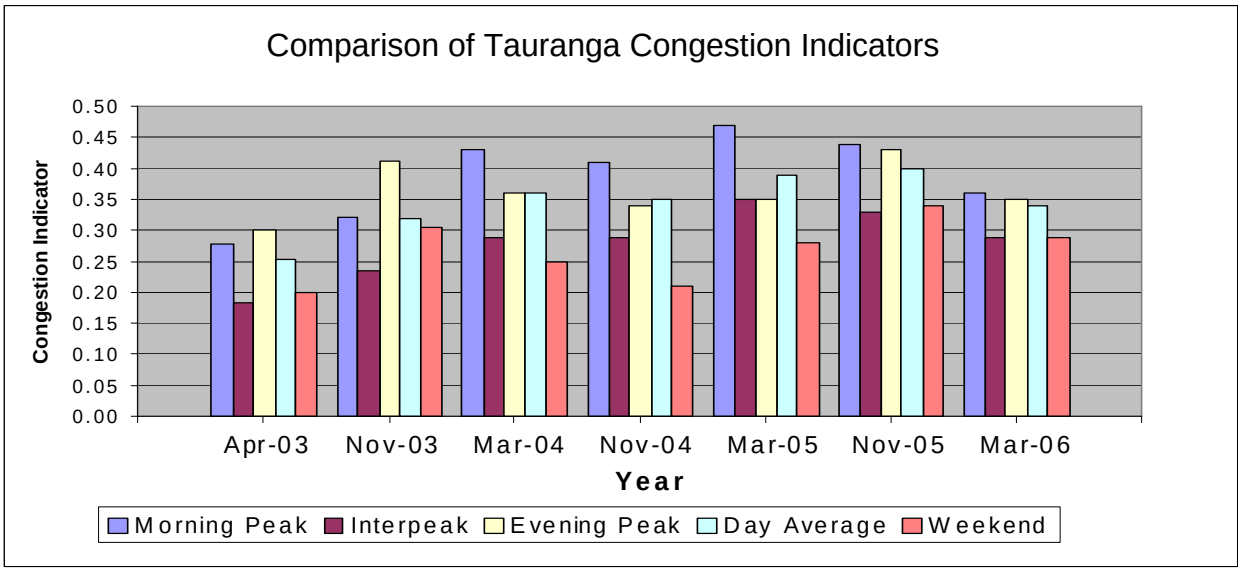


Figure 4: Congestion Indicators for Tauranga[3]

10. Year 2006 results for Christchurch

Care must be taken when comparing Christchurch data between years or between cities, as there have only been three surveys, and the routes and starting times have altered between the three surveys, making comparisons with previous years problematic.

The results for the March 2006 show increasingly high congestion across all time periods. However, it should be noted that the Christchurch monitored network contains a high proportion of urban roads and a lower proportion of rural state highways and motorways compared to other monitored cities.

The March 2006 survey results suggest an upward trend in congestion indicators, though it may be too soon to establish if this is the result of increasing congestion, or if it is the result of changes to the collection methodology.

[3] The GPS/ GIS collection methodology was first adopted in November 2003. The November 2003 results for Tauranga were significantly affected by road works. In March 2004 the surveyed network was expanded with the addition of more rural state highway.

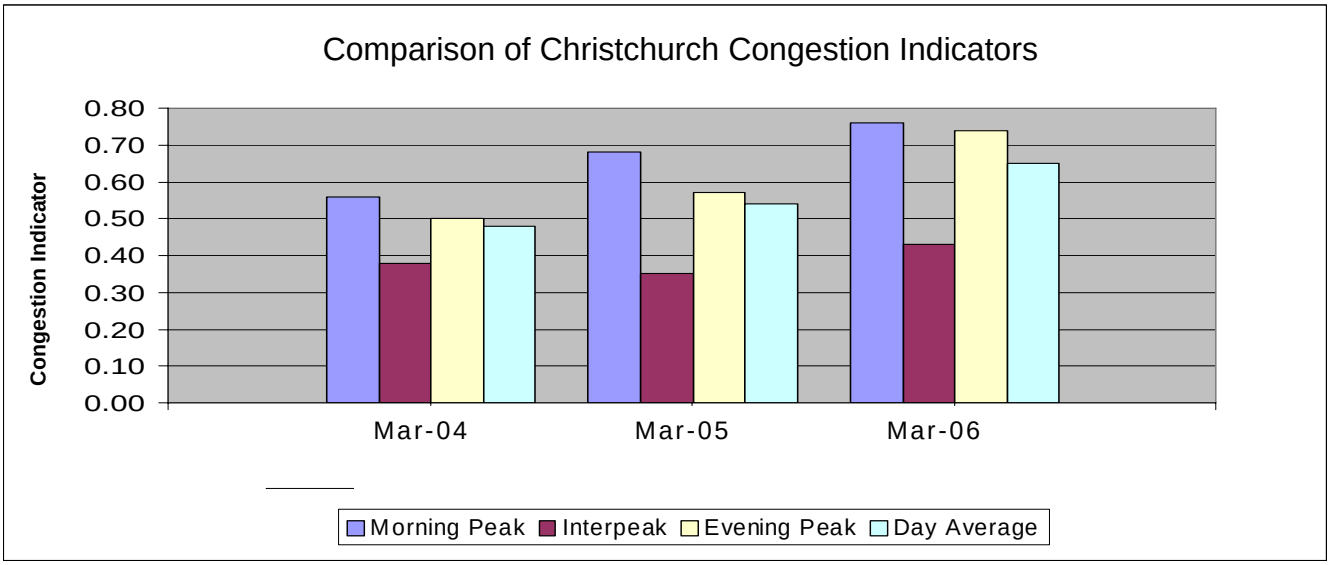


Figure 5: Congestion Indicators for Christchurch[4]

11. Trends from the Travel Time Performance Programme

The results from the Travel Time Performance programme show trends of increasing CGI across the network in Auckland, Wellington, and Tauranga for the period (year 2002/3 to 2005). The March 2006 survey shows a slight decrease in CGI from previous years in Auckland, Wellington, and Tauranga which may be due to the increase in petrol prices.

Trends for travel time variability shows that road users experienced the highest level of travel times uncertainty during the PM peak period; this trend is consistent in Auckland, Wellington, and Tauranga. Auckland has the highest level of travel time variability, PM peak variability for March 2006, at 35%, is the highest figure recorded for any city since the surveys began.

This programme has implemented in Christchurch however, due to changes in data collection methodology and the lack of available data, it is too early to predict if a trend of increasing congestion is emerging.

12. Discussions on Travel Time Performance across NZ and Australian Cities

There has been much debate as to whether one could compare CGI between various cities. Nominal speeds and road hierarchy can differ between different surveyed routes and cities. This makes it difficult to compare CGI of different cities, even though the collection methodology may be similar the data will reflect slightly differing road conditions. Although a useful illustrative tool, care must be taken when comparing the overall congestion between monitored cities due to the different makeup and speed limits of each of the surveyed routes and cities. Most Australian arterials are posted at 60 kph and although similar actual speeds of travel may be experienced in NZ the "congestion" impact will be higher as the differential between posted and actual is greater in Australia.

[4] The routes for the Christchurch were altered for the 2005. The start times for the 2006 survey were altered to catch key congestion 'pinchpoints' for the routes being surveyed.

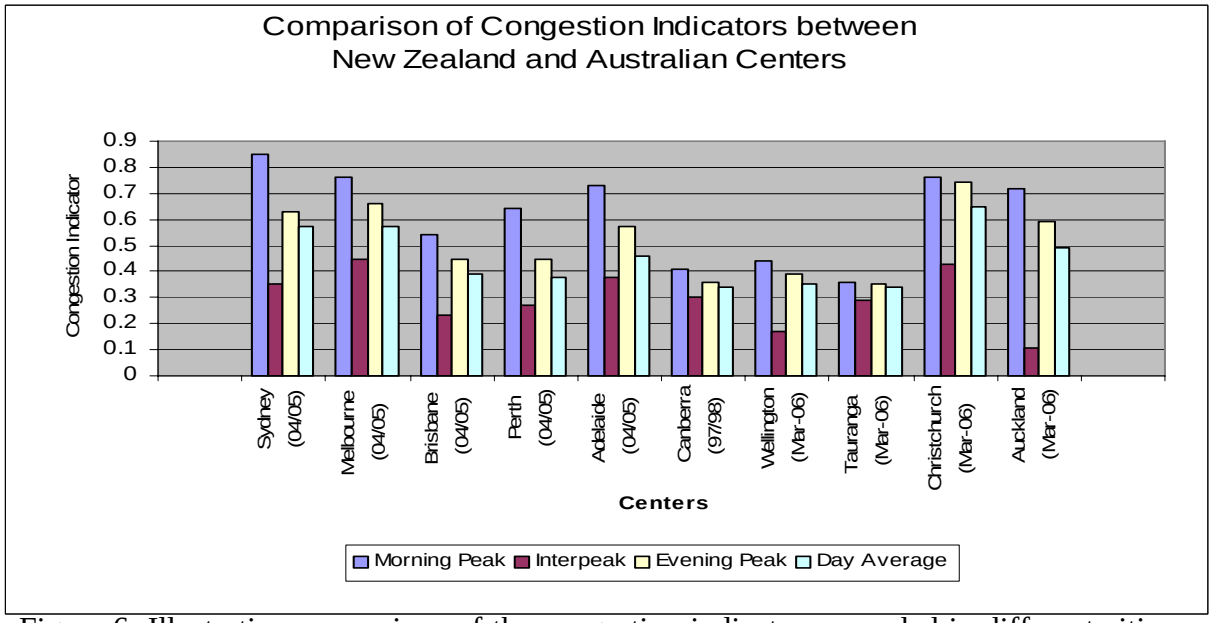


Figure 6: Illustrative comparison of the congestion indicators recorded in different cities throughout Australasia

In an attempt to enable better comparison between cities in New Zealand, CGI of the same road category are used for comparison. The following graph contains a comparison of congestion indicators between cities where only the urban state-highway (non-motorway) portions of the surveyed road network has been analysed.

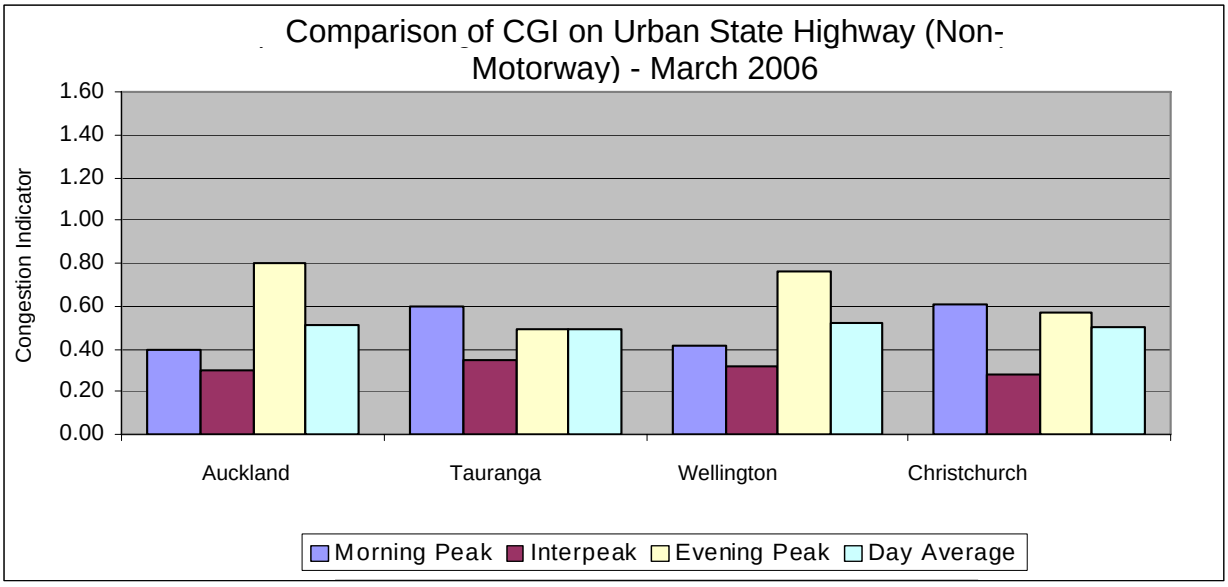


Figure 7: Comparison of CGI on Urban State Highway (Non-Motorway) recorded in different cities throughout New Zealand

Results show that the highest congestion indicator for traffic on urban state highways (non-motorways) occurs in the Auckland PM peak period, followed closely by the Wellington PM Peak period.

Another example of such comparison can be shown with the graph below that compares the congestion indicators on roads with a 50km/h speed limit (including any 50km/hr sections of state highway) in each of the surveyed cities.

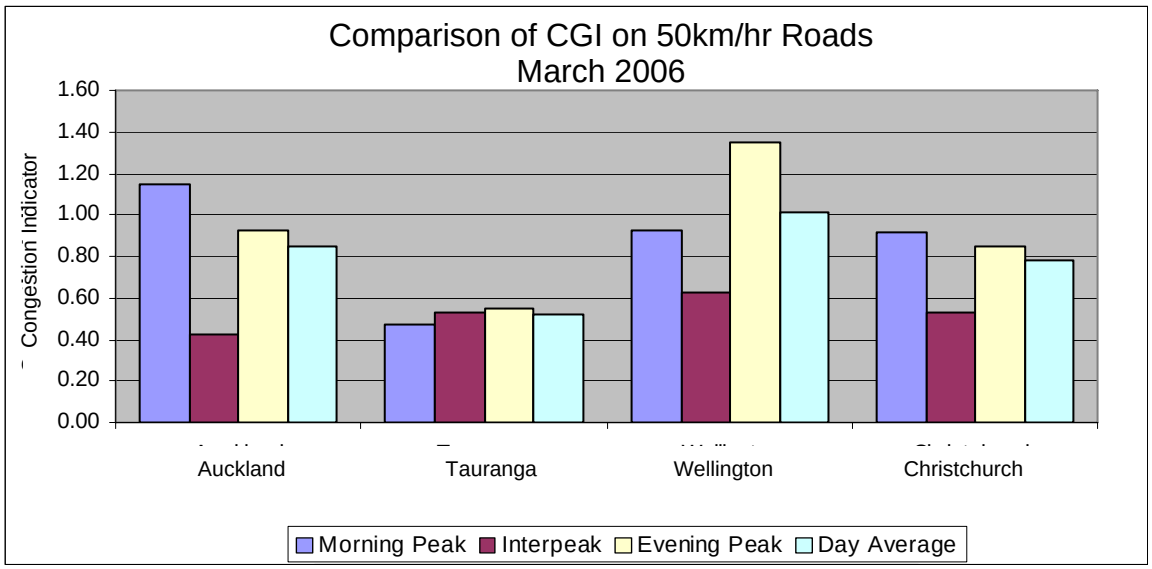


Figure 8: Comparison of CGI on 50km/h speed limit recorded in different cities throughout New Zealand

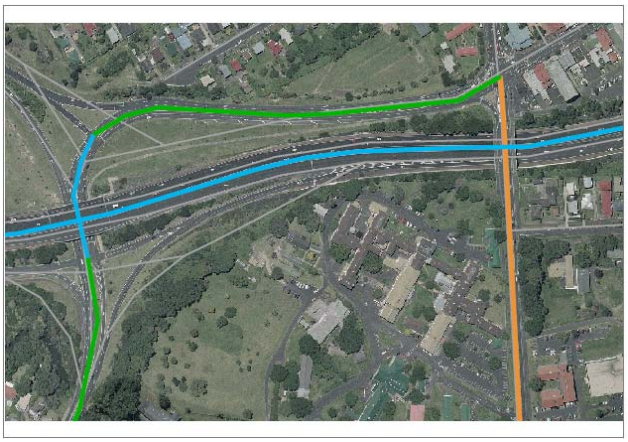
Results shows that Auckland has the highest CGI on 50km/h roads for the AM peak period. Wellington has the highest PM peak CGI for 50km/hr roads. For Auckland, Wellington, and Christchurch high congestion rates occur during AM and PM peak periods, where as for Tauranga the congestion rate remains relatively constant all day. This graph also indicates that congestion is not limited to the state highways portion of the road network.

13. Future Enhancement: Online Resources

Transit New Zealand and Beca are currently working together to develop an online resource capable of displaying the results of travel time performance programme using an Internet portal. The benefits of this are numerous, as the online system will provide congestion information in a manner far more accessible than the current text reports. Use of the Internet will enable road-controlling authorities from across the country to view congestion relating to their city, and view trends over time, far more easily than having to flick between multiple volumes of reports.

GIS displays and analysis technology are used to develop the congestion webpage. The graphic display and intuitive interface provide a far more visual display of where and when travel time delay occurs.

The intention is that traffic information from other data collection sources such as traffic volumes and speed will be added to this resource to provide a more complete view of traffic network conditions.



14. Future Application of Programme’s Results: Network “Health” Reporting

There is increasing demand for better reporting on the “health” of the network and consistent reports in most cities that congestion is getting worse by the day. But is the situation really deteriorating that fast? Many authorities are preparing comprehensive annual reports on the whole network that goes well beyond just reporting on volume and speed factors.

Australian State Roading Authorities tend to differentiate between asset management and transport management to a much greater degree than in New Zealand. The responsibility for traffic matters is normally included with a special section or department referenced to as Traffic and Road Use Management (TRUM). A good example of the level of reporting in Melbourne can be found on the website www.vicroads.vic.govt.au, where a range of Annual Reports are available. Vicroads Traffic Systems Performance Monitoring report covers Urban Travel Trends, Freeways, Road Safety, Urban Lane occupancy (cars, Buses, tracks, cyclists etc) and Freight. Trends in all the above are tracked in information provided.

In the US the South-west Washington, Regional Transportation Council prepares a very comprehensive report on its Congestion Management System in the Vancouver / Clark Country area (NOT Vancouver, Canada). The report is accessible at www.rtc.wa.gov and provides data on a Congestion Ratio, average vehicle occupancy (including bus, transit seat capacity), intersection performance etc. This trend follows to a degree the move toward customer-based Measures of Level of Service.

As with the Vicroads Traffic Systems Performance Monitoring report, results from the Travel Time Performance programme can be use and will contribute significantly to such Network “Health” Reporting.

15. Programme Evolution: Congestion Management System (CMS)

It is intended that this Travel Time Performance programme will evolve to a Congestion Management System (CMS) similar to those implemented in Memphis, Ohio and Kansas’ MARC (Middle-America Regional Council). These CMS follow similar concepts as the Crash Reduction Studies undertaken in New Zealand. The proposal to develop a CMS is as follows:

- For each urban area developing a CMS, a team is formed representing Transit New Zealand, Local Authorities, Land Transport New Zealand if appropriate, and a team leader from the consultant;
- Traffic information collected from various data collection programmes are combined usefully to provide input to the system. Ideally this should be presented in a map where areas of persistent congestion can be easily identified and major transportation infrastructure initiatives planned within 10 years can be shown;
- If appropriate, mode-use and mode-split information is gathered to examine in association with any changes in congestion;
- The team identifies persistent congestion worse than average 'rates' for the region;
- These routes are targeted for congestion management study, which includes site visits to identify causes of congestion, and recommendations for low cost congestion reduction measures, identification of potential capacity improvements, or public transport initiatives;
- The team identifies areas with high travel time variability. Routes are selected and studied for the causes of poor trip time reliability. These studies may include an audit route to identify where the major contributors to trip time reliability occur (generally intersections and capacity restriction points);
- These initiatives are combined in a CMS Report, which would be produced in conjunction with a report on the Travel Time Surveys and congestion monitoring results.

Each year, there would be annual monitoring (similar to CRS studies) of how initiatives and capital investment has impacted regional and local congestion and travel time reliability on a region wide basis and also along specific routes selected for the CMS.

16. Conclusions

This Travel Time Performance programme is a big step towards a system that can be used to manage the complex traffic congestion issues on our transportation network. It provides key decision makers, engineers and planners in the transportation industry with very useful information regarding the trends of travel time performance along strategic routes of selected cities. Availability and applications of this information are essential for Road Controlling Authority (RCA) to continually improve on their effectiveness in operating and managing the road network.

In order for the benefits of these travel time information surveys to be fully realised, the team recommend enhancement of the presentation and use of these information using GIS technology. A GIS based webpage and various network "health" reporting should also be developed to allow sharing of these travel time knowledge with all interested parties.

Sharing and integrating complementary traffic data collection programmes between RCA should also be advance to form a Congestion Management System (CMS). CMS is "a systematic process for managing congestion that provides information on transportation system performance and on alternative strategies for alleviating congestion". It is through such a collaborative system RCA are able to develop appropriate performance measures and set targets for continual improvement.