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NZ TRANSPORT AGENCY
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PINNING DOWN THE BENEFITS OF TRAVELLER INFORMATION SYSTEMS

A recent literature review aimed to provide hard evidence to support the many direct and indirect benefits attributed to traveller information systems (TIS).

The literature review, conducted in 2013, aimed to fill the current knowledge gaps around the costs and benefits of TIS, and provide a reference to inform current and future traveller information projects in New Zealand. URS New Zealand Ltd was contracted to carry out the review.

ABOUT TIS

TIS is the name for systems that disseminate information about the road network and public transport systems to travellers. The systems are widely claimed to provide direct and indirect benefits for end users, both before and during their journeys, by enabling them to travel more efficiently on the transport networks.

End users of TIS are anyone who needs to travel – cyclists, private and commercial drivers, pedestrians, commuters, public transport users and drivers of emergency vehicles.

TIS allow users to access up-to-date information about the transport network, which they can use to plan their trips, including how, when and where they will travel. A diverse range of information is available, for example about congestion, travel times, crash locations and whether public transport services are running on time. This is collected and disseminated through the TIS.

Most TIS are made up of three main elements: the information sources (that the travel data is collected from); the operational systems (used to process the collected data and monitor the network); and the TIS delivery mechanisms (the means by which the processed data is disseminated to the public). There is a huge variety of technologies and systems used within each of these elements, and with ongoing developments in the IT sector they are continuing to evolve.

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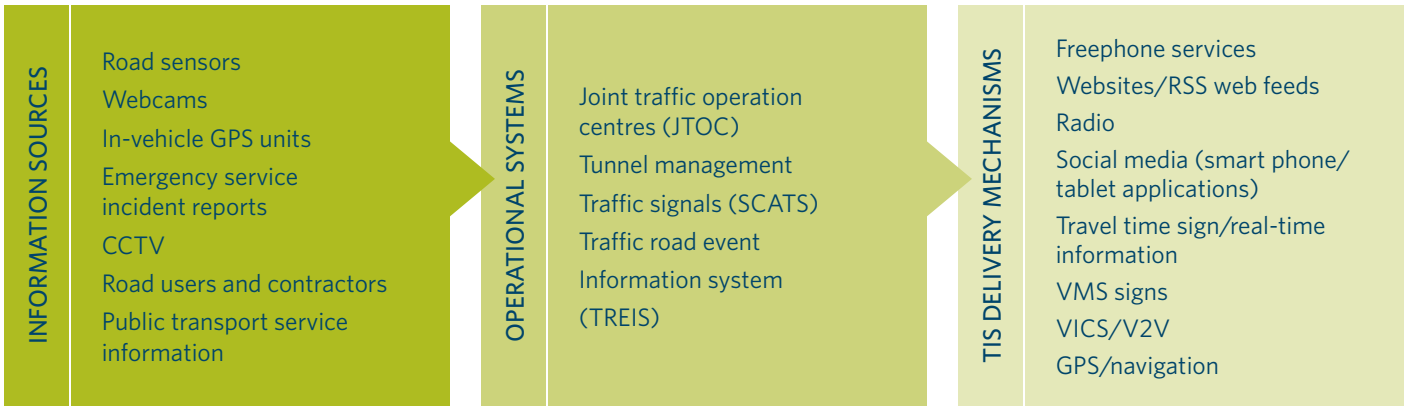
The figure below shows some of the more common technologies currently used in New Zealand for the elements that make up TIS.



Key elements of TIS provision

BACKING UP THE CLAIMS

Anecdotally, TIS are claimed to provide many direct and indirect benefits for end users, including time and vehicle operating cost savings. That there is some truth in these claims would seem apparent from the fact that many private motorists are willing to pay to have access to TIS, and many government organisations and commercial transport operators provide TIS for their fleets.

However, tangible evidence-based information to back up these claims is hard to come by, making it difficult for transport practitioners to establish a business case for installing TIS.

The literature review aimed to bring together all the available relevant information (national and international) into one source, which practitioners in New Zealand could then use to decide whether TIS projects were in fact justified.

The research team looked for information on both the costs and benefits of TIS. They found that while establishing the costs tended to be relatively easy, as this was largely just the cost of the TIS equipment, the benefits were more intangible and, as a result, harder to pin down. Little objective and relevant information was available from around the world about the tangible and measurable financial benefits, and in the information the team did find, there were significant gaps and difficulties in applying it to a New Zealand context.

Despite this, the research team found significant evidence that the travelling public values information, particularly when en-route, and from this and other indicators were able to infer that TIS is a technology waiting to be applied in the appropriate circumstances in New Zealand.

APPROACH TAKEN FOR THE REVIEW

Worldwide, there are a large number of different TIS available and in use, and end users are making increasing use of these various technologies. All TIS were considered as part of the literature review, although there was a particular focus on the types of TIS provided by central, regional and local government, as the authors anticipated these would be most relevant to their report's readers.

The information, once collated, was categorised according to whether it related to urban or rural journeys, and whether the systems were used before a journey or en-route.

Information about the systems' benefits and costs was then categorised according to whether these were direct or indirect. The benefit and cost parameters were aligned with those used in the NZ Transport Agency's Economic evaluation manual (2013), namely:

- travel time savings
- vehicle operating costs
- crash cost savings.

Two additional benefits were included, namely:

- vehicle emission reductions
- customer satisfaction.

CONCLUSIONS

The research concluded that there are many measurable benefits to TIS. While there are significant gaps in the literature available, particularly around the use of emerging technologies and social media, large amounts of information are project or case-based research. This means the results are real and have been tangibly extracted. Many of the resources are also less than five years old, therefore the information gathered from the literature review could be considered current and up to date.

The table below summarises the findings from research:

JOURNEY TYPE		DIRECT BENEFITS		INDIRECT BENEFITS		
		TRAVEL TIME COST SAVINGS	VEHICLE OPERATING COST SAVINGS	CRASH COST SAVINGS	VEHICLE EMISSION REDUCTION	CUSTOMER SATISFACTION
Pre-trip	Urban	Reduces early and late arrivals. Better departure time decisions. Informed mode choice decisions.	Reduces travel distance/ time spent in congestion.	Allows hazards to be avoided.	Encourage mode shift to PT. Reduces distances travelled and stop start traffic.	The uptake experienced by existing TIS shows that users perceive value in the provision of these services.
	Rural		Shorter routes taken	Especially when TIS is a weather warning system.	Reduces distances travelled.	
En-route	Urban	Congestion relief through high proportion of travellers changing route.	Congestion relief	Allows hazards to be avoided. Reduces congestion and associated crashes. Reduces the likelihood of secondary crashes.	Reduces distances travelled and stop start traffic.	
	Rural		Shorter routes taken	Especially when TIS is a weather warning system. Reduces the likelihood of secondary crashes.		

Direct benefits include travel time cost savings and vehicle operating cost savings. The travel time cost savings are the benefits from reduced travel times and account for the majority of direct benefits from TIS. The benefits in vehicle operating cost savings can range from fuel cost savings due to shorter journeys and time saved travelling. This in turn can reduce maintenance and repair costs.

Quantifying the direct benefit contribution of TIS has been historically difficult to determine, but the research found good examples already in existence. The literature suggests that benefit-cost ratios for TIS are generally very high and could range from 16:1 to 25:1.

The literature also showed many examples of indirect benefits from TIS. These mainly result from less congestion on the network, more informed choices and improved driver decisions, leading to less erratic and safer driver practices as well as reductions in carbon dioxide, noise and greenhouse gas emissions. For example, the literature showed that in Europe the overall effect of road safety related traffic information is estimated to be an average of 2.7% reduction in fatalities and 1.8% reduction in injuries. International studies have also found that with improved traveller information, emissions could be reduced by up to 25% for organic compounds, 1.5% for nitrogen oxide and 33% for carbon monoxide.

The research also identified customer satisfaction is internationally increasingly being quoted as a measurable benefit for TIS. This is however a relatively new concept and methods for quantifying benefits are still being developed. Methods include factors such as satisfaction associated with TIS and customers' willingness to pay. The contingent valuation method, for example, uses a survey to ask people how much they would be willing to pay for a specific service. For the regional 511 deployments in the US a recent study measured customer satisfaction, which ranged from 68% to 92%.

The research found that TIS are also often associated with broader customer satisfaction benefits, which in turn help enhance the success of the TIS applications. There are many examples included in the research, such as TripCheck in Oregon, which found that 83% of commuters considered internet-based traffic and weather information to be important. An evaluation of the SmartBus ITS program for the Chattanooga Area Regional Transportation Authority found that two thirds of bus tracking website users said they used public transport more frequently due to the availability of real-time information.

But this is just the beginning. The technology behind TIS will continue to develop, with increases in processing power and advances in wireless communication systems allowing traveller data to be gathered and disseminated faster, more reliably and at less cost than ever before. TIS are one of the many sectors within the technology field that have benefited from and will continue to benefit from the rapid growth in the IT sector.

Literature review of the costs and benefits of traveller information projects, NZ Transport Agency research report 548

Available online at **www.nzta.govt.nz/resources/research/reports/548**

PROJECT PURSUES MEANINGFUL PRODUCTIVITY ESTIMATES FOR TRANSPORT SECTOR

Research has investigated four different techniques for estimating productivity at a disaggregated level for the New Zealand transport sector.

The research project was initiated by the Ministry of Transport and undertaken by Martin, Jenkins & Associates in Wellington and Coelli Economic Consulting Services in Ballandean, Australia. Kris Iyer, who headed the trans-Tasman research team, explains the situation that prompted the research.

'Statistics New Zealand published productivity information in 2012, which showed that although the transport and storage sector had outperformed most other industries in the 1980s and 1990s, it had experienced virtually no growth in terms of productivity since the early 2000s.

'The reasons for this were not clear from the aggregated data, but obviously it was concerning, because of the important role that transport plays in our national economy.

'The aim of our research was to provide productivity estimates at a disaggregated sub-industry level that would make it easier to pin down the sources and components of transport productivity growth, and provide a starting point for better understanding the contributions that various transport services make to the economy.'

These sub-industries were: road freight transport; inter-urban and rural bus transport; urban bus transport (including tramways); taxi and other road passenger transport; rail freight transport; rail passenger transport; water freight transport; water passenger transport; air and space transport; scenic and sightseeing transport; pipeline transport; other transport services (not elsewhere classified); postal services; courier pick-up and delivery services; stevedoring services; port and water transport terminal operations; other water transport support services; airport operations and other air transport support services; customs agency services; freight-forwarding services; other transport support services (not elsewhere classified); grain storage services; other warehousing and storage services.

The project investigated four different approaches for measuring productivity. The four approaches were: the growth accounting framework; the Tornqvist index; the Malmquist index; and the input–output tables-based approach.

The productivity estimates derived from these approaches were then disaggregated by mode (air, sea, road and rail) and movement type (people and freight). Data from Statistics New Zealand's Integrated Data Infrastructure was used for the analyses, with data rendered confidential as necessary.

In addition, the research also investigated the contributions that capital, labour and intermediate inputs make in driving productivity growth at the sub-industry level. Productivity growth was decomposed into two components – technical change and efficiency change – the former capturing advancements in technology and the latter capturing smarter working.

As an important output of the project, the team developed several productivity calculation interfaces (one for each of the four approaches investigated) and a user manual. These tools will enable the Ministry of Transport to update the statistics compiled by the approaches as Statistics New Zealand's data is updated.

However, the team cautioned there was a lack of consistency between the productivity estimates computed using the four different approaches. Although the approaches are fundamentally similar, the estimates derived from them do not align. Some variation was to be expected (because the timeframes, data and weightings applied by the different approaches varied), yet the team found that productivity estimates computed by the four approaches were 'spectacularly different in magnitude'.

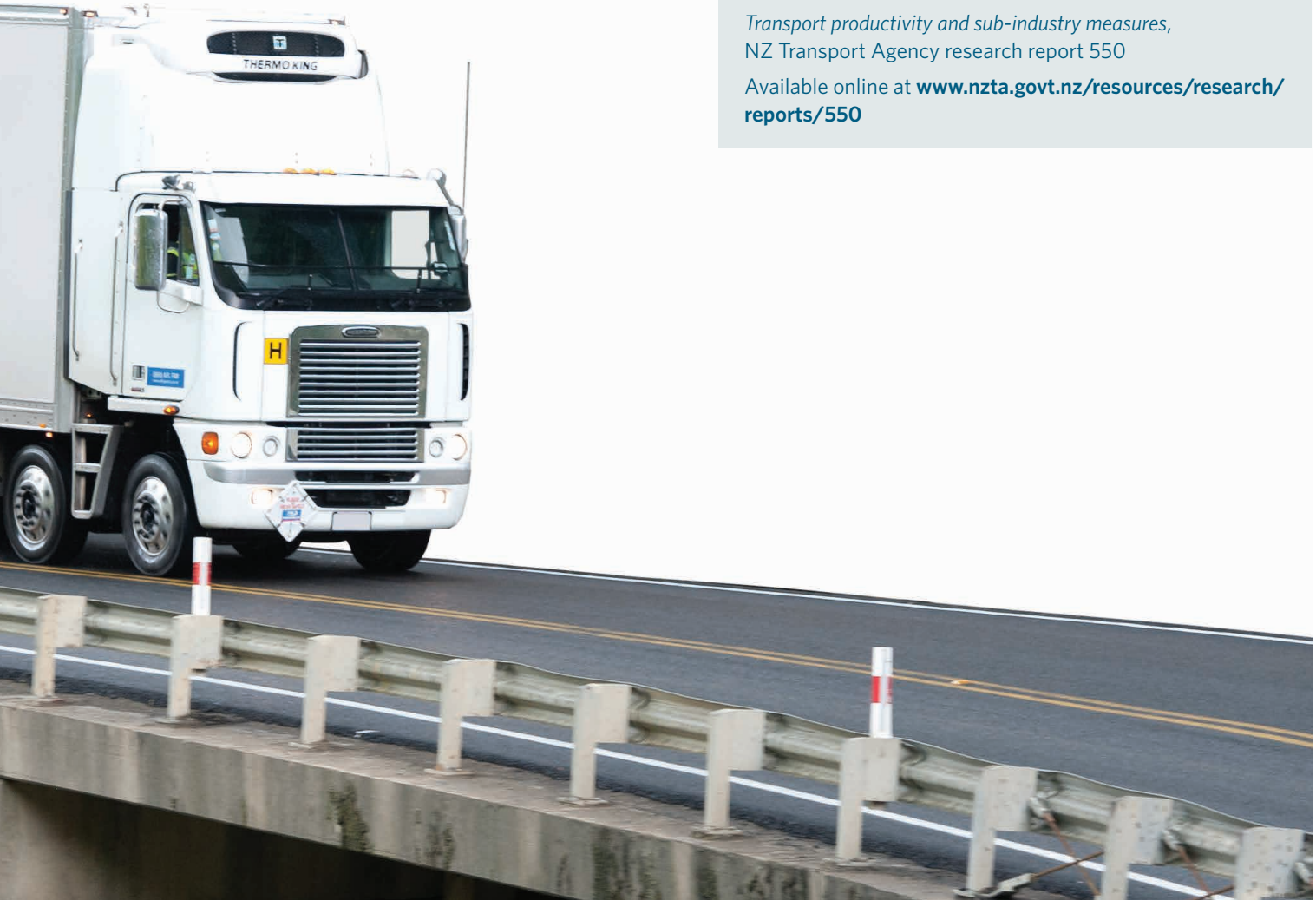
Kris says, 'When we started the research, we thought it would be useful to repeat the exercise every couple of years, to see how the estimates and the industry were changing. What the project showed, was that actually this would not be overly useful. Making available the differing results from the four different estimates is actually more likely to confuse matters, than to aid understanding. Although there are reasons for the spectacular differences across the estimates, these probably would be lost in the public commentary. In addition, despite their differing results, the four approaches are in principle very similar, and as result should not be expected to provide useful different insights from a policy point of view.

'Instead, we recommend that it would be sufficient to use just the Tornqvist index number formula to compute the productivity of sub-industries. This could be complemented, where appropriate, with analysis based on a Malmquist index number approach. The reason we also suggest the latter approach is that it's able to distinguish between technical change and efficiency change, both of which are mutually exclusive and exhaustive components of productivity and could be driven by different factors. Moreover, this approach is able to shed light on company-specific determinants of productivity.'

The research report explains and summarises the results generated by the various productivity estimates. In addition to the specific tools developed as part of the project, the report will provide policy insights for transport decision-makers in New Zealand, including national and local government agencies.

Transport productivity and sub-industry measures,
NZ Transport Agency research report 550

Available online at **www.nzta.govt.nz/resources/research/reports/550**



RESEARCH TACKLES GAP IN UNDERSTANDING HOW CAR PASSENGERS VALUE TRAVEL TIME SAVINGS

This research project, recently completed by Ian Wallis Associates, involved exploratory primary market research to examine how car passengers value travel time savings.

Ian Wallis says, 'Car passengers account for the second largest mode share (after car drivers) of person travel in New Zealand. Yet although there's been extensive international research on how car drivers value travel time savings, there is a dearth of research on car passengers' values and perspectives.'

A review of the international literature, conducted as part of the research project, confirmed that very limited evidence was available about car passenger values and no studies had specifically examined the factors (such as household and personal income, and alternative use of travel time) that influence these values.

Ian says, 'It's important that, in New Zealand and internationally, we develop better understanding of how car passengers value travel time savings, both for transport demand modelling and forecasting, and for input to economic evaluations of improvements to road systems.'

The exploratory market research involved in-depth face-to-face interviews with adults in 10 car-owning households in New Zealand. It explored the respondents' attitudes to and preferences for travelling by car, as a driver or a passenger. Key issues examined included:

- their willingness to pay to save time in a variety of car travel situations
- how their valuations differed according to whether they were travelling as a driver or passenger, and according to the presence of other passengers (particularly children)
- the extent to which the valuations expressed by individual respondents were consistent with any group valuation for the 'car' (ie the valuation ascribed by all the adult occupants as a group).

The research reached the following main findings.

- In most cases, individuals' valuations were broadly similar, whether they were travelling as the driver or passenger. Most of the respondents preferred to drive, indicating that their value of time savings as a driver would tend to be lower than if they were travelling as a passenger.

- Respondents often found it difficult to place values on time savings, especially in hypothetical situations. This was particularly the case for car passengers, as they were not usually paying the costs of the trip, and therefore had difficulty in making trade-offs between time savings and costs.
- Individual respondents' valuations were often sensitive to specific trip characteristics and situations (eg trip duration, trip frequency, extent of time saving, time constraints on the trip).
- Car driver and car passenger valuations, given in response to willingness to pay questions, were not simply additive (ie a combined valuation arrived at by the group of people on the trip could be less than the sum of the separate valuations of the individuals on that trip). This may have been because the individual respondents' valuations implicitly made some allowance for the other members of the group (for example, where trip costs came from a common family budget).
- There were clear indications that the presence of children on a trip (particularly young children on longer trips) could significantly increase the value of time savings for the adults in the car.

The research report concluded, 'Our exploratory research in this project suggests that current valuations used for car passenger values of travel, both in New Zealand and internationally (typically taken, for behavioural purposes, as 75% of driver values), may be unrealistic, and that the combined valuation for a group of people in a car may often differ substantially from the sum of the valuations of the group members individually. Hence, one of our conclusions is that there is a serious knowledge gap relating to this topic, both in New Zealand and internationally.'

Based on this and other findings from the exploratory research, the report assessed the priorities and options for more extensive (quantitative) research, designed to derive a new set of car passenger values for demand modelling and economic evaluation applications in New Zealand. It considered three different options for future research approaches, and compared their respective merits and shortcomings.

Given the lack of previous research on this topic internationally, the experience and findings from this exploratory research project should be of wider interest to international research into the valuation of time savings.

Car passenger valuations of quantity and quality of time savings, NZ Transport Agency research report 551

Available online at **www.nzta.govt.nz/resources/research/reports/551**

DRUG-DRIVING A GROWING ISSUE IN NEW ZEALAND

A study to investigate the attitudes, prevalence, habits and risks associated with drug use and driving among New Zealand drivers has confirmed that drug-driving is a growing road safety problem.

Consistent with previous research in New Zealand and overseas (where studies have consistently recorded a gradual rise in the numbers of people driving while under the influence of drugs), the current study found that a sizeable proportion of respondents had driven after taking drugs, either alone or with alcohol.

Beca Ltd was contracted to carry out the research. Conducted in 2012, the study involved telephone and internet surveys with respondents from the general population (1,000 and 241 respondents respectively), and 196 face-to-face interviews with habitual drug users of the four main drug types: alcohol and other drugs, cannabis, methamphetamine and benzodiazepine. Respondents in the face-to-face group were nearly all male and in prison.

Dennis Robertson was the lead researcher for the study. He says, 'There has been growing concern in New Zealand over the past decade about the role that drugs are playing in driver impairment and traffic crashes. Alongside this, there's a growing need for road safety promoters, educators and enforcers to understand the issues and risks, and the countermeasures needed to deal with the problem.

'Our overall aims were to provide a drug-driving demographic profile of New Zealanders and to suggest possible countermeasures. We specifically wanted to build understanding around the relationship between social drug use, habitual drug use, and their impacts on driving and the associated road safety risk.'

The study found there were distinctly different risk profiles and perceptions of risk among the groups surveyed and interviewed. (This concurred with overseas research, which has noted that social and habitual drug users are two very different groups, with different issues that need to be considered, much like social drinkers and habitual drink-drivers.) There were also New Zealand-specific factors linked to drug-driving, which meant that overseas findings and approaches may not be automatically applicable here.

PREVALENCE

Alcohol was the main substance used before driving, followed by alcohol and cannabis together, and cannabis alone. Prescription drugs also featured significantly.

Nearly half (47%) of the survey respondents (from the general population) had driven after taking drugs or alcohol. Most of these (80%) said they had only driven after taking alcohol (as opposed to other types of drugs). A sizeable proportion (9%), however, also admitted driving under the influence of social and recreational drugs. The remainder (11%) had used a combination of alcohol and drugs.

Cannabis was the main drug mentioned by the surveyed group, followed by various prescription drugs. Other recreational drugs mentioned included P, party pills and ecstasy. Cannabis use was more prevalent among younger respondents, while the proportion of those driving after using prescription drugs increased significantly in the age groups 46 years and above. There was also high reported use of non-narcotic analgesics (paracetamol and aspirin), although the respondents did not consider that these affected their driving abilities.

In comparison, all the participants in the face-to-face interviews (who were mainly resident in prison) admitted to drug-driving. Alcohol, cannabis, methamphetamines and mixed drug use were the main types of drugs used by these drivers. Well over one-third (41.3%) were likely to use a number of drug combinations (three drugs or more) before driving.

Respondents in the face-to-face interview group reported the following drug use and driving behaviours for particular drugs.

- Among those taking cannabis, 50% took cannabis seven days a week, 92% drove within three hours of taking cannabis, and 60% drove daily.
- Valium (diazepam) was the main drug of choice, with over half of the group taking it. Benzodiazepine was also popular, with 35% of the group taking it, not as a medical prescription.
- Methamphetamine users tended to take the drug seven days a week or until they ran out. Most of these users (98.1%) said they drove daily after taking the drug and within a three-hour time frame.

Among face-to-face respondents, over three-quarters (79%) had been involved in at least one crash and four-fifths (80%) had a previous driving conviction. Only one-third (32%) held a current driver licence. Despite this, most of this group perceived they were good drivers and considered themselves safety conscious. Just over half considered themselves law abiding.

RISKS

The study indicates that driving after drinking alcohol still poses a major road safety issue. However, the finding that most people who drove while under the influence of illegal drugs had also consumed alcohol, means that existing drug-driving enforcement mechanisms in New Zealand should be effective in capturing the majority of drug-drivers.

These mechanisms will not be so effective for respondents in the face-to-face interview group, though, who reported different patterns of drug use from the general population (they were more likely to drive having used cannabis or other mixed drugs, but not necessarily alcohol). This, combined with the fact that most of this group did not hold a driver licence, poses a separate challenge (in terms of detection, identification and tracking) for road safety practitioners.

Interestingly, respondents who were questioned about their views on the driving risks associated with cannabis use reported that they thought it caused fewer issues than alcohol, with a sizable proportion believing it had no effect on their driving performance or, in fact, improved it. Many methamphetamine users also believed the drug affected their driving positively (43% compared with 38% negatively). In contrast, over half of the respondents who took benzodiazepine believed the drug negatively affected their driving. Commonly reported effects on driving, for all drugs, included changes in mood and reaction times.

COUNTERMEASURES

Respondents were asked to identify (from a list) those countermeasures they thought would be most likely to discourage them from drug-driving.

Among the survey respondents, most considered randomised roadside testing for drug use, enforcement and penalties, such as vehicle impoundment and loss of licence, would be the most effective countermeasures.

The face-to-face group also believed randomised roadside testing for drug use and vehicle impoundment would be effective, although this group also identified fear of being caught a major deterrent. The latter finding possibly reflects the fact that most of this group already had a driving conviction and only 32% held a licence.

Social media, as a deterrent, was not rated highly by either group, although survey respondents from the general population considered it more likely to be effective than the face-to-face respondents.

CONCLUSIONS

Dennis says that the study's findings provide a positive starting point for understanding the complexity of the issues surrounding drug-driving and for developing countermeasures for what is now an established road safety issue.

He says, 'The study's findings were consistent with those from other studies, and to some extent we can assume that actions taken to counter drug-driving overseas will be similarly effective here. There are, however, some subtle differences that need to be considered. The scope of our research meant we were unable to establish the impact of these differences, but this is an area that could be usefully considered further in future.'

New Zealanders' attitudes towards drug-driving and suggested countermeasures, NZ Transport Agency research report 544

Available online at **www.nzta.govt.nz/resources/research/reports/544**

BRIDGE DESIGNS FOR SITES PRONE TO LIQUEFACTION AND LATERAL SPREADING

NZ Transport Agency research report 553: *The development of design guidance for bridges in New Zealand for liquefaction and lateral spreading effects* was published on the Transport Agency's website earlier this year. The report is the result of a research project towards the development of guidelines for the design of bridges on sites prone to liquefaction and lateral spreading in New Zealand.

The research project included a review of seismic behaviour of bridges on sites prone to liquefaction and lateral spreading in New Zealand and overseas, a study of available design methods for bridges against liquefaction and lateral spreading effects, detailed consideration of the bridge design framework in New Zealand and development of appropriate design methodology for New Zealand conditions.

The purpose of the project was to identify a clear set of available procedures for analysis and design, based on observed seismic behaviour of bridges (reviewed case studies) and on the most recent research findings. The report summarises these methods and provides references to supporting materials (where such references are available).

More work is required on the report's findings, however, before they can be included in the Transport Agency's *Bridge manual*. In the interim, the report is intended for engineers who are familiar with geotechnical and structural design practice for the static and seismic loading of bridges.

The project was led by Opus International Consultants Ltd, with members of the research team also drawn from the University of Canterbury and the University of Auckland.

THE RECOMMENDED METHODS

Design of bridges for liquefaction and lateral spreading effects is a complex technical problem. The key considerations and issues that are important for the design of bridges on sites prone to liquefaction and lateral spreading include the following:

- Evaluating the liquefaction potential at the site. Key questions that need to be answered are:
  - › at what level will liquefaction be triggered?
  - › what is the extent and nature of liquefaction in a design earthquake event?
- Assessing the effects of liquefaction including magnitude of lateral spreading and ground subsidence, down drag and bending of piles from soil inertia and displacements, stresses induced in the superstructure.
- Selecting the best value structural form or ground improvement concept to ensure the magnitude of damage to the bridge and loss or reduction of service for the route is within acceptable limits.

The quality of the developed design solution, the seismic behaviour of bridges and the ability of the bridge and geotechnical engineers to assess the post-earthquake condition of the bridge are highly dependent on whether all of these issues have been adequately addressed.

EARTHQUAKES AND BRIDGES

The seismic performance of bridges has a substantial effect on post-earthquake response and recovery efforts and on the quality of life of affected communities. The performance of bridges on New Zealand's state highway network is particularly crucial, as these roads serve as primary lifeline routes in the event of a natural disaster.

Bridges and highway structures located at sites with shallow groundwater tables or close to bodies of water can be susceptible to earthquake damage. Liquefaction of saturated sand-like materials (sands, sandy gravels, non-plastic silts), and cyclic softening or failure of clay-like materials (plastic silts and clays) and lateral spreading can result in significant damage to bridges and highway structures.

Earthquake damage to bridge abutment slopes can include ground failures, excessive lateral displacements and settlements. There are numerous reported cases of this type of damage worldwide, with recent local examples including earthquake damage to bridge structures as a result of the 2010 Darfield and 2011 Christchurch earthquakes. Soil deformation, due to liquefaction and lateral spreading, can also result in damage to bridge abutments, pier foundations and the structural elements of bridges.

The causes and effects of damage to bridges as a result of liquefaction and lateral spreading have been well documented. However, design approaches to mitigate the risks often incorporate costly ground improvements. It is important that the design methods for bridges located on susceptible sites are regularly reviewed and improved to enable cost-effective bridge design solutions to be developed.

Ferrymead Bridge construction – The new Ferrymead Bridge designed by Opus to resist liquefaction and lateral spreading effects is currently under construction
Christchurch City Council

The research report provides several methods for analysing the potential impact on bridge structures and piles when built on liquefied soils. These range from simple methods using an equivalent static analysis approach to a rigorous time-history analysis, based on the effective stress principle. The report classifies these methods into three different categories.

- Pseudo-static analysis or equivalent static analysis – based on their review of the available pseudo-static analysis methods, the research team recommends two design methods as the most appropriate for New Zealand conditions: the Cubrinovski method and the Pacific Earthquake Engineering Research Center (PEER) method. These are described in depth in the report.
- Direct dynamic time history analysis – this form of analysis incorporates two subcategories: a) effective stress analysis, which considers the effects of excess pore pressures and liquefaction through detailed constitutive modelling, and b) total stress analysis, which is dynamic analysis using total stresses or equivalent stresses (either ignoring excess pore pressures or considering them in a simplified manner). Direct dynamic time history analysis allows the response of the entire bridge system (soil-pile-pier-abutment-deck), throughout the duration of the earthquake (from initiation of shaking to the post-earthquake equilibrium), to be considered in a single analysis. For this category of analysis, the design team concluded, 'A sound numerical analysis that is well calibrated and executed provides the most realistic simulation of the actual bridge behaviour.'
- Substructure analysis methods – these methods are essentially hybrid approaches, which are tailored to address specific aspects of performance assessment. Substructure analysis methods use a set of separate but related analyses (including those used in the other two categories of analysis) to assess the performance of a bridge subsystem. The design team considered that a design procedure proposed by the Multidisciplinary Center for Earthquake Engineering Research was the most appropriate for substructure analysis in New Zealand conditions, and this is described in full in the research report.

The report goes on to conclude, 'The effect of liquefaction and lateral spreading can be evaluated by considering a single member (eg a single pile), a subsystem of the bridge (eg pile group, pier piles or piled abutment), or the whole bridge. Each of these models is acceptable in the evaluation of the bridge performance provided proper boundary conditions and modelling assumptions are used, and there is a clear understanding of the analysis objectives and limitations. The cyclic response should be considered both in the transverse and longitudinal directions, whereas the lateral spreading response is commonly considered in the longitudinal direction of the bridge.'

Other pre- and post-construction design and analysis matters considered and summarised in the report include:

- requirements for geotechnical investigations
- evaluation techniques for liquefaction and lateral spreading
- methods for making ground improvements
- methods for analysing liquefaction
- structural mitigation solutions
- construction and monitoring issues.

It was not possible to address all design issues within the scope of the research project, so the report identifies those areas where further investigation and refinement is required.

The development of design guidance for bridges in New Zealand for liquefaction and lateral spreading effects, NZ Transport Agency research report 553

Available online at **www.nzta.govt.nz/resources/research/reports/553**

Photomontage – Photomontage of the new Ferrymead Bridge *Christchurch City Council*

JOURNEY TIME MODEL RETURNS MIXED RESULTS

A project to develop a model for predicting travel times has returned results of varying accuracy and highlighted useful lessons for the future.

The project's intention was to clarify how historical and near real-time data could be used to calculate reliable and timely travel time predictions for the strategic road network.

To this end, a model was selected and tested using sample data from Auckland's strategic road network. The long-term aim was to determine whether it could subsequently be used for predicting journey times on strategic roads throughout New Zealand.

However, despite some positive indications, the study concluded that it was difficult to predict journey times using a statistical method and current data availability. The research nevertheless showed that accurate predictions were possible in certain situations, even up to a week into the future. Doing so consistently would require the right model to be selected for the specific circumstances and the quality of the underlying data sets to improve.

TRAVEL TIME PREDICTABILITY

Access to accurate information about journey times is important both for travellers and transport planners and policy makers.

Journey times are known to influence travellers' route and mode choices, as well their activity patterns (what they do and when as part of the journey). Transport planners and policy makers use journey time estimates for performance monitoring, congestion management, travel demand modelling and forecasting, traffic operations strategies and to justify transport infrastructure and improvement projects, amongst other things.

With the increasing availability and use of intelligent transport systems (including travel information, traffic management and route guidance systems), there has been a corresponding increase in the availability of historic and real-time traffic data. This, together with developments in information technology, has raised the question of whether it is possible to accurately predict travel times, and if so, how?

DEVELOPING THE MODEL

The research was carried out by Sinclair Knight Merz (now Jacobs) in 2012. As a first step, the project team reviewed existing prediction methods and case studies on travel time predictability. Based on this review, they selected statistical analysis as the recommended method, and this choice was later refined to non-linear time series analysis following some initial testing.

The selected method was then applied to the Auckland strategic motorway network to test its accuracy. This involved constructing a demonstrator model, capable of reading historic traffic data, and using the model to make travel time predictions, for particular links within the network, over time horizons ranging from five minutes to one week. Data drawn on included information about environmental conditions, incidents, and traffic speeds, densities and flows. The predictions generated by the model were then compared with actual observations about journey times to test the model's accuracy.

The results were mixed. For some links, the model could produce accurate journey time predictions over five-minute horizons. For these links, the model was also capable of producing reasonably accurate predictions for journey times up to a week in the future. However, this accuracy was not consistent, with predictions generated for other links proving to be inaccurate.

The project team sought to 'identify the factors that might influence the model's ability to accurately predict times for certain links and not others', but concluded that 'there appeared to be no single contributory factor'. Neither the length of the particular link or traffic volumes appeared to have much influence, although the proximity of the link to a major intersection did (for links close to intersections, the predictions tended to be less accurate).

LESSONS LEARNT

The research report contains a section on the lessons learnt from the project. The intention is to provide 'decision makers within the transport sector with guidance for the further development of a travel time predictability system'.

Lessons learnt included the following.

- Data quality – the accuracy of the data available created limitations for developing a successful model. Although the traffic data available (flows, segment speeds) was generally of good quality, there were large gaps where detectors had been out of action for long periods. In addition, the weather data was of very poor standard and there were issues with the incident data. The project team stressed that accurate and reliable data is critical when undertaking this type of complex modelling process, 'Any future work undertaken would need to ensure that accurate and reliable data could be provided across the network of interest.'
- Data rationalisation – the modelling undertaken in the project involved the entire data set, but if the exercise is repeated, the team thought it would be worthwhile to spend time sorting the data into sub-sets (for example, weekends and week days; speed limits; proximity to ramps and intersections). If this data rationalisation is performed at the outset, 'stronger modelling outcomes may well be achieved and it would be possible to better understand the key parameters influencing the accuracy of travel time predictions and their effects'.
- Statistical modelling approach – the statistical method was used for the modelling in the project, partially because 'it is much simpler and quicker to implement and easier to maintain'. However, the study demonstrated there were 'significant limitations' with the method, and the project team recommended that 'future studies may be better focusing on the simulation model' (which was the other main option considered), even though it required 'significant data collection and calibration'.
- Motorway network – the study looked at the full Auckland motorway, but future studies could usefully focus on a smaller section of the network. 'Although this might limit the likelihood of finding correlation between links and data, it would allow more intimate assessment of the factors which are impacting on the ability to predict travel times along the network.' Elements to look at when selecting a study area include the simplicity of the network, the availability of full and accurate data for it and the lengths of the links within it.

Overall, the project team concluded, 'it is currently very difficult to predict journey times using the statistical method and current data availability with sufficient accuracy across the Auckland network. However, the research indicated that accurate predictions are certainly possible in some situations and that further study may result in improved accuracy across the network.'

Travel time predictability, NZ Transport Agency research report 554

Available online at **www.nzta.govt.nz/resources/research/reports/554**

NEW RESEARCH REPORTS

Survey methods for driver mobile phone use

NZ Transport Agency research report 556

Available online at www.nzta.govt.nz/resources/research/reports/556

Reducing driver distraction, including distraction resulting from mobile phone use, is an aim of New Zealand's Safer Journeys programme. Currently mobile phone usage by New Zealand drivers is captured by self-report or observational surveys. However, studies have indicated that these methodologies might be under-representing actual usage rates. The aims of this study were threefold: first, to establish how drivers' mobile phone usage has been monitored worldwide through a review of relevant literature; second, to assess whether there was an improved method for monitoring mobile phone usage through a review of available equipment; and, finally to conduct a trial of the identified method to evaluate whether it could improve mobile phone monitoring in New Zealand. Trial results show that a mobile phone detector did not identify all observed mobile activity. However, roadside observers detected a lower level of mobile phone usage in passing vehicles (5.5%), compared with the mobile phone detector (9.6%), meaning that up to 43% of mobile phone use is not detected by the existing visual observation methods. Further testing is required to resolve the gaps between roadside observations and equipment detection, but there is evidence that observational methods of mobile phone detection could be enhanced through technological solutions.

Getting more from our roads: an evaluation of special vehicle lanes on urban arterials

NZ Transport Agency research report 557

Available online at www.nzta.govt.nz/resources/research/reports/557

With increasing demand for travel and limited opportunities for increasing capacity within urban areas there is increasing pressure to make more effective use of the capacity available. One approach is the introduction of special vehicle lanes where particular classes of traffic, typically buses and high occupancy vehicles are permitted to use the lane.

Vehicles eligible to use special vehicle lanes typically represent only a limited part of the total traffic flow, resulting in lower and more reliable travel times for those vehicles. However, where existing road space is reallocated, other traffic may face increased congestion as the capacity available is reduced. Users may respond by changing their behaviour to take advantage of improved travel conditions in the special vehicle lane.

Because the setup costs of special vehicle lanes are typically small, their economic assessment therefore depends critically on whether the reduction in costs for the managed traffic is greater than any increase for the remaining traffic.

This report considers evidence on these issues using New Zealand data and international research and outlines a systematic approach and analytical modelling techniques for the assessment of special vehicle lanes on arterial roads.

Epoxy modified bitumen chip seals

NZ Transport Agency research report 558

Available online at www.nzta.govt.nz/resources/research/reports/558

The research investigated aspects of the use of epoxy modified bitumen for the construction of chip seals. Changes in the shear modulus, needle penetration and cohesive energy of the epoxy bitumen were used to monitor changes in the material as it cured at 35°C and 45°C and after accelerated ageing at 85°C for 177 days. Wheel-tracking tests were used to determine the ability of the material to resist chip embedment and flushing. The adhesion to aggregate and resistance to water-induced stripping was also measured. Epoxy bitumen curing rates would enable seal construction within timeframes used with conventional binders. However, although the ultimate strength of the materials was satisfactory, the curing rate would be too slow for epoxy bitumens to be useful as a lower cost substitute for commercially available high-friction surfacing binders. Epoxy bitumen demonstrated good resistance to water stripping without added adhesion agents. Epoxy bitumen seals were highly effective in resisting chip embedment into a soft substrate and might be a means of controlling or eliminating flushing in the field. The materials used in this study were prototype formulations that may need to be optimised for low temperature flexibility. Further investigation is needed to properly characterise low temperature behaviour.

OBTAINING TRANSPORT AGENCY RESEARCH REPORTS

All research reports published since 2005 are available free of cost for downloading from the Transport Agency's website www.nzta.govt.nz/planning/programming/research

PDF scans of research reports published prior to 2005 are available by emailing research@nzta.govt.nz

A NOTE FOR READERS

NZTA research newsletter

NZTA research is published quarterly by the NZ Transport Agency. Its purpose is to report on research invested in through the Transport Agency's Research Programme, to act as a forum for passing on national and international information, and to aid collaboration between all those involved. For information about the Transport Agency's Research Programme, see www.nzta.govt.nz/planning/programming/research.html.

Advertisements of forthcoming conferences and workshops, that are within the newsletter's field of interest, may be published free of charge when space permits.

Published articles may be reproduced and reference made to any part of this publication, provided appropriate credit is given.

All general correspondence, queries related to conference notices, and requests for additions or amendments to the mailing list, should be made to research@nzta.govt.nz

The current edition of the newsletter, NZTA research, is available in hard copy and on the Transport Agency website at www.nzta.govt.nz/resources/nzta-research/. Back editions are available online only.

Disclaimer

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Email alerts of newly published research reports

Email notifications are provided when new issues of *NZTA research* are published. Notification is also provided when new Transport Agency research reports are published on the Transport Agency's website at www.nzta.govt.nz/planning/programming/research.html. Please email research@nzta.govt.nz if you would like to receive these email alerts.

Do we have your correct details?

We would like to hear from you at research@nzta.govt.nz if you wish to update your name, email or address details, to alter the number of hard copies of *NZTA research* you'd like to receive or to go on to the email list for alerts of the publication of newsletters and research reports.

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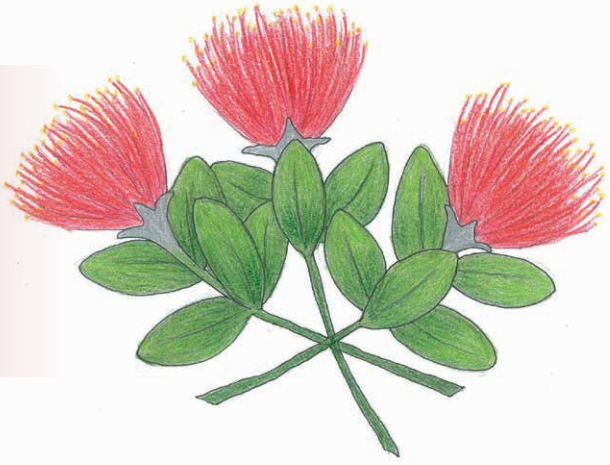
DID YOU KNOW...

That there is a spreadsheet on the Transport Agency website listing all published Transport Agency research reports?

The spreadsheet is searchable by several criteria and can be found at **www.nzta.govt.nz/planning/programming/research.html**

The spreadsheet has two worksheets; the first worksheet lists research reports with associated key words and the second lists research reports with the report abstracts.

WISHING YOU A MERRY CHRISTMAS AND SAFE JOURNEYS FROM THE NZ TRANSPORT AGENCY



NZ TRANSPORT AGENCY WAKA KOTAHI

New Zealand Government