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NZTA research

NZ TRANSPORT AGENCY
WAKA KOTAHI

2 Reviewing bridge asset management practices

4 Fringe benefits tax and company cars

6 New model to help plan bus services

7 Calibration of trip distribution

9 New research reports

12 Transport research in 2012

UPDATED MODEL A USEFUL SAFETY MANAGEMENT TOOL

Updated analysis of crash-rate data for New Zealand roads has refined an existing crash-prediction model, enabling proactive identification of safety problems and potential improvements.

Numerous crash-prediction models have been developed for New Zealand and Australian roads. Most have been developed for specific applications, including the statistical model created by Peter Cenek and Robert Davies in 2004 for predicting injury crashes on New Zealand two-lane state highways. Based on Poisson regression, this predictive model was notable for being one of the first to successfully relate crash rates to road geometry and road condition. It has been widely used to analyse the safety performance of the state highway network, leading to numerous safety improvement projects.

New research to update and build on the earlier model was carried out by the original research team between 2007 and 2009. The earlier model used traffic flow, road geometry and road condition as inputs to predict the number of fatal and injury crashes on rural road networks under dry and wet road conditions. Refinements to the model made as a result of the latest research include the ability to take into account differences between the local and general speed environment, crash severity, and interactions between curvature and roughness. Changes have also been made to enable better separation of road gradient effects.

Peter Cenek of Opus Central Laboratories says, 'The model was already relatively sophisticated, but these refinements will make it even more useful for guiding safety initiatives and economically justifying them.'

ABOUT THE UPDATED MODEL

The regression model used in the analysis assumes that crashes are statistically independent and that the number of crashes in each 10m section of road follows a Poisson distribution. The model is multiplicative, using a linear combination of the road's characteristics (including factors such as gradient, curvature,

continued on page 2

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out-of-context-curve effect, skid site classification, skid resistance, region, and the road's classification as rural or urban), with inputs including the average daily traffic for each side of the road.

Peter explains, 'The reported crash rate for a given 10m length of road is the average of rates for 10m lengths within 100m either side of the 10m length of interest. So the crash rate is an average over 210m, which allows for error in reporting the exact location of a crash and for the fact that crashes often end some distance from where they started.'

One of the most striking outcomes of the research was the close agreement between the results from the refined model, which was derived from data over the 10-year period from 2000 to 2009 and those from previous statistical modelling using data over the 6-year period from 1997 to 2002. Also interesting was the agreement between the analyses when all casualty crashes were taken into account, and when only serious or fatal crashes were considered; the high level of correlation between the two suggests that the low reporting rate associated with minor injury crashes is not a serious problem when it comes to crash prediction.

Similarly there was little variation between results when 'year-x-region' interaction was included in the model, suggesting that crash reporting rates are sufficiently consistent, across years and regions, not to undermine the model's analyses.

Peter says, 'There is still more variability in the data than the Poisson model would predict. In this case the model is unlikely to fit exactly, as there are numerous things not included, but the fit might be the best we can reasonably expect. However, it is possible that the problem lies in the estimates of average daily traffic that we are using and this is worth investigating further.

'Overall, we feel that the results reinforce that this is a robust crash-prediction model, capable of taking into account both road condition and road geography, which will be a useful tool for managing the safety of New Zealand's state highways. In particular, the model allows users to proactively identify existing engineering-related deficiencies in road safety and better quantify the potential for improvement.'

The full research report details the model in its most refined form, and provides two example applications of its use: a 'what-if' study for skid resistance, and a 'what-if' study for roughness. The report also documents the crash prediction models currently being used to help achieve the government's Safer Journeys strategy (New Zealand's road safety strategy for 2010–2020).

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Modelling crash risk on the New Zealand state highway network, NZ Transport Agency research report 477

Available online at www.nzta.govt.nz/resources/research/reports/477

TAKING A TIERED APPROACH TO BRIDGE DATA COLLECTION AND MANAGEMENT

A review of bridge asset management practices, here and overseas, has found that although asset managers collect a large amount of data about bridges it is not always linked back to strategic decision-making. This means that opportunities to gain the maximum value from the data are lost.

Asset data collection typically forms one of the earliest stages of the asset management cycle. Data is collected to create an inventory of assets, and build a picture of their condition and performance. It is then used to:

- appraise whether strategic goals are being achieved
- understand if the current condition of assets and how they are being used is meeting level of service targets
- identify options and inform decisions about maintenance, renewal and replacement
- set budgets for future works.

Researchers from the University of Auckland and Opus International Consultants were part of the recent project team investigating asset management practices for New Zealand bridges. They state, 'Clearly the entire asset management cycle hinges on this data, which needs to be of the appropriate type, volume and quality. However, our study showed that the type of data currently being collected in New Zealand has to be improved if managers are going to adopt the advanced asset management practices used overseas.

'The impetus to move to these more advanced approaches is coming from the Office of the Auditor-General, which has identified shortfalls in current practices. However, at present bridge asset managers don't necessarily have the data to support advanced approaches. There is also a need to change some of the ways we are currently collecting information about bridges to ensure data is reliable and more useful for network-level management.'

The research project focused on the data required to meet the needs of the bridge asset management process, the methods of collecting that data, and the quality assurance, validation and verification practices associated with it.

Drawing on this information, it went on to recommend a strategy that will ensure New Zealand bridge management practice is underpinned by sound principles and quality data.

'Taking such a strategic and targeted approach to bridge data collection will put bridge asset management in New Zealand on a par with road asset management, and help close the gaps that the Office of the Auditor-General has identified,' say the report authors.

WHAT'S HAPPENING OVERSEAS?

Until recently, a defects approach to assess the condition of bridges was generally used in New Zealand. The outcome is a catalogue of specific issues to be addressed which, although adequate for core asset management, provides little information about long-term deterioration trends.

Many countries have used formalised condition-rating systems for a number of years, which provide a numerical assessment of condition. This allows advanced asset management practices to be adopted, enabling managers to predict asset condition into the future.

THE PROPOSED STRATEGY

The strategy recommended by the study, and set out in the full research report, provides a clear and defined path between the management of bridges, including their regular condition inspections and assessments, and the strategic outcomes they attain for their transport networks.

To this end the strategy identifies the key categories of data that will have to be collected – inventory, maintenance, cost, environmental, network, safety, condition and testing data – and provides guidance on how the data should be managed.

One of the major changes the strategy proposes is the adoption of a tiered approach to bridge asset management. This is in contrast to the current one-size-fits-all approach, which treats all bridges the same.

The tiered approach acknowledges that not all networks will have the same requirements, and takes into account an individual bridge's risk and criticality within the network to assign to it an asset management approach.

'Bridges can be categorised as requiring core, intermediate or advanced levels of asset management, allowing managers to focus on those bridges that are central to their network's operation,' say the researchers.

Core-level bridges will require only simple techniques that collect data relating to key performance criteria, such as loading and safety. Intermediate and advanced-level bridges will require managers to collect a broader range of performance data about them, and data will have to be collected by increasingly accurate means. The impact of changing the data collection process should be minimal, and by doing less on non-critical structures and more on important ones, the proposed approach could be cost-neutral.

DATA COLLECTION APPROACHES

At present, bridge condition data in New Zealand is largely collected through visual inspections.

The authors say, 'In the study we identified that visual inspections don't always provide consistent or reliable outcomes, and critical problems with bridges were not always being picked up. Overseas, managers are routinely integrating non-destructive evaluation and structural health monitoring into their data collection processes, and we're recommending that should also be happening here.'

Non-destructive evaluation, through one-off or periodic tests, is useful for accurately defining current issues and assessing long-term trends in deterioration. Structural health monitoring can be used to monitor bridge performance, either on an ongoing basis or as required. It also means assessments are more proactive than is achieved through visual inspections or non-destructive testing.

Both non-destructive evaluation and structural health monitoring are needed to support the more formalised bridge condition-rating systems being used overseas. A characteristic of these more advanced approaches is the ability to accurately predict asset performance and condition into the future.

Augmenting visual inspections with non-destructive evaluation and structural health monitoring for bridges that require intermediate and advanced-level management will provide greater robustness for the data collected about them. It will enable managers to focus more intensive testing and monitoring where it is required within the network, without wasting resources on less critical or lower-risk bridges.

A recommendation that managers adopt variable frequencies for their visual inspections (with intermediate and advanced-level bridges inspected more frequently than core-level ones) will create savings for managers, allowing them to redirect time and budgetary resources towards the bridges that need them more. Savings made can also be used to fund the more advanced data collection techniques.

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Data collection and monitoring strategies for asset management of New Zealand road bridges, NZ Transport Agency research report 475

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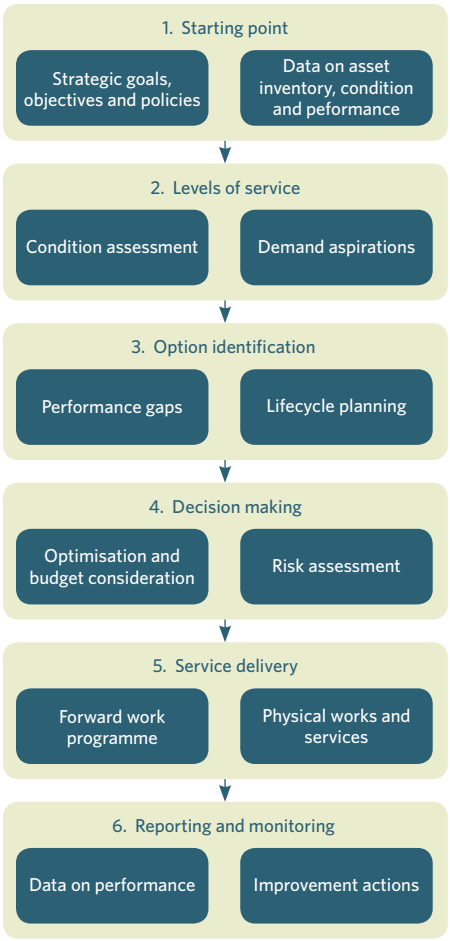
ASSET MANAGEMENT FRAMEWORK (ROADS LIAISON GROUP 2005)



THE IMPORTANCE OF BRIDGES

Bridges play a critical role in New Zealand's road network. On average, there is a bridge for every 2.5km of the state highway network and every 5.2km of the national road network.

Bridges need to be managed effectively as:

- they are less easily repaired than roads, generally requiring special access and closure to traffic to carry out work
- they are expected to perform for much longer than roads, with service lives of 70+ years and design lives of 100 years
- often, they cannot be easily upgraded to improve their service levels, eg to carry greater truck weights
- their failure generally has a significant impact on the network as a whole
- their failure mechanisms are more complex than roads, with less built-in redundancy against failure.

HOW TAX POLICY AFFECTS TRAVEL BEHAVIOUR

Research has identified ways to help fringe benefit tax (FBT) policies better support the government's transport goals, while also being more equitable for employees.

Current New Zealand FBT policies unintentionally encourage employers to offer their employees company cars and subsidised parking in partial place of wages. This is because these benefits are often more attractive to employees, as they are wholly or partially untaxed and so worth more than their cash equivalent.

But fringe benefits have other, unintended, economic, social and environmental impacts, including encouraging people to drive bigger cars, more often, and discouraging them from using the more sustainable modes of transport (such as car-pooling, public transport, walking or cycling) that current transport policy aims to promote.

WHAT IS FRINGE BENEFIT TAX?

FBT is defined by Inland Revenue as 'a tax on benefits that employees receive as a result of their employment, including those benefits provided through someone other than an employer'. Its goal is to tax anything that an employer provides to an employee in the place of salary or wages.

The tax was introduced in New Zealand in 1985 to counter a growing trend for employers to provide employees with a range of (up until then) untaxed benefits instead of wages or salary. This trend itself came about as a result of a high top marginal tax rate of 66%, providing a disincentive to increase wages beyond a certain point. (This tax rate was reduced alongside the introduction of FBT.)

Further improvements can be made, however, especially to reflect current government policy that encourages more sustainable transport modes. At present, a range of benefits are exempt from FBT, including most employer-provided car parks available for employees' free use. Company cars do attract FBT, but it is based on their value and does not include running costs (such as fuel, insurance, tolls and parking), making them particularly attractive to employees as fuel prices continue to rise.

Moreover, untaxed fringe benefits create tax inequity, as employees who receive them are essentially paying less tax than their counterparts who receive all their remuneration as wages or salaries.

In addition, FBT is not a neutral tax with respect to untaxed benefits, in that the salary that an employee sacrifices is worth less (because it would be taxed) than the untaxed benefit gained. This goes against the principal of tax neutrality, which requires tax policy should not alter individual or company investment decisions.

TAKING A FRESH LOOK AT FRINGE BENEFIT TAX

A recent study by Booz & Company has investigated the degree to which the government's current tax policies unintentionally influence people's travel behaviour in ways that sometimes contradict stated government strategic policy objectives for travel. The study also evaluated potential tax policy reforms that could help address these side-effects.

Knowles Tivendale of Booz & Company says, 'How the government's fringe benefit tax policy treats company cars, employee parking and public transport subsidies can significantly affect the overall composition of the national vehicle fleet, as well as commuting patterns and location decisions, both commercial and residential.

'Our study found that current policies are having some significant, often unintentional, impacts. For example, employees might choose larger vehicles than they would normally drive and drive more kilometres annually than they otherwise would. There was also a notable reduction in the use of other modes of transport by employees who had access to a company car or employer-provided parking, and a tendency for both employers and employees to choose more remote, automobile-dependent locations in which to live and work when a car was being provided.'

The negative side-effects include increased congestion, parking costs, crash rates, energy consumption and pollution emissions, and continued urban sprawl that exacerbates transport problems.

The research focused on current tax policy for company cars and employer-provided parking, using various methods to measure the impact, and comparing it with equivalent policy overseas, in order to frame recommendations for reform.

COMPANY CARS

In New Zealand, company cars are the second most popular mode for commuting (after private cars). Around 22% of cars used during peak commute times are company cars, yet despite this, their impact on transport policy and behaviour had been largely unstudied in New Zealand.

Studies overseas suggest that company cars tended to be larger, driven further and involved in more crashes than private cars, and the current study set out to examine if the same was true here.

The research used motor vehicle registration data to identify the types and features of company cars used in New Zealand. In general, company cars were found to be heavier and have higher engine ratings than privately registered cars.

Knowles explains that one reason for this is because (unlike some other countries studied) New Zealand FBT is calculated on the purchase price and depreciated value of vehicles, not their fuel efficiency or emissions ratings.

'There is not the same incentive for employees to choose smaller cars, if their employer is paying the fuel bills,' says Knowles. 'The expense of running a car is a large part of its overall cost, but these expenses are not presently taxed, so represent a tax-free benefit for employees.'

Also, because company cars are typically used for 3–5 years before being sold as private vehicles, this skew towards larger vehicles is passed through to the national vehicle fleet, with more larger cars entering the market than would otherwise be the case.

Journey to work data from the 2006 Census showed that company cars tended to be driven more often on longer commuting routes where high-quality public transport wasn't available than their privately owned counterparts. This confirmed research overseas that employees with longer commutes valued company cars more than those who lived closer to work. The flow-on effect is that the availability of company cars in fact encourages, or at least offers no disincentive to, urban sprawl and overuse of the road network that generates congestion.

CAR PARKS

The other area focused on by the research was employer-provided parking. At present, this is exempt from FBT in New Zealand where the car park is on the employer's premises or is leased by an employer for their employee's exclusive use.

Parking represents a high-value untaxed benefit for employees, and analysis of 11 company travel plans (representing 5770 employees) showed that the provision of parking significantly influenced the mode of transport that employees choose to commute to work.

Knowles says, 'Workplaces with plenty of free parking tended to have much higher numbers of employees travelling to work as sole occupants in cars, and lower numbers travelling by public transport compared with workplaces where parking was limited or charged for.

'This is an issue for Inland Revenue, which is missing out on tax revenue, and also for other taxpayers (who are subsidising parking as a result), and from a transport policy perspective, as untaxed parking subsidies encourage people to drive more, own more cars and make less sustainable transport decisions that impact on the wider community.'

AREAS FOR SUGGESTED REFORM

The research identified areas of tax policy that could feasibly be changed to help apply FBT more equitably and to better align it with government transport policy. Options included:

- introducing a graduated FBT for company cars based on CO_2 emissions (as in the UK and Ireland) to encourage employers to provide and, employees to choose, smaller and more-efficient vehicles
- including employer-provided parking as a taxable fringe benefit (as in Australia)
- exempting the costs of using public transport or cycling from taxable income, or enabling employees who use an alternative mode of transport to car travel to choose cash or a subsidised public transport pass instead of a car park (as in the United States).

Although Inland Revenue is concerned that introducing further FBT exemptions, such as for public transport costs, will create market distortions, the study argues that existing distortions in favour of car-based travel need to be removed or at least eased through equal FBT treatment of all travel options.

Knowles says, 'FBT reform is an opportunity to create a more neutral travel cost environment, and achieve more efficient, equitable and sustainable travel patterns.'

The research also looked at other transport policy reforms that addressed some of the distortions and unwanted travel behaviours currently arising from FBT. Measures such as levying all central business area parking, including employer-provided parking, and congestion charges for peak-time travel would encourage people to consider alternative modes of transport without requiring FBT reform.

Another option is to encourage employers to pay their employees to travel by public transport and pick up the bill for the associated FBT. This would still be cheaper than providing a company car, and is popular in the United States where a range of annual passes and employee travel products are aimed at the employer subsidy market.

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Company cars and fringe benefit tax – understanding the impacts on strategic transport targets, NZ Transport Agency research report 474

Available online at www.nzta.govt.nz/resources/research/reports/474

NEW MODEL TO HELP PLAN BUS SERVICES

The strength of the recently developed New Zealand Bus Policy Model (BPM) is that it can analyse bus service operating costs and financial performance, both for existing services and for a wide range of service-change scenarios, says the Greater Wellington Regional Council, which piloted the model.

A methodology and computer-based model was developed by Wellington-based consultants Ian Wallis Associates to assess levels of demand, operational requirements, costs and financial performance for scheduled bus services in New Zealand. The model was developed in close conjunction with the Greater Wellington Regional Council, then piloted by council staff in its two designed applications – firstly, to assess the performance of existing services and secondly, to assess the impact of any changes to the bus system.

The council says the model provides 'a simple and consistent but flexible approach' and has already given the council valuable financial information on off-peak services at different time periods. 'This information is beginning to be used in the council's service planning area, when considering such issues as increasing spans and varying frequencies of off-peak services (principally at evenings and weekends).'

Now that the piloting stage has been completed, the model can be adapted to meet the data, systems and requirements of other regional councils, bus operators and the NZ Transport Agency, the researchers say.

Using Microsoft Excel spreadsheet software, the BPM results screen provides a high-level overview of public transport data so users can compare existing services with different scenarios. Results for each scenario are given according to: total cost, total revenue, cost recovery, subsidy per passenger, cost per kilometre and cost per hour. These are all broken down by day types (weekdays, Saturdays, Sundays) and time periods (weekday peak, inter-peak, evenings).

As the BPM also allows the assessment of groups of routes and services, it can also be useful in identifying possible benefits of grouping various services together and the cost implications of this.

Greater Wellington Regional Council first used the model to assess possible changes to services in parts of Porirua. Ian Wallis Associates subsequently applied the model to analyse the costs and financial performance of all existing bus services (by area/route group) in the Wellington region, as one input to the council's current fare structure review.

'In future, we also anticipate using the model to assist in financial forecasting and scenario analyses – for example, on the impacts of fuel price scenarios on both the supply and cost side and the patronage and revenue side of services,' the council says.

Consultant principal Ian Wallis says the starting point for the model is to establish a database of existing bus services for an area or service of interest, including data on patronage, passenger kilometres, fare revenue, operating statistics (bus hours, bus kilometres) and unit costs. These inputs are broken down by route or area, day and time.

The BPM can then be applied as a service performance diagnostic tool to look at the performance of existing services in terms of operations, market demand and unit operating costs. Using the BPM to appraise the existing transport system will give users annual estimates by route and time period, of operating statistics, operating costs, patronage and fare revenues.

Starting with this breakdown of current performance information, the BPM can then be used as a scenario analysis tool to assess how possible changes to the bus system might impact on the system's operational and financial performance.

It can compare impacts of changes in operating costs and fares or concessions and estimate how demand will be affected by such changes. It can assess the effects of changing how the service is operated, such as in running times, operating hours and service frequency. The model can also be used to assess the impacts of changes in external factors that affect demand for bus travel, such as petrol price hikes and population or urban development trends.

The knowledge gained from such thorough analysis could help public transport providers allocate service contracts and develop their network structure. It also allows them to make informed decisions on changing various aspects of services, through providing systematic estimates of changes in operating costs, patronage, fare revenues and funding requirements.

The BPM will complement the council's network-based models (the Wellington Transport Strategy Model and the Wellington Public Transport Model) by providing operational and financial performance data at a detailed level (by bus route and time period). 'The BPM readily allows the user to assess either system-wide or more localised scenarios and can be run multiple times to compare these,' it says.

In future, the model could be enhanced to incorporate rail and ferry services as well as buses, and to be able to assess a wide range of fare structure changes.

The BPM research was commissioned to address a perceived lack of tools available to regional councils, bus operators and the NZ Transport Agency that could focus on financial performance of public transport, broken down in various ways, such as by region, route and time period.

The NZ Transport Agency also wanted consistent ways to appraise public transport service performance to use in service reviews being undertaken by regional councils, including assessment of major public transport system improvements (eg in the Wellington case, the Wellington City Bus Service Review and the Wellington PT Spine Study).

The assessment of financial performance of bus services at a unit level was also seen as an important input for the development of the proposed Public Transport Operating Model.

'There was a need for better and more consistent budget planning tools in general, particularly in an environment of relatively volatile fuel prices, with fuel price movements affecting both the costs of service provision and patronage levels (which in turn impact on service-level requirements),' Ian says.

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New Zealand Bus Policy Model, NZ Transport Agency research report 472
Available online at www.nzta.govt.nz/resources/research/reports/472

CALIBRATION OF TRIP DISTRIBUTION BY GENERALISED LINEAR MODELS

A comprehensive report on research conducted by John Shrewsbury describes how the statistical methods of generalised linear models (GLMs) can be applied to calibrate trip distribution within a major working transport model, the Wellington Transport Strategy Model. The research was undertaken as a doctoral thesis at the University of Canterbury.

TRIP DISTRIBUTION

Trip distribution is also known as gravity modelling or destination choice. It combines the demand from land use (generated by the homes and workplaces in each zone) with the supply of transport (described by zone-to-zone costs through the network) to estimate the number of trips between each pair of individual zones. An understanding of trip distribution is necessary to forecast the traffic on particular links or services in different networks or with different land uses. It depends on the extent to which costs deter travel; the study developed methods for calibrating cost deterrence functions from observed data.

The report shows that a simple model can be calibrated from a 'foursquare' matrix of observed trips (see figure 1), between two production (home) zones and two attraction (work) zones. In practice, larger observed matrices present a great deal of redundancy in information, together with substantial errors from sampling; GLMs find the most likely model amongst this conflicting data.

GENERALISED LINEAR MODELS

GLMs have been used for over 30 years and are available in many of the major statistical packages. They are a development of linear (least squares) regression, but allow a wider variety of forms and error distributions. GLMs have previously been widely used for accident analysis and simple mode split modelling.

The report shows that log-linear GLMs can reproduce observed trips and travel overall, and by segments where separate constants (K factors) and cost coefficients are fitted. In the research, GLMs recovered the Wellington Transport Strategy Model's 17 constants and 14 cost coefficients from both its observed and synthesised commuting distributions. These were segmented by car availability, geographic hierarchy and two main modes. Subsequent calibration was based on a single, fully observed matrix of internal car commuting trips from the 2001 household travel survey, in order to develop methodology for GLMs, rather than re-evaluating the Wellington model.

It is possible to fit a trip distribution by simple iterative methods (Furnessing), but this gives a stepped deterrence function (figure 2a). This has been fitted by GLM, but is shown to overestimate travel. More plausible functions, such as the linked slopes in figure 2b, have also been fitted by manipulating GLMs, but splines offered better empirical functions than either these or polynomials.

FIGURE 1 | 'FOURSQUARE' DATA: MINIMUM FOR CALIBRATION

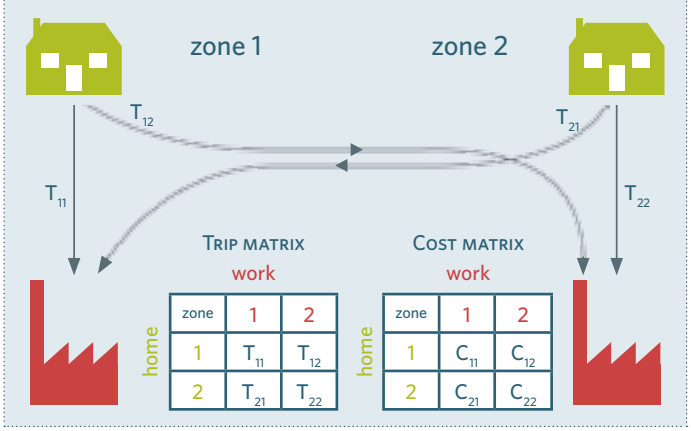
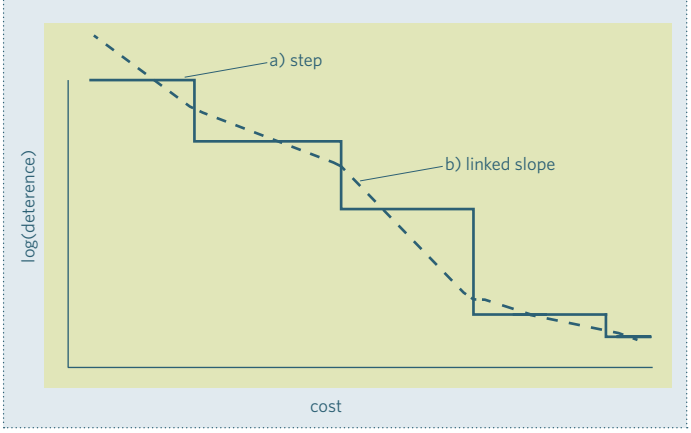


FIGURE 2a | EMPIRICAL DETERENCE FUNCTIONS



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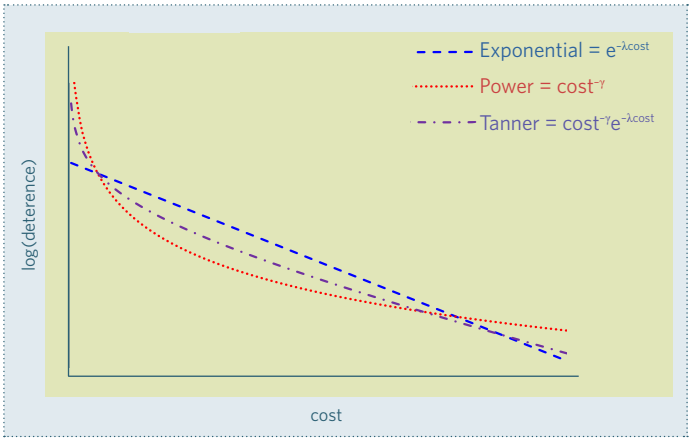
Theories of choice and maximum entropy lead to the Exponential deterrence function, the simplest, natural analytical function in a log-linear GLM, appearing as a straight line in figure 2b. The Power function, a generalisation of the inverse square law of the physical gravity model, does not fit as well to Wellington data, and is sensitive to the formulation of intra-zonal and external costs. However, a linear combination of the Exponential and Power, the Tanner, improves significantly on the fit of the Exponential. It makes geographic segmentation unnecessary in the Wellington car commuting data, and is consistent with the effect of 'cost damping' observed in other studies. A non-linear combination of Exponential and Power, the Box-Cox, fitted slightly better still, but non-linear forms were harder to fit and interpret than standard GLMs.

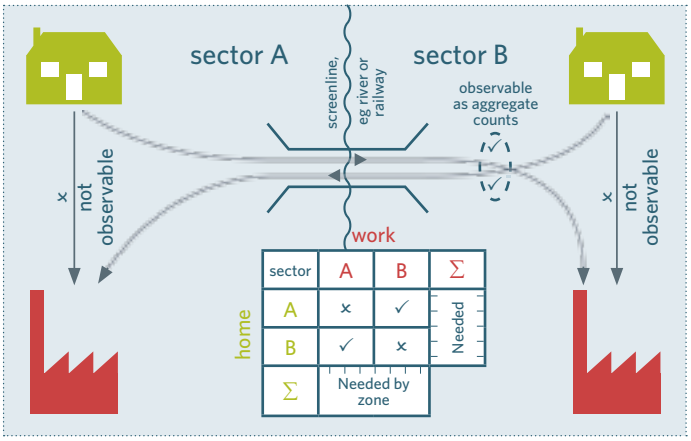
Figure 2b | Analytical deterence functions



MODEL ESTIMATION FROM COUNTS

Aggregate count data is more readily available than zone-to-zone trip observations, but cannot be handled by standard GLMs. However, the Trips MVESTM matrix estimation package (now Cube Analyst) takes the same maximum likelihood approach to fitting log linear models to aggregate count data. The report shows how it can be used to calibrate a trip distribution from counts, incorporating period and direction effects (see figure 3).

Figure 3 | Observable count data



Traffic counts across four Wellington screen-lines (one a CBD cordon) gave about the same information as 1000 household interviews. Zonal trip end information was also needed, and probably would be in any practical case, but might be obtained from planning data. The synthesised trip distribution models met GEH validation criteria for fit to the screen-line counts, but only if due allowance was made for the likely error in the trip ends.

The study also disaggregated data from zones to households, persons and trips, demonstrating a consistency in calibration but also showing varying effects of factors such as income, occupation and period of travel.

Hierarchical GLMs (HGLMs) were formulated to fit mixed logit models, but were unable to reproduce the coefficients of simple nested logit models. This would have allowed the general modelling of choices with different levels of uncertainty, such as trip distribution and mode split, or the red bus, blue bus problem. Geospatial analysis by HGLM showed no evidence of spatial error patterns, either as random K factors or as correlations between them.

GLMs provide statistical measures of fit that are approximations to the standard measures for simple regression. Under sparsity, with few trips observed in a large matrix, some approximations become poor. The residual log-likelihood appears unhelpful, and the Pearson chi-square test thoroughly unreliable, but changes in the log-likelihood are robust, and more reliable than the t statistic for large changes or non-linear models. These findings are likely to apply to accident models also.

These statistics need proper weighting of data to allow for sample expansion: ideally the weights are calculated alongside sample expansion. A single, common weight appears adequate for a survey designed with a single sampling rate. Allowance can be made for uneven sampling, and must be made for lack of independence between trips to and from the workplace by the same worker. Weights for screen-line counts are inferred from GEH validation criteria.

FINDINGS

The study concluded that GLMs provide a flexible and sound basis for calibrating gravity models for trip distribution, for a wide range of deterrence functions.

John says, 'The theory of generalised linear models is now well-established and documented, and the algorithms are mature, robust and available in commercial and open-source software. As a result, we commend them as an effective and versatile method for calibrating trip distribution models. In my report I've identified several practices that I recommend model developers look at adopting in the future.'

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Calibration of trip distribution by generalised linear models, NZ Transport Agency research report 473

Available online at www.nzta.govt.nz/resources/research/reports/473

NEW RESEARCH REPORTS

Field evaluation of media filtration stormwater treatment devices

Research report 493

J Moores, J Gadd, P Pattinson, C Hyde – National Institute of Water and Atmospheric Research Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/493

This study evaluated the performance of media filtration stormwater treatment devices for removing suspended solids, copper and zinc from road runoff. Between September 2010 and March 2012, a field programme comprising the measurement of runoff volumes and the collection and analysis of influent and effluent samples was conducted using three different commercially available devices installed at sites in the Auckland region.

Field conditions were found to have a marked influence on device performance. In particular, low suspended solid concentrations in runoff contributed to each of the three devices achieving lower overall contaminant removal rates than reported previously, although performance varied in relation to differences in influent quality between sites and between storm events. Relatively frequent bypassing of treatment also influenced performance, with contaminant removal rates typically lower during storm events where bypassing occurred. The devices generally achieved only limited removal of dissolved copper and zinc, with export of dissolved zinc occurring in one case and effluent samples from another of the devices routinely exceeding a water quality guideline for dissolved zinc. The results of the study provided the basis for guidance on the use, design, operation and maintenance of media filtration devices and on expectations relating to their performance.

Transport corridors and community structures

Research report 496

M Douglass and J Dryden

Freely available online at www.nzta.govt.nz/resources/research/reports/496

This research gives a regional planning and strategic perspective of some New Zealand experience in creating transportation corridors and community structures from a planning perspective. For major urban areas, future open space corridors and multi-mode transportation corridors are complementary and can economically provide a fundamental framework for urban development. The past processes have typically left the purchase of these open spaces to each special purpose agency, and also until too late in the chain of strategic planning to secure sufficient corridors and shared open space. Early and confident identification of these corridors leads to economy and efficiency in urban development. It also reinforces their combined contribution to sustainable community structures, long-term coherent urban form and a flexible and future-proofed transportation system.

The report includes recommendations relating to corridor protection zones, designations, early corridor land purchase and arterial access management structure plans. These are proposed to assist with future corridor planning.

Transport's proportion of total costs for New Zealand businesses

Research report 495

A Kemp, K Counsell, M Chow – NERA Economic Consulting

C O'Fallon – Pinnacle Research & Policy Ltd

Freely available online at www.nzta.govt.nz/resources/research/reports/495

An efficient transport system is crucial to the New Zealand economy. It facilitates businesses delivering goods to consumers, retail stores and ports for export, and maintaining business competitiveness. The objective of this research was to understand the importance of transport costs as a proportion of total business costs, and examine the opportunities to reduce these costs for New Zealand businesses.

We selected three industries as case studies – the logging, flower and grocery industries – covering different operating conditions and types of goods.

Through interviews and the collection of cost data from businesses in each case study industry, we estimated the transport costs as a proportion of its operating costs and revenue. Transport costs as a proportion of revenue ranged from 15% to 25% for the logging industry, and 1% to 12% for the grocery industry. There was insufficient information for the flower industry to estimate transport costs as a proportion of revenue.

We found that most businesses were seeking transport cost savings wherever possible, especially where those costs were within their direct control. However, smaller businesses where transport costs were bundled within delivered goods prices had limited opportunities to manage those costs.

Finally, we identified for further consideration a number of transport policy opportunities that might reduce transport costs for New Zealand businesses.

Freight transport efficiency: a comparative study of coastal shipping, rail and road modes

Research report 497

PD Cenek, RJ Kean, IA Kvatch, NJ Jamieson – Opus International Consultants

Freely available online at www.nzta.govt.nz/resources/research/reports/497

Customers for long-distance goods haulage are free to decide which transport modes to use on the basis of price and performance. However, independent up-to-date information on which to base such decisions is limited in New Zealand and so existing modes and established haulers are favoured.

In order to address this knowledge gap, a comparative study was undertaken involving the haulage of containers instrumented to allow real-time monitoring of time, location and impact forces. In analysing the results, emphasis was placed on journey duration, impact loading, fuel use/CO_2 emissions and price. The principal finding was that, of the three transport modes investigated, coastal shipping appeared to be the most cost-efficient and environmentally acceptable means of transporting containerised freight between the North and South Islands. However, to have equivalency with the road mode in terms of fuel consumption and CO_2 emissions per kilometre a container is transported, the maritime mode has to transport at least 297 containers per vessel, and the rail mode at least 25 containers per train. The use of an instrumented container was shown to be a low-cost and effective way of assessing the state of New Zealand's main modes of freight transport from a consumer's perspective.

Modelling of extreme traffic loading effects

Research report 499

P Cenek, R Henderson, I McIver, J Patrick – Opus Central Laboratories

Freely available online at www.nzta.govt.nz/resources/research/reports/499

In New Zealand, premature failure of low-volume, low-strength state highways and local authority roads has sometimes occurred due to significant changes in heavy commercial vehicle traffic. Current New Zealand pavement deterioration models (eg NZ-dTIMS and HDM) were not designed to simulate these sudden increases in traffic loading and their effects over short distances.

The NZ-dTIMS and HDM models along with other pavement distress models were investigated to establish their suitability for modelling extreme variations in traffic loading. The relationships between measurements of structural strength and pavement condition data were investigated for selected pavements. The sensitivities of some pavement deterioration and pavement distress models to extreme traffic loading were also investigated.

The key finding was that the extreme traffic loading must be sustained for a lengthy duration to show up in RAMM pavement condition and reactive maintenance cost data. This observation indicates that employing pavement deterioration models may be the preferable analysis route for evaluating the effects of extreme traffic loading rather than analysing historical RAMM data. To enable this, the available pavement deterioration models need to be improved to better model observed localised pavement damage that results from extreme traffic loading, particularly edge break.

Strategic electronic monitoring and compliance of heavy commercial vehicles in the upper North Island

Research report 500

C McBride and P Kirby – Traffic Design Group

Freely available online at www.nzta.govt.nz/resources/research/reports/500

This research report on the strategic electronic monitoring of heavy commercial vehicles (HCVs) was prepared by Traffic Design Group in 2011–12. The aim of the research was to provide a conceptual framework within which technology systems could be operated at strategic, tactical and operational levels. The goal is to improve national productivity, by maximising efficiency for transport operators and enforcement staff alike, improving road safety, better protecting road and bridge assets and creating a fairer economic environment through greater compliance with HCV legislation.

Overloaded HCVs create significant additional wear and tear and damage and even reduce the economic lift of New Zealand's roads and highways. Overloaded vehicles do not pay for the additional tonnes they carry, leaving the considerable extra maintenance and renewal costs to be unfairly borne by operators who pay their correct share of road user charges. Overloading vehicles beyond the legally allowable weight can also compromise the vehicle's body, brakes, chassis, wheels and/or engine.

Currently 84% of freight travels by road within New Zealand and the volume is predicted to double.

The aim and recurring theme of this research report is improving the efficiency and effectiveness of the fundamental enforcement process, which is to identify, process and release or escalate.

Assessment of shear stress limits in New Zealand design standards for high-strength concrete bridge beams

Research report 501

M Al-Ani, R Rogers, J Ingham – University of Auckland

Freely available online at www.nzta.govt.nz/resources/research/reports/501

The design of concrete beams for shear loading is governed in New Zealand by the provisions of NZS 3101. The shear design provisions of NZS 3101 impose two limits on the permissible design shear capacity, including a maximum shear capacity of 8MPa. This 8MPa limit influences the efficiency of concrete beam design, and in particular the design of concrete bridge beams that have concrete compressive strengths greater than 40MPa. The validity of this limit was assessed through an examination of a number of other international design standards, statistical analyses using databases composed of all previous experimental testing of reinforced concrete (RC) and prestressed concrete (PC) beams, and results from an experimental investigation aimed at addressing deficiencies in the compiled databases.

The research found that the limits in NZS 3101 are excessively conservative compared with the limits imposed in most other design standards. This observation was reinforced by analysis of the databases and results of the experimental investigation, which supported the need for a limit on the nominal design shear capacity but found that an absolute limit of 8MPa was overly restrictive. Alternative limits were proposed, and the absolute limit of 10MPa was found to provide improved design accuracy without compromising safety.

A natural environment and cultural asset management system for New Zealand's state highway network: towards a practical concept and application

Research report 503

Colin D Meurk – Landcare Research Manaaki Whenua, Lincoln

Robert H Watts – GreenVisioNZ, Christchurch

Simon R Swaffield – Lincoln University, Canterbury

Shaun Awatere – Landcare Research Manaaki Whenua, Hamilton

Freely available online at www.nzta.govt.nz/resources/research/reports/503

Internationally there is an increasing expectation for roadways to have a minimal environmental footprint, to express local environmental and cultural context, and to protect or respect natural, historical and landscape assets – in addition to being efficient and safe. New Zealand depends on the integrity of its clean green brand and the highways are the shop window of the nation and critical to the impression gained by overseas tourists and traders, but also to residents. Legibility of heritage is a sign of identity, protectiveness and cultural maturity. Key elements that should be revealed are geo-morphology, indigenous biota, and Māori and colonial culture. This can be achieved through conservation, restoration and interpretation. Engagement with communities, iwi, engineers and ecologists is crucial, and culture change has to be championed at the highest level. Leadership must reinforce the latent interest in asserting an Aotearoa New Zealand identity. Aspirational milestones for 'naturalising' the highways should be set. Planting guidelines are appropriate to conventional requirements while contributing to these goals. Despite start-up costs, the system will become cheaper to run while the heritage assets will increase in value and become largely self-sustaining. The natural environment and cultural asset management process is designed to address these national and local priorities.

NZTA RESEARCH – FROM THE ROAD RESEARCH UNIT IN 1953 TO TWEETS IN 2012 AND BEYOND!

More than 500 Research Programme reports are now published on the NZTA's website at www.nzta.govt.nz/planning/programming/research. They are the reports of research funded from the National Land Transport Fund, which has been successively managed by Transit NZ, Transfund NZ, Land Transport NZ, and now the NZ Transport Agency (NZTA).

The history of transport sector research in New Zealand goes further back, to 1953, when the National Roads Board was established (see information at www.teara.govt.nz/en/1966/road-engineering/3), with the Road Research Unit as part of it. Research publications are listed at http://openlibrary.org/publishers/Road_Research_Unit,_National_Roads_Board#.

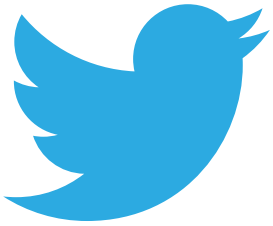
The NZTA's research approach is to invest in applied research that delivers strategic outcomes for the land transport sector. In other words, the results of the NZTA's Research Programme research must be applicable to interventions that can be used in New Zealand in the short-to-medium term for longer-term impacts. The research must be innovative and relevant, and play a critical role at the forefront of land transport thinking, thereby helping achieve the government's goals for transport. This innovative, applied transport research complements the focus on 'blue skies' research commissioned by the Science and Innovation Group of the Ministry of Business, Innovation and Employment.

All research reports published since 2005 are available free of cost for downloading from the NZTA's website. PDF scans of research reports published prior to 2005 are available by contacting research@nzta.govt.nz. As well there is a spreadsheet available on the NZTA's website, where you can search for research reports by using a range of criteria – go to: www.nzta.govt.nz/planning/programming/docs/published-research-reports-20111031.xls.

If you'd like to be emailed when new NZTA research reports are published on the website, please email research@nzta.govt.nz.

Or you can read about them here in *NZTA research*, a newsletter published quarterly by the NZTA. Its purpose is to report the results of research invested in through the NZTA's Research Programme, to act as a forum for passing on national and international information, and to aid collaboration between all involved.

The NZTA is keen to use new forms of communication to let people know about research reports and findings so that the investment is leveraged to greater effect. Watch out for tweets about NZTA research and follow us on @nzta_news!



A NOTE FOR READERS

NZTA research newsletter

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

Contributed articles are also welcome, should not exceed 1000 words and are to be emailed to research@nzta.govt.nz. Illustrations must be of high quality. *NZTA research* reserves the right to edit, abridge or decline any article.

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Enquiries on articles should be made to the authors of research reports whose details are listed at the end of the articles. Otherwise 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.

Editions of this newsletter, *NZTA research*, are available in hard copy or on the NZTA website at www.nzta.govt.nz/resources/nzta-research/. Back editions are available online only.

Disclaimer

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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 or address details, or to alter the number of hard copies of *NZTA research* you'd like to receive.

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The NZTA has another quarterly newsletter you might be interested in.

Exchange is the Public Transport Leadership Forum's quarterly e-newsletter. It informs transport sector leaders and rail, bus and ferry operators across New Zealand about the forum's vision, synergies and planned initiatives to improve the effectiveness of public transport in New Zealand.

For more information about this newsletter, go to www.nzta.govt.nz/about/newsletters.