Session 6b

GROWTH AND DEMAND II

THURSDAY 29 AUGUST 3.30 - 5.30PM

ROAD USE AND ROAD USER REVENUE IN NEW ZEALAND
Ted van Geldermalsen

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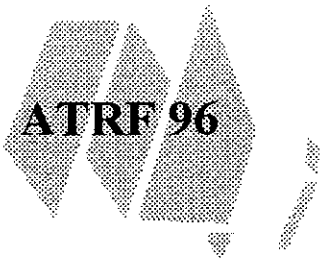

ROAD USE AND ROAD USER REVENUE IN NEW ZEALAND

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ABSTRACT

A database has been assembled containing traffic flows on all New Zealand roads. It has been used to calculate the vehicle kilometres travelled by different vehicle types in each region, and on state highways and local roads

Distributions of vehicle weights are recorded for each heavy vehicle type. These are used along with the published schedule of Road User Charges rates and the distances travelled by each vehicle type, to calculate the estimated Road User Charges revenue generated in each area. Petrol excise duty revenue is also estimated

The total distance travelled by all vehicles on all roads in New Zealand in 1994 was approximately 32 billion vehicle-kilometres. State highways accounted for 44% of total travel even though they only comprise 12% of the road network. Unsealed low volume roads make up 40% of the national road network but only account for 3% of vehicle kilometres travelled.

Estimates were made of the petrol excise and Road User Charges revenue generated by road use in each territorial authority area and on the state highway and local road networks as a whole. The results show that in some areas income from road users is greater than Transit New Zealand expenditure while in others (generally rural) it is substantially less. This is not unexpected and reflects the fact that the roading system operates as a network and expenditure is based on needs rather than being necessarily tied to where income is generated.

This is the first time such a detailed picture of traffic flows on New Zealand's public roads has been compiled. The results of this project will assist transport policy-makers in many areas including planning, funding and safety.

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1 Introduction

This paper explains how the national traffic database (NTD) was used to estimate road use and to calculate revenue generated by road use in New Zealand. The development of the NTD and its structure are described. A comparison is made between the calculated revenue for different regions and the corresponding Transit New Zealand (Transit) road expenditure information for those regions. The paper also considers other possible applications of the NTD and makes suggestions for improving the quality of its data.

The NTD is a snapshot of traffic flows on all public roads in New Zealand as at July 1994. It contains an estimate of the traffic count on every road link as well as tables of the proportions of different vehicle types on each type of road and the weights of the different vehicle types. For each road link the NTD also contains information such as road length, whether the road is state highway (managed by Transit) or local road, sealed or unsealed, and urban or rural.

The NTD has been used to estimate the petrol tax and Road User Charges revenue generated by the use of roads in different areas, and by the use of state highways compared with local roads.

A copy of the NTD is supplied on computer diskette with the Transit research report, Transit (1996a)

2 National Traffic Database

2.1 Development

In May 1994 Transit commissioned Works Consultancy Services (the consultant) to establish a national traffic database. The database was to record travel on all New Zealand public roads, measured in terms of average daily traffic, traffic composition and weights of heavy vehicles.

Work began with the development of a proposed methodology. A pilot study was carried out covering Gisborne and Hawkes Bay regions to prove and refine the methodology. Several adjustments were made before the study was extended to the rest of the country. Complete details of the methodology finally adopted and the assumptions made in developing the database are reported in Transit research report, Transit (1996b)

A preliminary version of the NTD was completed in February 1995. Work has continued since then to improve the accuracy of vehicle weight data, and to correct faults that were identified when the preliminary database was used for analysis. Final completion of the project was achieved in May 1996.

The development of the NTD has been a significant undertaking, involving a large number of the consultant's staff and sub-contractors, and costing over $500,000.

The completed database comprises three files:

- The section data file contains approximately 120,000 road links each with an associated estimate of annual average daily traffic (traffic count).
- The vehicle classification distribution file contains distributions of vehicle types (traffic composition) on different types of road.
- The vehicle weight distribution file contains distributions of weights for each heavy vehicle type.

2.2 Section Data File

This is the main file in the NTD. It contains all the information that is specific to each section of road including a unique identifier, the section length, the road type and the best estimate of the traffic count for that section. This file is based on data gathered from each road controlling authority's (RCA's) RAMM inventory. RAMM is the computerised road assessment and maintenance management system used by all New Zealand RCAs. RCAs include territorial authorities and Transit.

The consultant first took an extract of the relevant fields of data from each RCA's RAMM inventory. This was down-loaded into a series of spreadsheets for further adjustment and updating. The NTD was then assembled by joining together all of the spreadsheets. The NTD uses the same system for referencing road links as the RCA RAMM inventories. This makes it possible to transfer data from the NTD back into RAMM.

Not all RCAs' RAMM inventories are complete. In a number of cases missing roads had to be added to the spreadsheets. For example some RCAs keep their unsealed road data separately from their RAMM inventory so this data needed to be added manually. A few RCAs had not recorded some of their roads and the consultant had to extract this information from maps. Some low traffic volume unsealed roads in a number of rural territorial authorities were combined into surrogate roads having the total length and weighted average traffic volume of their constituent roads.

Motorway on and off ramps are included as separate roads. Because of the high traffic volumes on motorways, ramps are potentially significant locations of road use.

The traffic volume estimates for all links in the spreadsheet were adjusted to a common date, July 1994, by applying regional traffic growth rates. Some of the traffic counts and estimates in some RCA RAMM inventories were up to six years old.

2.3 Vehicle Classification Distribution File

This file contains the proportions of each vehicle type on each road type.

The consultant conducted traffic composition surveys on approximately 450 road links. These were 24 hour surveys done with automatic traffic classifiers. The road links to be surveyed were selected by a stratified random sampling process. Forty links were selected in each RCA by a method which ensured that a cross section of roads from high to low traffic volume would be surveyed. Five of these links in each RCA were surveyed for the initial NTD development. It is intended that the other 35 selected links in each RCA be surveyed over the next few years and the NTD progressively refined.

Previous research had shown that roads with different functions carried different mixes of traffic and that the different traffic mixes corresponded to 11 different road types, for example urban arterial, urban residential rural strategic and rural summer recreational. The survey data was therefore grouped into these 11 road types and an average traffic composition was determined for each road type.

Vehicle types are classified into one of 15 classes using a system derived by Transit from the AUSTROADS classification system. The system has been developed to enable traffic composition to be surveyed with automatic traffic classifying equipment.

2.4 Vehicle Weight Distribution File

The vehicle weight distribution file records vehicle weight data based on information from two sources. Some of the data is the result of a survey by the Police Commercial Vehicle Investigations Unit. The Investigations Unit estimated the weights of approximately 5000 randomly chosen heavy vehicles covering the NTD vehicle types on different road use categories in different geographical regions. Additional data was obtained from Transit's weigh-in-motion stations on State Highway 1 at Drury, Pukerua Bay and Waipara.

Individual vehicle weights were sorted into groups. Each combination of vehicle type, road use category and geographic region was a separate group. A weight profile was determined for each group. This was characterised by arranging the weights for the group in order of increasing weight and then identifying the weight in tonnes for each of 13 percentiles, 5%, 10%, 20%, 25%, 30%, etc. Results were then compared and in the case of groups with insufficient observations or groups whose results were not statistically different the weights were combined into larger groups and the weight distributions recalculated.

The vehicle weight distribution file consists of 13 records for each road use category and geographic region, corresponding to the 13 non-car vehicle types, ie vehicle types 3 - 15. As noted above, the data for some road use categories and geographic regions has been combined so not all are individually represented. Each record comprises 14 fields. These are the vehicle type and the weight in tonnes at each of the 13 percentile points.

3 Vehicle Kilometres Travelled

The NTD contains traffic flow information for 92,736 kilometres of road. The NTD was used to calculate the total annual vehicle kilometres of travel (VKT) on various combinations of roads.

VKT is calculated using the following data:

- road link lengths
- road use category of each road link
- traffic composition associated with the road use category
- average daily traffic count for each road link

VKT is calculated by multiplying road link length by the traffic count and proportion of vehicle type and then summing the result of this for all of the roads or vehicle types in the area of interest.

The total annual VKT by all vehicles on all roads is 31.7 billion.

Other results are shown in tables 1 and 2.

Table 1: Annual Vehicle Kilometres Travelled on State Highways and Local Roads

	State Highways	**Local Roads** (including Special Purpose Roads)
Length of Road (km)	10,744	81,992
Percentage of total length	12%	88%
Annual VKT	13,900 million	17,800 million
Percentage of total annual VKT	44%	56%

State highways are clearly much more heavily trafficked on average than local roads. Additional analysis also showed that state highways carry a higher proportion of heavy vehicles on average than local roads.

Table 2: Annual Vehicle Kilometres Travelled on Sealed and Unsealed Roads

	Sealed Roads	**Unsealed Roads**
Length of Road (km)	55,698	37,038
Percentage of total length	60%	40%
Annual VKT	30,900 million	800 million
Percentage of total annual VKT	97%	3%

It can be seen that while the length of unsealed roads is significant, at 40% of the total roading network they only account for 3% of total usage.

Transit (1996c) presents details of VKT by region and territorial authority. Separate figures are provided for travel by petrol powered vehicles (mostly cars) and Road User Charges licensed vehicles (predominantly heavy vehicles) on state highways and local roads and for travel on sealed and unsealed roads.

The Auckland region's roads have the greatest usage by both cars and heavy vehicles, accounting for 30% of the national total VKT (9,380 million VKT), even though they only account for 8% of the nation's network by road length.

4 Income Calculations

4.1 Total Revenue

This section describes how the NTD is used to calculate petrol excise and Road User Charges revenue. The actual total revenue recorded in the Government's accounts, provides a check on the results of the calculation.

There are 3 main sources of revenue for the Land Transport Fund. The following figures show the total revenue actually collected from each source for the 12 months ending 30 June 1994 (M = million):

- Motor Vehicle Registration Fees $146.9
- Net Excise Duty on Petrol $273.4
- Net Road User Charges $352.1

Of these, petrol excise and Road User Charges revenue relate directly to road use and are the amounts that can be calculated using the NTD. Motor vehicle registration fees are a fixed charge, unrelated to usage.

The revenue from motor vehicle registration fees is almost equal to the amounts distributed from the Land Transport Fund to the Land Transport Safety Authority and the Police. As this revenue and expenditure is almost offsetting it has been ignored in the subsequent calculations.

To calculate petrol excise and Road User Charges revenue it is necessary to calculate the VKT for each vehicle type on each road type in each RCA's road network. This calculation was described in section 3.

4.2 Petrol Excise Revenue Contribution

The calculation of Land Transport Fund petrol excise revenue (based on 9.4 cents per litre dedicated to the Land Transport Fund) includes only the VKT by petrol powered vehicles of types 1 and 2. The total annual VKT by these two vehicle types is substituted into the

following formula:

Petrol excise = VKT x $0.094/litre x litres/100 km

In order for petrol excise revenue to equal the $273.4M actually collected the average fuel consumption rate needs to equal 10.55 litres per 100 kilometres. This compares with an average fuel consumption rate of approximately 9.4 litres per 100 kilometres estimated for the New Zealand car fleet in EECA (1993). The higher figure calculated using the NTD can partly be explained by the fact that these VKT figures include a number of petrol powered light commercial vehicles up to 3.5 tonnes.

Petrol excise revenue for any subset of roads such as for an individual RCA is calculated by substituting the corresponding VKT for that RCA's roads into the above equation. It is assumed that the average fuel consumption rate is the same for all roads.

4.3 Road User Charges Revenue

Road User Charges (licence fee per 1000 kilometres) depend on vehicle type. The vehicle types used for determining charge rates for Road User Charges distance licenses are different from those used in the NTD. The Road User Charges vehicle types are defined according to the number of axles per vehicle and whether the vehicle is powered or unpowered (trailers). For each Road User Charges vehicle type the charges depend on the vehicle weight. Road User Charges do not increase linearly with weight. As weight increases the charges increase at an increasing rate to reflect the fact that road wear increases in proportion to the fourth power of vehicle axle weights.

The calculation of Road User Charges revenue commences with a calculation of the VKT on the roads in each road use category in the area of interest e.g. a RCA. This is multiplied by the traffic composition proportion for each vehicle type to obtain the VKT by each vehicle type except petrol powered vehicles. Each VKT amount is multiplied by an appropriate weighted average Road User Charges rate. These amounts are summed to obtain the total Road User Charges revenue for the area of interest.

The weighted average Road User Charges rate referred to above, is calculated separately for each record in the NTD vehicle weight distribution file, ie for each vehicle type, on each road type, in each region. This calculation is detailed further in Transit (1996c).

The above calculation gives a figure of $374M for the total Road User Charges revenue from all vehicles on all roads. This is slightly higher than $352.1M actually collected. It is assumed that Road User Charges avoidance partially accounts for the difference in revenue, i.e. some of the travel recorded in the NTD is being made without payment of the appropriate charges. To make calculated Road User Charges revenue based on the NTD equal the revenue actually collected, all NTD Road User Charges calculations were factored down by $352.1M/$374M = 0.941.

It is likely that the above adjustment does not fully reflect the extent of Road User Charges avoidance. A recent study, MOT (1996a), estimated that Road User Charges avoidance

may be 15% and a further study has now been initiated by the Ministry of Transport to increase the accuracy of this estimate.

It is considered that the above result should be treated with caution. The data to calculate Road User Charges revenue (and hence avoidance) still requires further refinement. This will be an ongoing process.

Road User Charges revenue for an individual RCA is calculated by only including the road sections in that RCA's network in the above calculation.

5 Expenditure Data

Transit expenditure data was collated to enable comparison of expenditure with revenue for each region. Expenditure data from the 1992/93, 1993/94, and 1994/95 financial years was used in the analysis. Data from these three years was averaged to give an annual average expenditure figure that smoothes out year to year fluctuations, particularly in construction and flood damage repairs.

All Transit expenditure was used in the analysis, including state highway, local road and public passenger transport (public transport) expenditure. Transit provides financial assistance for public transport, the majority of which goes to the main centres. Omitting this distribution of road user income would give a distorted picture of extent to which the main centres are receiving less funding than they generate.

Transit provides the funding for 100% of the cost of state highway work. The expenditure on state highways has been broken down by territorial authority area. Capital and maintenance expenditure is differentiated to enable separate analysis of the capital expenditure in each region.

For local roads, only Transit financial assistance for road works that are eligible for financial assistance was included in the comparisons of income and expenditure. The territorial authorities' local share of the cost of this work and their expenditure on ineligible works were omitted because the income, from local authority rates, and the expenditure both occur within the territorial authority area and by definition will balance within that area.

Three sets of public transport expenditure information were collected. The first of these was the Transit financial assistance to regional councils for public transport services. The second was regional petrol tax revenue and the third was the regional council's own share of expenditure on assistance to public transport, funded from local authority rates. As with local roads, only Transit expenditure was included in the income and expenditure comparisons. The regional petrol tax revenue and regional rates contributions were omitted for the same reasons as the local share of local road expenditure was excluded.

The expenditure figures contain a distribution of the Transit head office and operational costs which are reported in the Transit Roading Statistics.

6 Comparison of Income and Expenditure

6.1 General

A summary of all income and expenditure results by territorial authority area is presented in Transit (1996c). Following publication of this report a small error was detected in the results for one RCA (Matamata-Piako District). The following discussion draws on a corrected set of results so some figures will differ slightly from those published in the report.

The revenue calculations indicate that the total income resulting from the use of local roads is $308M and that of state highways is $317M. Thus state highway usage accounts for 51% of total petrol excise and Road User Charges revenue. By contrast only 44% of VKT is travelled on state highways. The difference is because a greater proportion of travel by heavy vehicles, which pay more on average than light vehicles, occurs on state highways.

Table 3 summarises the total income and Transit expenditure by region. The expenditure figures in Table 3 include all Transit financial assistance for public transport as well as for local roading.

Table 3: Total Income versus Total Transit Expenditure ($M)

	Region	Income	Exp.	Difference	Income as % of Exp.
1	Northland	26.1	44.2	-18.1	59%
2	Auckland [1]	152.2	115.0	37.2	132%
3	Waikato	90.8	90.6	0.2	100%
4	Bay of Plenty	45.3	36.2	9.1	125%
5	Gisborne	6.0	19.4	-13.4	31%
6	Hawkes Bay [1]	24.1	29.2	-5.1	82%
7	Taranaki	19.9	17.8	2.1	112%
8	Manawatu-Wanganui	48.3	44.0	4.3	110%
9	Wellington	51.9	47.9	4.0	108%
10	Nelson-Marlborough	16.9	27.4	-10.5	62%
11	Canterbury [1]	77.0	58.4	18.6	132%
12	West Coast [1]	10.1	23.5	-13.4	43%
13	Otago	35.5	50.1	-14.6	71%
14	Southland	17.7	24.7	-7.0	72%
15	Chatham Islands	0.0 [2]	1.0	-1.0	2%
	TOTAL	621.8	629.4	-7.6	

[1] See Section 7 for comments on accuracy of these figures.

[2] Actual income for Chatham Islands was approximately $22,000.

The regional surpluses and deficits will vary from year to year because the expenditure figures include capital (construction) expenditure and the distribution of such expenditure by region is not constant. The fluctuations are smoothed to some extent by averaging expenditure figures for three years. However, particularly large capital projects could still cause volatility, even with this smoothing. For example if construction of two large projects in the Auckland region such as the south eastern arterial and the proposed Orewa bypass was to occur simultaneously the surplus in Auckland region could almost disappear. Areas with backlogs of worthwhile projects may incur high expenditure levels for extended periods of time while clearing the backlogs. This can significantly affect the results of the above analysis.

Total income and expenditure do not exactly match because not all income is allocated to Transit (some goes to the Land Transport Safety Authority and Police) and Transit receives a small amount of income from sources other than the Land Transport Fund.

It is important to note that roading is a network, made up of many links and that each individual trip will use a different combination of links. It is not necessary for every link to be independently financially viable. For some roads expenditure is greater than revenue produced, yet this may be necessary to enable traffic to access the core network where costs may be less than revenue. It would be inappropriate to jump to strong conclusions regarding individual roads without first considering the viability of the network as a whole.

6.2 Capital Expenditure

The NTD was used to compare the distribution of roading capital expenditure and income by region. Capital expenditure includes new roads, improvements to existing roads and bridge renewals. In absolute terms Auckland receives the most capital expenditure ($44.6M), followed by Waikato ($25.1M). This is consistent with where traffic growth and consequential pressures on road capacity are greatest.

Taranaki and Canterbury receive the smallest amount of capital expenditure as a proportion of the income generated in those regions. West Coast and Northland receive the greatest amounts by proportion. In Northland's case this is partly due to the substantial seal extension programme which has been necessary to keep pace with high tourism growth.

7 Accuracy

7.1 Verification of the National Traffic Database

A number of checks were made to verify the NTD. These included:

- sending a copy of the NTD to all RCAs and requesting them to advise any errors which they detected,

- comparing estimates of VKT calculated from the NTD with the latest information from state highway RAMM inventories,
- comparing NTD individual traffic counts for main roads in selected territorial authorities with the latest traffic count data from these territorial authorities,
- scrutinising the traffic growth rates used to update RCA supplied traffic counts from prior years,
- comparing the total national VKT calculated using the NTD with estimates from other studies,
- calculating total petrol excise and Road User Charges revenue and comparing the results with the amounts actually collected, and
- comparing VKT for Road User Charges licensed vehicles with the total distance of licenses actually sold.

Some findings from the checks include the following:

- In total the NTD indicates 31.7 billion VKT per annum. This figure is approximately 5% lower than the 34.2 billion VKT per annum estimated in the Environmental Externalities report, MOT (1996b). While the difference is significant it is considered that both figures are within the range of acceptable estimates of total VKT.

- VKT for state highways in Hawkes Bay, Canterbury and West Coast regions varied noticeably from figures calculated using the most up to date the RAMM information. The reason for this is not known but investigations are continuing in order to resolve the discrepancies when the NTD is next updated.

- In the Auckland region, traffic growth rates of 8-10% per annum appear to have been used for updating traffic count information on many local roads. This is considered too high. In addition it appears that some traffic count data supplied for the NTD may inadvertently have been recorded as relating to 1990 when in fact it was more recent and hence did not require factoring up for traffic growth.

7.2 Statistical Precision of VKT and Revenue Figures

The accuracy of calculations performed using the NTD such as the VKT results and the revenue calculations is limited by the methodology used to construct the NTD. The database figures for traffic counts, traffic composition, and average vehicle weights are all estimates with varying levels of statistical precision.

The statistical error of the VKT figures in section 3 is unknown. For some purposes it is necessary to have VKT figures whose precision is known. This can be achieved with the NTD by using only the traffic count results from the sites which were randomly selected by the consultant as described in section 2.3. In this case all traffic count information supplied by RCAs is ignored. With only five of the 40 sites selected in each RCA area surveyed at this stage such VKT figures will have a statistical precision of $\pm$ 28% for any particular RCA. This will be improved to $\pm$ 10% when all 40 sites have been surveyed in each area. The national VKT total will be accurate to $\pm$ 3% when all sites have been

surveyed in each area.

The calculations in section 3 and the comparisons with expenditure in section 6 use the traffic count estimates supplied by RCAs for every road link. Since the statistical error of these is unknown the results of the calculations are also of unknown precision. However it is considered probable that most of the results will be within ± 10% for each RCA.

Calculations involving traffic composition and vehicle weights are less precise. At this stage of its development the NTD should only be used to make estimates of these characteristics at a network level and not for individual road links or routes.

8 Other Applications

Although the NTD was developed primarily for the Land Transport Pricing Study it has already been used for other purposes.

The Land Transport Safety Authority has used the NTD to assist in determining the optimal allocation of road safety budgets and interventions. Accident numbers were referenced against the NTD to determine accident rates, that is accidents per distance travelled, for different regions. Areas with higher accident rates might warrant greater safety expenditures.

The NTD has been used in a number of Transit research projects. Some of these projects have stretched the limits of its statistical precision. However they have indicated a demand for an information base such as this and helped to indicate the areas where future development might be most usefully targeted.

In essence the NTD is a first attempt at a demand model for the roading system. It shows what the demand is to use each road given the current level of charges for road use. Such information is essential if roads are to be managed in an efficient manner and meet the needs of road users. Much more sophisticated demand information would need to be obtained if funding allocations were ever to be based on such a model.

9 Future Improvements

On 1 July 1996 a new agency, Transfund New Zealand (Transfund) will take over Transit's road funding role. In future Transfund will distribute funding from the Land Transport Fund to all RCAs including Transit which will become solely the state highway controlling authority. It is expected that Transfund will become the owner of the NTD.

Over the next six months Transfund will work with the Ministry of Transport, Land Transport Safety Authority, Transit and other interested organisations, on a strategy for further development of the NTD.

Issues to be considered as part of this strategy include:

- long term ownership of the NTD
- identification of all parties who may have an interest in the NTD
- funding of future data collection
- frequency of data collection
- statistical precision
- quality control of data
- addition of other types of data
- linkages to other databases, e.g. Land Transport Safety Authority and Police road safety data.

Improving the quality and statistical precision of the NTD will not come cheaply. For example, the proposed additional classification surveys in each RCA area could cost as much as $1,000,000 to complete if the same survey method is adopted as was used for the initial NTD development.

Checks on the data in the NTD noted discrepancies for state highway data in three regions and for local road data in the Auckland region. It is intended to investigate and resolve these discrepancies as soon as possible. This may occur at the same time as the formulation of the future development strategy for the NTD

As noted in section 7, calculations involving traffic composition and vehicle weights are less precise than those involving traffic counts and VKT. Some of the research projects and other studies to which the NTD is being applied require this data to be more accurate. Examples of such studies include development of a national state highway strategy, evaluation of possible heavy transport routes, and identification of optimal levels of service for maintenance. It is intended to address this need as part of the future development strategy.

10 Conclusions

A national traffic database has been assembled showing traffic flows on all public roads in New Zealand. This is the first time such a detailed picture of traffic flows on New Zealand's public roads has been compiled. Initial indications are that the database will be an invaluable tool for all types of roading and road safety policy development.

The information in the database shows that each year a total of 31.7 billion vehicle kilometres are travelled by all vehicles on all roads in New Zealand.

State highways account for 44% of all road use measured in terms of vehicle kilometres travelled. In addition state highways carry a greater proportion of heavy vehicles on average than do local roads.

Unsealed low volume roads make up 40% of the road network by length but only account for 3% of road usage.

The database was used to calculate estimates of the petrol excise duty and Road User Charges revenue generated by road use in each local authority area and on the state highway and local road networks as a whole. The results were compared with Transit expenditure and financial assistance. The results show that in some areas income from road users is greater than Transit expenditure while in others it is substantially less.

The database is already being used in other areas of transport policy development. The uses to which the database has been put have highlighted areas for further improvement and refinement and a strategy is being developed to achieve this.

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