Valuing Public Transport Quality using Passenger Ratings & Willingness to Pay Surveys

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Abstract

This paper summarises a survey of 12,557 Auckland, Christchurch and Wellington bus and rail passengers in 2012-13 using Stated Preference (SP) or conjoint market research and Rating surveys to understand the trade-off between price and quality.

In the SP surveys, passengers were asked to rate vehicle and stop/station quality on a five star system similar to that used by restaurants, cinemas and hotels and trade-off quality with travel time, service frequency and fare in a set of travel choice experiments. The aim was to estimate 'Willingness to Pay' values. To explain the overall vehicle and stop ratings, a separate rating survey was undertaken which used a nine point scale. Objective data on vehicle age, vehicle type and stop/station characteristics were used to explain the passengers ratings.

Unlike other reviewed approaches, the approach did not require any capping of the overall value of vehicle and stop/station quality. The approach lends itself to monitoring and valuing operator performance. It has been exported to Australia to assess, train, bus, Light rail and ferry quality in Sydney and Melbourne. It is also applicable for use in other service sectors but it is dependent on stated rather than revealed preferences.

1. Background & Study Scope

The study for NZTA and undertaken by Douglas Economics looked at the trade-off between price and quality for bus and train users in Auckland, Christchurch and Wellington. The valuations estimated from the results of a survey of 12,557 bus and rail passengers carried out between November 2012 and May 2013 on 1,082 different services.

2. Literature Review

Thirteen studies were reviewed which valued vehicle and stop/station quality. The studies included 7 Australasian studies and 6 international studies that straddled more than two decades dating back to a 1991 study of public transport services in Wellington. Table 1 lists the studies.

Most of the studies used Stated Preference (SP) techniques but other approaches were used. For example, the Wellington Rail study (8) used a Priority Evaluator (PE) approach in which a shopping list of service improvements including a travel time saving was presented. Respondents were asked to allocate $100 across the items listed to indicate their relative priority for improvement. Although respondents were able to complete the shopping list, the total package value when expressed in train minutes was implausibly highly.

Table 1: Studies Reviewed

#	Title & Author	Location	Modes	Survey	Citation
1	*"Quality of Public Transport"* - SDG NZ Ltd Wellington (1991)	Wellington NZ	Bus & Rail	1991	ATC (2006)
2	*"Value of Rail Service Quality"* - PCIE Sydney (1995)	Sydney, Aus	Rail	1995	ATC
3	*"Liverpool - Parramatta Transitway Market Research"* - PPK/PCIE (1998)	Sydney, Aus	Bus	1998	ATC
4	*"Developing a Bus Service Quality Index"* - Hensher (1999 & 2002)	Sydney, Aus	Bus	1999-2002	ATC Balcombe (2004) Bristow (2009)
5	*"Valuing UK Rolling Stock"* Wardman & Whelan (2002)	UK	Rail	Pre 2001	Balcombe, Bristow
6	*"Survey of Rail Quality Dandenong"* - Halcrow (2005)	Victoria, Aus	Rail	2003	ATC
7	*"Value of Sydney Rail Service Quality using Ratings"* - Douglas & Karpouzis (2006)	Sydney, Aus	Rail	2004-5	Litman (2011) Bristow
8	*"Tranz Metro Wellington Station Quality Surveys"* - Douglas Economics (2005)	Wellington, NZ	Rail	2002 & 2004/5	*
9	*"London, Bus & Train Values"* - SDG LUL (2004 & 2008)	London, UK	Bus & Rail	1995-2007	Bristow
10	*"Values for Package of Bus Quality Measures in Leeds"* Evmorfopoulos (2007)	Leeds, UK	Bus	2007	Bristow
11	*"Soft Measures Influencing UK Bus Patronage"* AECOM (2009)	Provincial Cities, UK	Bus	2009	*
12	*"Valuing Premium Public Transport in US"* - Outwater et al (2010)	Four Cities, USA	Bus & Rail	2010	*
13	*"Universal Design Measures in Public Transport in Norway"* - Fearnley (2011)	Norway	Bus	2007	*

The review converted the valuations of the 13 studies reviewed into (i) equivalent minutes of onboard bus/train time (IVT) and (ii) the percentage of the average fare paid. Where only a fare value or a time value (but not both) were estimated, an 'external' value of time was imported. For instance the 2004 Sydney Rail rating study (7) used a value of time estimated by another study, Douglas Economics, 2004 and Wellington rail station survey (8) used the value of time given in the NZ Economic Evaluation manual.

Some of the studies provided estimates bus and rail which meant that the number of observations exceeded the number of studies. For vehicles, 17 IVT valuations were provided by the 13 studies and 16 percentage fare valuations. The value of the vehicle and station 'packages' varied widely across the observations reflecting differences in study context, study methodology and in the make-up of the packages themselves such as whether 'ongoing' maintenance aspects were included (e.g. cleanliness, staff friendliness etc) as well as physical aspects (new versus old, low floor versus steps etc).

Given the wide range, the review calculated the median and the inter-quartile range as well as the mean. For vehicles, the median value of the improvement package 4.3 minutes compared to a mean of 7.3 minutes which was skewed upwards by two high values. The inter-quartile range was 3.4 to 7.4 minutes. The values when expressed in terms of the percentage of the average fare paid were closer. The median value was 27% and the mean 34%.

Table 2: Value of Vehicle Improvements

Statistic	IVT Mins	% Fare
Mean	7.3	34%
Upper Quartile 75%	7.4	54%
Median	4.3	27%
Lower Quartile 25%	3.4	14%
Observations	17	16

There was a wide range in values thus the inter-quartile range was calculated.

The highest value for a package of vehicle quality improvements was estimated by Hensher in a 1999 survey of bus users. The package of improvements (wide entry doors, very clean, very smooth buses and very friendly drivers) was worth 32 minutes or 90% of fare. Next highest was an AECOM (11) study which valued a package of new buses with low floors, (air conditioning, trained drivers, on-screen displays, audio announcements, CCTV, leather seats, operating to a customer charter to be worth 15 minutes of onboard travel time (27% of fare).

The US study (12) estimated a 'premium' bus service with WIFI, comfortable seats, temperature control and clean vehicles was worth 3 to 6 minutes of travel time whereas a similar premium rail service was valued at 4.3 minutes plus 0.13 minutes per minute of train time.

The SDG London study (9) estimated that travelling by the 'best' rather than 'worst' vehicle was worth 2.4 minutes for buses and 3.6 minutes for trains.

Table 3 presents the same analysis but for bus stops and train stations. It is worth mentioning here that most studies did not say whether the values applied to passengers who transferred or alighted at the stop/station as well as to boarders (i.e. the value was some or sort of weighted average).

Table 3: Value of Stop Improvements

Statistic	IVT Mins	% of Fare
Mean	9.8	41%
Upper Quartile 75%	10.7	58%
Median	5.7	25%
Lower Quartile 25%	4.2	10%
Observations	12	9

In the absence of any definition, it is presumed that the values are for passengers who boarded their first bus or train at the stop/station. The likelihood is that the values for alighters would be less (probably around a half) since 'exposure' is less.

Only the 1995 Sydney rail study (2) made reference to the number of stations 'experienced' factoring the values down by 2.1 (the average number of stations per trip). The 2004 Sydney study (7) asked passengers about their board station and the Wellington survey (8) referred to a nominated station (which could be the board or the alight station).

As with vehicles, the composition of the stop/station packages varied. Some included information such as the Hensher study (4). The US study (12) included personal security whereas most of the other studies considered weather protection, seat provision and lighting.

The highest package value was 44 minutes by the Wellington Priority Evaluator study (8). As previously mentioned, the high value probably resulted from focusing attention on station attributes and away from travel time (included to derive valuations). Next highest was the Norwegian study (13) which valued weather protection and seating at 14 minutes but which also probably overestimated the values by unduly focussing attention on them.

The London 2007 survey (10) valued 'worst to best' bus stops at 1.9 minutes and 3.6 minutes at train stations. The Dandenong study (6) which used a Priority Evaluator, valued a package of rail station improvements at 5.4 minutes (91% of the average fare).

Again the median value of 5.7 minutes is considered more reliable than the mean of 9.8 minutes which was affected by high 'outliers'. There were fewer percentage fare than time based observations (9 versus 12). The median estimate was 25% of fare.

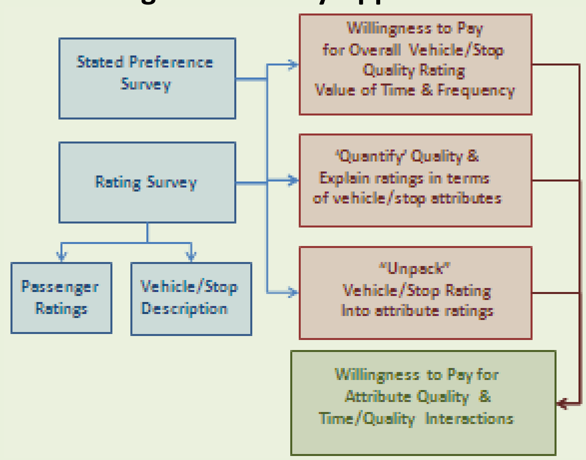
Of the studies reviewed, the system-wide study of Sydney rail users (7) which used a rating questionnaire in tandem with a 'what if' questionnaire to derive values for the rating changes was considered the most promising to build on. Most of the other studies valued individual attributes such as 'no steps versus one step to board' then constructed 'package' values by addition. In doing so, the resultant valuations were often large and required downwards adjustment such as in the SDG London study (9) which capped improvements at 27 pence.

Where it was considered that the Sydney study could be improved on was by replacing the 'what if' question with a Stated Preference survey of overall vehicle and stop/station quality measured by a rating score.

3. Survey Approach

The survey involved two questionnaires: a rating survey completed by 7,201 passengers (57% of the total); and a Stated Preference (SP) survey completed by 5,356 passengers (43%) that presented a series of pair-wise journey choices.

Figure 1: Survey Approach



Two questionnaires were used to estimate the travel time, frequency and quality valuations

As mentioned in section 1, the use of a 'hybrid' rating/SP approach was new. The literature review found no similar approach. The closest was a system-wide study of Sydney rail users undertaken in the mid 2000s that used a rating survey and a 'what if' questionnaire to derive valuations rather than a SP survey. Most of the studies reviewed valued individual attributes such as 'no steps versus one step to board' and then constructed 'package' values by addition. In doing so, the resultant valuations were often large and required downwards adjustment. However in this study, no adjustments were made and continuous valuations were estimated.

Passenger completing a questionnaire

After deciding on a hybrid rating/SP approach, the survey approach was piloted in Wellington in November 2012. The rating survey worked well as a self completion questionnaire. In contrast, the first SP surveys were 'interviewer led' and it was difficult to interview on moving buses so the questionnaire was rewritten as a self-completion questionnaire which worked well and provided the bonus of a much enlarged sample size over three times larger than the agreed target.

The survey covered subsidized urban bus and train services, longer distance rail services (Wairarapa and Auckland-Pukekohe) and outer Christchurch bus services. Also surveyed was the Wellington Airport

Flyer which operates without subsidy and offers a premium bus service at higher fares. Altogether, services operated by fifteen bus companies and two rail operators were surveyed.

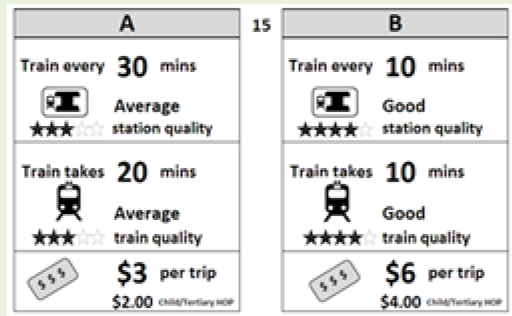
The study valued vehicle and stop/station quality and assessed service frequency, time spent on the bus or train (in-vehicle time) and fares. Frequency, time and fare enabled vehicle quality and stop/station quality to be valued in minutes and dollars. The relationship between quality and travel duration was also explored.

4. Stated Preference Questionnaire

The Stated Preference questionnaire presented a series of pair-wise journey choices such as the example in Figure 2. The choices varied in terms of in-vehicle time, frequency, fare, vehicle quality and stop quality. The statistical design required 25 choices which were divided into three sets of 8/9 in order to reduce the task for passengers.

In order to cater for the different trip lengths, fares and frequencies of the bus and train services in the three cities surveyed, twenty two different SP questionnaires were used. All the designs retained the same time, fare and quality differences however so that response could be pooled and overall models estimated.

Figure 2: Stated Preference Show card



An example of one of the 25 Stated Preference pair-wise choices completed by rail passengers.

Each of the 5,356 SP questionnaires provided an average of 7.4 responses to the 8/9 SP journey choices. The resultant total of observations to was 39,865 which enabled models by gender, trip purpose, age group, income, trip length, mode and city to be estimated with high statistical accuracy.

To describe stop/station and bus/train quality, a five star system (similar to that used for films and restaurants) was used with verbal descriptions provided. One star indicated very poor; two poor; three average; four good and five very good. Partly to familiarise respondents with the star system, passengers were first asked to rate their vehicle and the stop/station where they boarded.

Figure 3: Five Star Rating

7. Please rate the quality of this train in terms of its appearance, information, facilities, cleanliness, comfort and staff on a 1-5 scale where 1 is very poor and 5 is very good.

Please tick one box	1 Very Poor ★☆☆☆☆	2 Poor ★★☆☆☆	3 Average ★★★☆☆	4 Good ★★★★☆	5 Very Good ★★★★★
Train Rating					

After transforming the five point and nine point rating scales onto the same percentage scale (0% very poor, 50% average and 100% very good) the two surveys were found to give identical 70% vehicle ratings for bus with only a 2% difference for trains at 74% Rating and 76% SP.

The logistic function shown in equation 1 was fitted to the individual response data. The quality 'power' parameters of 0.7 for station quality and 0.65 for vehicle quality were estimated by fitting different values and determining the optimal fit.

$$Pa = \frac{Z}{1+Z} \text{ where}$$

$$Z = \exp\left\{ \begin{array}{l} \alpha + \alpha_c C + \beta_f \Delta F + \beta_v \Delta V + \beta_{si} \Delta SI + \\ \beta_{sq} \left\{ (1 - SQ_A{}^{0.7}) - (1 - SQ_B{}^{0.7}) \right\} + \beta_{vq} \left\{ (1 - VQ^{0.65}) - (1 - VQ^{0.65}) \right\} \end{array} \right\} \quad \text{..... 1}$$

$Pa =$ proportion choosing A
$\Delta F =$ difference in fare in dollars per trip A-B
$\Delta V =$ difference in in-vehicle time in minutes A-B
$\Delta SI =$ difference in service interval (minutes between departures) A-B
$\Delta VQ =$ difference in bus/train quality rating
$\Delta SQ =$ difference in bus stop/train station rating
$\alpha, \beta_i \phi_i =$ parameters to be estimated
$C =$ fare concession entitlement taking a value of 1 if entitled to a concession else zero.

The estimated parameters and t values are presented in Table 4. All the attributes had correct negative sign; fewer people chose the option the lower the time, cost or quality. The parameters were also highly significant, far exceeding the 95% confidence threshold of 1.96. Service interval was the strongest with a |t| value of 36 in the overall model. Next was onboard time followed by fare and stop quality with |t| values of around 30. Least important was vehicle quality at 22. The weakest parameters were the concession fare parameter and the constant with |t| values of 14.4 and 7.8 respectively (which was a desirable result).

The relative valuations presented at the bottom of the table are graphed in Figure 4 (which also shows the accuracy range of the estimates).

The overall value of service interval was 0.6. The value of service interval was higher for bus at 0.67 than for rail at 0.43 reflecting the shorter bus service intervals both in the SP designs and also as experienced by passengers. The value of service interval was noticeably higher for Christchurch at 0.93 although there was a wider range on this estimate.

The overall value of onboard time was $9.84 per hour. At $19/hr, the Auckland rail estimate was double the overall average but needs to be treated with caution given the high error which ranged from $10 to $27 /hour. The lowest value of time was $6.57/hr for Christchurch Bus. Wellington bus had the second highest value of time of $12.07 per hour with Auckland bus users have a value of time of $9.70 / hour which was close to the overall bus value of time of $9.84/hr.

Wellington rail users had a value of time of $9.41 per hour which was three quarters of the Wellington bus value. Including the Auckland rail users raised the average rail value of time to $10.91/hr which was 10% higher than the overall bus value.

The value of vehicle quality was worth 19 minutes and $3.12 per trip. The valuation represented three quarters of the average onboard time of 26 minutes and just over 80% of the average fare of $3.78. Across the market segments the valuation ranged from 15 minutes (Wellington Bus) to 24 minutes (Christchurch Bus and Wellington Rail). It should be remembered that the quality values are 'extremes' measuring changes from very poor 0% to very good 100%. The observed range in vehicle quality across the bus and train routes surveyed was much narrower ranging from 63% to 83% which would be valued at 2.8 minutes of onboard time or 45 cents of fare (i.e. about 10% of the average onboard travel time or average fare paid).

Table 4: Estimated Models

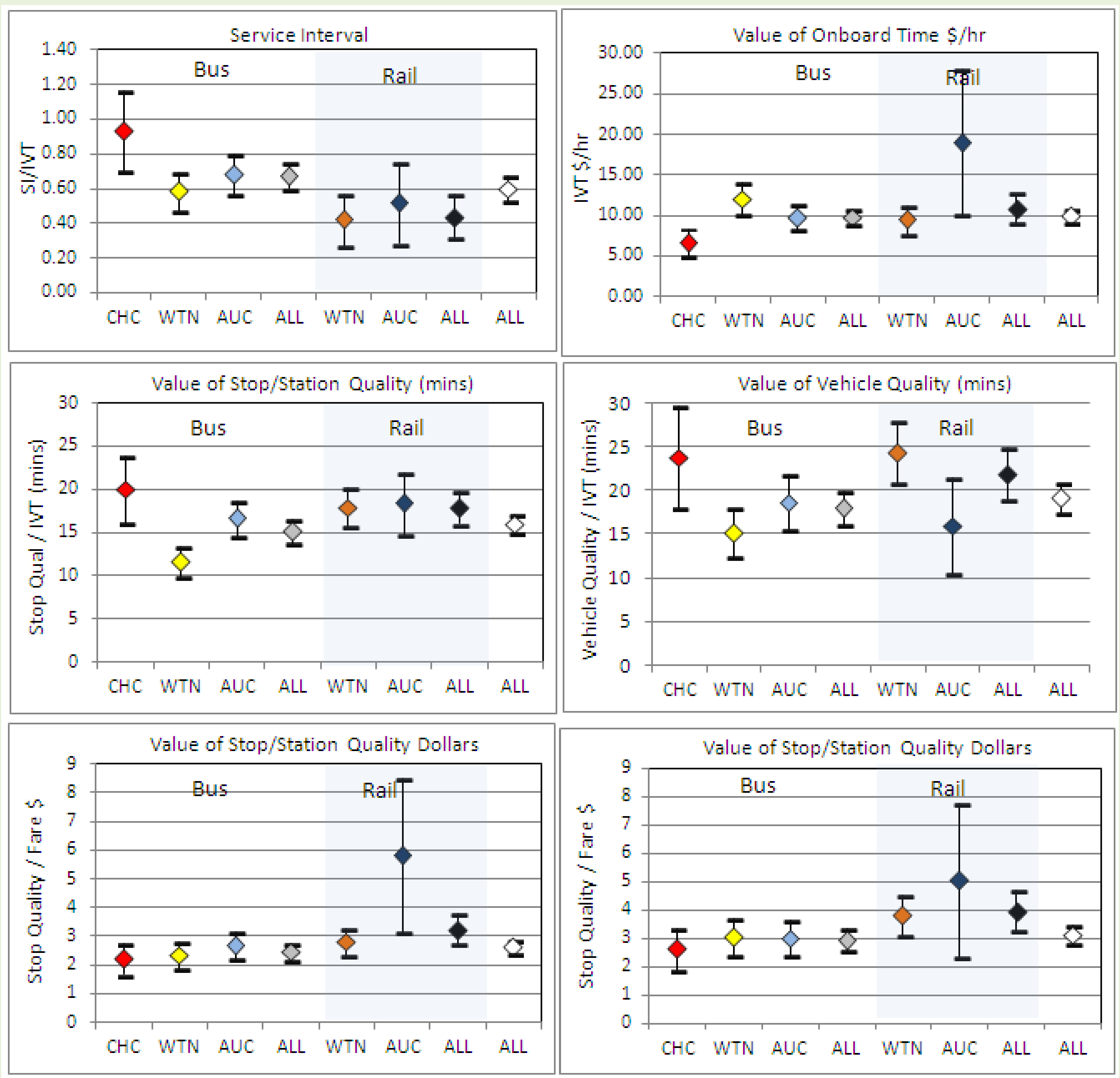
	Bus				Rail			ALL
Parameter Estimates	CHC	WTN	AUC	ALL	WTN	AUC	ALL	
SI Dif	-0.042	-0.043	-0.036	-0.039	-0.028	-0.036	-0.030	-0.036
IVT Dif	-0.045	-0.074	-0.053	-0.058	-0.067	-0.070	-0.068	-0.060
Fare Dif	-0.411	-0.368	-0.328	-0.355	-0.427	-0.221	-0.374	-0.366
Stop Qual Dif	-0.900	-0.861	-0.879	-0.875	-1.200	-1.286	-1.216	-0.958
Veh Qual	-1.068	-1.113	-0.985	-1.037	-1.625	-1.112	-1.484	-1.142
Concession Fare Constant	-0.308	-0.440	-0.447	-0.447	0.093	-0.520	-0.814	-0.879
Constant	-0.382	-0.442	-0.364	-0.390	-0.031	-0.621	-0.171	-0.303
|t| Values	CHC	WTN	AUC	ALL	WTN	AUC	ALL	ALL
SI Dif	21.0	21.5	36.0	39.0	14.0	12.0	15.0	36.0
IVT Dif	9.0	18.5	17.7	29.0	13.4	8.8	17.0	30.0
Fare Dif	13.3	16.0	17.3	27.3	17.1	4.7	17.0	33.3
Stop Quality Dif	10.2	12.9	16.0	23.0	16.2	10.1	19.0	29.0
Veh Quality Dif	8.0	10.6	11.6	17.6	13.5	5.6	14.5	22.4
Concession Fare Constant	3.0	3.3	7.0	8.9	0.1	5.7	11.0	14.4
Constant	3.8	5.7	5.6	8.7	0.3	4.1	2.3	7.8
Observations	5,941	9,478	14,060	29,479	7,672	2,714	10,386	39,865
Interviews	759	1,197	1,765	3,721	1,002	343	1,345	5,057
Relative Valuations	CHC	WTN	AUC	ALL	WTN	AUC	ALL	ALL
Service Interval / IVT (mins)	0.93	0.58	0.68	0.67	0.42	0.51	0.44	0.60
Stop Quality / IVT (mins)	20	12	17	15	18	18	18	16
Vehicle Quality / IVT (mins)	24	15	19	18	24	16	22	19
Value of Onboard Time $/hr	6.57	12.07	9.70	9.80	9.41	19.00	10.91	9.84
Stop Quality $/trip	2.19	2.34	2.68	2.46	2.81	5.82	3.25	2.62
Vehicle Quality $/trip	2.60	3.02	3.00	2.92	3.81	5.03	3.97	3.12

The value of stop quality (measured from very poor to very good) was worth 16 minutes of onboard time or $2.62 per trip. The value ranged from 12 minutes for Wellington Bus to 20 minutes for Christchurch. Auckland rail had the highest fare valuation of $5.82 per trip and Christchurch the lowest at $2.19 per trip. The Auckland rail valuation should be treated with caution give the wide range.

A series of models were fitted to the data producing values that varied by trip length, service frequency and income. A 'super model' was fashioned that brought together passenger and mode/city characteristics. 22 'effects' were found to be statistically significant. Table 5 presents the results. Males were less sensitivity to in-vehicle time than females by around a fifth. Company business trips were much less sensitive (-44%) to fare whereas young passengers were more sensitive. Older passengers (<64) were much less sensitive to fare probably reflecting the entitlement to free travel with a gold card.

Auckland bus users were less sensitive and Christchurch bus users more sensitive to fare than Wellington bus users. House persons and unemployed passengers were less concerned about in vehicle time as were older passengers and Auckland bus users. Passengers making shopping trips had a lower sensitivity to service interval as did house persons, older passengers and Auckland bus users whereas passengers travelling in the PM peak were more sensitive. As regards stop quality, shopping trips were more sensitivity to quality as were rail respondents. For vehicle quality, passengers visiting friends and relatives or making entertainment/holiday trips were more sensitive. Wellington rail users were also more sensitivity than bus passengers and Auckland rail users.

Figure 4: Estimated Relative Valuations



The graphs show the mean estimate of the relative valuation and also the standard error range to gauge the accuracy of the estimate. Four of the fives market segments were estimated with reasonable precision. The exception was Auckland Rail.

Table 5: Analysis of Respondent Profile on Attribute Sensitivity

Variable	Parameter	Effect
Gender	Male*IVT	-22%
Journey Purpose (Base = Work)	Comp Business * Fare	-44%
	Shopping * SI	-22%
	Shopping * Stop Quality	39%
	VFR * Vehicle Quality	38%
	Ent/Hol * Vehicle Quality	52%
Socio-Econ Status (Base = Employed)	House Person * SI	-33%
	House Person * IVT	-27%
	Unemployed * IVT	-44%
Age Group (Base = 25-64)	Age <18 * Fare	12%
	Age 18-24 * Fare	9%
	Age>64 * SI	-43%
	Age>64 * IVT	-43%
	Age>64 * Fare	-59%
Time Period	PM Peak * SI	30%
Mode (Base=Bus)	Rail * Stop Quality	44%
City & Mode (Base = WTN Bus)	WTN Rail * SI	-48%
	WTN Rail * Vehicle Quality	56%
	AUC Bus * SI	-30%
	AUC Bus * IVT	-17%
	AUC Bus * Fare	-13%
	CHC Bus * Fare	22%

A series of regression runs were undertaken to determine a 'super-model' in terms of explanatory power. Interaction variables were created which multiplied the attribute variable with socio-economic, demographic and trip profile dummy variables (1,0). Only statistically significant interactions (95% CL) were retained. The effects have been colour coded to reflect direction and magnitude. Blue signifies less sensitive and red more sensitive with dark shading indicating a large effect and light shading a lesser effect. As examples, the final model showed males to be 22% less sensitive to in-vehicle time and shopping trips to be 39% more sensitive to stop quality.

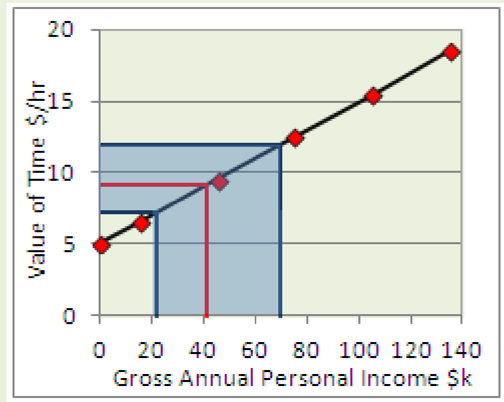
It should be noted that the effect on the relative attribute valuations (e.g. the value of time) was complicated by the inter-related nature of the market segments. For instance a shopping trip could be made by a male. The full application of the extended model would require a spreadsheet to feed in details of passenger profile of the route in question.

5. Value of In-Vehicle Time

An important 'by product' of the research was to estimate how much passengers were willing to pay to save time. The average value of in vehicle time was $9.89 per hour; a figure 76% higher than the $5.60/hr value in the NZ Economic Evaluation Manual which itself was based on a similar surveys undertaken over a decade previously. A lower median value of time of $7.50/hr was estimated from the response to a straight forward question asking whether passengers were willing to pay one dollar more to save eight minutes. The answer of the 1,630 respondents was exactly 50%. One half had a higher value of time than $7.50 an hour and one half a lower value.

As well as providing a 'basic' value, the study was able to quantify the effect of vehicle quality on the value of time. The response to the SP survey showed passengers were willing to pay $5.40 more to save an hour travelling on a very poor quality bus (or train) than to save the same hour is spent on a very good bus. The extremes of very poor and very good need to considering in understanding this value.

Figure 5: Value of Time & Income



The willingness to pay to save travel time increased with income from $5/hr at 'zero' income to $18.50/hr for respondents on an annual gross income of $135k.

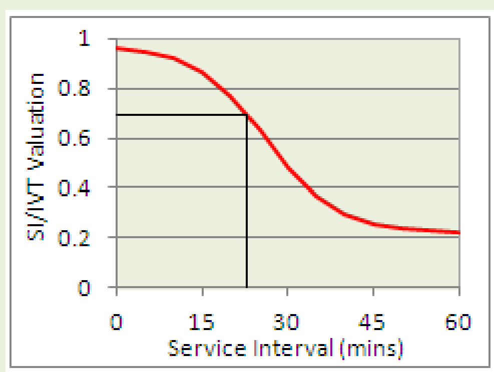
Another feature of the research was to standardize the values for income. Passengers with higher incomes were more willing to pay to save time than passengers on low incomes.

At a notional zero annual income, the value of time was $5/hr. The value increased to $18.50/hr for passengers on $135k. Across the bus and train routes surveyed, average incomes ranged from $22k to $70k a year with the predicted value of time ranging from $7.20 to $12/hr (the blue shaded area). The survey results were standardized at the average income of $40.8k but can be re-positioned at any income level. Standardization enables economic evaluations (where 'spatial equity' is important) to avoid biasing investment towards wealthier areas.

For demand forecasts, behavioural valuations will be needed rather than equity values and to this end, the researched parameter values can be reset at the income level of the study area of interest. To assist, the profile of 43 aggregated bus and rail routes in Auckland, Christchurch and Wellington for peak and off-peak travel is provided in the report. Furthermore, an updating index is provided to uplift the valuations for future growth in average income. The updating method proposed is an alternative to using the consumer price index (CPI) which NZTA has used.

6. Value of Service Interval

Figure 6: Service Interval Function



A curvilinear function for service interval (SI) best fit passengers' valuations of service frequency relative to time spent on the train or bus. The function is a marginal curve and therefore the valuation for a particular SI needs to be added (area under the curve).

Another parameter estimated by the survey was service frequency. Passengers travelling on high frequency (e.g. every five minutes), medium and low frequency services (e.g. hourly) were interviewed (including the evening and weekend). The survey also asked about wait times enabling a mathematical relationship between frequency and waiting time to be estimated.

A curvilinear function matched the passenger response to service interval closest. For high frequency services (where a large portion of passengers are likely to turn up 'at random' rather than consult a timetable), the valuation of a minute of service interval (the 'gap' between successive services) was close to a minute spent on the bus or train. Thus the valuation was close to the 'common convention' of valuing wait time twice that of in-vehicle time (assuming passengers wait for half the headway on average).

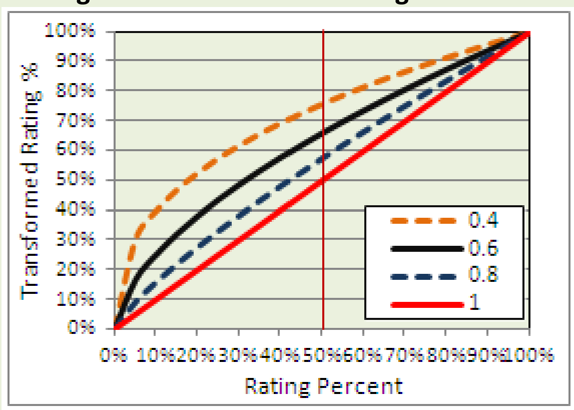
For less frequent services, the valuation declined so that for an hourly service, the valuation was 0.2 thereby reflecting the alternative use that service interval 'time' can be put to. At the average service interval of 23 minutes, the relative valuation was 0.7 which was close to the Australian Transport Council guideline figure of 0.72 but higher than 0.63 which was has been the value the NZ Economic Evaluation manual has pivoted around.

7. Value of Vehicle & Stop/Station Quality

The study was also able to relate the value that people placed on the quality of their bus stop or train station to the frequency of their service. It was found that as service interval increased (and hence waiting time increase), the value placed on stop/station quality increased. A very good bus stop was worth 0.75 minutes of in-vehicle time compared to a waiting at a very poor bus stop per minute of service interval.

Passengers were also found to care more about quality when it was very poor or poor than when it was good or very good'. To accommodate this declining sensitivity to quality, alternative 'power' values ranging from 0 to 1 were fitted.

Figure 7: Transformed Rating Function



Passengers were more sensitivity to poor quality than high quality which was accommodated through a power function.

Values of 0.65 for vehicle quality and 0.7 for stop quality best fit the data. For a value of 0.65, an average quality rating of 50% was transformed to 64% thus narrowing the difference to very good (100%) and widening the difference (hence importance) to very poor (0%). These values were used in equation 1 shown earlier.

The rating questionnaire asked passengers to rate the bus or train they were travelling on and the bus stop or train station where they boarded. Respondents were asked to rate lists of vehicle and stop/station attributes on a 1 to 9 scale with 1 being very poor and 9 very good. Two sets of models were estimated: the first set explained the variation in the overall vehicle and overall stop/station ratings in terms of the vehicle/stop characteristics, trip and passenger profile data; the second set measured the relative importance of the individual attributes in terms of their ability to explain the overall rating. The large sample enabled both sets of models to be estimated with high statistical accuracy.

8. The Rating of Vehicles and Stop/Stations

In combination, the two surveys presented a snap-shot picture of urban bus and rail transport in the three main centres of New Zealand at the end of 2012 and early/mid 2013.

Profile information of bus and rail users was tabulated by aggregated route, aggregated bus stop and by rail station for peak and off-peak travel. Profile was described in terms of gender, trip purpose, age group, income, ticket type, fare paid, frequency of public transport use, trip length, service interval, wait time and rail access mode.

The report contains many photographs of vehicles, bus stops and stations to describe quality. This photograph shows a new Matangi train which scored 82% the highest rating of any vehicle surveyed.

The rating survey provided the opinion of passengers of the quality of the bus or train and also of the bus stop or train stations they were using when surveyed.

To help understand the rating results, the report contains numerous photographs of the buses, trains, bus stops and train stations in Auckland, Christchurch and Wellington.

9. Analysis of Bus & Train Quality

For the vehicle ratings, a descriptive analysis was undertaken first with results tabulated and graphed for 43 aggregated bus and train routes. The average vehicle rating across the 43 'aggregated' routes was 71%. The two routes that achieved the highest vehicle ratings were the Outer Loop bus service in Auckland (83%) and the Johnsonville rail line in Wellington (82%) Both routes used new buses and trains that were less than a year old. At the 'other end' of the scale, the lowest rated bus route was the Far South Paparakura (400s) service in Auckland which scored 63% and the lowest rated rail route was the East Line in Auckland at 64%. Both these services used old buses and trains.

Table 6: Grand Final Model of Overall Vehicle Rating

Model		Variable	Linear		Logit	
			Beta	|t|	Beta	|t|
17	Grand Final Model	Bus	-0.169	9.4	-0.881	9.5
		Vehicle Age	-0.019	30.8	-0.097	32.3
		Bus*Age	0.014	18.7	0.073	18.3
		Bus * Seats	0.0012	3.1	0.005	2.5
		Bus * Premium	0.067	7.4	0.375	6.9
		Auckland	0.024	6.0	0.107	5.4
		Trolley Bus	0.027	2.5	0.129	2.4
		PM Peak	-0.024	6.0	-0.116	5.5
		Ent/Hol	0.038	5.8	0.195	5.6
		VFR	0.018	2.9	0.089	2.8
		Female	0.016	5.3	0.079	4.4
		Retired	0.055	7.4	0.298	7.3
		Under 18	-0.035	6.3	-0.168	6.0
		Aged 18 - 24	-0.019	4.8	-0.093	4.4
		Constant	0.837	12.3	1.596	63.8

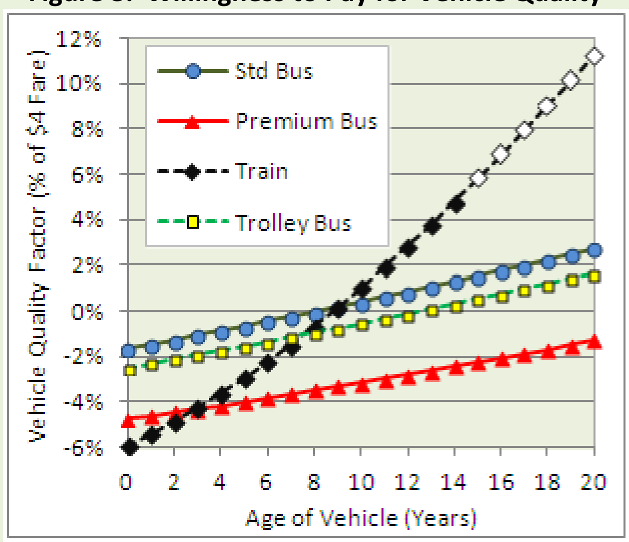
The 'grand final model' explaining the overall vehicle rating of bus and train respondents was fitted on 11,990 responses and included 14 vehicle type, passenger and trip profile explanatory variables and was specified with a brand new train as the base mode (constant).

The range in vehicle rating across the 43 routes was about 20% from the mid sixty percents to the mid eighty percents and the range was roughly the same for buses as is was for trains. When valued using the SP results, the 20% rating difference was equivalent to 2.4 minutes of in-vehicle time or 8% of the $4 average fare.

The passenger vehicle ratings were then related to the characteristics of the buses and trains surveyed. To do this, the identification code of each vehicle was recorded by surveyors. Objective data was then obtained from Auckland Transport (AT), Environment Canterbury (ECAN) and Greater Wellington Regional Council (GWRC) on each surveyed vehicle that described the make, age, seat capacity, euro engine rating, air conditioning and whether the bus was low floor, wheel chair accessible and had a bike rack.

A total of 35 different vehicle types were surveyed: 28 buses and seven trains. The highest rated vehicle was the Matangi train (see photo) which scored 82% overall. The Matangi, had only been introduced onto Wellington train services a year previously and came top in seven attributes and second in four. Only in terms of staff (which is not a vehicle attribute), did the Matangi rank less than second. The ex British Rail loco hauled carriages used on the longer distance Wairarapa line scored 78% overall. At 59%, the Ganz Mavag Wellington electric multiple units which averaged thirty years in service scored the lowest rating of the train types surveyed. The four Auckland diesel powered trains (which are to be replaced with electric stock) rated around 68%.

Figure 8: Willingness to Pay for Vehicle Quality



The research estimated a higher willingness to pay (WTP) for travelling on a new train than a new bus but the WTP declined faster as the train aged.

Five bus types dominated the survey with each surveyed over 900 times: Alexander Dennis (ADL) the MAN11, MAN12, MAN17 and Scania. The MAN11 buses were the oldest averaging fifteen years in service and scored 66%. The MAN12 and MAN17 were younger at ten and eight years respectively and scored 66%. The Scania buses which were used on the Wellington Airport Flyer have next stop display, automatic announcements, leather seats and bag storage facilities. They were also younger, averaging four years in service. The Scania averaged a rating of 74%.

The vehicle data was combined with passenger profile data such as gender, trip purpose and age group to explain the ratings using linear and 'S' shaped 'logit' models. The linear model was the easiest to interpret since the parameters were percentages but the logit model had advantages for forecasting since it kept the predicted ratings within zero and 100%.

The constant, estimated at 84% was the rating for a brand new train. The fourteen variables added or subtract from this rating. For bus, the ratings were higher for larger buses with a rating of 70% for a new 25 seat midi bus, 72% for a standard 42 seat bus and 75% for a 72 seat articulated bus. A new electric trolley bus was 2.7% higher and a premium service like the Auckland Loop or the Wellington Airport Flyer was 6.7% higher.

As bus and trains aged, their rating declined, with a steeper annual decline (1.88%) for trains than for buses (0.44%) although it should be noted that for trains, age was measured from the year of last refurbishment rather than from new.

The response to the SP survey enabled the vehicle ratings to be converted into equivalent fare increases. Compared to an eight year old bus, passengers were willing to pay a 5.9% higher fare for a new train and a 4.7% higher fare for a new 'premium' bus service. For a new trolley bus, the fare increase was 2.5% and 1.6% for a new standard bus. As the vehicles aged, the WTP declined so that after three years, trains were valued the same as a premium bus and after nine years, the same as a standard bus.

The other explanatory variables in the vehicle rating model reflected the profile of the respondent. Females for example rated their vehicle 1.6% higher than males and retired passengers rated 5.5% higher than non retired passengers. Young respondents less than 18 years old rated 3.5% lower.

The second strand of analysis determined the relative importance of attributes such as cleanliness/graffiti versus seat availability/comfort. Importance was assessed by regressing the overall rating on the thirteen individual attribute ratings. Linear and logit models were fitted on the 6,800 responses to the rating questionnaire. Ride quality and staff were the two most important attributes accounting for 14% of the total rating with vehicle outside appearance third on 13%. In terms of rating, staff rated highest at 73% with outside appearance next 72%. For Christchurch, the bumpy roads caused by the earthquake reduced the ride quality rating to 64%.

Seat availability and comfort on 12% and environmental impact (noise and emissions) on 10% were ranked 4th and 5th in importance. Of the two, seat availability/comfort rated higher at 74% than environmental impact (62%).

Of middling importance (at 6-8% each) were inside cleanliness and graffiti, ease of getting on and off, heating and air conditioning and onboard information and announcements. Amongst these attributes, ease of getting on and off rated highest on 77%, with information and announcements rating lowest on 64%.

Table 7: Vehicle Attribute Importance & Rating

Attribute	Importance	Rating
1 Smoothness & Quietness	14%	64%
2 Driver/Staff	14%	73%
3 Outside Appearance	13%	72%
4 Seat Availability & Comfort	12%	74%
5 Environmental Impact	10%	62%
6 Inside Cleanliness & Graffiti	8%	75%
7 Ease of On & Off	7%	77%
8 Heating & Air Conditioning	7%	69%
9 Info. & Announcements	6%	64%
10 Space for Bags	4%	66%
11 Lighting	2%	75%
12 Toilet Avail. & Cleanliness	2%	76%
13 Computer & Internet (WIFI)	1%	41%
Overall Rating	100%	72%

The vehicle attributes that passengers rated were the same for buses and trains excepting staff and the inclusion of toilet availability/cleanliness on the Wairarapa train service.

The least important attributes were space for personal belongings, lighting, toilet availability/cleanliness and 'ability to use your computer and connect to the internet (WIFI)' with each attribute explaining less than 5% of the overall rating. Of these attributes, lighting and toilets rated highest scoring 75-76% and computer & internet rated lowest at 41%.

Determining the relative importance of the vehicle attributes enabled the WTP valuations to be 'unpacked'. Some worked examples are included in the report to show how the effect of a particular attribute can be valued. One worked example included in the report looked at converting a diesel bus (pre Euro engine standard) to an electric trolley bus. The valuation used the environmental impact rating which predicted a 3.4% increase in the overall bus rating which itself was valued at 1.5% of the fare.

The model was extended to look at how trip and socio-demographic characteristics affected attribute importance. Ten 'interactions' were statistically significant. Toilet availability and cleanliness was important for trips over 40 minutes but unimportant for shorter trips. Females placed less importance on the environment and more on the inside cleanliness of the vehicle. Retired passengers attached more importance to seat availability and comfort and less on the environment.

Table 8: Vehicle Attribute Importance by Market Segment

Attribute	Market Segment	Effect
Toilet Avail & Cleanliness	Trips > 40 mins	+
Environment	Females	-
" " "	Retired Passengers	-
" " "	Entertainment/Hol. Trips	+
" " "	Visit Friends/Rels Trips	-
Inside Cleanliness & Graffiti	Females	+
Outside Veh. Appearance	18-25 year olds	-
Seat Avail. & Comfort	Retired Passengers	+
" " " "	Under 18 year olds	-
" " " "	Visit Friends/Rels Trips	+

Legend: + More important - Less important

Passengers visiting friends or relatives were more interested in seat availability/comfort and less interested in the environment impact of the vehicle whereas passengers making entertainment/holiday trips attached more importance to the environment. 18-25 year olds were less interested to the outside appearance of the bus or train whereas young respondents (under 18) attached less importance to seat availability/comfort.

10. Bus Stop & Train Station Analysis

A similar two stranded analysis was undertaken on the bus stop and rail station rating data. Analysed by aggregated route, the bus stop ratings had a similar range as for vehicles with a low of 60% on South Auckland bus routes and a high of 81% on the Auckland Northern Express Busway where new stations had been built at Albany and Akoranga.

The new bus station at Akoranga on the Northern Express in Auckland was highly rated scoring 81%

The rail station ratings had a narrower range from 61% on the Hutt line in Wellington to 71% on the Onehunga line in Auckland.

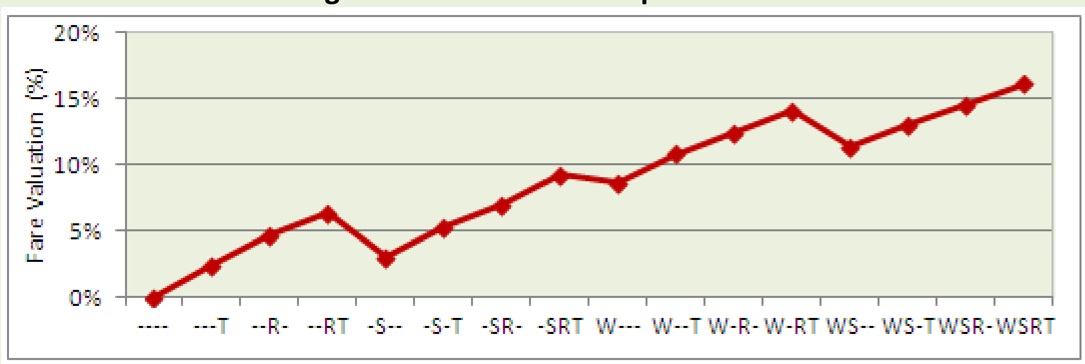
In general, Auckland rail stations tended to be rated higher reflecting the extensive upgrade program that had taken place. However, the analysis by route masked much wider variations by individual bus stop and train station.

Much of the detailed analysis was undertaken separately for bus stops and train stations because the list of attributes was shorter than for train stations.

11. Analysis of Bus Stop Ratings and Facility Valuations

The hundreds of bus stops that were rated were difficult to assess individually because the locations given by respondents were often imprecise. In anticipation of this, the rating questionnaire asked passengers whether a shelter, seats, a timetable and real time information was provided at their stop. The sample of 3,349 respondents covered all sixteen possible combinations and at the extremes, a bus stop with no facilities was rated at 46% and one with all four facilities was rated at 75%. The SP survey valued the WTP difference at 16% of fare. Providing shelter was worth 9%, seating 3%, real time information (RTI) 3% and a timetable 2%.

Figure 9: Value of Bus Stop Facilities



Facs	----	---T	--R-	--RT	-S--	-S-T	-SR-	-SRT	W---	W--T	W-R-	W-RT	WS--	WS-T	WSR-	WSRT
Rating	46%	50%	54%	57%	51%	55%	58%	62%	61%	65%	68%	71%	66%	69%	72%	75%
% Fare	0%	2%	5%	6%	3%	5%	7%	9%	9%	11%	12%	14%	11%	13%	15%	16%

The overall bus stop rating increased from 46% when there was no shelter (W), seating (S) a timetable (T) or real time information (R) to 75% when all four facilities were provided. Using the SP overall stop/station valuation, the ratings were converted into percentage fare valuations.

Table 9: Overall Bus Stop Rating Explanatory Model

	Linear		Logit	
Variable	Beta	|t|	Beta	|t|
SHELTER	0.137	12.5	0.599	13.1
SEATING	0.045	3.5	0.189	3.3
TIMETABLE	0.033	2.8	0.148	2.6
RTI	0.054	6.5	0.261	7.5
RETIRED PAX	0.055	5.1	0.229	4.1
RAINING	-0.034	3.3	-0.148	3.2
CITY CENTRE	-0.047	5.6	-0.230	6.1
SUBURBAN	-0.076	9.9	-0.358	10.2
WAIT TIME	-0.003	10.6	-0.015	9.5
CONSTANT	0.536	37.0	0.264	3.6

A full model explaining the overall bus stop rating was estimated on a sample of 7,232 respondents.

Passenger characteristics were added to the bus stop facility data to improve the explanatory power of the model. Of the four provision variables, shelter explained 51%, RTI 20%, seating 17% and a timetable 12% of the overall rating. City centre bus stops rated 4.7% lower than bus stations with suburban bus stop 7.6% lower. Retired passengers were significantly different from other passengers, rating their bus stop 5.5% higher. When it was raining, the rating reduced 3.4%. The rating also decreased as the waiting time increased although the decrease was very gradual at 0.3% per minute.

The second strand of analysis assessed the relative importance of the five bus stop attribute ratings in terms of their ability to explain the overall rating.

Of the five attributes, cleanliness and graffiti, weather protection and seating were the three most important; each explaining around a quarter of the overall bus stop rating. Information explained 18% and lighting was the least important explaining 10%.

The model was extended to see how passenger and trip profile characteristics affected attribute importance.

Retired passengers attached a greater importance to weather protection whereas young passengers were more concerned about information at their bus stop. Respondents who waited longer than ten minutes placed a greater importance on information and lesser importance on seating and weather protection.

Table 10: Relative Importance of Bus Stop Attributes

#	Attribute	Importance	Av. Rating
1	Cleanliness & Graffiti	25%	69%
2	Weather Protection	23%	61%
3	Seating	23%	60%
4	Information on bus times	18%	67%
5	Lighting	10%	59%
Overall Bus Stop Rating		100%	68%

The overall rating was regressed on the attribute ratings (3,479 observations) to determine relative importance.

Table 11: Passenger Profile & Bus Stop Attributes

Attribute	Market Segment	Effect
Weather Protection	Retired Passengers	+
Information	Under 18 year olds	+
Weather Protection	Wait > 10 minutes	-
Seat Avail. & Comfort	Wait > 10 minutes	-
Information	Wait > 10 minutes	+

Legend: + More important - Less important

Passenger and trip profile data was used to assess whether attribute importance varied by market segment.

12. Rail Station Ratings & Valuations

The third area of analysis was the train station ratings. The ratings were found to vary more than the bus stops and train and bus vehicle ratings.

The highest rated train station scoring 79% was Newmarket in Auckland which was largely rebuilt in 2010 with lift and escalator access. The lowest rated station was Ava in Wellington, a station plagued by graffiti attacks and which only managed a 25% rating.

The range in rating from highest to lowest was therefore 54% and when the SP results were applied, the WTP was worth 30% of the average $4 fare for using Newmarket rather than Ava station.

The first set of models explained the variation in the overall rating of the Auckland and Wellington rail stations. Fitted on 4,478 observations, the model found that the largest six stations which were classified as 'hubs' were rated 12.4% higher

Newmarket station, which was largely rebuilt in 2010, and was the highest rated station at 79%.

Ava on the Hutt line in Wellington suffers from graffiti attacks and was rated the lowest at 25%. The station was being repainted when photographed.

than major stations with smaller local stations that generally had fewer facilities and were in some cases maintained to a lower standard were rated 2.9% lower.

Stations that had been upgraded within the last ten years were rated 7.1% higher and if upgraded with the last five years a further 3.3% higher. A set of passenger profile variables was included that found passengers travelling in the off-peak to rate their station 2.5% higher than peak travellers. Likewise retired passengers rated their station 5.5% higher and house persons 5.3% higher than employed passengers and students. Passengers making trips for entertainment/holiday reasons rated 4.2% higher. Finally, passengers accessing their station by car rated stations 2.7% lower than passengers who walked or used bus to get to the station.

Table 12: Station Rating Explanatory Model

#		Variable	Linear Beta	Linear |t|	Logit Beta	Logit |t|
14	Full Model	OFFPK	0.025	3.1	0.112	3.8
		ENT/HOL	0.042	3.8	0.199	3.4
		RETIRED	0.055	3.9	0.264	3.4
		HSEPERS	0.053	2.3	0.253	2.0
		CAR&PARK	-0.027	3.1	-0.118	3.1
		HUB	0.124	15.5	0.575	14.7
		LOCAL	-0.029	3.6	-0.121	3.4
		UPG10Y	0.071	7.9	0.317	8.1
		UPG≤5Y	0.033	3.3	0.161	3.6
		CONSTANT	0.561	73.8	0.252	7.2

A model was fitted to explain the overall rail station rating on 4,478 observations

The SP valuations enabled the effects of station upgrading to be valued such that for a local station, passengers were willing to pay a 6% higher fare within the first 5 years of the upgrade and a 4% higher fare with the next five to ten years (zero thereafter).

A comparative 'before and after' analysis of the rail station ratings was undertaken using data from a similar rating survey undertaken by Douglas Economics in 2002 and again in 2004 for Tranz Metro Wellington. The survey (labelled 2003) used the same rating scale and attribute list as was one of the studies included in the literature review. The survey provided 5,423 observations which increased the total sample to 8,576.

The rating data was aggregated by station and the difference in rating for each station calculated. Only stations with more than twenty observations in both surveys were included which provided 45 station pairs.

Ten stations were upgraded between the surveys. Other refurbishment or renewal works was undertaken at several other stations with GWRC and Ross Hayward (Tranz Metro manager for much of the period) providing historical information.

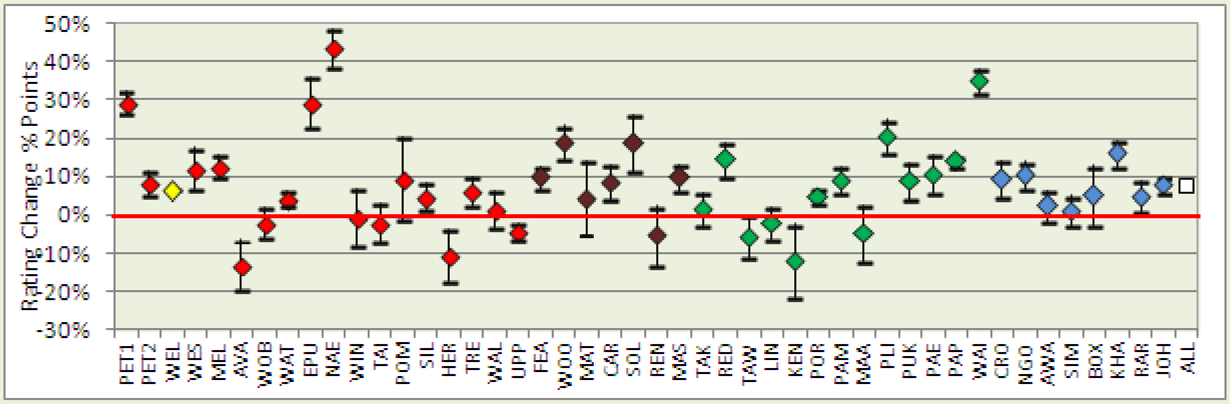
There was a wide variation in the overall rating. The rating increased at 35 stations but declined at

A major upgrade of Naenae station was undertaken in 2012 with the platform surface renewed and shelter replaced. The increase in passenger rating was substantial at 44% points (2003-2013).

Naenae station before upgrading.
(Photo provided by Steve Bird of GWRC)

eleven. The biggest increase was at Naenae (44%) which had been upgraded in 2012 with large increases around 30% at Petone, Epuni, and Waikanae which had all been upgraded. The largest rating falls of over 10% were at Ava, Heretaunga and Kenepuru.

Figure 10: Change in the Overall Station Rating of Wellington Rail Stations 2003-2013



There was sufficient response to compare the change in rating (2003-2013) for 45 stations. Petone had two observations since it was upgraded in 2003. The upper and lower bars are the standard error. The stations are shaded to denote the rail line: red Hutt; brown Wairarapa; green Kapiti; blue J'ville and yellow for Wellington station which serves all four rail lines. The white square is the average.

The data was used to explain the change of fourteen ratings such as weather protection, toilets and the overall rating. The model explained the change in rating across the stations according to whether or not upgrading had occurred during the ten year period. All the parameters were of the expected sign with upgrading or renovation (works deemed of a non major nature) having a positive effect on the passenger ratings. The explanatory power was reasonable for the overall model, with half the variation in the rating change across stations explained. However for the models of staff and toilets, the added explanation provided by the upgrade variables was low with substantial 'noise' in the ratings across the stations.

Table 13 presents the effect of renovation. Station upgrading increased the rating by 22.5% (model 14). The weather protection rating (model 1) increased 4% after 'roof renovation' and by 18% after a major station upgrade. Since all the stations were upgraded were renovated, the upgrade and renovation parameters should be added. The constant indicates that the station ratings increased by 6% over the ten year period. For information (model 5), there was little change in rating despite the system-wide installation of electronic timetables.

There was a wide spread in the cleanliness/graffiti rating with noticeable declines at some stations such as a 20% decline at Ava (see box). Station upgrading increased the rating by 18.5% and renovation by 11%. The constant was statistically significant and indicated a small underlying improvement of 2.5% over the decade.

The rating of staff was not related to station upgrading but did increase by 6% from retail improvements reflecting the assistance and reassurance that staff at privately run station shops can provided. For the retail rating, the model picked up a large 43% jump from the opening cafes and shops at stations. For ticketing, the introduction of cafes and shops increased the rating by a third.

There was a general upwards trend in the rating of car parking and passenger set down facilities of 8%. Station upgrading increased the rating by 10% which was a little more than the just upgrading the car park (8%). There was a much larger general increase of 19% in the rating of the 'ease of transfer to and from bus' with station upgrading adding 10%.

The overall station rating increased 22.5% from station upgrading. Over time, the effect of upgrading decreased at 2% points a year so that after ten years the effect was fully eroded. The upgrading of a station car park was associated with an 8.5% overall station rating increase although minor station refurbishment works did not have a significant effect. The small constant of 2.3% indicated that there had been a small underlying improvement in the rating over the ten year period.

Using the estimated parameters the effects of a major upgrade on the passenger rating can be predicted. Figure 11 shows the predicted effect.

For a station with a base rating of 50%, upgrading increased the rating to 73% on completion. The rating then declines to 64% midway through the fifth year and 54% mid way through the tenth year. The average increase over the first five years was therefore 18% and averaged 13% over the full ten years. The predictions were therefore nearly double the cross-sectional model (10% and 7%).

Table 13: Explanatory Models of Wellington Station Rating Change 2003-13

#	Attribute	Variable	Linear β	STE	|t|	Adj R^2
1	Weather Protection	UPGRADE	0.137	0.033	4.2	0.43
		RENOVATION	0.044	0.027	1.6	
		CONSTANT	0.062	0.014	4.4	
2	Seating	UPGRADE	0.142	0.044	3.2	0.40
		RENOVATION	0.075	0.037	2.0	
		CONSTANT	0.052	0.007	7.4	
3	Platform Surface	PLTSURF RENEW	0.165	0.030	5.5	0.51
		RENOVATION	0.104	0.030	3.5	
		CONSTANT	0.019	0.020	1.0	
4	Platform on/off	PLTSURF RENEW	0.136	0.044	3.1	0.37
		RENOVATION	0.147	0.046	3.2	
		CONSTANT	-0.063	0.021	3.0	
5	Infor-mation	UPGRADE	0.188	0.040	4.7	0.33
		CONSTANT	-0.009	0.018	0.5	
6	Lighting	UPGRADE	0.082	0.037	2.2	0.36
		RENOVATION	0.082	0.031	2.6	
		CONSTANT	0.070	0.013	5.4	
7	Clean & Grafitti	UPGRADE	0.185	0.061	3.0	0.39
		RENOVATION	0.107	0.051	2.1	
		CONSTANT	0.025	0.010	2.5	
8	Toilets	UPGRADE	0.143	0.044	3.3	0.32
		TOILET UPGRADE	0.127	0.042	3.0	
		CONSTANT	0.025	0.018	1.4	
9	Staff	RETAIL UPG	0.046	0.017	2.7	0.14
		CONSTANT	0.013	0.014	0.9	
10	Retail	RETAIL UPG	0.429	0.072	6.0	0.39
		CONSTANT	0.078	0.019	4.1	
11	Ticketing	RETAIL UPG	0.326	0.060	5.4	0.26
		CONSTANT	0.119	0.016	7.4	
12	Car Parking	UPGRADE	0.100	0.040	2.5	0.24
		CAR PARK UPG	0.079	0.035	2.3	
		CONSTANT	0.078	0.015	5.2	
13	Bus Facilties	UPGRADE	0.101	0.040	2.5	0.11
		CONSTANT	0.188	0.018	10.4	
14	Overall Rating	UPGRADE	0.225	0.057	3.9	0.50
		UPG_YEARS	-0.020	0.010	2.0	
		CAR PARK UPG	0.086	0.029	3.0	
		CONSTANT	0.023	0.015	1.5	

Models 1-13 fitted on 44 and model 14 on 45 observations

Fourteen models were fitted using station upgrade data. Three functional forms were fitted with the linear model the easiest to interpret. The logit model has advantages for forecasting.

Using the SP valuations, the WTP for a station upgrade was calculated at 11% of fare ($4) for the first year and 2% for the tenth. The average WTP was 7% over the ten year period.

The third and final strand of analysis of the station ratings was to determine the relative importance of the individual rating attributes in explaining the overall rating. The modelling included the 2002-04 Wellington survey data to widen the range in ratings and increase the sample size to 8,712. Table 14 presents the estimated model.

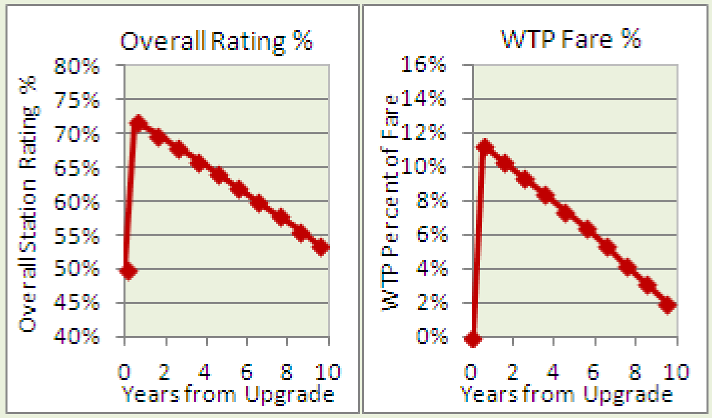
The most important attribute was cleanliness/graffiti which explained 17% of the overall rating. Weather protection and platform seating were the second and third most important at 12% and 11% respectively. Thus the top three factors were exactly the same as for bus stops.

Six attributes were of middling importance: ease of platform access, platform surface, information, ticket purchase, car parking and lighting with each explaining 7-9%. Of least importance were retail 4%, bus transfer 3%, staff 2% and toilets 2%.

The importance factors enable the change in one station attribute or a package of attributes to be assessed and then valued. For example, improving the cleanliness and graffiti from 56% to 66% at a station with an overall rating of 58% would produce a predicted overall rating of 60%. The increase of 2% would be valued at 1% of fare.

As with bus stops, the basic explanatory model was extended to include passenger characteristics. Table 15 presents the significant effects. Passengers making shopping trips were the most 'different' from the 'average' attaching greater weight to seating and to staff and lesser weight to cleanliness/graffiti, retail facilities and car parking.

Figure 11: Effect of a Major Station Upgrade



The logit model was used to predict the effect of a major upgrade for a station with a base rating of 50%. The SP values were then applied to calculate the WTP fare increase.

Table 14: Relative Importance of Rail Station Attributes

#	Variable	Arribute Importance	Average Rating
1	Station Cleanliness & Graffiti	16.9%	56%
2	Weather Protection	12.4%	52%
3	Platform Seating	11.2%	45%
4	Ease of Getting To/From Platform	9.2%	70%
5	Platform Surface	8.7%	56%
6	Timetable Info & Announcements	8.3%	59%
7	Ease of Ticket Purchase	7.6%	53%
8	Car Parking & Car Pick Up	7.6%	57%
9	Station Lighting	6.6%	57%
10	Ability to buy food, drinks, paper	4.4%	39%
11	Ease of Bus Transfer * Bus Users^	2.8%	58%
12	Availability & Helfulness of Staff	2.2%	55%
13	Toilet Availability & Cleanliness	2.2%	34%
	Overall Station Rating	100%	58%

^ passengers accessing by bus (8% of total)

Explanation of the overall train station rating in terms of individual train station attributes. Sample was 8,712 respondents (included 2002 survey.

Retired passengers attached more weight to seating. Females attached greater importance to station lighting.

Young respondents (under 18) attached more importance to ease of getting on and off the platform and ticketing and less importance to cleanliness/graffiti. Infrequent rail users attached less importance to bus transfer facilities than regular rail users.

Table 15: Passenger Profile & Station Attribute Importance

Attribute	Market Segment	Effect
Platform Seating	Shopping	+
Cleanliness/Graffiti	" " "	-
Staff	" " "	+
Retail	" " "	-
Car Parking	" " "	-
Platform Seating	Retired	+
Lighting	Female	+
Platform On/Off	Young (<18)	+
Cleanliness/Graffiti	" " "	-
Ticketing	" " "	+
Bus Transfer	Infrequent Users	-

Legend: + More important - Less important

Passenger profile data was used to assess whether attribute importance varied by market segment.

13. Comparison of Bus Stop & Train Station Ratings & WTP

Finally, the bus stop and train station ratings were brought together and compared. Table 16 and Figure 12 present the comparison.

Bus stops were split into bus stations, city centre stops and local stops and train stations into hubs, major stations and local stations.

Table 16: Rating and Relative value of Bus Stops & Train Stations

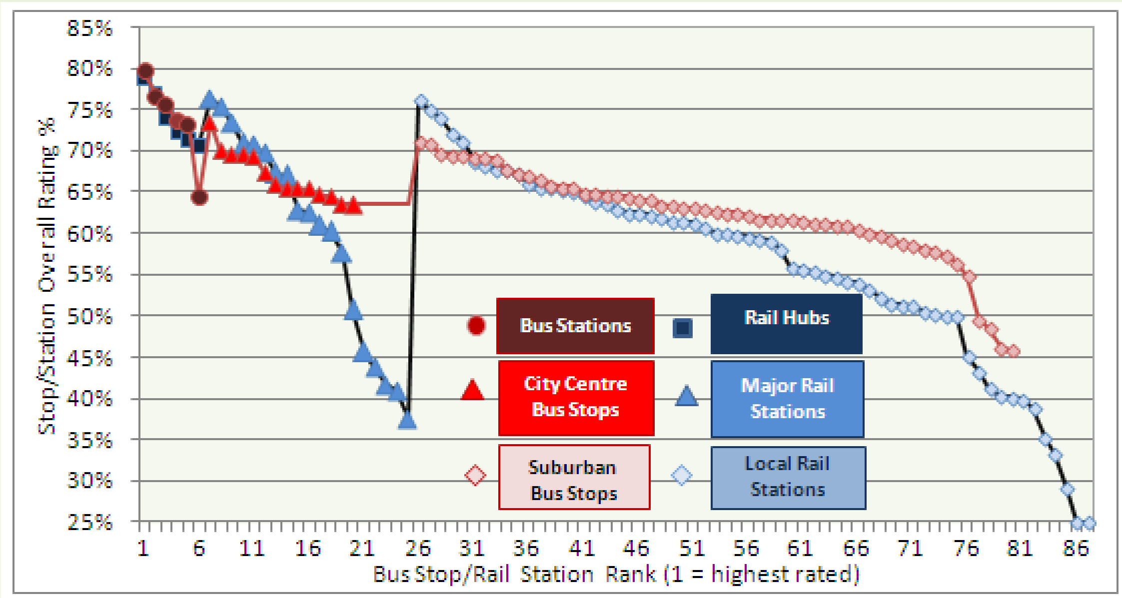
		Stop/Station Rating			% Fare Value		
Mode	Category	Av	High	Low	Av	High	Low
Rail	Hub	74%	79%	71%	5%	7%	3%
Rail	Major	60%	76%	38%	-2%	6%	-14%
Rail	Local	56%	76%	25%	-4%	6%	-22%
Rail	All	58%	79%	25%	-3%	7%	-22%
Bus	Station	74%	80%	64%	5%	8%	0%
Bus	City Centre	67%	73%	63%	2%	4%	-1%
Bus	Suburban	62%	71%	46%	-1%	3%	-10%
Bus	All	64%	80%	46%	0*	8%	-10%

* Base on which other values were estimated

The bus stops and train stations were classified into six groups each. The overall rating was then compared and the WTP expressed as a percentage of the $4 fare was calculated relative to an average bus stop.

The analysis showed that the best rail stations and the best bus stops were rated similarly but with rail stations having a slight edge for major and local rail stations over city centre and suburban bus stops. Some lowly rated rail stations brought the average down below that of bus stops. As a consequence, the WTP was 2% lower for the average major rail station and 4% lower for the average local station compared to the average bus stop. Thus the survey provided little evidence to value the average rail station higher than the average bus stop which has been a conventional modelling assumption.

Figure 12: Range in Train Station and Bus Stop Ratings



There was a much greater range by train station and aggregated bus stop as Figure 5 shows. Ratings ranged from 80% down to 25%. Hub rail stations (described later) and bus stations rated the highest. For major and local rail stations, there was a wide range in rating which was greater than for city centre and suburban bus stops.

14. Halo Effects

The analysis of attribute importance both for vehicles and stop/stations assumed that the service attributes were independent of each other. Thus improving one attribute, for example station lighting had no effect on the rating of other attributes. In other words, there were no indirect or 'halo' effects.[1] It is more likely that improvements in one attribute e.g., lighting would have a halo effect on how passengers see other aspects for example the timetable or the getting on/off the train; and, by increasing the rating of other attributes, the overall rating will increase.

The NZ study did not estimate halo effects but a similar large study of Sydney rail services has been extended to cover halo effects, Douglas Economic (2015). As a guide to the likely size of halo effects, Table 17 presents estimates from the Sydney study which used a two-step approach. The first step fitted a set of models to explain the rating of each attribute in terms of the other attributes. The second step multiplied the coefficients by the respective direct effect coefficients.

[1] The halo effect was named by psychologist Edward Thorndike in reference to a person being perceived as having a halo. Halo effects have been studied in relation to how an overall impression of a person, company or brand is influenced by the assessment of component attributes, characteristics or properties. The halo effect is whereby positive feelings in one area cause other attributes to be viewed favourably. The effect can work in the converse negative direction (the horns effect) whereby if the observer dislikes one aspect of something, they will have a negative predisposition towards other aspects.

The typical multiplier for a improving a train attribute was around 2 implying that the direct effects presented in Table 7 understated the total impact by around one half. These multipliers are only valid however for a single attribute since as more attributes are improved, the 'intra' attribute effect gets larger and the halo effect (which is outside of the direct attribute effect) gets smaller. In extremis, if all attributes were improved there would be no halo effect.

Table 17: Halo Effects for Train Attributes - Sydney Rail (2015)

Attribute	Direct*	Halo*	Total*	Multiplier
Outside Appearance	0.07	0.10	0.17	2.43
Ease of On/Off	0.11	0.08	0.19	1.73
Seat Av & Comfort	0.10	0.09	0.19	1.90
Space for Belongings+	0.01	0.07	0.08	8.00
Smoothness/Quietness	0.08	0.13	0.21	2.63
Heating & Air Conditioning	0.06	0.06	0.12	2.00
Lighting	0.09	0.11	0.20	2.22
Cleanliness/Graffiti	0.10	0.07	0.17	1.70
Onboard Information	0.05	0.06	0.11	2.20
Ability to use elect devices (wifi)	0.04	0.04	0.08	2.00
Personal Security	0.05	0.08	0.13	2.60
Onboard Staff	0.06	0.04	0.10	1.67
Environment	0.05	0.05	0.10	2.00
Toilets	0.02	0.03	0.05	2.50
Layout	0.12	0.08	0.20	1.67

Notes: Parameters are for a 100% increase. ^ Total effect divided by Direct effect. + direct effect parameter was statistically weak. * Numbers rounded two decimal places. Douglas Economics (2015)

The NZ study did not estimate halo effects but a similar large study of Sydney rail services has been extended to cover halo effects, Douglas Economic (2015).

15. Respondent Comments

A space was provided at the end of the rating questionnaire for respondents to make a comment and over 1,100 passengers did so. The comments were entered verbatim into an excel spreadsheet and coded into categories then analysed and reported. Some of the comments provide useful suggestions for NZTA, regional transport authorities and bus and train operators to consider. A space was also provided for those willing to participate in a future internet survey to give their email address. Over 900 respondents did so which provides an interview panel to monitor attitudinal changes and look at other attributes such as interchange, reliability and crowding.

Table 18 presents a categorisation of the comments made. The breakdown was similar for Christchurch and Wellington bus users with a third related to vehicle quality and 6-7% related to bus stop quality. Amongst the comments made regarding 'vehicle quality', several were compliments about the bus driver or train staff. Relatively few comments were made about the journey time (also known as speed of service or in-vehicle travel time) frequency or price. Thus of the attributes of primary focus in this study, vehicle quality comments were the most predominant. Amongst the issues not of primary interest to this study, reliability dominated, accounting for 20% of comments made.

Table 18: Categorisation of Comments

		Number of Comments						Percent of Total Comments					
		Bus			Rail			Bus			Rail		
#	Description	CHC	WTN	AUC	WTN	AUC	Total	CHC	WTN	AUC	WTN	AUC	Total
1	Vehicle Quality	50	65	80	7	60	262	34%	32%	20%	27%	16%	23%
2	Stop/Station Quality	9	15	27	3	38	92	6%	7%	7%	12%	10%	8%
3	Service Frequency	3	4	23	0	14	44	2%	2%	6%	0%	4%	4%
4	Journey time	1	1	8	1	4	15	1%	0%	2%	4%	1%	1%
5	Price	4	13	10	0	5	32	3%	6%	2%	0%	1%	3%
6	Ticket Issues	3	6	18	0	67	94	2%	3%	4%	0%	18%	8%
7	Reliability	22	31	110	9	59	231	15%	15%	27%	35%	16%	20%
8	Information	1	3	1	0	1	6	1%	1%	0%	0%	0%	1%
9	Other	7	12	22	0	26	67	5%	6%	5%	0%	7%	6%
10	General satisfaction	36	39	101	0	89	265	25%	19%	25%	0%	24%	23%
11	Survey Issues	9	12	5	6	6	38	6%	6%	1%	23%	2%	3%
	Total	145	201	405	26	369	1,146	100%	100%	100%	100%	100%	100%

A further fifth to a quarter of the comments expressed the respondent's satisfaction with the service generally.. This was more prevalent in Christchurch, where 27% of those commenting were satisfied with the service, and least in Wellington (13% satisfied).

Auckland bus respondents differed from Christchurch and Wellington with a greater preoccupation with reliability issues and a correspondingly lesser interest in vehicle quality. At 27%, the percentage of reliability related comments was nearly twice as high as for Christchurch and Wellington. At 20%, the percentage of comments about vehicle quality for Auckland was around one half that for the other two cities.

For Auckland rail, ticketing issues with the recently introduced electronic HOP card accounted for 18% of comments whereas for bus, the HOP card had not yet been introduced. As a consequence, the percentage of comments about vehicle quality and reliability was lower.

Comments on Wellington Bus Drivers:

+ *"Very good driver - Maori very good"*
+ *"Can't help traffic - bus driver always polite, smiles and says hi/goodbye. 5.10 bus on Riddiford"*
+ *"The bus driver on the inbound 23 at 7.30am is lovely and should ask the lady he flirts with every morning to go on a date"*
- *"Many bus drivers are very rude! Many don't allow older people to sit down before driving off. Fix it!!"*
- *"This has been positive. Sometimes bus drivers are very rude, especially to kids".*
- *"Driver smelled of booze"*

Comments on Auckland Bus Stops & Train Stations

B *"Smells like something died at my bus stop, has done for months"*

B *"Better signage for bus stops"*

R *"The trains are smelly and noisy. Onehunga station is popular there is no shelter for tagging off. We need a long station shelter and easier exiting from car park"*

R *"The condition of Remuera station is very good. I gave an average score. Could give more shelter and seating. Trains- main issue is not enough seats, standing room only at leave from Ellerslie to Britomart"*

R *"It would be great to have additional car park lighting at Manurewa. Also it would be nice if coffee vendors could operate by stations. More rain protection needed in winter. Wifi on trains would be useful too"*

R *"The trains need upgrading and better lighting on walkway of Baldwin Ave because at night its pitch black"*

Example comments on Vehicle Quality:

CHC	*"Nice, pity about graffiti though"*
CHC	*"No leg room for tall people"*
WTN	*"Great view window (esp. for tourists). Keep ads off them!"*
WTN	*"Travel time is important to me, hence I catch the 91 Flyer rather than catch an 83 that stops everywhere between the Hutt Valley and Wellington. Thanks for the opportunity to respond (questionnaire emailed)".*
AUC	*"Buses don't have windows, so rely on are conditioning, but it is never on, and I catch bus daily, when full, it gets very hot"*
AUC	*"Sorry, trains are just not enjoyable in Auckland"*
AUC	*"Old trains are scary. Don't look nice. They smell and always afraid to get on"*
AUC	*"Stations great!! Trains average, get it sorted"*
AUC	*"Need electronic trains sooner, the diesels are too old"*
AUC	*"When are the new trains coming? $20 penalty fare over the top and I always pay!!"*
WTN	*"The new Matangi trains have very inadequate shoulder room"*
WTN	*"The electric (trolley) buses are great but need a bit of a spruce up"*

16. Concluding Remarks

In conclusion, the study developed an extensive data base to value service quality based on a large scale survey of 12,557 bus and train users in Auckland, Christchurch and Wellington.

By using ratings, a flexible methodology was developed that could handle different 'packages' of improvements. As well as new buses and trains and new facilities for bus stops and train stations, changes in operational factors such as cleanliness/graffiti and staff could be monitored and valued.

It is worth noting that the same hybrid rating and SP approach has now been used in Sydney in 2013-14 to survey bus, rail, LRT and ferry services (Legaspi & Douglas, 2015) and in Melbourne in 2014 by Public Transport Victoria to survey bus, tram and rail services. Of particular note is the estimation of indirect 'halo' effects for Sydney Rail which approximately doubled the direct effect of improvements to individual attributes. There would be merit in estimating a matrix of halo effects using the NZ data and in merging the results of the NZ, Sydney and Melbourne studies to develop a wider library of vehicle and stop parameters.

There would be benefits to NZTA, PT Victoria and Transport for NSW (TfNSW) in merging the results of the NZ, Melbourne and Sydney surveys to widen the range of vehicles, bus stops and rail stations.

There is the opportunity to survey bus users in the Dunedin, Hamilton and the smaller towns of New Zealand. Ferry users could also be surveyed using questionnaires that would only need small modifications. Another opportunity is to resurvey Auckland rail passengers to see how they value the new electric rolling stock introduced after the surveys were completed.

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Appendix - Summary of Vehicle Types Surveyed & Ratings

			Vehicle Details							Rating	
#	Vehicle Type	M	Age Years	Seats N	BikeRack CCH (%)*	Air Con (%)	Super Low Floor (%)	WChair Acc (%)	Euro Engine	Overall Rate %	Sample Size
1	ADL	B	1.5	37	na	100%	100%	100%	5	75%	905
2	BCI	B	5	38	na	Na	Na	na	3	79%	14
3	DLMacr	B	10	43	na	100%	100%	100%	3	75%	40
4	DLMerc	B	8	39	100%	0%	100%	100%	3	75%	28
5	MAN11	B	14.9	39	84%	0%	80%	60%	1	66%	1137
6	MAN12	B	9.9	41	100%	20%	100%	100%	3	69%	930
7	MAN13	B	5.2	32	na	100%	100%	100%	3	75%	15
8	MAN14	B	5.4	39	na	100%	100%	100%	3	69%	253
9	MAN15	B	5	41	na	100%	100%	100%	4	74%	9
10	MAN16	B	5.2	41	100%	30%	100%	100%	3	69%	306
11	MAN17	B	8.2	50	100%	50%	100%	100%	3	69%	1010
12	MAN18	B	2.6	43	100%	80%	100%	100%	4	71%	104
13	MAN1A	B	2.2	41	100%	100%	100%	100%	4	71%	255
14	MAN22	B	21	53	na	0%	0%	0%	Pre	60%	37
15	MANSG	B	30	76	na	0%	0%	0%	Pre	66%	11
16	MRC30	B	10.6	43	na	0%	0%	0%	1	67%	27
17	MRC709	B	16	25	na	0%	0%	0%	1	50%	6
18	NISSL	B	14	38	na	0%	100%	0%	Pre	60%	12
19	NISSS	B	16.4	38	na	0%	90%	40%	Pre	62%	47
20	OPTL	B	13	40	0%	0%	100%	100%	2	59%	35
21	OPTMR	B	18	22	na	0%	0%	0%	Pre	64%	70
22	OPTX	B	15	40	na	0%	100%	100%	2	58%	15
23	SCAN	B	3.7	47	100%	90%	100%	100%	4	74%	1054
24	TROLY	B	3	43	na	0%	100%	100%	T	73%	316
25	VOLB10	B	29	43	Na	0%	0%	0%	1	37%	19
26	VOLB12	B	10	54	Na	0%	0%	0%	3	81%	4
27	VOLB7	B	5.3	45	Na	40%	100%	100%	4	72%	391
28	Zhong	B	2.9	39	100%	10%	100%	100%	4	62%	104
29	RA_ADK	R	11	68	Na	100%	na	na	Diesel	67%	84
30	RA_ADL	R	11	68	Na	100%	na	na	Diesel	66%	897
31	RA_SA	R	9	60	Na	100%	na	na	Diesel	68%	481
32	RA_SD	R	9	60	Na	100%	na	na	Diesel	69%	33
33	RW_DIE	R	5	64	Na	100%	na	na	Diesel	78%	288
34	RW_GM	R	13	74	Na	0%	na	na	Electric	59%	499
35	RW_MAT	R	1	75	Na	100%	na	na	Electric	82%	2553

* Bicycle racks were only available on Christchurch buses with percentage only calculated for CHC buses