Pricing strategies for public transport
Part 2: Literature review
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Abbreviations and acronyms

ATC	Australian Transport Council
AUC	Auckland
BAH	Booz Allen Hamilton
CHC	Christchurch
DMU	diesel multiple unit
EEM	*Economic evaluation manual* (NZ Transport Agency)
EEMV2	*Economic evaluation manual volume 2*
EMU	electric multiple unit
IVT	in-vehicle time
LRT	light rail transport
MSC	mode specific constant
MSF	mode specific factor
PCIE	Pacific Consulting (now Douglas Economics)
PE	priority evaluator
PT	public transport
RP	revealed preference
RTI	real-time information
RUB	*Requirements for urban buses in New Zealand*, see 'www.nzta.govt.nz/resources/requirements-for-urban-buses/
SDG	Steer Davies Gleave
SP	stated preference
SQI	service quality index
TfL	Transport for London
TP	transfer price
Transport Agency	New Zealand Transport Agency
UD	universal design
WEL or WTN	Wellington (WEL denoting Wellington rail station and WTN the city)

Contents

1 Introduction

1.1 Summary

The literature review focuses on market research studies that have estimated time-based or willingness-to-pay values for qualitative aspects of urban bus and rail services as listed in table 1.1.

Table 1.1 Attributes reviewed

#	Attribute
1	Bus and train 'vehicle' quality package
2	Bus stop and train station quality package
3	Vehicle design appearance, ambience and facilities
4	Stop design appearance, ambience and facilities
5	Information
6	Personal safety, security
7	Maintenance/cleanliness/graffiti removal
8	Staff availability/appearance/friendliness and performance

A total of 13 studies were reviewed covering two decades and dating back to a survey of Wellington public transport services (SDG 1991a). Wherever possible, the original study reports were reviewed so that not only the results could be reviewed but also the methodology. In this way, the review could inform possible future market research.

1.2 EEM starting point

The starting point for the review was the tabulation of attribute values presented in the Transport Agency (2010) *Economic evaluation manual volume 2* (EEMV2). These values were based on stated preference surveys undertaken by SDG in 1995 and 1999 (Bristow and Davison 2009). Thus, to a large degree, the values for bus relate to market research undertaken in London in the mid–late 1990s.

The EEMV2 tabulation covers a wide range of vehicle and infrastructure quality attributes for bus and rail. There are differences in the list for rail and bus, however, and the EEM does not include the ATC values for rail infrastructure. Although wide ranging, the list is not exhaustive; it does not cover the newness of the vehicle or station or the 'look' and is omits some newer attributes such as text messaging and wifi.

1.3 Thirteen studies reviewed

The 13 studies that were reviewed are listed in table 1.2. The studies were identified either by other reviews or were known to the authors. It should be noted that some of the studies cited (eg Wardman) themselves contain an element of review and so more studies are covered by the review than 13.

Three studies covered bus and rail services, five covered bus and five covered rail. Two New Zealand studies were included: a 1991 SP survey of bus and rail quality undertaken in Wellington and a 2002–2005 survey of Wellington train station quality. Five Australian studies, three UK studies, one US study and one Norwegian study were also included.

Importantly, none of the studies reviewed had the explicit purpose of developing pricing strategies; they were either related to forecasting demand such as providing input parameters into demand forecasting models or their purpose was to evaluate improvements. As a consequence, the studies did not provide results that were particularly useful for developing pricing strategies.

Table 1.2 Studies reviewed

#	Study	Reference	Location	Modes covered	Year of survey	Label
1	The effects of quality improvements in public transport	Steer Davies Gleave (SDG 1991a)	Wellington, New Zealand	Bus and rail	1991	SDGWTN
2	Values for rail service quality	Pacific Consulting (PCIE 1995)	Sydney, Australia	Rail	1995	SYDRl95
3	Liverpool to Parramatta transitway feasibility study	PPK Environment & Infrastructure (PPK 1998)	Sydney, Australia	Bus	1998	SYDTW
4	Developing a bus service quality index	(a) Hensher and Prioni (2002) and (b) Hensher et al (2003)	Sydney, Australia	Bus	1999–2002	HenBS
5	Valuation of improved railway rolling stock: a review of the literature and new evidence.	Wardman and Whelan (2001)	UK	Rail	Pre 2001	UKRS
6	Survey of rail quality – Dandenong Victoria	Halcrow (2005)	Victoria, Australia	Rail	2003	RQVIC
7	Values for rail service quality using ratings	Douglas and Karpouzis 2006a	Sydney, Australia	Rail	2004/5	SYDRl04
8	Tranz Metro Wellington station quality survey	Douglas Economics (2005)	Wellington, New Zealand	Rail	2002 & 2004/5	WTNRST*
9	London bus and train values – 1995, 1999 and 2007 surveys	SDG, cited in Bristow and Davison (2009), Balcombe et al (2004) and ATC (2006)	London, UK	Bus and rail	1995–2007	SDGLND
10	Values for a package of bus quality measures in Leeds	Evmorfopoulos (2007), cited in Bristow and Davison (2009)	Leeds, UK	Bus	2007	LDSBQ
11	The role of soft measures in influencing patronage growth and modal split in the bus market in England.	AECOM (2009)	UK provincial cities	Bus	2009	AECOMBS
12	Valuing premium public transport services in US	Outwater et al (2010)	US cities	Bus and rail	2010	USPT
13	Passengers' valuations of universal design measures in public transport	Fearnley et al (2011)	Norway cities	Bus	2007	NORPT

Sources: Balcombe (2004); Australian Transport Council (2006); Bristow (2009); Litman (2008); * Not previously reviewed

1.4 Survey methodology

Most of the studies estimated values using SP instead of revealed preference (RP) data based on actual patronage response.

Ideally, actual patronage and revenue response (technically referred to as RP data) should provide the firmest basis for estimating willingness to pay. However, although demand response to quality improvements is in itself important, such data would not necessarily provide estimates of passengers' willingness to pay unless there were situations where fares had been raised. In the absence of such fare rises, willingness to pay would only be calculated indirectly using fare elasticities.

In fact, there are few examples of studies that have used RP data. Of the 13 studies reviewed, only two used RP data. The 2009 AECOM study (11) looked at 10 case studies of quality bus improvements in the UK but found statistical difficulties in isolating the effect of improved quality from other general changes (notably the introduction of concessionary fares) and therefore relied on SP market research surveys to develop quality valuations. The second study, completed earlier in 2001 (5), looked at train refurbishment in the UK, used ticket sales data to compare with forecasts produced by SP surveys. Their comparison found that basing the forecasts on SP studies produced too high a patronage response and therefore too high willing-to-pay valuations.

The remaining studies based their values purely on the response to SP type questions without RP calibration using either SP choice experiments; priority evaluator (PE) or transfer price (TP) questions.

SP surveys usually present respondents with a series of journey choices, usually a pair of journeys or sometimes three journeys. The journeys differ in terms of their travel times, costs and most importantly in terms of this study, the quality of service. In each choice situation, passengers indicate their preference. Analysis of responses enabled the sensitivity to the attributes to be determined and from these results, the relative value of attributes including willingness to pay. In this regard, the 1991 Wellington study (1) was different in that willingness to pay was asked to measure the strength of preference.

Most of the surveys presented 'within mode' choices, either bus versus bus, or rail versus rail. Some presented choices between car and public transport such as the 2009 AECOM UK bus study (11).

The survey by Hensher to develop a bus service quality index for NSW (4a and b) was the most complex requiring passengers to choose between three bus journeys differing in bus fare, travel time, reliability, walking time and nine other service quality attributes relating to the vehicle, bus stop and information.

An alternative approach to covering a long list of quality attributes in one pass is to use a suite of SP surveys. The AECOM study (11) used an 'unpacking SP' and the US study of premium transit quality (12) used a maxdif SP in which passengers were requested to rank the attributes into most preferred and least preferred. The detailed attribute results were then combined with the results of a higher-level quality SP in which varying quality standards were presented as packages.

An alternative to SP choice experiments is the PE which presents a shopping list of service improvements for the respondents to choose from. By including a fare reduction or a travel time saving in the list, the relative importance of the quality attributes can be established. However, by focusing attention on quality, the technique is likely to produce inflated values as found for the Wellington rail study (8). To avoid this, the results of the PE can be constrained to values estimated by the SP as was done by a 1991 survey of NSW rail services.

Two studies, a survey of bus improvements in Leeds, England (10) and a study of universal design measures in Norway (13) also asked simpler contingent valuation or TP questions in addition to the SP surveys. The TP questions asked passengers' willingness to pay directly for a package of quality improvements. Generally, these simpler questions tend to be regarded as overestimating willingness to pay. However in the Norwegian study, the TP questions gave values a quarter of the size of the SP survey.

The way the vehicle and infrastructure attributes were presented to passengers varied. Several studies used photographs or pictograms to describe the attributes. Others used a word description and two Australian rail studies (2 and 7) used passenger ratings to measure quality as perceived by the passenger.

1.5 Survey approach

The early studies reviewed used face-to-face interviews. More recently, two studies (12 and 13) have posted the questionnaire on the internet and either recruited people 'on the street' or obtained lists of likely participants. The response rate for these two surveys was wildly different however.

The Sydney and Wellington rail surveys (7 & 8), which asked passenger to rate their service, used self-completion questionnaires handed out and collected onboard trains. In Sydney, some surveys were undertaken by interviewers and it was found that doing it this way the passengers tended to give a higher rating.

Only one SP study, a bus SP by Hensher (4a and b) used a self-completion questionnaire handed out on buses.

Telephone surveys are difficult because of the difficulty for respondents to remember the choices; only one study of Dandenong rail (6) used this approach. As well as paper questionnaires, computers have been used to present the questionnaires and record response.

Eight studies only surveyed existing users and four surveys also included non-users. The 1991 Wellington study (1) surveyed car, walkers and cyclists as well as bus and rail users. The AECOM study (11) was limited to commuting to work trips but included car commuters as well as bus users. The US study (12) of Salt Lake City used an additional database to supplement the sample of non-public transport (predominately car) users.

1.6 Valuations reported

In order to make the valuations presented in the different reports, they were converted into (a) equivalent minutes of onboard bus/train time (IVT) and (b) the percentage of the average fare paid.

In fact, none of the 13 studies reported both measures based on data collected by the surveys although six studies did include both fare and IVT as attributes in the SP surveys, for example, the Hensher SP Sydney surveys (4a and b) included fare and IVT but only reported results in 'utils'. For studies where both fare and IVT were reported, the attribute values were calculated using the estimated value of time. In several cases however, concerns were made about the size of the value of time; it was either too high, as in the Dandenong study (6) or too low as in the Norwegian study (13).

Where only fare or IVT values were provided, an 'external' value of time was used. This was the case in the 2004 Sydney Rail rating based study (7) which used a value of time estimated by a contemporary SP survey (Douglas Economics 2004b). For other studies, a value of time referenced in the report was used, eg 2007 London bus valuations (9) or was taken from a known source, eg the Wellington rail station survey (8) for which the Transport Agency's value of time in the EEMV1 was used.

All the studies presented average valuations. Six studies segmented the results by either trip length or time period (or both) but seven studies only provided average valuations. Some studies explored the effect of user and trip profile on the valuations but none reported valuations by market segment.

The strongest evidence for willingness to pay to increase with trip length was provided by the 2004 Sydney rail rating study (7) which surveyed a wide range in trip lengths from short trips under 15 minutes to two hour trips. For bus, there was no strong evidence reported for valuations to increase with trip length.

None of the studies provided a willingness-to-pay profile that gave the percentage of respondents willing to pay more than a certain amount for the provision of an attribute or an improvement in service. This lack of detail reflects the orientation of the studies. Considered the closest in specification to producing a willingness-to-pay profile was the 1991 Wellington study (1), which directly asked passengers their willingness to pay a higher fare for their preferred choice. Unfortunately only the average willingness to pay was reported.

Four studies surveyed non-users as well as users (1, 3, 11 and 12) with the results suggesting car users tend to have higher values of quality than bus and rail users.

1.7 Package effects

The review found mixed results regarding whether the value of an improvement package comprising several attributes was greater or less than the sum of the individual attribute values. To a large extent, however, the estimated package effects reflected the survey designs.

The most extreme 'package effect' was the US study of premium transit (12) which found that the sum of the individual attribute valuations estimated by a detailed 'maxdif' SP was 10 times greater than the package quality value estimated by an overall mode choice SP experiment of bus versus rail versus car.

The SDG (1996) London bus SP survey, which was used to develop values for the 2004 version of the TfL *Business case development manual,* estimated a value for passengers' ideal package of 26 pence. This was regarded as a willingness-to-pay cap. However, the sum of the SP attribute values totalled around £1.

Wardman and Whelan (5) estimated a package effect of 0.5 in their analysis of SP/RP studies of UK rolling stock refurbishment whereby the sum of the individual effects associated with ride quality, seating layout, seating comfort, noise, ventilation and ambience as estimated by SP studies needed to be halved to get the value of the overall package.

The Norwegian study of bus/tram stop facilities (13) asked TP questions of the package of improvements which gave a value that was only a quarter of the sum of the attribute values estimated by the SP.

Two studies estimated a contrary package effect whereby the value of the sum of the individual attributes was less than the package effect. The 2004 Sydney rail study (7) estimated a package effect of 1.17 for trains and also stations by comparing the forecast value of improving the overall rating with the individual attribute ratings.

The AECOM study (11) was undertaken of 10 corridors in provincial UK cities. AECOM compared the sum of attribute valuations with the package SP estimate and found the package effect to be 10% higher than the sum of parts estimate.

1.8 Comparison of estimated vehicle package values

Table 1.3 presents the wide range in the package value for bus and train quality improvements. What can also be seen is that measuring in terms of onboard time or percentage fare had a major bearing on the relative valuation.

In part, this is due to differences in the make-up of the packages inhibiting 'like-for-like' comparison. Particularly important is whether 'ongoing' aspects of service quality such as cleanliness, graffiti removal, staff friendliness, driver performance and announcements are included. For the Wellington public transport study (1) NSW transitway study (3) and UK rail refurbishment (5) only design factors are included.

The method of estimation is also considered to have a large influence on the package valuation with the SP and rating valuations tending to be lower than the PE and TP estimates.

A third factor influencing the value is how the package value is calculated. That is, whether it is (a) a package that is actually presented to respondents enabling a direct estimate to be reported or (b) whether it is subsequently calculated by adding the estimated values for individual attributes. If (b), the package value may have then been adjusted or constrained. A fourth factor is the 'base' quality from which the improvement is measured. Last, as should be expected, some of the variation is due to study context: differences in attribute quality (both base and 'improvement'); differences in fare and travel time by which the qualitative attributes are measured against; and differences in respondent and trip profile.

The highest package value was estimated by Hensher (4a and b) in a study of Sydney buses. The vehicle package which offered wide entry doors, very clean and very smooth buses and very friendly drivers was valued at 32 minutes of travel time or 90% of fare.

Next highest was the AECOM (11) study which estimated a value of 14.8 minutes (27% of fare) for a bus quality package including new low-floor buses, with climate control (air conditioning), trained drivers, on-screen displays, audio announcements, CCTV, leather seats, customer charter and an in-vehicle seating plan.

The US study of premium bus services (12) estimated lower package values of between 3.1 and 5.8 minutes. However the package covered fewer attributes: wifi onboard seating availability, seating comfort, temperature control and vehicle cleanliness. For rail, the package value was estimated to increase with trip length (0.13 minutes per minute of onboard train time).

The values for London included in the 2004 version of the TfL *Business case development manual* (9) were lower when expressed in terms of travel time at 2.4 minutes for bus and 3.6 minutes for rail but higher in terms of fare (73% and 50%). It should be noted that the values were estimated in terms of fare and have been converted as part of this review into minutes by applying an externally derived value of time.

The EEM package values are reasonably exhaustive in attributes included but have not been halved as recommended in the ATC (2006) manual. The estimated bus value of 5.4 minutes is similar to the US PT study (12) but is only half the AECOM value. The rail value is higher than the other estimates when measured in train minutes (11.4) but lower when measured in percentage fare (25%).

Table 1.3 Vehicle package values

#	Reference	Package description	IVT mins	% Fare
1	SDG (1991a) Wellington	Old to new bus (Wellington)	3.1	11%
		Standard to new bus	1.4	5%
		Standard bus to trolley bus	1	1%
		Old to new train	3.4	8%
		Standard to new train	1.2	4%
		Standard bus to standard train	1.1	4%
2	PCIE (1995) Sydney rail	10% rating point improvement in overall Sydney train rating	1.9	8%
		Improvement from average to best train in Sydney fleet rating	4	16%
3	PPK (1998) Sydney bus transitway	Std bus to transitway bus (incl stop) – SP bus users	0.4	5%
		Std bus to transitway bus (incl stop) – SP rail users	6	51%
		Std bus to transitway bus (incl stop) – SP car users	5	63%
		New modern bus vs standard bus – PE bus users	5	22%
		New modern bus vs standard bus – PE car users	6	43%
		New modern bus vs standard bus – PE rail users	3	15%
4	Hensher and Prioni (2002) and Hensher et al (2003) Sydney bus	1999 survey – wide entry, v.clean and v.smooth, v.friendly driver	32	90%
		2000 survey – wide entry, v.clean, v.smooth, v.friendly driver	19	65%
5	Wardman (2001) UK	Train renewal (30-minute trip)	1.3	1.5%
6	Halcrow (2005) VIC rail	Train package (air con, clean seats, no graffiti safe) PE	4.6	77%
7	Douglas and Karpouzis (2006a) Sydney rail	10% improvement in overall train rating with:	2.2	12%
		• " " " strong trip length & pk/off-pk effects	0.7S–5.3L	5%S–16%L
		• improvement from worst to best train in fleet rating	2.7	15%
		• improvement from average to best train in fleet rating	1.3	8%
8	Doug. Econ. (2005)	Vehicles not covered	na	na
9	SDG (2007) London	Worst to best bus 2007 survey	2.4	73%
		Worst to best train 2007 survey	3.6	50%
10	Evmorfopoulos (2007) Leeds	Quality package vs std bus (incl. stop attributes) – SP	4.3	9%
		Quality bus package of quality vs std bus (incl. stop attributes) – TP	7.4	15%
11	AECOM (2009) UK	On-bus quality package	14.8	27%
12	Outwater et al (2010) US	Value of premium service package (4 cities)	3.1–5.8	nc
		Salt Lake City – work commuters – bus	4.3	nc
		Salt Lake City – non-work commuters – bus	5.5	nc
		Salt Lake City – work commuters – rail (constant + per min)*	4.3+.13/m	nc
13	Fearnley (2011) Norway	not covered	na	na
14	NZ Transport Agency (2010b) review	Summation of bus (vehicle) attributes ^	5.4	12%
		Summation of train (vehicle) attributes ^	11.4	25%

nc: no data on average fares and non commuting value of time to calculate % Fare valuations

^sum of attribute values (no downwards adjustment for multiple attributes); * only work model presented

1.9 Bus stop and train station package values

A summary of the estimated value of bus stop and train station values is presented in table 1.4. An issue that has not been well addressed is whether the bus stop and train station values apply to only the board stop or to the board and alight stops (ie the values are an average for the two stops).

For bus, most of the value is likely to be for the board stop because that is where passengers spend most of their time (waiting for a bus). Virtually no time will be spent at the alight stop. However, city centre bus stations may add value through the provision of facilities. Also, the return trip reverses the board and alight stations.

For train stations, amenities and ambience offered at the alight station are more important, such as ease of getting off the train, alighting the platform, attractiveness/lighting of the accessways and concourse and the ease of exiting the ticket barriers. There are also interchange stations to consider where passengers both alight, move around the station and wait for trains.

Only the 1995 Sydney rail study (2) made reference to the number of stations. The station values were factored down according to the number of stations used per trip (2.1) whereas the 2004 study (7) only asked passengers about their board station. The 2004 study referred to the boarding station on the questionnaire and the Wellington survey (8) referred to a nominated station.

Like the vehicle package values, the composition of the packages varied, which makes comparisons difficult. Some included information such as the Hensher value (4a and b); the US study (12) included personal security whereas others were limited to design aspects (weather protection, seat provision, lighting etc).

The highest package value was 44 minutes estimated using the PE for the redevelopment of a station in Wellington (8). The high value is considered to result from the questionnaire design focusing passenger attention on station improvements.

Next highest was the Norwegian study (13) which estimated a value of 13.8 minutes for bus stops with weather protection and seating versus neither. This study, by focusing attention on bus stop facilities, probably overestimated passenger valuations.

The London 2007 survey (9) estimated low values when expressed in in-vehicle time (IVT) of 1.9 minutes for improving bus stops from worst to best and 3.6 minutes for train stations. Higher values were produced when the values were expressed in terms of fare of 58% and 50% respectively. A similar finding was produced for the Dandenong PE (6) (5.4 minutes but 91% of fare).

The EEM values of four minutes for a full package of bus stop improvements and seven minutes for a rail station are towards the lower end of the estimates.

Table 1.4 Bus stop and station package values

#	Reference	Package description	Mins	Fare %
1	SDG (1991a) Wellington New Zealand	Shelter and seats versus unprotected bus stop	6	3%
		New vs standard rail station – rail commuters	22	11%
		New vs std rail station – bus, car and non-rail commuters	8	4%
2	PCIE (1995) Sydney rail	10% rating point improvement in station rating^	1.1	4%
3	PPK (1998) Sydney bus transitway	Modern bus stop (shelter and seats) - priority evaluator bus users	6	na
		As above for car users	17	na
		As above for rail users	6	na
4	Hensher and Prioni (2002) Sydney bus	Sydney bus survey – value of shelter with seats, timetable and map	2.8	10%
5	Wardman and Whelan (2001)	Not covered	na	na
6	Halcrow (2005) Victoria rail	Dandenong (Victoria) regional rail station improvement package estimated by a priority evaluator survey	5.4	91%
7	Douglas and Karpouzis (2006a) Sydney rail	10% rating point improvement in overall station rating*	1.3	7%
		10% rating point increase with trip length+	0.4S-2.4L	3.4%S-9.3L%
		Value of improving from worst (39%) to best station (75%)	4.5	25%
8	Douglas Economics (2005) Wellington rail	Value of Petone station Wellington using priority evaluator	44	115%
9	SDG (2007) London	Worst to best bus stop London 2007 survey	1.9	58%
		Worst to best train station London 2007 survey	3.6	50%
10	Evmorfopoulos (2007) Leeds	Not reported (stop quality included in vehicle value)	na	na
11	AECOM (2009) UK	Bus stop quality package – cities in England	7	13%
12	Outwater et al (2010) USA	Value of premium service stop/station package – average of 4 USA cities	4.4	na
13	Fearnley et al (2011) Norway bus	Bus shelter with seating versus no shelter/seats Norway	13.8	na
14	NZ Transport Agency (2010b) review	EEM review): Full package of bus stop improvements	4	9%
		Bus station	3	8%
		Rail station	7	15%

^ value for single station (survey values were divided by 2.1 stations); * rating of station passenger boarded:
+ figures given for short S and long L for peak trips.

2 Study purpose and scope

2.1 Study purpose

The purpose of the study was to provide willingness-to-pay values for PT service level and quality attributes and to develop a methodology that could use the values to incentivise improvements from a customer, operator and funder perspective.

This chapter presents the findings of the literature review. The literature review assesses the extent of current knowledge and its applicability to New Zealand. Any knowledge gaps are identified and the review assesses the different market research techniques that have been used to estimate willingness-to-pay values.

2.2 Study scope

Six issues as listed in figure 2.2 in the main part of the report were discussed and the scope of the study delimited. In doing so, the scope was delimited principally in terms of the market research stage which provisionally would follow on from the literature review.

In reviewing the literature, some willingness-to-pay values for attributes, modes or trip lengths that would have been considered 'out of scope' have been included where they were presented alongside 'in scope' attributes, modes or trip lengths.

2.2.1 Transport modes

Willingness-to-pay values presented in this review are for bus and rail. A few values are presented for light rail where they have been estimated as part of a wider study.

2.2.2 Trip length

Values are presented for urban passenger transport. In terms of trip length, a limit of 90 minutes of bus/rail travel time was suggested in the scoping report. This limit is considered to be more relevant in determining the scope of a market research sample. In terms of the literature review, the specifics of the individual surveys determined the trip length limit. No attempt has been made to exclude trips or adjust values for studies that include trips that may have exceeded the 90-minute limit.

The review sought to establish the extent to which trip length influences the willingness to pay for bus and train quality since firm evidence could guide the market research sampling strategy and influence the development of pricing strategies. Some studies, mostly rail studies, presented values for short, medium and long trips and one study allowed for rail willingness to pay to increase linearly with trip length. However for bus, all the studies presented an average willingness to pay that did not vary with trip length.

2.2.3 Nature of the contract

The literature review has focused on studies that have estimated values for scheduled PT bus and rail services, which may be subsidised or provided commercially. The services may offer standard or premium levels of service (actual or hypothetical).

The review has not looked at studies that focused on school bus services, rural bus services or services that are provided for the disabled.

2.2.4 Geographical scope

The literature review has focused on urban public transport and has not covered rural services or inter-urban services.

2.2.5 Patronage scope

Most studies have presented an average value for the sample of respondents interviewed. Some studies have reported values for peak and off-peak travel. A few studies report values for different types of user which could be important in developing pricing strategies.

Type of user can be considered in terms of the frequency of PT use; whether the passengers travel free; the treatment of passengers too young to be interviewed; and whether the passengers have a disability.

In terms of frequency of use, most studies have focused on existing public transport users (including occasional users). A few studies have surveyed non-public transport users, mostly car users but sometimes walkers and cyclists. Where available, we discuss any estimated differences in the willingness-to-pay valuations for service quality between PT users and non-users.

Some passengers are entitled to free bus and rail travel. Estimating willingness-to-pay values for these passengers is clearly problematic since fare can only be hypothetical. Similarly, young passengers under 15 are not usually interviewed. Where information is provided, the review comments on how these types of passenger have been treated and whether any adjustment was made to the overall willingness-to-pay values.

A few studies have estimated values for passengers with disability or encumbered by shopping or luggage. These studies have usually focused on train station attributes such as passenger lifts. Not surprisingly, much higher willingness to pay has been reported for passengers with mobility problems. Some examples of these types of study are reviewed.

2.2.6 Attributes considered

The Request for Proposals – Public Transport Research Topics, issued by the Transport Agency dated 15 August 2011, included the following description of the study outlining attributes to be considered: 'To apply an investment analysis to assess the willingness of customers to pay for service improvements to public transport. This research will look at different services improvements, including network improvements (eg increased frequency, longer hours of operation) and quality improvements (eg wifi, increased seat widths) to determine what improvements customers are most willing to pay for, and how much they are willing to pay. The research will compare differences in preferred service improvements and willingness to pay of different demographic groups. This information will then be used to develop pricing strategies that can be applied to incentivise the types of improvements that customers are most willing to pay for.'

The scoping report dated February 2012 advocated the list of qualitative attributes covered in the EEMV2, section 7.2, as a starting point for the literature review.[1]

These attributes are considered qualitative or 'soft' in nature, such as seat comfort or smoothness of ride; they are by nature more difficult to measure than 'hard' variables. Hard variables, such as travel time and frequency, have been better researched and tend to form the basis of most travel demand forecasts whereas there has been less research into qualitative attributes of service.

[1] Section 7.2 of the EEM contains three tables of values expressed in equivalent in-vehicle time minutes for bus and rail improvements. The values were taken from a 2006 review study undertaken for the ATC.

The EEM tabulates values for bus, trains and infrastructure reference the ATC guidelines (ATC 2006). A summary of the attributes listed in the EEM is provided in table 2.1. Chapter 3 discusses the attributes and values in more detail.

Table 2.1 List of qualitative attributes covered in EEM

Vehicle Attribute	Description & Sub-Attributes
Boarding	Ease of getting on/off
Driver/Staff	Attitude of driver (bus) and quality of ride. Presence of train attendant
Cleanliness	Litter, graffiti, state of windows, inside/outside appearance
Facilities	Clock, CCTV, onboard toilets (train)
Information	External numbering/labeling, interior route number/diagram. Frequency/audibility of announcements
Seating	Layout e.g. facing direction of travel, type e.g. whether tip-up, leg room, cleanliness/maintaince
Comfort	Ventilation and air conditioning
Infrastructure Attribute	**Description & Sub-Attributes**
Stop/Shelter	Condition, size, seating, cleanliness, graffiti
Ticketing	ticket sales/type of tickets offered
Security	Lighting, CCTV
Information	Clock, timetables, real time information, payphone

Source: ATC 2006 National Guidelines, Volume 4

Omitted from table 2.1 are crowding and reliability. As regards crowding, EEM volume 1 (table A4.1) includes a 39% higher value of time for standing onboard buses and trains than travelling seated (eg $6.60 per hour standing versus $4.70 per hour seated per hour for commuting) based on work by Beca Carter Hollings & Ferner et al (2002).

Reliability values were also reviewed by Beca Carter Hollings & Ferner (2002) [2] and have been extensively researched in New Zealand by Vincent (2008) using SP market research.

Although omitted, crowding and reliability will have interactive effects on the values of some of the qualitative attributes – in particular seat comfort and information. Clearly, providing comfortable seats on bus and trains will have value to those who can sit in them and not to those who have to stand because of crowding. Likewise, providing real-time information (RTI) will have more value, the less reliable the service runs to timetable.

Collectively, the studies that have been reviewed have covered a wide range of service quality attributes. Some studies have covered attributes outside the primary scope of interest such as service reliability and crowding. The values for these are reported so that the relative importance of the 'in scope' attributes can be assessed.

There was a question mark as to whether driver/staff related attributes should be included. The literature review has included bus driver and staff-related values where they have been estimated as part of a wider study.

As well as reviewing willingness to pay for individual attributes, the review has looked at how the attributes may be packaged and how the value of the package may differ from the sum of the individual attribute valuations. In this regard, several of the market research studies have developed 'ideal' or

[2] The Beca Carter Hollings & Ferner (2002) recommendation for reliability was a value of 0.8 minutes in-vehicle time per minute reduction in the standard deviation of the scheduled pick-up time.

‘perfect’ services, or defined high-quality service ‘packages’ that were compared with medium and low-quality packages. In terms of the estimated values, some studies have imposed an upper limit of cap on the value of a package or factored down the individual attribute values, often considerably so, to an estimated package value.

There is also the question of how quality levels may be applied in practice. The ‘requirements for urban buses’ (RUB) developed by the Transport Agency provides a guide (the 80/20 rule in which some basic requirements can be set aside) for developing a base standard for bus vehicles. The RUB specifies ‘standard’ attributes, plus a range of ‘desirable’ characteristics, such as air conditioning and audio information on buses.

The standard attributes, even though they will not be included in every bus currently in use, provide a reference quality. The additional attributes or improved attributes that represent a premium service could be the ‘desirable characteristics’ included in the RUB. The possibility is that older buses that fail to meet the standard will be withdrawn first and replaced by premium buses that may more than meet the standard.

There is no similar RUB standard for rail. The range in rolling stock used and proposed for Auckland and Wellington provides a reference for determining ‘standard’ and ‘premium’ vehicle carriages.

3 Bus and rail values – EEM and ATC vehicle and infrastructure values

3.1 Introduction

A starting point for the review is the tabulation of transport service user benefits presented in section 7.2 of the EEMV2 (NZ Transport Agency 2010). The qualitative values given for bus and rail are, in fact, a copy of the values included in appendix A of the ATC (2006) *National guidelines for transport system management in Australia* (except that rail infrastructure values for stations are not included in the EEM tabulations).[3]

The ATC valuations were developed by Booz Allen Hamilton from a review of the literature. A list of sources is given under each ATC table. However it is likely (as acknowledged in the ATC report) that most of the bus values originate from a single source: the 2004 version of the *Business case development manual*.[4] These values in turn derive from SP market research undertaken by SDG in 1995 and 1999 (Bristow and Davison 2009). Thus, to a large degree, the willingness-to-pay values for bus relate to market research undertaken in London around 15 years ago.

A review of 1995 SDG survey is provided in section 5.9 that references Bristow (2009). The review shows that although the SDG study is influential, it was not without methodological issues. Whether and how the estimated survey values have been adjusted or augmented by TfL for inclusion in the *Business case development manual* is not known.

The EEM and ATC guidelines present the values in minutes of IVT; in other words, the saving in travel time valued the same as the quality improvement. The Transport Agency notes that the values can be converted into willingness-to-pay measures by multiplying by the values of time in EEMV1, section A4.2. Dividing by an average fare expresses the willingness to pay as a percentage fare increase.

3.2 Bus and train values

Table 3.1 presents the values of bus and vehicle attributes given in ATC (2006). As previously mentioned, these guidelines give values in minutes of in-vehicle (on bus or train).

[3] The vehicle values (bus and train) were taken from ATC guidelines (2006, section A9, table A.11) and the bus infrastructure values were taken from section A10, table A.12. The rail infrastructure values in table A.12 are not presented in the EEMV2.

[4] The TfL *Business case development manual* has subsequently been updated. At the time of writing (June 2012) the latest version on the web was 2008. The current online version is dated 2013.

Table 3.1 Bus and train vehicle values (ATC 2006)

BUS	Sub-Attribute	Value mins	WTP C/trip	% of Fare	Comment
Boarding	No steps	0.1	1	0.2%	Difference between 2 steps and no steps
	No show pass	0.1	1	0.2%	Two stream boarding & no show pass relative to single file past
Driver	Attitude	0.4	3	0.9%	Very polite, helpful, cheerful, well-presented compared with businesslike & not very helpful
	Ride	0.6	4	1.3%	anxiety/irritation
Cleanliness	Litter	0.4	3	0.9%	No litter compared with lots of litter
	Windows	0.3	2	0.7%	Clean windows with no etchings c.f. dirty windows with etchings
	Graffiti	0.2	1	0.4%	No graffiti compared with lots of graffiti
	Exterior	0.1	1	0.2%	Very clean everywhere compared with some very dirty areas
	Interior	0.3	2	0.7%	" " " "
Facilities	Clock	0.1	1	0.2%	Visible digital clock showing correct time compared with no clock
	CCTV	0.7	5	1.6%	CCTV recorded visible to driver & driver panic alarm c.f. no CCTV
Information	External	0.2	1	0.4%	Large route number & destination from/side/rear plus line diagram or side relative to small routes number of front/side rear
	Interior	0.2	1	0.4%	Easy to read route number & diagram display cf no info inside bus
	Info on next stop	0.2	1	0.4%	Electronic sign and announcements of next stop and interchange compared with no information of next stop
Seating	Type/Layout	0.1	1	0.2%	Individual-shaped seats with headrests, all seats facing forward compared with basic double bench seats with some facing
	Tip-up	0.1	1	0.2%	Tip-up seats in standing/wheelchair areas compared with all standing area in central aisle
Comfort	Legroom	0.2	1	0.4%	Small luggage space c.f. restricted legroom & no small luggage
	Ventilation	0.1	1	0.2%	Push-opening windows giving more ventilation compared with slide-opening windows giving less ventilation
	Air conditioning	1.0	7	2.2%	Air conditioning
ALL	**Summation**	**5.4**	**36**	**12%**	**Summation of Above Factors (1)**
RAIL		**Value mins**	**WTP C/trip**	**% of Fare**	
Driver/Staff	Train attendant	1.6	11	3.6%	
	Ride	1.2	8	2.7%	Quiet and smooth
Facilities	CCTV	2.0	13	4.4%	
	Onboard Toilets	0.6	4	1.3%	
Information	Interior	1.1	7	2.4%	Frequent and audible train announcements
Seating	Comfortable	1.5	10	3.3%	
	Layout	0.7	5	1.6%	Facing travel direction
	Maintained	1.2	8	2.7%	Clean and well maintained
Comfort	Ventilation	1.5	10	3.3%	Air conditioning
ALL	**Summation**	**11.4**	**76**	**25%**	**Summation of Above Factors(1)**

Notes: (1) The summation value was calculated by Douglas Economics. The ATC table makes the following comment: For a package of changes the total valuation is expected to be lower than the sum of the individual components. Source: IVT valuations in minutes given in ATC Guidelines, ATC (2006). WTP fare valuations calculated using a value of time of $4/hour and an average fare of $3 per trip.

Willingness to pay in cents per trip has been added to table 3.1 using a value of time of $4/hr and a percentage fare value based on an average fare of $3 per trip.[5]

[5] Clearly, the value of time therefore has a major bearing on the willingness-to-pay values: the higher the value of time, the higher the willingness to pay. Moreover, how the values were estimated in the first place and how they were then converted into values for inclusion into the ATC is important. As an example, TfL (2004) which was a key source of the ATC values presents values in pence per trip (see section 11.5.9). Therefore Booz Allen Hamilton, who undertook the ATC review, would have needed to convert the values in the opposite direction (by dividing the fare values by a value of time).

In regard of the value of time, ATC (2006, table A.1) gives a mean value of IVT of $10 per hour ($9.97) expressed in 2006 dollars.[6] By contrast, the value of public transport time for bus and rail given in the 2010 EEM is around $4 per hour for seated passengers.[7] Table 3.1 has calculated willingness to pay using the $4 per hour figure. Had, ATC (2006) been used, willingness to pay would have been 2.5 times higher.

The EEM and ATC do not provide guidance on the average fare paid to calculate percentage willingness-to-pay values. A fare of $3 (including GST) has been used in table 3.1 to calculate the percentage fare willingness to pay.[8]

For bus, a total of 19 vehicle values are presented covering boarding the bus, driver attitude and quality of ride, cleanliness, onboard facilities (provision of a digital clock and CCTV); information provided internally and externally; seating and air conditioning.

In consideration of the values, ATC (2006) states the values are 'typical valuations for bus and rail' and 'that the valuation is the maximum benefit that could be gained. For example, a litter value of 0.41 minutes is the maximum valuation that could be placed on a bus service with no litter'.

The ATC guidelines do not identify the specific source of the values or how exactly the guideline values were produced.

In terms of the bus values, ATC (2006) makes the comment that 'extensive information for bus attributes exists from the *Business case development manual* which is extremely detailed on the benefits of changing aspects of the service particularly in the London context'. The ATC found it 'difficult to compare detailed sources like this with the other research because the case attributes are defined more generally in the majority of the research. In most of the research, it is not clear what is included in the attributes and how people have interpreted the options given'.

Most of the bus attributes are valued at under half a minute (six were valued at 0.1 minutes and five at 0.2 minutes). Only three were worth over half a minute each: air conditioning was the most valued at 1 minute; then onboard CCTV at 0.7 minutes and smoothness of ride at 0.6 minutes.

The total value of the individual attributes was 5.4 minutes which converts to a willingness to pay of 36 cents or 12% of a $3 fare. Regarding package valuations, ATC (2006) makes the important comment that their expectation is the total package value is likely to be less than the sum of the individual attribute valuations although 'there is little research to suggest what this maximum is'. If the bus values do mostly source from the SDG 1995 market research (Bristow and Davison 2009), then a cap was already in place on the total value (see section 5.9) so a further downwards adjustment would be unwarranted.

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[6] The ATC average was based on a straight average of values reported by 21 studies (some being excluded due to being inappropriate). Bus had a lower value ($8.78) than rail $10.25 per hour. The value of time in the peak period was 8% higher than in the off-peak.

[7] For commuting to/from work, a value of $4.70 per hour is given and $3.05 for other purposes. A value of $21.70 per hour is also given for travel on company business but this is a relatively infrequent trip purpose. Based on a 2004 profile survey of Wellington rail patronage (sample of 14,593) purpose weights of 49% commuting, 50% other and 1% company business would give an average value of $4.04 per hour (Douglas Economics (2004a). Higher values of time are given for passengers standing on buses and trains of $6.60 commuting to/from work and $4.05 other purposes (company business value remains at $21.70 per hour) but these values reflect the disutility of standing and crowding relative to being seated and therefore at less appropriate for calculating the willingness to pay for qualitative attributes.

[8] The 2004 Wellington rail profile study (Douglas Economics 2004a) estimated an average rail fare of $2.95 per trip. Bus passengers tend to pay a lower fare because of shorter trip lengths, so an average of $2.50 was considered reasonable. Updating to 2012, suggests an average of $3 per trip. For simplicity, the same average fare of $3 per trip has been used for both bus and rail.

For rail, ATC (2006) states the research was 'predominately Australian and more general than bus'. Only nine attribute valuations are provided. Nevertheless the total package is worth 11.4 minutes, double that of bus. All the attributes are valued more than 0.5 minutes. Onboard CCTVs were valued the most at two minutes (nearly three times higher than bus). Onboard train attendants were the next highest at 1.6 minutes with comfortable seating and air conditioning each valued at 1.5 minutes.

3.3 Bus and rail infrastructure values

Also provided in ATC (2006) (but not in the EEM) is a set of model specific factors that enable comparisons of the quality of bus and train to be made. Given their relevance to the current study, these values are presented here.

The infrastructure valuations are presented in tables 3.2 (bus) and 3.3 (rail). Values are tabulated for the waiting or transfer environment; ticketing, security and information are tabulated with the list of attributes and description differing for bus and rail. The values were sourced from studies similar to those for bus and train vehicles.[9]

There is no guidance on whether the values apply to the destination as well as the origin stop or station.

As with the vehicle valuations, the valuation of train station attributes is higher than for bus totalling 6.8 minutes versus 4.1 minutes. Again however, the guidelines note that the package value is likely to be less than the sum of the attribute valuations and recommend the values be divided by two to adjust for any overestimation. This halving has not been done, however, in producing the sum of attributes valuations.

[9] In addition to the 10 studies listed under the bus and train vehicle valuations, SP market research of transfer/interchange in Scotland ITS et al (2001); wait time perceptions by Mishalani et al (2006); SP market research by PCIE (1996) of the M2 Busway in Sydney are referenced.

Table 3.2 Bus infrastructure values (ATC 2006)

BUS	Sub-Attribute	Value mins	WTP C/trip	% of Fare	Comment
Stop/Shelter	Condition	0.1	1	0.2%	Excellent condition, new look c.f. basic but parts worn & tatty
	Size	0.1	1	0.2%	Double-sized shelters compared with single-size
	Seating	0.1	1	0.2%	Seats plus shelter versus no shelter and seats
	Cleanliness	0.1	1	0.2%	Spotlessly clean compared with some dirty patches
	Litter	0.2	1	0.4%	No litter compared with lots of litter
	Graffiti	0.1	1	0.2%	No graffiti compared with lots of/offensive graffiti
	Type	0.2	1	0.4%	Glass cubicle giving good all-round protection compared with no shelter
Ticketing	Roadside machines	0.1	1	0.2%	Pay by cash (change given), credit/debit card compared with pay by coins (no change given)
	Machine Availability	0.2	1	0.4%	At busiest stop compared with none
	Sale of one-day pass	0.1	1	0.2%	On bus sale, same prices as elsewhere c.f. no sale of one-day pass
	cash fares	0.3	2	0.7%	Cash fares on the bus, driver giving change compared with no cash
	two-ticket transfer	2*1 ticket transfer			
Security	Security point	0.3	2	0.7%	Two-way communication with staff compared with no security
	CCTC	0.3	2	0.7%	Recorded and monitored by staff if alarm raised compared with no CCTV
	Lighting	0.1	1	0.2%	Very brightly lit compared with reasonably lit.
Information	Terminals	0.1	1	0.2%	Screen with real-time information for all buses from that stop compared with current timetable and map for route.
	Maps	0.2	1	0.4%	Small map showing local streets and key locations versus no small
	Countdown signs/RTI	0.8	5	1.8%	Up to the minute arrival times/disruptions, plus audio compared with no countdown sign
	Clock	0.1	1	0.2%	Digital clock telling correct time compared with no clock
	Contact number	0.1	1	0.2%	Free-phone number shown at sop compared with no number
	Location of payphones	0.1	1	0.2%	One payphone attached to shelter compared with no payphone, simpler more user-friendly
	Simple timetable	0.4	3	0.9%	Simple more user-friendly
Sum of Bus Attributes		4.1	27	9.1%	Summation of Bus Attributes (1)
Bus Stations		≤3.0	25	8.3%	Bright lighting, CCTV cleaned frequently, customer service staff walking around at info desk, central electronic sign giving departure times, snack bar, cash-point, newsagent, landscaping, block paving & photo-booths. (1)

For notes see footnote to table 3.3.

Table 3.3 Rail infrastructure values (ATC 2006)

RAIL		Value mins	WTP C/trip	% of Fare	Comment
Passenger Facilities	Waiting Room	0.2	1	0.4%	
	Platform Seating	0.3	2	0.7%	
	Toilets	0.4	3	0.9%	
	Weather Protection	0.3	2	0.7%	Canopies
	Telephones	0.2	1	0.4%	
	Platform Lighting	0.3	2	0.7%	
	CCTV	0.6	4	1.3%	
	Café	0.3	2	0.7%	
Clean-liness & Appear-ance	Cleanliness	0.5	3	1.1%	
	Litter-free	0.5	3	1.1%	
	Grafitti-free	0.3	2	0.7%	
	Modern	0.2	1	0.4%	
Ticketing	Manned Booths	0.3	2	0.7%	
	Auto Machines	0.2	1	0.4%	
Infor-mation	Helpful Staff	0.5	3	1.1%	
	Knowledgable Staff	0.5	3	1.1%	
	PA System	0.4	3	0.9%	
	Signage	0.3	2	0.7%	
	Clocks	0.2	1	0.4%	
	Information	0.3	2	0.7%	Information about next service
Sum of Rail Attributes		6.8	45	15.1%	Summation of Rail Attributes (1)

ATC note (1): The sum has been calculated by Douglas Economics. The ATC table makes the following comment: experience from other Stated Preference surveys indicates that the perceived benefits of multiple features are less than the sum of individual components. When multiple features are combined, the values should be divided by two to adjust for any overestimation.
Source: ATC 2006 National Guidelines, Volume 4

For bus the highest valuation at 0.8 minutes is for countdown signs that give RTI on bus services. Next highest is a simple timetable at 0.4 minutes with availability of cash fares at 0.3 minutes and CCTV at 0.3 minutes.

For rail, values for station staff are given. The highest value is for CCTVs at 0.6 minutes. Helpful staff is worth 0.5 minutes with knowledgeable staff having the same valuation. Similarly cleanliness is given a value of 0.5 minutes, the same value as 'litter free'.

3.4 Mode specific factors

ATC (2006) also presents a table of model specific factors which represent 'perceptions about one mode over another when other factors such as journey time, fare and frequently have been excluded'. To some extent, the values provide a 'bridge' to link bus, tram/LRT, rail and ferry in terms of their net relative quality.

The ATC comments that the factors can be used in two ways: first as a fixed penalty mode specific constant associated with accessing and boarding the system thus representing 'quality aspects of boarding a service such as negotiating steps, having to pay a driver'; and second, as an IVT factor in which the penalty associated with a transport mode is 'distance or time-based and relates to the quality of the IVT such as comfort and air conditioning'.

A list of eight references is given under the ATC (2006) table with a comment that the values were generally based on work undertaken in Auckland by BAH (2000b) which included a review of international evidence.[10]

ATC (2006) give values expressed in terms of IVT. Table 3.4 presents the valuations. The total mode specific factor is calculated for a 20-minute trip and includes the constant mode specific factor and the IVT factor. The values are relative to a standard bus, thus the mode specific constant for bus is zero and the IVT factor is 1. For a busway, a better quality of stop facilities gives a mode specific constant value worth a two-minute travel time saving and a better in-vehicle experience than an on-street bus which gives a benefit of two minutes for a 20-minute trip or a mode specific factor worth four minutes. With a value of time of $4 per hour, the MSF would be worth 27 cents (9% of a $3 fare).

Table 3.4 Mode specific constant and factors (ATC 2006)

Mode		MSC in mins	IVT Factor	Total MSF mins (1)	Comment
Bus	On-street	0	1	0	Reference Case
	Busway	-2	0.9	-4	Better quality of stop facilities and better in-vehicle experience than on-street bus
	Guided Busway	-2	0.85	-5	Same quality of stops as busway but slightly better ride quality to guiding of bus
Tram/LRT	Tram	-1	0.9	-3	Same in-vehicle experience as busway but poorer quality of stops
	LRT	-2	0.85	-5	Station quality and in-vehicle experience similar to busway
Heavy Rail	Old DMU/EMU	-1	0.9	-3	Older station facilities and older vehicles (in-vehicle quality similar to tram)
	Refurbished DMU/EMU	-2	0.8	-6	Improved station facilities and in-vehicle experience
	New DMU/EMU	-3	0.75	-8	Best quality station and in-vehicle experience
Ferry (2)		-20	0.7	-26	Generally have a better in-vehicle experience than other modes; however these should be used with extreme caution

included review of international evidence. 1: Total mode specific factors based on average in-vehicle time of 20 minutes (provided for information purposes only) 2. Ferry MSC values should be used with extreme caution as they are highly context specific and include modelling biases

Abbreviations: MSC = mode specific constant; IVT = in-vehicle time; MSF = mode specific factor; DMU = diesel multiple unit; EMU = electric multiple unit.

ATC (2006) comments that 'in general passengers perceive rail, LRT and Trans and ferries as 'better' modes of transport than on-street buses due to better station/stop facilities, improved ease of boarding/alighting and a better in-vehicle experience (smooth, less jerky ride, CCTV, on-board information systems etc)'.

For instance, a new train (either a diesel multiple unit or an electric multiple unit) is worth eight minutes compared with an on-street bus with three minutes due to improved station and boarding with five minutes due to a better 'in-vehicle experience'.

[10] The seven other references were a comparison of bus and rail patronage attraction by Ben Akiva and Morikawa (2002); modelling parameters for use in the Auckland Public Transport Model by BAH (2000b); an assessment of the demand performance of bus rapid transit by Currie (2005); a study of PT route choice by Delft University of Technology (1988); SP market research by PCIE (2000) of radial rail routes out of Brisbane; three UK studies of light rail by SDG (1991b and1992a).

The use of an IVT factor distinguishes the values from the fixed vehicle values presented in section 3.2 and from all but one of the 13 studies reviewed in chapter 5.

3.5 Comments

The values in the EEMV2 provide a starting point for the review. The values largely derived from surveys undertaken by SDG in London in the mid-1990s (SDG 1996).

A wide range of vehicle and infrastructure attributes for bus and rail is covered. There are differences in the list for rail and bus however. For infrastructure, the EEM does not include the values for rail. The list is not exhaustive; it does not cover the newness of the vehicle or station or the 'look'. The study is also becoming dated since it is based on material that is now a decade old. Some new sources of information have become available such as text messaging. The value of wifi is not covered.

Defining the levels of what are, by their nature, qualitative attributes is admittedly difficult. The ATC provides descriptions for each attribute and in terms of the maximum value, the description is either true or it is false. Thus in terms of litter, there is either litter in the station or there is not. Bus drivers are either 'very polite, helpful, well-presented' or they are 'businesslike and not very helpful'. Rail station staff are either 'knowledgeable' or not. However, reality will be 'shades of grey' rather than black and white which suggests a proportion of the value likely. Moreover, passenger perceptions of quality will vary: some may consider rail staff as knowledgeable and some may not; some may like a modern glass rail station whereas others may prefer an historic Victorian edifice.

The attributes are valued in terms of equivalent IVT minutes. Converting them to willingness-to-pay values requires a value of IVT. The higher the value of time, the higher the implied willingness to pay. The current New Zealand value for bus and rail travel is around $4 per hour in comparison with the recommended ATC (2006) value of $10. The willingness to pay is therefore 40% of what would be calculated using the ATC (2006) value of time.

Only average values are provided with no segmentation by trip length, time period, passenger type or trip type. Average values may be satisfactory for evaluation purposes but are less helpful in developing pricing strategies for which the distribution of valuations such as the percentage of passengers with a value above X dollars would be useful.

4 Summary review of the literature

4.1 Introduction

This section provides a summary comparison of 13 studies that have estimated values for qualitative attributes of urban public transport services. The studies cover two decades dating back to a 1991 survey of Wellington public transport services.

The emphasis is on comparing the survey methodologies, the attributes covered and the estimated values. More detailed descriptions of each study are provided in chapter 5.

Section 4.2 lists the 13 studies reviewed.

As section 4.3 shows, none of the studies reviewed had the explicit purpose of developing pricing strategies but instead were either related to forecasting demand or evaluating improvements.

Section 4.4 looks at the study methodologies used which shows that all but two were based on SPs rather than actual behaviour. Section 4.5 looks at the interview methods and sample sizes obtained.

Section 4.6 describes the two measures of valuation which were minutes of bus/rail IVT and the percentage fare. Section 4.7 looks at the issues involved in estimating package values. Sections 4.8 to 4.15 compare the valuations estimated by each study and also compare them with those in the EEMV2.

Table 4.1 gives the attributes covered and the report sections.

Table 4.1 Valuations covered and relevant report section

Section	Attribute
4.8	Vehicle package
4.9	Stop/station package
4.10	Vehicle design appearance, ambience and facilities
4.11	Stop design appearance, ambience and facilities
4.12	Information
4.13	Personal safety/security
4.14	Maintenance/cleanliness/graffiti removal
4.15	Staff availability/appearance/friendliness and performance

4.2 Studies reviewed

The 13 studies reviewed have estimated values for qualitative attributes for urban bus and rail services. It should be noted that some of the studies cited contain an element of review and so more studies are covered by the review than 13. The studies are listed in table 1.2.

The studies were identified either by reviews undertaken by Balcombe (2004), ATC (2006), Litman (2008) and Bristow and Davison (2009) or were known to the authors. Rather than rely on previous reviews, the aim has been to go back to the original study and for the most part, this has been possible. By going back to the original study, it has been possible to review the survey methodology as well as the results thus aiding the specification of the provisional market research stage.

4.3 Study purposes

None of the studies reviewed had the explicit purpose of developing pricing strategies; they were either related to forecasting demand such as providing input parameters into demand forecasting models or for the purpose of evaluating improvements. As a consequence, the studies were not oriented towards providing the results likely to be most useful for developing pricing strategies.

Table 4.2 Study purposes

#	Label	Purpose	Description
1	SDGWTN	DF	Deriving values for qualitative aspects of public transport service for inclusion in regional transport model
2	SYDRI95	Ev	Estimating values for qualitative factors of rail service for economic evaluations
3	SYDTW	DF	Market research to derive parameters for inclusion in demand model to estimate patronage for a proposed Transitway
4	HenBS	Ev	Deriving a service level quality index for bus contracting
5	UKRS	DF	Meta-analysis of Stated Preference and Revealed Preference studies valuing rail rolling stock quality
6	RQVIC	DF	Valuing qualitative aspects of service of a medium distance rail service in Victoria
7	SYDRI04	Ev	Estimating values for qualitative factors of rail service for economic evaluations
8	WTNRST	Ev	Provision of management information on passenger satisfaction with station quality and priorities for improvement.
9	SDGLND	Ev	Estimating values for qualitative factors of bus and rail service for economic evaluations
10	LDSBQ	DF	MSc Thesis exploring passenger valuation of bus quality improvements typical of bus rapid transit (BRT)
11	AECOMBS	DF	Identification and quantification of patronage changes attributable to 'soft' measures of bus service introduced in provincial cities in the UK.
12	USPT	DF	Investigation of the characteristics of premium bus and rail services and how mode choice can be affected.
13	NORPT	Ev	Estimation of the passenger benefits of universal design features for vehicles and facilities to enable accessibility for as many passengers as possible

DF Demand forecasting; Ev Evaluation -either economic, business case or management information

4.4 Description of study method

Table 4.3 provides a summary of the methodologies used.

Table 4.3 Study methodologies

#	Label	Method	Desc	Method
1	SDGWTN	PT SP	Photos & Rating	Stated Preference (SP) pairwise PT v PT trips choices using photographs of vehicles & rating questions to extrapolate valuations to set of vehicle/stop types. SP looked at bus/train/LRT vehicle types/age; stop/station quality, early/late services, information, seat availability, reliability, walk access. Passengers asked to choose preferred trip and then asked willingness to pay extra on base fare.
2	SYDRI95	Rail SP & PE Linked	Photos & Rating	3 q'aires: 1 in-depth likes/dislikes and 2 SP with PE ('bag of points'). Indepth showed photos of trains & stations and asked for ratings and likes/dislikes; SPs covered (1) train quality; station quality; personal security and fare and (2) reliability; on-train crowding; information; cleanliness and grafitti and fare. Passengers presented pairs of trips and asked which they preferred. A set of PEs with varying fare/time gave attribute importance.
3	SYDTW	Mode Choice SP & PE	Photos/ Pict-ograms	Transitway v bus, car or rail SP featuring travel time & cost. TWay-Bus constant was value of TW quality. PE allocated $100 to list (access, frequency, ride smoothness, reliability, modern bus stops with weather protection & seating, bus stop info, new modern buses & varying travel time). SP & PE results not linked.
4	HenBS	Bus v Bus v Bus SP	Word Desc	Complex SP survey requiring respondents to choose between three bus journeys differing in bus fare, travel time, reliability, walking time and nine other service quality attributes relating to the vehicle, bus stop, information, driver friendliness, bus cleanliness. Different lists of attributes covered on two surveys.
5	UKRS	SP & RP	-	Regression analysis of 18 SP and 8 Revealed Preference (RP) studies to estimate a meta-value for rail rolling stock refurbishment and a set of adjustement factors for SP studies
6	RQVIC	Rail SP & PE	Word Desc	SP and PE survey (not linked). The SP covered onboard time, departure time displacement, express service, seating availability, cleanliness and train cancellations. The PE included a halving of fare which was used to value the quality improvements.PE not linked to SP
7	SYDRI04	Rating model & PE (not used)	Pax Rating	Rating model - passenger ratings for 48 individual rail attributes used to explain overall rail journey rating with the size of parameter taken as a measure of the attribute's importance which was then expressed relative to in-vehicle time. Second survey asked passenger travel time reduction to get an excellent in-vehicle time rating which was then used to convert changes in attribute rating into invehicle time.
8	WTNRST	Rating & PE	Station Rating	Passenger ratings for Wellington rail station for two years which gave effect of redevelopment of Petone station. PE used to indicate importance of station improvements which were valued in rail minutes.
9	SDGLND	SP	Picto-grams	3 SPs: (1) Journey SP: pre-trip information, bus stop infrastructure, information at bus stops (incl. reliability), hailing & boarding, the driver, moving to seat, travelling & leaving bus. (2) Attribute Bundles v fare SP (3) Max WTP for ideal service (respondent's top 4 attributes) priced at 10,20, 30 & 40p more than 'as now' service.
10	LDSBQ	Bus SP & TP	Not known	Bus v Bus Quality SP quality (low floor access; off-vehicle fare collection; real time information onboard buses; segregated track; air conditioning; CCTV on board buses; a high level of sound proofing and an environmentally friendly vehicle.
11	AECOMBS	Bus v Bus & Bus v Car SP	Word Desc	RP analysis of patronage and ticket data for ten corridors where quality improvements have been undertaken. Four SPs: a route choice bus v bus SP; a demand effects SP (car v bus); an 'unpacking' SP which considered bus attributes in detail; and, an SP about different types of bus information. Generally, respondents completed questions for two types of SP.
12	USPT	PT v Car SP & MaxDif Linked	Picto-grams	Mode choice SP: PT (either Bus or Rail) v PT v car. PT varied in service level. PT quality was premium or standard for vehicles; modernized or standard for stop/station; and, informative or standard for information. A definition of the features was given. Unpacking SP exercise of most/least preferred attribute ('Maxdif')of vehicle, stop and information attributes. Results of MaxDif SP were scaled down to SP package values.
13	NORPT	Bus v Bus SP & TP	Picto-grams	4 Bus v Bus SP q'aires with pictograms covering fare, travel time, information; ease of boarding, shelter and cleanliness, shelter and snow/ice removal. 3 questions on the max fare WTP for improvements

RP Revealed Preference; SP Stated Preference; PE Priority Evaluator; TP Transfer Price

Ideally, actual patronage and revenue response, technically referred to as RP data, to significant quality improvements in public transport services should be able to provide the effects of quality packages. Few studies have attempted to do this, however, and of those that have, few have been successful. Moreover, although estimating patronage response is in itself important such studies will not provide estimates of willingness to pay for quality improvements unless fares are raised in some situations. Without fare rises, willingness to pay can only be inferred indirectly from the application of fare elasticities of demand.

Of the 13 studies reviewed only two used RP data. A 2009 AECOM study (11) looked at 10 case studies of quality bus improvements in the UK but found statistical difficulties in isolating the effects of quality from other general changes (notably the introduction of concessionary fares). The ability to include 'control' cases would facilitate analysis, but this proved difficult.

An earlier 2001 study of train refurbishment in the UK (5), used ticket sales data to compare with forecasts produced by SP market research studies. Their comparison found that basing the forecasts on SP studies would produce too high a patronage response. Indeed, some of the SP studies they reviewed produced implausibly high response and the authors suspected that respondents had seen through the purpose of the research and had inflated their responses for strategic reasons.

SP surveys present respondents with a series of journeys choices, usually a pair of journeys or sometimes three journeys. The journeys differ in terms of their travel times, costs and most importantly in terms of this study, the quality of service. In each choice situation, passengers indicate their preference. Analysis of response enables the sensitivity to the attributes to be determined and from these results, the relative value of attributes including the willingness to pay is determined. In this respect, the 1991 Wellington study was different in that willingness to pay was included to measure the strength of preference.

Most of the surveys presented 'within mode' choices, either bus versus bus, or rail versus rail. Some presented choices between car and public transport such as the AECOM (2007) UK bus study (11).

The two exceptions that did not use SP data were a study by Sydney rail study by Douglas Economics (7), which used passenger satisfaction ratings together with TP questions and a survey of rail stations in Wellington, which used a PE to assess rail customer priorities for improvement.

The Hensher surveys which were used to develop a bus service quality index for NSW (4a and b) were the most complex requiring passengers to choose between three bus journeys differing in bus fare, travel time, reliability, walking time and nine other service quality attributes relating to the vehicle, bus stop and information.

As an alternative to trying to get values for all attributes in one pass, three studies used a PE to look at a longer list of quality attributes. Two studies (3 and 6) did not link the results of the PE with the SP. The other study (2) combined the results of the PE with those of the SP survey.

An alternative approach to covering a long list of quality attributes was to use a suite of SP surveys. The AECOM study (11) used an 'unpacking SP' and the US study of premium transit quality (12) used a maxdif SP in which passengers were requested to rank the attributes into most preferred and least preferred. The detailed attribute results were then combined with the results of a higher-level quality SP in which varying quality standards were presented as packages.

Two studies, a survey of bus improvements in Leeds, England (10) and a study of universal design measures in Norway (13) also asked simpler contingent valuation or TP questions in addition to the SP surveys. The TP questions asked passengers' willingness to pay for a package of quality improvements directly. Generally, these simpler questions are avoided because they are considered to overestimate willingness to pay. However in the Norwegian study, the TP questions gave values only a quarter those of the SP survey.

The way the vehicle and infrastructure attributes were presented to passengers varied. Several studies used photographs or pictograms to describe the attributes. Others used a word description and two Australian rail studies (2 and 7) used passenger ratings to measure quality as perceived by the passenger.

4.5 Description of sample and interview method

A variety of interview methods have been used as summarised in table 4.4.

Table 4.4 Sample and interview method

#	Label	Method	Sample	Non Users Surveyed?	Sample
1	SDGWTN	Face to face	596	Yes - Car, Walk & Cyclists	Bus and rail passengers surveyed at stations/stops. Car, walkers and cyclists interviewed on street and at activity centres. Took 10-15 mins.
2	SYDRI95	Face to face	2,780	No- Rail Users Only	Rail passengers interviewed face to face on trains using three questionnaires
3	SYDTW	Face to face	>1,000	Yes- Car, Rail & Bus	Bus and rail passengers surveyed face to face at stations/stops. Car users interviewed at activity centres
4	HenBS	Self comp-letion	3,849 & 1,478	No - Bus Users Only	Two surveys 1999 & 2000. Questionnaire were handed out on buses.
5	UKRS	na	na	?	Study analysed previous surveys
6	RQVIC	Telephone	926	No- but infrequent	Computer aided telephone interview of 926 people out of 2,789 contacts (33%). Regular and infrequent rail users surveyed
7	SYDRI04	Self-completion	2,732	No - Rail Users only	Self completion questionnaires handed out and collected onbaord trains by fieldworkers
8	WTNRST	Self comp-letion	4,683	No - Rail Users only	Self completion questionnaire handed out on trains. 2,560 passengers were surveyed in 2002 and 2,123 in 2004/5
9	SDGLND	Face to face	947	No - Bus Users Only	1996 survey interviewed 947 people (presumed bus users) but 27% were removed because of 'inconsistent responses'. Sample size for 1999 and 2007 surveys not known
10	LDSBQ	Face to face	91	No - Bus Users Only	Bus passengers interviewed at bus stops
11	AECOMBS	Computer aided Face to face	2,895	Yes - Car & Bus users surveyed	Commuters only (mainly bus but 820 car users) who had use bus at least once interviewed at houses using a Computer Aided Personal Interviews (CAPI) but difficult to find bus users so the sample boosted by on street recruitment then interviewed at a local venue e.g. hotel.
12	USPT	Web internet q'aire	2,017	Yes - transit & non transit	Salt Lake City (case study) ≈ 2,000 responses: 1,445 respondents (70%) from an email database of riders/non riders; 272 intercepted on-street and 300 non transit users 'purchased'. Samples sizes for other cities not known.
13	NORPT	Web internet q'aire	406	No - bus/tram users only	Invitation cards distributed on buses with personal password and the internet address to the web-based survey and informed about a small lottery prize. The survey was self-completed once logged onto the website. The response rate was "strikingly low" at 5.5%. A total of 451 respondents logged on and 406 (90%) completed q'aire.

Early studies used face-to-face interviews. More recently, two studies (12 and 13) have posted the questionnaire on the internet and either recruited people 'on the street' or obtained lists of likely participants. The response rate for these two surveys was wildly different however.

The Sydney and Wellington rail surveys (7 and 8) asked passenger to rate their service on self-completion questionnaires handed out and collected onboard trains. In Sydney, some surveys were undertaken by interviewers and it was found in these cases that the passengers tended to give a higher rating.

Only one SP study, a bus SP by Hensher (4a and b) used a self-completion questionnaire handed out on buses.

Telephone surveys are difficult because of the difficulty for respondents to remember the choices; only one study of Dandenong rail (6) used this approach. As well as paper questionnaires, computers have been used to present the questionnaires and record responses.

Eight studies only surveyed existing users and four surveys also included non-users. The 1991 Wellington study (1) surveyed car, walkers and cyclists as well as bus and rail users. The AECOM study (11) was limited to commuting to work trips but included car commuters as well as bus users. The US study (12) of Salt Lake City used an additional database to supplement the sample of non-transit (predominately car) users.

4.6 Valuations and segmentation

A summary of the type of valuations and the extent to which the values were segmented is provided in table 4.5.

The reporting of results and presentation of relative valuations varied across the studies hampering comparative analysis. To enable comparison, two valuations were calculated for each study:

- the value in minutes of bus or train IVT
- the percentage fare valuation (%fare) or % willingness-to-pay valuation.

Wherever possible, the survey results were used to produce the values. If the study reported values in terms of fare, the value of time was used to convert the values into equivalent IVT minutes. For ease of understanding, values of time have been expressed in hourly figures. The UK studies often reported pence per minute.

$$V(IVTmins) = 100\frac{60}{VOT\$ / hr}.V(FAREcents) \quad \text{(Equation 4.1)}$$

$V(FARE)$ = value of attribute reported in terms of fare

$V(IVT)$ = value of attribute converted into IVT

To calculate the %Fare valuation, the average fare was used ie $\frac{V(Fare)}{AverageFare}$.

The advantage of expressing the values in IVT minutes is that exchange rate conversions and inflation updates are avoided. Also, the values compare with those in the EEMV2 and can be converted into New Zealand fare values using a value of time appropriate for New Zealand.

Presenting the values as percentage fare willingness-to-pay measures allow the effect of local differences in the average fares to be taken into account and allow the %Fare to be then applied to the New Zealand average fare.

Table 4.5 Segmentation of sample and results

#	Label	Value	Trip Length	Peak/ Off-Peak?	Segmentation
1	SDGWTN	Fare	Yes	Yes	WTP asked but only Av. reported. Variation assessed by trip length, time of travel & mode. IVT not included so VOT of $4/hr assumed. $2 fare used to calaculate %WTP.
2	SYDRI95	IVT	Yes	Yes	Value of time from another SP survey used to calaculate WTP. Values tabulated by trip length (Short, Med, Long) and pk/off-pk. Short trips tended to have lower quality valuations than mediu, & long trips with off-peak trips having higher valuations than peak trips.
3	SYDTW	Fare&IVT	Yes	No	Av time value in bus minutes tabulated by mode. Only passengers travelling in AM peak interviewed. Shorter (trips internal to study area) trips & longer (external) trips modelled.
4	HenBS	Utility	No	No	Results by bus operator but not trip length or time period. Models reported in utility but IVT & % fare values could be calaculated.
5	UKRS	%Fare & %Time	No	No	%Fare and %IVT reported Converted to IVT for a trip of 30 minutes
6	RQDnd	Fare & IVT	No	Yes	Peak, off-peak & weekend models for SP. SP included fare & IVT as attributes. Estimated VOT was very high for weekday travel >$30/hr which was used to convert PE WTP values into time.
7	SYDRI04	IVT	Yes	Yes	Av ratings estimated but WTP was estimated by trip length & time period. Values converted into fare using exteranl VOT. IVT and % fare valuations increased with with trip length with off-peak values higher than peak.
8	WTNRST	IVT	No	No	Results tabulated by station. WTP values calculated using a value of time of $4/hr and average fare.
9	SDGLND	Fare & IVT(96)	No	No	Av WTP (pence) reported. 1996 gave value of time (considered low) to calculate time values & Manual gives av. fare. 2007 survey did not give a VOT. TfL Business Manual VOT used which was much higher than 1996 value.
10	LDSBQ	Fare & IVT	No	No	Little variation in trip length. Survey included fare & IVT. VOT considered low. Qualitative analysis of income/gender difs.
11	AECOMBS	Fare & IVT	No	No	Av commuting to work IVT values derived from results. Converted to %fare using VOT of 4p/min (considered low) and av. fare. Some segmentation by travel mode undertaken.
12	USPT	Fare & IVT	Bus - No Rail- Yes	Yes ≈ by Work/Non Work	Overall mode choice models presented for work & non work trips. Fare& IVT included as attributes. Some variables introduced to account for income, gender, rural/urban origin on choice of PT or car. Quality valuation increased with rail trip length but not for bus.
13	NORPT	Fare & IVT	No	No	IVT & fare included as attributes. WTP reported converted to IVT using VOT (considered very low). Only av. valuations reported.

In fact, none of the 13 studies reported both measures based on data collected by the surveys although six studies did include both fare and IVT as attributes in the SP surveys. For example, the Hensher SP Sydney surveys (4a and b) included fare and IVT but only reported results in 'utils'[11]. For studies where both fare and IVT were reported, the attribute values were calculated using the estimated value of time. In several cases, however, concerns were made about the size of the value of time; it was either too high, eg in the Dandenong study (6) or too low as in the Norwegian study (13).

Where only fare or IVT values were provided, an 'external' value of time was used. This was the case in the 2004 Sydney rail rating based study (7) which used a value of time estimated by a contemporary SP survey, Douglas Economics (2004a). For other studies, a value of time referenced in the report was used,

[11] A measure of the choice sensitivity of respondents to the differences in travel time, cost and other attributes specified in a logistic model.

eg 2007 London bus valuations (9) or was taken from a known source, eg the Wellington rail station survey (8) for which the EEMV1 value of time was used.

All the studies presented average valuations. Six studies segmented the results by either trip length or time period (or both) but seven studies provided only average valuations. Some studies explored the effect of user and trip profile on the valuations but none reported valuations by market segment.

The strongest evidence for willingness to pay to increase with trip length was provided by the 2004 Sydney rail rating study (7) which surveyed a wide range in trip lengths from short trips under 15 minutes to two-hour trips. For bus, there was no strong evidence reported for valuations to increase with trip length.

None of the studies provided a willingness-to-pay profile that gives the percentage of respondents willing to pay more than a certain amount for the provision of an attribute or an improvement in service. This lack of detail reflects the orientation of the studies which, as section 4.2 outlines, was either for demand forecasting or evaluation purposes and was not to develop pricing strategies. Considered the closest in specification to producing a willingness-to-pay profile is the 1991 Wellington study (1) that directly asked passengers willingness to pay a higher fare for their preferred choice. Unfortunately only the average willingness to pay was reported.

Four studies surveyed non-users as well as users (1, 3, 11 and 12) with the results suggesting that car users tend to have higher values of quality than bus and rail users.

4.7 Package/survey technique effects

Two issues are whether (i) the value of the sum of the parts is likely to be smaller or greater than the whole when determining values for attribute packages – the so called 'package effect' and (ii) whether the survey methodology affects the result:

Bristow (2009) describes the package effect as 'where the sum of the stated preference based values of individual attributes that compose a package is typically found to exceed the valuation of the overall package. The source of the problem is rarely identified in empirical research. Are there genuine effects arising from, for example, interaction or budget effects, or is the package effect a function of using stated preference, such as might arise from halo effects or response bias? It must also be remembered that a different form of package effect might exist here, whereby introducing specific improvements makes little difference to bus demand but when several are introduced together, as with a Quality Bus Partnership scheme, the demand impacts are disproportionately large'.

As regards survey technique and even after correcting for package effects, SP-based valuations can be unbelievably high. Reviews by Bristow and Davison (2009) and Faber Maunsell (2003) have attributed overestimation to strategic response bias from providing respondents with a 'vuvuzela' to overblow their valuations in order to influence policy makers, Wardman and Bristow (2007).

This review has found that package effects and survey technique issues are linked. Table 4.6 summarises the findings.

Table 4.6 Package and survey technique effects

#	Label	Package Effect	Comment
1	SDGWTN	-	Vehicle & stop 'packages' presented using photos with values explained by asking respondents their likes/dislikes about each photo.
2	SYDRI95	-	Example train (exterior, vestibule, interior) and station (entrance, accessways, platform) depicting low, medium and high quality presented (exterior, vestibule, eating) to estimate package values. Series of Priority Evaluators were used with varying times/fares. When analysed the PE values tended to be higher; reliability was twice the SP value.
3	SYDTW	-	SP and PE were undertaken but not linked. PE package value was much higher than SP estimate ranging from 3 times higher for rail to 44 times higher for bus.
4	HenBS	-	Single SP used to estimate all parameters. Package effect not addressed
5	UKRS	0.5	A package effect of 0.5 was estimated whereby the sum of the individual effects associated with ride quality, seating layout, seating comfort, noise, ventilation and ambience as estimated by SP studies needed to be halved to get the value of the overall package.
6	RQDnd	-	Separate SP and PE which were not linked.
7	SYDRI04	1.17	Three linked ratings (overall, train & station) modelled mathematically with functional form producing an effect whereby improvingthe overall train/station rating by 10% had a 17% greater effect than improving all the individual train/station attributes by 10%. Strong trip length & pk/off-pk effects.
8	WTNRST	-	Only PE used
9	SDGLND	0.25?	The 1996 survey an ideal service package was modelled of respondent's top 4 attributes. This was valued at 26 pence which was considered to be a value 'cap'. Summing the reported bus and station attribute values gives a total value of £1, thus the ideal package was around a quarter the size of the attribute package.
10	LDSBQ	-	Package value estimated with no commentary available on the individual attributes
11	AECOMBS	1.1	An analysis was undertaken of ten areas and compared the sum of attribute valuations with a package SP estimate. The SP package estimate was found to be 10% higher than the sum of parts estimate over the ten areas
12	USPT	0.1	The Study used two types of SP questionnaire: Package SP and MaxDif which looked at individual attributes (most preferred/least preferred). The MaxDif resulted in much higher attributes typically around 10 times higher than the package values.
13	NORPT	0.25	SP package values (sum of attribute values) were compared with Transfer Price questions. The TP questions gave much lower values of around one quarter the SP

The large number of quality attributes has led to the development of sets of attributes and the design of two or more survey instruments to cover the full list. Some studies have developed a suite of SP experiments and others have used PEs to prioritise sets of individual attributes.

To link the results, either common attributes are included in both survey instruments or packages are presented in 'higher order' SP surveys such as the US study (12) and the Sydney rating survey (7) then results suitably scaled.

Not all studies have linked the results from different surveys. The Sydney transitway (3) and the Dandenong rail study (6) are examples where results of PE surveys were not linked to SP surveys.

The alternative approach is to include all the attributes in a single SP (or PE) survey. An example is Hensher (4a and b) who designed a survey that required respondents to choose between three bus journeys differing in bus fare, travel time, reliability, walking time and nine service quality attributes relating to the vehicle, bus stop and information.

The review found mixed results regarding the issue of whether the package effect is different from the sum of the individual parts. The most extreme package effect was the US study of premium transit. The study used two types of SP: a mode choice SP featuring two public transport modes (eg bus and rail) and car. The modes were described in terms of travel time and costs and an overall descriptor for vehicle (premium or standard) and also stop quality (modernised or standard). The second type of SP, called maxdif, looked at individual vehicle and stop attributes for public transport together with travel time and cost attributes. In each choice, respondents were asked to indicate their most preferred and least preferred attribute. The maxdif produced a much higher package value when the attributes were summed that was around 10 times higher than the package value estimated by the mode choice SP.

The Norwegian study of bus/tram stop facilities (13) asked TP questions of the package of improvements which gave a value that was only a quarter of the sum of the SP package value.

The SDG (1996) London bus SP survey, which was used to develop values for the TfL *Business case development manual,* estimated a value for passengers' ideal package of 26 pence which was regarded as a willingness-to-pay cap. However, the sum of the SP attribute values totalled around £1.

Wardman and Whelan (5) estimated a package effect of 0.5 in their analysis of SP/RP studies of UK rolling stock refurbishment whereby the sum of the individual effects associated with ride quality, seating layout, seating comfort, noise, ventilation and ambience as estimated by SP studies needed to be halved to get the value of the overall package.

Two studies estimated a contrary package effect whereby the value of the sum of the individual attributes was less than the package effect. The 2004 Sydney rail study (7) estimated a package effect of 1.17 for trains and also stations by comparing the forecast value of improving the overall rating with the individual attribute ratings.

AECOM (11) studied 10 corridors in provincial UK cities. AECOM compared the sum of attribute valuations with the package SP estimate and found the package effect to be 10% higher than the sum of parts estimate.

4.8 Vehicle package values

Table 4.7 presents the package value of vehicle attributes by study. Two measures are presented to value the package of quality attributes: the equivalent saving in onboard bus/train time and the percentage fare increase.

At the bottom of the table are EEM/ATC package values for comparative purposes. It should be noted that the ATC table from which the EEM values have been taken includes the footnote 'experience from other SP surveys indicates that the perceived benefits of multiple features are less than the sum of individual components. When multiple features are combined, the values should be divided by two to adjust for any overestimation'. However, the values in table 4.7 have not been factored down to calculate the package values.

As can be seen, there is a wide range in values. What can also be seen is that measuring in terms of onboard time or percentage fare has a major bearing on the relative valuation.

In part, this is due to differences in the make-up of the packages which make 'like-for-like' comparison very difficult. Particularly important are whether 'ongoing' aspects of service quality such as cleanliness, graffiti removal, staff friendliness, driver performance, announcements are included. For the SDG WTN study (1) NSW transitway study (3) and UK rail refurbishment (5) only design factors are included.

Table 4.7 Vehicle package values

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	Old to New Bus	3.1	11%
		Standard to New Bus	1.4	5%
		Standard Bus to Trolley Bus	1	1%
		Old to New Train	3.4	8%
		Standard to New Train	1.2	4%
		Standard Bus to Standard Train	1.1	4%
2	SYDRI95	10% Rating Point Improvement in Overall Train Rating	1.9	8%
		Improvement from Av to Best Train in Fleet Rating	4	16%
3	SYDTW	Std Bus to TWay Bus (incl stop) - SP Bus Users	0.4	5%
		Std Bus to TWay Bus (incl stop) - SP Rail Users	6	51%
		Std Bus to TWay Bus (incl stop) - SP Car Users	5	63%
		New Modern Bus v Standard Bus - PE Bus Users	5	22%
		New Modern Bus v Standard Bus - PE Car Users	6	43%
		New Modern Bus v Standard Bus - PE Rail Users	3	15%
4	HenBS	1999 Survey - Wide Entry, V.Clean & V.Smooth, V.Friendly Driver	32	90%
		2000SP- Wide Entry, V.Clean, V.Smooth,V.Friendly Driver	19	65%
5	UKRS	Train renewal (30 minute trip)	1.3	1.5%
6	RQDnd	Train package (air con, clean seats, no graffiti safe) PE	4.6	77%
7	SYDRI04	10% Improvement in Overall Train Rating with	2.2	12%
		" " " strong trip length & pk/off-pk effects	0.7S-5.3L	5%S-16%L
		Improvement from Worst to Best Train in Fleet Rating	2.7	15%
		Improvement from Average to Best Train in Fleet Rating	1.3	8%
8	WTNRST	Vehicles not covered	na	na
9	SDGLND	Worst to Best Bus 2007 Survey	2.4	73%
		Worst to Best Train 2007 Survey	3.6	50%
10	LDSBQ	Quality Bus Package v Std Bus (incl. stop attributes) - SP	4.3	9%
		Quality Bus Package of Quality v Std Bus (incl. stop attributes) - TP	7.4	15%
11	AECOMBS	On-bus Quality Package	14.8	27%
12	USPT	Value of Premium Service Package (4 cities)	3.1-5.8	nc
		Salt Lake City - Work Commuters - Bus	4.3	nc
		Salt Lake City - Non Work Commuters - Bus	5.5	nc
		Salt Lake City - Work Commuters - Rail (Constant + per min)*	4.3+.13/m	nc
13	NORPT	not covered	na	na
14	EEM2	Summation of bus (vehicle) attributes ^	5.4	12%
		Summation of train (vehicle) attributes ^	11.4	25%

^sum of attribute values (no downwards adjustment for multiple attributes); * only work model presented
nc: no data on average fares and non commuting value of time to calculate % Fare valuations

The method of estimation is also considered to have a large influence on the package valuation with the SP and rating valuations tending to be lower than the PE[12] and TP estimates.

A third factor influencing the value was how the package value was calculated. That is, whether it was (i) a package that was actually presented to respondents enabling a direct estimate to be reported or (ii) whether it has been subsequently calculated by adding the estimated values for individual attributes. If (ii), the package value may have then been adjusted or constrained.

[12] The PE valuations were noticeably larger than their SP counterparts but this difference is not shown up in the table. The relatively low IVT value for the Dandenong rail study (6) results from the very high value of time used to convert the fare values. The low values for the Sydney transitway study (3) result from limiting the package to new modern buses.

A fourth factor is the 'base' quality from which the improvement is measured.

Last, as should be expected, some of the variation was due to study context: differences in attribute quality (both base and 'improvement'); differences in fare and travel time which the qualitative attributes were measured against; and differences in respondent and trip profile.

The highest package values were estimated by Hensher (4a) from a 1999 survey of bus users. The vehicle package offering wide entry doors, very clean and very smooth buses and very friendly drivers was valued equal to 32 minutes of travel time or 90% of fare.

Next highest was the AECOM study (11) which estimated a value of 14.8 minutes (27% of fare) for a bus quality package including new low floor buses, with climate control (air conditioning), trained drivers, on-screen displays, audio announcements, CCTV, leather seats, customer charter and in-vehicle seating plan.

The US study of premium bus services (12) estimated lower package values of between 3.1 and 5.8 minutes. However the package covered fewer attributes: wifi, onboard seating availability, seating comfort, temperature control and vehicle cleanliness. For rail, the package value was estimated to increase with trip length (0.13 minutes per minute of onboard train time).

The values for London included in the 2004 version of the TfL *Business case development manual* (9) were lower when expressed in terms of travel time at 2.4 minutes for bus and 3.6 minutes for rail but higher in terms of fare (73% and 50%). It should be noted that the values were estimated in terms of fare and have been converted as part of this review into minutes by applying an externally derived value of time.

The EEM package values are reasonably exhaustive in attributes included but have not been halved as recommended in the ATC (2006) manual. The estimated bus value of 5.4 minutes is similar to the US PT study (12) but is only half the AECOM value. The rail value is higher than the other estimates when measured in train minutes (11.4) but lower when measured in percentage fare (25%).

4.9 Bus stop and train station package values

A summary of the estimated value of bus stop and rail station values is presented in table 4.8. An issue that has not been well addressed is whether the bus stop and rail station values apply to only the board stop or to the board and alight stops (ie the values are an average for the two stops).

For bus, most of the value of attached to improved stop quality is likely to be in terms of board stop simply because that is where passengers spend most time (waiting for a bus). Virtually no time will be spent at the alight stop. However, city centre bus station termini may add value in provision of facilities. Also, the return trip reverses the board and alight stations.

Table 4.8 Bus stop and station package values

#	Label	Package Description	Mins	Fare %
1	SDGWTN	Shelter & Seats versus unprotected bus stop	6	3%
		New v Standard rail station - Rail Commuters	22	11%
		New v Std Rail station - Bus, Car & Non Rail Commuters	8	4%
2	SYDRI95	10% Rating Point Improvement in Station Rating^	1.1	4%
3	SYDTW	Modern Bus Stop Weather Protected & Seats PE Bus Users	6	na
		as above Car Users	17	na
		as above Rail Users	6	na
4	HenBS	1999 Survey - Shelter with Seats, Timetable & Map	2.8	10%
5	UKRS	not covered	na	na
6	RQDnd	Station package PE	5.4	91%
7	SYDRI04	10% Rating Point Improvement in Overall Station Rating*	1.3	7%
		" " " increase with trip length+	0.4S-2.4L	3.4%S-9.3L%
		Value of Improving from worst (39%) to best station (75%)	4.5	25%
8	WTNRST	Value of Petone Station Redevelopment (PE)	44	115%
9	SDGLND	Worst to Best Bus Stop 2007 Survey	1.9	58%
		Worst to Best Train 2007 Survey	3.6	50%
10	LDSBQ	not reported (stop quality included in vehicle value)	na	na
11	AECOMBS	Bus Stop Quality Package	7	13%
12	USPT	Value of Premium Service Stop/Station Package (Av. 4 cities)	4.4	na
13	NORPT	Bus Shelter with sitting place versus no shelter/seats	13.8	na
14	EEM2	Full package of bus stop improvements	4	9%
		Bus station	3	8%
		Rail Station	7	15%

^ value for single station (survey values were divided by 2.1 stations); * rating of station passenger boarded:
+ figures given for short S and long L for peak trips. PE Priority Evaluator

For rail stations, amenities and ambience offered at the alight station are more important, such as ease of getting off the train, alighting the platform, attractiveness/lighting of the accessways and concourse and the ease of exiting the ticket barriers. There are also interchange stations to consider where passengers alight, move around the station and wait for trains.

Only the 1995 Sydney rail study (2) made reference to the number of stations in developing values. The station values were factored down to represent station values according to the number of stations used on an average trip (2.1) whereas the 2004 rating study asked passengers only about their board station. The 2004 study (7) referred to board station on the questionnaire and the Wellington survey (8) referred to a nominated station.

Like the vehicle package values, the attributes included varied which makes comparisons of the estimated values difficult. Some included information such as the Hensher value (4a and b). The US study (12) includes personal security whereas others are more limited to weather protection, seat provision, lighting etc.

The highest package value was 44 minutes estimated using the PE for the redevelopment of a station in Wellington (8). The high value is considered to result from questionnaire design focusing passenger attention on station improvements.

Next highest was the Norwegian study (13), which estimated value of 13.8 minutes for bus stops with weather protection and seating versus neither. This study, by focusing attention on bus stop facilities, probably overestimated passenger valuations.

The London 2007 survey estimated low values when expressed in IVT of 1.9 minutes for improving bus stops from worst to best and 3.6 minutes for rail stations. Higher values were produced when the values were expressed in terms of fare of 58% and 50% respectively. A similar finding was produced for the Dandenong PE (5.4 minutes but 91% of fare).

The EEM values of four minutes for a full package of bus stop improvements and seven minutes for a rail station are towards the lower end of the estimates.

4.10 Vehicle design, appearance, ambience and facilities

A summary of the values estimated by the 13 studies is provided in table 4.9.

Table 4.9 Vehicle design, appearance, ambience and facilities

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	only vehicle packages estimated	na	na
2	SYDRI95	Modern Exterior	0.4	1%
		Air Conditioning	1.5	6%
		Quiet & Smooth Ride	1.2	4%
		Comfortable Seats	1.5	6%
		Seats facing Travel Direction	0.7	3%
		Onboard & Clean Toilets	0.6	2%
3	SYDTW	Smooth ride (PE) Av value	4	23%
4	HenBS 1999	Wide Entry 2 steps v narrow 4 steps	3	10%
		Air Conditioning - No Cost	2.2	8%
		Gen. Smooth v Jerky sudden braking	6.4	22%
		Very Smooth v Jerky sudden braking	11	38%
	2000	Wide entry no steps v narrow 4 steps	13	36%
		Wide entry no steps v wide 2 steps	17	47%
5	UKRS	Only package value reported	na	na
6	RQDnd	All trains air conditioned (PE)	1.3	23%
7	SYDRI04	10% Rate Pt - train o/s appearance	0.15	0.8%
		" " ease of train boarding	0.22	1.1%
		" " seat comfort	0.07	0.4%
		" " smoothness of ride	0.1	0.5%
		" " quietness	0.22	1.1%
		" " heating & air conditioning	0.15	0.8%
		" " lighting	0.13	0.7%
		" " layout & design	0.38	1.9%
8	WTNRST	na	na	na
9	SDGLND	Bus branding	2.3	8%
	1996 Bus	Low floor bus v high steps	2	6%
		Seats face forward vs some sideways	2.5	8%
		Smooth v rough vehicle motion	8.8	28%
		Roomy seats v cramped	2.5	8%
		Standard seats v bucket	0.9	3%
		Opening windows v ventilation grill	2.1	7%
		Two sets of doors for egress	3.5	11%
	2007 Bus	Aircon v opening windows some pax	0.2	7%
		Opening windows all pax v some pax	0.2	6%
		Large wheelchair space v some space	0.1	3%
		Smooth ride v jerky	0.3	8%
		No noise or vibration whole journey	0.2	6%
		" " at stops only	0	1%
	2007 Rail	Bright Lighting on train v diimly lit	0.3	5.0%
		Bumpy ride v extremely bumpy	0.4	5%
		Very smooth v extremely bumpy	0.5	7.0%
10	LDSBQ	na	na	na
11	AECOM	New bus with low floor	1.8	3.0%
		Climate control	1.2	2.0%
		Leather seats	1.1	2.0%
		in-vehicle seating plan	2.2	4.0%
		WIFI	0.8	nc
12	USPT	On-board seating comfort	0.5	nc
		On-board temperature	1	nc
13	NORPT	Low floor vehicle	4.5	5%
14	EEM/ATC	No steps	0.1	0%
	Bus	2 stream board & no show pass v single	0.1	0%
		digital clock	0.1	0%
		individual seats v bench seats	0.1	0%
		tip seats in wheelchair area v all	0.1	0%
		small luggage space v restricted leg	0.2	0%
		push open windows v slide windows	0.1	0%
		air conditioning	1	2%
	Rail	quiet and smooth ride	1.2	3%
		onboard toilets	0.6	1%
		comfortable seats	1.5	3%
		seat facing direction of travel	0.7	2%
		air conditioning	1.5	3%

4.11 Bus and train stop/station design, appearance, ambience and facilities

Wherever possible the values exclude information, security (eg CCTV) cleanliness/maintenance, staff and ticketing where not specific to stations.

Table 4.10 Bus and train stop/station design, appearance, ambience and facilities

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	only packages estimated	na	na
2	SYDRI95	Automatic Ticket Machines	0.3	1.0%
		Modern Appearance	0.2	0.6%
		Improved Lighting	0.4	1.7%
		Clean Available Toilets	0.4	1.6%
		Telephones	0.3	1.2%
		Kiosk/Newsagent/Café	0.2	0.6%
		Escalator & Lifts	0.2	0.9%
		Platform Shelter & Shade	0.4	1.4%
		Platform Seating	0.4	1.6%
3	SYDTW	Package estimated	na	na
4	HenBS	1999: Bus Shelter & seats v neither	2.8	10%
		2000: Bus Shelter & seats v neither	10.4	29%
5	UKRS	na	na	na
6	RQDnd	Package estimated	na	na
7	SYDRI04	10% Rate Pt ease of train on/off	0.08	0.4%
		" Platform weather protection	<.01	0.0%
		" Platform Seating	0.04	0.2%
		" Platform Surface	0.07	0.3%
		" Subway/overbridge	0.01	0.1%
		" Station Building	0.1	0.5%
		" Lifts/Escalator	0.03	0.1%
		" Signing	0.05	0.2%
		" Lighting	0.03	0.2%
		" Toilet availability/cleanliness	.0o1	0.1%
		" Car Park	0.01	0.1%
		" Car Park drop off	0.01	0.1%
		" Taxi	0.01	<.1%
		" Bus Transfer & Waiting	0.02	0.1%
		" Bike facilities	0.02	0.1%
		" Telephone	0.01	<.1%
		" Retail	0.05	0.1%
		" Ticketing	0.16	0.8%
14	EEM/ATC	Double size bus shelter v single	0.1	0.2%
	Bus	Glass weather protected v no	0.2	0.4%
	Rail	Waiting Room	0.2	0.4%
		Platform Seating	0.3	0.7%
		Toilets	0.4	0.9%
		Weather Protection	0.3	0.7%
		Telephones	0.2	0.4%
		Platform Lighting	0.3	0.7%
		Café	0.3	0.7%

#	Label	Package Description	IVT mins	% Fare
8	WTNRS	Station Signage	1.8	4%
		Platform Board/Alight	1.5	3%
		Plat Weather Protection	9.4	22%
		Plat Seating	4.8	11%
		Platform Surface	1.5	3%
		Subway/OverBridge Design	1.8	4%
		Main Stat Building Design	1.8	4%
		Station Lighting	3.5	8%
		Car Parking Facilities	1.8	4%
		Car Drop Off Area and Waiting Facilities	0.6	1%
		Taxi Waiting Area and Facilities	0.3	1%
		Bus Transfer Area and Waiting Facilities	0.6	1%
		Bike Rack Facilities	0.6	1%
		Station Telephones	2.0	5%
		Station Retail Catering & Vending	0.9	2%
		Ticket Purchase at Station	1.2	3%
9	SDGLND	Shelter with roof & end panel	4.7	15%
	1996 Bus	Basic shelter with roof	3.8	12%
		Moulded seats at bus stop	2.8	9%
		Lighting at bus stop	3.1	8%
		Flip seats at bus stop	1.8	6%
		Bench seats at bus stop	0.8	2%
		Payphones at bus stop	3.2	10%
		Bus stops close to kerb	4.8	16%
	2007 Bus	Brightly lit v no lighting	0.3	9%
	2007 Rail	Good Weather Protected Platform	0.2	3%
		Step free station v no step free	0.3	5%
10	LDSBQ	na	na	na
11	AECOMBS	New bus shelters	1.1	2%
		New interchange facilities	1.3	2%
12	USPT	Station/stop shelter	1.1	nc
		Proximity to services (café, dry clean)	1.2	nc
		station/stop benches	0.5	nc
13	NORPT	Shelter no seats	8.4	9%
		Shelter with seats	13.8	15%

4.12 Information

The EEM values for information are comparatively low. The highest value for RTI at 0.8 minutes, 1.8% is roughly half the AECOM value (11) of 1.7 minutes and although similar to the 0.7 minute TfL (9) value for platform information on next train, was four times lower in percentage fare terms.

The Norwegian study (13) estimated the highest value of 10.9 minutes for RTI. The 1999 Hensher survey (4a) estimated a value of 9.3 minutes for timetable information versus no information.

Over recent years, mobile phone availability and the provision of information to personal computers has changed the way many people obtain timetable and fare information on bus and rail services. These developments are reflected in the information attributes included in the 2009 AECOM (11) and 2007 London buses surveys (9) but largely post-date the ATC/EEM values.

Table 4.11 Information values

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	Leaflets only to At Stop Information	1.1	4%
		Telephone Enquiry System & RTI at Stop	1.1	4%
2	SYDRI95	Airline Style Information	0.6	2%
	On-train	Frequent & Audible Train Announcements	1.1	4%
	At-Stat	Train Indicator Board	0.4	1%
		Frequent & Audible Announcements	0.4	2%
		Manned Ticket & Information Booths	0.4	2%
3	SYDTW	Full info at stops - Bus Users	4	19%
	(PE)	Full info at Stops - Rail Users	5	32%
		Full info - Car Users	13	86%
4	HenBS	1999 SP: No Info to Timetable	9.3	32%
		1999 SP:No Info to Timetable & Map	6.1	21%
		2002 SP: No Info to Timetable & Map	7	20%
5	UKRS	na	na	na
6	RQDnd	Advance info at station about cancellations	0.7	11%
	(PE)	Advance info by SMS about cancellations	0.3	4%
7	SYDRI04	10% Rating Imp in on-train announcements	0.2	0.8%
		10% Rating Imp in station announcements	0.1	0.3%
		10% Rating Imp in station information	0.03	0.1%
8	WTNRST	Timetable info	1.2	3%
	(PE)	Platform RTI	6	16%
9	SDGLND	Standard timetables at home	4.6	15%
	1997	Standard maps at home	3.3	11%
		Five star phone service	2.3	8%
		Customized local inf, at home	1.7	5%
		Guaranteed customized info at stop	8.3	27%
		Countdown	7.6	24%
		Guaranteed current info at stop	7.3	24%
	SDGLND	Countdown	5.2	12%
	2007 Bus	Countdown + audio info	5.3	12%
		Mobile Phone SMS (std rate applies)	0.8	2%
		as above but with delay info	1.1	3%
	SDGLND	Ticket Hall: Hand-written notices	0.6	9%
	2007Rail	Ticket Hall: Electronic displays	0.8	10%
		Platform info on next train	0.7	9%
		On train electronic display	0.5	7%
10	LDSBQ	not provided	nk	nk
10	LDSBQ	not provided	nk	nk
11	AECOMBS	On bus on-screen information	1.3	2%
		Audio announcements	1.2	2%
		Real Time Public Information at stops	1.7	3%
	Info SP	Info SP: Real Time Information	1.7	3%
	" "	RTI in City Centre	1.7	3%
	" "	RTI at Bus Station	2.1	4%
	" "	SMS RTI-Free	1.3	2%
	" "	SMS RTI at 10p/message	0.6	1%
	" "	Audio announcements on Bus	0.4	1%
	" "	SMS-Timetable - free	0.2	0.5%
	" "	Web Based Information	0.6	1%
12	USPT	RTI - Work Trips	4.7	nc
		RTI - Non Work Trips	5.5	nc
		Wait time with RTI (rail work trips)	0.4	nc
13	NORPT	Local map	1.2	1%
	At stop	Changes in departure via speaker	1.8	2%
		RTI on screen	10.9	12%
		All three above	12.5	13%
	Onboard	Next stop via speaker	9.8	10%
		Next stop via screen	9.9	11%
		Next stop via speaker & screen	11.4	12%
14	EEM/ATC	External route information on bus	0.2	0.4%
	On Bus	Internal easy to read info	0.2	0.4%
	" "	Info on next stop	0.2	0.4%
	On Train	Frequent & audible announcements	1.1	2.4%
	Bus stop	Screen with RTI for all buses	0.1	0.2%
	" "	Small map	0.2	0.4%
	" "	Countdown signs/RTI incl disruptions	0.8	1.8%
	" "	Digital clock at stop	0.1	0.2%
	" "	Free phone Contact number	0.1	0.2%
	" "	Simple timetable	0.4	0.9%
	Rail Stat	Helpful Staff	0.5	1.1%
	" "	Knowledgeable Staff	0.5	1.1%
	" "	PA System	0.4	0.9%
	" "	Signage	0.3	0.7%
	" "	Clocks	0.2	0.4%
	" "	Information	0.3	0.7%

4.13 Personal security/safety

Personal security and safety are used interchangeably but can have different connotations. Personal security is usually considered in relation to anti-social behaviour whereas personal safety can be considered in terms of avoiding accidents or emergencies.

Table 4.12 Personal security/safety

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	na	na	na
2	SYDRI95	On-train CCTVs	2	8%
	On-train	Platform CCTVs	0.7	3%
3	SYDTW	na	na	na
4	HenBS	1999: Reasonably Safe v Reasonably Unsafe	4.8	16%
		1999: Very Safe v Reasonably Unsafe	5.8	20%
5	UKRS	na	na	na
6	RQDnd	Secure Station Car Parking	0.6	10%
	(PE)	Feel safe at all times on train	1.5	26%
		Feel safe at all times on station	1.1	19%
7	SYDRI04	10% Rating Improvement in train & station	0.68	3.5%
8	WTNRST	Emergency Help Points at Stations	1.8	4%
	(PE)	Security Cameras at Station	4.5	11%
9	SDGLND	CCTV recording at all stops	0.4	13%
	2007 Bus	CCTV recording at some stops	0.4	12%
		On Bus CCTV	0.1	5%
	SDGLND	Staff in station & easy to see	0.9	12%
	2007Rail	CCTV & monitored all time	0.8	8%
		Trnsprt Police avail locally 5-15min resp	0.3	5%
		Trnsprt Police avail immediately <15min resp	0.4	6%
		Help Points - fire alarm	0.5	7%
		Help Points-fire alarm/emergency button&talk	0.4	6%
		ON board train CCTV	0.8	11%
10	LDSBQ	na	nk	nk
11	AECOMBS	CCTV at bus stops	2.9	5%
		CCTV on buses	2.5	5%
12	USPT	Station/Stop lighting/safety (Av work/NonWork)	0.8	nc
		Station/Stop Security (Av Work/Non Work)	0.9	nc
13	NORPT	na	na	na
14	EEM/ATC	CCTV on buses	0.7	1.6%
		CCTV on trains	2	4.4%
		Bus Stop Security Point	0.3	0.7%
		Bus Stop CCTV	0.3	0.7%
		CCTV at stations	0.6	1.3%

Vehicle and infrastructure attributes related to personal security include CCTV and help points. The SDG London 2007 study also included staff and the availability of transport police. Lighting has also been included. Excluding the PE valuations, the studies were reasonably consistent in valuation.

The highest values for CCTV cameras were estimated by AECOM (11) at 2.9 minutes for bus stops and 2.5 minutes for onboard buses. Lower values were estimated for London in 2007 (9) of 0.8 minutes for both onboard and at stop CCTVs.

Comparable values are included in the EEM of two minutes for CCTVs on trains, 0.7 for buses and 0.6 for rail stations.

A reasonable expectation is that some security measures may, from the passenger perspective, produce similar benefits thereby suggesting that the combined or package effect will be less than the sum of the parts.

On the other hand, brighter lighting may have general amenity value as well as heighten passengers feeling of personal security and safety. Indeed, for the two Sydney rail studies (2 and 7) lighting has been included under station design, appearance, amenity and facilities. The US PT study (12) included lighting alongside safety and distinguished safety from security. The two aspects were valued at 0.8 and 0.9 minutes respectively.

Rather than value specific attributes, Hensher (4) and the Dandenong rail study (6) valued the feeling of passenger safety. The latter study also included car park security as an attribute.

4.14 Maintenance, cleanliness and graffiti removal

Table 4.13 provides the willingness-to-pay values for maintenance, cleanliness and graffiti removal. Values have been estimated for vehicle exteriors and interiors and for bus stops and areas of train stations such as the ticket hall and platform. Usually cleanliness has been distinguished from graffiti and the London studies (9) have also estimated specific values for litter.

Most studies have used word descriptions such as buses are ‘very clean or ‘not clean enough’ and bus stops are in ‘excellent condition’ or ‘worn and tatty’. For the word description, the problem is in applying the values to actual services. The alternative is to use passenger ratings or mystery shopper ratings (as used by TfL).

The highest values were estimated by Hensher (4) and the Norwegian bus/tram study (13). The Hensher 2002 survey estimated a value of 8.9 minutes (25% of fare) for a very clean bus versus a not very clean bus. The Norwegian study estimated a value of 10 minutes for satisfactory bus stop cleanliness versus not satisfactory. The EEM/ATC values were relatively low by contrast; the highest valuation was 1.2 minutes (2.7%) for a clean and well maintained train.

The 2004 Sydney rating based study (7) estimated a benefit of 0.26 minutes (1.3% of fare) for a 10% rating point improvement. The maximum benefit would therefore be 2.6 minutes (10.3% of fare).

Table 4.13 Maintenance, cleanliness and graffiti removal

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	na	na	na
2	SYDRI95	10% Rating Improvement in train cleanliness	0.3	1.3%
	On-train	Well maintained train seats	1.2	4.5%
		10% Rating Improvement in station cleanliness	0.2	0.6%
3	SYDTW	na	na	na
4	HenBS	1999: Clean enough v bus v not clean enough	4.3	15%
		1999: Very clean bus v not clean enough	6.4	22%
		2000: Very clean bus v not very clean bus	8.9	25%
5	UKRS	na	na	na
6	RQDnd	Train seats always clean	1.1	18%
	(PE)	Graffiti removed	0.6	10%
		Fully maintained & cleaned stations	0.8	13%
7	SYDRI04	10% Rating Improvement in train cleanliness	0.26	1.3%
		" " "graffiti	0.08	0.4%
		" " "station cleanliness	0.13	0.7%
		" " "station graffiti	0.05	0.2%
8	WTNRST	Clean station	2.3	10%
14	EEM/ATC	Bus: No litter v lots of litter	0.4	0.9%
		Bus: Clean windows v dirty/etched	0.3	0.7%
		Bus: No graffiti v lots of graffiti	0.2	0.4%
		Bus:Exterior very clean v some dirty areas	0.1	0.2%
		Bus: Interior very clean v some dirty areas	0.3	0.7%
		Train: Clean and well maintained	1.2	2.7%
		Bus stop: excellent condition v worn & tatty	0.1	0.2%
		Bus stop spotlessly clean v some dirty patches	0.1	0.2%
		Bus stop: No litter v lots of litter	0.2	0.4%
		Bus Stop: No graffiti v lots of graffiti	0.1	0.2%
		Rail Station: Clean	0.5	1.1%
		Rail Station: Litter free	0.5	1.1%
		Rail Station: Graffiti free	0.3	0.7%

#	Label	Package Description	IVT mins	% Fare
9	SDGLND	Clean stop v dirty bus stop	10	32%
	1996 Bus	Clean bus v dirty bus	7.1	23%
	2007 Bus	Bus No litter v lots of litter	0.4	11%
		Bus No litter v small amount of litter	0.3	9%
		Very clean bus interior v some very dirty areas	0.4	13%
		Reasonably clean bus interior v some v dirty	0.8	13%
		No etching on windows v lots of etching	0.2	5%
		Very clean bus exterior v some v.dirty areas	0.01	0.2%
		Reasonably clean exterior v some v.dirty areas	0.01	0.5%
	2007	Very Clean Ticket Hall v very dirty	0.4	6%
	Rail	Very Clean Platform v very dirty	0.3	4%
		Platform Seats in good condition v poor state	0.2	3%
		Station: No Litter v lots of litter	0.3	5%
		Station: No Litter v some litter	0.3	4%
		Station" No graffiti v some graffiti	0.2	2%
		Station" No graffiti v zero graffiti	0.3	5%
		Train: Fairly good v poor condition	0.3	4%
		Train: Excellent v poor condition	0.4	6%
10	LDSBQ	na	nk	nk
11	AECOMB	not included	na	na
12	USPT	Cleanliness of transit vehicle	0.5	nc
13	NORPT	Satisfactory bus stop cleanliness v not	10	10%
		Ice/snow removal	13	14%

4.15 Staff availability, appearance and friendliness

Table 4.14 presents the valuations estimated for the availability, appearance and effectiveness of staff. It should be noted there is some overall with the value of personal safety/security, information and also smoothness of ride (particularly for buses).

Table 4.14 Staff availability, appearance and friendliness and effectiveness

#	Label	Package Description	IVT mins	% Fare
1	SDGWTN	na	na	na
2	SYDRI95	Station attendant present	0.4	1.7%
	On-train	Manned Ticket & Info Booth	0.4	1.5%
3	SYDTW	na	na	na
4	HenBS	1999: Very Friendly Bus driver v Very Unfriendly	13.1	45%
		1999: Friendly bus driver v Very Unfriendly	6.1	21%
		2000: Very Friendly Driver v Not Very Friendly	6.1	17%
5	UKRS	na	na	na
6	RQDnd	na	na	na
7	SYDRI04	10% Rating Pt Improvement in station staff	0.1	0.4%
8	WTNRST	Availability and Friendliness of Station Staff	0.6	1%
9	SDGLND	Driver gives change when needed	3.3	11%
	Bus 1996	Helpful driver	1.3	4%
		Smart driver appearance	0.1	0%
	Bus 2007	Polite, helpful, cheerful driver v businesslike	0.2	5%
	Rail 2007	Staff ease to see v no staff visible	0.9	10%
		Staff not easy to see v no staff visible	0.7	10%
10	LDSBQ	na	nk	nk
11	AeconBS	Trained bus drivers	2.6	5%
12	USPT	na	na	na
13	NORPT	na	na	na
14	EEM/ATC	Very polite, helpful bus driver v not helpful	0.4	0.9%
		Train attendant available	1.6	3.6%
		Rail Station - helpful staff	0.5	1.1%
		Rail Station - knowledgeable staff	0.5	1.1%

5 Study summaries

5.1 Public transport quality improvements, Wellington - SDG 1991

This study (SDG 1991a), although conducted over 20 years ago, is the only large-scale New Zealand study that has estimated willingness-to-pay values for qualitative aspects of public transport. The purpose of the study was to estimate values that could be used in the Wellington Regional Transport Model.

Two SP surveys were designed to value eight attributes: vehicle quality, stop quality (facilities and appearance), service reliability (eg the percentage chance of being five minutes late); seat availability (the chance of onboard standing); early morning (before 6am) and evening service (after 7pm) availability; service frequency (the interval between services) and access (the walk time to and from public transport). Passengers were presented with a set of pair-wise PT choices in which the levels of the quality attributes were varied. A notable feature was asking about the willingness to pay as a measure of the strength of preference rather than including fare as a journey attribute. After asking passengers which journey they preferred, they were asked how much more they would be willing to pay over the standard fare of $2 ($5 for long-distance trips).[13] Only average values were reported, although it should have been possible to derive a willingness-to-pay profile.

Photos were used to present the vehicle (interior and exterior) and stop types. Passengers were asked to rate a set of vehicle photos (interior and exterior) and asked to give their likes and dislikes which allowed the willingness-to-pay valuations to be disaggregated.

The survey was undertaken by face-to-face interviews. The interviews lasted about 10–15 minutes. In total, 596 respondents were interviewed. The sample included public transport users (bus and rail) and non-public transport users (car, cyclists and walkers) were interviewed. The study reported values in cents per trip. As well as this valuation, table 5.1 presents values expressed in terms of the percentage of fare and IVT minutes. [14] As can be seen the IVT valuations are quite high and result from a low value of access walk time of $1.08 cents per hour. If a value of IVT of $4 per hour was used the values would be one tenth the size.

[13] As a guide, passengers were asked whether they would be willing to pay more than $1. A set of willingness-to-pay boxes was included: 0, <25 cents, < 50 cents etc.

[14] The percentage fare was based on a $2 fare as used in the questionnaire for all but long trips ($5). IVT was not included as an attribute. Therefore, the IVT valuations were calculated assuming a value of IVT of $4 per hour. It would also have been possible to use the access, reliability or service interval valuations and apply a conventional weighting. Both the access and service interval valuations would have given high IVT valuations because of their low monetary valuations.

Table 5.1 Value of quality improvements in public transport – Wellington

Attribute and Respondent Group	Cents per Trip	Percentage Fare ^	IVT mins+
Vehicle Quality			
New vs Standard Bus	9	5%	1.4
Old vs Standard Bus	-11	-6%	-1.7
Trolley vs Standard Bus	1	1%	0.2
New UK NSE vs Standard Train	8	4%	1.2
New LRT vs Standard Train	17	9%	2.6
Old Jville vs Standard Train	-8	-4%	-1.2
Standard Train vs Standard Bus	7	4%	1.1
Stop Design			
Shelter vs Unprotected bus stop	2	1%	0.3
Shelter & Seats vs Unprotected bus stop	6	3%	0.9
New vs Standard rail station - Rail Commuters	22	11%	3.3
New vs Standard rail station - Non Rail Commuter Trips	8	4%	1.2
Reliability			
Value of one minute of lateness - Car	20	10%	3.0
Value of one minute of lateness - Other	15	8%	2.3
Value of one minute of lateness - Walk/Cycle Commuters	6	3%	0.9
Seat Availability: Value of 1 minute of standing	2.6	1%	0.4
Information Availability			
Value of At Stop Information on Leaflets only	7	4%	1.1
Value of Telephone Enquiry System & Real Time Info - At Stop Inf(	7	4%	1.1
Availability of Morning & Evening Services			
Value of Hourly services	42	21%	6.3
Value of Hourly to Half Hourly services	12	6%	1.8
Service Interval			
Value of a minute of Service Interval - Commuters	1.9	1%	0.3
Value of a minute of Service Interval - Non Commuters	0.7	0%	0.1
Access: Value of a minute of walk access	1.8	1%	0.3
^ Calculated on a base fare of $2 per trip			
+ calculated assuming a value of $4/hr			

Source: SDG 1991a

Respondents were willing to pay 9 cents per trip more (5%) to travel on a new bus rather than a standard bus. For an old bus, the willingness to pay was 11 cents lower than a standard bus. A trolley bus (a bus powered by overhead electricity) was valued slightly higher, at 1 cent per trip, than a standard (diesel).

For trains, a new UK commuter train was valued 8 cents per trip higher than the standard train with an old Johnsonville line train valued 8 cents lower. A new LRT vehicle (as used in Grenoble) was valued 17 cents higher than a standard train.

The survey also enabled bus and train vehicles to be compared with a standard train valued 7 cents per trip higher than a standard bus.

Willingness to pay increased with journey length but there was no consistent tendency for commuters to value vehicle type differently from other trip purposes.

By asking why passengers liked or disliked a particular train, it was possible to disaggregate the valuations into comfort, convenience (IVT, frequency, access, cost and reliability) and environmental considerations. Comfort-related factors were by far the most important, explaining up to 90% of some vehicle ratings. For trolley bus and LRT vehicles, environmental reasons were frequently cited which contributed 2.5 cents per trip to the valuation implying that willingness to pay can include altruism.

Trolley buses were also considered unreliable (treated as a convenience factor) which led to a reduction of 4 cents per trip in the valuation by commuters.

In terms of bus stop, providing a shelter was valued at 2 cents per trip and providing seats at 6 cents per trip. Higher values were estimated for rail stations. Rail commuters were willing to pay 22 cents for a new station compared to 8 cents by other respondents.

Providing at stop information was valued at 7 cents per trip on 'leaflets only'. Providing a telephone enquiry system and RTI was worth an additional 7 cents per trip.

Reliability was valued highly with a one-minute reduction in expected lateness valued at 20c per trip.

Passengers were willing to pay for the provision of early morning and late evening services. Hourly services were valued at 42 cents per trip and half-hourly services an extra 12 cents per trip. These values can be viewed as a willingness to 'cross-subsidise' services by paying more on existing services. Values for the service interval (SI) and walk access time were also estimated. The willingness to pay was low with an hour of SI valued or walking valued at just over $1 which compares with a prevailing of IVT of $4 per hour.

In summary, this SDG study was the only New Zealand study and although undertaken over 20 years ago, the method and results remain applicable. It is the only survey where willingness to pay was asked directly rather than being derived indirectly during analysis. Although the method was capable of estimating a willingness-to-pay profile, only the average willingness to pay was reported. The survey only looked at PT preferences and not choice of mode such as car versus bus. However car, walkers and cyclists were included in the sample. The survey used photographs to standardise the quality of vehicles and by asking about likes and dislikes, the willingness-to-pay values were explained in terms of convenience, comfort and environmental factors. For vehicle quality, a new train or new bus was valued around at just over 1 minute greater than a standard train or bus. In terms of fare, the willingness to pay was around 4%–5%.

5.2 Values of rail service quality, Sydney - PCIE 1995

This mid-1990s study estimated values for train and station type, reliability, crowding, cleanliness and personal security. The study took over a year to complete and involved three different questionnaires covering in-depth likes/dislikes: SP, PE ('bag of points') and rating questions. In total, 2,780 Sydney rail passengers were interviewed over six months (1994–95). Values were estimated in terms of additional fare per trip, the percentage fare and the equivalent change in IVT.[15]

Table 5.2 presents a set of overall valuations.[16] The survey also estimated values for peak and off-peak trips for short (under 20 minutes) medium and long (over 60 minutes) trips which are presented in tables 5.3 and 5.4. Passengers making long trips were willing to pay the more for improvements although there was little difference between short and medium-distance travellers. Expressing the values in equivalent in-

[15] The value of in-vehicle rail time (which averaged $4.20 per hour) was estimated in another study.

[16] The market segment values were then weighted to produce the overall valuations presented in table 5.2.

vehicle train time reduced the difference for long-distance passengers because they also had a higher value of time. By time period, passengers travelling in the off-peak tended to have a higher valuation than passengers travelling in the peak.

Overall valuations for train and station were estimated which included train appearance, air conditioning, ride-quality, seating, toilets etc.[17] The values were based on passenger ratings of photographs of the interior (seating), vestibule and exterior of current trains.[18] The ratings varied from 44% for the oldest train in the fleet to 88% for the newest train in the fleet.

For stations, photographs were shown of the entrance (street appearance, ticket sales and concourse), access-way (concourse-platform connecting areas) and platform for 11 stations chosen to represent low to high quality. The overall station rating varied from a low of 42% to a high of 77%.

Example photos of low, medium and high train and station quality were then shown in a set of SP questions alongside personal security (train attendants or security cameras) and fare.

Passengers were willing to pay 13.1 cents per trip (7.6% of the average fare) for a 10% point improvement in overall train rating (ie including air conditioning, ride quality, seating, appearance, layout, facilities etc). Expressed in terms of the equivalent travel time reduction gave a value of 1.9 minutes.

Passengers were estimated to value travelling on the best versus the worst-rated train at eight minutes or 58c per trip (33%). These values halve to four minutes or 29c (17%) for best versus the average-rated train.[19]

[17] Values were estimated for individual attributes rather than packages. For example, the value of introducing security cameras was estimated and so was the value of introducing train attendants but the value of introducing both security cameras and train attendants (which would likely be less than the sum of the two attributes) was not estimated.

[18] A 1-9 scale was used which was converted to a percentage scale for analysis purposes.

[19] Calculated as the simple average of the highest and lowest rated trains (88%+44%/2), ie 66%.

Table 5.2 Value of train and station attributes for Sydney rail services

Attribute	Fare Percent	Fare cents	IVT mins
Train Attributes:			
10% Cleanliness Improvement	1.3%	2.3	0.3
Presence of a train attendant	6.0%	11.1	1.6
Provision of On-train CCTVs	7.7%	13.7	2
Airline Style Information	2.3%	4.4	0.6
Frequent & Audible Train Annoucements	4.0%	6.9	1.1
Modern Exterior	1.4%	2.4	0.4
Air Conditioning	5.7%	10.1	1.5
Quiet & Smooth Ride	4.3%	7.7	1.2
Comfortable Seats	5.6%	9.9	1.5
Seats facing Travel Direction	2.5%	4.3	0.7
Well Maintained Seats	4.5%	7.8	1.2
Onboard & Clean Toilets	2.2%	4.2	0.6
10% Point Improvement in Overall Train Rating	7.6%	13.1	1.9
Station Attributes:			
10% Rating Improvement in Cleanliness	0.6%	1.1	0.2
Station Attendant	1.7%	2.9	0.4
Platform Security Camera	2.8%	5.1	0.7
Computerised Train Indicator Board	1.4%	2.5	0.4
Frequent & Audible Annoucements	1.5%	2.5	0.4
Manned Ticket & info Booths	1.5%	2.8	0.4
Automatic Ticket Machines	1.1%	1.8	0.3
Modern Appearance	0.6%	1	0.2
Improved Lighting	1.7%	3	0.4
Clean Available Toilets	1.6%	2.9	0.4
Telephones	1.2%	2.2	0.3
Kiosk / Newsagent / Café	0.6%	1.1	0.2
Escalator & Lifts	0.9%	1.5	0.2
Platform Shelter & Shade	1.4%	2.5	0.4
Platform Seating	1.6%	2.7	0.4
10% Point Improvement in Overall Station Rating^	4.3%	7.5	1.1
1 minute of lateness	-11.1%	-19.6	-2.9
1 min of standing versus crowded seat	-3.0%	-5.2	-0.8
1 minute of crowded versus comfortable seat	-2.1%	-3.5	-0.6

^ Improvement to a single station

Source: PCIE (Douglas Economics) 1995

Table 5.3 In-vehicle time value of Sydney train and station attributes by market segment

	Quality Factor	Peak Short	Peak Med	Peak Long	Off-Peak Short	Off-Peak Med	Off-Peak Long	ALL
	Train Attributes:							
Rating	10% Point Imp in Train Rating	1.8	1.3	1.6	2.0	3.5	2.7	1.9
Cleanliness	10% Point Imp in Cleanliness/Grafitti	0.3	0.3	0.3	0.5	0.3	0.4	0.3
Security	Presence of a train attendant	1.5	1.2	1.7	1.9	1.8	2.0	1.6
	Provision of On-train CCTVs	2.0	1.6	1.6	2.8	2.4	2.1	2.0
Information	Airline Style Information	0.5	0.6	0.7	1.0	0.2	1.3	0.6
	Freq & Audible Train Annoucements	1.1	0.6	0.7	1.9	1.2	1.2	1.0
Appearance	Modern Exterior	0.3	0.2	0.3	0.6	0.5	0.4	0.3
Air Con.	Air Conditioning	1.4	1.1	1.3	2.6	1.5	1.5	1.4
Ride Quality	Quiet & Smooth Ride	0.9	0.7	1.0	2.2	1.2	1.9	1.1
Seating	Comfortable Seats	1.2	1.0	1.3	2.8	1.5	2.2	1.4
	Seats facing Travel Direction	0.6	0.4	0.4	1.1	0.8	0.9	0.6
	Well Maintained Seats	1.1	1.0	0.9	1.9	1.1	0.9	1.1
Toilets	Onboard & Clean Toilets	0.5	0.3	1.0	0.9	0.5	1.3	0.6
	Station Attributes^:	Pk_S	Pk_M	Pk_L	OP_S	OP_M	OP_L	ALL
Rating	10% Point Imp in Station Rating	1.0	1.1	0.9	0.8	1.5	1.3	1.1
Cleanliness	10% Point Imp in Cleanliness/Grafitti	0.2	0.1	0.1	0.3	0.2	0.2	0.2
Security	Station Attendant	0.4	0.3	0.3	0.5	0.6	0.4	0.4
	Platform Security Camera	0.7	0.6	0.6	1.0	1.0	0.8	0.7
Information	Computerised Train Indicator Board	0.4	0.3	0.3	0.6	0.4	0.5	0.4
	Frequent & Audible Annoucements	0.4	0.3	0.2	0.6	0.5	0.4	0.4
Ticketing	Manned Ticket & info Booths	0.4	0.2	0.4	0.6	0.5	0.5	0.4
	Automatic Ticket Machines	0.2	0.2	0.1	0.6	0.3	0.2	0.3
Appearance	Modern Appearance	0.1	0.1	0.1	0.4	0.2	0.2	0.1
	Improved Lighting	0.4	0.3	0.4	0.7	0.5	0.5	0.4
Facilities	Clean Available Toilets	0.4	0.3	0.4	0.6	0.5	0.6	0.4
	Telephones	0.3	0.2	0.3	0.5	0.4	0.4	0.3
	Kiosk / Newsagent / Café	0.1	0.1	0.1	0.4	0.1	0.3	0.2
	Escalator & Lifts	0.3	0.1	0.2	0.4	0.2	0.3	0.2
	Platform Shelter & Shade	0.3	0.3	0.3	0.7	0.4	0.5	0.4
	Platform Seating	0.4	0.2	0.3	0.9	0.4	0.5	0.4
Reliability	Value of one minute of Lateness	4.5	3.9	4.4	5.8	4.7	4.0	4.4
Crowding	Stand v Crowded Seat (per minute)	1.0	0.3	0.1	1.5	0.2	0.2	0.6
	Crowded Seat v Plenty Seats (/ min)	0.5	0.1	0.1	1.6	0.1	0.1	0.4
Parameters	Value of Time $/hr	4.03	4.35	7.69	2.4	3.69	7.69	4.2
	Average Fare $ per trip	1.56	1.8	3.16	1.28	1.77	3.62	1.82
	Stations per Trip	2.1	2.1	2.3	2	2.1	2.2	2.1

^ Improvement to a single station

Source: PCIE 1995 (Douglas Economics)

Table 5.4 Percent fare value of Sydney train and station attributes by market segment

	Quality Factor	Peak Short	Peak Med	Peak Long	Off-Peak Short	Off-Peak Med	Off-Peak Long	ALL
	Train Attributes:							
Rating	10% Point Imp in Train Rating	7.6%	5.3%	6.6%	6.2%	12%	9.4%	7.2%
Cleanliness	10% Point Imp in Cleanliness/Grafitti	1.4%	1.1%	1.2%	1.5%	1.2%	1.4%	1.3%
Security	Presence of a train attendant	6.7%	5.0%	6.9%	6.0%	6.2%	7.2%	6.1%
	Provision of On-train CCTVs	8.7%	6.3%	6.7%	8.7%	8.3%	7.6%	7.5%
Information	Airline Style Information	2.2%	2.2%	2.8%	3.0%	0.8%	4.7%	2.4%
	Freq & Audible Train Annoucements	4.8%	2.5%	2.9%	5.8%	4.1%	4.1%	3.8%
Appearance	Modern Exterior	1.3%	1.0%	1.1%	2.0%	1.7%	1.4%	1.3%
Air Con.	Air Conditioning	5.9%	4.6%	5.1%	8.1%	5.2%	5.3%	5.5%
Ride Quality	Quiet & Smooth Ride	3.7%	3.0%	4.2%	7.0%	4.2%	6.6%	4.2%
Seating	Comfortable Seats	5.1%	4.1%	5.3%	8.8%	5.2%	7.7%	5.4%
	Seats facing Travel Direction	2.6%	1.8%	1.8%	3.4%	2.7%	3.1%	2.4%
	Well Maintained Seats	4.9%	3.8%	3.8%	5.9%	3.9%	3.2%	4.3%
Toilets	Onboard & Clean Toilets	2.0%	1.3%	4.0%	2.7%	1.7%	4.6%	2.3%
	Station Attributes^:	Pk_S	Pk_M	Pk_L	OP_S	OP_M	OP_L	ALL
Rating	10% Point Imp in Station Rating	4.2%	4.6%	3.5%	2.6%	5.3%	4.6%	4.1%
Cleanliness	10% Point Imp in Cleanliness/Grafitti	0.7%	0.4%	0.5%	0.9%	0.6%	0.6%	0.6%
Security	Station Attendant	1.9%	1.4%	1.3%	1.6%	2.0%	1.6%	1.6%
	Platform Security Camera	3.1%	2.4%	2.4%	3.1%	3.3%	2.7%	2.8%
Information	Computerised Train Indicator Board	1.5%	1.1%	1.3%	2.0%	1.4%	1.6%	1.4%
	Frequent & Audible Annoucements	1.9%	1.1%	0.8%	1.8%	1.6%	1.5%	1.4%
Ticketing	Manned Ticket & info Booths	1.7%	1.0%	1.6%	1.9%	1.8%	1.8%	1.5%
	Automatic Ticket Machines	1.0%	0.9%	0.6%	1.7%	0.9%	0.7%	1.0%
Appearance	Modern Appearance	0.5%	0.3%	0.4%	1.3%	0.6%	0.6%	0.5%
	Improved Lighting	1.7%	1.2%	1.5%	2.3%	1.8%	1.8%	1.6%
Facilities	Clean Available Toilets	1.7%	1.2%	1.7%	1.7%	1.6%	2.0%	1.6%
	Telephones	1.2%	1.0%	1.2%	1.4%	1.4%	1.3%	1.2%
	Kiosk / Newsagent / Café	0.6%	0.4%	0.5%	1.3%	0.5%	1.0%	0.6%
	Escalator & Lifts	1.2%	0.3%	0.9%	1.3%	0.8%	1.1%	0.8%
	Platform Shelter & Shade	1.3%	1.1%	1.4%	2.2%	1.5%	1.7%	1.4%
	Platform Seating	1.7%	0.9%	1.2%	2.7%	1.5%	1.9%	1.5%
Reliability	Value of one minute of Lateness	19%	16%	18%	18%	16%	14%	17%
Crowding	Stand v Crowded Seat (per minute)	4.4%	1.1%	0.4%	4.8%	0.7%	0.6%	2.1%
	Crowded Seat v Plenty Seats (/ min)	2.2%	0.6%	0.3%	4.9%	0.5%	0.4%	1.4%
Parameters	Value of Time $/hr	4.03	4.35	7.69	2.4	3.69	7.69	4.2
	Average Fare $ per trip	1.56	1.8	3.16	1.28	1.77	3.62	1.82
	Stations per Trip	2.1	2.1	2.3	2	2.1	2.2	2.1

^ Improvement to a single station

Source: PCIE 1995 (Douglas Economics)

The overall train valuation was disaggregated into exterior, vestibule and interior valuations. The disaggregation was based on the response to a PE question in which passengers were asked to allocate 100 points between the three areas to indicate their relative importance. Train interior accounted for just over one half (52%) of the overall rating with the vestibule accounting for 29% and the exterior 21%. Thus a 10% rating point train interior improvement would be valued at roughly half the overall value or 6.5c per trip.

For stations, passengers were willing to pay 7.5 cents for a 10% point rating improvement in quality. To use the highest rated station rather than lowest, passengers were willing to pay 26 cents per trip (per station) which halves to 13 cents for the average rated station.

The overall valuation was disaggregated into station entrance (30%), access-way (34%) and platform (36%) based on response to a PE question.

Personal security improvements were included with train and station quality. Passengers were willing to pay 13.7 cents for on-train security cameras and 11.1 cents for train attendants. At stations, the valuations were 5.1 cents and 2.9 cents respectively.

A second SP survey looked at reliability, on-train crowding, information, cleanliness and graffiti and fare. Reliability was highly valued with a minute of expected lateness valued at 19.6 cents or three minutes of onboard train time. On-train crowding was valued in terms of standing and crowded seating. A minute of standing was valued equivalent to 0.8 minutes of crowded seating with crowding seating valued at 0.6 minutes of uncrowded seating.

Train and station 'information' values were estimated. Similar station valuations, equal to 0.4 minutes of onboard time, were estimated for computerised train indicator boards, frequent and audible announcements and manned ticket and information boards. For trains, a higher value of 1.1 minutes of onboard train time was estimated for frequent and audible announcements.

The values for individual train and stations attributes were based on the response to a set of PE questions in which respondents were asked to pick five improvements from a list and allocate 100 points to indicate their relative importance. Train and station lists were shown separately.

The study also included an overall PE. This question was interesting from a methodological viewpoint since it was designed to produce 'stand alone' valuations by including a fare reduction and travel time savings. Six questionnaire variants were developed in which the size of the fare reduction and the time saving were varied. Passengers only completed one variant but by comparing the results it was possible to value the improvements in fare and onboard train time.

Where comparisons were possible, it was found that the PE produced noticeably higher valuations than the SP questionnaires. For reliability, the PE gave a value double that of the SP survey. The higher size was explained in the report as resulting from specifying fare reductions. It is also likely that the PE focused attention towards the individual quality improvements and away from the fare and travel time reductions. Wherever an attribute was estimated by both methods, the SP valuation was used. Wherever there was not, the PE valuations were scaled down to maintain the relative importance of the attribute.

Amongst the train quality attributes, passengers were valued comfortable seats at 16.6 cents compared with 7.3 cents by passengers travelling medium distances. Clean and available toilets were valued at 12.5 cents for long-distance travellers whereas short- and medium-distance passengers had much lower valuations of 3.1 cents and 2.4 cents respectively.

The survey established passengers were reasonably satisfied with the level of information as they rated on-train information at 74% and station information at 67%. The highest valuation was attached to the provision of frequent and audible on-train announcements at 6.9 cents. At stations, similar valuations of around 2.5 cents per trip were estimated for announcements, computerised train indicator boards and manned ticket and information booths.

Passengers were willing to pay 2.3 cents for a 10% point rating improvement in train cleanliness/reduced graffiti.

The study also produced valuations for reliability and on-train crowding. A minute of expected lateness was valued at 31 cents or 4.4 minutes of IVT. A minute of standing versus sitting in crowded conditions was valued at 3.9 cents or 0.56 minutes of IVT and sitting in a crowded seat versus uncrowded seating was valued at 0.37 minutes of IVT.

The estimated valuations were used by the State Rail Authority of New South Wales in economic evaluations of rolling stock and station improvements between 1995 and 2005 when they were replaced by a new set of valuations.

In summary, Sydney rail passengers participating in the survey estimated values for service reliability, on-train crowding and train and station quality. The train and station values covered cleanliness, information and personal security. Photographs were used to standardise train and station quality. Values were produced for peak and off-peak trips for short, medium and long trips. Average values were then produced by weighting the market segment results. Improving overall train quality from average to a high was valued at four minutes or 29 cents (17% of the average fare).

5.3 Liverpool-Parramatta transitway research - PPK 1998

This 1998 study provides an example of market research being undertaken as part of a demand forecasting exercise. The market research involved SP modal choice experiments and a PE that explored the relative importance of bus service improvements. By surveying bus, rail and car users, the study also provides a comparison of values by travel mode. The results were used to forecast the demand for a transitway linking Liverpool, Hoxton Park and Parramatta in Sydney. The study was carried out by PPK Environment & Infrastructure (1998).

The SP survey required respondents to choose between two hypothetical journeys – one journey being by bus or transitway. The other journey depended on the respondent’s current mode: bus, car or rail. In total, seven SP questionnaires were developed to handle the types of journey made. Over 1,000 people were interviewed with minimum quotas of 100 set for each category.

Photographs and pictograms were used to describe bus, rail and transitway. Bus and rail were ‘as now’ with the transitway described as operating on a separate road for buses (like trains), smooth services not held up by other traffic, modern bus stations and stops and modern buses.

Table 5.5 presents the estimated parameters for variables of relevance. The value of the qualitative features of a transitway compared with a standard bus (ie net of travel time, access time, frequency and fare) was worth a time saving of around six minutes for car users and five minutes for rail users but only 0.4 minutes for bus users. The value of time on bus/rail was highest for car users at $10.30 per hour and lowest for bus users at $6.40.

Table 5.5 Qualitative value of a transitway versus a standard bus

Parameter	Bus	Car	Rail by Access Mode Car-Int	Car-Ext	Bus-Int	Bus-Ext	Average
TW-Bus	0.055	0.338	0.703	0.335	0.695	-0.05	na
|t|	0.4	1.9	3.1	3.1	3.6	0.4	
IVT	-0.125	-0.057	-0.102	-0.084	-0.079	-0.117	na
|t|	9.8	6.5	8.9	14	6.2	9.6	
Fare	-1.168	-0.332	-0.646	-0.517	-0.506	-1.03	na
|t|	5.9	3.9	5.2	8.8	3.9	7	
Relative Valuation	Bus	Car	Car-Int	Car-Ext	Bus-Int	Bus-Ext	Average
TW-Bus (mins)	-0.4	-5.9	-6.9	-4.0	-8.8	0.4	-4.8
VOT ($/hr)	6.4	10.3	9.5	9.7	9.4	6.8	8.9
Fare Value (Cents)	-12	-158	-184	-106	-235	11	-128
% Fare ^	-5%	-63%	-74%	-43%	-94%	5%	-51%
Sample Size	100	194	113	362	114	160	749

Notes: ^ average fare of $2.50 assumed based on fares presented in SP

Source: PPK 1998

Using the reported values of time, produced a fare valuation of 12 cents for bus users, 158 cents for car users and 128 cents for rail users. These converted to percentage fare valuations of 5%, 63% and 51% respectively. The survey therefore estimated a much higher willingness to pay for car and rail users than bus users

The PE asked respondents to allocate $100 to a list of improvements to indicate their relative importance. Included in the list of improvements was bus access, frequency, smoothness of ride, reliability, modern bus stops with weather protection and seating, information at bus stops, new modern buses and bus travel time. Table 5.6 presents the points allocated to each attribute.

To derive valuations expressed in terms of bus time, two versions of the questionnaire were used in which the bus travel time saving was either three minutes or six minutes. The difference in response to the two questionnaire versions was used to calculate the relative valuations. This feature distinguishes the study from the Dandenong and Wellington PE surveys where only one travel time was specified.

Table 5.6 Liverpool-Parramatta priority evaluator – points allocation

Attribute	Points Allocated		
	Bus	Car	Rail
a) Bus Stops within 5 mins walk at each end	10	10.9	5.8
b) Bus Services Run Every 5 mins	19.1	17.3	17.6
c) Smooth Bus Ride	7.3	6.5	5.8
d) On time - No Road Traffic Delays	20.1	18.3	18.0
e) Modern Bus Stops & Stations with Weather Protection & Seating	13.4	20.5	16.8
f) Full information at all Bus Stops & Stations	9.1	14.7	15.8
g) New Modern Buses	11	6.7	7.0
h) Bus Journey 4.5 mins Faster^	10	5.1	13.4
Total Points	100	100	100
^ average of 3 Mins & 6 Mins below:			
h1) Bus Journey 3 Mins Faster	6.2	3.8	10.6
h2) Bus Journey 6 Mins Faster	12.7	6.1	15.9

Source: PPK 1998

The resultant valuations presented in table 5.7 are much higher than the qualitative SP constants (TW-Bus) indicated. The overall improved bus package (smooth bus ride, full information and modern stops and buses) was worth 16 minutes to rail users, 19 minutes to bus users and 41 minutes to car users. For rail, the package was three times higher than the SP value and for car it was seven times higher.

Thus for car, the PE quality package was seven times higher than the SP survey estimate (41 minutes for the PE versus just under six minutes for the SP). For rail, the PE was three times higher and for bus 38 times higher.

The time values were converted into % fare valuations using the SP value of time and an average fare of $2.50. Bus and rail users were willing to pay nearly double the $2.50 bus fare and car users nearly triple the fare for the package of quality improvements.

Across the attributes, reliability was most highly valued especially by car users, followed by modern bus stops and stations and frequent bus services.

New modern buses were valued at three to five minutes with a smooth ride value valued at two to six minutes which ranked them last and second last in relative importance.

Table 5.7 Liverpool-Parramatta priority evaluator – valuations

Attribute Valuation	Valuation in Bus Mins			Valuation in % Fare		
	Bus	Car	Rail	Bus	Car	Rail
a) Bus Stops within 5 mins walk at each end	5	10	2	21%	66%	12%
b) Bus Services Run Every 5 mins	8	14	6	36%	99%	36%
c) Smooth Bus Ride	4	6	2	15%	41%	13%
d) On time - No Road Traffic Delays	9	15	6	37%	104%	36%
e) Modern Bus Stops & Stations^	6	17	6	27%	114%	35%
f) Full information at all Bus Stops & Stations	4	13	5	19%	86%	32%
g) New Modern Buses	5	6	3	22%	43%	15%
Quality Package c)+e)+f)+g)	19	41	16	83%	284%	95%

^ see Table 4.3.2 for full description

Source: PPK 1998

5.4 Bus service quality indices, NSW - Hensher 2002-03

In the late 1990s to early 2000s, Hensher used a SP questionnaire approach to develop a bus service quality index (SQI). Two surveys were undertaken. The first survey was undertaken in 1999 and was reported in Hensher and Prioni (2002). The second survey was undertaken in November–December 2000 and was reported in Hensher et al (2003).

As well as qualitative attributes such as driver friendliness and bus cleanliness, the survey looked at a range of quantitative attributes: fare, onboard time and service frequency. The list of attributes differed between the two surveys. Hensher used SP survey techniques to estimate the parameters governing the SQI measure. Both surveys used a self-completion questionnaire handed out on buses. The survey therefore only obtained the views of bus users.

The survey was complex and required respondents to choose between three bus journeys differing in bus fare, travel time, reliability, walking time and nine other service quality attributes relating to the vehicle, bus stop and information. Figure 5.1 presents an example choice.

Figure 5.1 Example stated preference choice

Service Feature	*Bus Package of the Bus Company A*	*Bus Package of the Bus Company B*	*Bus Package of the Current Bus*
Reliability	10 minutes late	on time	7 minutes late
One-way fare	same as now	same as now	2 dollars
Walking distance to the bus stop	5 minutes more than now	5 minutes more than now	5 minutes
Personal Safety at the bus stop	reasonably unsafe	reasonably safe	very safe
Travel Time	25% longer than the current travel time	25% quicker than the current travel time	30 minutes
Bus stop facilities	No shelter or seats at all	Seats only	Seats only
Air conditioning	Not available	Available with no surcharge	Not available
Information at the bus stop	Timetable but no map	Timetable but no map	Timetable and a map
Frequency	Every 15 minutes	Every 30 minutes	Every 60 minutes
Safety on board	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often	The ride is jerky; sudden braking occurs often
Cleanliness of seats	Clean enough	Clean enough	Very clean
Ease of access to the bus	Wide entry with no steps inside the bus	Wide entry with 2 steps inside the bus	Wide entry with 2 steps inside the bus
Driver behaviour	Friendly enough	Very friendly	Very friendly

If Bus A and Bus B were available today, which bus service would you choose?

Source: Hensher and Prioni (2002)

By developing a series of choices, the SP survey was able to determine a set of parameters describing passengers' sensitivity to changes in the service levels attributes.

The first survey undertaken in April – May 1999 obtained a sample of 3,849 useable questionnaires. Table 5.8 presents the relative attribute values expressed in terms of the onboard bus time, the fare and the percentage of fare. The results were not disaggregated by trip length or by time period.

Table 5.8 Value of bus attributes for Sydney bus services (Hensher and Prioni 2002)

Attribute	Attribute Level	Attribute Base Level	IVT Mins	Fare Cents	Fare %^
Reliability	Minute of Lateness	na	1.8	12	6%
Access time	Minute of Access Time	na	1.4	9	5%
Frequency	Every 60 minutes	Every 15 minutes	-18.3	-123	63%
	Every 30 minutes	" " "	-3.8	-26	13%
Bus Stop Waiting Safety	Reasonably Safe	Reasonably Unsafe	*4.8*	*32*	16%
	Very Safe	" " "	5.8	39	20%
Bus Stop Facilities	Seats only	No Shelter No Seats	*-ve/ns*	*-ve/ns*	*-ve/ns*
	Bus Shelter with Seats	" " "	2.8	19	10%
Information at Stop	Timetable	None	9.3	62	32%
	Timetable & Map	" " "	6.1	41	21%
Bus Access	Wide Entry 2 Steps	Narrow Entry 4 Steps	3.0	20	10%
	Wide Entry No Steps	" " "	*-ve/ns*	*-ve/ns*	*-ve/ns*
Bus Air Conditioning	Available - No Cost	None	2.2	15	8%
	Available 20% Fare Surcharge	" " "	*-5.4*	*-36*	*-19%*
Bus Seat Cleanliness	Clean Enough	Not Clean Enough	*4.3*	*29*	*15%*
	Very Clean	" " "	6.4	43	22%
Driver Attitude	Friendly Enough	Very Unfriendly	6.1	41	21%
	Very Friendly	" " "	13.1	88	45%
Quality of Ride	Generally Smooth	Jerky Sudden Braking	6.4	43	22%
	Very Smooth	" " "	11.0	74	38%
Value of Time Cents/hr			na	402	na

^ percentage of base fare of $1.94 (reported by Hensher, Stopher and Bullock 2003)
Fare values are in 1999 dollars; na not applicable -ve/ns negative value and not significant
Values in italics not significant at 95% confidence level

In terms of reliability, a minute of lateness was valued the same at 1.8 minutes of onboard bus time in vehicle time (IVT). Likewise a minute of walk access to/from the bus stop was valued at 1.4 minutes of IVT. In terms of frequency, an hourly bus service was valued at 18 minutes of onboard time and a half-hourly service at four minutes compared with a 15-minute service.

Two values for bus stop waiting safety were estimated. The value of feeling reasonably safe rather than unsafe was valued at 4.8 minutes with passengers willing to pay 32 cents or 16% of the average fare of $1.94. Feeling very safe was valued at 5.8 minutes or 1 minute more than feeling reasonable safe.

Providing a bus shelter with seats was worth 2.8 minutes compared with a bus stop without shelter or seats. Providing a timetable at a bus stop was worth 9.3 minutes but counter intuitively providing both a timetable and a map was worth less at 6.1 minutes.

In terms of the onboard bus trip, having a friendly driver was the most highly valued attribute: a friendly enough bus driver was worth 6.1 minutes and a very friendly driver worth 13.1 minutes.

The second most valued bus attribute was smoothness of ride. A generally smooth ride versus a jerky ride with sudden braking was valued at 6.4 minutes and a very smooth ride was worth 11 minutes or 38% of the fare.

Providing a wide entry door with two steps compared with a narrow entry with four steps was worth three minutes. However, the parameter for no steps was not significant.

Air conditioning was valued at 2.2 minutes or 8% of fare. Accordingly, not enough passengers were willing to pay a 20% fare surcharge for air conditioning and the parameter value was negative.

Having a clean enough bus was worth 4.3 minutes and a very clean bus 6.4 minutes.

Hensher and Prioni (2002) did not report a value for a package of improvements. However, it was possible to derive a value for a premium bus service versus a standard service by summing attribute values.[20] A package value worth 19 minutes of bus time was calculated. In terms of willingness to pay the package was worth $1.27 per trip or 65% of fare.

The list of attributes in the second survey was different. A total of 1,478 bus passengers provided useable questionnaire responses.

As for the first survey, relative valuations were not reported but have been calculated in table 5.9 using the parameters estimates. The paper presented models for nine bus routes (called segments) but not an overall model. Table 5.9 presents an average valuation calculated for the number of reported segments. For some attributes, the parameter was statistically insignificant and was not reported. For example, the driver friendliness values were based on only five segment estimates (none of which were statistically significant at the 95% confidence level).

The values for reliability and access time were close to the estimates of the first survey. For bus frequency, the value of an additional bus per hour was 3.5 minutes.

The second survey introduced crowding as an attribute. Sitting all the way rather than standing was worth 18 minutes of bus time. As the average bus trip was 22 minutes, passengers effectively valued standing time at 80% of the bus time. Standing part way was valued at seven minutes of bus time.

The value of onboard travel time was estimated at $3.28 per hour which was lower than in the first survey ($4.02 per hour).

The values for some of the qualitative attributes were noticeably higher than in the first survey. In part this may have resulted from calculating the average on only the reported segment values.

Bus entry/exit had a much higher cost than in the first survey but it should be noted that the average is based on only three out of the nine segments. Having a narrow four step entrance compared with a wide entrance with no steps was valued at 13 minutes. Perversely, having a wide entrance with a two-step entrance had a higher cost of 17 minutes which compares with a value of only three minutes in the first survey

[20] The package value was calculated as the difference between the high and medium quality values and comprised the value of three minutes for wide entry two steps versus narrow entry two steps; 2.2 minutes for air conditioning; 2.1 minutes for a very clean versus clean enough bus; seven minutes for a friendly versus friendly enough bus driver; and 4.6 minutes for a very smooth versus generally smooth ride.

Table 5.9 Value of bus attributes for Sydney bus services (Hensher et al 2003)

Parameter	IVT mins	Fare C/trip	Fare %	Number of Segments Reported^	Significant*
Reliability (minute of lateness)	1.6	9	5%	9	3
Access time (minute)	1.6	9	4%	9	8
Bus Frequency N/hr	3.5	19	10%	9	9
Seat All Way versus stand all way	18.1	99	51%	9	8
Stand Part Way versus stand all way	7.0	38	20%	6	6
No Timetable No Map	-7.0	-38	-20%	7	1
Narrow 4 Steps versus wide entry no steps	-12.8	-70	-36%	3	2
Wide Entry 2 Steps versus wide entry no steps	-16.7	-91	-47%	3	3
Seats under cover at stop versus no seats and no cover+	10.4	57	29%	9	9
Very Clean Bus versus not very clean bus	8.9	49	25%	4	3
Very Friendly Driver versus not very friendly driver	6.1	33	17%	5	0
Value of Time $/hr	3.28	na	na	9	8

^ number of reported segments (max=9) on which average value derived

* number of market segment parameters significant at 95% confidence limit (t=1.96)

+ Exactly the same values were reported for seats only

Fare values in 2000 dollars and have been calculated on a base average fare of $1.94 reported in the study

For information, the base level of information was included in the reported models. The results implied that not having either a timetable or a map at the bus stop was worth seven minutes of bus time compared with having either a timetable or a map (or both). The value of seven minutes was similar to the first survey.

Having seats at a covered bus stop was worth 10 minutes compared with three minutes in the first survey.

Travelling on a very clean bus rather than a not very clean bus was valued at nine minutes which compares with six minutes in the first survey.

Having a very friendly driver versus an unfriendly driver was valued at six minutes which was half the value of 13 minutes estimated in the first survey.

In summary, the two SP surveys estimated values for a range of quantitative and qualitative attributes. Of the two surveys, the first survey is considered to have produced a more realistic set of values.

Nevertheless, for the qualitative attributes, the values remain high, ranging between 2 and 17 minutes of onboard time for individual attributes of service. A package value was not reported and no adjustments were made for possible package effects. A value for a ‘premium’ bus service was calculated at 19 minutes or 65% of fare by summing the reported attribute vehicle valuations.

The study has been cited frequently, eg in Balcombe (2004), ATC (2006), Bristow and Davison (2009), Outwater et al (2010) and Litman (2008).

5.5 Valuing rolling stock, UK - Wardman and Whelan 2001

This UK study by Wardman and Whelan (2001) is included because it used RP data of actual travel choices between different rolling stock types to calibrate SP-based models. In this regard, the study is different from the other studies reviewed which were based purely on SP or customer rating data.

The study reviewed 18 SP studies that had valued rolling stock. The authors considered the values tended to be high, some implausibly so and it was suspected that respondents had seen through the purpose of the research and had inflated their responses for strategic reasons.

These findings were backed up by a review of eight RP studies where new rolling stock had been introduced. In four studies there had been no significant change in demand and in the other four studies there had been increases of between 3% and 8% with the most precisely estimated increase being 4%.

A regression model was used to explain 45 valuations of rolling stock they had compiled from their SP literature review. A variable accounting for whether the purpose of the study would have been known to the respondents found valuations to be three times higher than where the purpose was not known. Another variable accounting for familiarity found that passengers familiar with new rolling stock had valuations 44% lower than passengers who were unfamiliar.

It was found that refurbishment that changed seat layout, ride quality, ventilation, ambience, noise and seating comfort from levels associated with slam door stock to new air-conditioned South East stock was worth around 2.5% of the fare. However, the authors argued that most refurbishments would be worth somewhat less than this with 1.5% being a 'representative figure'.

A factor of 1.7 converted fare into time valuations based on valuations tabulated by the authors. Thus a 1.5% fare valuation would convert to a time valuation of 2.6%, which for a half-hour train ride would indicate rolling stock refurbishment was equivalent to a time saving of 1.3 minutes.

The study also the estimated a package effect of 0.5 whereby the sum of the individual effects associated with ride quality, seating layout, seating comfort, noise, ventilation and ambience as estimated by SP studies needed to be halved to get the value of the overall package.

5.6 Survey of rail quality, Dandenong VIC – Halcrow 2003

The study was undertaken by Halcrow Consulting for the Victorian Department of Infrastructure, Public Transport Division in 2003. The study purpose was to prioritise and monetise a range of rail service attributes that included: frequency, express services, reliability, seat availability, comfort, personal safety, information, station facilities, car parking at stations, bus connections.

The survey was undertaken on the Melbourne – Dandenong corridor. Interviews were conducted by telephone (CATI). A total of 926 people were interviewed from 2,789 contacts (33%). Regular and infrequent rail users were included in the sample.

There were two parts to the survey: a SP survey and a PE (Bag of Money). The results of the two surveys were not linked. The SP covered onboard time, departure time displacement, express service, seating availability, cleanliness and train cancellations. The results are shown in table 5.10. The PE presented a list of improvements and asked respondents to allocate $1,000 across the list to indicate their relative priority. By including 'halving of fare' on the list of improvements, Halcrow was able to value the improvements relative to a fare reduction.[21] Table 5.11 presents the valuations.

[21] Ideally, two or more questionnaires with the fare reduction differing in the amount should have been used.

Table 5.10 Stated preference of rail attributes – Dandenong rail services

Parameter	All	Peak	Off-Peak	Weekend
On train time	-0.020	-0.023	-0.022	-0.020
Departure Time difference	-0.020	-0.022	-0.020	-0.016
Cost	-0.039	-0.039	-0.059	-0.193
Train Cancellation	-0.173	-0.218	-0.151	-0.052
Express Train Parameter	0.603	0.949	0.190	1.311
Crowding Parameter	0.526	0.492	0.616	0.363
Cleanliness Paramater	0.349	0.335	0.347	0.410
Value of Onboard Train Time $/hr	30.3	34.7	22.3	6.1
Departure Time difference IVT mins	1.0	1.0	0.9	0.8
Crowding (invt mins)	-27	-22	-28	-18
Cleanliness (ivt mins)	-18	-15	-16	-21
Train Cancellation (invt mins)	8.8	9.7	6.9	2.7
Express Train (ivt mins)	-30.6	-42.1	-8.7	-66.6
Number of observations	814	368	363	83

Source: Halcrow (2003)

The first seven attributes listed in the table were more quantitative than qualitative: express services, frequency, fare and reliability. The other 13 attributes covered the amenity and facilities of trains and stations and the provision of information. The improvement which was allocated the most dollars by passengers was a halving of fare. Second was train reliability and third equal was removal of the three-zone pricing and an increased weekday service frequency. The highest-ranked qualitative attribute was feeling safe on trains which was ranked 5th. Air-conditioned trains were 7th and feeling safe at stations was 9th.

The fare value attached to the individual improvements was high relative to the average fare of $3. Respondents were willing to pay 34 cents or 11% of the $3 fare for advance information at stations about train cancellations. Feeling safe on trains was valued at 78 cents per trip (26%) and air conditioning was valued at 68 cents (23%). In total, the package value of the 12 quality improvements was worth $5.66 or 189% of the $3 fare.

Halcrow did not link the results of the PE to the SP survey. However the SP survey did estimate a value of time has been used in table 5.11 to convert the fare values into time values. The estimated average value of time was high at $30.28 per hour which had the effect of lowering the time value of the attribute improvements (compared with a value of time of around $10). For example, the value of air-conditioned trains was equivalent to a 1.3 minute travel time saving with the package of the quality improvements worth 11.2 minutes.

In summary, the study gives an idea of the relative importance of a range of rail attributes but the PE survey overstated the fare value of the improvements.

Table 5.11 Value of rail attributes – Dandenong rail services

#	Attribute	Valuation			Rank
		Fare $	Fare %	IVT mins^	
1	Every second train an express service	0.78	26%	1.5	5
2	Increased frequency of weekday services (50% increase)	0.79	26%	1.6	3
3	Increased frequency of weekend services (50% increase)	0.44	15%	0.9	12
4	Half the existing fare	1.5	50%	3.0	1
5	Removal of zone 3 pricing	0.79	26%	1.6	3
6	Train always within 5 minutes of timetabled time	1.12	37%	2.2	2
7	No more than 1 peak cancellations per week	0.62	21%	1.2	8
8	Ability to get a seat on a regular basis (95% of the time)	0.5	17%	1.0	11
9	Advance information at station about cancellations	0.34	11%	0.7	16
10	Advance information by SMS about cancellations	0.13	4%	0.3	20
11	All trains air-conditioned	0.68	23%	1.3	7
12	Seats always clean	0.54	18%	1.1	10
13	Removal of graffiti	0.3	10%	0.6	19
14	Improved station facilities (seats, shelter, toilet etc)	0.44	15%	0.9	12
15	Fully maintained & cleaned facilities (seats, shelter,toilet etc)	0.38	13%	0.8	14
16	More car parking at the station	0.36	12%	0.7	15
17	Secure parking at the station	0.31	10%	0.6	18
18	Feel safe at all times on the train	0.78	26%	1.5	5
19	Feel safe at all times at the station	0.58	19%	1.1	9
20	Bus timetable scheduled to meet rail services	0.32	11%	0.6	17
	Train Package (11+12+1+18)	2.3	77%	4.6	na
	Station Package (9+14+15+16+17+19+20)	2.73	91%	5.4	na
	Quality Total (sum 8:20)	5.66	189%	11.2	na

^ Calculated using average value of time of $30.28/hr

Source: Halcrow (2003)

5.7 Rail service quality, Sydney – Douglas and Karpouzis 2006

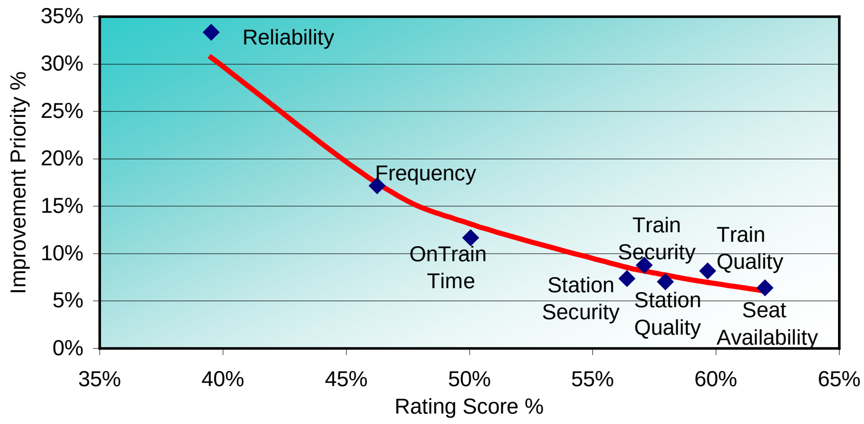
This study estimated values for train and station quality attributes using rating information provided by a questionnaire survey of rail passengers. In this regard, the study is unique from the other studies reviewed.

The rating approach was considered to have 'appeal for measuring qualitative service attributes since by benchmarking quality, as perceived by the passenger, it is possible to interpolate or extrapolate the likely benefit from changes in quality. Thus, it is possible to gauge the likely rating to a station refurbishment by surveying the existing station rating, forecasting the likely rating after improvement and assessing the value of the rating change' (Douglas and Karpouzis 2006).

The study involved two surveys. The first asked passengers to rate attributes of their journey on a nine-point scale with 1 being very poor and 9 excellent. A total of 2,732 passengers were interviewed. Three lists of attributes were presented. The first list included service frequency, on-board train time, reliability, ease of getting a seat, personal security, train, board station. Passengers were also asked to give an overall rating. A second list presented individual train attributes and an overall train rating and a third list presented station attributes and an overall station rating. In all, 48 attributes were covered.

As well as asking rating questions, the survey also included a priority evaluator for the main journey attributes. Passengers were asked to allocate 100 points to indicate their priority for improvement. The priority for improvement was compared with the satisfaction rating. Attributes rated highly tended to have a low priority for improvement. For example, reliability was the most poorly rated attribute, scoring 40% and had the highest priority for improvement attracting 33% of the 100 points. Train quality, station quality, personal security on trains, personal security at stations and seat availability achieved above average ratings and were relatively low priorities for improvement.

Figure 5.2 Improvement priority and rating – 2005-06 RailCorp rating survey



The priority improvement data was not used to develop attribute valuations. This was done by reference to the passenger response to the rating questions. In essence, the individual attribute ratings were used to explain the train, station and overall service ratings.

Statistical models were fitted to the data to explain the relative importance of each attribute. Logistic ('S' shaped) functions were used to constrain the ratings to 0-1 intervals. The size of the estimated parameters indicated the relative importance of the attributes to explaining the overall rating. By including on-board train time, it was possible to express each attribute relative to that of onboard train time.[22]

Three models were estimated. At the top level, an overall rail service rating was modelled on the ratings of frequency, on-train time, reliability, seat availability, train, station and personal security.

At the second level, the overall train rating was modelled on the train attribute ratings: train outside, ease of boarding and alighting, seat comfort, smoothness, quietness, air conditioning, lighting, cleanliness, graffiti, train announcements and layout.

Similarly, the overall station rating was modelled on the individual station attribute ratings: ease of platform boarding and alighting, weather protection, platform seating, platform surface, subway-overbridge, station building, lifts and escalators, signing, station announcements, information, lighting, cleanliness, graffiti, toilets, staff, car park, car drop off, taxi, bus, bicycle, telephone, retail and ticketing.

Table 5.12 presents the estimated model. Proportionate weights were calculated to combine the train and station parameters with the overall model parameters. For the train quality model, a weight of 0.212 was calculated (see equation 5.1) implying train quality explained one-fifth of the overall journey rating.

[22] The relative importance was the ratio of the parameter estimates (the onboard train time parameter being the numeraire).

$$w_{TQ} = \frac{z_{TQ}}{\sum_X z_X} = \frac{1.03}{4.86} = 0.212$$ (Equation 5.1)

where: w_{TQ} = weight for train quality attributes

Likewise, station quality explained one quarter of the over journey rating, the same as reliability. On-train time, was a less important explanatory factor at 10% with service frequency explaining 8% and personal safety 7%. Seat availability was the least important explanatory factor accounting for 3%.

For the individual train attribute rating, the parameter for train outside was estimated at 0.45. Dividing by the sum of the train attributes parameter (4.13) gave a weight of 11%.

The 'final' parameters (ζ'_X) were calculated as the respective model weight (w_M) multiplied by the estimated attribute parameter (ζ_X), equation 5.2.

$$\zeta'_X = w_M \zeta_X$$ (Equation 5.2)

The final parameters are in the sixth column of table 5.12. The seventh column shows the relative importance of each attribute (calculated as the ratio of the individual parameter to the sum of all parameters). Equation 5.3 shows the calculation for train outside which has a proportional weight of 0.023 or 2.3% of the overall journey rating.

$$Pr(z') = \frac{z'_X}{\sum_X z'_X} = \frac{0.11}{4.86} = 0.023$$ (Equation 5.3)

Finally, column 8 gives the parameter ratio (Z_x) of each attribute rating to the on-train time rating thus expressing the attribute ratings in terms of the on-train time rating. For train outside, the ratio was 0.22 and for reliability the ratio was 2.46, equation 5.4.

$$Z_X = \frac{z'_X}{z'_V} = \frac{1.23}{0.5} = 2.46$$ (Equation 5.4)

where:

Z_X = ratio of attribute X rating parameter to on-train time rating parameter

ζ'_X = on-train time rating parameter

There were also some strong positive correlations between the individual attribute ratings. For example, passengers who rated night-time personal security on trains poorly also tended to rate station personal security poorly. The degree of multi-collinearity in attribute ratings required the creation of some 'composite' attributes. The composite ratings were derived by regressing the overall rating on the individual attribute ratings. The relative size of the parameter estimates was then used to develop a weighted average rating

Table 5.12 Relative attribute rating importance – October 2004 – February 2005 survey

Model	Attribute	Model Estimates		Final Parameters		Percent	On-Train Time
		Parameter (ζ)	|t|	Weight	Parameter (ζ')	of Total	Ratio (Zx)
Overall	Frequency	0.40	1.58	100.0%	0.40	8.2%	0.80
"	On Train Time	0.50	1.92	100.0%	0.50	10.3%	1.00
"	Reliability	1.23	5.20	100.0%	1.23	25.3%	2.46
"	Seat Availability	0.15	0.84	100.0%	0.15	3.1%	0.30
"	Train Day Safety	0.09	1.32	100.0%	0.09	1.9%	0.18
"	Train Night Safety	0.07		100.0%	0.07	1.4%	0.14
"	Station Day Safety	0.09		100.0%	0.09	1.9%	0.18
"	Station Night Safety	0.07		100.0%	0.07	1.4%	0.14
"	Train Quality	1.03	3.72	100.0%	1.03	21.2%	2.06
"	Station Quality	1.23	4.51	100.0%	1.23	25.3%	2.46
"	Total Rail Service	4.86	na	100.0%	4.86	100.0%	9.72
Train	Train Outside	0.45	2.51	11%	0.11	2.3%	0.22
"	Ease of Board & Alight	0.39	2.00	9%	0.10	2.0%	0.19
"	Seat Comfort	0.44	2.40	11%	0.11	2.3%	0.22
"	Smoothness	0.36	1.71	9%	0.09	1.8%	0.18
"	Quietness	0.43	2.10	10%	0.11	2.2%	0.21
"	Air Conditioning	0.55	3.40	13%	0.14	2.8%	0.27
"	Lighting	0.16	0.94	4%	0.04	0.8%	0.08
"	Train Grafitti	0.17	3.08	4%	0.04	0.9%	0.08
"	Train Cleanliness	0.42		10%	0.11	2.2%	0.21
"	Train Announcements	0.23	2.10	6%	0.06	1.2%	0.12
"	Layout	0.53	3.30	13%	0.13	2.7%	0.26
"	Total Train Attributes	4.13	na	100%	1.03	21.2%	2.06
Station	Platform Train On-Off	0.19	0.33	2%	0.03	0.5%	0.05
"	Weather Protection	0.24	0.55	3%	0.03	0.7%	0.07
"	Platform Seating	0.23	0.32	3%	0.03	0.7%	0.06
"	Platform Surface	0.15	0.22	2%	0.02	0.4%	0.04
"	Subway / Overbridge	0.52	1.52	6%	0.07	1.5%	0.15
"	Station Building	0.54	0.35	6%	0.08	1.5%	0.15
"	Lifts & Escalators	0.48	0.31	5%	0.07	1.4%	0.13
"	Information	0.35	1.64	4%	0.05	1.0%	0.10
"	Announcements	0.43		5%	0.06	1.2%	0.12
"	Signing	0.43		5%	0.06	1.2%	0.12
"	Lighting	0.42	0.54	5%	0.06	1.2%	0.12
"	Station Cleanliness	0.59	1.50	7%	0.08	1.7%	0.16
"	Station Grafitti	0.59		7%	0.08	1.7%	0.16
"	Toilets	0.30	0.41	3%	0.04	0.9%	0.08
"	Staff	1.05	2.03	12%	0.15	3.0%	0.29
"	Car Park	0.07	0.14	1%	0.01	0.2%	0.02
"	Car Drop Off	0.05		1%	0.01	0.2%	0.01
"	Taxi	0.16	0.18	2%	0.02	0.5%	0.04
"	Bus	0.71	0.96	8%	0.10	2.0%	0.20
"	Bike	0.07	0.12	1%	0.01	0.2%	0.02
"	Telephone	0.17	0.38	2%	0.02	0.5%	0.05
"	Retail	0.15		2%	0.02	0.4%	0.04
"	Ticketing	0.98	1.66	11%	0.14	2.8%	0.27
"	Total Station Attribute	8.86	na	100%	1.23	25.3%	2.46

Source: RailCorp Surveys, Douglas Economics Analysis DEL Valuation06_5b.xls!Model

The second survey asked questions that enabled the on-train rating to be translated into on-train time minutes. By doing so, it was possible to develop travel time valuations for all the attributes. A sample of 1,100 passengers was obtained. Passengers were asked to estimate the time they would spend onboard the train, how they rated the speed of their train service on a one to nine scale and how short the travel time would have to be for them to rate the speed as excellent.

A statistical model was estimated that took into account the current rating and on-board travel time. The fitted model ensured that the required travel time reduction was zero for an excellent rating and increased as the rating reduced. The model also meant that a larger proportional travel time saving was required for a good rating than an average rating. The model also took account of length of travel. For example, passengers travelling 15 minutes and who rated their train time average (50%) would require a six-minute reduction (40% quicker) to rate it excellent. By comparison, passengers travelling 40 minutes required a 15-minute reduction (37.5% quicker). The values were converted into fare by applying values of travel time.[23]

Table 5.13 presents the estimated value of improving the rating of each attribute by ten percentage points. Tables 5.14 and 5.15 provide tabulations by trip length and time period measured in in-vehicle minutes and percentage fare.

The train attributes were calculated from a base rating of 60% and the station values from a base attribute rating of 50%. Onboard train time (IVT) and fare valuations are presented.[24] Two values are given for improving the overall train and station rating: the sum of the individual attribute ratings and the overall or ‘package’ value. In both cases, the package value was greater than the sum of the attribute valuations which contrasts with SP and PE estimates where attribute valuations are often factored down to get plausible package valuations.

For trains, a 10% point ‘package’ improvement was valued at 2.23 minutes compared with 1.92 minutes for improving each train attribute by 10% points. For stations, the values were 1.25 and 1.07 minutes respectively.

In terms of fare, the train package was valued at 32.6 cents or 12.4% of the average fare and the station improvement package at 18.3 cents (6.4%)

[23] An average value of $8.80 per hour was estimated by SP survey, see Douglas Economics (2004a)

[24] To calculate percentage fare valuations, the fare valuation was divided by the average fare of $2.62.

Table 5.13 Value of train and station attributes for Sydney rail services – value of a 10 percentage point improvement

Train 60% Train & 60% Attrib Rating	IVT mins	Fare Cents	Fare %
Train Outside Appearance	0.15	2.2	0.8%
Ease of Train Boarding	0.22	3.2	1.2%
Seat Comfort	0.07	1.0	0.4%
Smoothness of Ride	0.10	1.5	0.6%
Quietness	0.22	3.2	1.2%
Heating & Air Conditioning	0.15	2.2	0.8%
Lighting	0.13	1.9	0.7%
Cleanliness	0.26	3.8	1.4%
Grafitti	0.08	1.2	0.4%
On-train Announcements	0.16	2.3	0.9%
Layout & Design	0.38	5.5	2.1%
Sum of Attributes	1.92	28.0	10.7%
Overall Train	2.23	32.6	12.4%
Personal Security 50% Rating	**IVT mins**	**Fare Cents**	**Fare %**
Personal Security Trn& Stat	0.68	10.0	3.5%

Station 60% Stat & 50% Attrib Rating	IVT mins	Fare Cents	Fare %
Ease of Train On & Off	0.08	1.2	0.4%
Platform Weather Protection	0.004	0.1	0.0%
Platform Seating	0.04	0.6	0.2%
Platform Surface	0.07	1.0	0.4%
Subway/Overbridge	0.01	0.1	0.1%
Station Building	0.10	1.5	0.6%
Lifts/Escalators	0.03	0.4	0.2%
Signing	0.05	0.7	0.3%
Station Announcements	0.05	0.7	0.3%
Information	0.03	0.4	0.2%
Station Lighting	0.03	0.4	0.2%
Cleaning	0.13	1.9	0.7%
Grafitti	0.05	0.7	0.3%
Toilets	0.01	0.1	0.1%
Staff	0.09	1.3	0.5%
Car Park	0.01	0.1	0.1%
Car Park Drop Off	0.01	0.2	0.1%
Taxi	0.01	0.1	0.0%
Bus Transfer & Waiting	0.02	0.4	0.1%
Bike Facilities	0.02	0.3	0.1%
Telephone	0.01	0.1	0.0%
Retail	0.05	0.7	0.3%
Ticketing	0.16	2.4	0.9%
Sum of Attributes	1.07	15.5	5%
Station Overall	1.25	18.3	6%

Amongst the train attributes, train layout and design was the most highly valued at 0.38 minutes; cleanliness was second and ease of train boarding third.

For stations, ticket purchase (ticket office and automatic ticket machines) station cleanliness, the availability and helpfulness of station staff and the station building were the most valued improvements. Telephones and platform weather protection were the least valued. An oddity is the low value attributed to weather protection.

The value of improving personal security from 50% to 60% was estimated to be worth 0.68 minutes.[25]

Table 5.14 shows the valuations to increase with trip length especially for train attributes. For example, the peak overall train valuation increases from 0.71 minutes for short trips (under 25 minutes) to 0.1.92 minutes for medium trips (25-59 mins) and to 4.46 minutes for long trips (over 60 minutes). A similar rise

[25] Strong correlations between the ratings of personal security on trains and at stations for day and night time travel meant that only an overall valuation was reported.

in value was estimated for off-peak trips with off-peak passengers tending to have a higher valuation than average peak passengers. (2.25 minutes versus 1.65 minutes).

Table 5.14 Sydney train and station IVT valuations by market segment – valuations in rail IVT (mins) for a 10 percentage point improvement

Train Attributes	Peak			Off-Peak			All Trip Lengths		
Train 60% Attrib 60%	Short	Medium	Long	Short	Medium	Long	Peak	Off-Pk	All
Train Outside	0.05	0.15	0.36	0.08	0.22	0.46	0.13	0.12	0.15
Board/Alight	0.07	0.22	0.5	0.12	0.32	0.65	0.19	0.26	0.22
Seat Comfort	0.02	0.07	0.17	0.04	0.1	0.22	0.06	0.09	0.07
Ride Smoothness	0.03	0.1	0.24	0.06	0.15	0.31	0.09	0.12	0.1
Quietness	0.07	0.22	0.5	0.12	0.31	0.65	0.19	0.26	0.22
Air Conditioning	0.05	0.15	0.35	0.08	0.22	0.45	0.13	0.18	0.15
Lighting	0.04	0.13	0.3	0.07	0.19	0.39	0.11	0.16	0.13
Cleanliness	0.08	0.26	0.6	0.14	0.37	0.77	0.22	0.31	0.26
Graffiti	0.03	0.08	0.19	0.05	0.12	0.25	0.07	0.1	0.08
Announcements	0.05	0.16	0.37	0.09	0.23	0.47	0.14	0.19	0.16
Layout	0.12	0.38	0.88	0.21	0.54	1.13	0.32	0.46	0.38
Sum Attribute Values^	0.61	1.92	4.46	1.06	2.77	5.75	1.65	2.25	1.92
Overall Train Rating*	0.71	2.25	5.32	1.17	3.12	6.56	1.93	2.64	2.23
Station Attributes	Peak			Off-Peak			All Trip Lengths		
Station 60% Attrib 50%	Short	Medium	Long	Short	Medium	Long	Peak	Off-Pk	All
Ease of Train On-Off	0.03	0.08	0.18	0.04	0.1	0.2	0.07	0.08	0.08
Weather Protection	0.002	0.005	0.01	0.002	0.006	0.012	0.004	0.005	0.004
Platform Seating	0.02	0.05	0.01	0.02	0.06	0.12	0.04	0.05	0.04
Platform Surface	0.03	0.07	0.16	0.04	0.09	0.18	0.06	0.08	0.07
Subway/Overbridge	0.04	0.011	0.024	0.005	0.014	0.027	0.009	0.011	0.01
Station Building	0.04	0.01	0.23	0.05	0.013	0.027	0.09	0.11	0.1
Lifts/Escalators	0.01	0.03	0.06	0.01	0.04	0.007	0.02	0.03	0.03
Signing	0.02	0.05	0.12	0.03	0.07	0.13	0.04	0.05	0.05
Announcements	0.02	0.06	0.12	0.03	0.07	0.14	0.05	0.06	0.05
Information	0.01	0.03	0.06	0.01	0.03	0.07	0.02	0.03	0.03
Lighting	0.01	0.03	0.07	0.02	0.04	0.08	0.03	0.03	0.03
Cleanliness	0.05	0.14	0.3	0.07	0.17	0.34	0.12	0.14	0.13
Graffiti	0.02	0.05	0.12	0.03	0.07	0.13	0.04	0.06	0.05
Toilets	0	0.01	0.03	0.01	0.02	0.03	0.01	0.01	0.01
Station Staff	0.03	0.09	0.2	0.05	0.12	0.23	0.08	0.1	0.09
Car Park	0	0.01	0.03	0.01	0.02	0.03	0.01	0.01	0.01
Car Drop Off	0.005	0.013	0.03	0.007	0.017	0.034	0.011	0.014	0.013
Taxi Facilities	0.002	0.005	0.012	0.003	0.007	0.014	0.005	0.006	0.005
Bus Facilities	0.009	0.025	0.056	0.012	0.032	0.063	0.021	0.027	0.024
Bike Facilities	0.009	0.024	0.054	0.012	0.031	0.061	0.021	0.026	0.023
Telephone	0.002	0.006	0.013	0.003	0.007	0.014	0.005	0.006	0.005
Stat Facilities	0.019	0.052	0.115	0.026	0.066	0.132	0.044	0.055	0.049
Ticketing	0.061	0.172	0.383	0.084	0.217	0.435	0.147	0.182	0.162
Sum Attributes^	0.439	1.023	2.387	0.574	1.31	2.506	0.947	1.172	1.065
Overall Station*	0.46	1.36	3.13	0.62	1.65	3.33	1.16	1.37	1.25

Notes: ^ Sum of attribute valuations; * value of improving train/station rating by 10% points
Short 0-14 mins rail IVT; Med 25-59; Long >59 mins; Peak Wekkday 0600-0930 & 1500-1830

Table 5.15 also shows the percentage fare valuation to increase with trip length. To some extent, these values depend on the value of time and the average fare. For the overall train rating, the peak value increased from 5.3% for short trips to 11.8% for medium and 15.9% for long trips. The same rise in value was estimated for off-peak trips but with off-peak passengers tending to have a higher valuation than peak passengers.

Table 5.15 Sydney train and station % fare valuations by market segment – valuations in percentage fare for a 10 percentage point improvement

Train Attributes	Peak			Off-Peak			All Trip Lengths		
Train 60% Attrib 60%	Short	Medium	Long	Short	Medium	Long	Peak	Off-Pk	All
Train Outside	0.4%	0.8%	1.1%	0.6%	1.3%	1.5%	0.7%	0.7%	0.8%
Board/Alight	0.5%	1.2%	1.5%	0.9%	1.9%	2.2%	1.0%	1.5%	1.2%
Seat Comfort	0.1%	0.4%	0.5%	0.3%	0.6%	0.7%	0.3%	0.5%	0.4%
Ride Smoothness	0.2%	0.5%	0.7%	0.4%	0.9%	1.0%	0.5%	0.7%	0.6%
Quietness	0.5%	1.2%	1.5%	0.9%	1.8%	2.2%	1.0%	1.5%	1.2%
Air Conditioning	0.4%	0.8%	1.0%	0.6%	1.3%	1.5%	0.7%	1.0%	0.8%
Lighting	0.3%	0.7%	0.9%	0.5%	1.1%	1.3%	0.6%	0.9%	0.7%
Cleanliness	0.6%	1.4%	1.8%	1.0%	2.1%	2.6%	1.2%	1.8%	1.4%
Graffiti	0.2%	0.4%	0.6%	0.4%	0.7%	0.8%	0.4%	0.6%	0.4%
Announcements	0.4%	0.8%	1.1%	0.7%	1.3%	1.6%	0.8%	1.1%	0.9%
Layout	0.9%	2.0%	2.6%	1.5%	3.1%	3.8%	1.7%	2.7%	2.1%
Sum Attributes	4.5%	10.1%	13.3%	7.7%	16.0%	19.2%	9.0%	13.1%	10.7%
Overall Train	5.3%	11.8%	15.9%	8.5%	18.0%	22.0%	10.5%	15.3%	12.4%
Station Attributes	Peak			Off-Peak			All Trip Lengths		
Station 60% Attrib 50%	Short	Medium	Long	Short	Medium	Long	Peak	Off-Pk	All
Ease of Train On-Off	0.2%	0.4%	0.5%	0.3%	0.6%	0.7%	0.4%	0.5%	0.4%
Weather Protection	0.01%	0.03%	0.03%	0.01%	0.03%	0.04%	0.02%	0.03%	0.02%
Platform Seating	0.1%	0.3%	0.0%	0.1%	0.3%	0.4%	0.2%	0.3%	0.2%
Platform Surface	0.2%	0.4%	0.5%	0.3%	0.5%	0.6%	0.3%	0.5%	0.4%
Subway/Overbridge	0.3%	0.1%	0.1%	0.0%	0.1%	0.1%	0.0%	0.1%	0.1%
Station Building	0.3%	0.1%	0.7%	0.4%	0.1%	0.1%	0.5%	0.6%	0.6%
Lifts/Escalators	0.1%	0.2%	0.2%	0.1%	0.2%	0.0%	0.1%	0.2%	0.2%
Signing	0.1%	0.3%	0.4%	0.2%	0.4%	0.4%	0.2%	0.3%	0.3%
Announcements	0.1%	0.3%	0.4%	0.2%	0.4%	0.5%	0.3%	0.3%	0.3%
Information	0.1%	0.2%	0.2%	0.1%	0.2%	0.2%	0.1%	0.2%	0.2%
Lighting	0.1%	0.2%	0.2%	0.1%	0.2%	0.3%	0.2%	0.2%	0.2%
Cleanliness	0.4%	0.7%	0.9%	0.5%	1.0%	1.1%	0.7%	0.8%	0.7%
Graffiti	0.1%	0.3%	0.4%	0.2%	0.4%	0.4%	0.2%	0.3%	0.3%
Toilets	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Station Staff	0.2%	0.5%	0.6%	0.4%	0.7%	0.8%	0.4%	0.6%	0.5%
Car Park	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Car Drop Off	0.0%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%	0.1%
Taxi Facilities	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Bus Facilities	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
Bike Facilities	0.1%	0.1%	0.2%	0.1%	0.2%	0.2%	0.1%	0.2%	0.1%
Telephone	0.01%	0.03%	0.04%	0.02%	0.04%	0.05%	0.03%	0.03%	0.03%
Stat Facilities	0.1%	0.3%	0.3%	0.2%	0.4%	0.4%	0.2%	0.3%	0.3%
Ticketing	0.5%	0.9%	1.1%	0.6%	1.3%	1.5%	0.8%	1.1%	0.9%
Sum Attributes	3.3%	5.4%	7.1%	4.2%	7.6%	8.4%	5.1%	6.8%	5.9%
Overall Station	3.4%	7.2%	9.3%	4.5%	9.5%	11.1%	6.3%	7.9%	7.0%
Value of Time $/hr	9.51	9.35	9.53	8.14	7.60	7.23	9.46	7.83	8.76
Average Fare $/trip	2.13	2.96	5.32	1.87	2.19	3.60	2.90	2.25	2.62

Notes: ^ Sum of attribute valuations; * value of improving train/station rating by 10% points
Short 0-14 mins rail IVT; Med 25-59; Long >59 mins; Peak Wekkday 0600-0930 & 1500-1830

The results were used to estimate the value of different rolling stock types. The average passenger rating for the different train types in the fleet ranged from 54% (for R&S sets, the oldest in the fleet) to 72% (for the newest Millennium sets), a difference of 18% points. When valued, the difference in rating was worth 2.7 minutes or 38 cents per trip (13% of the average fare) for the best versus the worst. When halved to get the value of improving train quality from average to the highest gives a value of 1.3 minutes or 19 cents (7.5% of the average fare).

For stations, the value of improving the worst-rated station (39%) to that of the highest (75%) would be valued the same as a 4.5 minute saving in rail time and a 25% fare reduction.

Both the train and station rating valuations were close to those estimated in 1994/95 study. For a 10% point improvement in train rating, the survey estimated a package value of 2.2 minutes which compares with 1.9 minutes estimated in 1994/95. The station value of 1.25 minutes compared with 1.1 minutes estimated in 1994/95.

RailCorp has used the attribute values in the economic appraisal of rolling stock and station improvements. As the values do not relate to specific improvements but rather to passenger ratings, an additional step is required. For instance, to evaluate a station upgrade, the analyst would need to estimate the passenger rating before the improvement and forecast the rating after the improvement. The 'before' rating could be based on a survey at the station. The 'after' rating could be benchmarked against other stations.

In summary, the study developed a system for valuing train and station quality based on passenger ratings without any SP type trade-off questions. In this respect, the study was unique. The use of ratings is an efficient way of describing quality from a passenger perspective and avoids the need to develop quality levels. The approach was used in a stepwise fashion to value overall train quality and then individual train attributes. Unlike other studies, the nature of the fitted model meant that the package effect was greater, albeit not markedly, than the sum of the effect of the individual attributes. Improving train quality from an average standard to the highest was assessed equivalent to a 1.3 minute travel time reduction or 19 cents (7.5% of the average fare). Values were produced for the peak and off-peak and by trip length.

5.8 Wellington station quality – Douglas Economics 2005

This study by Douglas Economics for Tranz Metro Wellington involved a passenger rating and importance survey of station attributes. The study purpose was to provide management information on passenger satisfaction with station quality across the network and priorities for improvements.

The study has been included because it provides an assessment of an actual station redevelopment in New Zealand by passengers. The study also demonstrates the potential to overestimate passenger valuations using the PE technique.

Surveys were undertaken in 2002 and 2004/05 with the findings reported in 2005 for Tranz Metro Wellington. Passengers were asked to rate various aspects of the stations they used and indicate their priorities for improvement. In 2002, 2,560 passengers were surveyed and in 2004/5, 2,123 were surveyed.[26] Of particular interest was the redevelopment of Petone station (ranked 6th biggest in usage of the 54 station network) in 2003 between the two surveys. The survey therefore provides useful 'before and after' data to assess the impact of station redevelopment from a passenger perspective. In 2002, 113 Petone station users were interviewed and in 2004/05, 80 were interviewed.

Passengers were asked to rate rail station attributes for the station they used, see table 5.16.

[26] The sample sizes exclude non-metro stations, ie those on the Palmerston North and Wairarapa lines.

Table 5.16 Station ratings by Wellington rail users 2002 and 2004/05

Attribute	All Stations		Petone	
	2002	2004/5	2002	2004/5
Station Signage	53%	58%	45%	72%
Ease of Getting On/Off the Train from Platform	67%	71%	72%	79%
Platform Weather Protection - Wind & Rain	46%	48%	50%	64%
Platform Seating Availability, Comfort & Appearance	41%	40%	40%	63%
Platform Surface Smoothness and Appearance	50%	49%	48%	68%
Subway or Overbridge Design and Appearance	50%	48%	47%	55%
Main Station Building Design and Appearance	45%	49%	36%	78%
Information about Train Services at Station	56%	56%	57%	75%
Availability and Friendliness of Station Staff	63%	66%	66%	78%
Station Lighting	47%	52%	47%	69%
General Station Cleanliness	47%	51%	47%	73%
Toilet Availability Appearance and Cleanliness	39%	43%	-	55%
Day Time Feeling of Station Personal Security	65%	67%	63%	80%
Night Time Feeling of Station Personal Security	42%	45%	37%	59%
Car Parking Facilities, Security and Access	58%	55%	61%	61%
Car Drop Off Area and Waiting Facilities	51%	54%	48%	62%
Taxi Waiting Area and Facilities	46%	48%	50%	66%
Bus Transfer Area and Waiting Facilities	45%	49%	51%	72%
Bike Rack Facilities and Security	46%	51%	42%	59%
Station Telephones	50%	51%	44%	57%
Station Retail Catering & Vending Machines	53%	53%	-	57%
Ticket Purchase at Station	65%	66%	58%	70%
Overall Station Rating	48%	54%	46%	67%
Sample Size	2,560	2,123	113	80

Passengers rated 23 station attributes and provided an overall rating for the station they used on 1 – 9 scale (1 very poor and 9 excellent).[27] The scale was then transformed into a percentage scale ({1-R}/8). No attempt was made to develop a station rating model similar to that developed for Sydney (see previous section) although the data would have enabled such a model to be estimated.

Across all metro stations, the overall station rating was 'average' changing only slightly between the two surveys: from 48% in 2002 to 54% in 2004/05. However for Petone, the overall station rating increased by 21 percentage points, rising from 46% in 2002 before redevelopment to 67% in 2004/05 after redevelopment. The biggest increase was for the main station building which increased from a rating of 36% to 78%. After completing the rating questions, passengers were asked to allocate $100 to a list of station improvements to indicate their priorities for improvement. At the bottom of the list, was a five-minute faster train time which provided a guide to the relative valuation of the improvements, see table 5.17.

[27] Some facilities were unavailable at some stations. Tranz Metro provided a list of stations where subway/overbridges, staff, toilets, bicycle racks, telephones, retail and ticket purchase facilities were available. The data was applied to the passenger ratings. Where facilities were unavailable, the rating was omitted from the analysis.

Table 5.17 Station improvements 2002 and 2004/05 – share of $100 allocated to improvement

Improvement	All Stations 2002	All Stations 2004/5	Petone 2002	Petone 2004/5
Station Signage	3%	3%	3%	3%
Ease of Getting On/Off the Train from Platform	3%	2%	2%	4%
Platform Weather Protection - Wind & Rain	16%	16%	11%	15%
Platform Seating Availability, Comfort & Appearance	7%	9%	7%	4%
Platform Surface Smoothness and Appearance	3%	2%	1%	1%
Subway or Overbridge Design and Appearance	3%	3%	4%	7%
Main Station Building Design and Appearance	3%	3%	9%	2%
Timetable Information about Train Services	2%	2%	1%	2%
Platform "Real-Time" Information Displays on Next Train	9%	12%	7%	11%
Availability and Friendliness of Station Staff	1%	1%	1%	0%
Station Lighting	7%	5%	8%	1%
General Station Cleanliness	4%	4%	3%	1%
Toilet Availability Appearance and Cleanliness	7%	7%	10%	7%
Emergency Help Points	3%	3%	3%	1%
Security Cameras at the Station	7%	8%	9%	6%
Car Parking Facilities	3%	3%	4%	6%
Car Drop Off Area and Waiting Facilities	1%	1%	2%	4%
Taxi Waiting Area and Facilities	1%	0%	0%	0%
Bus Transfer Area and Waiting Facilities	1%	1%	2%	1%
Bike Rack Facilities	1%	1%	1%	2%
Station Telephones	4%	3%	1%	0%
Station Retail Catering & Vending Machines	2%	1%	3%	1%
Ticket Purchase at Station	2%	2%	1%	1%
Five Minutes Faster Train Trip	9%	8%	7%	18%
Sample Size	2,560	2,123	113	80

For metro stations, passenger priorities for improvement remained roughly constant whereas for Petone, station redevelopment changed passenger priorities noticeably as can be seen from table 5.18 which presents the valuation in IVT minutes and table 5.19 which presents valuations in terms of the percentage fare.

For all stations, just less than 10% of the budget was allocated to the five-minute journey time improvement and 90% to station improvements. The most important station improvement was improved weather protection at 16% followed by RTI (9%–12%), platform seating (7%–9%), security cameras (7%–8%) and toilets (7%).

Before Petone station was redeveloped, 7% of passengers' improvement budget was allocated to journey time improvements; slightly less than average. After redevelopment, passengers shifted more of their improvement budget towards a faster rail trip so that at 18%, the share was noticeably more than for the average station. The biggest compensating reductions were for the design and appearance of the main station building (9% –2%) and for station lighting (8%–1%). For both these attributes, the rating had increased noticeably.

The study did not report any attribute valuations since this was not a study objective. In fact, as only one journey time was presented it was not possible to derive marginal valuations expressed in travel time.[28] What is presented in table 5.18 is an 'average' value calculated as the attribute share divided by the journey time share multiplied by five minutes. Table 5.19 has used a value of time of $4 per hour and an

[28] Marginal valuations would have required at least two journey time savings to have been presented to passengers. For example, another questionnaire could have presented a 10-minute saving, an approach used in the 1994 Sydney study (see section 5.2).

average fare of $2.80 for all metro trips and $2.54 for Petone trips to calculate the percentage fare valuation.[29]

Table 5.18 Rail travel time value of improvement – value in rail time minutes

Improvement	All Stations		Petone		
	2002	2004/5	2002	2004/5	Dif
Station Signage	1.7	1.9	2.1	0.8	1.3
Ease of Getting On/Off the Train from Platform	1.7	1.3	1.4	1.1	0.3
Platform Weather Protection - Wind & Rain	8.9	10.0	7.9	4.2	3.7
Platform Seating Availability, Comfort & Appearance	3.9	5.6	5.0	1.1	3.9
Platform Surface Smoothness and Appearance	1.7	1.3	0.7	0.3	0.4
Subway or Overbridge Design and Appearance	1.7	1.9	2.9	1.9	0.9
Main Station Building Design and Appearance	1.7	1.9	6.4	0.6	5.9
Timetable Information about Train Services	1.1	1.3	0.7	0.6	0.2
Platform "Real-Time" Information Displays on Next Train	5.0	7.5	5.0	3.1	1.9
Availability and Friendliness of Station Staff	0.6	0.6	0.7	0.0	0.7
Station Lighting	3.9	3.1	5.7	0.3	5.4
General Station Cleanliness	2.2	2.5	2.1	0.3	1.9
Toilet Availability Appearance and Cleanliness	3.9	4.4	7.1	1.9	5.2
Emergency Help Points	1.7	1.9	2.1	0.3	1.9
Security Cameras at the Station	3.9	5.0	6.4	1.7	4.8
Car Parking Facilities	1.7	1.9	2.9	1.7	1.2
Car Drop Off Area and Waiting Facilities	0.6	0.6	1.4	1.1	0.3
Taxi Waiting Area and Facilities	0.6	0.0	0.0	0.0	0.0
Bus Transfer Area and Waiting Facilities	0.6	0.6	1.4	0.3	1.2
Bike Rack Facilities	0.6	0.6	0.7	0.6	0.2
Station Telephones	2.2	1.9	0.7	0.0	0.7
Station Retail Catering & Vending Machines	1.1	0.6	2.1	0.3	1.9
Ticket Purchase at Station	1.1	1.3	0.7	0.3	0.4
Total	51.7	57.5	66.4	22.2	44.2

As can be seen, the package valuation which is the summation of the attribute values was large. For metro stations, the package valuation was over 50 minutes. Amongst the attributes, weather protection was worth 9 to 10 minutes; RTI 5 to 7.5 minutes and platform seating 4 to 6 minutes.

For Petone station, the package of improvements was valued at 66 minutes before redevelopment and 22 minutes after redevelopment. Thus station redevelopment can inferred to have been worth 44 minutes of journey time or 116% of the average fare.

As the overall rating of Petone station increased by 21 percentage points, the survey results imply that a 10 percentage rating point improvement would be worth 21 minutes of onboard train time [30] which compares with only 1.25 minutes estimated by the Sydney rating model (see section 5.7). The Wellington valuation is therefore 17 times higher than the Sydney value.

The estimated values produced by the PE are considered high and probably resulted from the questionnaire focusing passenger attention unduly on station quality.

[29] The revenue per trip was estimated by Douglas Economics in a large-scale profile survey for Tranz Metro Wellington (Douglas Economics 2005).

[30] 100x((44 minutes ÷ 21) ÷ 10)

Table 5.19 Percentage fare value of improvement

Improvement	All Stations		Petone		
	2002	2004/5	2002	2004/5	Dif
Station Signage	4%	4%	6%	2%	3%
Ease of Getting On/Off the Train from Platform	4%	3%	4%	3%	1%
Platform Weather Protection - Wind & Rain	21%	24%	21%	11%	10%
Platform Seating Availability, Comfort & Appearance	9%	13%	13%	3%	10%
Platform Surface Smoothness and Appearance	4%	3%	2%	1%	1%
Subway or Overbridge Design and Appearance	4%	4%	7%	5%	2%
Main Station Building Design and Appearance	4%	4%	17%	1%	15%
Timetable Information about Train Services	3%	3%	2%	1%	0%
Platform "Real-Time" Information Displays on Next Train	12%	18%	13%	8%	5%
Availability and Friendliness of Station Staff	1%	1%	2%	0%	2%
Station Lighting	9%	7%	15%	1%	14%
General Station Cleanliness	5%	6%	6%	1%	5%
Toilet Availability Appearance and Cleanliness	9%	10%	19%	5%	14%
Emergency Help Points	4%	4%	6%	1%	5%
Security Cameras at the Station	9%	12%	17%	4%	12%
Car Parking Facilities	4%	4%	7%	4%	3%
Car Drop Off Area and Waiting Facilities	1%	1%	4%	3%	1%
Taxi Waiting Area and Facilities	1%	0%	0%	0%	0%
Bus Transfer Area and Waiting Facilities	1%	1%	4%	1%	3%
Bike Rack Facilities	1%	1%	2%	1%	0%
Station Telephones	5%	4%	2%	0%	2%
Station Retail Catering & Vending Machines	3%	1%	6%	1%	5%
Ticket Purchase at Station	3%	3%	2%	1%	1%
Total	123%	137%	174%	58%	116%

Based on $4/hr value of time & average fare of $2.80 All metro trips and $2.54 for Petone trips

5.9 London bus and train values – SDG research 1995 to 2007

These London surveys are of particular relevance since, as identified by Bristow and Davison (2009), the values used by the ATC (2006) in their appraisal guidelines 'follow a similar pattern and use the TfL *Business case development manual* as a source' and these values were then transferred to the EEMV2.

The London research dates back to market research undertaken in 1995 by SDG of bus trip quality (SDG 1996). The research has been repeated, the most recent being undertaken in 2006/07. Unfortunately, it was not possible to obtain the original SDG market research reports and so this review is reliant on commentary by Bristow and Davison (2009) and the values published in the TfL (2008) *Business case development manual.*

The SDG (1996) study looked at 32 bus attributes. In-depth interviews with 17 bus passengers helped group the attributes to reflect different parts of a journey. SP surveys were then undertaken of 947 respondents across London. The make-up of the sample is not known but is presumed to have been people who had used bus. There were three types of SP. The first SP looked at different parts of a journey and did not include fare. The parts of the journey were: pre-trip information, bus stop infrastructure, information at bus stops (including reliability), hailing and boarding, the driver, moving to a seat, travelling in a seat (including travel time) and leaving the bus.

The second SP presented bundles of attributes (taking attributes from the first SP) and asked passengers to trade off quality versus fare. The third SP was a maximum willingness-to-pay SP based on an ideal bus service composed of the respondent's top four attributes priced at 10 pence, 20 pence, 30 pence and 40 pence more than an 'as now' bus service.

The results of the second SP were used to estimate a bundle or package value which was then unpacked using the results of the first SP. The ideal service SP was used to identify respondent 'outliers' and help identify inconsistent responses. In fact, 27% of the 947 respondents were removed from the data-set because of 'inconsistent responses' which as Bristow comments is a 'high level of inconsistency'.

The estimated values are presented in table 5.20. SDG as cited in Bristow and Davison (2009) presented the values in pence per trip. In table 5.20, a percentage fare valuation is presented (based on a fare of 37 pence).[31] Also presented is an IVT valuation which used a value of time of 1.2 pence/minute (72 pence per hour) estimated by the study. [32] Regarding the value of time, SDG considered the survey to have estimated 'low' values. Indeed, Bristow considered the values to be 'very low compared to the other studies which also tend to find low values of time for bus users'. [33] The implication of using a higher value of time would be to produce lower time-based valuations.

[31] There was no estimate of the average bus fare but for 2003, the average fare was 44 pence per passenger trip. Applying the change in the Retail Price Index gives a figure of 37 pence for 1995.

[32] The 1995 SP obtained a value of in-bus time that declined with trip length. For short trips (up to 10 minutes), the value was 90 pence per hour; for medium trips (1--20 minutes) the value was 72 pence per hour and for longer bus trips (over 20 minutes) the value was 24 pence per hour.

[33] Converting to NZ$ at an exchange rate of $NZ3 per £ (an approximate value for that time) gives a value of time of $NZ2.16 for the medium trip category. The value is therefore less than half the current (2012) New Zealand value of onboard bus time of $5 per hour.

Table 5.20 London bus values – adapted from SDG (1996)

Attribute Category	Attribute Level	Value UK p/trip (1996)	% of Fare^	Value mins/trip#
Pre Trip	Standard timetables, at home	5.5	15%	4.6
	Standard Maps, at home	3.9	11%	3.3
	Five star phone service	2.8	8%	2.3
	Customized local information, at home	2.0	5%	1.7
Bus Stop Infrastructure	Shelter with roof and end panel	5.6	15%	4.7
	Basic shelter, with roof	4.5	12%	3.8
	Moulded seats at bus stop	*3.4*	*9%*	*2.8*
	Lighting at bus stop	3.1	8%	2.6
	Flip seats at bus stop	2.2	6%	1.8
	Bench seats at bus stop	*0.9*	*2%*	*0.8*
	Dirty bus stop	-11.8	-32%	-9.8
Bus Stop Infrastructure	Guaranteed customized local info at stop	10.0	27%	8.3
	Countdown	9.0	24%	7.5
	Guaranteed current info at stops	8.8	24%	7.3
	Best reliability improvement (>=10 headway)	7.8	21%	6.5
	Best reliability improvement (<=10 headway)	7.1	19%	5.9
	Medium reliability improvement (>= 10 headway)	6.8	18%	5.7
	Medium reliability improvement (<=10 headway)	4.4	12%	3.7
	Payphones at bus stops	3.8	10%	3.2
	Phones X medium reliability (<=10 headway)	-3.8	-10%	-3.2
	Phones X best reliability (>=10 headway)	-4.8	-13%	-4.0
	Phones X best reliability (<=10 headway)	-5.0	-14%	-4.2
	Countdown X medium reliability (<=10 headway)	-5.0	-14%	-4.2
	Countdown x best reliability (>=10 headway)	-5.3	-14%	-4.4
	Phones X medium reliability (>=10 headway)	-5.5	-15%	-4.6
	Countdown X best reliability (<=10 headway)	-6.7	-18%	-5.6
	Countdown X medium reliability (>=10 headway)	-6.9	-19%	-5.8
Hail & Board	Bus stops close to kerb	5.8	16%	4.8
	Bus branding	2.8	8%	2.3
	Low floor bus (v high steps)	2.4	6%	2.0
	Compulsory stop versus request	*1.7*	*5%*	*1.4*
	Split steps (v high steps)	*-0.3*	*-1%*	*-0.3*
The Driver	Driver gives change when needed	4.0	11%	3.3
	Interaction: appearance X ID	*2.5*	*7%*	*2.1*
	Interaction: appearance X ID badge	*2.2*	*6%*	*1.8*
	Interaction: appearance X attitude	*1.9*	*5%*	*1.6*
	Helpful driver	*1.5*	*4%*	*1.3*
	Smart driver appearance	*0.1*	*0%*	*0.1*
	Driver shows ID badge	*-0.8*	*-2%*	*-0.7*
Moving to Seat	*Luggage area replaced with standing room*	*2.0*	*5%*	*1.7*
	Some seats sideways on	-3.0	-8%	-2.5
	Medium crowded (v low)	-4.7	-13%	-3.9
	Medium smooth vehicle motion (v smooth)	-6.4	-17%	-5.3
	Highly crowded (v low)	-9.5	-26%	-7.9
	Rough vehicle motion (v smooth)	-10.5	-28%	-8.8
Travelling in Seat	Roomy seats (v cramped)	3.0	8%	2.5
	Value of time, pence per minute	1.2	3%	1.0
	Bucket seats (v standard seats)	*-1.1*	*-3%*	*-0.9*
	Ventilation grille (v opening windows)	-2.5	-7%	-2.1
	Dirty bus interior	-8.5	-23%	-7.1
Leaving Bus	Two sets of doors	4.2	11%	3.5
	Electronic display of next bus stop name	3.9	11%	3.3
	Driver announcements on PA	*-0.9*	*-2%*	*-0.8*
'Ideal Service'	Definition limited to 2-4 attributes	26.1	71%	22

^ Based on an average fare of 37p. # Based on a value of bus time of 1.2p/min or 72p/hr. Statistically insignificant valuations in italics. Source: Bristow (2009) (adapted from SDG (1996)).

The willingness to pay for the passenger's 'ideal service' was 26.1 pence or 71% of the average fare. When converted into onboard bus time, the ideal service was worth 22 minutes. SDG used the ideal service valuation as a 'cap' on the individual valuations.

Only average values have been reported, ie the distribution of willingness-to-pay values was not given. Some segmentations of the 'ideal' package value were reported for age and gender which were summarised by Bristow and Davison (2009) as men had higher values than women and younger people had higher values particularly the 11–15 age group. Income did not have a consistent effect. There is no reporting of the effect of trip length other than on the value of time. Peak and off-peak values and journey purpose values were not presented.

Table 5.20 presents 53 attribute valuations covering pre-trip information, the bus stop infrastructure and the bus trip itself. The values cover design, operation and maintenance aspects of service with both positive and negative aspects of service quantified. The largest valuation was for bus stop cleanliness with a dirty bus stop imposing a cost of 11.8 pence or 9.8 minutes of bus time. Similarly, a dirty bus interior imposed a cost of 8.5 pence.

Guaranteed customised information at bus stops was worth 10 minutes. A set or reliability values were estimated that interact with service headway (how often the buses depart). Amongst the hail and board values, bus branding was valued at 2.8 pence and low-floor buses at 2.4 pence. A set of driver values are presented but only one 'driver gives change when needed' was statistically significant with a valuation of 4 pence per trip. 'A helpful driver' was worth only 1.5 pence per trip and was not statistically significant.

'A rough vehicle motion' classified under 'moving to seat' imposed a cost of 10.5 pence and 'replacing the luggage area with standing room' was valued at 2 pence.

In consideration of the study values and method, Bristow and Davison (2009) concluded that it is 'an important and influential study' but one 'with issues particularly relating to the assumptions made'. Issues raised by Bristow and Davison include the limitation of the ideal service to no more than four attributes thereby representing a 'considerable improvement' rather than an 'upper cap'; and the design and strength of the preference question which may not have focused respondents on cost sufficiently; and, a lack of consideration of the 'high values' and how much was due to 'strategic bias'.

The values provide a base for the values in the TfL (2008) *Business case development manual,* which as well as the 1995 survey study also references values from a 1999 study and a 2007 study (all by SDG). Again it was not possible to obtain details of these later studies and Bristow and Davison (2009) do not critique them. Of particular note is the provision of rail values which were not provided in the 1997 study.

Tables 5.21a and b and 5.22a and b present the values for bus and rail respectively. As with the 1997 study, TfL (2008) presents the values in pence per trip. Alongside the fare value, we have tabulated a percentage fare and onboard time value. The percentage fare value is based on the average fares in the manual which were 44 pence for bus and £1.23 for rail. The values of time use the market price values of £8 per hour for bus and £10.15 per hour for tube passengers. It should be noted that these values were not derived from the SDG survey and are much higher than the 1997 survey value of 72 pence per hour for bus. Consequently, the time values are much lower than in table 5.20. This difference is important in transferring the values to NZ$.

Generally, the values are lower than those in 1997. The use of much higher values of time, which equate to $16.50 per hour for bus and $20.90 per hour for rail in New Zealand, produce values that are closer in size to those in the ATC (2006) and EEM manuals.

Table 5.21a London bus quality of service values (SDG 2007, as cited in TfL 2008)

Category	Attribute	Base Quality	Improvement	Pence / Trip	% of Fare^	IVT Mins #
Bus Stop Shelter	Cleanliness	Some dirty patches on	Shelter spotlessly clean	1.5	3%	0.1
	Timetable/Stop Illumination	Not illuminated	Illuminated	2.7	6%	0.2
	Condition of Stop and Shelter	Basic working order but some parts worn or tatty	Excellent condition /like new	0.8	2%	0.1
			Good condition perhaps slightly faded or signs of repair	0.2	0%	0.01
Bus Stop Environ-ment	Surveillance cameras at bus stop or shelter	No CCTV	CCTV recording at all stops	5.6	13%	0.4
			CCTV recording at some stops	5.4	12%	0.4
	Lighting	No lighting	Very brightly or reasonably lit	4	9%	0.3
	Litter	Lots of litter	No litter	1.4	3%	0.1
			Small amount of litter	0.8	2%	0.1
	Grafitti	Lots of graffiti	No graffiti	3.1	7%	0.2
			Small patches of graffiti	2.6	6%	0.2
Bus Stop Infor-mation	Countdown sign at bus stop	No Countdown sign	Electronic display of up to the minute bus arrival times, delays & other information.	5.2	12%	0.4
			above plus audio announcements also available for visually impaired	5.3	12%	0.4
	Mobile phone bus real time information service	No information about bus service on mobile phone	Send text message with bus stop code and get return text with times of next buses (standard text rate applies)	0.8	2%	0.1
			as above plus relevant delay information	1.1	3%	0.1
Bus Environ-ment	On-Bus CCTV	Posters indicating that bus is monitored by CCTV	Screens showing live CCTV views inside bus, upstairs & down (artic front & back)	2.2	5%	0.2
			Screens showing live CCTV views inside bus, upstairs only (artic back only)	1.8	4%	0.1
	Ventilation	Opening widonws giving ventilation to some passengers	Air conditioning, circulating cool fresh air throughout the bus	3.1	7%	0.2
			Open windows giving ventilation throughout the bus	2.5	6%	0.2
	Wheelchair & Buggy space	Dedicated area for wheelchairs and/or buggies or up to six people standing	Large dedicated area for wheelchairs and/or buggies or up to ten people standing with fewer seats elsewhere	1.1	3%	0.1
	Electronic information displays inside bus	No electronic information inside the bus about the next stop	Electronic sign and voice announcement of the next stop with some 'alight here' and route information with text.	4	9%	0.3
			As above maps and diagrams and with driver announcements on route	4.3	10%	0.3
Bus Clean-liness	Litter	Lots of litter	No litter	4.7	11%	0.4
			Small amount of litter	4.1	9%	0.3
	Cleanliness of interior	Some very dirty areas inside the bus	Very clean inside the bus	5.9	13%	0.4
			Reasonably clean inside the bus	5.6	13%	0.4
	Etching on the windows	Lots of etching	No etching on windows	2.2	5%	0.2
	Cleanliness of exterior	Some very dirty areas on the outside of the	Very clean bus outside	0.1	0%	0.0
			Reasonably clean bus outside	0.2	0%	0.0

See table 5.21b for notes

Table 5.21b London - bus quality of service values (SDG 2007, as cited in TfL 2008)

Category	Attribute	Base Quality	Improvement	Pence / Trip	% of Fare^	IVT Mins #
Driver & Quality of Journey	Crowding	Long wait of more than 5 minutes and no seat on bus	Short wait of less than 5 minutes and a seat on the bus	2.9	7%	0.2
			Short wait of less than 5 minutes and have to stand on the bus	2.1	5%	0.2
	Smoothness of driving	Jerky ride causing	Smooth ride - no jerkiness	3.6	8%	0.3
	Noise	Engine produces intrusive nosie or vibration throughout journey	No intrusive noise or vibration from engine throughout journey	2.8	6%	0.2
			Engine produces intrusive noise or vibration only while bus is at stops	0.3	1%	0.0
	Driver Attitude & behaviour	Businesslike but not very helpful	Polite, helpful and cheerful	2.3	5%	0.2
Package	Bus Stop	Worst	Best	25.5	58%	1.9
	Bus	Worst	Best	32.3	73%	2.4
	Stop & Bus	Worst	Best	57.8	131%	4.3

Source: TfL Business Case Manual Table E4.9. Notes: ^ based on an average fare of 44 pence per trip # based on a value of time of 13.35 pence per minute

Table 5.22a London - rail quality of service values (SDG 2007, as cited in TfL 2008)

Category	Attribute	Base Quality	Improvement	Pence / Trip	% of Fare	IVT Mins
Ticket Hall	Cleanliness	Very Dirty	Very Clean	7.2	6%	0.4
	Information about Service Disruptions	No information in the ticket hall	Hand-written notices	10.7	9%	0.6
			Electronic displays	12.9	10%	0.8
	Ticket office opening hours	No ticket office (but station manned)	Ticket office open 8am-7pm or longer	6.5	5%	0.4
Platform Facilities	Cleanliness of Platform	Very Dirty	Very Clean	4.7	4%	0.3
	Next Train Information	No information	Electronic Information on next train	11	9%	0.7
	Seating	No Seats	Seats but in poor state of repair	1.1	1%	0.1
			Seats in good condition	4.4	4%	0.3
	Protection from Weather	No waiting room or areas protected from weather on platform	Wind shelters in seem places providing some protection from wind and rain	3.8	3%	0.2
			As above but providing good all-round protection	4.1	3%	0.2
Station Environ-ment	Litter	Lots of Litter throughout station	Some Litter	3.7	3%	0.2
			No Litter anywhere in the station	5.5	4%	0.3
	Station Exterior	Outside of station in poor state of repair	Outside of station in good state of repair	4.2	3%	0.2
	Graffiti	Extensive graffiti sprayed or drawn	Fair amount of graffiti in station	2.9	2%	0.2
			No graffiti in station	5.9	5%	0.3
	Step Free Access around Station	No step free access in station	Step free access between station entrance & ticket hall only	5.1	4%	0.3
			Step free access throughout station	5.6	5%	0.3

See table 5.22b for notes

Table 5.22b London - rail quality of service values (SDG 2007, as cited in TfL 2008)

Category	Attribute	Base Quality	Improvement	Pence / Trip	% of Fare	IVT Mins
Station Security	Staff Presence	No staff visible in station or ticket hall	Staff present in the station/ticket hall but difficult to see	12	10%	0.7
			as above but easy to see	14.5	12%	0.9
	Surveillance Cameras	No CCTV in station	CCTV in station monitored some of the time and recorded	9.6	8%	0.6
			as above but monitored all the time & recorded	9.8	8%	0.6
	Transport Police	Police available on system but not necessarily close to the station. Response time over 15 minutes	Police available locally. Response time 5-15 minutes	5.8	5%	0.3
			Police available immediately. Response time less than 15 minutes	7.5	6%	0.4
	Help Points	No help points in station	Help point with fire alarm only	5.3	4%	0.3
			as above & with emergency button facility to talk to staff	7.6	6%	0.4
Train Security & Information	Lighting on Train	Carriage dimly lit	Carriage brightly lit	5.8	5%	0.3
	Electronic Display	No electronic display in carriage	Flat screen style display showing next station, final destination information and relevant service disruption information	8.7	7%	0.5
	Surveillance cameras	No CCTV on train	CCTV covering majority or entire carriage	13.4	11%	0.8
	PA Announcements	Public announcement impossible to hear,	Public announcement message able to be heard	8.4	7%	0.5
Train Environment	Cleanliness of train and seat	Inside of train very dirty	Inside of train reasonably clean	7.4	6%	0.4
			Inside of train spotlessly clean	9.1	7%	0.5
	Overall condition of train	Train in poor condition - lots of torn or patched upholstery or significant damage to other fitting (arm rests, handrails etc)	Train in fairly good condition - small areas of torn or patched upholstery or damage to other fittings	4.7	4%	0.3
			Train in excellent condition - all items looking new	7.2	6%	0.4
	Quality of ride	Extremely bumpy and uncomfortable ride - impossible to read or stand comfortably	A lot of train movement - difficult to read while standing or to stand comfortably	6.1	5%	0.4
			Very smooth ride	8.6	7%	0.5
Package	Station	Worst	Best	103.8	84%	6.1
	Train	Worst	Best	61.2	50%	3.6
	Station & Train	Worst	Best	165.0	134%	9.8

Source: TfL Business Case Manual Table E4.9. Notes: ^ based on an average fare of 123 pence per trip; # based on a value of time of 16.91 pence per minute

Package values for stop/station, vehicle and stop/station and vehicle combined have been calculated from the TfL (2008) values. The package values are shown at the bottom of the tables (b). For bus, the total package value (worst to best) is calculated at 57.8 pence (131% of the 44 pence average bus fare) and comprises 25.5 pence (58%) for bus stop improvements and 32.3 pence (73%) for bus vehicle improvements. Expressed in onboard time, the package was worth 4.3 minutes.

The package values for rail were larger. The total package was worth 165 pence (134% of the average fare) or 9.8 minutes of train time. Of this, 103 pence was for the station component (6.1 minutes) and 61 pence for the train package (3.6 minutes).

5.10 Bus quality measures, Leeds UK - Evmorfopoulos 2007

Evmorfopoulos (2007), cited in Bristow and Davison 2009) examined the values placed on a package of bus quality improvements typical of bus rapid transit (BRT) The study was undertaken as part of an MSc thesis and was small in scale with 91 bus passengers interviewed as they waited at bus stops along two main radial roads in Leeds in 2007. This summary is based on the review in Bristow and Davison (2009).

The package of bus improvements included low-floor access; off-vehicle fare collection; RTI onboard buses; segregated track; air conditioning; CCTV on board buses; a high level of sound proofing and an environmentally friendly vehicle.

The survey used SP choice experiments and found that passengers valued the total package of improvements at 12.7 pence per trip in terms of fare and in 4.3 minutes in terms of bus time. The time value was based on an estimated value of bus time of 3 pence per minute (£1.80 per hour) which was considered low. A higher value of time would reduce the package value when expressed in minutes.

At the time, the single adult fare was £1.50 which produces a percentage fare value of 8.5%. Some passengers would use concessions and travel passes which would lower the average fare paid (therefore giving a higher percentage fare value).

Some segmentation of the sample was undertaken which found high-income passengers (above £10,000 per year) to value the package at 15 pence which was 50% more than low-income passengers who valued the package at 10 pence. Gender was also a factor with men valuing the package higher than women.

A simpler transfer price question was also asked which produced a higher willingness to pay for a package worth 22 pence in terms of fare. The fare value converts to a percentage fare increase of 15% and an equivalent time saving of 7.4 minutes using the SP data.

The survey included an attribute importance question in which passengers were asked to score each attribute in terms of importance on a 1–10 scale. The highest scores were given to segregated track, environmentally friendly vehicle, CCTV on board, RTI onboard and air conditioning which all scored over 7. Less important were low floor access, off-vehicle fare collection and a high level of sound proofing. For low floor access, there was a clear difference by respondent age with passengers over 60 rating it highly but younger passengers scoring it less than 5.

5.11 Soft measures and bus use in England – AECOM 2009

The aim of this major AECOM (2009) study was to identify and quantify patronage changes attributable to 'soft' measures of bus service. The soft measures considered by AECOM were classified into six categories as shown in table 5.23. Of note is the inclusion of marketing and ticketing which have been omitted in most of the other studies reviewed.

Table 5.23 Categorisation of soft measures affecting bus patronage

Soft impact	Measures
Quality of in-vehicle experience	Vehicle: age ease of access, seating quality, cleanliness, entertainment, CCTV Driver: training to achieve politeness and smooth ride
Increased awareness of service availability	Conventional and unconventional marketing approaches
Improved knowledge while travelling	Real-time Information, public service announcements on vehicle
Ease of use	Smart cards, travel cards, ticket structure, low floor vehicles
Quality of waiting and walking experience	Shelters, bus stations, ticket machines, seating, information provision, CCTV, staff presence, lighting
Safety and security	CCTV, staff presence lighting

Source: AECOM (2009)

The study was wide ranging including a literature review; a case study analysis of the patronage impact of improvements in bus service; qualitative market research with passengers, operators and planning authorities), focus groups and structured interviews with users; and quantitative research involving SP surveys.

The case study analysis assessed 10 case studies of improved urban bus services in England. AECOM described the schemes and assessed the patronage impact using before and after patronage statistics (where such statistics were available). Table 5.24 presents a summary.

AECOM concluded that the quantitative evidence demonstrated four of the cases had strong evidence of success and that there was some evidence in four others. To some extent the analysis was hindered by the effects of the UK-wide change in the concessionary fare policy in April 2006 which AECOM found to be the 'most influential factor in changing patronage' (p6). Otherwise, AECOM concluded there had been little or no change in far-paying passenger numbers for most schemes. However, no growth was classified as a success, since many schemes were introduced against a background of declining bus usage.

Given the wide variation in the schemes and the impact of the concessionary fares on patronage, it was difficult to discern the effect of the specific improvements either soft or hard.

It is likely, that similar difficulties would be encountered in trying to quantify the patronage impact of bus and rail improvements in New Zealand or using actual examples to validate the values estimated through passenger surveys. The review is of interest in identifying the bus improvement packages that have been introduced for which willingness-to-pay values would be useful.

Table 5.24 Patronage assessment of improved bus quality in England

Service name	Improvements	Patronage Impact
1.Poole: MORE – Wilts & Dorset Dec 2004***	Simplified & rebranded routes Additional routes Aug 2005 New LF buses New seat configurations CCTV	Difficult to separate effect of CF & additional routes, however adult fare paying passenger numbers have increased by significantly more than bus
2.Hull interchange Sept 2007*	Links bus & rail network Kiss & ride CCTV Cycle parking	Too soon to say (reporting occurred in April 2008). Slight increase in pax following interchange opening, then returned to post-CF levels
3.T&W: Go Ahead North East Feb 2007 (-)	Re-branding of services (locally Simplified network & fares	Not enough data to show any increase in fare paying pax
4. Kent Fastrack***	Revamp & addition of services (to coincide with major commercial & residential development) RTI; Simplified fares & ticketing Marketing & Branding	Difficult to dissociate from large scale new housing growth. Patronage growth outstripped mileage growth
5. Cambridgeshire Citibus Since 2001***	Simplified branding / advertising Improved routing RTI; Simpler fares; Telemarketing (free tickets to try	Steady increase of patronage since 2001.
6. Leeds: FTR Jan-Aug 2007***	High quality buses CCTV; New ticketing technology Driver & conductor training RTI on-board; Audio annoucements	'Seems to be the beginning of an upwards trend in fare paying patronage' but too soon to tell
7. Warrington Interchange Aug 2006*	New interchange: RTI, fully New bus fleet: LF, new driver livery, marketing	There was a decrease while a temporary interchange was used, then patronage increased to new higher level with new
8. Burnley: Blazefield Witch Way Spring 2005*	Spring 2005: On inter-urban routes (not local urban services): Quality buses (seating) RTI; Bus stop upgrades Marketing /targeting new users	No change in the level of the fare paying pax over the 3 year period examined
9.Warwick Goldline 66 Late 2007	Low Floor buses Leather, high back seats Special driver training refund if bus is >20 mins late	Slight increase in pax to Sept 2008 (over and above CF increase)
10. Nottingham Route 30 Early 2008 (-)	'Eco-link' / 'eco-buses' (ethanol) Earlier, had personalised Cycle parking	Overall, no increase in fare-paying pax (to Sept 2008)

Source: AECOM (2009) AECOM assessment: *** strong evidence of success; * some evidence; (-) limited information

The initial qualitative research established the importance of hard as well as soft factors in influencing bus use. Table 5.25 presents the results of the research which shows reliability and frequency to be the most important factors with fare third, safety at the bus stop fourth and walk time to the bus stop fifth. The top three factors were all defined as 'hard' measures. Safety at the bus stop was the top-ranked soft measure. Making up the top 10 were safely walking to the bus stop, seat availability, comfort, waiting time at the bus stop and information provision. The time on the bus (In vehicle time) was ranked only 17 out of 20 factors. The implication being that passengers should measure soft attributes relatively highly if expressed in vehicle time.

Table 5.25 Importance of travel factors

Rank	Factor	Type	Sum*	Mean
1	Reliability of Bus	Hard	276	6
2	Frequency of Bus Service	Hard	164	3
3	Fare Paid	Hard	131	3
4	Safety at Bus Stop	Soft	110	2
5	Walk Time to Bus Stop	Hard	86	2
6	Safety Walking to Bus Stop	Soft	78	2
7	Seat Availability	Soft	77	2
8	Comfort	Soft	77	2
9	Waiting Time at Bus Stop	Hard	73	1
10	Information Provision - Planning	Soft	71	1
11	Bus Type (low floor v non low floor)	Soft	68	1
12	Driver Attitude	Soft	68	1
13	Cleanliness	Soft	61	1
14	Bus Stop/Shelter Features	Soft	58	1
15	Information Provision at Bus Stop	Soft	58	1
16	Walk Time from Bus Stop	Hard	36	1
17	In Vehicle Time	Hard	35	1
18	Safety from Bus Stop	Soft	34	1
19	Ticket Type	Soft	23	0
20	Marketing/Branding	Soft	10	0

(where 1 was the most important) the following scores were allocated: 10 = Rank 1 (Most Important); 8 = Rank 2; 6 = Rank 3; 4 = Rank 4; 2 = Rank 5; and 1 = Considered important but not in the top 5. (Note: there is an apparent

Source: AECOM (2009)

Based on the results of the importance data, AECOM concluded that 'threshold effects' need to be overcome for car users to consider bus as a viable option and these threshold effects were considered 'hard' rather than 'soft' in nature. As an example, a high frequency (10 minutes headway) reliable service was cited as necessary before soft factors came into play.

In terms of soft measures, safety was particularly important. Ease of boarding was a key issue for certain people and also whether there was enough space to store an unfolded pushchair. There was an expectation that new buses would be comfortable and clean.

Car drivers were sensitive to problems related to the car, ie congestion, cost of parking and availability of parking. Increases in these were likely to push people to the bus more than soft factors.

The quantitative research involved several SP surveys: a route choice bus versus bus SP; a demand effects SP (car versus bus); an 'unpacking' SP which considered bus attributes in detail; and a SP about different types of bus information. Generally, respondents completed questions for two types of SP. Surveys were undertaken in 10 survey areas.

The SP only interviewed commuters who had used bus at least once. The values are therefore considered to relate to commuting trips. Interviews were undertaken at people's houses using computer aided personal interviews but it was difficult to find bus users so the fieldwork company boosted the sample using a hall test method where people were recruited on street and asked to do the interview at a local convenient venue, eg hotel.

There were two types of SP: a 'quality/unpacking SP' and an 'information SP'. The sample size for the 'quality/unpacking SP' was much larger with 1,146 surveys conducted amongst those who had a quality bus service in their area to determine their reaction to the removal of the service. A further 820 car users were surveyed who did not have a quality bus service for their journey to work but where there were such services in the area. In each case, the respondent was shown an illustration of what a quality bus looked like. The information SP had a sample of 248 interviews.

Table 5.26 presents the final models estimated by AECOM for the 'unpacking SP and information SPs. It should be noted that the results were not combined so that RTI has two values - the information SP value of 4.2 minutes and the unpacking SP value of 1.7 minutes. AECOM considered the higher information values were due to fewer attributes in the SP. There would therefore seem to be merit in scaling the information values down to be comparable with the unpacking SP.

A percentage fare valuation was reported that uses the estimated value of time of 4 pence per minute and an average fare of £2.20.

For each attribute an overall value, expressed in bus in vehicle time, was estimated. The highest valued attribute in the 'unpacking' SP was CCTV at bus stops at 2.9 minutes. Second were 'trained drivers' at 2.6 minutes and third was CCTV on buses at 2.5 minutes. Thus personal security related improvements were highly valued. A new bus with a low floor was valued at 1.8 minutes and a new shelter was valued at 1.1 minutes. The vehicle package, calculated by summing relevant unpacking attributes, was worth 14.8 minutes; the bus stop package seven minutes and the total package 23.2 minutes.

RTI displays at bus stops, bus stations and city centres were valued at between four and five minutes of bus time by AECOM. If adjusted to be comparable with the unpacking SP, the value would be 1.7 minutes.

The value for short message service (SMS) providing real-time timetable information to mobile phones or other communications systems depended on whether the service was free or charged. If free, a SMS service was valued at 3.2 minutes and 1.3 minutes after adjustment. If charged at 5–10 pence per message, the value more than halved and if charged at 20 pence, the value was not significantly different from zero. If the SMS was limited to just timetable information (ie not RTI) and was free, the value was estimated at 0.6 minutes (0.2 minutes adjusted), only one-fifth the value of the real-time SMS information.

AECOM did not present values by trip purpose or distance. However for some attributes, values were presented separately for bus and car users; for most of these, car users had higher valuations. For example, car users valued new low floor buses at 2.2 minutes versus 1.2 minutes by bus users.

A feature of the market research was that the set of quality attributes included in the unpacking SP varied across the 10 study areas. Only 'new bus with low floor' featured in all SPs. 'Trained drivers' featured in eight of the SPs and RTI in nine SPs.

Table 5.27 presents the total package values by area. In fact, two in vehicle time-based values are presented: the full estimated package value (denoted SP value) and a 'sum of parts value' calculated by summing the individual attribute values. For eight of the areas, the SP value was higher than the sum of parts value. For example, for Poole, the SP value was 14.4 minutes whereas the sum of parts value was 11.5 minutes so the SP value was 25% higher.

Table 5.26 Valuation of soft measures

	On-bus, Off-bus	Average Valuation			Value by Mode (mins)	
		IVT Mins	T Stat	%Fare**	Bus	Car
1	New Bus with Low Floor	1.8	6.9	3%	1.2	2.2
2	Climate Control	1.2	2.5	2%	-	-
3	Trained Drivers	2.6	6.6	5%	2.5	2.8
4	On-screen displays	1.3	2.7	2%	1.9	0.9
5	Audio Announcements	1.2	2.2	2%	-	-
6	CCTV on Buses	2.5	4.8	5%	1.7	3.2
7	Leather Seats*	1.1	1.2	2%	-	-
8	Customer Charter*	0.9	1.2	2%	-	-
9	In-vehicle Seating Plan*	2.2	2.5	4%	-	-
10	New Bus Shelters	1.1	2.6	2%	-	-
11	Real Time Public Information	1.7	5.3	3%	1.5	1.7
12	New Interchange Facilities	1.3	2.6	2%	-	-
13	CCTV at Bus Stops	2.9	5.2	5%	3.7	2.5
14	Simplified Ticketing	1.4	3.7	3%	0.8	2.1
	^ Vehicle Package sum(1:9)	14.8	na	27%	16.4	9.1
	^ Stop Package sum(10:13)	7.0	na	13%	9.4	4.2
	^ Total Package sum(1:14)	23.2	na	42%	13.3	15.4

	Information - modelled separately	Value	T Stat	AdjVal #	% Fare	Bus	Car
15	Real Time Information	4.2	4.5	1.7	3%	-	-
16	RTI in City Centre	4.3	3.7	1.7	3%	-	-
17	RTI at Bus Station	5.1	4.7	2.1	4%	-	-
18	SMS RTI-Free	3.2	4.2	1.3	2%	-	-
19	SMS RTI-5p	1.4	1	0.6	1%	-	-
20	SMS RTI-10p	1.6	1.7	0.6	1%	-	-
21	SMS RTI-20p	ns	ns	ns	ns	-	-
22	Audio Annoucements on Bus	1.1	1.1	0.4	1%	-	-
23	SMS-Timetable - free	0.6	1.7	0.2	0%	-	-
24	Web Based Information	1.4	1.9	0.6	1%	-	-

* taken from AECOM Table 0.2; ^ Package value estimated by Douglas Economics sum of attribute valuations; ns not significant; - not reported; na not applicable # information values scaled down to the ratio of the RTPI unpacking SP value of 1.7 over the information SP value of 4.2; ** % Fare calculated using VOT of 4p/min and an average fare of £2.20. For information, scaled down values used.

Source: AECOM (2009) Bus soft measures SP results (unpacking and information SP)

On average, the SP value was 10% higher than the sum of parts, a finding about which AECOM makes the following observation: 'earlier work by SDG (1996) maintained that under certain circumstances a combination of different soft bus interventions can be valued more than the sum of the individual interventions due to the halo effect or interactions between the variables'. As would be expected, the value of the package effect has also varied according to the number of attributes included. However, AECOM considered the package effects that were detected were not entirely consistent across areas and were considered sufficiently small to be ignored'.

Table 5.27 Package valuation

Area	Attributes							SP Value mins1	SOP Value mins2	% of Av*	Value pence+	% of Av*
1. Poole	New LF Bus	Trained Drivers	On-Screen Displays	Climate Control	CCTV at Bus Stops	RTPI		14.4	11.5	32%	46	27%
2. Hull	New LF Bus	CCTV on Buses	Simplified Ticketing	New Interchange				7.7	7.0	35%	28	19%
3. Tyne & Wear	New LF Bus	Trained Drivers	CCTV on Buses	New Bus Shelters	Simplified Ticketing	RTPI	Customer Charter^	13.0	11.2	19%	45	13%
4. Dartford	New LF Bus	Trained Drivers	Climate Control	Audio Ann'ments	CCTV at Bus Stops	RTPI	New Bus Shelters	13.5	12.6	52%	50	25%
5. Cambridge	New LF Bus	Trained Drivers	RTPI	New Bus Shelters				6.5	7.2	21%	29	15%
6. Leeds	New LF Bus	On-Screen Displays	CCTV on Buses	Audio Ann'ments	Climate Control	RTPI	New Bus Shelters	11.2	10.8	68%	43	19%
7. Warrington	New LF Bus	Trained Drivers	RTPI	New Interchange	New Bus Shelters	RTPI		8.2	7.4	46%	29	26%
8. Burnley	New LF Bus	Trained Drivers	CCTV on Buses	New Bus Shelters	RTPI			10.5	9.7	14%	39	10%
9. Warwick	New LF Bus	Trained Drivers	New Bus Shelters					7.2	5.5	25%	22	9%
10. Nottingham	New LF Bus	Trained Drivers	CCTV on Buses	Simplified Ticketing	New Bus Shelters	RTPI		9.3	11.2	41%	45	30%

Notes: 1 SP value take from AECOM Table 6.4B and divided by IVT parameter. 2 Sum of Parts value taken from AECOM Table 6.6; ^ customer charter added for T&W as per text; * Percent of average bus time/fare using information provided in AECOM Table 7.11; + converted into fare using value of time estimated by AECOM of 4 p per minute.

Source: AECOM (2009) Bus soft measures SP results (unpacking SP) – value of package in bus in vehicle time minutes

In table 5.27, the 'sum of parts' package values have also been expressed in terms of fare and have been placed next to the list of attributes included in the SP.[34] The 'sum of parts' values ranged between 5.5 and 12.6 minutes largely reflecting the number of quality improvements which ranged from 3 to 7. The values are therefore much less than the sum of the parts value of 23.2 minutes based on all 14 attributes in table 5.26.

The three highest values were for areas with the greatest number of improvements: Dartford at 12.5 minutes with seven attributes; Poole at 11.5 minutes with six attributes and Tyne and Wear at 11.2 minutes with seven attributes.[35] The lowest values were for areas with the fewest number of attributes - Cambridge at 7.2 minutes with four attributes and Hull at seven minutes with four attributes.

The fare valuations were calculated by multiplying by a value of time of 4 pence per minute estimated by AECOM. Thus for Poole, the package value of 14.4 minutes converted into a fare willingness to pay of 46 pence which was 27% of the average fare (£1.70 per trip).

The percentage bus time valuations ranged from 14% for Burnley to 68% for Leeds. The range in the percentage fare valuations was narrower from a low of 9% for Warwick to a high of 30% for Nottingham.

[34] The fare and percentage in vehicle time valuations were calculated by Douglas Economics. It should be noted that the package values calculated by summing the attribute values do not match the package values given in AECOM table 6.4b.

[35] The Tyne and Wear value reported by AECOM excludes the customer charter value.

AECOM conducted tests of potential interaction effects, whereby the valuation of one attribute depended upon the level of another. As an example, the willingness to pay for climate control could increase, the longer the trip. However AECOM found interaction effects to be negligible.

AECOM then combined the SP data with actual travel data obtained by the survey and from the National Travel Survey[36] to assess whether proximity to quality bus services increased bus patronage. Several models were cast but the results were not conclusive. AECOM found that 8 of the 10 areas had higher average bus use where there were quality buses but for only three areas was the result statistically significant at the 10% level. They concluded that 'this stream of work has been a little disappointing and the statistical evidence from the surveys carried out does not consistently show'.

The researchers also developed models to assess whether bus service quality affected route choice. Three of the 10 areas were modelled where bus users had a choice between a non-quality and quality bus service. Bus quality was modelled using rating scores although it is not clear from the report how the rating score was calculated. The models combined the results of the SP questions with actual travel behaviour data. Respondents who made irrational choices were removed and the models distinguished between respondents who thought the SP was realistic or not. The resultant valuations are presented in table 5.28.

Bus quality was valued at 1.66 minutes per rating point. As the average difference between the quality and non-quality buses was 2.18 rating points, the value of a quality bus over a non-quality bus was worth 3.6 minutes or 14.4 pence. The values were therefore much lower than the 'unpacking' SP values in table 5.27 for which the average value for the same three areas was 10.6 minutes. The route choice SP therefore gave an overall value which was three times lower than the unpacking SP.

Table 5.28 Bus route choice bus quality values

Attribute	Minutes	Pence
In-vehicle Time	1	4
Walk Time	1.12	4.5
Headway	0.66	2.7
Quality Bus Rating	1.66	6.6
Quality v Non Quality Bus (2.18 Rating Pts)	3.6	14.4
Percent of Average	18%	6%

Source: AECOM (2009) bus soft measures SP results (route choice SP)

In summary, the AECOM study is a major piece of research on the value of bus quality. The research looked at 10 case studies where bus services had been improved and undertook market research into user and non-user attitudes towards bus service attributes. AECOM found it difficult to ascertain the patronage impact of the bus service improvements from actual patronage data largely because of the confounding effect of other factors particularly a change to a concessionary fare scheme.

Qualitative market research established reliability, frequency and fare to be the most important attributes. Bus in vehicle time was lowly rated at 17 out of 20 attributes. Safety at the bus stop was the top-ranked 'soft' factor.

SP surveys were then used to estimate values for a range of attributes. The most successful survey estimated values for 14qualitative attributes. Both bus and non-bus users were surveyed. The values were expressed in bus IVT with individual attribute improvements valued at between one and three minutes.

[36] www.gov.uk/government/collections/national-travel-survey-statistics

The most valued attributes were CCTVs on bus and at bus stops followed by trained bus drivers. If all 14 attributes were introduced, the total package was worth 23 minutes of bus time. For the 10 case studies, the package values were lower, ranging from 5.5 minutes to 12.6 minutes because there were fewer improvements. When converted into fare, the improvement packages ranged between 9% and 25% of the average adult fare. The valuations were therefore reasonably substantial which is somewhat at odds with the inability to discern a strong demand response in the actual patronage data.

The survey studied car as well as bus users and for some attributes significant differences in valuation were estimated. Only average values were reported however and the effect of trip length was not explored. The survey was also limited to commuting to work trips.

5.12 Premium services in US cities – Outwater et al 2010

This US study by Outwater et al (2010), sponsored by the US Federal Transit Administration, investigated the characteristics of premium transit services and how mode choice can be affected. The study comprised two phases. The first phase, summarised in a 2010 paper involved a literature review and market research undertaken in Salt Lake City. The second phase intends to extend the market research to other cities and was not complete at the time of writing this review. Some initial second phase results reported at a TRB workshop in January 2012 by Campbell have been included in this review.

The literature review conducted by Outwater et al (2010) considered that several travel attributes were traditionally omitted from mode choice models. Most were either qualitative (eg comfort and safety) or quantitative and difficult to measure (eg reliability). Their review of eight studies concluded that reliability, station/stop comfort, onboard amenities and RTI were the most important. In terms of the survey methods used to estimate attribute values, the authors concluded that 'there is significant research that has been conducted on quantifying and modelling non-traditional attributes. However, the techniques to do so vary considerably and the research is new enough that no standards currently exist on how best to estimate these variables. It is expected that as this research progresses, best practices will emerge on how to most efficiently estimate these variables'.

Their review also considered how values for non-traditional attributes had been considered in the forecasting process. They cited the 'Bus rapid transit practitioner's guide' *TCRP report 118* (Kittelson & Associates et al 2007), which had found that new bus rapid transit services had experienced higher ridership increases than their traditional attributes would normally indicate. The reasons behind underestimates of premium transit service patronage were considered to be related to public perception of safety, heightened awareness, brand visibility, and various service attributes that are measurable but not typically included in most forecasting models. The authors noted that instead of attempting to value individual attributes, demand models often included mode-specific constants. A constant of 10 to 15 minutes of bus IVT time was referenced as reflective of the perceived difference between conventional bus and a premium bus (FTA 2006).

Salt Lake City was used as a case study. Just over 2,000 responses were obtained including transit and non-transit users; 1,445 respondents (70%) were obtained from an email database of riders/non riders. A further 272 were intercepted in Salt Lake City and a sample of 300 non-transit users was 'purchased'.

The self-completion questionnaire was in three parts: (i) a respondent profile section; (ii) a SP exercise of service level packages; and (iii) a SP exercise of the most/least preferred options (referred to as 'Maxdif').

The third part of the survey provided valuations of individual service attributes which could be scaled to the value of the overall package (second part). Figure 5.3 presents an example of each of the two SP questions. Each respondent completed eight of each type of question (ie 16 SPs in total).

Figure 5.3 Salt Lake City – example stated preference questions

Part 1 Stated preference example question

Which option are you MOST LIKELY to choose and which are you LEAST LIKELY to choose for your trip to work?

Please look at each option carefully because choices will change from screen to screen.

Please select one option in each row.

To see a definition, please put your mouse over the .

	Option #1: Take the BUS	Option #2: DRIVE	Option #3: Take the TRAIN
Transit Service Features	• STANDARD on-board features • STANDARD station/stop • REAL-TIME arrival/ departure info available		• STANDARD on-board features • MODERNIZED station/stop • REAL-TIME arrival/ departure info available
Travel Time	• Walk 5 mins. to station/stop • Wait time: 10 mins. • 10 mins. ride on bus • 1 transfer • 1 in 10 trips experience delay of 5 mins. or more	• 13 mins. drive • 1 in 10 trips experience delay of 2 mins. or more	• Walk 5 mins. to station/stop • Wait time: 20 mins. • 10 mins. ride on train • No transfer • 1 in 10 trips experience delay of 10 mins. or more
Cost	• Transit: $5.50 one-way	• Parking: $11.00 a day • Gas: $4.50 a gallon	• Transit: $9.00 one-way
MOST Likely	○	○	○
LEAST Likely	○	○	○

Part 2: 'Maxdif' example question

SALT LAKE CITY TRAVEL STUDY

If these were your only choices, which transit option are you MOST LIKELY to use and which are you LEAST LIKELY to use?

Please assume all other aspects of transit service are the same across all of the options.

	Option #1	Option #2	Option #3
Time Riding on Transit	12 mins.	9 mins.	11 mins.
Transit Fare	$0.80	$1.20	$1.00
Station/Stop Distance	More than 10 mins. walk of your home/work	Within 10 mins. walk of your home/work	More than 10 mins. walk of your home/work
Station/Stop Shelter	Effectively protects you from bad weather	Effectively protects you from bad weather	Limited or no shelter
Route Name/Number Identification	Easy to immediately identify on outside of transit vehicle	Difficult to immediately identify on outside of transit vehicle	Difficult to immediately identify on outside of transit vehicle
MOST Likely	○	○	○
LEAST Likely	○	○	○

A key distinction of the study was that respondents were asked to choose between transit and car in the SP questions whereas most other studies are confined to comparing public transport trips. Another distinction is that bus and train were covered options whereas most of the other studies address one or the other mode. Comparing the part 1 and part 2 questions shows a marked difference in the transit fare. Part one gives a one-way bus fare of $5.50 and a rail fare of $9 whereas the maxdif example gives a transit fare of 80 cents to $1.20.

Quality was represented as a package labelled as premium or standard for vehicles, modernised or standard for stop/station and informative or standard for information. A definition of the features was presented to ensure respondents would understand what the differences were. Figure 5.4 presents the definitions. It should be noted that the definitions omit wifi for which a value is reported based on the maxdif results.

Figure 5.4 Salt Lake City – bundle definitions

Bundle Definitions		
On-Board Amenities	Premium	
	1	Vinyl seats
	2	Transit has efficient air-conditioning & heating
	3	Your trip is uncrowded and you have a seat
	4	Train/bus is new & very clean
	5	Seats are comfortable with back and neck support
	6	Transit ride is smooth & quiet
	7	Clear announcements indicate next stop & any delays
	Standard	
	1	Cloth seats
	2	Transit has some air-conditioning & heating
	3	Your trip is crowded and you may or may not have a seat
	4	Train/bus is maintained, but not new.
Station/Stop Amenities - DESIGN	Modernized Station/Stop	
	1	Has bicycle storage
	2	Is well lit and safe
	3	Is well maintained & clean
	4	Has comfortable benches
	5	Is spacious, with good visibility & open sightlines
	6	Has modern looking shelter to protect from bad weather
	7	Has been recently renovated with high-quality materials
	8	Has retail services such as coffee shop, dry cleaners, etc.
	Standard	
	1	Is maintained
	2	Graffeti and vandalization are NOT present
	3	Has some benches
	4	Is safe
Station/Stop Amenities - INFORMATION	Informative Station/Stop	
	1	Signs show minutes until next arrival/departure
	2	Transit routes & schedules are clearly posted
	3	Service change information is posted & announced
	4	Posted routes & schedules are easy to understand
	5	Posted routes & schedules are always accurate
	6	Neighborhood map with streets is clearly posted
	Standard	
	1	Transit routes & schedules are posted
	2	Name of station/stop is visible

The results of the public transport v car SP are presented in table 5.29. The paper only presented the model for work trips. The paper used car travel time (IVTT_A) as the numeraire to calculate the relative valuations. In table 5.29, the travel time for transit has been used instead. This causes a slightly reduction in relative valuation since respondents were slightly less sensitive to car time than transit time.

A premium service was worth 3.2 minutes of onboard travel time to commuters compared with a standard service.[37] The same value applied to bus and rail. However for rail, another term, interacting with travel time increased the value by 0.13 minutes per minute of travel time. Thus for a 30-minute rail trip, the value of a premium service would be worth 3.6 minutes.

Modernised stop/station design was valued at 4.3 minutes by commuters. As with onboard vehicle quality, an interactive term was included for rail that allowed for the station value to increase with waiting time at 0.36 minutes per minute of waiting time. Thus for a 10-minute wait, the value of a modernised rail station would be worth 4.66 minutes.

RTI was valued at 4.7 minutes.[38] The same value applied to bus and rail.

[37] This compares with 3.7 minutes given in table 2 of the Outwater et al (2010) paper which was based on the car travel time parameter.

[38] The information bundle label (RTI) is not the same as the bundle description (informative station/stop).

Table 5.29 Premium service public transport versus car stated preference results

Attribute	Mode	Coeff	StdErr	t Stat	Relative Value	Calculation
IVTT_A (min)	Car	-0.033	0.005	-6.6		
ivtt_Transit(min)	Bus,train	-0.039	0.006	-6.5	1.2	times IVTT_A
Access time (min)	Bus,train	-0.054	0.009	-6.0	1.4	times IVTT_T
Wait time (min)	Bus,train	-0.053	0.004	-13.3	1.4	times IVTT_T
Trip Gas Cost $	Car	-0.175	0.026	-6.7	11.3	$/hr (IVTT_A)
Fare $ one-way	Bus,train	-0.405	0.02	-20.3	5.8	$/Hr (IVTT_T)
Parking Cost ($/day)	Car	-0.235	0.007	-33.6	8.4	$/hr (IVTT_A)
Reliability	All	-0.018	0.006	-3.0		
Transfers (0=no,1=yes)	Bus,train	-0.351	0.043	-8.2	9.0	times IVTT_T
Transit Info (0=no real time,1 = real time)	Bus,train	0.185	0.055	3.4	4.7	times IVTT_T
Stop design (0=standard,1=modern)	Bus,train	0.167	0.043	3.9	4.3	times IVTT_T
On-board amenities (0=standard,1=premium)	Bus,train	0.125	0.052	2.4	3.2	times IVTT_T
IVTT (min) with modern on-board amenities	Train	0.005	0.002	2.5	0.13	times IVTT_T
Wait time (min) with real-time information	Train	0.014	0.006	2.3	0.36	times IVTT_T
Option to work from home (0=no,1=yes)	Car	0.905	0.23	3.9		
Male (0=no,1=yes)	Car	-0.121	0.067	-1.8		
HH Income less than 125K (0=no,1=yes)	Train	-0.236	0.099	-2.4		
HH Income less than 125K (0=no,1=yes)	Car	0.192	0.067	2.9		
Origin TAZ is rurual (0=no,1=yes)	Train	-0.965	0.495	-1.9		
Origin TAZ is rurual (0=no,1=yes)	Car	0.855	0.385	2.2		
Transit users service inclination factor	Car	-0.115	0.04	-2.9		
Transit users service availability factor		-0.505	0.048	-10.5		
auto constant		0.71	0.158	4.5	18.21	times IVTT_T
train constant		0.002	0.061	0.0	0.05	times IVTT_T
bus constant		0	fixed			
auto nest (auto)		1	fixed			
transit nest (bus,train)		0.651	0.054	12.1		
Number of Observations		32616				
Log Likelihood		-5840				
Log Likelihood (no coefficients)		-10709				
R-sqrd		0.455				
RSqAdj		0.454				

Notes - Outwater used auto time parameter as numeraire not transit time parameter

Source: Outwater et al (2010) work trips – Salt Lake City survey results

The maxdif SP questions aimed to unbundle the vehicle, stop and information bundles. However only public transit users completed the maxdif questions which, the authors considered in hindsight, to have been a 'limitation' and would be relaxed when the survey was repeated in other cities.

Table 5.30 presents the attribute valuations in in-vehicle minutes after they have been 'scaled' to equal the package valuations. The values are lower than those presented in the Outwater et al (2010) paper because the transit time parameter has been used rather than the car travel time parameter. Also provided is a willingness-to-pay value measured in cents per trip.[39]

[39] The study did not provide the value of time for non-commuters so it was not possible to produce willingness-to-pay values for non-commuters. The average trip length and average fare was not reported so it was not possible to express the valuations as percentages.

Table 5.30 Value of vehicle, stop and information attributes

Attribute	IVT value mins Work Trips	IVT value mins Non-Work Trips	Fare C/trip Work
Reliability	0.5	0.7	4
Onboard Amenities	3.2	5.2	31
WiFi	0.6	1.0	6.0
On-Board Seating Availability	1.3	1.9	12.9
On-Board Seating Comfort	0.5	0.5	5.0
On-Board Temperature	0.9	1.1	9.0
Cleanliness of Transit Vehicle	0.5	0.5	5.0
Station Amenities	4.3	5.5	41
Station/Stop Lighting/Safety	0.9	0.7	8.2
Station/Stop Shelter	1.0	1.3	9.9
Proximity to Services	0.8	1.6	7.4
Cleanliness of Station/Stop	0.4	0.5	4.1
Station/Stop Benches	0.4	0.5	4.1
Station/Stop Security	0.9	0.8	8.2
Transit Real-Time Information	4.7	5.5	46
Amenities Interacted with Time Components			
IVT with modern on-board amenities (Train)	0.13	0^	1.2
Wait time with real time info (Train)	0.36	0^	3.5
Subtotal: Information + Station + Vehicle	12.2	16.2	118

non work values calculated using ratio of work trip values

^ not statistically signficant

Source: Outwater et al (2010) Salt Lake City survey results – values in in-vehicle minutes

In terms of onboard amenities, seat availability ('the vehicle is uncrowded and you can get a seat') was the most highly valued at 1.3 minutes for work trips and by 1.9 minutes by non-work trips. Temperature (air conditioning) was the second most important attribute at 0.9 minutes for commuters. The study also estimated a value for having wifi availability onboard the bus/train that was worth 0.6 minutes for commuters and one minute for non-work trips. Cleanliness and seat comfort were each valued at 0.5 minutes.

The value of the bundle of station attributes was greater than the vehicle bundle. The study is not explicit as to whether the values apply to the origin station, the destination station or both stations. For commuters, shelter was the most valued individual attribute at one minute followed by lighting/safety at 0.9 minutes. Station/stop security (spacious, good visibility, open sight lines) was also valued at 0.9 minutes by commuters. Proximity to services (has retail services such as coffee/dry cleaners) was valued at 0.8 minutes. Having a new and very clean station was valued less at 0.4 minutes compared with a maintained and non-vandalised station. Having comfortable benches rather than some benches was also valued at 0.4 minutes.

No breakdown of the information bundle was provided. The only attribute tabulated was RTI which was valued at 4.7 minutes.

Combining the premium vehicle, modernised stop and information bundles gives a total package value of 12.2 minutes or 118 cents.

Reliability was measured in terms of whether 1 in 10 trips were delayed (the length of delay was not specified). A reliable service was valued at 0.5 minutes of IVT.

The Outwater et al (2010) paper did not mention the size of the scaling factor applied to the individual attributes in order to constrain the values to the size of the bundle values. However the TRB presentation by Campbell (2012) provided unscaled and scaled values for the premium vehicle attributes. This table for the Chicago survey showed scaling was marked, reducing the values 10-fold. For example, seating comfort was valued at 7.7 minutes by Chicago commuters before scaling but only 0.8 minutes after scaling.

Table 5.31 Scaling of individual attribute values

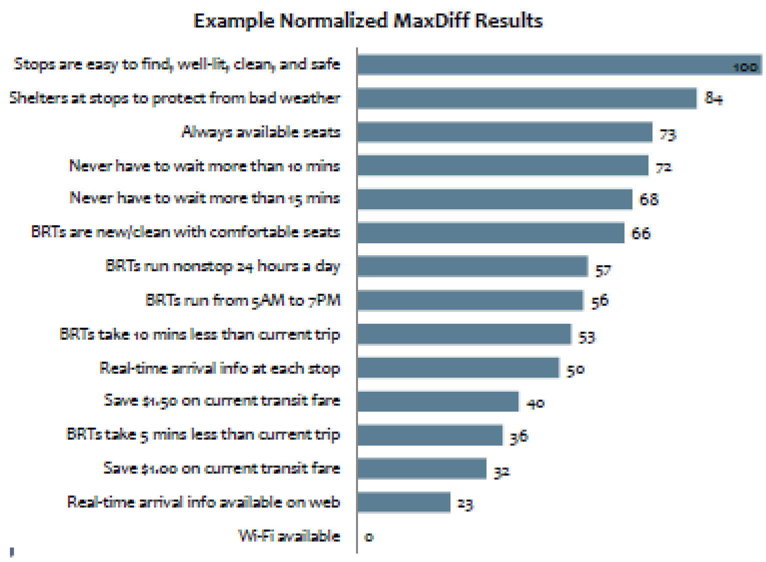
Attribute	Un-scaled	Scaled	Percent
On-board features bundle	62.7	5.8	9%
Seating availability	20	2.2	11%
Seating comfort	7.7	0.8	10%
Temperature	16.4	1.4	9%
Cleanliness	8.2	0.6	7%
Productivity features	10.4	0.9	9%

Source: Campbell TRB (2012)

Vehicle attributes – Chicago commuters – value in IVT minutes

The TRB presentation (Campbell 2012) also presented the relative importance of a range of attributes obtained the 'maxdif' surveys undertaken in New Jersey, Chicago and Portland. These surveys focused on bus rapid transit attributes with the list of attributes differing by city. Figure 5.5 presents the ordering of attributes which were normalised so the most important attribute which was 'stops are easy to find, well lit, clean and safe' scored 100 and the least important attribute which was wifi scored zero. The inclusion of travel time savings and fare reductions enables the importance of the qualitative attributes to be assessed. Most of the quality attributes were preferred to a 10-minute saving or a $1.50 fare reduction. The results accord with the high unscaled values in table 5.31.

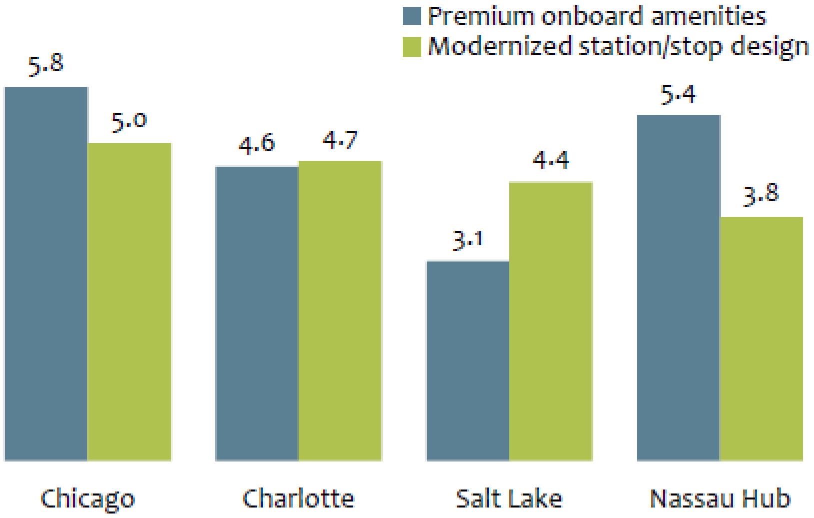
Figure 5.5 Relative attribute importance



Source: Campbell (2012) New Jersey, Chicago and Portland

Campbell (2012) also presented the bundle values for premium onboard amenities and modernised station/stop design for Chicago, Charlotte and Nassau Hub alongside the values for Salt Lake City. Figure 5.6 presents the values. For onboard amenities, Salt Lake City commuters had the lowest value of 3.1 minutes and Chicago commuters the highest at 5.8 minutes. The range in value for station/stop design was narrower from 3.8 for Nassau Hub to 5 for Chicago. The combined value of premium onboard amenities plus modernised station/stop design was around 10 minutes.

Figure 5.6 Comparison of attribute values



Source: Campbell (2012) commuters – values in equivalent onboard bus/train minutes -

In summary, this US study is of particular relevance to the Transport Agency research in its attempt to value premium bus and rail services. At the time of the review, only full results of the Salt Lake City market research were available together with some initial results for some other cities. The study used a two-stage approach to derive attributes. Firstly overall package values were obtained for premium service amenities and modernised stop/station facilities. Then, values for individual attributes comprising the package were estimated using a second SP survey.

The total value of the individual attributes when summed was found to be far greater than the package value, 10 times greater for Chicago. When scaled down to the package values estimated by the first survey, the value of a premium onboard service ranged between 3.1 and 5.8 minutes and a modernised bus stop/station was valued between 3.8 and 5 minutes. A combined bus and station package was therefore valued at around 10 minutes. Amongst the individual attributes, the Salt Lake City survey established onboard seat availability was the most valued bus attribute, and shelter the most important stop/station attribute.

Bus and rail were modelled together and the analysis found that with the inclusion of reliability, vehicle, stop/station and information attributes, there was no significant residual preference for rail or bus.

The study only reported average values but did investigate whether valuations of onboard amenities depended on trip length and whether the valuation of stop facilities depending on waiting time. For bus, no significant relationship was estimated but for rail, onboard amenities decreased the value of time and real time information reduced the cost of waiting time.

5.13 Universal design measures, Norway – Fearnley et al 2011

This Norwegian study by Fearnley et al (2011) estimated the passenger benefits of universal design (UD) features for public transport. UD refers to the requirements for vehicles and facilities to enable accessibility for as many passengers as possible. Fearnley et al considered UD could benefit all passengers not just special need groups. Their study attempted to value different UD measures using SP surveys among public transport passengers in Norway.

The researchers chose to use SP surveys to value UD measures because 'the requirements on data on observed behaviour (revealed preference) of travellers, relating their choices to their valuation of UD measures, would be demanding and expensive. Moreover, it is usually difficult to distinguish the effect of "softer" attributes with revealed preference data'.

The study started with a focus group and qualitative surveys to provide insights into perceptions of UD. These surveys found that that UD measures (eg RTI) were not well understood. As a consequence, illustrations of the different provisions were used in the SP surveys.

The surveys were undertaken in 2009 using a web-based internet questionnaire. Invitation cards were distributed on seven transport lines with a high provision of UD measures in three Norwegian cities. The invitation card gave a short study description; a personal password and the internet address to the web-based survey; and informed about a small lottery prize. The survey was self-completed once logged onto the website. The response rate (completed questionnaires divided by distributed invitation cards) was 'strikingly low' at 5.5%. A total of 451 respondents logged in the website and of these, 406 (90%) completed the questionnaire.

The questionnaire consisted of an introduction, questions about an actual trip (fares, travel times, perceived provision of UD measures, etc), three SP choice experiments (CE), three contingent-value questions (CV), socioeconomic questions, questions about the respondents' special needs and a comment box.

Four SP CEs were developed. All four featured pair-wise comparisons of public transport trips. Each CE had three attributes which made the choices were simple to understand as figure 5.7 shows. Fare was included on all four CEs. The other two attributes varied: CE1 included travel time on the bus/train and information; CE2 included information and ease of boarding; CE3a included shelter and cleanliness and CE3b included shelter and snow/ice removal. All respondents completed CE1 and CE2 with 50% doing CE3a and 50% CE3b.

The estimated values are presented in table 5.32. Fearnley et al (2011) reported willingness-to-pay fare values in Norwegian kroner (NOK). Table 5.32 also presents values in bus/rail minutes using the estimated value of time of time of 0.37 NOK/minute. The authors considered the value of time to be 'relatively low compared to other estimates of VTT for public transport in Norway'. The study they reference, Ramjerdi et al (2010) gives a value of time of 51 NOK per hour or 0.85 NOK per minute which is 2.3 times higher than the UD value of time. The result of having a low value of time is that the value of the UD measures when converted into minutes will also be low.

The third column converts the NOK values into New Zealand cents. The value of time, although considered low for Norway, converts to NZ$4.88 per hour which is higher than the $4 per hour average value for bus travel in the EEMV1.

Figure 5.7 Examples of universal design stated preference choice experiments

Source Fearnley et al (2011)

The estimated values for the UD measures were high both in dollar and minute terms. RTI at the stop was valued the most at 10.9 minutes of bus time. Maps and announcements were valued much less at one tenth and one sixth the value of RTI respectively. The willingness to pay for providing all three measures was 10% higher than for RTI. The two on-board vehicle information measures, speaker and screen, were valued similarly at around 10 minutes. There was little increase (10%) from providing both measures together.

In terms of ease of boarding, a low floor vehicle was valued at 4.5 minutes (37 cents) and 5.6 minutes if combined with elevated kerbs. Providing a bus shelter was valued at 8.4 minutes without seats and 13.4 minutes with seats. A clean service (satisfactory as opposed to dissatisfactory) was valued at 9.8 minutes.

Adding the attribute values together gave a total value for the UD package of 43 minutes or $NZ3.52.

After completing the CE questions, respondents were presented with three CV questions which asked the maximum fare increase they would be willing to pay for lighting at the bus stop; a public transport service which is fully UD upgraded (unspecified); and a specified package of UD measures the same as the package value for the CE. The average willingness to pay presented in the three bottom rows of table 4.32[40] was 2.8 NOK or 7.5 minutes for lighting at stops/stations (using the CE value of time). A fully upgrade UD service was valued at 3.9 or 10.5 minutes NOK and the specified package of measures was valued at 4.4 NOK or 11.9 minutes. The values were therefore much less than the package value of 16 NOK estimated by the SP surveys which is noteworthy finding given that SP is often used to avoid over-estimation from direct willingness-to-pay questioning. Fearnley et al (2011) attributed the reverse finding of a lower CV value to the fact that 'the provision of UD measures is already widespread in the three cities, the low willingness to pay for the UD package in CV would seem plausible. The willingness to pay is only for what they would gain in addition to what is already provided'. An alternative explanation is that the SP values were overestimates. Indeed, in explaining the SP values, the authors comment that the focus and design of the survey may have played a role in producing the high values.

[40] Any respondent not willing to pay a fare increase who also indicated a protest vote (for example 'the improvements should be financed through other channels') were excluded.

Table 5.32 Estimated values for universal design measures in Norway

#	Stated Preference Choice Experiment Attribute	Value Mins	2009 NOK	% Fare	2011 NZC
1	Value of Time (per Minute)	1	0.37	1%	8
	Information at the stop/station (base=timetable				
2	Local map	1.2	0.4	1%	9
3	Changes in departures via speaker	1.8	0.7	2%	15
4	Real-time information on screen	10.9	4.1	12%	89
5	All three information devices	12.5	4.6	13%	102
	Information on board (base = no information)				
6	Next stop via speaker	9.8	3.6	10%	80
7	next stop via screen	9.9	3.7	11%	81
8	Next stop via speaker and screen	11.4	4.2	12%	92
	Improved boarding (base = no adjustments)				
9	Low vehicle floor	4.5	1.7	5%	37
10	Low vehicle floor and elevated kerb at stops	5.6	2.1	6%	46
	Shelter (average value of CE3a & CE3b)				
11	Shelter without sitting place	8.4	3.1	9%	69
12	Shelter with sitting place	13.8	5.1	15%	112
	Satisfactory cleanliness and ice/snow removal				
13	Cleanness	9.8	3.6	10%	80
14	Ice/snow removal	13.4	5.0	14%	109
	Package (5+8+10+12+13)	43	16	46%	352
#	Contingent Value Max WTP values				
1	Stop lighting	7.5	2.8	8%	61
2	Unspecified UD Package	10.5	3.9	11%	85
3	Specified UD Package above (5+8+10+12+13)	11.9	4.4	13%	97

1NZD=0.88USD (Apr 2012) & 1USD=5.7NOK(2009); %Fare based on average fare of 35NOK
1NOK=0.22NZD(Apr 2012)

In summary, this Norwegian study looked at information, ease of vehicle boarding, shelter and seating, cleanliness and ice/snow removal. SP choice experiments and direct willingness-to-pay questioning were used to estimate values. The surveys were undertaken using a web-based questionnaire. A low response rate of 5.5% was achieved. The SP surveys estimated high values for the quality attributes but a low value for travel time. The combined result was a value of 43 minutes for the total package of improvements. This high result was attributed in part by the authors to the focus and design of the questionnaire. By contrast, the much simpler willingness-to-pay questions obtained a package value that was one quarter the size.

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