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Valuing Public Transport & Wayfinding Information

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Abstract

Information helps people to go boldly around in time and space. Maps and signs help people plan 'where' to travel and 'how best to get there' with timetables helping them plan 'when' to travel and giving them an idea as to 'when' they might arrive.

This paper presents user values to help planners evaluate the cost-benefit of providing and improving the quality of information at tram stops, bus stops, rail stations and on-board vehicles. Values are also provided for wayfinding information at activity hubs and on streets.

The values are based on a literature review and market research undertaken in Melbourne of 2,769 people in 2014 using three types of survey. A Stated Preference (SP) survey estimated values for vehicle and station quality which included information as an attribute. A rating survey enabled the overall vehicle and stop quality values to be deconstructed into individual attributes including information. A priority evaluator (PE) survey estimate the relative importance of sources of information for familiar and unfamiliar public transport trips including wayfinding signage. By 'bridging' the PE results with the SP and Rating estimates, values for wayfinding information, which to date have been difficult to find in the research literature were estimated.

Key words:

Stated Preference, Value of Information, Rating surveys, Priority Evaluator, Trains, Rail, Melbourne, Wayfinding information, Internet Panel surveys, Leicester Square, Piccadilly Circus, Toronto 360, Legible London.

1. Introduction

Information helps people to go boldly around in time and space. Maps and signs help people plan 'where' to travel and 'how best to get there' with timetables helping them plan 'when' to travel and giving them an idea as to 'when' they might arrive.

Today, the ubiquitous cell phone and the ability to get virtually instantaneous spatial and temporal information at a scroll of the thumb, somewhat questions the wisdom of installing expensive 'static' timetables and maps but there is, and always will be, a need to confirm 'where you are and where your bus might be' especially, for those without cell-phone information either by choice, poor reception or just a flat battery.

The questions that planners face is how many static signs and timetables should be erected, where they should be located, what they should display and, for this paper, what 'value' do they actually add in relation to the cost they will incur.

This paper only attempts to address the first half of the last question by estimating values for public transport information provided at tram stops bus stops, rail stations, on-board vehicles and for wayfinding information provided on street and at activity hubs.

The values have been gleaned from a literature review and from surveying 2,769 Melbournians in 2014 using Stated Preference (SP), Rating and Priority Evaluator methods.

The SP and Rating surveys were self-completion questionnaires handed out and collected on-board buses, trams and trains. A total of 981 SP and 903 Rating questionnaires were obtained. The Priority Evaluator survey was collected through an internet panel survey of 885 Melbourne residents.

To help the reader find their way around the paper the wayfinding is as follows: Section 2 describes the nine types of information. Section 3 reviews the literature on public transport timetable information with section 4 reviewing the benefits of wayfinding information in overseas cities such as London, Edmonton and Toronto.

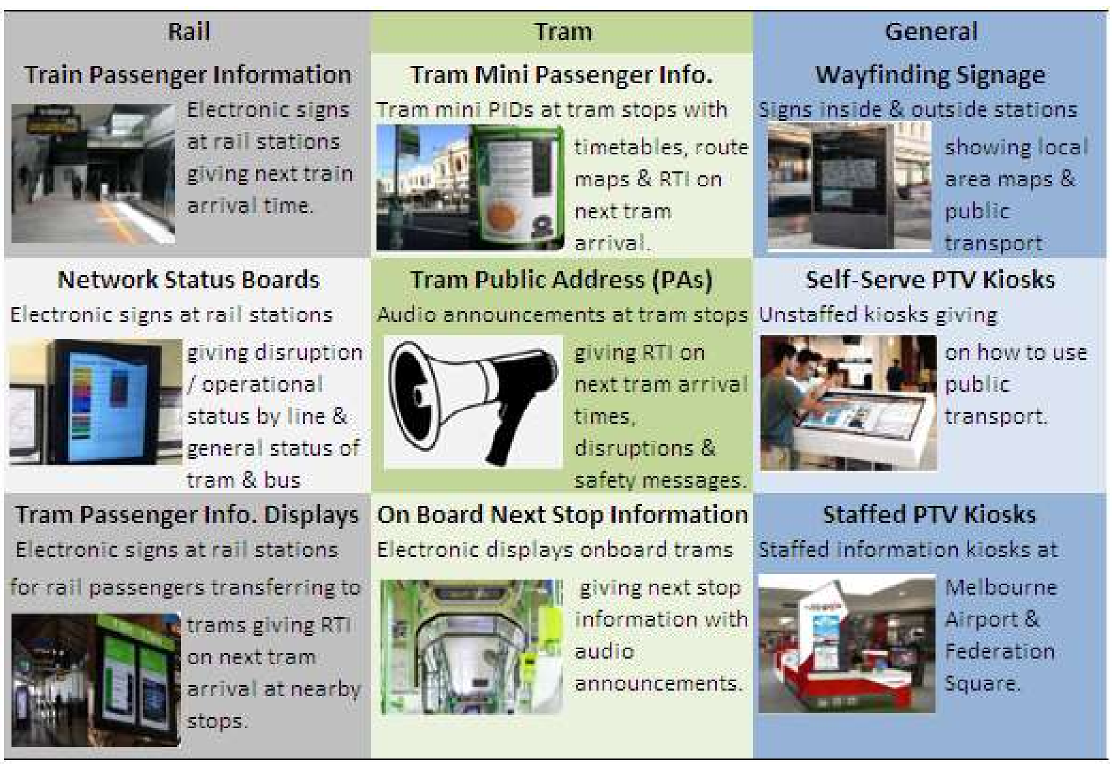
Section 5 provides an overview of the Melbourne survey approach. Section 6 summarises the Stated Preference survey in terms of the design, analysis method and results. Section 7 presents the bus, tram and train ratings and Section 8 the bus stop, tram stop and rail station ratings.

Section 9 looks the Priority Evaluator survey and how the value of spatial information such as wayfinding signs was estimated. Section 10 summarises the estimated values for information and Section 11 makes some concluding remarks.

2. Types of Information & Valuation

The aim of the study was to value the nine types of public transport information in Figure 1.

Figure 1: Types of Information



There were three types of rail station information in the left hand column; three types of tram information (stop and on tram) in the middle column; and, three types of general information shown in the right hand column covering wayfinding signage, self-serve information and staffed information kiosks such as Melbourne Airport and Federation Square.

Value was measured in terms of the percentage of the public transport fare and also in terms of the equivalent travel time saving.

3. Review of Public Transport Information Valuations

In a review for the OECD of public transport convenience factors, Wardman (2014) argued that *"large sums of money are being spent on real-time information on platforms and some bus stops, but increasingly less on more traditional information such as paper maps posted on stations and bus stops. Evidence is required to ensure that the appropriate policies are being followed"*.

As regards the relative importance of information versus other convenience factors, Wardman placed information equal last alongside transfer penalties in a list of ten convenience factors. Such atomistic analysis has its place, as this paper proves, but it must be acknowledged at the outset that without information, whether a train carries any passengers at all and whether passengers know where they are actually going will be 'hit or miss'.[1]

As part of developing the survey program for Melbourne a literature review was undertaken. As well as collating the reported values, the review assessed the survey and analysis method. In all, fourteen studies were reviewed. They ranged from a 1991 Wellington NZ study to the 2013 London Business Case Manual. Most used SP and valued information on its own or as part of a package of vehicle and/or stop improvements. Some studies used Priority Evaluator techniques and some Rating surveys. Generally, those studies that focussed on information, particularly priority evaluator surveys, produced higher valuations. Whereas when considered as part of a package and surveyed using SP techniques the values were lower.

Table 1 presents the valuations expressed in equivalent minutes of on-board time (IVT Mins) and the percentage of the average fare (Fare %).

An evolution from printed paper timetables to mobile phone applications is evident. In 1991, SDG estimated printed timetables to be worth 4% of fare for Wellington NZ. Eight years later in Sydney, Hensher estimated a timetable and map to be worth 6 minutes of on-board time for Sydney bus users and 21% of the fare. Here a convoluted design and a focus on bus quality probably led to the escalation in value.

The three London studies provide evidence of an erosion in the value of information. The earliest valuations were compiled by SDG in 1997 from SP surveys and estimated Real Time Information (RTI) at bus stops to be worth 24% of fare. By 2007, the value had halved to 12% and by 2013 it was down to 8% in the London Business Case Manual.

Elsewhere in the UK, AECOM in 2009 estimated RTI at city centre bus stops to be worth 3% of fare which is lower than the 8% value in London. However, when expressed in equivalent time, the value was six times higher than in London (1.3 minutes versus 0.26 minutes.[2]

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[1] In terms of understanding the value of information, the value of nuts on your car wheel comes to mind. The nuts may be a small cost item and your 'willingness to pay' for a new set might be low but without them, your car would certainly come a crashing round a corner to leave you cursing for not having a fully screwed on set as you recover in your hospital bed.

[2] Differences in the value of time and average fare account for the discrepancy.

Table 1: Values of Public Transport Information

#	Reference	Loc-ation	Type of Information	App-roach	IVT Mins	Fare %
1	SDG(1991)	WTN	1.Bus stop printed timetable (PT) versus leaflets only	SP	1.1	4%
			2.Telephone enquiry system & RTI versus leaflets		2.2	8%
2	PCIE (1995)	SYD	3.Ontrain frequent & audible announcements	SP/P	1.1	4%
			4.Station train indicator boards		0.4	1%
			5.Frequent and audible station announcements		0.8	2%
			6.Manned ticket & information booths		0.8	2%
3	PCIE (1998)	SYD	7.Full information at stops - bus users	PE	4	19%
			8.Full information at stops - rail users		5	32%
			9.Full information at stops - car users		13	86%
4	Hensher (2002)	SYD	10.Timetable & map versus no info	SP	6	21%
5	Halcrow (2003)	VIC	11.Advance info on cancellations at stations	PE	0.7	11%
			12.Advance info on cancellations via SMS		0.3	4%
6	DougEcon (2004)	SYD	13.10% rating improvement - station info	SP/R	0.1	0.3%
			14.10% rating improvement - on train info		0.2	0.8%
7	DougEcon (2005)	WTN	15.Timetable Information at stations	PE	1.2	3%
			16.Platform real time information displays stations		6	16%
			17.10% rating improvement - on train info		0.2	0.8%
8	SDG (1997)	LON	18.Standard timetables at home	SP	4.6	15%
			19.Standard maps at home		3.3	11%
			20.Five star phone service		2.3	8%
			21.Countdown Real Time Info at bus stop		7.6	24%
9	SDG (2007)	LON	22.Countdown Real Time Info at bus stops	SP	5.2	12%
			23.Mobile phone SMS (@ standard phone call rate)		0.8	2%
			24.Mobile phone SMS (as above) with delay info		1.1	3%
			25.Rail Station ticket hall electronic displays		0.8	10%
			26.Platform electronic info on next train		0.7	9%
			27.Onboard train electronic displays		0.5	7%
10	AECOM (2009)	ENG	28.On bus electronic info	SP	1.3	2%
			29.On bus audio announcements		0.4	1%
			30.RTI at city centre bus stops		1.7	3%
			31.SMS RTI - free of charge		1.3	2%
			32.SMS RTI @ 10 pence per message		0.6	1%
			33.SMS timetable – free		0.2	0.5%
			34.Web based information		0.6	1%
11	Outwater (2010)	USA	35.Real Time Info at bus stops - work trips	SP	4.7	n/a
			36.Real Time Info at bus stops - non work trips		5.5	n/a
12	Hammer (2007)	NWY	37.Local map at bus stop	SP	1.2	1%
			38.Real Time Info at bus stop		10.9	12%
			39.Onboard 'next stop' via screen		9.9	11%
13	LBC TfL (2013)	LON	40.Bus stop Countdown RTI incl. diversions/delays	SP	0.26	8%
			41.Mobile phone type in code - next bus info & delays		0.09	3%
			42.Map showing routes serving stop		0.30	9%
			43.Bus station - manned info desk		0.08	3%
			44.Good signing around bus station		0.17	5%
			45.Onboard electronic sign & next stop announcement		0.15	5%

Notes: WTN Wellington NZ, SYD Sydney, VIC Dandenong rail corridor Victoria; NWY Norway, LON London.
SP Stated Preference; SP/Rate SP/rating surveys; PE Priority evaluator; LBC London Business Case Manual

A Norwegian study by Hammer (2007) estimated what first appears an unduly high value for RTI at bus stops of 10.9 minutes of travel time. Maybe waiting for buses in freezing weather might also make uncertain wait times seem longer. Or it may be that the high values result from the researchers focusing respondent attention on bus stop improvements.

Some studies estimated valuations by user group. PCIE (1998) found Sydney car users valued public transport information more than bus and train users.

Since the study was completed, additional studies and reviews have been completed. In section 10, similar surveys undertaken in NZ and Sydney are used to benchmark the Melbourne results. In 2018, Brakewood and Watkins looked at the benefits of RTI in terms of waiting time and estimated RTI to be worth two minutes of waiting time (equivalent to 4 minutes of on-board time given the usual double weighting).

The work is similar to work by Tisato in the late 1980s early 1990s in Adelaide that looked at how the 'cost' of finding out about timetables influenced the proportion of rail passengers turning up at 'random' versus timing their arrival at rail stations for their train, Tisato (1992, 1997).

Also in 2018, De Gruyter, Currie et al reported a meta-analysis of customer amenity research showed how socio-economics, location, trip characteristics can affect valuations.

4. Review of Wayfinding Information Valuations

From the early/mid-2000s, city authorities started to install wayfinding signs in the central areas to help public transport users, pedestrians and cyclists find their way around. In nearly all cases, the justification was qualitative rather than quantitative since researchers have struggled to put a monetary value on the benefit of wayfinding signage.

For Melbourne, the 2007 Inner Melbourne Wayfinding Signage Action Plan did not even attempt to estimate a dollar value. The Action Plan aimed to establish the appropriate signage at 45 locations/decision points to *"encourage and enable people to use active transport modes"*. The main justification was research undertaken in London that showed "*between 60-80% of people were likely to make more walk trips when they had access to good quality map-based information, illustrating the safe walking routes, walk-time estimates and the range of destinations that could be easily reached on foot",* Grant and Herbes (2007).

Figure 2: Wayfinding Signage Melbourne 2007

Photo: Inner Melbourne Wayfinding Signage Stage 1, Part 1, Main Report

The London research had been undertaken as part of a prototype project *'Legible London'* which installed 19 wayfinding signs. The signs were designed for the Central London Partnership (CLP) and Transport for London (TfL) by AIG (2006). The strategy aimed to *"give people the confidence to get lost – safe in the knowledge that it is possible to get back on the beaten track"*. The full system was estimated to cost £40 million ($Aus 47 million).

For central London, it was not the absence of signs but the proliferation of different signs that confused rather than informed. 32 different pedestrian wayfinding systems were in use in central London. People however were considered to be over-reliant on the London Underground map that distorts walking distances. AIG surveys found that *5% of passengers exiting Leicester Square tube station started from a station less than 800 metres away* (often Piccadilly Circus).[3]

Although unable to give a CBA result, AIG considered the £40 million program would be better value than the £400 million Cross River Tram or the £10 billion Crossrail project by encouraging walking and in so doing "*reduce the pressure on the tube system, reduce congestion on buses, stimulate the local economy, encourage greater street life and potentially improve personal safety"*.

A post implementation appraisal of the prototype project found that the number of people feeling lost reduced by a third, journey times reduced by 16%, over 60% considered the system had encouraged them to walk more and 90% considered wanted it expanded across London, Arquati D (2008).

Another London study into the effects of better street design by the Centre of Architecture and Built Environment in 2017 (CABE) used multiple criteria named 'Pedestrian Environment Review System' (PERS). PERS was used to examine 11 factors including legibility of landmarks and sightlines which had a 5% importance score in the PERS system.[4] An increase in PERS of 1% point was predicted to increase retail floorspace by 5%.

Across the Atlantic in Edmonton Canada, the planners made several attempts to create a wayfinding program (costing around Aus $12 million) but *"failed at the value for money decision"* because although *"wayfinding offers many benefits to a growing city, it has not so far obtained support as a priority for the investment needed for citywide implementation"*, Applied (2014).

Surveys were undertaken before and after wayfinding signage was introduced. The results were mixed as Table 2 shows. Excluding the people who did not need any information, the most important source before wayfinding signage was introduced was smartphone apps at 63%. After the introduction, the percentage reduced to 42%. There was a slight increase in the use of LRT station signs but reductions in the use of street name signs and directional signs. The biggest increase was in *'places I know'* which increased from 7% to 28%.

TransLink Vancouver introduced a wayfinding system for their trolley bus, diesel bus and metro train system in 2008-10. For rail users, TransLink based their Cost Benefit on a survey of Sydney rail passengers by Douglas and Karpouzis (2006) that established values of 0.4¢ and

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[3] Surveys of 248 pedestrians leaving Leicester Square tube station in 2006 found that the tube map was the most commonly used method for journey planning with 45% using it, followed by on-line information 20% with A-Z and other guidebooks on 17%. Three quarters of respondents measured time rather than distance with nearly three-quarters misunderstanding the distance and less than 60% able to identify the correct way to another tube station.

[4] Quality of the environment was the most important factor (24%). The other factors were personal security (13%) permeability (12%) user conflict (11%) surface quality (10%) maintenance (9%) and lighting (7%) legibility (5%) dropped kerbs/gradients (4%) obstructions (3%) and effective width (2%).

1¢ per trip. TransLink assessed the scheme for bus users on customer satisfaction ratings (similar to those conducted in Sydney) which showed an increase in the rating of information from 49% to 89%.

Table 2: Information Sources used in Edmonton (Before & after Survey of Wayfinding Program)

	Used Source?		Most Important Source?	
Information Source	Before	After	Before	After
Referred to a map	3%	7%	4%	12%
Smartphone/mobile phone application	22%	22%	63%	42%
Signs in the LRT station/pedestrian way	2%	10%	2%	4%
Street name signs	7%	18%	13%	5%
Directional signs on street/way-markers	2%	10%	11%	9%
Places I know e.g. buildings, large stores	8%	31%	7%	28%
Non needed I know the way / I know the area	60%	50%	-	-
Total	104%	148%	100%	100%
Sample Size	223	168	223	168

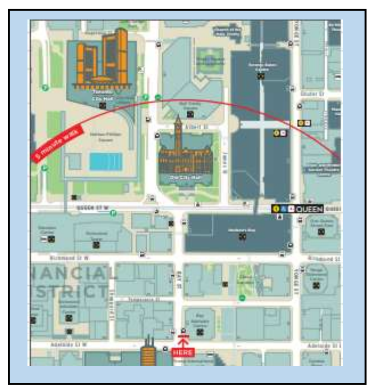
Source: Applied (2014)

The City of Toronto commenced a 'Wayfinding 360' project in 2011. The project included pedestrian, vehicular, cyclist and transit wayfinding information, City of Toronto (2018). A pilot project costing $C800000 comprising 12 narrow signs, 4 wide signs, 5 finger post signs, updates to 12 existing wayfinding signs and 38 transit shelter wayfinding maps was implemented. Pre and post-implementation surveys were undertaken that asked respondents to rate signage in the pilot area on a number of factors. Table 3 presents the result which shows the percentage who felt that *'signing helped people find their way around'* increased from 61% to 81% and the percentage *'feeling they could learn new and interesting locations or attractions'* increased from 44% to 82%.

Table 3: Before and After Survey of Toronto 360 Wayfinding Project

Helps people	Before	After
Find their way around	61%	89%
Make informed choices about walk routes	39%	83%
Learn new and interesting locations or attractions	44%	82%
Feel comfortable walking in local areas	91%	98%

Source: City of Toronto 'Implementation Handbook' (2018)



An economic analysis of the Toronto 360 pilot project borrowed findings from the Legible London project to calculate pedestrian walk time savings of between C$11 and C$33 million plus avoided car congestion costs of C$6-$13 million that gave the project a Benefit Cost Ratio of between 0.9 and 2.4.

5. Melbourne Survey Approach

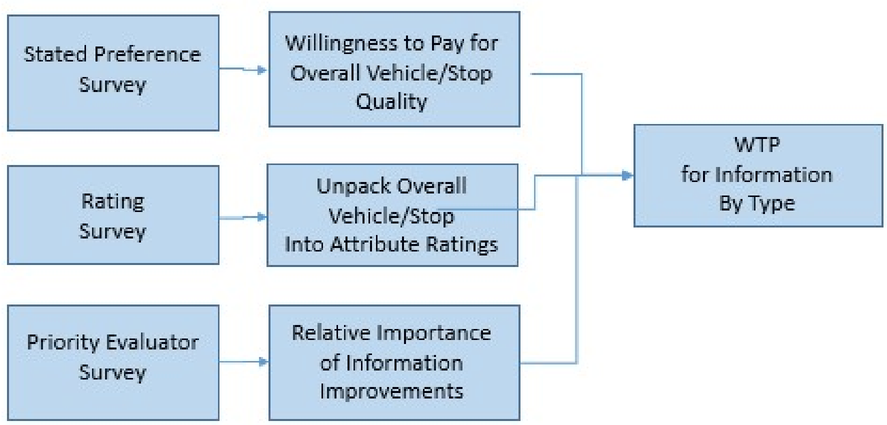
The survey used a combined Rating and SP approach developed by Douglas (2016) in a study commissioned by the New Zealand Transit Agency of bus and train users in Auckland, Christchurch and Wellington.

The approach has also been used in New South Wales as part of estimating demand parameters for Inner Sydney, see Douglas and Jones (2016); and estimating values of time for bus, train, Light Rail and ferry, Douglas and Jones (2018).[5]

Figure 2 sets out the approach. The rating survey asks respondents to rate the stop they boarded at and the vehicle they were travelling on when surveyed. Respondents are asked to give an overall rating and ratings for individual stop and vehicle attributes including information which were then used to explain the overall rating. The SP survey includes overall stop and vehicle ratings with fare, travel time and frequency to enable the overall ratings to be valued. Thus together the rating and SP survey estimate the value of changes to the ratings of vehicle and stop attributes in terms of fare and travel time.

The Priority Evaluator survey determines the relative importance of various information improvements and by including some attributes on the rating survey it is possible to link the results and estimate values for a set of information improvements.

Figure 3: Market Research Approach



The surveys include socio- economic, demographic and trip profile questions to adjust results for sampling issues and explain the variation in response.[6]

The Melbourne surveys were undertaken in October 2014. The rating and SP questionnaires were handed out on weekday and weekend services up to 7pm. Metropolitan services were surveyed. Longer distance regional train and bus services were not surveyed.

The Priority Evaluator (PE) internet panel survey took 11-15 minutes and surveyed users of PT services and a few non users. In total, 885 respondents were completed the internet survey between 8th and 12th October 2014.

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5 The Melbourne questionnaire was the same as those used in Sydney and NZ. As only cosmetic changes were made, no piloting was needed. The changes tailored the ticket type categories to Melbourne and at the request of the PTV some of the rating questions were changed with some questions on disability status and trip familiarity added.

6 The rail and tram profiles reflected the off-peak emphasis of the sample. Unfortunately the rail operator would not allow surveys to be undertaken on peak trains before 9am and between 4pm and 7pm which meant that 87% of passengers were travelling off-peak. A set of weights were developed to re-weight the rail and tram results from the SP survey. A set of journey purpose weights were developed that used PTV data to adjust the SP survey results.

Altogether 2,769 respondents completed a survey. 571 bus, 561 tram and 752 rail users completed a rating or SP questionnaire with roughly equal numbers by mode.[7] The PE survey was dominated by rail users with 721 metropolitan and 15 regional users. A further 76 tram, 28 metropolitan bus, 1 regional bus user and 44 non users completed the on-line questionnaire.

Table 4: Sample Sizes by Mode

Survey Type	Sample Size				
	Bus	Tram	Rail	Non User	All
Rate	280	286	337	na	903
SP	291	275	415	na	981
Priority Evaluator	29	76	736	44	885
Total	600	637	1,488	44	2,769

A summary of the sample profiles is presented in Table 5 with the SP & Rating surveys distinguished from the Priority Evaluator survey.

Table 5: Profile of Response of SP, Rating and Priority Evaluator (PE) Internet Panel (IP) survey

Profile	SP & Rating	PE (IP)	Comment
Sample Size	1,884	885	903 Rate, 981 SP with even splits by mode. PE (Internet Panel) 81% metro rail, 2% regional rail, 9% tram, 3% bus.
Peak share of response	20% Peak & 80% Off-Peak	na	Bus at 49% was the only mode reflective of actual share. Rail peak share near zero due to train operator banning peak surveys. Tram peak share was also low at 13%.
Trip Purpose	32% to/from work	45%	SP & Rating profile varied by mode reflecting time periods surveyed: Bus JTW was 44% versus 33% tram & 23% rail. Education shares were 21% bus and 20% rail with tram lower at 10%.
	21% to/from education	7%	
	50% other	48%	
Gender	53% Female	50%	For SP&Rating surveys the tram had the highest female share at 60% with rail & bus lower with 51% female shares.
Age	33 was average age	45	The PE sample was older averaging 41 (41% over 50). Rating/SP respondents were younger with 40% under 24 (under 12s not surveyed) with 7% over 64.
Employment	49% Employed	61%	PE survey had greater share employed (61%) than the Rating/SP with tram 58%, bus 47% & rail 45% (off-pk survey).
	36% Student	9%	
Occupation of employed	49% Manager/Professional 47% Sales/Clerical	na	SP response coded by occupation category showed little variation by mode.
Income	$40k Income p.a.	$60k	PE higher average income ($60k) than SP Q'aire (non-response infilled using emp/occup). Tram highest at $46.7k with rail $38.2k and bus $36.2k.
Trip length	Average of 26.5 mins	na	Tram shortest 20 mins, rail longest 34 mins, bus 23 mins.
Frequency	Service every 17 mins		Tram most frequent at 11 mins apart, bus & rail 19 mins.
Wait	Wait averaged 7 mins		Tram wait shortest at 5 mins with bus & rail at 11 mins.

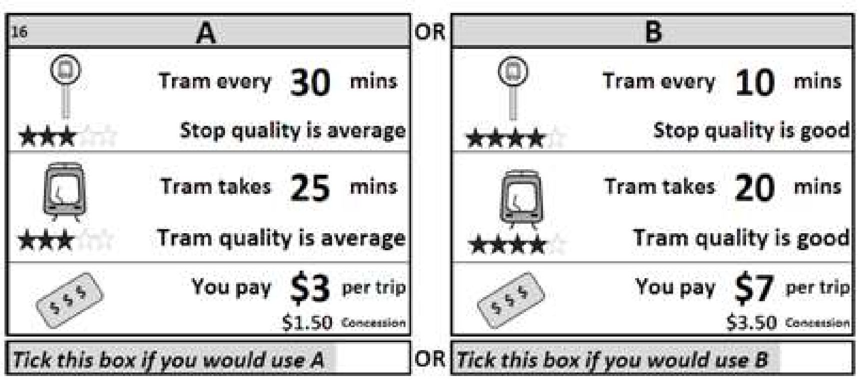
[7] The response rate was close to 100% with the surveyors handing them out with pencils if necessary and then returning to collect the completed questionnaire and providing assistance on an 'as needs basis'.

Profile	SP& Rating Survey	PE Survey	Comment
Average Fare	$3.40 per trip	na	Some response adjustment to estimate single fares. Bus fares were the lowest at $2.90, tram $3.10 and rail was highest at $4/trip. Overall average of $3.40.
Ticket Type	45% myki pass, 20% 2hr & 31% daily pass	na	Bus sample most representative with rail and tram higher non-pass shares due to low peak samples.
Fare Zone	Z1 47%; Z2 18%; Z1+Z2 34%; Other 2%	na	Marked differences by mode, 85% of tram were Zone 1, 55% of Rail were Z1+Z2 and 43% of Bus were Z2.
Concession	41% used a concession	na	Rail highest with 44%, Bus 41% and Tram lowest on 35%.
Trip Frequency	78% weekly, 17% monthly 5% annual/1st time	44% weekly	Marked modal differences: 90% of bus weekly users, 81% tram & 65% rail reflecting time periods surveyed (rail off-pk focus). PE less frequent users.
Trip Familiarity	80% - 90% familiar with 10-20% unfamiliar	82% familiar	For SP/Rating survey, tram had the lowest 'familiar' share (80%) with bus highest (90%). PE was 82%.
Rail Access	48% walk, 20% car, 17% bus/tram	na	Varied by location with higher walk shares at inner suburban stations & higher car at outer suburban stations.
Impairment	13% had an impairment	17%	Rating/SP except rail (not asked) 6% mobility, 4% sight & 4% hearing impaired. PE: 5% mobility, 8% sight & 4% hearing.

6. Stated Preference Survey

The SP survey presented bus, tram and train users with a series of pair-wise choices. The choices 'traded-off' overall vehicle and overall stop/station quality with travel time, service frequency and fare. An example of one of the tram show cards is provided in Figure 4.

Figure 4: Example Stated Preference Show Card



Vehicle and station quality was measured on a 5 star scale similar to those used to rate restaurants, hotels and movies. Prior to answering the SP choice questions, respondents were asked to rate the stop/station where they boarded and the vehicle they were travelling on. Figure 5 shows the vehicle rating question. This was done to make respondents think about their stop/station and vehicle in context of rating system. Respondents were also asked about the frequency of their service, the travel time and the fare.

Each of the five attributes featured in the SP choices could take one of five levels. A full design would have required 3,125 pair wise choices (5^5). Instead, a fractional design (in which the main effects were not independent of interactions) was used. The ordering of the show cards was randomised and half the cards were swapped so that the expensive mode was sometimes on the right and sometimes on the left.[8] The 25 questions were then split into three sets (2 sets of 8 and one of 9) with each respondent completing one of the 8 or 9 choice sets.

Figure 5: Five Point Quality Scale

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

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

Each respondent provided 8 or 9 responses which produced a total of 6,950 SP responses from the 981 respondents. The design was well balanced with 46% choosing service A (the quicker option) and 54% service B (the cheaper option).

Response to the SP questions was analysed using equation 1. For stop and vehicle quality, the 5 star ratings were converted into a percentage scale by subtracting 1 from the rating and dividing the remainder by 4. Thus a 5 star rating became 100% and 1 star rating 0%. The percentage was then subtracted from 100% to make the parameter negative (like the other three variables). In essence, the variable was measuring ‘dis-quality’.

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

$$Z = \left\{ \begin{array}{l} \alpha + \beta_f \Delta F + \beta_{fc} \Delta F.C + \beta_t \Delta T + \beta_{si} \Delta SI + \beta_{vq} \left\{ (1 - VQ_A^{\phi vq}) - (1 - VQ_B^{\phi vq}) \right\} \\ + \beta_{sq} \left\{ (1 - SQ_A^{\phi sq}) - (1 - SQ_B^{\phi sq}) \right\} \end{array} \right\} \text{.......(1)}$$

F= Fare difference (A-B) in dollars (taking account fare concession (½ΔF) where appropriate)
C=Concession entitlement taking a value of 1 if entitled to a concession else zero
T=Difference in train time (A-B) in minutes
SI=Difference in service interval (A-B) in minutes
VQ=Difference in train quality rating (A-B) transformed by power function (Φ=0.7)
SQ=Difference in station quality rating (A-B) transformed by power function (Φ=0.7)
α and β = parameters to be estimated.

Stop/station and vehicle quality was transformed by applying a power function. The power function reduced the sensitivity as the rating increased.[9] Figure 6 shows the effect of the transformation parameter. Various values were tested with a value of 0.7 adopted.[10]

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[8] Swapping the choices was done to encourage respondents to look at the cards more carefully (expensive mode was sometimes on the right and sometimes on the left on the left. Where attributes were the same for service A and B (as in SP experiment 1) they were not shown.

[9] For vehicle quality (VQ) the transformed variable was VQ^{ϕ} where ϕ was between 0 and 1. With ϕ=0, the quality rating was zero for all ratings. With ϕ=1, quality was non-transformed. Only between 0 and 1 was the transformation effective.

[10] Only for ratings between very poor and very good is the transformation effective. At the two extremes, the transformed rating was the same. With a power parameter of 0.8, a rating of 50% was ‘increased’ to 57%. With a parameter of 0.5 it was increased to 71% and to 81% with a parameter of 0.3. Thus the smaller the parameter, the greater the relative weight to low ratings and the less weight to high ratings. A range of values were tested for the power function. Values of 0.6 to 0.8 optimised goodness of fit. For bus a value of 0.6 for both vehicle and stop optimised goodness of fit. For tram, the optimum values were 0.6 for stop and 0.8 for vehicle. For rail, the values were 0.7 for

6: Power Function used for Stop & Vehicle Quality

The fitted model is presented in Table 6. All the parameters had correct negative sign; fewer respondents chose option A, the longer the time, the greater the cost or the lower the quality when compared to option B. Table 6 presents the estimated parameters.

Table 6: Estimated Stated Preference Model

Parameter	Mode: Bus β	Bus |t|	Tram β	Tram |t|	Rail β	Rail |t|	All β	All |t|
SI	-0.050	12.5	-0.053	13.3	-0.030	10.0	-0.041	20.5
IVT	-0.078	9.3	-0.071	7.9	-0.043	6.6	-0.059	13.1
Fare	-0.330	9.4	-0.342	9.3	-0.162	6.1	-0.251	13.8
Fare Conc	-0.508	8.3	-0.188	2.9	-0.114	2.6	-0.238	7.8
Stop Qual	-1.048	7.0	-0.690	4.5	-0.874	7.6	-0.873	11.2
Veh Qual	-0.531	2.3	-0.193	0.8	-0.420	2.3	-0.389	3.2
VOT - Std $/hr	14.34	6.6	12.44	6.0	16.74	4.4	14.38	9.3
VOT - Conc $/hr	5.63	6.3	8.05	4.4	10.01	3.3	7.39	7.7
VOT - Av $/hr	10.85	8.0	10.99	7.2	13.78	5.5	11.59	11.6
SI/IVT	0.65	7.5	0.76	6.8	0.74	5.5	0.71	11.0
Stop Qual/IVT	13.5	5.6	9.9	3.9	21.7	5.0	15.1	8.5
Veh Qual/IVT	6.7	2.2	2.7	0.8	9.7	2.2	6.4	3.1
Concession %	40%		33%		44%		40%	
Income $kpa	35		47		38		40	
IVT (mins)	23		20		35		28	
Observations	2,040		1,833		3,077		6,950	

All the parameters were statistically significant (|t| > 1.96) except for tram quality.[11] The most precise estimate was service interval. The parameters for in-vehicle time, cost and stop quality were also highly significant. The parameter for vehicle quality was weaker.

The value of time (VOT) was estimated for standard and concession passengers (who could obtain the time savings at half the price – see the show card in Figure 3). For standard fare users, the VOT was $14.38/hr. The VOT for fare concession respondents was around half the

station and 0.8 for train. Thus the values ranged from 0.6 to 0.8. A value of 0.7 was mid-way and was adopted. It was also the value used in Sydney.

[11] Models were estimated with and without the constant. There are theoretical and empirical reasons to support either approach. The average of the models with and without a constant are presented in the Table 6.

standard fare value at $7.39/hr. With 40% of respondents entitled to a fare concession, the weighted average VOT was $11.59/hr. By mode, the VOT ranged from $10.85/hr for bus to $10.99/hr for tram to $13.78/hr for rail.

A minute of service interval was worth 0.71 minutes of in-vehicle time.[12] The estimate was a little higher than the estimate for NSW of 0.64 by Douglas and Jones (2018) and for NZ of 0.6 by Douglas (2016).

Improving stop quality from very poor to very good was equivalent to a 15 minute saving in in-vehicle time. Vehicle quality was valued less at 6.4 minutes. It should be stressed that both these values are theoretical maximums since it would be virtually impossible for everyone in a group to value quality as very poor before a change and very good after the change. In fact, the observed ratings suggested a reasonable quality range of 40% to 80%. Applying the power parameter of 0.7 reduces the value of the 40-80% change by a third. As a result, the feasible quality range was worth 5 minutes for stop/station quality and 2 minutes for vehicle quality. By comparison, the value of stop and vehicle quality for NSW was around 4 minutes for a 40-80% quality range. For NZ it was around 5 minutes for stop quality and 6 minutes for vehicle quality.

7. Vehicle Ratings

The surveyors recorded the details of the bus, tram and train surveyed. Figure 7 describes the vehicle types that were surveyed.

Buses were categorised into two types: SmartBus and Standard. Trains were categorised into three types: X'Trapolis, Siemens and Comeng (which had Alstom and EDI refurbish variants). Trams were categorised into three types, new (E, D and C); standard (A, B) and old (Z and W).

The survey asked passengers to rate their bus, tram or train on a 9 point scale with 9 being very good, 7 good, 5 average, 3 poor and 1 very poor.[13] For analysis purposes, the passenger ratings were converted to a percentage rating by subtracting 1 and dividing the remainder by 8. Thus a rating of 9 'very good' became 100% and a rating of 1 'very poor' became 0%.

Figure 8 summarises the passenger ratings. The 'Smart' buses and the newer trams (C, D & E) scored the highest passenger ratings of 73%.

Standard buses rated at 71%, 2% points lower than the Smart Bus.

The older W and Z trams and the standard A, B trams rated in the middle with 65%.

The Alstom X'trapolis train scored 67%, with the Siemens Nexas on at 65% with the Comeng train being the lowest rated vehicle with a rating of 60%.

Within each vehicle type category, the average rating varied by surveyed service such that across the sample of 137 services surveyed, the vehicle rating ranged from a low of 45% to a high of 84%.

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[12] The valuation of service interval implied that if the frequency of a service was reduced from half hourly to every 20 minutes (a reduction of ten minutes) the improvement would be equivalent to a reduction in on-board time of 7 minutes.

[13] Intermediate ratings were included so the full scale of 1,2,3,4,5,6,7,8,9 was included on the questionnaire.

Figure 7: Vehicle Types Surveyed

	**SmartBus bus** used on 3 orbital & 4 Rapid Transit Manningham-City routes (#s 703,900-908). Use low-floor vehicles. Some stops have RTI & features for visually impaired. 15 buses surveyed.		**A class Tram. Single vehicle** tram seating 40. Introduced from 1988. No onboard electronic info. 3 vehicles surveyed.
	**Standard bus** - variable details. 23 buses surveyed.		**Z class Tram.** Narrow front end single vehicle tram seating 40. Introduced from 1978 onwards. No onboard electronic information. 12 vehicles surveyed.
	**E class Tram.** Bombadier. Newest tram introduced from 2012. Articulated, 4 sections each seating 64 pax. Has electronic onboard information. Only one vehicle surveyed.		**W class tram.** Heritage tram used on city circle. Introduced circa 1952. Seats 52.No onboard electronic information but has a manual bell. 1 tram surveyed.
	**D class Tram.** (D1&D2) Combino tram introduced from 2002. Articulated, 4 sections each seating 58 pax. Has electronic onboard information. Introduced from 2002. 2 vehicles surveyed.		**X'Trapolis train.** Alstom introduced 2002. 3 car units 264 seated 133 std (crush 697). 16 vehicles surveyed.
	**C class Tram** (C1&C2) Citadis tram. Articulated, 5/3 sections each seating 54/40 pax. Has electronic onboard information. Introduced from 2002. 3 vehicles surveyed.		**Siemens Nexas train.** Introduced from 2002. 3 car set, seats 264. 19 vehicles surveyed.
	**B class Tram (B1&B2)** ComEng built. Wide front - double articulared tram seating 74/76. Introduced from 1990. No onboard electronic info. 17 vehicles surveyed.		**Comeng train.** Introduced from 1981. Refurbished 2002 with two variants Connex and EDI. 16 Alstom trains surveyed and 9 EDI.

Figure 8: Ratings of Vehicle Types

Mode	Average Rating	Lowest Rated	Middle Rated	Highest Rated	Rating Range
Bus	71%	Standard Bus 71% 	not applicable only 2 types	Smart Bus 73% 	71%-73%
Tram	66%	Older Tram, W,Z 65% 	Standard Tram A,B 65% 	New Tram C,D,E 73% 	65%-73%
Train	64%	Comeng 60% 	Siemens Nexas 65% 	Alstom X'trapolis 67% 	60%-67%
All	66%	Comeng 60%	-	Smart Bus/New Tram 73%	60%-73%

* calculated on the average rating per service surveyed (Rating + SP surveys combined) where a rating given.

The ratings of the individual vehicle attributes are given in Table 7. The new tram rated the highest scoring over 80% in outside appearance, ease of on/off, seat availability and comfort, lighting and cleanliness and graffiti. It scored its lowest rating for space for possessions (71%) and internet connectivity (71%). In terms of information, new trams with their on-board information rated higher (74%) than standard and old trams (55%-56%) where there is no next stop information.

The Comeng train scored the lowest ratings particularly in cleanliness/ graffiti (58%), information (59%), internet connectivity (53%) and environmental noise and emission impacts (57%).

Table 7: Vehicle Attribute Ratings

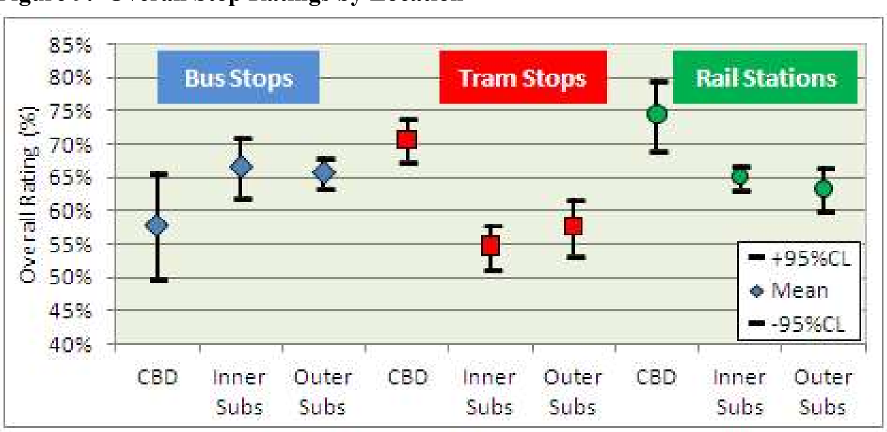
Vehicle Attribute	Bus		Tram			Rail			All
	Smart Bus	Std Bus	New Tram	Std Tram	Old Tram	Xtra	Siem	Comg	
Outside Appearance	74%	74%	81%	62%	63%	67%	66%	60%	68%
Ease of On Off	78%	78%	82%	66%	67%	76%	77%	72%	74%
Ticket Purchase	69%	71%	-	-	-	-	-	-	70%
Seat Avail & Comfort	73%	76%	82%	69%	69%	74%	74%	67%	72%
Space for Possessions	69%	70%	71%	59%	65%	66%	62%	61%	65%
Smoothness/Quietness	65%	66%	72%	62%	62%	68%	70%	62%	65%
Heating/Air Con	73%	70%	76%	63%	57%	71%	74%	68%	69%
Lighting	75%	76%	82%	69%	68%	74%	77%	71%	73%
Cleanliness/Grafitti	67%	74%	82%	66%	65%	56%	59%	58%	65%
Information	64%	60%	74%	55%	56%	70%	63%	59%	62%
Internet Connectivity	44%	49%	71%	57%	50%	54%	58%	53%	52%
Driver	77%	74%	78%	69%	70%	-	-	-	73%
Environmental Impacts	65%	65%	74%	60%	58%	60%	61%	57%	62%
All - Rating Survey	73%	72%	77%	66%	67%	70%	70%	63%	69%
All - Rating & SP	71%	71%	73%	65%	63%	66%	65%	60%	66%
Sample Size (Rate)	117	136	33	123	73	99	109	110	800
Sample Size (Rate+SP)	252	281	64	251	157	217	230	263	1715

* Calculated on the average of respondent ratings by vehicle type where response given.

8. Stop & Station Ratings

Rail stations achieved the highest average rating (67%) and tram stops the lowest (61%) with bus stops scoring 65%. Ratings varied by location however as Figure 9 shows.

Figure 9: Overall Stop Ratings by Location



The rating survey asked respondents to rate their stop/station in terms of a list of attributes. Rail stations had a longer list than bus and tram stops. The response is presented in Table 8.

Table 8: Stop/Station Attribute Ratings (Rating Survey)

Stop Attribute	Bus	Tram	Rail	All
Weather Protection	57%	53%	68%	60%
Seat Provision	60%	54%	56%	56%
Platform Surface	-	-	66%	67%
Ease of On/Off	-	-	74%	74%
Timetable Information	68%	69%	69%	69%
RTI Information	60%	52%	70%	61%
Lighting	73%	61%	69%	68%
Cleanliness/Grafitti	54%	70%	63%	62%
Toilet Avail & Cleanliness	-	-	45%	45%
Staff Avail & Helpfulness	-	-	61%	61%
Retail	-	-	58%	59%
Ticket Purchase	-	32%	66%	51%
Car Access Facilities	-	-	57%	57%
Bus Access Facilities	-	-	66%	66%
All - Rating Survey	66%	61%	68%	65%
Sample Size	256	257	308	821

Lighting was the highest rated bus stop attribute at 73% with cleanliness and graffiti the lowest on 54%. By contrast, for tram stops, cleanliness and graffiti was the highest rated attribute on 70% with ticket purchase the lowest on 32%.

For rail stations, ease of on/off was the highest on 74% with toilet availability and cleanliness the lowest on 45%.

Timetable information rated higher than Real Time Information (RTI) at tram stops (69% versus 52%) and also bus stops but for rail stations, timetables and RTI rated reasonably highly at 70%.

Bus and tram respondents were asked whether certain facilities were available at their stop. Table 9 compares the overall rating obtained according to what facilities were availabile.

Table 9: Effect of Provision of Facilities on Bus & Tram Stop Rating

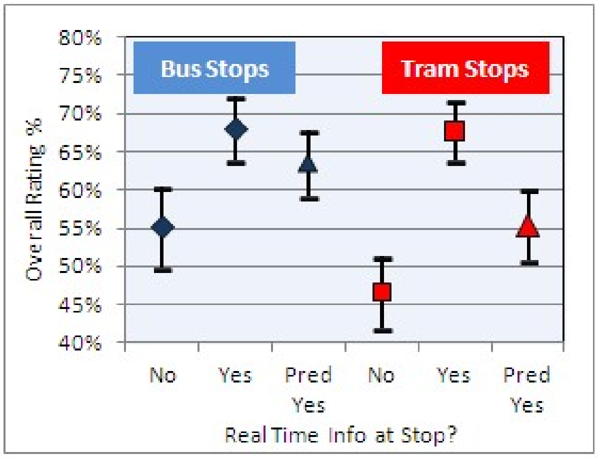
	Av Rating (%)			Sample			Std Error		
Facility	Bus	Tram	All	Bus	Tram	All	Bus	Tram	All
No Shelter	44%	42%	43%	67	80	147	3%	4%	2%
Shelter	69%	65%	67%	184	196	380	2%	2%	1%
No Seating	41%	40%	40%	48	52	100	4%	4%	3%
Seating	67%	63%	65%	203	224	427	2%	2%	1%
No Timetable	55%	48%	50%	10	22	32	6%	6%	5%
Timetable	62%	59%	60%	246	244	490	2%	2%	1%
No Real Time Info	55%	47%	50%	91	115	206	3%	2%	2%
Real Time Info	68%	68%	68%	139	142	281	2%	2%	1%
No Raised Platform	na	47%	na	na	137	na	na	2%	na
Raised Platform	na	69%	na	na	130	na	na	2%	na
No Myki Ticket Purch	na	53%	na	na	196	na	na	2%	na
Myki Ticket Purch	na	70%	na	na	61	na	na	3%	na
Average^	61%	58%	60%	280	286	566	2%	2%	1%

^ rating survey response only

Shelter increased the average rating rating from 43% to 67%. Timetables increased the rating from 50 to 60% and RTI from 50% to 68%.

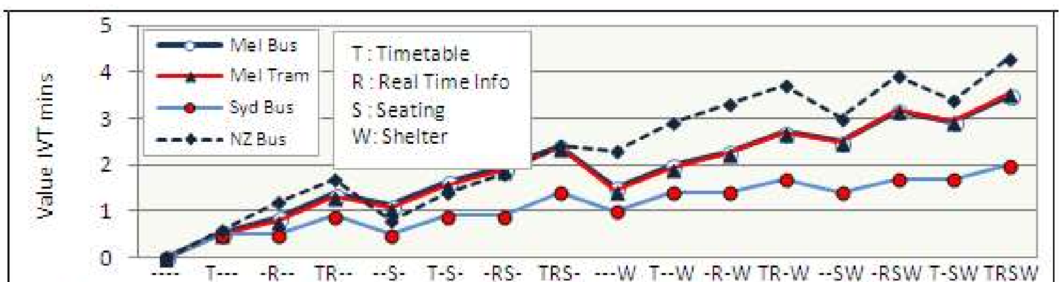
Figure 10 plots the overall rating with the availability of RTI. Given there was a correlation between RTI and other facilities being available, regression was used to remove it. Having done so, the 'predicted' rating improvement with RTI reduced to 9% for bus stops (55% to 64%) and 8% for trams (47% to 55%).

Figure 10: Provision of RTI at Bus & Tram Stops



By using the 'package' values from the SP survey (section 4) in combination with the rating changes (section 8), the value of providing facilities at bus and tram stops was estimated. Figure 11 presents the value of providing timetables, RTI, seating and shelter. The figures are expressed in equivalent IVT minutes. Also presented are values for Sydney and NZ bus stops.

Figure 11: Valuation of Bus & Tram Stop Facility Provision in IVT minutes



	----	T---	-R--	TR--	--S-	T-S-	-RS-	TRS-	---W	T--W	-R-W	TR-W	--SW	-RSW	T-SW	TRSW
Mel Bus	0	0.5	0.9	1.4	1.1	1.6	1.9	2.4	1.5	2.0	2.3	2.7	2.5	3.2	2.9	3.5
Mel Tram	0	0.5	0.8	1.3	1.1	1.6	1.9	2.4	1.4	1.9	2.2	2.7	2.5	3.2	2.9	3.6
Syd Bus	0	0.5	0.5	0.9	0.5	0.9	0.9	1.4	1.0	1.4	1.4	1.7	1.4	1.7	1.7	2.0
NZ Bus	0	0.6	1.2	1.7	0.8	1.4	1.8	2.4	2.3	2.9	3.3	3.7	3	3.9	3.4	4.3

The value of providing a timetable was worth 0.5 minutes at stops with no other facilities. RTI was valued more highly at 0.8 minutes at tram stops and 0.9 minutes at bus stops. Providing both types on information was valued at 1.4 minutes for bus and 1.3 minutes for tram. Therefore, the incremental value from providing RTI in addition to a timetable was 0.5 minutes.

Information was valued slightly less at stops with seating and shelter. Providing a timetable was worth 0.4 minutes and RTI 0.7 minutes.

The value of providing all four facilities was around 3.5 minutes. By comparison, the value for Sydney was lower at 2 minutes and NZ higher at 4.3 minutes.

PTV asset data was researched to see what facilities were available at tram stops. There were problems in matching the location given by respondents with the stops listed in the asset data base so instead tram 'street sections' were referenced and the proportion of stops with facilities calculated.[14]

Table 10 compares perceived availability with actual availability for CBD stops, Inner suburban stops (IN) and Outer (OUT) suburban stops.[15]

Table 10: Perceived versus Actual Availability of Facilities at Tram Stops

	Real Time Info		Seating		Shelter		Raised Platform		Rating Survey#	
	Rating Survey	Asset Data	Rating Survey	Asset Data	Rating Survey	Asset Data^	Rating Survey	Asset Data	Time-table	Myki Ticket
CBD	82%	70%	85%	81%	83%	58%	77%	67%	90%	44%
IN Suburb	40%	13%	76%	46%	58%	7%	34%	14%	92%	12%
OUT Suburb	41%	3%	85%	47%	79%	4%	31%	18%	92%	16%
All	71%	28%	81%	57%	73%	22%	49%	31%	92%	24%

^ 4 metre or longer shelter. # Timetables & myki ticketing not included in asset database

82% of respondents thought RTI was available at tram stops they boarded which was higher than the asset data base figure of 70%. Either respondents thought RTI was provided when it wasn't or relatively more passengers boarded at stops where RTI was provided.[16] The difference was greatest for shelter (83% versus 58%) and least for seating (85% versus 81%).

The availability of RTI was lower at suburban tram stops. Again, a higher percentage of respondents (40%) thought it was available than the asset data base (13% at inner suburban stops and 3% at outer suburban stops).

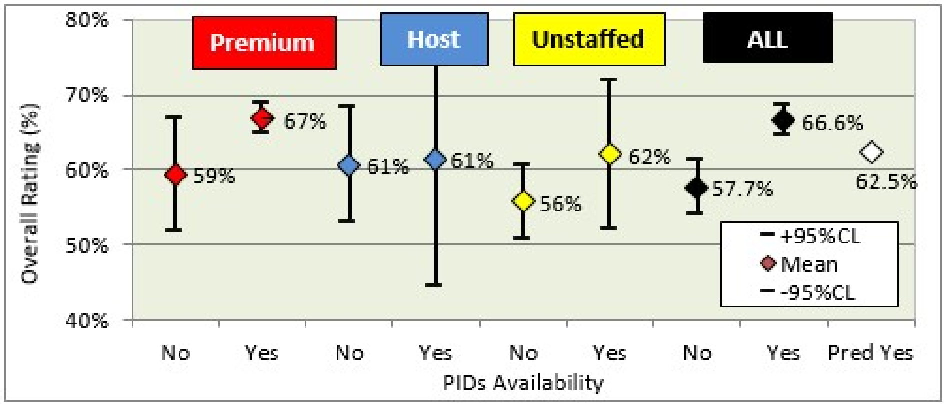
The difference in the availability percentage was most marked for shelter which probably reflected the 4 metre long definition in the asset data base.

For timetable and myki ticketing (put value on the travel card), there was no data on actual provision so only perceived availability is tabulated. Timetable availability averaged 92% whereas myki ticketing was only perceived available at stops by a quarter of respondents.

The availability of facilities was not asked on the rail survey. It was possible to compare the ratings given by respondents with whether of not Platform Information Displays (PIDs) and other facilities was available at specific stations. Figure 12 shows the overall station rating against actual PID availability.

Overall, stations without PIDs rated at 57.7% and stations with PIDs 66.6%. PIDs availability was therefore associated with a rating 9% points higher. Stations with PIDs were more likely to have other facilities however which would also have contributed to their higher rating. The 'grouped station' ratings of premium, host and unstaffed help control for this effect which reduced the predicted incremental effect of PIDs to 4.8% points (62.5% versus 57.7%).

[14] Given that no weighting was applied to usage of the stops within a section, the analysis was only approximate.
[15] Given the method, the asset data base figures were effectively weighted by survey response which gave a greater weight to street sections where survey response was high and no weight at all to sections where there were no survey response.
[16] This would not be reflected in the Asset data base since equal weight was given to all stops in a street section.



The value to rail passengers from PIDs was established by transforming the change in rating by the 0.7 power function (see Figure 5). This reduced the 4.8% point change to 3.9%.[17] The percentage was then multiplied with the maximum in-vehicle time value for a 100% rating change estimated by the SP survey which as can be seen from Table 6 was 21.7 minutes for rail passengers. The resultant value of providing RTI was therefore 0.85 minutes. This value converts to a WTP of 19 cents given the rail VOT of $13.78/hr. Expressed as a percentage of the average fare of $4 (see Table 3) gives a benefit measure for RTI of 4.9% of fare.

At 0.85 minutes, the value was a slightly higher than the 0.7 minutes calculated for RTI at bus and tram stops (without timetables).

9. Valuing the Quality of Information

"Availability of information is not your issue. The information needs to be current / accurate, and that it is not!!" commented one respondent. Another asked for *"better information on board trains please as half the time the signage isn't working"*

Fortunately, the rating survey was deliberately designed to assess the value of improved quality of information as well as the quantity. As a reminder, the study approach was to use ratings and assess individual stop/station and vehicle attributes such as information and cleanliness. The attribute and overall ratings were presented in sections 7 and 8. By using the attribute ratings to explain the overall rating, the importance of each attribute was able to established and used to predict the value of improving the quality of an attribute.

To do this, two sets of models were estimated: one set for stop/station quality and one for vehicle quality. For stop and station quality, the individual stop/station attribute ratings were used to explain the overall stop/station using a logistic model which had the advantage of constraining the rating to the 0-1 interval as shown in equation 2.[18]

$$R_{ALL} = \frac{1}{1+\exp\left\{\alpha + \sum \beta R_x\right\}} \quad .....(2)$$

where: R_{ALL} = overall rating 0-1 scale; R_x = attribute rating; α, β = parameter estimates

[17] 62.5%^0.7 – 57.7%^0.7 = 0.72% – 68.1% = 3.9%
[18] A simpler linear model produced very similar results.

Given that some stop/station attributes were only included on the rail questionnaire and not on the bus and tram questionnaire, the full model was estimated in three parts. First, the attributes common to the bus, tram and rail questionnaire were modelled and then the additional rail attributes were added in a second model. A third model bridged the results.

The Part 1 'common attribute model' established weather protection, seating and information as the three most important attributes with each explaining a fifth of the overall rating. Lighting, cleanliness and ticket purchase facilities were less important. The model was estimated on 852 observations with all parameters statistically significant (t values ranging from 2.5 to 7.5).

The Part 2 'additional rail station model' established that platform surface and ease of platform on/off were the most powerful attributes with each accounting for 30% of the overall rating. Toilet availability, staff and car access facilities explained around 10% each with retail, bus access and car access facilities relatively unimportant. To derive more statistically robust parameters, the bus and car access attributes were multiplied by access mode.[19] The model was estimated on 322 observations with all parameters except retail (t=1.2) and bus facilities (t = 0.4) were statistically significant at the 95% confidence level.

A third model joined the two model parts together. The parameters in Part 1 and Part 2 models were used to calculate a composite rating variable which was fitted to the rail data. The Part 1 model beta parameter was 0.75 (t = 8.9) giving it two thirds of total importance and the Part 2 model parameter was 0.335 (t =3.5) giving it one third of total importance.

Table 11 presents the complete model with parameters estimated for Sydney and NZ alongside.

Table 11: Importance of Stop/Station Attributes

	Melbourne				Sydney 2013			NZ 2012/13	
	Beta		Importance		Importance			Importance	
Attribute	B&Tram	Rail	B&Tram	Rail	Bus	LRT	Rail	Bus	Rail
Weather Protection	0.976	0.675	24%	17%	26%	13%	8%	23%	12%
Seating	0.812	0.561	20%	14%	19%	14%	11%	23%	11%
Information	0.854	0.590	21%	15%	23%	17%	8%	18%	8%
Lighting	0.572	0.395	14%	10%	11%	13%	8%	10%	7%
Cleanliness & Graffiti	0.580	0.401	14%	10%	15%	31%	14%	25%	17%
Rail|Tram * Ticket Purchase	0.264	0.182	7%	5%	6%	13%	14%	-	8%
Platform Surface	-	0.386	-	10%	-	-	13%	-	9%
Ease of On/Off	-	0.342	-	9%	-	-	9%	-	9%
Toilet	-	0.127	-	3%	-	-	2%	-	2%
Staff	-	0.119	-	3%	-	-	6%	-	2%
Retail	-	0.059	-	1%	-	-	2%	-	4%
Car Access % x Car Facilities	-	0.126	-	3%	-	-	2%	-	8%
Bus Access % x Bus Facilities	-	0.028	-	1%	-	-	2%	-	3%

Estimated constants omitted

For bus and tram, the parameters were the Part 1 estimates. For rail, the part 1 estimates were reduced a third and the part 2 estimates by two-thirds. The outcome was that Melbourne was similar to Sydney and NZ in terms of the importance of bus stop information scoring 21%

[19] Thus if a passenger accessed the station by bus, bus access facilities were relevant. If not the attribute 'importance' was zero. Likewise for car access facilities.

compared to 23% and 18%. However in terms of rail station information, Melbourne respondents allocated nearly twice as much importance than Sydney and NZ (15% versus 8%).

Generally the three profiles were broadly similar excepting a greater importance attached to ticket purchase at Sydney rail stations and to cleanliness and grafitti at Sydney LRT stops and NZ bus stops.

The model can be used to assess the impact on improvements to individual attributes. There are two ways the model can be applied.

The logit model can be used incrementally as shown by equation 3. Imagine a base overall rail station rating of 60%. New passenger information displays (PIDs) are expected to increase the rail station information rating by 10% points (it does not matter what the base information rating is). The model predicts the new overall station rating would increase to 61.4%.

$$R_{ALL}^{new} = \frac{R_{ALL}\exp\left\{\sum \beta\Delta Xi\right\}}{R_{ALL}\sum \beta\Delta Xi + \left(1 - R_{ALL}\right)} = \frac{0.60\exp\{0.59x0.1\}}{0.60\exp\{0.59x0.1\} + (1-0.60)} = 0.614 \text{ ......(3)}$$

The value of the improvement requires the application of the power parameter (0.7) to both the base and predicted overall ratings. This gives a transformed change in overall rating of 1.14%.

Multiplied by the maximum value (0-100%) of rail station quality of 21.7 minutes (see Table 6) gives a value for the improvement of 0.25 minutes of rail time or 1.4% of the average fare of $4.

A simpler approach is to use the percentage importance which for Melbourne rail stations is 15%. The importance is then multiplied by the expected increase in rating (10%) and added to the base overall rating. The new overall rating would be 61.5% which is 0.1% higher than the logistic model%.[20]

The same regression approach was used to explain the vehicle ratings. Table 12 presents the fitted model estimated on 800 observations.

Table 12: Importance of Vehicle Attributes

	Melbourne		Importance %	
Attribute	Beta	Importance %	Sydney 2013	NZ 2012/13
Outside Vehicle Appearance	0.60	13%	13%	13%
Ease of Getting on/off	0.20	5%	8%	7%
Bus * Ticket Purchase	0.09	2%	na	Na
Seat Availability & Comfort	0.42	9%	10%	12%
Space for Bags	0.27	6%	1%	4%
Smoothness & Quietness	0.13	3%	11%	14%
Heating & Air conditioning	0.44	10%	11%	7%
Lighting	0.55	12%	6%	2%
Cleanliness & Graffiti	0.60	13%	10%	8%
On-board Information	0.41	9%	6%	6%
Bus & Tram - Driver Friendliness	0.11	2%	14%	14%
Internet Connectivity	0.17	4%	0%	1%
Environmental Impact	0.45	10%	10%	10%
Toilet Availability & Cleanliness	na	na	na	2%

[20] The approaches will only diverge when large changes in attribute quality are assessed involving combinations of attributes or when changes are made from overall ratings that are either low(less than 30%) or high (greater than 70%) reflecting the curvature of the logistic function.

Outside appearance, heating/air con, lighting, cleanliness/graffiti and environmental impact were the most important attributes with each attribute explaining just over 10% of the overall vehicle rating. Next important were seat availability/comfort and on-board information which explained just under 10% each. Ticket purchase (only valid for bus), smoothness/quietness, driver friendliness and helpfulness and internet connectivity were of lesser importance.[21]

Tabulated alongside Melbourne are estimates for Sydney and NZ. In terms of the impotance of onboard information, Melbourne at 9% was fifty percent greater than Sydney and NZ (6%).

Outside appearance, heating/air conditioning, cleanliness and graffiti and environmental impact were similarly important. There were some differences with lighting twice as important in Melbourne (12%) as it was in Sydney or NZ. Smoothness and quietness at 3% was less important which could be attributed to the flatter terrain and straighter roads. The importance of driver/staff was also noticeably lower for Melbourne (2%) than for Sydney or NZ where it accounted for 14%. Onboard information was ranked 6th for Melbourne accounting for 9% making it higher than for Sydney and NZ where information accounted for 6%. Internet connectivity accounted for 4% which although small was still higher than for Sydney and NZ where it barely registered.

The parameters can be used in the same way as the stop/station model to value changes to individual vehicle attributes or packages of attributes. Thus for example, a 10% improvement in on-board information for a bus service with an overall vehicle rating of 60% would increase the rating to 60.09% (logit model) and be worth 0.05 minutes of bus time or 0.3% of the average bus fare of $2.90/trip.

Subsequent work undertaken in Sydney and NZ has explored the 'halo' effect of improving individual and combinations of attributes. The halo effect of improving one attribute can lead to passengers rating other attributes more highly. For single attribute improvements, the halo effect was found to double the value but as more attributes were improved, the halo effect got weaker such that if all attributes were improved by say 10%, the overall rating also improved by 10%, Douglas (2017a).

10. Priority Evaluator - Internet Panel Survey

The third survey included two Priority Evaluator (PE) questions. The aim was to estimate value of benefit for wayfinding signage, self-serve information kiosks and staffed information kiosks provided on streets and at hubs such as Melbourne Airport and Federation Square. An Internet Panel (IP) survey was used.

It is acknowledged that there are concerns about using IP surveys in valuation surveys. Significance (2012) and Douglas and Jones (2018) for example found that IP surveys can produce poor quality response in Value of Time surveys. Therefore in this study, the IP survey was limited to determining the relative importance of different types of information with the monetary value established 'outside' the survey by 'bridging' the results as ratios to the Rating/SP survey results.

The PE sought to value relative importance by asking respondents to allocate $100 across information improvements to indicate their relative importance. There were two PE questions. The first PE was a general PE asked after a set of rating questions. Figure 14 correlates the

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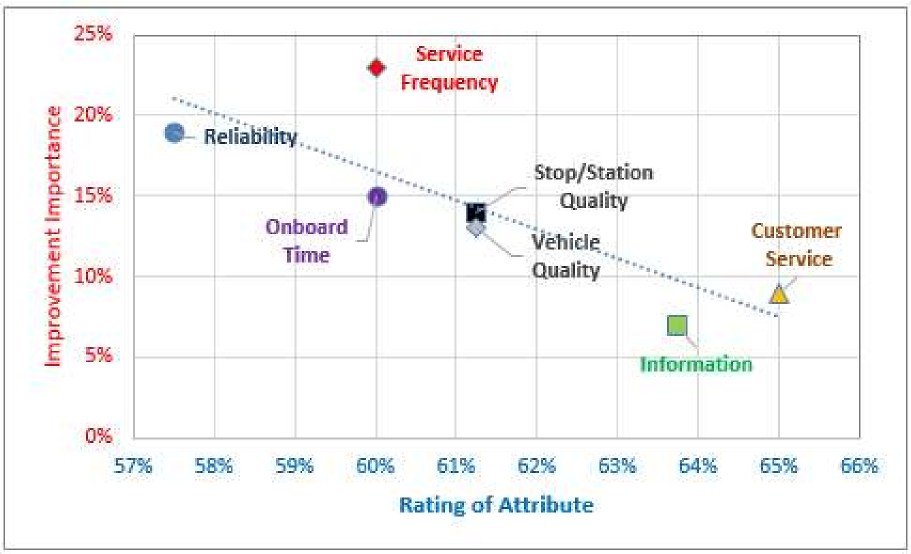
[21] In Sydney and NZ, the attribute was labelled ability to use you electronic device and connect to the internet.

response to both two questions and shows that as the rating improved for a service attribute less money was allocated to its improvement.

Overall, the PT system scored 61% overall. The ratings of the seven service attributes ranged from 58% to 65%. The response suggests that the perceived strengths of the Melbourne system were its customer service (staff) which scored 65% and information which scored 64%. The aspects of performance that rated least positively were travel performance related namely reliability (58%) service frequency (60%) and travel time (60%). Stop/station and vehicle quality scored just over 61%. Thus compared to the On-board Rating/SP questionnaire which gave ratings of around 65%, members of the IP had less favourable recollections of their public transport travel experience.

In terms of improvement, service frequency attracted just under a quarter of the priority dollars (23%). Reliability was second on 19% with on-board time third on 15%. Information was the attribute least needing improvement (7%).

Figure 14: Priorities for Improvement & Satisfaction Rating of Public Transport Attributes



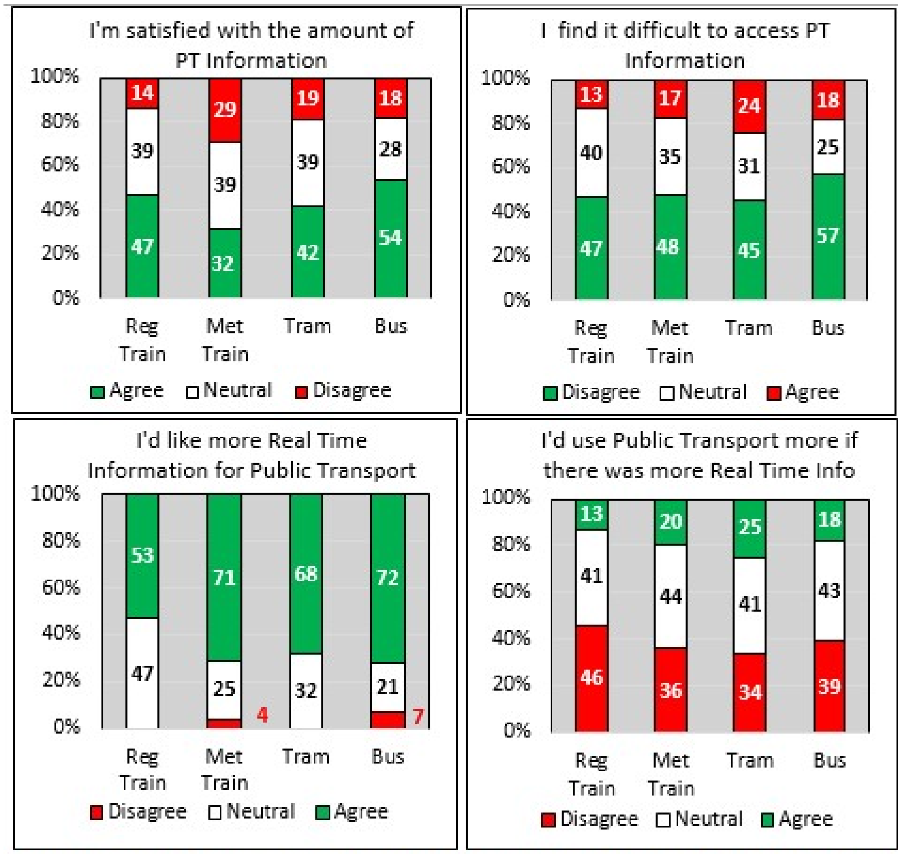
Four general question were asked about information. Figure 15 presents the results.[22]

In terms of the amount of information, 71% of Metropolitan Rail respondents were satisfied with the amount with 29% wanting more. Relatively tram respondents were satisfied (81%) with fewer (19%) wanting more information. 24% of Tram respondents found it difficult to access information however which was greater than Metropolitan Rail respondents (17%).

Despite the satisfaction with the amount of information, 71% of Metropolitan Rail and 68% of tram respondents wanted more RTI with 20% of Metro Rail and 25% of tram respondents saying they would make more trips if RTI was provided.

[22] The results for regional trains should be treated with caution given there were only 15 responses. Metropolitan Bus also had a relatively low sample of 28.

Figure 15: Preferences for Improved Information



Sample sizes: Regional Trains 15; Metropolitan Trains 721; Metropolitan Bus 28; Tram 76

The importance of information was expected to differ according to the familiarity of the trip. For familiar trips, there is a greater need for temporal information that tells travellers what is happening i.e. train and bus times, next stop, network status etc. For unfamiliar trips, the need is for spatial information that helps plan the journey such as wayfinding signage.

The PE questions about the importance of information were therefore asked twice. Once in the context of familiar trips and once in the context of unfamiliar trips.

To get an overall answer, respondents were asked how often they made familiar and unfamiliar trips. The profiles in Figure 16 show, somewhat unsurprisingly (as Alan Turing would certainly have detected from the data) that familiar trips are made regularly (mainly commuting trips) whilst unfamiliar trips are made irregularly. Overall, 82% of trips were familiar and 18% unfamiliar and this share was used to weight the response to the information PE question.

The PE question asked respondents to allocate $100 across a list of information improvements for tram and metro rail. Accordingly, only tram and metro rail response was used in the analysis. The dollar allocation for each improvement was averaged and expressed as a ratio of the amount spent on PIDs for All respondents. A value per trip was then determined by multiplying by the SP/Rating estimate. For tram, the combined value of 1.3 minutes for a timetable and RTI was taken as indicative of a mini PID. For rail, a value of 0.85 minutes for a rail station PID was used. Table 13 presents the resultant estimates.[23]

[23] The survey made no 'control for exposure' for the three spatial information sources. For tram, familiar trips valued wayfinding signage at 0.47 minutes and unfamiliar trips 0.85 minutes. Likewise metro rail respondents had values of 0.55

The ability to talk to a person at a staffed kiosks pushed up the value markedly on self-serve Information kiosks. For unfamiliar rail trips, the value was 0.18 minutes for staffed kiosks versus only 0.04 minutes for self-serve kiosks.

Figure 16: Public Transport Trip Frequency by Familiarity of Trip

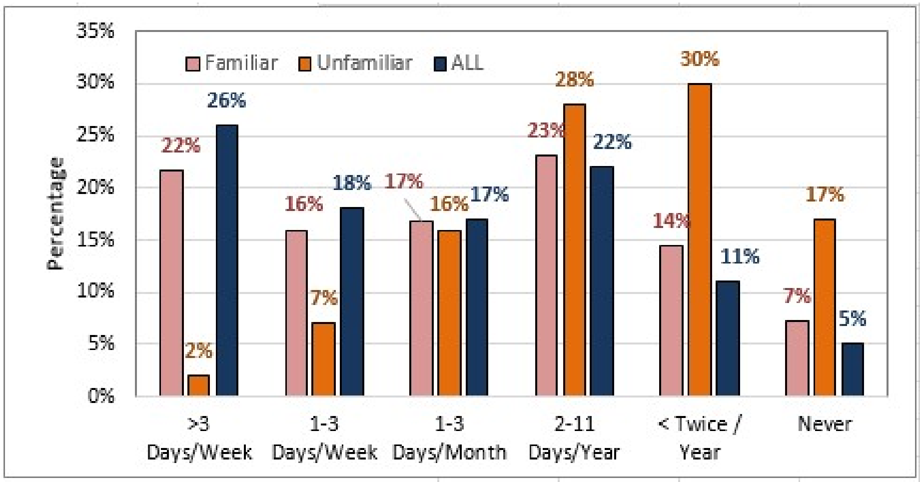


Table 13: Value of Information Improvements in Equivalent IVT Minutes

Information	Tram			Metro Rail		
	Familiar	Unfamiliar	ALL	Familiar	Unfamiliar	ALL
Tram Stop Mini PIDs	1.41	0.81	1.30	0.88	0.73	0.85
Tram Pas	0.53	0.53	0.53	-	-	-
On-board Next Stop Info	1.21	1.41	1.25	0.75	0.78	0.76
Tram PIDS at Rail Stations	0.94	0.86	0.93	0.61	0.57	0.60
Rail Station Network Status Boards	na	na	na	0.65	0.53	0.63
Wayfinding Signage	-	0.39	0.07	-	0.16	0.16
Staffed Kiosks	-	0.25	0.05	-	0.18	0.18
Self-serve PTV Kiosks	-	0.04	0.01	-	0.04	0.04
Total	4.09	4.28	4.13	2.89	2.99	3.22

11. Summary Values for Information

Table 14 presents a summary of the estimated values expressed in equivalent on-board minutes (IVT mins) fare (cents) and percentage of fare.

The SP/Rating surveys provided benefit values for installing PIDs at tram stops and at rail stations of 0.7 mins and 0.85 minutes respectively. By applying the values of time of $10.99/hr for tram and $13.78/hr for rail estimated by the SP survey (see Table 6) the travel time measures were converted into 20 cents and 14 cents per trip. Expressed as a percentage of the average fare ($3.10 and $4 see Table 5), the value converted to 4.9% and 4.1% of fare respectively.

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and 0.72. It was considered unlikely that people would consult wayfinding signs for trips they were familiar about and so in Table 13, zero was adopted for familiar trips and the difference in value (unfamiliar – familiar) for unfamiliar trips. The resultant values for unfamiliar trips was 0.38 minutes for tram 0.16 minutes for metro rail.

Table 14: Value of Information Improvements in Equivalent IVT Minutes

Information	Description	Users	Benefit per trip IVT Mins	Fare Cents	Fare %*
Train Station PIDs	Electronic signs at rail stations giving next train arrival time.	Rail	0.85	20	4.9%
Train Network Status Boards	Electronic signs at rail stations giving disruption / operational status by line & general status of tram & bus services.	Rail	0.63	14	3.6%
Tram PIDs at Rail Stations	Electronic signs at rail stations for rail passengers transferring to tram giving RTI on next tram arrival at nearby stops.	Rail & Tram Transfers	0.77	14	4.5%
Tram Stop PIDs & Timetables/Maps	Tram mini PIDs at tram stops with timetables, route maps & RTI on next tram arrival.	Tram	1.30	30	9.6%
Bus/Tram Stop RTI	Provision of Real Time Information at Stops	Bus/ Tram	0.70	13	4.1%
Tram PAs	Audio announcements at tram stops giving RTI on next tram arrival times, disruptions & safety messages.	Tram	0.53	10	3.1%
Tram On-board Next Stop Info	Electronic displays on-board trams giving next stop information with audio announcements.	Tram	1.25	23	7.4%
Wayfinding Signage	Signs inside & outside stations showing local area maps & public transport information.	All^	0.12	2.3	0.7%
Self-serve PTV Kiosks	Unstaffed kiosks giving information on how to use public transport.	All^	0.11	2.1	0.6%
Staff PTV kiosks	Staffed information kiosks at hubs such as Melbourne Airport & Federation Square.	All^	0.02	0.4	0.1%

*Based on fares of $2.90 bus, $3.10, tram, $4 rail. All Av $3.40. ^ average of tram and rail values

Installing Tram Mini PIDs with timetables and route maps at tram stops was worth 1.3 minutes or 30 cents per trip.

Compared to other studies, the value of PIDs at tram stops and rail stations fell midway between the values estimated for bus stops using similar surveys in Sydney (0.4 minutes) and NZ (1 minute). The estimates were higher when expressed in terms of the percentage of fare (2.7% Sydney and 3.8% NZ). For London, TfL valued rail station PIDs as worth just under a minute (56 seconds) of travel time with bus stop PIDs worth 0.32 minutes. The literature review (Table 1) found a much wide range in the value of RTI ranging from 0.5 minutes to 11 minutes.

On-board tram PIDs were valued roughly the same as mini tram stop PIDs which compares with London where on-board PIDs were three-quarters of station PIDs (44 sec vs 56 secs).

Combining the results with the Priority Evaluator survey produced values for ‘spatial information’. ‘General’ way-finding signage was worth at 0.12 minutes or 0.7% of fare. Staffed PT information kiosks had a slightly lower value of 0.11 minutes with self-serve kiosks worth less at 0.02 minutes.

Unfortunately, there were no comparable estimates in the literature to benchmark the Melbourne ‘spatial’ information values. The closest was for bus staffed information desks in London which TfL estimated as being worth 0.08 minutes or 3% of fare.

12. Concluding Remarks

The study estimated a suite of values that measure the benefit to public transport users from the provision and improvement of public transport information at tram stops bus stops, rail stations and on-board vehicles. Also estimated were values for providing wayfinding information at activity hubs and on streets.

The values were based on a literature review and market research undertaken in Melbourne in 2014 that used three types of survey. A Stated Preference (SP) survey estimated values for vehicle and station quality with information included as an attribute. A rating survey enabled the overall vehicle and stop quality values to be deconstructed into individual attributes such as information. A Priority Evaluator (PE) survey widened the list of information sources and in conjunction with the Rating/SP surveys provided values for wayfinding signage and information kiosks both staffed and unstaffed.

The values for Melbourne were broadly comparable with similar research undertaken in Sydney and NZ and also with values reported for London. It was not possible to find any values to benchmark the Melbourne estimates for wayfinding signage.

For Melbourne, the Internet Panel survey showed most respondents to be reasonably satisfied with the amount of information. Indeed, information alongside customer service was one of the strengths of the Melbourne system based on the ratings and priorities for improvement. Lower satisfaction and greater importance was attached to service frequency, reliability and travel time. Of 'middling' concern was the quality of stops/stations and vehicles.

The Rating survey, which was completed at the time of travel, found bus and train passengers to be more satisfied than tram users with their at-stop and on-board information. Real Time Information (RTI) was more of a concern at tram stops and also on-board older trams.

The SP survey was able to estimate values of travel time, service interval, vehicle quality and stop quality that were of reasonable magnitude and precision.

By analysing the rating survey in terms of the availability of information and also its ability to explain the overall stop and vehicle ratings, values for the availability and quality of information were estimated.

Installing Passenger Information Displays (PIDs) at tram stops was estimated to be worth 0.7 minutes of travel time or 4.9% of fare whereas at rail stations PIDs were worth 0.85 minutes and 4.1% of fare. The values fell midway between the values estimated for bus stops in Sydney and NZ using similar surveys.

Combining the Rating/SP survey results with those of the Priority Evaluator Internet Panel survey produced benefit measures for spatial information. 'General' way-finding signage was worth at 0.12 minutes or 0.7% of fare. Staffed PT information kiosks had a slightly lower value of 0.11 minutes with self-serve kiosks worth less at 0.02 minutes. Unfortunately, there were no comparable estimates in the literature to benchmark the Melbourne 'spatial' information values.

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