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Measuring amenity benefits of public realm in railway station precincts

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Abstract

Major rail infrastructure projects are city-shaping in nature and have the potential to generate economic benefits beyond conventional transport benefits. These benefits include improved amenity of public realm in railway station precincts, arising from place-making and precinct activation initiatives as part of the project scope. However, there is a lack of supporting parameter values based on local evidence in Australia, which compromises the ability to include such benefits in economic appraisals.

This research paper presents a stated preference survey undertaken in Greater Sydney. The survey was designed to estimate customers' willingness to pay (WTP) for improved amenity in railway station precincts. The research findings provide economic parameter values aligned with the Pedestrian Environment Review System (PERS) developed by Transport for London and calibrated with local evidence in Greater Sydney. The outputs can be applied to estimate the precinct amenity benefits in the cost benefit analysis of transport or place-making initiatives.

1. Introduction

For rail projects in Greater Sydney, there has been an increasing focus on place-making outcomes in the railway station precincts. Rail projects have commonly included precinct plans to deliver desirable place-making outcomes, leading to improved amenity or customer experience benefits. While such benefits are recognised in Australian Transport Assessment and Planning (ATAP) guidelines (Transport and Infrastructure Council, 2018), there has been a lack of primary research in Australia for quantification of amenity benefits in station precincts.

The ATAP guidelines presented the Pedestrian Environment Review System (PERS), which is a walking audit tool with a scoring system against various aspects in walking environment to allow for quantification of the quality of public areas. The PERS has been increasingly applied to many place-making projects in NSW to assess the level of service and quality provided for pedestrians across a range of pedestrian environments. However, the economic parameter values of the PERS were estimated in the context of the UK more than a decade ago (Accent and Colin Buchanan, 2006), which limits its applicability to place-making initiatives in NSW. Furthermore, the PERS economic parameters capture the 'use values' according to how many people experience the change in environment and the dwell time spent in the precinct. Relying on dwell time as a primary indicator of place success is not universally relevant in place-making initiatives as station precincts are not necessarily the users' trip destinations for rail customers. Furthermore, dwell time can be hard to reliably forecast in business cases which would limit its applicability.

The existing PERS and associated economic parameters have not been able to capture the economic values for the broader community. In the context of rail station precincts, there are various groups of beneficiaries from place-making initiatives in the station precincts. These could include rail customers, recreational visitors, passers-by, local businesses and local residents, while parts of the beneficiaries may not be rail users.

This research paper presents a stated preference survey undertaken in Greater Sydney. The survey was designed to estimate customers' WTP for improved amenity in railway station precincts. The research findings provide economic parameter values aligned with the PERS and calibrated with local evidence in Greater Sydney. The outputs can be applied to estimate the station amenity benefits in the cost benefit analysis of transport or place-making initiatives.

2. Literature review

The PERS framework was developed by Transport for London based on a stated preference survey conducted by Accent and Colin Buchanan (2006). The study undertaken by Accent and Colin Buchanan quantified the WTP values for improved walking amenity based on the road or street's function, categorised into the six themes:

1. Moving in the space – a coherent and accessible movement network e.g. width of a footpath or lack of obstructions.
2. Interpreting the space – clear and easy to understand routes and spaces e.g. clear signage and maps.
3. Personal safety – all users feel safe e.g. provision of lighting and physical and surveillance.
4. Feeling comfortable – creates streets and spaces for everyone e.g. provision of shelter and seating.
5. Sense of place – getting the details right e.g. aesthetic and features or quality materials.
6. Opportunity for activity – create active and passive spaces e.g. evidence of social interaction or diversity for different users.

The PERS is the recommended methodology for valuing the amenity benefits of place-making initiatives as recongised by the ATAP guidelines, Transport for NSW (2020), and the NSW Department of Planning and Environment (2022).

There is a need to update the economic parameters of PERS for the use of railway station precincts in NSW. Current estimates were generated from London more than 15 years ago without capturing the benefits to the broader community such as non-rail users. In addition, the preferences and values of Australia in 2023 are likely to be significantly different to those in the London study.

The literature reviewed covers a range of attributes of public realm design. Heuman et al. (2005), a seminal paper in the literature, produces WTP estimates for specific elements of public realm design. Sheldon et al. (2007) expands on this work by linking the methodology to the PERS framework to produce benefits associated with improvements in the score of PERS themes. Atkins Consultants & ITS Leeds (2011) undertake a similar exercise, albeit not specifically with PERS, demonstrating the ability to generalise the results in different geographical contexts.

Other papers, while not related to the PERS framework itself, examine the WTP for placemaking and related attributes that are closely related to placemaking. Yannes et al. (2010) investigates the WTP for transit systems with particular service and placemaking attributes. Specifically, these include differences for transit stops with ‘good’ and ‘bad’ overall placemaking, travel time, mode of transport (bus or train) and comfort level.

Grisolia, Lopex & Ortuzar (2015) derives WTP for addressing elements of community severance, defined as the separation of people from facilities, services, and social networks within a community, and/or people changing travel patterns due to the physical or psychological barriers created by transport corridors. While this is distinct from placemaking, it bears some similarity. The specific attributes included in the experience were high quality paving, gardens, CCTV and the presence of people. These are physical features that might also be included in PERS themes including personal safety, sense of place and opportunity for activity.

Douglas (2022) for Transport for NSW derives WTP through respondents stated preference questions around walk quality. Walk quality was quantified through ‘walk time’. Walk time was then converted to travel utilising a factor of 1.5 (derived through other studies) and then a time value of $16/hr was applied to value walk quality in dollar terms.

The majority of papers examined in the literature review utilise a stated preference choice experiment. In these experiments, respondents are asked to choose between different configurations of attributes that have both desirable and undesirable characteristics. By applying monetary values to these choices, the experiments indirectly reveal which attributes are preferred and how much people are willing to pay for them.

A limited number of papers use a contingent valuation method, while several others combine priority ranking questions with the stated preference exercise. The priority ranking component of the surveys ask respondents to consider each possible attribute improvement and systematically decide which improvement to preference. In addition to being used for the purposes of estimation, Atkins Consultants & ITS Leeds (2011) utilise this technique to anchor respondents in the context of the survey and gradually introduce them to the trade-offs between attributes prior to understating the stated preference questions. The use of a priority ranking approach is no longer necessary with more contemporary, non-orthogonal survey design which takes advantage of greater computational power to derive comparable underlying information.

While most studies limit themselves to a single test site, several undertake surveys across multiple test sites. These studies provide guidance on the ability to extrapolate results across broader geographic areas than those included in the choice experience. On this point, Sheldon et al (2006) demonstrate that derived coefficients are consistent across all sites included in their survey. Similarly, Atkins Consultants & ITS Leeds (2011) find that the parameter values derived were broadly consistent across the three sites included in their survey for most design features considered. Design features that appeared less consistent were those that were perceived to substantially trade off vehicle accessibility for pedestrian amenity. Importantly, these papers are those that directly consider the PERS framework.

Atkins Consultants & ITS Leeds (2011) suggest that values could be transferred between a survey and policy site by using an elasticity with respect to income combined with available income data. Similarly, values could be updated using a time-series income elasticity combined with gross state product per capita data.

3. Stated preference survey

3.1 Attributes

PERS was developed to measure the performance of place and assess changes in the physical environment. It captures information such as wider footpaths, more seating, better lighting, as well as user experiences such as personal safety and sense of comfort. The approach was developed with the intention to measure improved performance of attributes across six key themes.

Transport for NSW (2022) adapted PERS into the Value Assessment System for Place (VASP) which represents an independent process to assess the quality and characteristics of a change in the public realm associated with transport investment (Figure 1), aligned with the original PERS place attributes. VASP adapted the indicators (criteria) within the PERS framework to be systematic, holistic and experiential, making it better suited to the scale and types of transport projects, particularly at early concept design phase.

Figure 1: Value Assessment System for Place Framework

Personal Safety	Pedestrian physical safety Pedestrian perceived safety	The level of personal safety in a public space affects the quality and experience of users. Consideration is given to the presence of formal and informal surveillance, the co-location of activities and urban form with ground level active uses, lighting, evidence of anti-social behaviour, walking and cycling safety, security and the ability to get assistance.
Sense of Place	Architectural character and contextual integration History, heritage and Country Elements of natural environment	The 'sense of place' affects the experiences and perceptions of users and reputation of the place as a memorable, successful location. Consideration is given to the cohesive built form character, coherent integration with the context, respect for heritage and Country, the natural environment, quality of materials, the ambience, the aesthetics, the experiential qualities of the space and the atmosphere.
Opportunity for Activity	Outdoor elements for active and passive uses Activation and urban form supports activities	The degree to which a public space creates opportunity for activities that contribute to the vitality and attractiveness of the space. Consideration is given to user diversity, interaction levels, public realm design or inclusions of facilities that scaffold everyday and/or special event uses, passive and active uses depending on context, and functionality.
Moving in the Space	Ease of walking around Links that connect to other places and districts Equitable access for all users	The quality of moving in the space will affect the ease and functionality of the pedestrian experience and appeal of a public place. Consideration is given to the quality and dimensions of the pedestrian routes and spaces, relative spatial allocation for pedestrians in streets, barriers to movement and conflict with other users, route choice, permeability and links to the wider neighbourhood.
Feeling Comfortable	Built shade and weather protection Trees for shading, microclimate, beauty and biophilia Sensory comfort	'Feeling comfortable' is concerned with the ability of people to experience the public realm in comfort. Consideration is given to all sensory experiences, weather protection, seasonal and time of day factors, physical and temporal amenity and biophilia. Consideration is given to all people with key relevance to transport customers interchanging and waiting in the public realm.
Interpreting the Space	Legible and easy to navigate, self-explaining Clear address, entries and presentation of transport	The ability to interpret the space will enhance the functionality and attractiveness of a public space. Consideration is given to the legibility of routes, clear building addresses and entries, integration with local movement and desire lines, wayfinding and signage, self-explaining street environments, landmarks and provision for mobility or sensory impaired people.

Source: Transport for NSW (2022)

The survey design utilises the VASP framework to determine the key attributes underpinning each of the VASP themes, using a scoring scale of -3 to 3. A scoring of -3 represents a rating where criteria have not been met, and 3 represents exceptionally good quality, places where people are an obvious priority within the space. However, the scores themselves will not be visible to the respondents, they will only be used in the backend for the purposes of econometric estimation.

3.2 Survey instrument

The centrepiece of this study is a choice experiment designed to understand how much people are willing to pay for improvement in each of the six themes of the VASP framework, and whether the WTP values vary by user groups such as residents vs. visitors, and rail users vs. non-rail users. The use of a stated preference (SP) survey is preferred to alternative data collection methods such as a revealed preference (RP) survey including the hedonic method. This is because the SP method is able to cover all possible levels that a station precinct may score on a particular theme while controlling for variations in other VASP themes. Specifically, the VASP framework assesses the quality of public spaces using a package of components which can be classified into six themes. These are (i) moving in space, (ii) interpreting the space, (iii) personal safety, (iv) sense of place, (v) feeling comfortable, and (vi) opportunity for activity. Each theme is assessed on a scale from -3 (unacceptable) to +3 (excellent quality) aligned with the original PERS framework developed by Transport for London.

The survey instrument had four parts. The first part introduces the survey where the interviewer uses prescribed texts to brief each interviewee on what the survey entails and the purpose of the survey. The second part asked about accommodation circumstances with questions relating to the interviewee's home postcode, tenure type, weekly rent (for renters) or council rate (levies for house owners), the amount of time the interviewee spends in and around the station precinct where the interview takes place, the frequency of using rail and other public transport modes, and their purposes for using rail in a typical week. The third part is the SP experiment in which each interviewee faces six choice scenarios, covering three randomly selected themes of the VASP framework (2 choice scenarios per theme * 3 themes = 6 choice tasks). Figure 2 shows an example choice task designed for the 'personal safety' theme. A choice experience was developed for each of the 6 VASP themes.

Sitting behind the SP experiment is a D-efficient Bayesian design (see Hensher et al., 2015). The choice experiment was designed using Ngene (Choice Metrics, 2012) with 24 choice tasks, blocked into two sets of twelve tasks. Each block covers all six VASP themes but only three randomly selected themes were assigned to an interviewee. A partial design was used so that only one theme and the cost attribute vary in each choice task. This aims to reduce the interviewee burden. Each theme was represented by three carefully selected images of station precincts around NSW that convey the difference in quality of the station precinct. In addition to the images, short descriptors were also used to describe the station precinct quality (see Figure 2).

The cost levels were pivoted around monthly rate or weekly rent using eight levels, ranging from 0% to 15%. These levels cover the range of the percentage of council rate revenue allocated to the upkeep of high streets in the study area. Priors for the pilot survey were obtained from the literature, while the priors for the main surveys were obtained from a pilot survey of 28 interviews. A dual response was used in which the interviewee was asked to select the best and the worst options.

After completing the six choice tasks, the interviewee was asked socio-demographic information including household structure, household income, gender, age group, and the street address of their home. The last was later geocoded to identify whether the interviewee is a resident or a visitor to the station precinct where the interview took place.

Figure 2: Illustrative stated choice scenario reflecting personal safety theme

Suppose that part of your rates is spent on the upkeep of and improvements to streets and public spaces each year.

Thinking about the station precinct you frequently visit and reflecting on your **personal safety**, which of the following hypothetical designs would you support with an increase in your monthly rates?

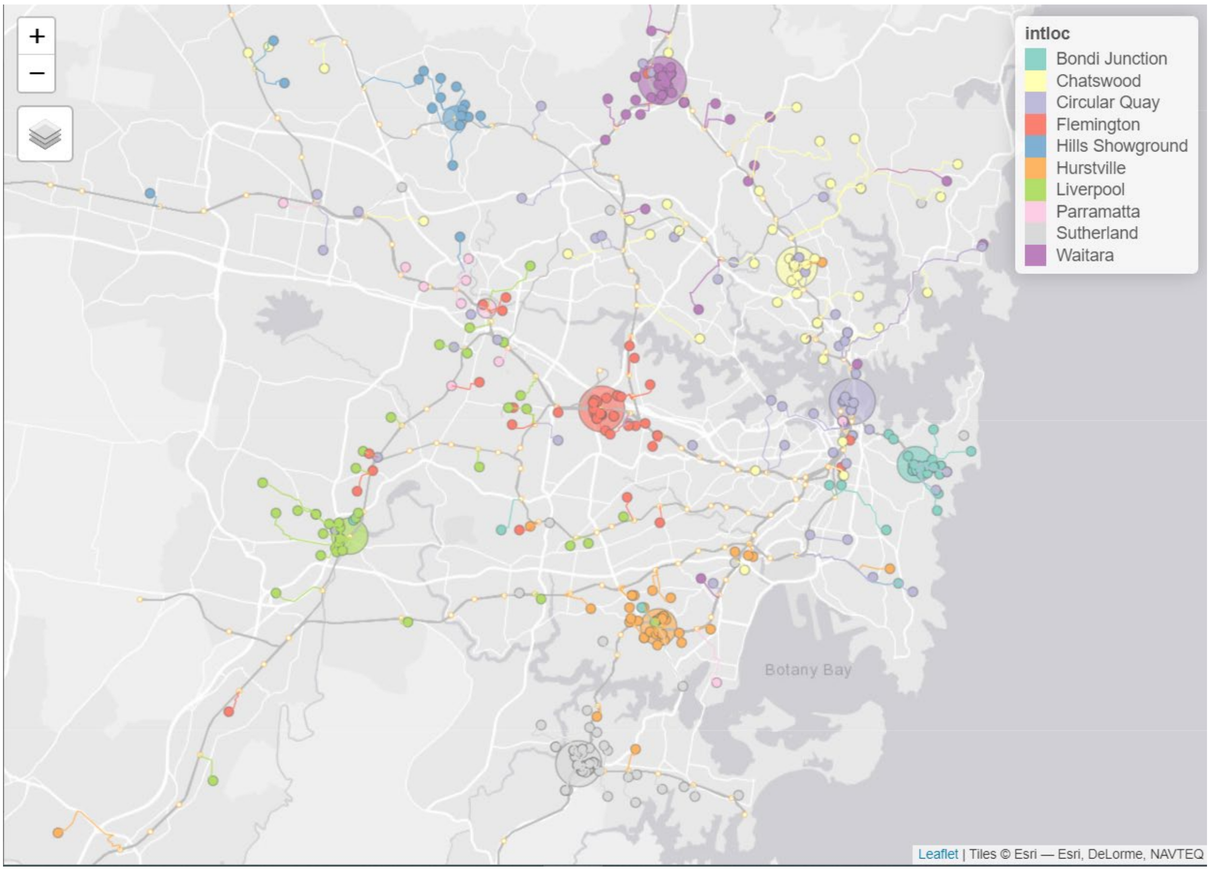
Location	Neighbouring buildings and shops	Some neighbouring buildings	Isolated
Pedestrian crossing	Raised zebra crossing	Traffic signal crossing	No crossing
Lighting	Lighting at station entry	Some lighting near entrance	Minimal near entrance
Surveillance	Station surveillance and from passers-by	Some surveillance	Minimal
Paths	Separate paths for pedestrians	Separate paths for pedestrians	Minimal
Cost per month	$8.00	$2.00	$0.00
Which design would you **most** prefer?	○	○	○
Which design would you **least** prefer?	○	○	○

3.2 Sampling and sample profile

The survey was conducted with assistance from Taverner Research who recruited participants for the Computer-Assisted Personal Interview (CAPI) accessed via iPads. Interviewers stayed with the interviewees until the second-choice task to make sure that the interviewee understood the trade-off required in the choice experiment. The survey was piloted on 11th and 12th December 2022 at Parramatta (Sydney Trains) and the Hills Showground (Sydney Metro)stations.

Following the pilot, minor changes were made, and the SP design was re-generated using model parameters estimated from the pilot sample of 28 interviews. The main survey was conducted between 18th February and 10th March 2023 at eight different stations that together provide spatial coverage (i.e., North, South, East, West of Sydney) and a mix of user groups (i.e., residents, visitors, rail users, and non-rail user). Figure 3 shows the spatial distribution of the interview locations and the interviewees' residential locations.

Figure 3: Interview location and spatial distribution of the sample



A sample of 400 valid interviews was contracted, aiming for a soft quota of 20% non-rail users. All people aged 18 and above were eligible with no other screening criteria or quotas applied. A sample of 466 valid interviews was obtained, including 28 pilot interviews. On average, each interviewer completed 21 interviews per day, with an average interview taking 15 minutes (a standard deviation of 6 minutes).

Table 1 provides a profile of the sample segmented by rail-user group and compares these against the adult population (people aged 18+) in Greater Sydney. Given the importance of rail-user WTP in the economic appraisal of station precinct, the survey over-sampled rail users who account for 84% of the total sample (390/466 = 84%). The rail-user sub-sample had an average age of 40 years, with a standard deviation of 17 years. In this subgroup, males accounted for 55% of the sample, slightly higher than the proportion of male rail users derived from the Sydney Household Travel Survey (HTS) for the Sydney Metropolitan Area. Of the 390 rail users in the sample, owners account for 60%, followed by renters at 24%, with the balance (16%) being adults living with their family rent-free (neither renting nor owning a house).

Compared to the rail user population living in Greater Sydney, the sample represented the owners well. However, renters were under-represented while people living with family rent free were over-represented. In terms of household structure, the rail-user sub sample included 19% single person, 27% couples with no children, 29% couples with children, 4% single parent, with the balance (21%) being other household types such as group households and multiple generation households. Generally, across rail-users and non-rail users group, households without children were over-represented while households with children, either two-parent or single-parent, were under-represented. This is mainly due to the sampling locations being around the station precincts. Specifically, travelling by train is less popular for households with children than for households without children. Hence, sampling around station precincts will have less chance of intercepting people from households with children, particularly those living in the local area.

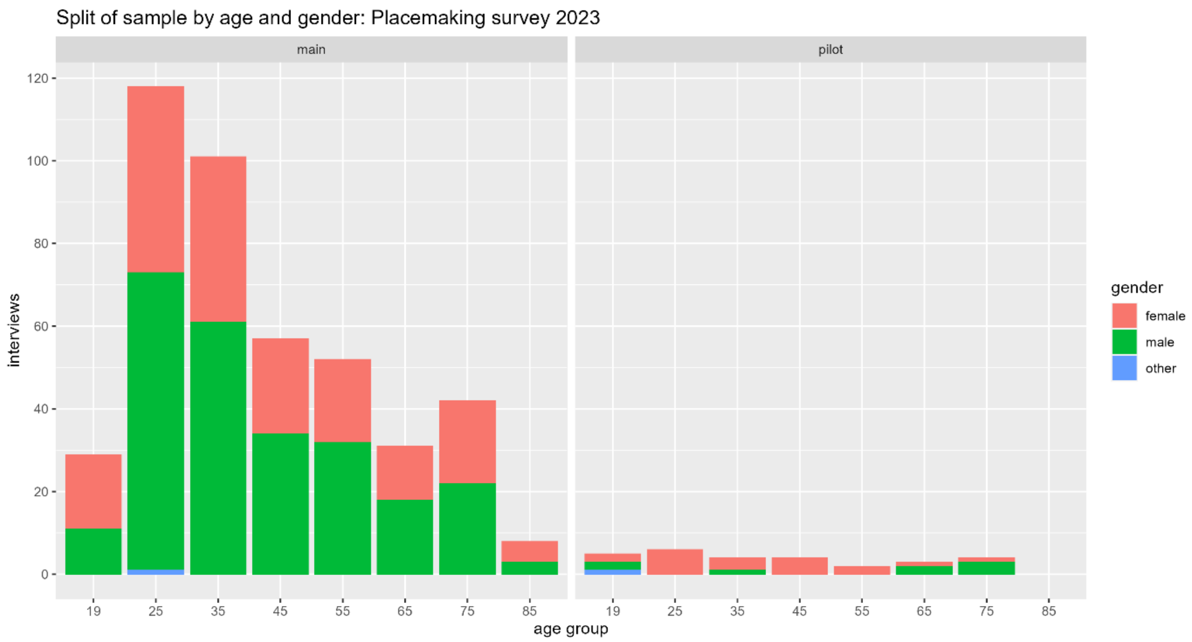
Table 1: Descriptive profiles of the sample and the Sydney Metropolitan area

	Rail user		Non-rail user	
Socio-demographics	sample	population	sample	population
Respondents age in year (standard deviation)	39.7 (17.1)	37.9 (15.7)	52.5 (18.7)	46.8 (17.3)
Male (%)	0.55	0.52	0.61	0.49
Owner (%)	0.60	0.64	0.41	0.75
Renter (%)	0.24	0.36	0.47	0.25
Living with family, rent-free (%)	0.16	0.01	0.12	0.01
Person living alone (%)	0.19	0.12	0.24	0.11
Couple only (%0)	0.27	0.21	0.30	0.24
Couple with child(ren) <15 years (%)	0.13	0.14	0.13	0.21
Couple with child(ren) 15+ (%)	0.13	0.21	0.13	0.20
Couple with children <15 and 15+ (%)	0.03	0.06	0.01	0.06
Single parent with child(ren) <15 (%)	0.01	0.01	0.00	0.02
Single parent with child(ren) 15+ (%)	0.02	0.10	0.03	0.08
Single parent with children <15 and 15+ (%)	0.01	0.02	0.01	0.01
Group/share household (%)*	0.04	n/a	0.04	n/a
Other household types (%)	0.17	0.13	0.11	0.08
Sample size (number of people aged18+)	*390*	*260,901*	*76*	*2,687,388*

*Note: * the Sydney HTS combine group/share households with other household types.*

Figure 4 shows the split of the sample by age and gender, segmented by survey wave. While the pilot sample was dominated by (young) females, the mix of gender and age groups was much better in the main survey. The proportion of young females (aged 18, 19) in the main survey was slightly higher than young males, but the opposite was true for older age groups, except the oldest (85+). It is noted that the sample covered all age groups, with the value showed in the x-axis of Figure 4 being the upper limit of each age group (e.g., 25 = 20 - 25), except the oldest group which includes people aged 85 or older.

Figure 4: Split of the sample by age group and gender: main vs. pilot survey



4. Econometric modelling

The SP survey tasks each respondent with choosing the best and the worst option amongst three unlabelled options that correspond to the Unacceptable (-3), Average (0/1) and Excellent (+3) aligned with the VASP framework. Data collected from these stated choice tasks, together with socio-demographics collected via the background questions, were used to estimate the rail-user's and non-rail user's WTP for the upkeep of or improvements to public spaces, using econometric modelling techniques described below.

The adopted econometric modelling technique is known as best-worst model (Louviere et al., 2015) – a variant of the traditional discrete choice models that were based on the Random Utility theory (McFadden, 1974). Given the dual responses (i.e., best and worst) and a choice task of size three (i.e., 3 options in each choice task), we can identify the full preference ranking of the alternatives. Although the Best question is asked before the Worst question, the respondent can possibly answer the Worst question first, followed by the Best question. The order in which the respondent respond to the best and the worst questions will inform the most appropriate model specification for the best worst data. Given that we don't know with certainty whether the respondent chose the best first option or the worst option first, all processing rules were explored with the empirical data.

For a choice set of size 3, four candidate processing rules are possible. Following Marley and Flynn's (In Press) notation, the four processing rules and their associated model specifications can be mathematically expressed as equations (2 – 4). Let Y denote a full choice set with 3 alternatives, $\rho = \rho_1, \rho_2, \rho_3$ be a typical rank order of the alternatives in Y from best (ρ_1) to worst (ρ_3), $B_Y(y)$ denotes the probability that alternative y is chosen as best in Y, and $W_Y(y)$ is the probability that alternative y is chosen as worst in Y).

Best–worst order:

$$B_Y(\rho_1)W_{Y-\{\rho_1\}}(\rho_3) = \frac{\exp(V_1)}{\sum_{j=1,2,3}\exp(V_j)}\frac{\exp(-V_3)}{\sum_{j=2,3}\exp(-V_j)} \tag{1}$$

Worst–best order:

$$W_Y(\rho_3)B_{Y-\{\rho_3\}}(\rho_1) = \frac{\exp(-V_3)}{\sum_{j=1,2,3}\exp(-V_j)}\frac{\exp(V_1)}{\sum_{j=1,2}\exp(V_j)} \tag{2}$$

Best–Best order (or repeated Best):

$$B_Y(\rho_1)W_{Y-\{\rho_1\}}(\rho_2) = \frac{\exp(V_1)}{\sum_{j=1,2,3}\exp(V_j)}\frac{\exp(V_2)}{\sum_{j=2,3}\exp(V_j)} \tag{3}$$

Worst–Worst order (or repeated worst):

$$W_Y(\rho_3)W_{Y-\{\rho_3\}}(\rho_2) = \frac{\exp(-V_3)}{\sum_{j=1,2,3}\exp(-V_j)}\frac{\exp(-V_2)}{\sum_{j=1,2}\exp(-V_j)} \tag{4}$$

where V_j is the observable utility, specified as:

$$V_j = \sum_k \beta_k X_{jk} \tag{5}$$

β_k is the set of econometric parameters to be estimated, and X_{jk} are the *k* themes (i.e., design attributes) of alternative *j* offered in the choice task.

For a choice set of three alternatives used in this placemaking survey, equations (1) and (3) are identical; so are equations (2) and (4). The latter can be proved by multiplying both numerator and denominator of equation (4) by exp(V_1 + V_2), and the former by exp(V_2 + V_3) (see Ho and Hensher (2017)). Thus, the empirical analysis of the best-worst data will use the best–worst and the worst-best processing rules (i.e., equations (1) and (2)). Both processing rules will be explored and compared against each other to select the one that fits better to the empirical data.

Importantly, both processing rules shared the same utility specification which takes a form similar to the following as a starting point.

$$V_j = \beta_1 * Safety_j + \beta_2 * Sense_j + \beta_3 * Opp_j + \beta_4 * Move_j + \beta_5 * Comfort_j + \beta_6 * Inter_j + \beta_{\cos t} * Cost_j \quad (6)$$

where *j* = Option *A*, *B* or *C;* β_1 to β_6 are the parameters associated with each of the 6 VASP themes (i.e., personal safety, sense of place, opportunities for activities, movement in space, comfortability of the space, interpreting the space) and β_{cost} is the cost parameter.

The marginal WTP for a 1 level increase in Personal Safety, Sense of Place, Opportunities for activities, Movement in Space, Comfortability of the space, Interpreting the space are calculated as:

$$WTP_{safety} = \frac{\beta_1}{-\beta_{cost}}\ ;\ WTP_{sense} = \frac{\beta_2}{-\beta_{cost}};\ WTP_{opp} = \frac{\beta_3}{-\beta_{cost}};$$
$$WTP_{move} = \frac{\beta_4}{-\beta_{cost}};\ WTP_{comfort} = \frac{\beta_5}{-\beta_{cost}};\ WTP_{inter} = \frac{\beta_6}{-\beta_{cost}} \quad (7)$$

Given that the cost in the best-worst stated preference survey is computed for the entire household (i.e., based on council rate, renting cost – both are household expenditure) and is shown as $ per month, the WTP calculated in (7) will have a unit of $ per household per month. For respondents who pay neither rate nor rent (e.g., people living with family rent-free), the best-worst SP choice task uses the average monthly renting cost that goes toward paying the council rate as a transfer price question. Hence, the WTP estimates are also in $ per household per month.

An extensive effort was made to search for the model that fits the empirical data best (hereafter the best model). Various model specifications were tested, including a simple multinominal logit model (MNL), mixed logit models, scaled MNL, and generalised mixed logit models (Hensher et al., 2015). The best model, identified via log-likelihood ratio tests, took the form of a generalised mixed logit model type II, also known as a hybrid model of scaled MNL and mixed logit. This model is obtained by fitting the weighting parameter, γ, of the generalised mixed logit in eq. (8) at 1 (see Fiebig et al., 2010).

$$\begin{aligned} \beta_i &= \sigma_i \beta + [\gamma + \sigma_i (1-\gamma)]\Gamma w_i, w_i \sim N[0, I] \\ \sigma_i &= \exp(-\tau^2/2 + \tau v_i), v_i \sim N[0,1] \end{aligned} \quad (8)$$

where $\boldsymbol{\sigma_i}$ is the random scaling parameter that accounts for preference heterogeneity across individuals using a scaling factor; τ is the structural parameter of the scaling factor $\boldsymbol{\sigma_i}$ to be estimated; $\boldsymbol{\beta}$ is a vector of population means to be estimated that represent the taste preference toward theme k (subscript omitted to simplify the notation); $\boldsymbol{w_i}$ and $\boldsymbol{v_i}$ are the individual specific heterogeneity components, with mean zero and standard deviation one. $\boldsymbol{\Gamma}$ is a diagonal matrix which contains standard deviations of the parameters $\boldsymbol{\beta}$'s on its diagonal.

Table 2 shows the estimation results of the best models for placemaking. Two separate best-worst models were estimated: one for rail-users and one for non-rail users. It is noted that we arrived at these two models after an extensive number of specifications were explored, including interacting each VASP theme with socio-demographics (such as age and gender) and resident status (local resident vs visitor). The latter was tested using the rail-user model which suggests no statistical difference between visitors and residents in terms of their sensitivity to cost or placemaking attributes. It is noted that the same test is not practically meaningful in the non-rail user model because this sub-sample is already small, which when sliced further results in a sample that is too small to deliver any significant difference.

Table 2: Estimation results of the best models for valuing public spaces

	Rail user			**Non-rail user**		
	Coefficient	sign.*	t-value	Coefficient	sign.*	t-value
Random parameters						
Sense of place, mean	0.193	***	4.74	-0.069		-0.43
Monthly cost, mean	-0.308	***	-11.23	-0.370	***	-4.54
Non-random parameter						
Personal safety	n/a			0.521	***	6.04
Personal safety * Female	0.614	***	11.16	n/a		
Personal safety * Male	0.430	***	10.24	n/a		
Opportunity for activities	0.438	***	13.2	0.213	***	2.89
Movement in place	0.374	***	10.99	0.195	***	2.68
Feeling comfortable	0.510	***	14.27	0.245	***	3.02
Interpretation of place	0.353	***	11.14	0.127	*	1.95
First option as best (1/0)	0.034		0.31	-0.497	*	-1.92
Last option as worst (1/0)	-0.361	***	-3.68	-0.010		-0.04
Standard deviation/spread of random parameter						
Sense of place (normal)	0.341	***	6.6	0.254	*	1.86
Monthly cost (constrained triangle)	0.308	***	11.23	0.370	***	4.54
Structural parameter τ	1.340	***	26.16	1.694	***	17.31
Weighting parameter γ	1	(fixed)		1	(fixed)	
Sample mean (std. dev) of scaling $\boldsymbol{\sigma_i}$	0.925 (1.51)		0.61	0.842 (1.80)		0.47
Model summary statistics						
Number of observations (choice tasks)	3,504			708		
Restricted log likelihood	-3,849.5			-777.8		
Log likelihood at convergence	-2,546.7			-456.8		

*Note: ***, **, * denotes significance at 1%, 5%, 10% level. n/a = not included for model identification purpose.*

All parameter estimates have the expected sign, with the monthly cost parameter being negative and all six VASP themes having positive parameters (where significant). Most parameter estimates are highly significant, except for the 'sense of place' parameter whose mean is not statistically significant in the model for non-rail users. By contrast, the same parameter in the rail user model is significant at 99% level of confidence. This suggests that while rail users value station precincts that have a "sense of place", non-rail users appear to divide on this placemaking aspect, with the standard deviation being significant at the 10% level while the mean is not. That said, the modelling evidence suggests a significant variation in preference for sense of place amongst non-rail users, with some non-rail users value sense of place while others do not, leading to the mean parameter being not statistically different from zero. The remaining five VASP themes are all significantly positive, suggesting that both rail users and non-rail users prefer improvements to these themes, all else being equal. This preference, however, varies across individuals, either in a systematic or random manner or both, as evidenced by the significance of the structural parameter τ of the scaling factor and the significance of the 'safety and gender' interaction terms. The magnitudes of the interaction parameters suggest that on average, all else being equal, female rail-users appear to place more weight (0.614) on personal safety of a station precinct than male rail-users (0.430); however, this gender difference is not statistically significant at the 95% level of confidence (albeit significant at 90%).

5. Results

5.1 WTP values

Table 3 shows the average WTP for one unit improvement in each VASP theme derived from the econometric modelling. These are unconditional WTP obtained by simulating the ratio of the public realm parameters and the cost parameter as shown in eq. (7). Across all six themes, rail users are willing to pay more than non-rail users, as expected since rail users are more likely to visit the station precincts on a regular basis. On average, rail users are willing to pay $2.20 for a unit, in terms of the VASP rating, improvement in personal safety. By contrast, the same improvement is valued at $1.06 by non-rail users. All the WTP values are statistically significant, except for non-rail users for the sense of place.

Table 3: Average WTP estimates for one unit change in VASP rating ($/household/month)

VASP theme	Rail users	Non-rail users
Personal safety	$2.20	$1.06
Opportunity for activities	$1.98	$0.43
Movement in place	$1.69	$0.40
Feeling comfortable	$2.31	$0.50
Interpretation of place	$1.60	$0.26
Sense of place	$0.85	Statistically insignificant

For application of these WTP values in business cases and economic appraisal, it is useful to convert the WTP estimates shown in Table 3 to value per use (i.e., $/train trip). To this end, the Sydney Household Travel Survey (HTS) data was used to estimate the average number of train trips per household per month. Catchment analyses were conducted, using four alternative catchments of 500m, 800m, 1000m, 1200m walking distance from each of the 10 interview locations.

The resulting catchments were then overlayed with the Sydney HTS data to estimate the average train trips per household per month. The 500m catchment results in the highest average number of monthly train trips per household (31.72). The average number of monthly train trips per household appears to be stable at around 27 trips/household/month for catchments between 800m and 1200m. Using this average, Table 4 shows the average WTP per rail trip.

Table 4: Average WTP per trip for one unit improvement to a VASP theme ($/trip)

VASP theme	Rail users
Personal safety	$0.08
Opportunity for activities	$0.07
Movement in place	$0.06
Feeling comfortable	$0.09
Interpretation of place	$0.06
Sense of place	$0.03

5.2 Case study

A case study of the Bella Vista Station precinct was undertaken to quantify the amenity benefits of public realm in the station precinct. As part of the Metro North West Line opened in 2019, Bella Vista Station precinct is becoming a vibrant place to live and work, with a mix of housing, retail, and business spaces to support community wellbeing. The station precinct will be highly mixed use, with transit oriented development, which will provide diverse and affordable housing once the precinct development is completed. The precinct will have low car parking provision, supported by bus and metro services.

While commercial and residential development occurs, interim activation uses have been required. This includes initiatives such as a temporary pocket park (1,200m^2), public domain and plaza activation in partnership with third parties (Figure 5), and a development site public art hoardings program.

The estimation of precinct amenity benefits at the Bella Vista station was undertaken using the following equation:

$$Amenity\ benefit = No.of\ trips * changes\ in\ VASP\ ratings * WTP\ values \qquad (9)$$

On a typical weekday, the station is estimated to attract around 4,320 rail passengers based on strategic travel demand modelling outputs. Assuming the precinct activation initiatives achieve a three unit increase in each VASP rating, the precinct benefit is estimated be around $20 million dollars in present value terms using the WTP values presented in Table 4 , based on a real discount rate of 7% with a 30-year appraisal period.

Figure 5: Bella Vista Station precinct activation initiatives

Image: Landcom

6. Conclusions

Building on the existing framework that has been recommended by state and national guidelines, this research provides local and updated evidence to the WTP parameter values of each PERS theme, calibrated with the VASP framework developed by Transport for NSW. The research outcomes suggest that customers in Greater Sydney, including rail and non-rail users, are willing to pay for improvements in railway station precincts.

The WTP values, combined with Transport for NSW's VASP framework which provide guidance on the assessment proposed initiatives, can be applied to assess the amenity benefits of public realm. This would enable practitioners to estimate the benefits associated with place-making, either for place-making initiatives or larger-scale transport projects that provide improved amenity in public spaces as part of the project scope.

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