This is the peer reviewed author accepted manuscript (post print) version of a published work that appeared in final form in:

Ardeshiri, Ali, Safarighouzhdi, Farshid, Rashidi, Taha Hossein 2021 'Measuring willingness to pay for shared parking', Transportation Research Part A: Policy and Practice, vol. 152, pp. 186-202

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The final definitive published version (version of record) is available at: 10.1016/j.tra.2021.08.014

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Measuring Willingness to Pay for Shared Parking

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ABSTRACT

This study explores how individuals evaluate different shared parking features, as an emerging concept. In this paper, we develop a latent class behavioural model for a sample of 1,008 residents in New South Wales, Australia to explore different segments of taste and preference for shared parking. The outcome of this study extends our understanding about the emerging concept of shared parking by quantifying monetary value, in terms of willingness-to-pay, of different features of this new emerging phenomenon. This study contributes to the literature by providing firsthand insights about how demand for shared parking is formed and how different policy implication can be made accordingly. The results indicate that pricing persists to be the sole most effective parking policy, however non-price-related attributes can help decision makers to make more informative decision when it comes to different pricing schemes. The study also highlights that shared parking can perform a significant role in accommodating the surplus arising from the excessive parking demand and inadequate supply up to almost 40% of demand. The outcome of this study is anticipated to inform and equip city authorities with advanced knowledge about such an emerging phenomenon which can help developing regulations before the concept is out of control. Information from this study can also guide the private sector and the wider community to identify and develop opportunities related to shared parking.

Keywords:

Shared Parking, Shared economy, Latent class, Willingness-to-pay, Parking policies, Parking facilities and services

1. Introduction

The rapid growth of urban motorisation is causing parking to become a concerned issue for urban transport management departments (Hu et al., 2015). The growing rate of car usage and scarce land in metropolitan areas, has made parking a key challenge for both drivers as well as the transport policy makers (Xiao et al., 2018, Parmar et al., 2020). When supply of parking does not meet the demand, search time for parking increases and creates emissions and traffic congestions (Shoup, 2006). Scholars have looked at various parking management strategies, including using new schemes and the emerging technologies for competent handling of parking resources. Indeed, in the emerging era of smart cities, urban and transport authorities are anticipated to develop understanding about how cities will be shaped when the parking market is driven by shared parking facilitators.

In today's world, the speedy evolution of technology in information and communication has significantly facilitated the shared economy. Various applications in smartphone devices as well as the online shared marketplaces have enabled providing peer-to-peer services. These developments have allowed the shared economy concepts to become successful in areas such as transport, hospitality, household items, office spaces, etc. Uber and Airbnb are example of big players in the shared economy. Exponential improvement in the computing power, smart phone application development, location-based services and the ubiquitous uptake of social media are the primary drivers of a shared economy, and specifically the shared mobility service provision including shared parking options, which are fully functional around the world, for example in Sydney Australia.

Shared parking is a component of the shared economy where parking space utilisation is optimised by allowing complementary land use types (residential for example) to share spaces instead of providing parking for each independent land use. Shared parking can enhance the overall parking space turnover rate significantly and reduce the amount of parking demand, save land and maximise the use of parking spaces (Hu et al., 2015).

Requests of shared parking is rising in high congested cities as an innovative way of managing the parking space. Shared parking as a complement to the classical private and public parking management mechanisms is expected to help the parking crisis by aligning the current demand for parking space and the shortfall of supplying the parking spaces, with the aim of not exacerbating the traffic conditions. In the past decade, scholars have extensively looked at the shared parking schemes from several standing points. For example, owners' propensity to engage in the shared parking scheme (Yan et al., 2020, Liang et al., 2019), parking demand and space allocation (Liang and Ye, 2011, Kim et al., 2015, Shao et al., 2016, Gu et al., 2021), shared parking pricing (Najmi et al., 2021, Gu et al., 2020, Hao et al., 2019), dynamic booking management (Chou et al., 2016), and plug-in hybrid electric vehicles charging infrastructure in shared parking lots (Huang et al., 2012). However, to the best of the authors' knowledge, no study has explored consumers preferences towards different shared parking features. This study aims to shed light in this space and explore in particular how potential users evaluate different shared parking features when considering and choosing the shared parking option.

Understanding the perception of landowners is also a critical area of study to be explored since some shortcomings of the shared parking scheme lie with owners' coordination of the space with inconvenience rising through the process of dealing with neighbourhood safety, a possible increase in neighbourhood traffic flow and possible crowding and extra noise. However, this is out of the scope of this research and readers are referred to the study by Yan et al. (2020) study where they explored owners' demographic characteristics, revenue and psychological concerns as well as context variables in the owners' propensity to engage in shared parking schemes.

The outcome of this study is anticipated to provide information to city authorities while getting informed about strategies for regulating such an emerging concept branching from area of shared economy. Information from this study can also guide the private sector and the wider community to identify and develop opportunities related to shared parking. The private sector can then work with the government authorities to develop shared parking schemes through incentivisation methods to facilitate public transport usage.

The 'sharing economy' is rapidly rising in Australia and entrepreneurs now have focused their attentions to benefit from unused driveways and transfer them into a public parking option. Several reasons have triggered this rapid rise in Australia. The demand for this type of service has increased in metropolitan cities like Sydney since the car spaces are disappearing from Sydney apartment developments. This is due to the tight controls imposed by planners in provision of parking in new blocks as well as the strategy to allow developers to reduce their cost of building and providing more affordable housing. Moreover, the local and state governments can benefit from promoting the shared parking option to fulfill their overall aim of creating a sustainable and liveable city by encouraging residents to support collaborative consumption. BaseUp, Share with Oscar, Parkhound and DIVVY are some of the leaders of shared parking in New South Wales, Australia who are pushing the boundaries of the feasibility of shared parking and allowing individuals and business owners to rent out spaces for themselves or their employees.

It is essential to note that this paper is not contributing to the literature on how shared parking should be implemented in terms of technologies required and guidelines for a successful business plan. Instead, the paper measures the preference of people if the shared parking technology becomes fully available to them the way on-street parking is. The findings of this study are envisioned to support strategic plans on designing effective pricing mechanisms for shared parking, as well as taxing schemes, and regulating the market to take the most from this emerging phenomenon before it becomes so dominant like Airbnb which forms regulations not being formed by regulations.

2. Literature review

Shared parking has received much attention recently as a way to deal with parking challenges in metropolis. Shared parking targets a key gap in the market in densely populated areas with little to no usable demand – by effectively utilizing existing underused infrastructure (Liu et al., 2019). Smart parking involves parking space owners renting it to other users when

unoccupied (Smith, 2005). Through blurring the lines between public and private parking infrastructure, shared parking maximizes occupancy rates while simultaneously reducing the overall supply and land use footprint (Liu et al., 2019). Shared parking can be implemented on both the macroscopic and microscopic levels with businesses having the potential to rent their lots to serve adjacent buildings (Chen et al., 2017, Ibrahim, 2017). This enables them to meet the demands of a diverse range of users thereby capturing additional revenue from time-based variations of demand (Chen et al., 2017).

Concurrently, residents can rent out their own spaces through a peer to peer market with the advent of new e-parking platforms that utilize smartphone technology to effectively match renters and road users (Liu et al., 2019). With the promise of reducing congestion and with the possibility of being implemented concurrently alongside smart parking technologies such as contactless payments, check in/outs and location tracking, shared parking has enormous potential to conserve space while also ensuring the efficiency of existing infrastructure (Chen et al., 2017, Pala and Inanc, 2009). Furthermore, shared parking unlocks new revenue streams for businesses and residents that can rent out their space for profit. Shared Parking, however, it not without its challenges. Stein and Resha (2018) identified numerous barriers in shared parking adoption in a comprehensive study. They primarily revolve around contractual issues surrounding liability and insurance of the renting cars, maintenance and duty of care surrounding the space itself as well as perceptions of safety within the shared parking space/ as well as the surrounding neighbourhood (Stein and Resha, 2018). Li, Tao and Liu (2019) also highlight how the efficiency and uptake of shared parking is also highly depended on users vacating the parking space at their designated time slot. Failure to do so not only reduces the overall efficiency of a shared parking solution, but also represents a loss of revenue and creates conflicts with the owner's parking rights – a key issue that currently inhibits residents from sharing their parking spaces (Li et al., 2019).

To address these concerns, new mathematical models are being utilized to effectively price shared parking spaces with considerations of for risk alongside traditional determinants of price such as location, time of day and length of stay (Li et al., 2019). Additionally, as businesses and residents begin adopting shared parking, agreements and contracts are being utilized to clearly outline to address legal ambiguities associated with sharing parking infrastructure (Willson, 2015, Cai et al., 2018). Having said that, analysing different policies related parking requires recognition of the potential of various elements of parking and their properties. Shared parking, along with the rise of sharing economy and transport, brings emerging parking solutions. Shared parking takes advantage of the fact that most private parking spaces are partially used during the day, while being vacant the rest of the time which leaves room for them to be utilised by others (Xiao and Xu, 2018). Shared parking has recently appeared as an effective way to manage the parking issue in urban areas. Undoubtably users perception about different factors that participated in their decision of choosing a shared parking option is very vital in successfully implementing the shared parking services. Liang et al. (2019) investigated factors affecting one's intention to use shared parking using psychological perspective viewpoint. The results of this study, that is based on a SEM model, confirms that combining the Theory of Planned Behaviour (TPB) with Technology Acceptance Model (TAM) can enlighten the variance in users' intention toward a shared parking system.

Furthermore, Liu et al. (2014) find out that parking reservation through parking permit distribution can efficiently facilitate traffic management. With cars being the most popular mode of transportation efficient parking management can significantly impact on road traffic congestion (Shao et al., 2016). Studies conducted in UK cities predict that charging for parking, as a tool for parking management, is more effective to promote public transport compared to increasing the transit service frequency (Rye et al., 2006). Similar findings have been reported in the literature on the capacity of parking management strategies in encouraging people to use more sustainable modes of transport. Some researchers (Simićević et al., 2012, Arnott and Rowse, 2013, Arnott, 2014, Millard-Ball et al., 2014, Yan et al., 2019) have focused on finding the optimal occupancy rate of parking facilities to determine parking price and parking time limits leading to minimum search time and egress distance.

The ownership of the parking spot is another issue which has been discussed in the literature. Underground parking spots of residential buildings might be managed by strata companies while the driveway of a house might be owned by the government while being is used by the residents. Where the driveway is part of the private residence, its ownership and management might be different than an underground parking facility of residential complex. Even private driveways might be restricted to be fully used for shared parking purposes because the inbound and outbound flow contributing to the traffic of the adjacent street might be restricting. As expected, shared parking like all other shared economies should be properly regulated, otherwise, the consequences may involve many regulatory agencies in the future to fic unprecedented consequences of this emerging phenomena (Shao et al., 2016).

There are various sets of parking elements affecting parking selection which have been selectively studied by researchers are listed below. Table 1 shows the most popular parking attributes in the previous research studies. These attributes are considered in formation of the survey design of this study, among which price and egress time are the core of pricing attributes. Many other attributes could be considered to define the shared-parking features. These features include, the regulation (e.g., permitted parking hour), price and density of on-street parking spaces near to the respondent's destination, whether the employer provides parking spaces will also affect the choice. Others looked at the trade-off between these features (Najmi et al, 2021, Gu et al, 2020 and 2021). Nonetheless, including these features in the design of this study which is already a complicated design can negatively affect the quality of the DCE of this study which is aimed at immediate features of shared parking as identified in the literature.

Table 1: Summery of parking features used in previous parking studies

Author (year)	Parking features
Simićević, J., et al. (Simićević et al., 2012)	parking price, purpose of trip
van Ommeren, J. N., et al. (van Ommeren et al., 2012)	Gender, age, income, purpose, trip duration, parking duration, neighborhood population, peak cruising time

Arnott, R. and J. Rowse (Arnott and Rowse, 2013)	curb-side parking limits, value of time, visit duration
Guo, Z. and S. McDonnell (Guo and McDonnell, 2013)	type of parking (garage, street, home), cruising time in weekend and weekdays, distance btw home and parking, household attributes, neighborhood attribute, household head attributes
Zhang, R. and L. Zhu (Zhang and Zhu, 2016)	egress time, parking fee, occupancy rate (chance of finding free space), distance from home, type of parking, search time, parking time restriction, expected fine for illegal parking, security
Melia, S. and B. Clark (Melia and Clark, 2018)	gender, age, driving license, car availability, public transport availability
Sweet, M. N. and M. R. Ferguson (Sweet and Ferguson, 2019)	gender, age, travel time, parking permit, vehicle ownership, job density, household size, parking price

Although different parking facilities and policies have its own pros and cons for parking management and urban and transport planners, the exact implementation of these facilities and policies, however, cannot be achieved with a one size fits all approach. Rather such solutions need to be contextually appropriate and considerate of the socioeconomic factors of the communities they are being implemented in (Ecola and Light, 2009).

While various works within the sphere of literature surrounding parking and transportation demand management have introduced and suggested various strategies to reduce parking demand and congestion, it is impossible to quantify the effectiveness of these studies without the specific use of certain experimental methods and models. A key determinant in ensuring the success of these policies is public compliance and perception. Therefore, it is crucial to gauge user preferences and willingness to pay to dictate the direction these interventions will undertake before they are utilized in the greater urban environment.

Traditionally, preferences and willingness to pay for parking in urban centres have been analysed using observed patterns of use in the real world. Methods such as hedonic pricing, multivariate regression analysis, and probit models have been used to measure willingness to pay values. For example, van Ommeren et al. (2011) used a hedonic price model and house price as the dependent variable to study residents willing to pay for on-street parking permits in Amsterdam. In this study, they demonstrated that residents are willing to pay €10 per day for a parking permit. Kobus et al. (2013) applied a probit models on data from paid parking transactions during shopping hours in the Almere CBD and estimated the choice between street and garage parking. They found that drivers are willing to pay a premium for street parking which ranges from €0.37 to €0.60. Regardless of the methods, the data for analysis has been based on observable decisions were reveals individual decision in the real world. Due to either lack of key information or imprecision in measuring information, these revealed preferences (RP) datasets typically suffer from omitted variables and/or measurement errors. Additionally, RP data provides limited control over the interested explanatory variables. This

issue becomes severe when not enough observations are available to isolate the effect of different variables of interest (Earnhart, 2001). Furthermore, this limitation can be intensified with the existence of multicollinearity where high correlation exists between two or more explanatory variables in the dataset (Greene, 2003). Finally, RP data can only measure preferences based on the past or current market conditions. When market conditions are stable, past and/or current preferences can be good predictors of future preferences. However, in new and unstable conditions, the use of historical data to predict future patterns is questionable. As an alternative, stated preference (SP) experiments have been used to collect data from participating individuals to measure their preferences for many transport-related behavioural research (de Dios Ortúzar and Willumsen, 2011). For example, Dell'Olio et al. (2009) used a stated preference experiment to investigate Santona resident's willingness to pay for underground parking. This study showed that on average respondents are willing to pay €0.716 per hour for an underground car park. Jeihani et al. (2015) used stated preferences data to finds willingness to pay and price elasticity for on-street parking demand and they found on average participants are willing to pay US$2.65 for on-street parking. Guo and McDonnel (2013) utilized a contingent valuation approach and used the payment cards approach to investigate New York City resident's willingness to pay for the parking permit program and indicated that just over half of participants were willing to pay an average of $408 per year for the parking permit. Several other studies (Xiao et al., 2018, Kobus et al., 2013, Guo and McDonnell, 2013, Arnott and Rowse, 2013, Milosavljević and Simićević, 2016) have also tried to estimate willingness to pay for parking fees for on and off-street parking while shared parking has not been studied with a focus on users' willingness to pay for different shared parking features. This study uses the SP approach to measure residents' willingness to pay for specific features of shared parking which has not been examined in previous studies which makes the contribution of this paper unique. SP experiments are not subject to the same sources of bias as real-world market data, although subject to hypothetical bias. In fact, SP experiments offer perfect control – each of the variables of the decision context are defined explicitly by the analyst, and there are no omitted variables and no measurement error (Mitchell and Carson 2013; Louviere et al., 2000). SP experiments utilize a variety of hypothetical scenario-based questionnaires that prevent several alternatives and policy combinations that attempt to capture individuals' decisions and trade-offs between different elements of proposed policies (Azari et al., 2013, Hensher, 1994). Using these choice modelling SP methods allows policymakers to understand the responses to a wider range of potential scenarios that may not be measurable in real life (Azari et al., 2013).

As more research is conducted into shared parking and its adoption in new and existing communities continues to grow, its benefits will undoubtedly become increasingly tangible. In the following section we will elaborate more on the method used in this study and how we gage individuals' decisions and trade-offs between different elements of proposed shared parking features.

3. Materials and methods

The choice of people to use shared parking in this study is developed based on the random utility theory framework (McFadden, 1973). In the following sections, a description of attributes and levels used in the DCE is presented followed by the data obtained for this study and method of analyses.

3.1 Experiment design and materials

Preferences for shared parking features are modelled using a DCE, where individuals were presented with two shared parking options as well as a no-choice option. Following a thorough literature review and a focused group discussion with experts from both public and private sectors such as transport strategic planners, policy makers, academics and shared parking app developers, eight attributes as presented in Table 2 were selected for this study. These attributes include "plan duration" which represents the period that the parking can be provided, "parking type" which indicates the area available to park the vehicle, "Suitable for" which recommends what vehicle body type can best fits in the space, "extra facilities" indicates the availability of additional services and facilities in the parking area. "Access" represent whether the renter is given full access or limited access to the area which is different to the "Space availability" in the sense that you might have access to enter the parking area, however, the space you have rented to park your vehicle might not be available at that time. In another scenario the space you have rented might be available all day for you to park your car, however you may not have all day access to the parking area. These two attributes are selected to represent similar existing limitations due to strata management rules, bylaws and regulations that some parking lot owners residing in building complexes may have. "Walking time to destination" represents an approximate time required for the parking user to walks from the parking lot to the destination. Finally, a parking cost (per hour units) attribute is also presented to highlight the fee that is required to be paid by the parking users when renting the parking space. Parking cost is an important indicator on how users select parking location and has a direct effect on users' choice.

This study unlike other parking choice studies did not include search time as an attribute since with the improvement in the intelligent parking services, which provide parking availability information to drivers through smart phone apps, it is believed that the parking search time is likely to exert even less of an influence on travellers parking choice.

The Ngene software (ChoiceMetrics, 2018) was used to create a D-efficient design (Scarpa and Rose, 2008) for this study. The final design had a D-error of 0.060 and include 64 choice tasks in 8 blocks providing each participant with eight repeated choice tasks.

Table 2: list of attributes and levels used in the choice experiment

Attributes	***Levels***
Plan duration	1- Hourly parking, 2- Daily parking, 3- Weekly parking, 4- Monthly parking
Parking type	1- Indoor lot, 2- Outdoor lot, 3- Lock up garage,

	4- Secured parking
Suitable for (car type)	1- Motorbike, 2- Small Hatchback/sedan, 3- Medium sedan, 4- SUV/4wd, 5- Van/truck
Extra facilities	1- CCTV, 2- Security gates, 3- Restroom, 4- Security patrols, 5- Car Wash, 6- Car Servicing
Access	1- 24/7, 2- Limited hours
Walking time to destination	1- 1 minute, 2- 5 minutes, 3- 10 minutes, 4- 15 minutes, 5- 20 minutes
Space availability	1- 7:30am-6pm, 2- All day
Cost per hour	1- $1, 2- $2.5, 3- $5, 4- $7.5

Task 1 of 8

Imagine you have driven your private vehicle today and like to examine the *shared parking* options available. Please select which option you would park your vehicle at.

	Option 1	Option 2
Plan duration	Hourly parking	Monthly parking
Parking type	Lock up garage	Outdoor lot
Maximum capacity for (vehicle type)	SUV / 4WD	Motorbike
Extra facilities		
CCTV	✓	✗
Security gates	✓	✗
Restrooms	✓	✗
Security patrols	✓	✗
Car wash	✗	✓
Car servicing	✓	✗
Access	Limited hours	24/7
Walking time to destination	15 min	5 min
Space availability	All day	7:30am - 6pm
Cost per hour	$5.00	$1.00
I would choose this option	○	○
I would *NOT* choose either of the options	○	

Figure 1: Screen capture of an example of the DCE task.

3.2 Data and case study

The Australian Bureau of Statistics data shows that Sydney's population in June 2019 had reached to 5.3 million (Australian bureau of statistics, 2019). The poor public transportation options in the suburban areas and the sprawl development of the city are some of the main reasons for the private car is being used for the most journeys (Bureau of Transport Statistics, 2014). This issue hand in hand with the city's sustainable and liveable vision and the affordable housing concept mentioned earlier, has paved the path for app developers and entrepreneurs to start developing different application platforms such as BaseUp, Share with Oscar, Parkhound and DIVVY. The emergence of these platforms and services highlights the fact that parking challenges in congested city like Sydney can be addressed using new revolution in the shared economy. Recently, the Committee for Sydney and Arcadis studied the future transport technologies in property and infrastructure preparedness and recommended that sharing economy will likely permeate through car parks. They also pointed out to the fact that currently in Sydney CBD the decoupling of parking spaces from individual lots are taking place, which highlights the expectation of the expansion of this practice throughout the city.

For this purpose, in November 2019, a stated preference survey focusing on individuals' preferences for different shared parking features was completed by 1,008 residents in New South Wales (NSW), Australia. Summary of respondents selected demographic characteristics are given in Table 3.

Table 3: Descriptive summary of respondents selected demographic characteristics

Variable	Surveyed	Population
Age groups		
Between 18 and 30	30.8%	30.4%
Between 31 and 45	43.1%	17.3%
Between 46 and 65	20.8%	31.8%
65 years and over	5.4%	20.5%
Gender		
Female	58.7%	50.7%
Male	41.3%	49.3%
Income (mean income per week)		
Income below $52K	23.1%	35.7%
Income between $52 - $104K	30.9%	21.7%
Income above $104K	36.0%	42.6%
Not specified	10.0%	NA
Employment		
Full time	60.6%	55.0%
Part time	19.9%	14.9%

Not engaged	19.5%	30.1%
Education		
Postgraduate	31.5%	10.0%
Undergraduate	42.6%	31.0%
TAFE Certificate or equivalent	22.8%	46.0%
Other	3.0%	13.0%
Household Structure		
Couple with kids	44.5%	50.6%
Couple without kids	24.6%	32.7%
Single parent	6.2%	14.8%
Other	24.7%	1.9%
Household Vehicle Ownership		
No vehicle	5.9%	11.6%
1 vehicle	51.3%	38.5%
2 vehicles	34.8%	33.8%
3+ vehicles	8.0%	16.1%

The survey was conducted among NSW residents aged 18 and above who had a driving license. No specific quota was applied based on the main demographic factors such as age, gender or income. Majority of respondents belonged to the 31 to 45 years age category with an average of 38.8 years. Compared to the NSW statistics the sample was skewed towards the 31 to 45 years age category and the 65 years and over were underrepresented. Female respondents with 58.7% representation were the dominant group. Similar to the NSW statistics, the majority of the households fall in the highest income range. Ten percent of the sample did not specify their household income. Over 60% are full time employees and 42.6% of the sample have an undergraduate degree. Participant were from different types of households with the majority from the "Couple family with children" category. Over 94% of the respondent indicated that one or more vehicles are available in their household.

3.3 Methodology

A latent class model (LCM) (see Swait, 1994, Ardeshiri and Vij, 2019) was used to probabilistically segment respondents to be homogeneous within and heterogeneous across segments based on individual characteristics and their predisposition towards different features of the shared parking. Thus, the model comprises two components: an individual class membership model and an individual shared parking choice model.

The individual class membership model probabilistically predicts that individual *i* belongs to individual class *r* formulated as a multinomial logit model:

$$P(Q_{ir} = 1) = \frac{\exp\,(Z_i \alpha_r)}{\sum_{r=1}^{R} \exp\,(Z_i \alpha_r)} \quad (1)$$

Where Q_{ir} is equivalent to individual *i* belonging to class *r*, and zero otherwise. Z_i represents a vector of individual's characteristics, such as age, income, gender and family structure; and

α_r is a vector of parameters to be estimated which is associated with the individual's characteristics. *R* represents different classes in the data, which is distinguished exogenously.

The model fit and behavioural interpretation of several models should be compared and contrasted to justify the number of classes to be selected in a LC model. Using individual preferred options given in the discrete choice experiment the following utility can be written for each choice task.

$$U_{ij|r} = X_j\beta_r + \varepsilon_{ij|r} \quad (2)$$

where X_j is a vector of characteristics of shared parking option *j*; β_r is a vector of class-specific parameters highlighting the importance of each of these attributes; and $\varepsilon_{ij|r}$ is the stochastic component of the utility specification, assumed to be i.i.d. Extreme Value Type I across individuals, shared parking options and classes with location zero and scale one. Swait (2006) as well as Shonkwiler and Shaw (2003) concluded that the LC model is not constrained by the i.i.a. (Independence of the Irrelevant Alternatives) property of the MNL model. Nevertheless, Greene and Hensher (2003) pointed out that the LC model considers independence of multiple choices to be made by the same individual.

Using the utility maximisation theory, the class-specific shared parking option choice model is expressed as follows:

$$P(Y_{ij} = 1 \mid Q_{ir} = 1) = \frac{\exp(X_j\beta_r)}{\sum_{j\epsilon J_r}\exp(X_j\beta_r)} \quad (3)$$

where Y_{ij} is one if individual *i* selects the shared parking alternative *j* and zero otherwise. Accordingly, in the class membership function, the joint probability of the sequence P_i=[P_{i1}, P_{i2},…, P_{ir}] will be the contribution of every individual *i* in the likelihood. This can be presented based on the following equation:

$$P_{i|r} = \prod_{t=1}^{T_i} P_{it|r} \quad (4)$$

There are R sets of β_r (taste parameters) and *R-1* sets of α_r (class membership parameters). In LC model respondents are assigned to every class up to a probability which is assumed to be 'latent'. The likelihood for individual *i* is the anticipation (over classes) of the class-specific donations:

$$P_i = \sum_{r=1}^{R} Q_{ir}P_{i|r} \quad (5)$$

The final log-likelihood for the entire sample can be calculated using vectors of taste parameters of $\beta_r$and r-1 latent class parameter of α_r. This log-likelihood is formulated as following:

$$LnL = \sum_{i=1}^{N} \ln P_i = \sum_{i=1}^{N} \ln \left[\sum_{r=1}^{R} Q_{ir} \prod_{t=1}^{T_i} P_{it|r} \right] \quad (6)$$

3.4 Measuring the willingness to pay values

In many empirical studies the research seeks to attain monetary values of welfare changes on the base of availability of a good or changes in the qualities of attributes apart from the price change. Based on the assumption of a linear relationship between different attributes in the utility function, the WTP for an attribute level for each latent class is calculated as:

$$WTP_{iA}^{c} = -\frac{\beta_{iA}^{c}}{\beta_{ip}^{c}} \quad (7)$$

Where WTP_{iA}^{c} is the price premium willing to pay for gaining an anticipated level of attribute *A* of the shared parking alternative *i* in class *C*. Furthermore β_{iA}^{c} and β_{ip}^{c} are the estimated coefficients of different features of shared parking and the price attribute. The overall WTP for the sample calculated by simply weighting the averages of the class WTPs. Whereas the weights are equal to the probabilities of class membership or class size $\hat{w}^{c}$ and the formulation is as follows:

$$WTP_{iA-average} = \sum_{c=1}^{C} \hat{w}^{c} \times WTP_{iA}^{c} \quad (8)$$

The asymptotic standard error of the WTP for each class can also be calculated using the Delta method with the following formula:

$$se(\hat{w}_k) = \frac{1}{\beta_k} \sqrt{var(\beta_k) - 2w_k cov(\beta_k, \beta_c) + w_k^2 var(\beta_c)} \quad (9)$$

Using the parameter estimates for $\hat{\beta}_k$ and $\hat{\beta}_c$ as the true parameter and exploiting the equivalent element in the asymptotic variance-covariance matrix given by the estimation software the standard error and later the confidence intervals for each class WTP values can be analytically computed (for more information on the Delta method see Bliemer and Rose, 2013, Daly et al., 2012a).

4. Results

A latent class model was used to estimate individuals' preferences regarding different shared parking features. Different models and sub-models were investigated using Pandas Biogeme 3.2.6 (Bierlaire, 2020). Usually the goodness of fit indicators BIC and AIC are used to determine the number of classes (Swait, 2006). Various utility specifications and statistical measures of goodness-of-fit as presented in Table 4 (i.e. the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the Consistent AIC (CAIC)) have been examined. In this study, the BIC and CIAC indicate that the two-class model is the preferred number of classes, while the AIC favours models with three classes. As it is evident from the

literature that the AIC tends to overestimate the number of classes and there is a consensus that parsimony is preferable in modelling (Mariel et al., 2015), the two-class model is selected as the preferred model specification.

Table 4: Goodness of fit measures versus number of classes

Number of latent classes	Number of estimated coefficients	Log-likelihood value	Sample size	BIC	AIC	CAIC
2	**42**	-4805.35	**1008**	**9914.99**	9698.70	**9736.70**
3	84	-4761.51	1008	10027.17	**9691.02**	9775.02
4	116	-4739.23	1008	10089.10	9715.02	9831.42

4.1 Model estimation

Following the aim of the study to evaluate the effect of all levels of shared parking features used in the DCE, effects coding was used and applied. Effects coding is an alternative to dummy coding where the reference point is described as the negative sum of the estimated coefficients. This highlights the fact that the reference point is now internalised in the β estimates and cannot be passed over onto the β_0 coefficient. The effect of all levels can be estimated when effects coding has been applied. This ensures the fact that all coefficients are uncorrelated with the intercept. Hence, the constant term can only represent the utility associated with the fixed comparator and removing the possibility of any misinterpretation (Louviere et al., 2000, Bech and Gyrd-Hansen, 2005, Ardeshiri and Rose, 2018).

As indicated earlier, two classes were identified in the sample population. These classes have different sensitivity to different features of shared parking. Over the subsequent paragraphs, we summarize some of the key attributes of each of these classes. To emphasize behavioural differences between classes, we conducted a sample enumeration exercise to calculate the expected socioeconomic composition for each class. We have included the results of the exercise in our description of the classes. All results have been weighted by age, gender and income as the main demographics characteristics to represent the NSW population. Table 5 and 6 present the estimated coefficients for the two-class latent model with and without panel effect. We have excluded insignificant parameters with p-values greater than 0.2 from the tables. The two-class model with panel effect has a higher goodness of fit estimated on which we provide detailed discussions.

4.1.1 Household Class 1

This class constitutes of 57.1% of the population and is probable to consists of 53% male and 47% female. The average age in this sample is likely to be 37.1. The dominant household structure is a couple family with children (43.3%). Just over 39% have a graduate degree or higher, 28.1% are likely to have a bachelor's degree and the remaining 32.9% have a diploma or lower degree. More than 65% of the households are prone to be full-time employed and the average household income is expected to be around $89,330 per annum.

The results indicate that respondents in this class prefer daily and hourly parking plans compared to weekly and monthly options. Class 1 are less interested in outdoor lots and would rather prefer a "secured parking" or "indoor lot" respectively. Respondents belonging to class 1 are more likely to prefer parking lots that are more suitable for medium-sized cars and SUVs with the latter being the most preferred option. These respondents are less interested in shared parking lots that are suitable for motorbikes and Vans. Members belonging to class 1 show positive preferences toward all supplementary features of the parking facilities except the car servicing option. Having a CCTV is the most preferred option and carwash being the least favourable one. Class 1 respondents appreciate having 24 hours/seven days a week access to the shared parking lot option and also a parking space to be available at all times during the day. Walking time to the destination from the shared parking lot and cost per hour were both found to be negative and significant in this class as expected. Highlighting that increase in both variables creates disutility for these respondents.

Class membership parameter estimates presented in Table 6 highlight the characteristics of the respondents who are more likely to belong to class 1. Results indicate that compared to class 2, class 1 members are more likely to be full-time employed males who are within the age bracket of 18-30 years old or be above 65 years of age and less likely to belong to the couple with no children category. Class 1 respondents are also less likely to be in the household annual income bracket above the $104k category in comparison to members belonging to class 2. Finally, respondents belonging to class 1, are less likely to have an undergraduate degree compared to members belonging to class 2.

4.1.2 Household Class 2

This class constitutes of 42.9% of the population and is likely to consist largely of females (65.7%) belonging to households structured as couple families with children 46.2%. Just under 42% of households in this class are likely to have a graduate degree or higher, 22.8% are likely to have a bachelor's degree and 35.3% have a diploma or lower. Compared to class 1, the average age of this sample is higher and is expected to be 41.3. Fewer households are likely to be full-time employees (54.4%) in contrast to class 1, however, the average annual household income in this class is $109,685 which is higher than class 1.

The results show that class 2 are indifferent toward the parking plan options. Similar to class 1, respondents that are more likely to fall in class two are less attracted towards shared parking lots located outdoor. However, unlike respondents belonging to class 1, their most preferred shared parking type is a locked garage. Class 2 members showed positive preferences towards shared parking suitable for all vehicle sizes except for motorbikes where they show a strong distaste. From the list of extra facilities available in the shared parking space, members that are likely to belong to class 2 have trivial preferences toward shared parking spaces that have restrooms, CCTV and car servicing options. Similar to members belonging to class 1, class 2 members also welcome having 24 hours/seven days a week access to the shared parking lot option and prefer for the space to be available at all times during the day. Furthermore, Similar to class 1 walking time and cost per hour were both found to

be negative and significant, however, respondents in class 2 are much more sensitive towards these attributes.

Table 5: Parameter estimates and their corresponding statistics for the class-specific shared parking choice model

Parameters	Latent class				Latent class with panel effect			
	Class 1		Class 2		Class 1		Class 2	
	Value	*Rob. p-value*	*Value*	*Rob. p-value*	*Value*	*Rob. p-value*	*Value*	*Rob. p-value*
Plan duration								
Hourly parking[ʁ]	**0.027**		-	-	**0.032**		-	-
Daily parking	0.155	0.000	-	-	0.172	0.000	-	-
Weekly parking	-0.077	0.045	-	-	-0.085	0.037	-	-
Monthly parking	-0.105	0.009	-	-	-0.119	0.006	-	-
Shared parking type								
Indoor lot[ʁ]	**0.031**		**0.031**		**0.032**		**0.028**	
Outdoor lot	-0.088	0.010	-0.226	0.000	-0.091	0.012	-0.224	0.000
Lockup garage	-	-	0.195	0.001	-	-	0.196	0.001
Secured parking	0.057	0.080	-	-	0.059	0.097	-	-
Suitable for (car type)								
Motorbike [ʁ]	**-0.232**		**-2.009**		**-0.229**		**-1.953**	
Small size vehicle	-	-	0.396	0.000	-	-	0.384	0.000
Medium sized vehicle	0.142	0.005	0.761	0.000	0.144	0.010	0.738	0.000
SUV	0.168	0.001	0.496	0.000	0.176	0.001	0.486	0.000
Van	-0.078	0.123	0.356	0.006	-0.092	0.093	0.345	0.003
Extra facilities								
CCTV	0.155	0.000	0.068	0.013	0.166	0.000	0.070	0.007
Security gates	0.113	0.000	-	-	0.123	0.000	-	-
Restroom	0.077	0.000	0.082	0.063	0.084	0.000	0.075	0.067
Security patrol	0.122	0.000	-	-	0.133	0.000	-	-
Car wash	0.057	0.005	-	-	0.061	0.006	-	-
Car Servicing	-	-	0.036	0.183	-	-	0.038	0.179
Access								
24 hours seven days a week [ʁ]	**0.076**		**0.086**		**0.082**		**0.085**	
Limited hours	-0.076	0.000	-0.086	0.035	-0.082	0.000	-0.085	0.022
Walking time to destination								
Walking time	-0.012	0.004	-0.064	0.000	-0.012	0.005	-0.063	0.000
Space availability								
7:30-6pm [ʁ]	**-0.135**		-	-	**-0.147**		-	-
All day	0.135	0.000	-	-	0.147	0.000	-	-
Cost per hour								
Hourly cost	-0.099	0.000	-0.666	0.000	-0.099	0.000	-0.649	0.000
Sigma	-	-	-	-	-0.533	0.000	-0.007	0.000

[ʁ] indicates the reference level in effects coding

Table 6: Parameter estimates and their corresponding statistics for the individual class membership model

Parameters	Latent class				Latent class with panel effect			
	Class 1		Class 2		Class 1		Class 2	
	Value	Rob. p-value	Value	Rob. p-value	Value	Rob. p-value	Value	Rob. p-value
Class intercept	0.236	0.000	Base class		0.172	0.000	Base class	
Age								
Aged between 18 - 30 years	0.430	0.035			0.417	0.034		
Aged between 31-45 years	-	-			-	-		
Aged between 46 - 65 years	-0.572	0.004			-0.536	0.007		
Aged above 65 years[ʁ]	**0.142**				**0.119**			
Household Structure								
Couple family with children								
Couple family with no children	-0.236	0.180			-0.231	0.170		
Other households[ʁ]	**0.236**				**0.231**			
Gender								
Female	-0.266	0.014			-0.260	0.012		
Male[ʁ]	**0.266**				**0.260**			
Employment status								
Full time employed	0.550	0.006			0.526	0.006		
Part time employed	-0.250	0.161			-0.250	0.143		
Unemployed	-	-			-	-		
Other[ʁ]	**-0.300**				**-0.276**			
Annual total household gross income (before tax)								
Income less than $52k	0.676	0.001			0.683	0.000		
Income between $52k - $104K	0.366	0.037			0.334	0.052		
Income more than $104k	-0.483	0.004			-0.470	0.004		
Not specified[ʁ]	**-0.559**				**-0.547**			
Education level								
Graduate	0.189	0.150			0.195	0.190		
Undergrad	-0.273	0.054			-0.260	0.057		
Certificate	-	-			-	-		
Other[ʁ]	**0.084**				**0.065**			
Estimation report								
Number of estimated parameters	42				44			
Sample size	1008				1008			
Init log likelihood	-5589.54				-6.121.49			
Final log likelihood	-4824.53				-4805.35			
Rho-square for the init. model	0.137				0.215			
Akaike Information Criterion	9733.06				9698.70			
Bayesian Information Criterion	9939.52				9914.996			
Number of draws	-				10,000			

[ʁ] indicates the reference level in effects coding

4.2 Willingness to pay calculation

This section draws further insights on the results by calculating willingness to pay (WTP) for various attributes. The variance and the standard error of the WTP measures for the sample population have been estimated through simulation using the Delta method. As stated earlier, the shared parking attributes were coded as effects variables, thus a WTP value was calculated for all attribute levels. For this process, 10,000 draws have been taken from the distribution of $\beta_k$and β_c, and the ratio of the coefficients is calculated for each draw (for an in-depth discussion see e.g. Hensher and Greene, 2003, Daly et al., 2012b). To validate the WTP means and standard errors, we replicated the two latent class model in willingness to pay space as well where similar outcome was achieved, however, for brevity the estimated results for the WTP space model is precluded. The WTP for desired shared parking features for each latent class and in the entire sample are presented in Table 7.

As evident in Table 7, the sampled population are willing to pay the highest for shared parking spaces that is suitable for an SUV (AUD$1.34/h) and medium (AUD$1.32/h) sized parking lot and CCTV (AUD$1.01/h), respectively. Some negative willingness to pay values were also calculated showing that respondents are not willing to choose the shared parking option with these features. For example, shared parking space suitable for motorbikes (AUD-$2.61/h), shared parking spaces that are only available between 7:30 am-6:00 pm (AUD-$0.84/h), shared parking spaces with a monthly plan (AUD-$0.68/h), outdoor shared parking lot (AUD -$0.67/h). In relation to the shared parking plan duration, respondents' WTP is highest for daily and hourly parking plans who are willing to pay a price premium of AUD$0.99 and AUD$0.18 per hour respectively. With regards to shared parking types, respondents are WTP higher for a secured garage (AUD$0.34/h) compared to an indoor lot (AUD$0.20/h), lockup garage (AUD$0.13/h) and outdoor parking (AUD-$0.68/h). The sampled population are willing to pay between AUD$0.25/h for shared parking suitable for small-sized vehicles and around AUD$1.3/h for spaces suitable for a van and medium-sized vehicles. The calculated WTP values indicated that respondents value these extra facilities in the following order: CCTV (AUD$1.01/h), security patrol (AUD$0.77/h), security gates (AUD$0.71/h), restroom (AUD$0.54/h), carwash (AUD$0.35/h), and car servicing (AUD$0.02/h). Respondents are willing to pay higher if the shared parking space is available for the entire day (AUD$0.85/h) to park their vehicle compared to being able to access the space anytime during the day (AUD$0.52/h). Moreover, respondents are willing to pay AUD$0.11 for every minute reduction in their walking time from the parking lot to the destination. The only significant contrast in calculated WTP values between the classes is observed for shared parking spaces suitable for vans where the calculated WTP value for class 1 is AUD -$0.92/h and for class 2 is AUD$0.53/h.

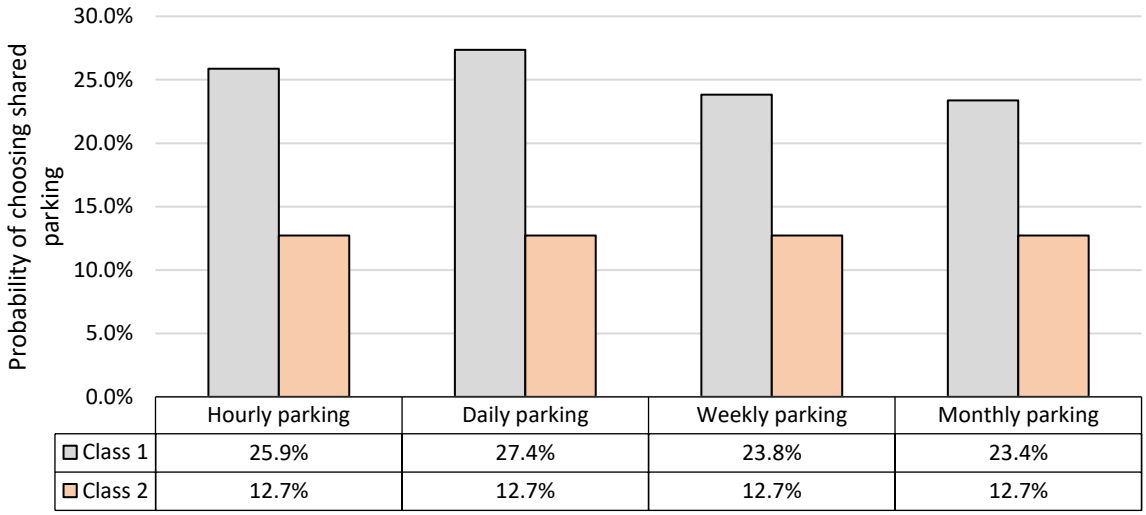
Table 7: Average WTP estimated at individual specific parameters (AUD$ per hour)

Parameters	Sample size (57.1%)	Sample size (42.9%)	Sample size (100%)	WTP 95% confidence intervals	
	Class 1 WTP	Class2 WTP	Sample overall WTP	Lower bound	Upper bound
Plan duration					
Hourly parking[ɤ]	$0.32 (2.29)		$0.18 (1.98)	$0.12	$0.41
Daily parking	$1.74 (3.85)		$0.99 (3.01)	$0.73	$1.89
Weekly parking	-$0.86 (-2.07)		-$0.49 (-2.98)	-$0.33	-$1.04
Monthly parking	-$1.21 (-2.08)		-$0.68 (-3.62)	-$0.49	-$1.36
Shared parking type					
Indoor lot[ɤ]	$0.32 (1.99)	$0.04 (2.78)	$0.20 (2.54)	$0.01	$0.41
Outdoor lot	-$0.91 (-2.19)	-$0.34 (-3.9)	-$0.67 (-2.08)	-$0.17	-$1.17
Lockup garage		$0.30 (2.02)	$0.13 (3.44)	$0.09	$0.39
Secured parking	$0.59 (1.83)		$0.34 (1.75)	$0.28	$0.65
Suitable for (car type)					
Motorbike [ɤ]	-$2.31 (2.11)	-$3.01 (2.89)	-$2.61 (2.81)	-$2.20	-$3.09
Small size vehicle		$0.59 (2.02)	$0.25 (3.39)	$0.22	$0.61
Medium sized vehicle	$1.46 (3.23)	$1.14 (3.84)	$1.32 (3.63)	$1.04	$1.61
SUV	$1.78 (2.33)	$0.75 (3.08)	$1.34 (2.02)	$0.67	$1.89
Van	-$0.92 (-1.84)	$0.53 (3.56)	-$0.3 (-1.81)	-$1.05	$0.30
Extra facilities					
CCTV	$1.68 (3.53)	$0.11 (2.1)	$1.01 (2.86)	$0.05	$1.74
Security gates	$1.24 (3.77)		$0.71 (3.46)	$0.68	$1.32
Restroom	$0.85 (3.84)	$0.16 (2.28)	$0.54 (3.44)	$0.09	$0.90
Security patrol	$1.35 (3.66)		$0.77 (3.65)	$0.64	$1.41
Car wash	$0.61 (2.83)		$0.35 (3.51)	$0.33	$0.69
Car Servicing		$0.06 (1.86)	$0.02 (2.14)	$0.01	$0.10
Access					
24 hours seven days a week [ɤ]	$0.83 (3.69)	$0.13 (2.77)	$0.53 (2.66)	$0.09	$0.91
Limited hours	-$0.82 (-3.73)	-$0.13 (-2.8)	-$0.52 (-2.7)	-$0.09	-$0.93
Walking time to destination					
Walking time	-$0.12 (-1.97)	-$0.09 (-3.35)	-$0.11 (-2.18)	-$0.07	-$0.15
Space availability					
7:30-6pm [ɤ]	-$1.48 (3.12)		-$0.84 (-2.34)	-$0.78	-$1.51
All day	$1.48 (3.09)		$0.85 (2.31)	$0.77	$1.52

Note: Elasticities are not informative for this model given that the alternatives are unlabelled.
The t-test values are shown in the parentheses.

5. Discussion

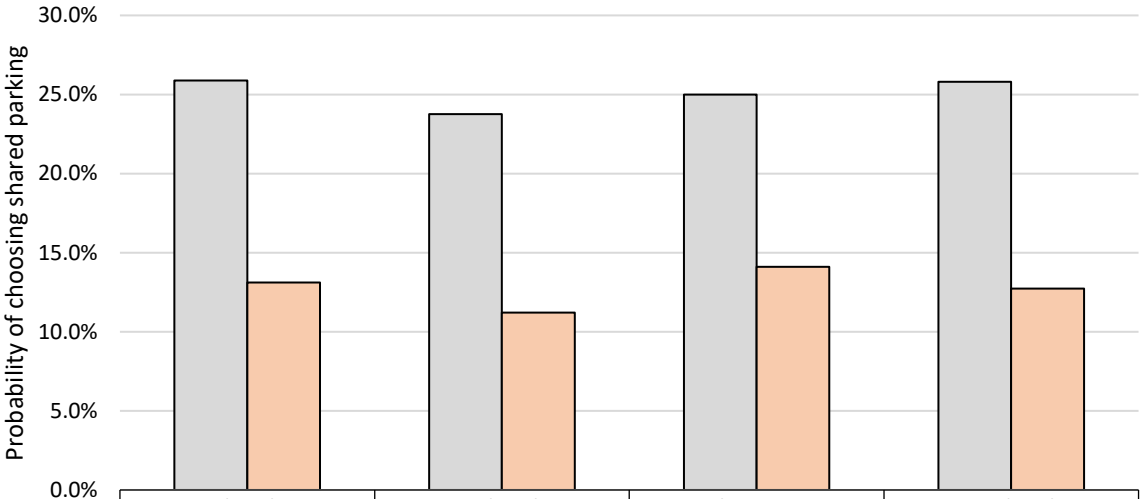
In this section we discuss how the probability of each segment of the model changes by a variation in one of the shared parking attributes used in this study. We use a sample enumeration to highlight the impact of this variation at the aggregate level. As stated in Train (2009), using sample enumeration is the most popular and straightforward method that the choice probabilities of each decision maker is summed or averaged over decision makers available in the sampled population. Results indicates that on average only 37.7% of the sample will choose shared parking as an option, out of which 25% are from members in class 1 and 12.7% are from class 2. Figure 2 reveals that while all other attributes are held in a fixed point, the "daily parking" option has the highest probability to be selected among all other shared parking plan types with a 40.1% chance of being chosen. The "monthly parking" option with only 36.1% has the lowest probability based on the aggregate results. Note that since none of the shared parking plan categories were significant for class 2 in our model, no change is observed in probability of accepting the shared parking between the plan categories for this class.



	Hourly parking	Daily parking	Weekly parking	Monthly parking
Class 1	25.9%	27.4%	23.8%	23.4%
Class 2	12.7%	12.7%	12.7%	12.7%

Figure 2: Probability of choosing a shared parking option for each segment of the sampled population based on different ***plan type***

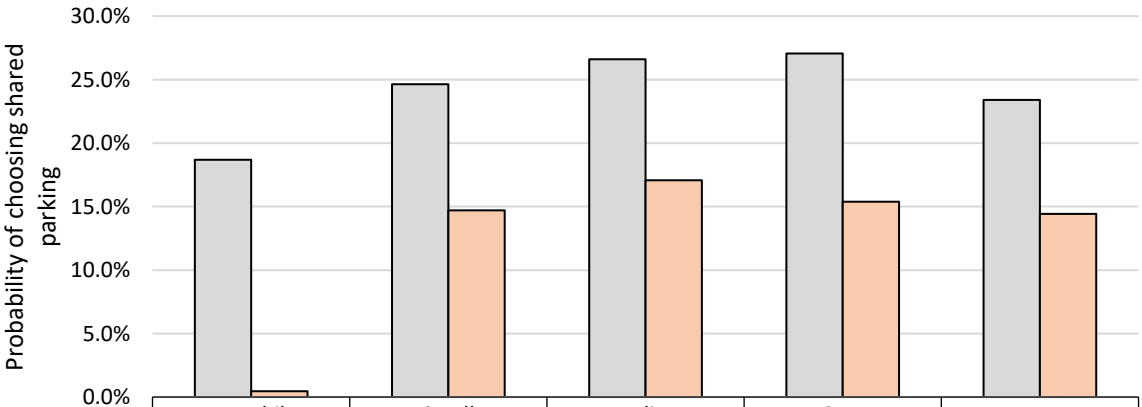
Looking at different parking type options, Figure 3 highlights that although class 1 are more likely to select secured parking type, however, on average among the two classes "lockup garage" with a probability of 39.1% is the most popular option. The outdoor lot feature reduces the probability of choosing the shared parking option by more than 4.1% to a low probability of 35% among all other parking type features.



	Indoor lot	Outdoor lot	Lockup garage	Secured parking
Class 1	25.9%	23.8%	25.0%	25.8%
Class 2	13.1%	11.2%	14.1%	12.7%

Figure 3: Probability of choosing a shared parking option for each segment of the sampled population based on different ***parking type***

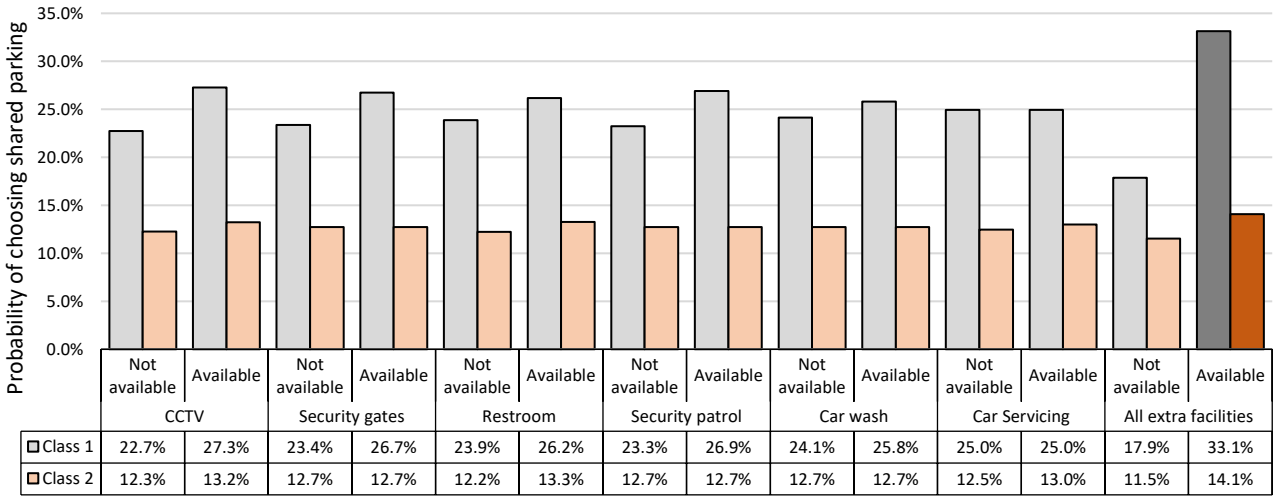
Figure 4 emphasizes that shared parking lot that are suitable for a medium or SUV vehicle are more likely to be selected although the former one has a slightly higher chance. A shared parking suitable for motorbike has by far the lowest likelihood to be selected as an option and reduces the probability from 43.7% for medium sized vehicle to 19.15% for motorbike. Parking type appropriate for small and van sized vehicles both have a probability of around 39.3% and 37.8% respectively. The message here is that decision makers and private lot owners need to recognize that demand for different sizes of parking exists although some more than others. The availability of a minimum numbers of each parking size can optimize resources and efficiently use the available land and space in the area.



	Motorbike	Small	Medium	SUV	Van
Class 1	18.7%	24.6%	26.6%	27.1%	23.4%
Class 2	0.5%	14.7%	17.1%	15.4%	14.4%

Figure 4: Probability of choosing a shared parking option for each segment of the sampled population based on different ***appropriate vehicle type***

Any extra facility can improve the probability of choosing a shared parking compared to not having the same facility, however as shown in Figure 5 each facility has different impact on the probability. Availability of CCTV as an extra feature has the highest impact on choosing a shared parking option. Whereas the availability of this extra facility can increase the probability of choosing the same parking without this facility by 5.51%. Security patrol is the second most popular extra facility feature where having this option can increase the probability of choosing a shared parking by 3.64% this is followed by security gates (3.36%), restroom (3.34%), carwash (1.66%) and finally car services (0.52%). Having all facilities can increase the probability of selecting the shared parking from 14.1% for when no extra facility is available to 33.1% for when all the facilities are available. These figures enable the shared parking providers to comprehend the impact of providing extra facilities and the associated costs for providing them. For example, having a CCTV available at a parking area can offset the negative impact of an increase in the egress time from 1 minute to 10 minutes or an increase in parking cost from $4.5 per hour to $7.5 per hour. Similar interpretations for other facilities are left for the readers to make.



	CCTV		Security gates		Restroom		Security patrol		Car wash		Car Servicing		All extra facilities	
	Not available	Available	Not available	Available	Not available	Available	Not available	Available	Not available	Available	Not available	Available	Not available	Available
Class 1	22.7%	27.3%	23.4%	26.7%	23.9%	26.2%	23.3%	26.9%	24.1%	25.8%	25.0%	25.0%	17.9%	33.1%
Class 2	12.3%	13.2%	12.7%	12.7%	12.2%	13.3%	12.7%	12.7%	12.7%	12.7%	12.5%	13.0%	11.5%	14.1%

Figure 5: Probability of choosing a shared parking option for each segment of the sampled population based on different ***extra facility options***

A very similar behaviour can be observed in Figure 6 where it looks at the probability of choosing a shared parking option for each segment of the sampled population based on different accessibility and space availability options. Having a full access to the parking area increases the probability by 3.45% from an aggregate value of 36.8% for both classes when access is limited to 40.2% when 24 hours/seven days a week access is offered. For the parking space availability this jump is even higher and goes from a probability of 35.4% for the option of having access only between 7:30am - 6pm to 41.5% for when the parking area is available all day.

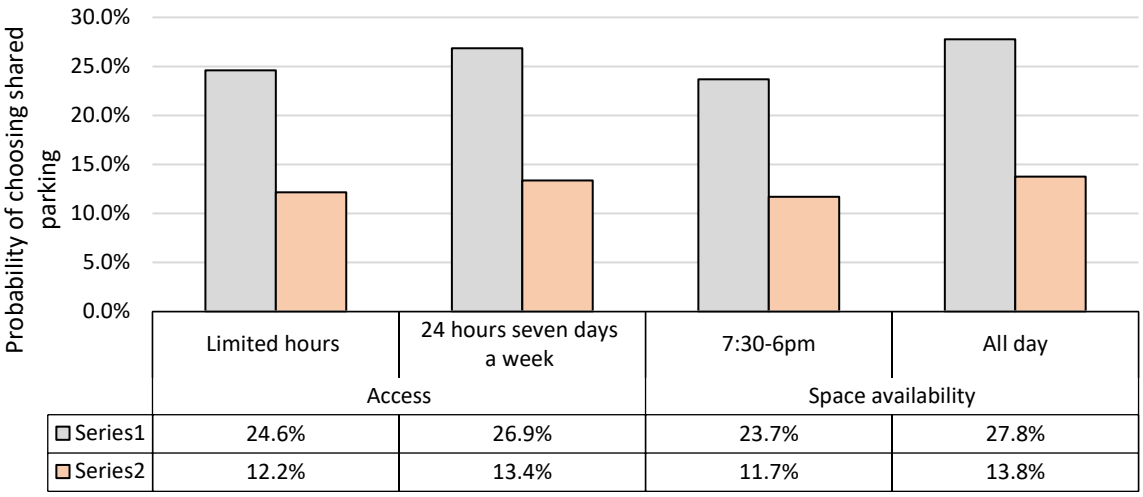


Figure 6: Probability of choosing a shared parking option for each segment of the sampled population based on different ***accessibility and space availability options***

Figure 7 presents the probability trend for when the walking distance between the shared parking space and the designated destination is varied from 1-minute up to 20 minutes. It shows that people belonging to class 1 show greater sensitivity to an increase in the walking distance. On the aggregate level, the probability of selecting the shared parking which is in a 1-minute walking time distance to the destination is around 39% whereas when it's a 20 minutes' walk its around 28.4%. This is consistent outcome as parking demand studies have consistently stated that drivers have a strong tendency to park at places very closes to the destination (Inci, 2015, Yan et al., 2019). Knowing the effect of egress time on parking decisions can be quite useful information for authorities when considering pricing strategies. Any price hikes can be offset by lowering egress time which can help to balance between enforcing policy and maintaining equity.

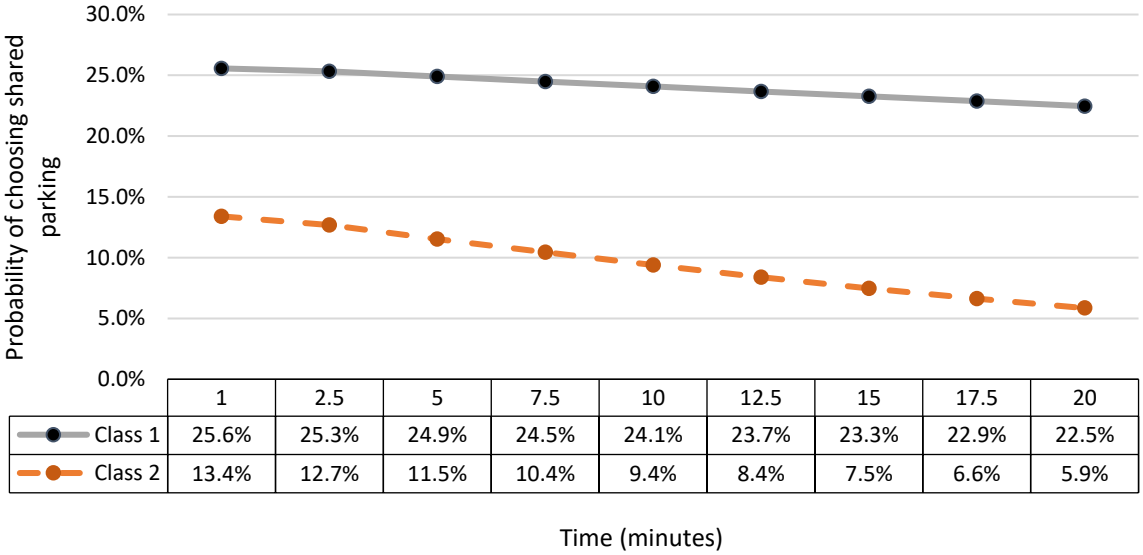
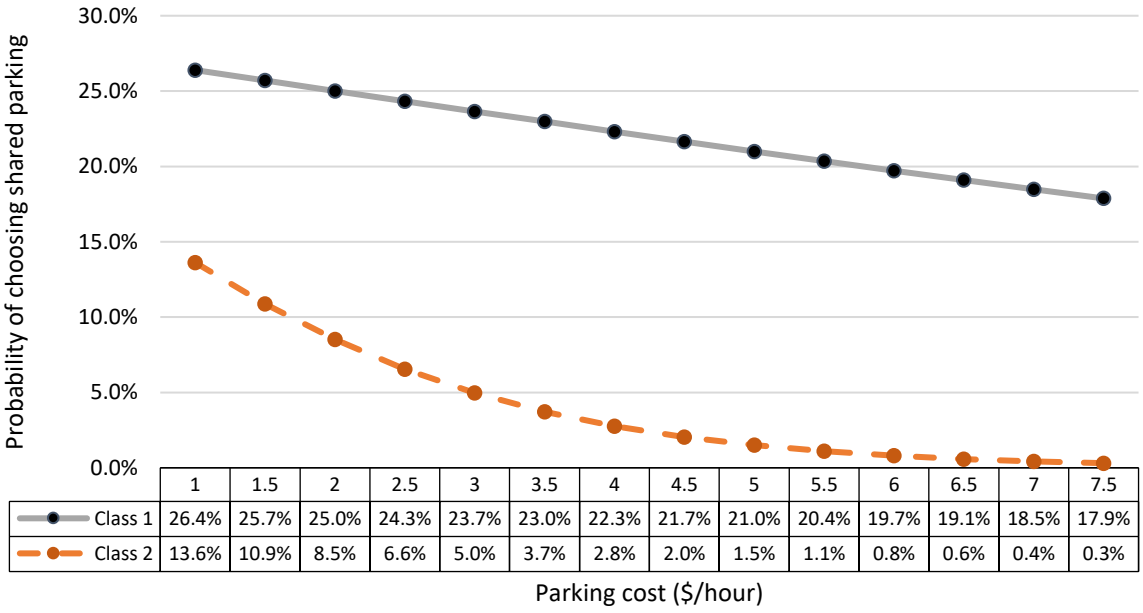


Figure 7: Probability of choosing a shared parking option for each segment of the sampled population based on different ***walking to destination duration***

Finally, Figure 8 presents the impact of an increase in the parking cost per hour. The figure highlights that people who are more likely to belong to class 2 are much more sensitive to the parking cost attribute whereas at a cost around $6 per hour, the probability of selecting the shared parking option is less than 1%. At a very low rate of $1 per hour, the probability can reach the highest aggregate value for both classes at around 40% whereas in the highest end of spectrum for a parking cost at $7.5 per hour almost 18.2% are likely to select this option.

The variation in the probability of choosing a shared parking due to an increase in the cost presented in Figure 8 highlights the fact that pricing and cost of parking is the single most impactful attribute which can alter parking behaviour. Yan et al. (2019) explain why cost is the most effective attribute for two reasons. First, individuals are highly sensitive to parking cost, and second other parking attributes have much less room for change compared to parking price.

As highlighted in parking studies (such as Yan et al., 2019, Piccioni et al., 2019, dell'Olio et al., 2019) variation in parking price can assist with policy makers decision to help balance the demand of parking and enable a higher revenue stream for private business owners as well as the local governments that could be used to improve local communities. It can also prevent unwanted parkers in the local area. Such behavioural approaches, especially in urban areas, dramatically impacts the safety of the area as well as the accessibility for all road users.



	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5
Class 1	26.4%	25.7%	25.0%	24.3%	23.7%	23.0%	22.3%	21.7%	21.0%	20.4%	19.7%	19.1%	18.5%	17.9%
Class 2	13.6%	10.9%	8.5%	6.6%	5.0%	3.7%	2.8%	2.0%	1.5%	1.1%	0.8%	0.6%	0.4%	0.3%

Figure 8: Probability of choosing a shared parking option for each segment of the sampled population based on different ***parking cost per hour***

Based on the information discussed in this section a final scenario was run in which a shared parking option based on the most suitable options for each alternative was selected. This shared parking option had a daily plan option in a locked-up garage which was suitable for an medium sized vehicle. All the extra facilities were available, and it offers full access to the car

park and the space is available for the entire day located at a 5-minute walking distance from the destination at an average value of $4.25 per hour. The results indicate that almost 2 out of 5 people (probability of 45%) will more likely select this option for their parking arrangement. These results can provide a clear indication to parking management and policy makers that shared parking can act as a complement to public parking and facilitated the existing gap in the excessive demand for parking and the inadequate supply of parking space (e.g., CBD) up to almost 45% in best case scenario.

6. Conclusion

The shared economy is facing a rapid growth due to its significant benefits and opportunities that may bring to the economy of dense urban areas. The sharing economy is continuing to expand and create new opportunities and marketplaces. Transport services are one of the main industries that keeps on getting better due to the sharing economy and one area that is becoming popular in transport services includes renting out residential parking spaces. This is an alternative to building new parking facilities, which is less cost and time effective, while shared parking promises a cost-efficient alternative as it improves traffic condition and optimizes resources. This study explored how individuals evaluate different shared parking features when considering choosing the shared parking option and contributes to the literature by providing firsthand insights into the demand for shared parking and its different features.

This article used a latent class model to accommodate preference heterogeneity and probabilistically segmented respondents in two classes to be homogeneous within and heterogeneous across classes based on individual characteristics and their predisposition towards different features of the shared parking. WTP values were estimated and reported for different features of the shared parking.

The current study has numerous critical policy implications that can be transmissible to different contexts. First, pricing persists to be the sole most effective parking policy. Second, the significance of egress time suggests that strategies that alter egress time can be effective policy tools when the authorities like to enforce pricing policy and maintaining equity. Thus, pondering on the substantial synergies among pricing and policies that reduce egress time, parking strategies it is recommended that policies to be implemented as a policy bundle. Third, non-price-related attributes also have a moderate impact on parking decisions and providing these additional drivers enable decision makers to comply and make more informative decision when it comes to different pricing schemes. Finally, shared parking in NSW can play a significant role in accommodating the surplus arising from the excessive parking demand and inadequate supply or help distributing the over-concentration parking demand up to almost 45% of demand in best case scenario.

Undoubtedly there is a dearth of parking studies in the transportation literature regardless of the fact that cars are parked 95% of the times and considerable amount of land and space are used for parking. The focus of many studies in this area has been related to cars when they are in motion rather than when they are parked. The current study adds to current parking

behaviour literature from two main viewpoints. First, the existing studies of parking choice behaviour have largely focused on on-street and off-street parking whereas very limited studies have looked at the shared parking option. Second, unlike many studies which solely focus on the cost of parking, search time and egress time this study also gives attention to non-price-related variables such as plan duration, parking type and space, availability of extra facilities, availability and accessibility of the parking and walking time to destination. Therefore, this research can help discover new applicable dimensions of parking decisions and their interaction, which can expand the parking-behaviour research and policies it endorses in other areas. Using the result from this study enables the private sector to work with the governing authorities to develop shared parking schemes that pivot on incentivisation towards active and public transport options.

The research has only illustrated the parking behaviour for shared parking, however, the future research can also include other types of parking such as on and off-street parking and explore the decisions in this vein. Future research could also look at incorporating additional information in the study such the impacts of a weekly and monthly pass or the effect of peak-hour/off-peak-hour time on respondents' sensitivity to shared parking pricing. Furthermore, in relation to promoting shared parking, it seems that another issue which should be considered by the government is the effect of this type of parking on the travellers' mode choice. In other words, improvement of parking accessibility would increase the use of private vehicles and can lead to a more congested road network in some zones of the city. Therefore, it needs a deliberate analysis of the implications of shared parking promotion policy to nominate the permitted zones and forbidden regions of the city for this scheme. Furthermore, the space owners do play a very vital role in the success of shared parking and this research can further be developed to incorporate the complexity of shared parking with many potential suppliers or users having overlapping needs. One aspect of parking that is dismissed in this study facility pertains to availability of charging facilities at the parking locations. Given the small share of EVs in Australia we dropped this attribute from the study while it can be considered in case EVs are considered. Further, the location of the parking could be included in the design of the survey which is left as another direction for expanding the scope of the work.

The current technology advancement in remote controlling has enabled gathering real time data related to the parking spaces available throughout the city. This has started to significantly grow the use of shared parking services. Transportation and infrastructure sectors will benefit from the shared economy and services such as shared parking and shared vehicles to better address the congestion issue and traffic flow as well as appropriately manage the utilisation of urban spaces.

Acknowledgment:

The paper includes an acknowledgement that the project has been partially funded by the Smart Cities and Suburbs Program though the Integrated Smart Parking System: Emerging and Shared Approaches project (SCS69276). The authors also like to acknowledge the support

from Rebecca Jacobs and her team from Randwick city Council as well as Alex Peck from Baseup.

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