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Planning and Transport Research Centre (PATREC)

REPORT

Part Four: Factors affecting travel behaviour choice Survey Pilot Results

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To Share or Not to Share: A Best-Worst Analysis of Peer-to-Peer Car-Sharing in an Autonomous Future

Background and Motivation

The high costs of motor vehicle ownership combined with the fact that many people only require occasional access to a vehicle, has generated interest in alternate options for accessing the convenience of car travel. One increasingly popular option is that of car-sharing (car clubs in the UK), whereby people rent cars for short periods of time either through a formal company (e.g., Go-Get in Australia, Zipcar in the U.S.), public agency or peer-to-peer arrangement (e.g., Car-Next-Door in Australia, Getaround in the U.S.). Car-sharing has already been embraced with recent analysis suggesting 5.8 million people worldwide were members of formal car-sharing organisations in 2016, a number projected to rise to 35 million by 2021 (Bert et al. 2016). This has been associated with an increase in the shared vehicle fleet from 86,000 to 550,000 over the same period and it is predicted that by 2030, 1 in 10 new cars sold will likely be used as a shared vehicle (McKinsey & Company 2016). These broad indicators belie evidence-to-date that suggests despite the potential for monetary gain, the majority of the driving public is cautious about forgoing their private vehicle and joining a commercially operated car-share scheme as a user or about sharing out their own vehicle to a stranger. For instance, recent evidence from San Fransisco/Oakland indicated only 25% of the population would be willing to rent out their vehicle in a peer-to-peer arrangement (Ballús-Armet et al., 2014) citing deterrents such as reliability, trust of the driver and concerns about not having the car available when they needed it. The topic of this study is car owners' willingness to share their vehicles on a peer-to-peer platform.

Against this backdrop, following various ongoing trials, autonomous vehicles (AVs) are anticipated to become an increasingly significant component of the fleet in the coming decades. AVs will likely open up additional opportunities in the vehicle sharing space largely because a driver is no longer required and the vehicle can conceivably operate for profit anytime the owner does not need it themselves. Given the average vehicle spends 23 out of 24 hours parked this is clearly a large opportunity cost that could be realised. Questions remain however as to whether consumers will embrace AVs and whether this could change the landscape in terms of willingness to share their vehicles as (arguably) many of the barriers are lowered although many admittedly remain.

With this in mind, the current paper presents findings from a survey of 700 Australians[1] designed to ascertain preferences for sharing their own vehicle through a peer-to-peer arrangement for financial reward might change in an autonomous future. A set of hypothetical games, employing a best-worst design, was used to establish willingness to share (WTS) of their current vehicle under the premise it is driven to work and available for short-term rental as an alternative to leaving it parked. Participants are required to trade-off the inconvenience and cost of parking versus the potential to gain financial reward moderated by factors such as the chance of the vehicle being returned late and the 'renter rating' of the driver[2]. The experiments are then repeated assuming the vehicle is fully driverless. The survey also collects general attitudes on vehicle-sharing and automation, which together with demographic, current travel characteristics and a 60-item personality profile provide an opportunity to investigate how these

[1] At the time of writing the abstract the online survey is still in the field. At this time there are 718 respondents, but the research team have not analysed the choice data. This abstract makes use of the 718 respondents' attitudinal data and personality profiles. The choice models reported here are based on a pilot survey of 50 respondents.

[2] The choice cards present the cost of parking is presented as a 'price' to reflect the market experience. Profits from sharing may vary due to demand and are presented these an expected or average daily profit. The choice experiment approach is preferred to a contingent valuation method because the preference results are more likely to be stable across tasks and the WTP for each attribute can be measured (Adamowicz, Boxall, Williams, et al. 1998)

exogenous factors impact WTS. The remainder of this extended abstract details the methodological approach used, followed by some preliminary results from them main survey and choice models based on the pilot study completed in July, 2017. Results from the main survey, completed in November 2017, will be fully incorporated into the final paper.

Methods and Data Collection

A web-based survey was designed in Qualtrics (http://uwa.qualtrics.com/jfe/form/SV_cuvpznJL0mhjwIR) with two discrete choice experiments aimed to determine early-market empirical estimates of the parameters that characterise current preferences for sharing vehicle (particularly AVs) in the context of commuting. The scenario offered to respondents was to imagine that a commercial provider introduced a car-sharing scheme near their workplace, and the respondents have the opportunity to join if they are willing, by renting out their vehicle to other members of the scheme during work time.

The first discrete choice experiment (Figure 1) asked respondents about sharing the current vehicle used for the journey to work or to nominate a second household vehicle. Participants were presented with four scenarios comprising two parking/non-renting options and two renting options and asked to select their most and least preferred. The experiment contained the following attributes:

- Parking cost for the vehicle that is not rented out;
- Parking distance (location from the workplace) for all options;
- For the rented out options:
    - Profit, expressed as amount of money received after subtracting running costs (including fuel, maintenance, wear and tear);
    - A maximum booking time allowed for renting the car;
    - Chance that the rented car is delayed due to congestion or late return;
    - Guaranteed renter rating from the commercial provider's records.

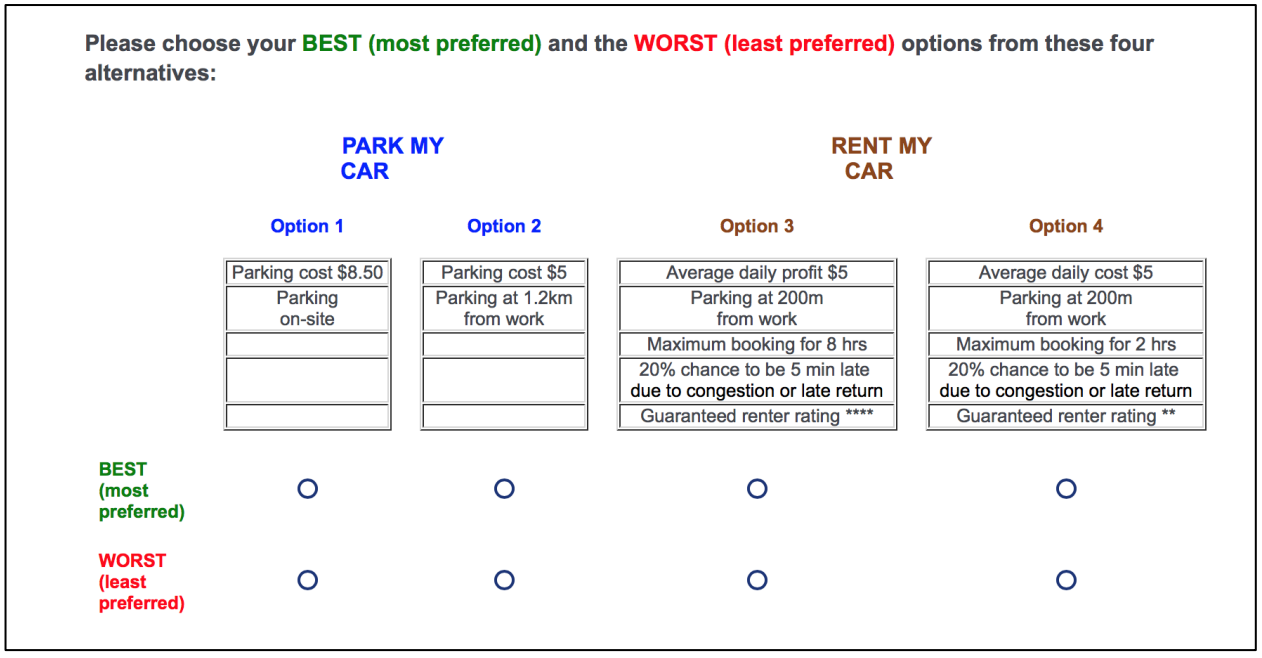

Figure 1: Example choice task for renting out current vehicle

The second experiment (Figure 2) asked respondents to imagine their commute in a fully autonomous car, which had a similar condition and value to their current car. Two options were possible: leaving

the AV to drive itself to a parking location, or again, renting it out for others to use. Regardless of the two options, the AV does the drop-offs and pick-ups from the workplace.

Renting out an AV had the same features as renting out current cars, except for the parking distance from work, which became the duration required for the AV to arrive at the user's workplace. The daily net parking cost also included the cost of the car travelling each direction between workplace and the parking location.

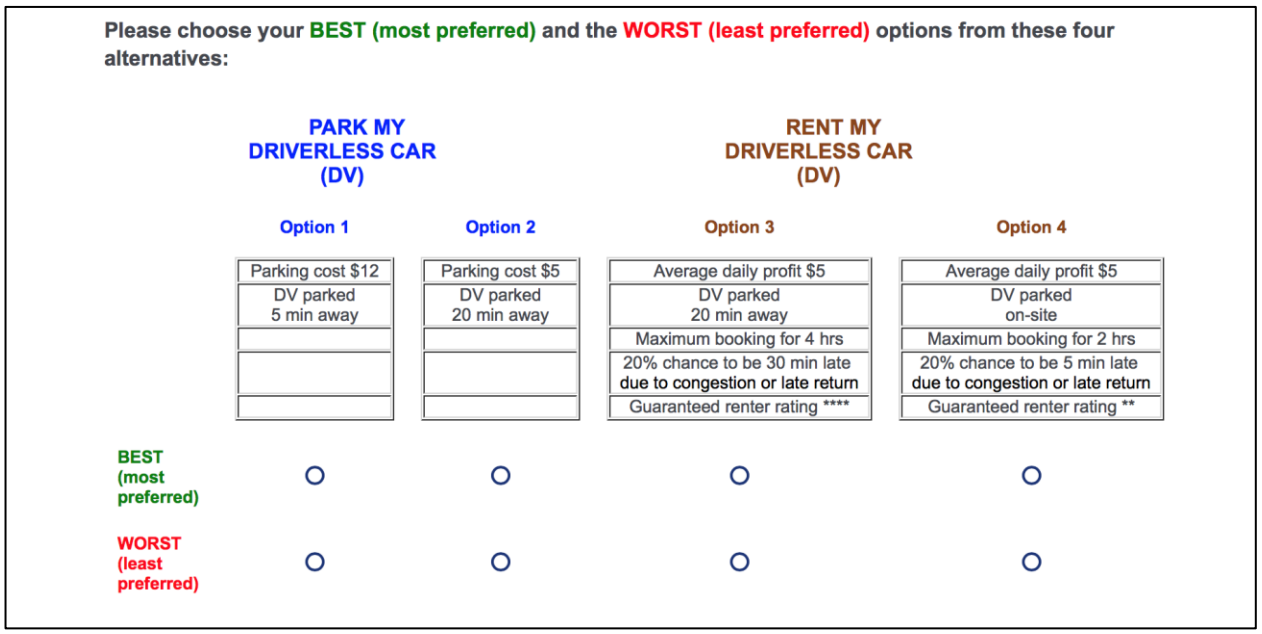

Figure 2: Example experiment renting out AV

Respondents received four scenarios for each situation (current car and future AV car), including two parking and two renting out alternatives, and they were asked to choose their most and least preferred alternatives. The scenarios were randomly chosen from sets of 12 experiments, optimised for min Dp, using a GA algorithm (Olaru et al. 2011).

Attitudes and personality profiles

The survey also included data on respondents' commuting patterns, attitudes towards AVs and towards sharing their own car. Respondents also rated perceived enablers and barriers to adoption of new technologies in the context of sharing their vehicle or owning an AV. The survey was able to take advantage of a broader study into consumer behaviour and access responses to a 60-item Big Five personality scale.

Confirmatory factor analysis (CFA) was applied to understand and summarise the attitudinal data and psychometric constructs of personality (openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism). In this abstract we report MANOVA results, exploring whether there are differences in personality constructs between groups based on respondents' willingness to adopt new technologies – AVs and car-sharing.

The choice models presented here are for a small sample used to test the experimental design and survey instrument. We report two latent class models: one each for sharing their current car and for sharing an AV in the future. The latent classes strengthen our original supposition that one class is averse to sharing, but if a good service is offered they may consider this option. The other class

considers the day-to-day economics of the alternatives and chooses on profit and convenience. In a later version of this paper we will be able to make use of the attitudes and profiles of respondents to uncover associations with class membership.

Results

A panel sample of 718 respondents from Australia (Sydney and Perth), all with driving licences, provided complete responses to the attitudinal and personality questions. The average duration of completion was 20.7 min. The sample included 55% males, 51% of the respondents had a bachelor degree or above, and 49.7% were full-time employees. On average, respondents had commutes of 26.7 min and access to 2.6 cars for daily use. Only 16% mentioned constraints when choosing their travel mode (e.g., chores to be undertaken after work). When asked directly, only one in four respondents stated they were likely to share their current vehicle (similar to the previously cited study from San Francisco) and one in three stated they would purchase an AV if it was available by 2025.

Table 1 offers descriptive statistics for several attitudinal/opinion taken from a review of sharing and technology adoption literature[3] and an inventory of personality items (Costa and Macrae 1992).

Table 1: Sample descriptive statistics

Construct	Indicator	Max	Mean	Std. Dev.
Outcomes of AV adoption	… safer roads	5	3.36	1.183
	… less congestion	5	3.37	1.112
	... quicker travel	5	3.26	1.143
	… lower emissions	5	3.26	1.093
	… lower insurance costs	5	3.38	1.162
	… lower vehicle ownership	5	3.33	1.167
Barriers for AV adoption	… safety	4	2.81	0.967
	… hacking of the system	4	2.84	0.85
	… liability and insurance	4	2.71	0.95
	… loss of pleasure from driving	4	2.66	1.157
Reasons for car sharing	A way to earn extra income	7	4.55	1.879
	Good for the environment	7	4.78	1.75
	Better than having it sitting doing nothing	7	4.62	1.855
	Providing access to a car for those who don't have one	7	4.32	1.802
	Allows me to belong to a group of people with similar interests	7	3.59	1.964
Deterrents for sharing the car	Reputation of the car-sharing company	7	5.26	1.633
	Liability in the case of an accident	7	5.88	1.423
	Having a stranger drive my vehicle	7	5.25	1.746
	Knowing the car is there when I need it	7	5.47	1.667
	Concern my vehicle is too unreliable for renting to others	7	4.00	2.147
Personality traits (Big Five	Extraversion	5	2.99	0.654
	Agreeableness	5	3.68	0.603

[3] Due to space the literature is not summarised here. We will report the literature review in the main paper.

Construct	Indicator	Max	Mean	Std. Dev.
BF)*	Conscientiousness	5	3.80	0.662
	Openness	5	3.37	0.646
	Neuroticism	5	2.89	0.792

Note: *The BF scale has 60 items, so we report here only the factors scores obtained from summarising the data.

A confirmatory factor analysis established the anticipated uni-dimensional constructs for: 1) perceived AV benefits (73.16% of the variance explained); 2) perceived AV barriers/concerns (64.11% explained variance); 3) motivations for car sharing (65.74%); 4) deterrents for car sharing (59.78%); 5) the big five personality traits (min 40.5% variance explained for each construct).

Correlational analysis indicates positive significant associations between benefits of AV, motivations for sharing, reported WTS, and a few personality traits. Specifically, Openness (indicative of adventure, unusual ideas, curiosity, and variety of experience) and Conscientiousness (tendency to be organised and show self-discipline, act dutifully and responsibly) had significant correlations with respondent's attitudes towards AVs and willingness to purchase an AV.

Agreeableness, Conscientiousness, and Openness have higher scores for those respondents who are more willing to share their car or to purchase an AV (Table 2). A test of differences (MANOVA) between the groups indicated – albeit marginal – differences in personality scales based on grouping for likelihood to purchase an AV (p=0.055) and willingness to share (p=0.098). The results in Table 2 highlight the potential to use personality profiles to help explain latent class memberships in the stated choice models.

Table 2: Big Five Personality Factor Scores

Personality factor score	Group	Likelihood to purchase an AV		WTS their current car	
		Mean	Std. Dev.	Mean	Std. Dev.
Extraversion	No	3.01	0.63	3.09	0.62
	Yes	*2.92*	*0.68*	*2.96*	*0.65*
Agreeableness	No	3.60	0.61	3.60	0.59
	Yes	*3.74*	*0.58*	*3.69*	*0.60*
Conscientiousness	No	3.76	0.72	3.69	0.60
	Yes	*3.81*	*0.64*	*3.77*	*0.70*
Openness	No	3.35	0.65	3.34	0.61
	Yes	*3.43*	*0.65*	*3.39*	*0.66*
Neuroticism	No	2.92	0.77	2.97	0.70
	Yes	*2.80*	*0.83*	*2.87*	*0.81*

Choice Models

Preliminary results of the discrete choice models show that service attributes including parking cost/profit, parking time/distance, renter rating, as well as positive attitudes towards AV and personality traits may be critical determinants of the use of AVs and the acceptance of sharing. The pilot survey included an attribute for undercover parking or on street parking, but parameter estimates were insignificant across all model specifications. It was decided not include the attribute in the main survey and, therefore, estimates are not reported here. An initial sample of 52 was whittled down to 44 useable responses (primarily judged by shorter than expected completion times). The best-worst choice

data looks promising (models on worst choice data had strong fits), but the choice models presented here are on *best* only choice data.

Two models are reported: a latent class (LCM) model for car-sharing the current vehicle and another for sharing a hypothetical AV that respondents may own sometime in the future. The motivation is to provide an evidence base for consumer choice models around the context of AVs, which is likely to open up additional opportunities in the vehicle sharing space. The course of inquiry was to see if the parameter estimates would change or be somewhat stable over the two choice contexts. While we are measuring consumers' early expectations, the modelling approach aims to measure if taking the driver out of the equation allows vehicle owners to be more open to sharing their vehicle. Admittedly, the models are made under the assumption that individuals still own cars in the future, but this does represent one conceivable way that AVs may enter the market (Sun et al., 2017).

Table 3 reports the choice estimates for the car-sharing context (on the left) and AV sharing (on the right). For both contexts a dominant class 1 (approximately 66%) is open to the possibility of sharing, but do weigh up the cost or profit of the alternative against the 'quality of the provider', as measured by the sharing attributes. There is a smaller class 2 that predominantly chooses to not share. The parameter estimates for this class should be interpreted with caution. For the AV sharing model, all sharing attributes have non-significant attributes. Whereas the attributes of 20% chance of being late and rating are significant, this may be due to some respondents that do choose across the parking and sharing, exhibiting price sensitivities that are more like class 2. We expect that the larger data set will allow a better specification of the latent class models that allow estimates of heterogeneity in the class membership function related to attitudes and personality profiles.

Table 3: Choice estimates for current car-sharing and AV sharing

Attribute	Car-Sharing (Current Car)		Car-Sharing (AV)	
	Parameter	**p-value**	**Parameter**	**p-value**
Dominant Class – Open to the idea of sharing				
Walking distance (m)[4]	-0.063	0.014	-0.024	0.081
Profit ($5, $8.50, $12), or Cost (-$5, -$8.50, -$12) per day	0.073	0.009	0.053	0.088
20% chance of being (5, 15 35) min late	-0.045	0.012	-0.064	0.007
Minimum renter star (0, **, ****) rating	0.289	0.002	0.769	0.000
Maximum (2hr, 4hr, 8hr) booking time	Did not fit		-0.440	0.000
Smaller Class – Strong preference for Not sharing				
Walking distance (m)	-0.013	0.710	-0.234	0.009
Profit ($5, $8.50, $12), or Cost (-$5, -$8.50, -$12) per day	0.123	0.031	0.327	0.025
20% chance of being (5, 15 35) min late	-1.216	0.050	-0.052	0.354
Minimum renter star (0, **, ****) rating	1.206	0.116	0.566	0.234
Maximum (2hr, 4hr, 8hr) booking time	Did not fit		-0.020	0.936
	Class Probability		Class Probability	
Prob Class l	0.621		0.670	
Prob Class 2	0.379		0.330	

Conclusions

The paper investigates the propensity of car owners to share their vehicle though a peer-to-peer car-sharing set-up. The subject of the inquiry is from the perspective of the car owner (lender), rather than the car-sharing consumer (borrower) and the aim is to assess whether removing the driver from the sharing model allow people to feel more comfortable about sharing their property. An additional dimension here is the inclusion of personality traits, in addition to attitudes and perceptions about sharing their cars and about AVs. Thus, this study brings together utilitarian (spatial, costing, chance of being late) and cognitive aspects of car ownership and sharing behaviour, as well as socio-psychological factors that may affect willingness to share AVs in the future.

Preliminary analyses suggest that personality profiles may underlie the propensity to share. The choice model results (whilst being limited by a small sample) indicate that the class of respondents may well be stable over the two choice contexts. Consumers who are unwilling to share their current vehicle, do not seem to be more open to sharing in a future where cars are autonomous. In itself this is an interesting finding as it suggests the deterrents to renting out a private vehicle to a stranger still dominate even with the removal of the driver element.

A final paper will based on a much larger sample (we anticipate 800+) that will allow mixing of attitudinal, personality and choice data through the use of a hybrid latent class models. We expect to publish this early next year.

[4] AV waiting time was converted to the time to walk at a rate of 1.4km.

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