WORKING PAPER

ITLS-WP-19-01

Mode-agnostic mobility contracts: identifying broker/aggregator models for delivering mobility as a service (MaaS)

By
Yale Z. Wong, David A. Hensher and Corinne Mulley

Institute of Transport and Logistics Studies (ITLS),
The University of Sydney Business School, Australia

January 2019

ISSN 1832-570X

INSTITUTE of TRANSPORT and LOGISTICS STUDIES

The Australian Key Centre in
Transport and Logistics Management

The University of Sydney

Established under the Australian Research Council's Key Centre Program.

NUMBER: Working Paper ITLS-WP-19-01

TITLE: **Mode-agnostic mobility contracts: identifying broker /aggregator models for delivering mobility as a service (MaaS)**

ABSTRACT: Mobility as a service (MaaS) promises a bold new future where bundled public transport and shared mobility options will provide consumers with seamless mobility on par with and exceeding that of private vehicle ownership. Whilst there is a growing body of work examining the market and end user demand for MaaS, there remains a limited understanding of the supply-side around new business models for delivering these integrated mobility services. Mobility broker/aggregator models have been proposed, but to date there exists no quantitative evidence to empirically test the conditions around which interested businesses might invest or supply in this new entrepreneurial model. In this paper, we propose the idea of mode-agnostic mobility contracts as the interface for bringing together specialised businesses as part of the new MaaS ecosystem. We identify the relevant attributes and attribute levels defining these contracts through an extensive interview and participatory research program with key stakeholders including MaaS operators, conventional transport operators, public transport authorities and consultancies, with a focus in the Nordic countries where such schemes are presently well advanced. These mobility contracts were then incorporated as part of a stated choice survey, and we document the face-to-face pilot used to finesse the survey instrument prior to the main survey. A preliminary mixed logit choice model based on collected data (n=202) is presented to showcase the potential of our stated preference survey to reveal what the market is willing to deliver in terms of MaaS and how the future service delivery ecosystem might look.

KEY WORDS: ***Mobility as a service (MaaS), Intelligent mobility, Service delivery, Broker/aggregator, Public transport contract, Stated choice experiment, Willingness-to-pay***

AUTHORS: **Wong, Hensher and Mulley**

Acknowledgements: This paper contributes to the research program of the Volvo Research and Educational Foundations Bus Rapid Transit (BRT+) Centre of Excellence. We acknowledge the Foundation for funding support. Edward Wei (ITLS) programmed our survey instrument. We thank Thredbo 15 participants in Workshop 7 and the many experts and business leaders who

agreed to be interviewed to inform the design of our mobility contracts and help finesse our survey instrument.

CONTACT:

INSTITUTE OF TRANSPORT AND LOGISTICS STUDIES (H73)

The Australian Key Centre in Transport and Logistics Management

The University of Sydney NSW 2006 Australia

Telephone: +612 9114 1824

E-mail: business.itlsinfo@sydney.edu.au

Internet: http://sydney.edu.au/business/itls

DATE: January 2019

1. INTRODUCTION

In recent years, a burgeoning literature has emerged on the mobility as a service (MaaS) concept—a popular interpretation of future collaborative and connected urban transportation, centred on a changing society embracing a sharing culture which can satisfy our mobility needs without owning assets such as a car. MaaS emerges because of opportunities afforded by digital information platforms to plan and deliver multimodal mobility options in point-to-point trips and/or first-and-last mile travel to public transport journeys. MaaS packages will provide consumers with seamless mobility options with integrated payments through a single application in much the same way as unified mobile plans provide users with a choice of calls, text and data options.

The premise for MaaS is to transform mobility based on asset ownership (usually, in the form of a private vehicle) to one where it may be consumed *as a service*. Central to this proposition is the move from outright purchase of mobility provision to a subscription-based model with a higher marginal cost of consumption, as compared with vehicle ownership where much of the cost is borne initially upfront and thereby regarded as 'sunk'. Accompanying this challenge of acceptance is the public's ideological attachment towards cars (*1*), but changing demographics offer encouraging signs for (at least in the younger generation in the West) embracing this cultural shift. Already, some versions of MaaS have been implemented, with UbiGo in Gothenburg and Whim in Helsinki (now also Birmingham) as promient examples, and core characteristics of MaaS schemes also beginning to be defined (*2; 3*).

The design and implementation of MaaS may be related to the *three Bs* "budgets, bundles and brokers" initially proposed in Hensher (*4*: 91*)*. **Bundles** relate to mobility packages which customers purchase, granting them a defined volume of access to each included mode (usually quantified by kilometres, hours or a percentage discount). Stated choice studies on end user preferences for bundled mobility products have thus far been conducted in London (*5*), Sydney (*6*), Newcastle upon Tyne (ITLS, forthcoming), as well as in work commissioned by industry bodies and consultancies as a way of revealing potential user preferences. Market testing MaaS is related to the **budgets** concept in terms of the need to elucidate the preferences of all stakeholders including demanders and suppliers in the MaaS supply chain. Far less work has to date been undertaken on the supply-side, particularly around potential business models and the likely emergence of mobility **brokers** (also known as aggregators) which bring together specialised businesses and value-add by offering that integrative function. Brokers form the conduit for connecting demanders of transport service and suppliers of the transport asset/capacity by facilitating the delivery of physical transportation (*7*).

In this paper, we focus on the *second and third Bs* in terms of mobility brokers and the budgets (preferences) of suppliers by identifying the conditions around which interested businesses might invest or supply in the MaaS entrepreneurial model. An empirical program of work based on interviews and participatory research helps inform the candidate attributes for inclusion in business investment utility models we are developing for MaaS. Our qualitative research focuses on key stakeholders including MaaS operators, conventional transport operators, public transport authorities and consultancies, especially those in Sweden and Finland where such schemes are presently well advanced. Through this, mobility contracts are designed and incorporated as part of a stated choice experiment to test supplier buy-in to the entrepreneurial model or broker interface for delivering MaaS. A face-to-face pilot with experts and industry stakeholders is then undertaken to finesse the survey instrument.

Preliminary results based on data collected to date are then presented. MaaS as a concept is moving fast, but we believe we have begun the first formalised study to test some of the ideas behind service delivery—this paper presents our starting position on the journey to fill this important research gap.

The remainder of this paper is structured as follows. Section 2 introduces our framework for the MaaS ecosystem, including brokers and the idea of mode-agnostic mobility contracts. Section 3 presents the method used to help us design these contracts and test our survey instrument. Section 4 discusses candidate attributes like how modal mix, risk and return, business size and equity contribution, branding and government support might influence respondents' propensity to invest/supply in these new business models. Following this, Section 5 presents the experimental design, including decisions around the sampling frame and what respondent characteristics or contextual variables to collect. Initial results are presented in Section 6 by applying a mixed logit choice model on data collected thus far. Section 7 concludes and describes next steps in our effort to identify the structure of mobility broker models for delivering MaaS.

2. DELIVERING MOBLITY AS A SERVICE

A number of service delivery models have been proposed for MaaS, with a range of different actors and varying degrees of government involvement. We propose a likely model based on mobility brokers/aggregators and defined by mode-agnostic mobility contracts which form the basis for this study.

2.1 Defining the broker: New business models

To date, fully-fledged MaaS brokers/aggregators remain few and far in between. Part of the reason is because the design and institutionalisation of such business model is particularly demanding given that innovations occur outside the exclusive control of traditional firm boundaries (*8*). Romanyuk (*9)* argues that MaaS is not a traditional business model but rather a networked business model co-created in a network of actors where the development process is continuous and iterative by nature. Kamargianni and Matyas (*10)* propose seven candidate actors including transport operators, data providers, technology and platform providers, information and communication technology infrastructure, insurance companies, regulatory organisations and universities/research institutions. Government is an active player amongst these actors which even as an interface magnifies the aggregation challenge. In their work, Kamargianni and Matyas (*10)* advocate for a government agency or quasi-government entity (including a public transport authority) to assume this broker role. Jittrapirom et al. (*11)*, however, in a Delphi study of 46 experts found transport operators as the preferred service integrator, followed by a third-party mobility provider and then local authorities.

We believe a government broker is a particularly challenging proposition since they might not only lack the incentive to innovate but also cause a potential conflict of interest, especially where both public and private operators exist as is the case in Australia. In Australia (and most other Western economies), government is increasingly removing themselves from service provision but rather only involving themselves at arm's length (*12*). They are better positioned playing a regulatory function to ensure a 'level' playing field (including setting common standards) for different MaaS operators to compete. We have hence assumed a private entity broker in our proposed model of the MaaS ecosystem for this research.

2.2 Situating the broker: Mode-agnostic mobility contracts

Having defined the broker, it is now necessary to situate it within a framework of demanders, suppliers and government (Figure 1). Brokers bring together suppliers of the transport asset/capacity, as well as other specialised businesses (like platform providers and financial enterprises), with this interface defined by mobility contracts. Opportunities exist for suppliers to also take up this broker role, as is the case with government-sponsored on demand (microtransit-type) trials in NSW (hence the blue shading). The broker in turn packages these raw services as bundles to demanders (end users), who purchases these products under a subscription or pay-as-you-go model. Given the new MaaS focus, government (who previously dealt directly with transport operators/suppliers) would now also interface with the MaaS broker/aggregator. Whether the broker(s) operate in an economically deregulated or a contracted environment (defined by what we term *accessibility contracts* as explored in Wong, Hensher and Mulley (*7*)) is beyond the scope of the present discussion. There is merit, however, in considering a framework without government interference initially to determine what the market is willing to provide before an institutional overlay is applied to ensure alignment with broader societal objectives. This is the approach we are assuming and has been supported by our fieldwork.

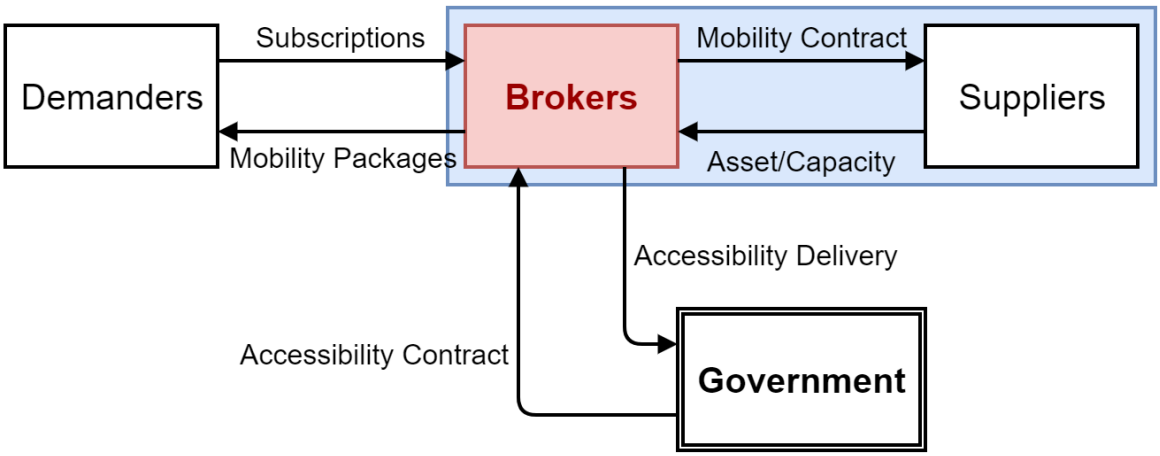


FIGURE 1: Proposed framework for the MaaS ecosystem, comprising the new function for a mobility broker aggregating different suppliers and delivering integrated service to demanders—excerpt from Wong, Hensher and Mulley (*7*)

Our primary interest in this paper, however, is in the broker/supplier interface as governed by mobility contracts. Various forms of involvement are possible from these constituent suppliers ranging from mere financing (**investing**) of the service provider to **supplying** intellectual knowhow or tangible assets like vehicles and depots. We have further considered at length what MaaS might mean for the future of public transport contracts (*4*). In Australia, there is a move from area-based, mode-specific, *output*-based contracts (in effect, to deliver kilometres on defined vehicle types), to mode-agnostic, *outcome*-based contracts where the MaaS operator has the flexibility to deliver services using any mode of their choosing. This suggestion aligns with public transport institutional reform over the past 30 years, including the increasing desire for a hybrid model which brings together the best of a contracted regime with the benefits and incentives inherent under economic deregulation (*12*). This serves as the theoretical underpinning for our empirical research program to design the broker/supplier interface that is the mobility contract.

3. METHODOLOGY

To design mobility contracts, we embarked on a qualitative program of interviews and participatory research with key stakeholders during August 2017. Informal interviews (structured around a study visit) were held with senior decision makers of two incumbent MaaS operators active in Helsinki and their regional public transport authority HSL. Our participatory research took place at the 15th *International Conference on Competition and Ownership in Land Passenger Transport* (known as the Thredbo series) in Stockholm where we ran a workshop over four days on the "'uberisation' of public transport and mobility as a service (MaaS)" (documented in Mulley and Kronsell (*13)*). Twenty-seven participants representing academia, government and industry (including transport operators and consultancies) came together in this Thredbo workshop (henceforth, the *Workshop*) to consider the objectives of MaaS, regulatory challenges, policy recommendations and research priorities (amongst other issues). We took these opportunities to test which attributes ought to be included in mobility contracts, the units they should be specified in (and levels), as well as candidate contextual influences on choice outcomes.

With mobility contracts defined, we then designed them as hypothetical choice scenarios and incorporated these choice tasks and other contextual variables as part of a stated choice experiment. Given the novelty of the MaaS concept and limited application of stated preference methods on supply-side issues in *any* market, a face-to-face testing process was required to finesse and validate the survey instrument (conducted in February to April 2018). An extensive pilot (n=23) was undertaken with experts and industry leaders with a focus on language, layout, the suitability of questions and contextual variables. Data was collected from this process to validate the model and confirm priors. The pilot results and qualitative research inform Sections 4 and 5.

4. MOBILITY CONTRACT DESIGN

Informed by fieldwork, a mobility contract was built around five attribute categories and thirteen design attributes. Table 1 outlines the list of attributes and attribute levels whilst Figure 2 situates them within an example choice task design. We now discuss the rationale for including each attribute.

TABLE 1: Attributes and attribute levels

Attribute category	**Attribute**	**Attribute levels** *Reference/base level underlined for dummy variables*
Mobility offering (Revenue mix) *Sums to 100%*	Fixed route public transport	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%
	On demand public transport	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%
	Carsharing	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%
	Taxi-like services	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%
	Shared ridehailing services	0, 10, 20, 30, 40, 50, 60, 70, 80, 90, 100%

Government support	Appeal to government through strategic/regulatory support	Enthusiastic, Lukewarm, <u>None</u>
	Monetary support for fixed route public transport	N/A (nested level), Yes, <u>No</u>
Return on investment	Expected average annual return on investment	-10, -5, 0, 5, 10, 15, 20%
	Possible range for annual return on investment	±2, 4, 6, 8, 10% *applied additively to above attribute*
Business branding	MaaS business and service branding	[Own company]-branded, New company branding, <u>Partner company branding</u>
Equity contribution	Total value of the MaaS business *Segmented by value*	**Small:** USD 0.7, 1, 2.5, 4.5, 7, 10 million
		Medium: USD 7, 10, 25, 45, 70, 100 million
		Large: USD 70, 100, 250, 450, 700, 1000 million
	Proportion equity and voting rights in the MaaS business	10, 20, 30, 40, 50, 60%
	Equity contribution to the MaaS business	*Product of above two attributes*

4.1 Mobility offering (Revenue mix)

Mobility offering defines the mix of modes operated by a mobility broker and in turn offered as part of integrated packages to end users. Five modes were selected as part of the potential set, noting that on demand public transport differs from shared ridehailing services in that there is an underlying contract being serviced by a subcontractor—often a transportation network company (TNC) and heavily subsidised. The proportion of revenue from the five modes total 100%. Sole modal offerings (i.e., 100% of one mode and 0% of the rest) can thus be interpreted as a status quo mode-specific contract. The need for this mobility offering attribute category is to test how different modal mixes might alter the propensity for respondents to invest/supply in the mobility broker. In the [Thredbo] Workshop, participants felt overwhelmingly that public transport ought to be at the core of any MaaS model. Whether public transport will naturally dominate, or must government play a role in directing the market through regulation and subsidies, is an unknown worth testing. We believe respondents from different sectors will be more inclined to support contracts with a particular modal bent (e.g., TNCs will support those with more taxi-like services).

4.2 Government support

Two types of government involvement have been selected as attributes defining each mobility contract, both of which exist as dummy variables. First, strategic/regulatory support refers to government in-principle support for MaaS, which may be exhibited through general policy direction (government masterplans, etc.) and further operationalised through the regulatory environment. Private investors are likely to avoid entry where there is only lukewarm government support or great market uncertainty. In pilot testing, this attribute was deemed even more important for publicly-owned transport operators. The Workshop recognised great tension between policy formulation and operator viewpoints, with regulatory support for MaaS which attempts to control for market failure thought to have the unintended consequence of stifling innovation (*13*).

The second attribute refers to monetary support by government in terms of any subsidy adjustment for fixed route public transport (the status quo) given a greater MaaS focus in the future. This constitutes a nested attribute since it will not feature for mobility contracts without a fixed route public transport component. There are important links here with whether MaaS can evolve in the absence of government financial support, and also the possible need for community service obligation payments to the broker. The question of whether these subsidies will be passed on as a profit margin to the private enterprise is also relevant.

4.3 Return on investment

Potential return on investment is a critical part of any business decision. Two attributes are included in this category—the expected average annual return and the potential variance in this return, the latter capturing risk and uncertainty. The expected return (linked to profit margin) varies in 5% increments between -10% and +20%. Negative return levels are included given the ubiquity of TNCs making short term losses in an effort to gain (effectively 'purchase') market share, backed by venture capital investors. The Workshop revealed Australian bus operators exhibiting a strong desire to enter the on demand market regardless of cost in order to showcase themselves as entrepreneurial, and hence help them win future tenders (particularly given government interest in on demand of late). We also found return expectations to vary considerably between businesses, with 8-30% having been touted (the upper end not uncommon with the community transport sector).

Return on investment might be a dominating attribute, but it is equally important to consider how this figure might vary. Realistically, the return might be based on some form of distribution (e.g., normal), but for simplicity we have not placed a probability for how this return might vary. Instead, a possible range for this return is defined, based on applying a number (2-10%) additively to the expected return. True return on investment will hence range between -20% to +30%, though a much smaller range will be displayed within each mobility contract.

4.4 Business branding

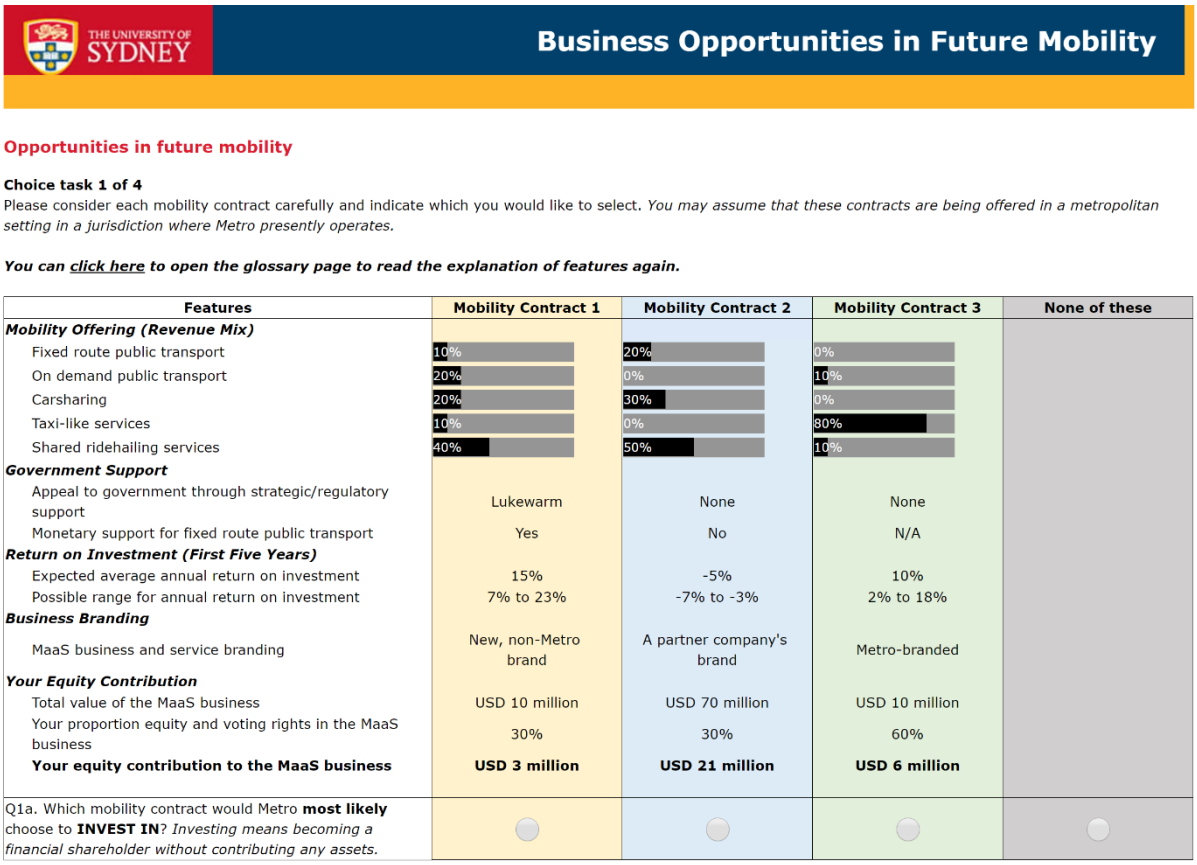
Branding, bidding power and ownership of the customer emerged as important issues during the interview program and Workshop. On one hand, businesses are keen to maintain their brand since customer loyalty is part of the value proposition they bring to any relationship. This is especially the case with Australian bus operators, who pointed to their loss of livery and brand identity as part of recent changes to the contracting regime. In partnering with technology providers (for instance, for on demand trials in NSW), bus operators found it difficult to proceed with larger players like Uber who were adamant in maintaining their brand, control of data and their digital platform. In the Helsinki case, the regional authority HSL expressed an element of regret in partnering with a MaaS provider since it meant a loss of control of their product, including marketing and ticket distribution channels. We have hence designed three dummy levels to capture and test how branding might influence choice outcomes.

4.5 Equity contribution

The three equity contribution attributes devised are important in that they define the scale of the MaaS business and also the size of respondents' stake in the broker. The first of these attributes relate to the size of the broker business by total value in USD—selected as a global currency of trade. It is crucial to include a dollar item to estimate willingness-to-pay for individual attributes. A fixed range of dollars were devised, and segmentation by value in

terms of organisation size implemented to ensure that the contracts remain relevant (almost a pivot design in effect). After thorough testing, we settled on using number of employees (collected as an earlier contextual variable) as a proxy for capturing organisation size, recognising the limitation in terms of labour intensity differences across sectors. The three respondent segments are **small** (≤999 employees), **medium** (1,000-9,999) and **large** (≥10,000) enterprises.

The second attribute relates to respondents' proportional equity contribution in the MaaS business, which range in 10% increments from 10-60%. Voting rights in the business are understood to be directly correlated with their equity investment, though in reality this may not always be the case. We propose to test how different broker sizes might affect interest in the business. For some companies, they may want a dominating share (and be monopolists) whilst others might be more risk averse and prefer a smaller starting stake. The actual contribution by respondents in USD is the final attribute and a function of the previous two values. Actual contribution captures either the value of respondents' financial investment or investment in-kind, thereby monetarising assets to their equivalent amount in equity (capturing the two choice response variables *investing* and *supplying* in the contract). This may be more difficult for transport operators in the case where government owns the assets, but there exists the opportunity for operators to use contracted assets in private work—charters are one example (*14*). The actual contribution range varies between USD 0.07-6 million for small enterprises, USD 0.7-60 million for medium enterprises, and USD 7-600 million for large enterprises. We ensured a degree of overlap to cater for organisation sizes at the margin.


THE UNIVERSITY OF SYDNEY

Business Opportunities in Future Mobility

Opportunities in future mobility

Choice task 1 of 4

Please consider each mobility contract carefully and indicate which you would like to select. *You may assume that these contracts are being offered in a metropolitan setting in a jurisdiction where Metro presently operates.*

You can click here to open the glossary page to read the explanation of features again.

Features	Mobility Contract 1	Mobility Contract 2	Mobility Contract 3	None of these
Mobility Offering (Revenue Mix)				
Fixed route public transport	10%	20%	0%	
On demand public transport	20%	0%	10%	
Carsharing	20%	30%	0%	
Taxi-like services	10%	0%	80%	
Shared ridehailing services	40%	50%	10%	
Government Support				
Appeal to government through strategic/regulatory support	Lukewarm	None	None	
Monetary support for fixed route public transport	Yes	No	N/A	
Return on Investment (First Five Years)				
Expected average annual return on investment	15%	-5%	10%	
Possible range for annual return on investment	7% to 23%	-7% to -3%	2% to 18%	
Business Branding				
MaaS business and service branding	New, non-Metro brand	A partner company's brand	Metro-branded	
Your Equity Contribution				
Total value of the MaaS business	USD 10 million	USD 70 million	USD 10 million	
Your proportion equity and voting rights in the MaaS business	30%	30%	60%	
Your equity contribution to the MaaS business	**USD 3 million**	**USD 21 million**	**USD 6 million**	
Q1a. Which mobility contract would Metro **most likely** choose to **INVEST IN**? *Investing means becoming a financial shareholder without contributing any assets.*	○	○	○	○

FIGURE 2: Screenshot of a choice task programmed in the survey instrument, for a hypothetical medium-sized mode-specific operator *Metro*

5. THE SURVEY INSTRUMENT

Having identified relevant attributes for mobility contracts, we then designed them as stated choice tasks and incorporated these, together with contextual variables, into a state-of-the-art survey instrument. The qualitative research informed the survey structure as well as candidate respondents.

5.1 Choice tasks and choice responses

The mobility contracts were incorporated within a hypothetical setting using best practice design principles to define alternatives associated with designed levels of attributes (*15*). Using Ngene, we generated D-efficient choice tasks of four alternatives (three mobility contracts plus one no choice/reference status quo—see Figure 2) in a six block, four sets per block design. The [Thredbo] Workshop explored a suite of partnership issues looking at market relationships in the MaaS era and the development of collaborations beyond standard procurement procedures (*13*). Recognising this, we offered choice responses to either *supply* in or *invest* into the new MaaS business. The difference herein lies between contributing physical assets and assets in-kind (e.g., buses, depots, personnel) or becoming solely a financial shareholder in the broker business. To better understand how respondents might supply, we asked which assets they would contribute (technology, vehicle, bricks and mortar, right-of-way and personnel), what partners they might like to work with (other transport operators, platform providers and financial enterprises—all of which we regard as crucial), as well as how involvement will affect their present service offering (in the case of mode-specific operators).

5.2 Contextual variables and survey structure

The survey instrument included a range of contextual questions to further embellish the stated choice data. The survey begins with objective questions collecting respondent characteristics, including market sector, ownership structure, jurisdiction of operation and number of employees. The survey then branches and for mode-specific operators, we ask for the modes they operate and for a vehicle count of each mode (as another measure of organisation size). Non-mobility providers are asked for their transport-related activities and interest in future transport initiatives. Both groups are requested to provide their return on investment expectations and perceived risk-free rate. Remarkably, industry respondents in the pilot exhibited no qualms in sharing this information (despite concern from academic experts).

Experience-conditioned discrete choice models constitute a recent advancement in the choice modelling literature, which to date has seen only limited applications—in transport modelling contexts (*16; 17*), healthcare (*18; 19*) and recreation (*20*). Each of these studies have found that respondent preferences are heavily influenced by their experience or familiarity with attributes and alternatives in the choice task. In the case of products or services not yet available on the market (like MaaS), then the conditioning agent can be considered as the respondents' awareness of an idea or experience. To account for heteroscedasticity conditioning in the analysis, we ask for respondents' (and their organisations') familiarity with the MaaS concept. We finish the survey by asking respondents to rate (on a Likert-scale) their decision-making confidence so as to allow us to validate the data and examine preference stability (*21*). The survey concludes with questions about respondents' position title, responsibilities and years active in the industry to see whether these factors might carry particular biases in their responses.

5.3 Candidate respondents

A candidate sampling frame was defined in terms of jurisdiction, market sector and position

level. We desired an international survey from the outset to obtain a global view, but recognise that some level of comparability between contexts is important, given the vastly different institutional and governance arrangements between countries. Hence, the jurisdictions of Australia, Hong Kong, Singapore, Japan, Western Europe and the United States were selected as the *core* sampling frame due to similar perspectives on risk and investment, and a level of dialogue and engagement between these economies.

The organisations selected were categorised under **mode-specific operators** (incumbent providers of *passenger* service) and non-mobility providers (new entrants) interested in partaking in the MaaS business model. Mode-specific operators include public transport operators, taxi operators, transportation network companies, carshare operators and bikeshare operators. **Non-mobility providers** comprise of vehicle manufacturers/suppliers, technology providers/startups, financial enterprises, infrastructure operators, property developers, telecommunications providers, consultancies, insurance companies and industry bodies. As mentioned, we decided that governments (i.e., transport regulators/authorities) would not form part of the candidate sample (unless they were an *operator* of transport service) since we deemed it unlikely they would partner within a mobility broker model (see Section 2.1).

One of the most important issues and major challenges in the study of business is identifying relevant decision makers within an organisation since preference responses are highly dependent on who provides the data (*22*). Our specific focus is on *senior executives making investment decisions* within companies in the market sectors of interest (e.g., Managing Directors, Chief Executive Officers). Respondent-specific data and firm-specific data were captured to account for different organisational structures between companies. In terms of recruitment, we engaged our partners in academia and industry (bus associations being particularly helpful) to assist with outreach as part of the respondent recruitment process.

6. PRELIMINARY RESULTS

Data collection on the live survey instrument has been in progress since May 2018. 202 responses have been collected as of October 2018 (Table 2), with a roughly equal mix of mode-specific operators and non-mobility providers, as well as Australian and non-Australian organisations. Small enterprises, however, account for 55% of the sample, as compared with 25% medium and 20% large. We believe this is representative of the potential mix of interested businesses. Based on design levels, the mean attribute levels (Table 3) for mobility contracts which respondents chose to invest or supply in were determined. These reveal a large public transport component amongst MaaS businesses which garnered the highest level of support. A higher return on investment expectation is also evident when respondents were asked to invest rather than supply. Larger business propositions are preferred by non-mobility providers, more than double the size of those selected by mode-specific operators. Finally, the average preferred stake in the broker business is around one third, with implied voting rights to the same extent.

TABLE 2: Respondent sample for data collected thus far

	Mode-specific operator				**Non-mobility provider**				**Grand Total**
Jurisdiction	**S**	**M**	**L**	***Total***	**S**	**M**	**L**	***Total***	
Australia	32	12	1	*45*	24	9	10	*43*	**88**

New Zealand	1	3		*4*			1	*1*	**5**
Singapore	2	2	1	*5*		1	1	*2*	**7**
Hong Kong		1	1	*2*	3			*3*	**5**
Other Asia			3	*3*			4	*4*	**7**
United Kingdom	2	2	2	*6*	6	1		*7*	**13**
Belgium		1		*1*	1		6	*7*	**8**
Germany					6		1	*7*	**7**
Luxembourg	2	1		*3*	3		1	*4*	**7**
Other Europe		3	1	*4*	12			*12*	**16**
United States	3	4	1	*8*	10	4	2	*16*	**24**
Canada		4		*4*		1	3	*4*	**8**
Other Countries		2		*2*	5			*5*	**7**
Grand Total	**42**	**35**	**10**	***87***	**70**	**16**	**29**	***115***	**202**

TABLE 3: Mean attribute levels for chosen alternatives (mobility contracts), stratified by organisation type and choice response

	Willing-to-invest		**Willing-to-supply**	
	Mode-specific operator	**Non-mobility provider**	**Mode-specific operator**	**Non-mobility provider**
Fixed route public transport	33.1%	23.3%	35.0%	26.8%
On demand public transport	18.2%	21.4%	18.6%	20.2%
Carsharing	14.5%	17.3%	14.6%	18.5%
Taxi-like services	19.2%	16.8%	16.4%	15.4%
Shared ridehailing services	14.9%	21.3%	15.3%	19.0%
Expected average annual ROI	8.9%	8.6%	6.5%	7.1%
ROI risk/variance	±6.5%	±6.2%	±6.3%	±6.4%
Total value of MaaS business	USD 62.5 million	USD 133.8 million	USD 66.2 million	USD 134.4 million
Proportion equity and voting rights	36.2%	34.4%	38.0%	34.90%
Equity contribution to MaaS business	USD 21.4 million	USD 44.4 million	USD 25.6 million	USD 44.9 million
Sample cases	*270*	*319*	*332*	*405*

A number of choice models were estimated using the econometric software package NLOGIT6, using generic utility functions for an unlabelled choice experiment. We began with a simple multinomial logit (fixed parameters) model to test the robustness of the model before moving to a more advanced, mixed logit (random parameters) model. Table 4 shows the statistical significance of the parameter estimates and how they contribute to the utility of a packaged alternative. It is clear again that public transport (both fixed and on demand) is an important part of the preferred modal mix. Return on investment and business size are also relevant attributes. Surprisingly, branding considerations proved to be statistically insignificant

(and thus omitted from this model). It is worth noting that even if the parameters are not statistically significant at their mean values, their variance (standard deviation parameter estimate) may be significant, demonstrating preference heterogeneity across the sample that is not adequately accommodated through only having a mean estimate. We added an alternative-specific constant on Mobility Contract 1 (ASCA) to investigate any possible left-right bias in terms of selected alternatives within the sample (noting that a constant has no behavioural meaning in a strictly unlabeled choice experiment except for directional bias). For the null (no choice) alternative, we tested contextual variables and found different effects between the invest and supply choice responses and respondents' organisation type (mode-specific or non-mobility).

TABLE 4: Mixed logit model parameters

	Willing-to-invest			**Willing-to-supply**		
	Parameter estimates (z-score)			**Parameter estimates (z-score)**		
Random parameters: Mean						
Fixed route public transport (%)	0.02709	***	(4.22)	0.03673	***	(5.68)
On demand public transport (%)	0.38287	***	(5.97)	0.37955	***	(6.04)
Carsharing (%)	0.00452		(0.62)	0.01420	**	(2.27)
Taxi-like services (%)	0.00271		(0.40)	0.00111		(0.18)
Shared ridehailing services (%)	0.01606	**	(2.54)	0.01704	***	(2.88)
Lukewarm appeal to government (1/0)	-0.17075		(-0.88)	0.02043		(0.12)
Enthusiastic appeal to government (1/0)	0.44278	*	(1.90)	0.62552	***	(3.18)
Monetary support for public transport (1/0)	0.24712		(1.29)	0.38618	**	(2.07)
Expected average annual ROI (%)	0.09092	***	(7.06)	0.02993	***	(3.07)
Potential variability in ROI (±%)	-0.02736		(-0.97)	-0.00064		(-0.02)
Total value of MaaS business (USD millions)	-0.00036		(-0.65)	0.00012		(0.25)
Proportion equity and voting rights (%)	0.00230		(0.48)	0.00393		(0.84)
Fixed (non random) parameters						
ASCA	-0.09884		(-0.58)	-0.42292	***	(-2.66)
No choice constant (Null)	2.41732	***	(2.74)	-0.52252		(-0.56)
Mode-specific operator (For null)	0.13582		(0.36)	0.93656	**	(2.12)
Random parameters: Distribution (Normal)						
Fixed route public transport (%)	0.03055	***	(5.68)	0.04138	***	(6.08)
On demand public transport (%) (Constrained)	0.38287	***	(5.97)	0.37955	***	(6.04)
Carsharing (%)	0.02491	***	(3.40)	0.00483		(0.47)
Taxi-like services (%)	0.02520	***	(4.28)	0.02747	***	(4.37)
Shared ridehailing services (%)	0.00726		(0.89)	0.01657	***	(2.91)
Lukewarm appeal to government (1/0)	1.10803	***	(4.41)	0.46345	*	(1.77)

Enthusiastic appeal to government (1/0)	1.71270	***	(5.60)	1.18668 ***	(4.51)
Monetary support for public transport (1/0)	0.66019	**	(2.37)	1.19684 ***	(3.26)
Expected average annual ROI (%)	0.09806	***	(7.17)	0.07832 ***	(4.87)
Potential variability in ROI (±%)	0.12010	***	(3.21)	0.13848 ***	(3.61)
Total value of MaaS business (USD millions)	0.00253	***	(3.75)	0.00152 **	(2.30)
Proportion equity and voting rights (%)	0.02963	***	(4.90)	0.01669	(1.42)
Model fit					
Log-likelihood at zero	-1120.12584			-1120.12584	
Log-likelihood at convergence	-925.05508			-869.49122	
McFadden Pseudo R-squared	0.1741508			0.2237558	
AIC (Sample adjusted)	2.354			2.217	

Mixed logit (random parameters) model based on 808 observations from 202 respondents ***, **, * ==> *Significance at 1%, 5%, 10% level*

Using the mixed logit model, willingness-to-pay estimates (Table 5) were obtained with the Wald method (see Hensher, Rose and Greene (*23)*). The average willingness-to-pay for investing in a mobility contract is USD 8.66 million per 1% unit of public transport revenue, as compared with just USD 1.35 million per 1% revenue unit of carsharing. This again shows public transport to be an important part of the preferred modal mix, and the difference is even more profound when businesses consider the choice to supply. Interestingly, the comparative value of financial support as compared to strategic/regulatory support is small, showing a preference for government involvement at arm's length only, without the possibility of undue interference. There are also signs of risk aversion evident with smaller equity contributions being preferred. As an application, our willingness-to-pay estimates can be used as inputs to determine the value of different MaaS business propositions. Table 6 prices the mean preferred contracts (based on selected attributes only), given the preference function of the sample. We note the higher value of supplying in contracts, as compared with investing—consistent with our earlier findings. The values presented are a lifetime figure so (say) for a 20 year time horizon gives USD 35-50 million which we think is a reasonable sum.

TABLE 5: Willingness-to-pay estimates for contract elements

Willingness-to-pay estimates	**To invest (USD million)**	**To supply (USD million)**
1% additional fixed route public transport revenue	8.66	18.50
1% additional on demand public transport revenue	7.18	7.53
1% additional carsharing revenue	1.35	3.76
1% additional taxi-like services revenue	0.01	-0.21
1% additional shared ridehailing services revenue	0.08	0.22
Presence of government subsidy	39.31	122.28

Lukewarm appeal to government	78.38	129.67
Enthusiastic appeal to government	260.26	360.08
1% additional return on investment	42.48	27.69
1% additional equity contribution	-0.52	-3.94

TABLE 6: Example mobility contracts and value (based on mean attribute levels in Table 3)

	Mobility contract			
	1	**2**	**3**	**4**
Fixed route public transport	33.1%	23.3%	35.0%	26.8%
On demand public transport	18.2%	21.4%	18.6%	20.2%
Carsharing	14.5%	17.3%	14.6%	18.5%
Taxi-like services	19.2%	16.8%	16.4%	15.4%
Shared ridehailing services	14.9%	21.2%	15.3%	19.0%
Expected average annual ROI	8.9%	8.6%	6.5%	7.1%
Contract value to invest (USD million)	**816.353**	**745.985**	**733.866**	**705.381**
Contract value to supply (USD million)	**1,049.603**	**896.532**	**1,022.361**	**915.011**

7. CONCLUSION AND NEXT STEPS

MaaS is a nascent topic which has emerged only in the past several years. Quantitative and empirical evidence on the design of supply-side subscription plans remains virtually non-existent and in this paper we begin the process of tackling the challenge to identify the conditions around which businesses might invest or supply in the mobility broker/aggregator model. The interview and participatory research process helped define the potential attributes to include in the mobility contract whilst pilot testing (n=23) helped us refine the survey instrument used in this novel application on MaaS. Data collection has thus far been smooth but not without its challenges. We have received encouraging feedback including that the survey is interesting and helps respondents organise their thoughts, but many participants also found the choice scenarios a little difficult with a few dropping out and others raising concerns of sensitivity over some of the questions asked (an issue which did not emerge in pilot). Some non-mobility providers invited to participate (e.g., logistics companies) also felt that the survey was not relevant, though this is a finding in itself for us about likely market interest as investors and/or suppliers. Analysis of preliminary data (n=202) confirmed the robustness of our approach and offered some useful initial insights.

We have commented on some of the challenges inherent and have prepared this paper with a view of streamlining future stated preference research on the supplier interface for MaaS. Our present focus is to continue data collection, with an aim to increase the present sample. As additional data is obtained, we will be further finessing our model, including interacting the attributes with the many (more than 50) contextual variables in the survey. Non-linear experience conditioned models (based on familiarity with the MaaS concept) will also be developed to test for any optimism bias (linked to the Gartner hype cycle) and how that might affect the preference of respondents. This will become an innovative *first* view on the topic and the beginning of greater interest in identifying the commercial, market-led equilibrium for MaaS. We plan to identify this by mapping the present results onto consumer preferences we have determined in our MaaS demand-side studies (*6*). Government can then evaluate whether it finds these results acceptable, aligning with the broader societal and urban

efficiency goals of cities, or whether an institutional overlay will be required to ensure that these objectives are met (*7*). Our research agenda is a first step towards informing these unknowns.

REFERENCES

[1] Mulley, C. Mobility as a services (MaaS)—Does it have critical mass? *Transport Reviews,* Vol. 37, No. 3, 2017, pp. 247-251.
[2] Kamargianni, M., W. Li, M. Matyas, and A. Schäfer. A critical review of new mobility services for urban transport. *Transportation Research Procedia,* Vol. 14, 2016, pp. 3294-3303.
[3] Jittrapirom, P., V. Caiati, A.-M. Feneri, S. Ebrahimigharehbaghi, M. J. A. González, and J. Narayan. Mobility as a service: A critical review of definitions, assessments of schemes, and key challenges. *Urban Planning,* Vol. 2, No. 2, 2017, pp. 13-25.
[4] Hensher, D. A. Future bus transport contracts under a mobility as a service (MaaS) regime in the digital age: Are they likely to change? *Transportation Research Part A: Policy and Practice,* Vol. 98, 2017, pp. 86-96.
[5] Matyas, M., and M. Kamargianni. Stated preference design for exploring demand for "mobility as a service" plans. Presented at 5th International Conference of Choice Modelling, Cape Town, South Africa, 2017.
[6] Ho, C., D. A. Hensher, C. Mulley, and Y. Z. Wong. Potential uptake and willingness-to-pay for mobility as a service (MaaS): A stated choice study. *Transportation Research Part A: Policy and Practice,* Vol. 117, 2018, pp. 302-218.
[7] Wong, Y. Z., D. A. Hensher, and C. Mulley. Emerging transport technologies and the modal efficiency framework: A case for mobility as a service (MaaS). Presented at 15th International Conference on Competition and Ownership in Land Passenger Transport (Thredbo 15), Stockholm, Sweden, 2017.
[8] De Reuver, M., H. Bouwman, and T. Haaker. Business model roadmapping: A practical approach to come from an existing to a desired business model. *International Journal of Innovation Management,* Vol. 17, No. 01, 2013, p. 1340006.
[9] Romanyuk, J. Mobility as a service—Hype or the future of transportation?In *School of Business, No. Master of Science in Economics and Business Administration,* Aalto University, Helsinki, Finland, 2018.
[10] Kamargianni, M., and M. Matyas. The business ecosystem of mobility-as-a-service. Presented at Transportation Research Board 96th Annual Meeting, Washington, D. C., United States, 2017.
[11] Jittrapirom, P., V. Marchau, R. van der Heijden, and H. Meurs. Future implementation of mobility as a service (MaaS): Results of an international Delphi study.In *Working Paper*, Nijmegen School of Management, Radboud University, Nijmegen, The Netherlands, 2018.
[12] Wong, Y. Z., and D. A. Hensher. The Thredbo story: A journey of competition and ownership in land passenger transport *In* Alexandersson, G., Hensher, D. A., & Steel, R. (Eds.), Competition and Ownership in Land Passenger Transport (Selected papers from the Thredbo 15 conference). *Research in Transportation Economics*, 2018.
[13] Mulley, C., and A. Kronsell. Workshop 7 report—The 'uberisation' of public transport and mobility as a service (MaaS): Implications for future mainstream public transport. *In* Alexandersson, G., Hensher, D. A., & Steel, R. (Eds.), Competition and Ownership in Land Passenger Transport (Selected papers from the Thredbo 15 conference). *Research in Transportation Economics*, 2018.
[14] Hensher, D. A. Using contracted assets to undertake non-contracted services as a way to improve cost efficiency under negotiated or tendered bus contracts. *Journal of Strategic Contracting and Negotiation,* Vol. 1, No. 2, 2015, pp. 111-128.

[15] Louviere, J. J., D. A. Hensher, and J. D. Swait. *Stated choice methods: Analysis and applications*. Cambridge University Press, Cambridge, United Kingdom, 2000.
[16] Hensher, D. A., and C. Q. Ho. Experience conditioning in commuter modal choice modelling–Does it make a difference? *Transportation research part E: logistics and transportation review,* Vol. 95, 2016, pp. 164-176.
[17] Ben-Elia, E., I. Erev, and Y. Shiftan. The combined effect of information and experience on drivers' route-choice behavior. *Transportation,* Vol. 35, No. 2, 2008, pp. 165-177.
[18] Neuman, T., E. Neuman, and S. Neuman. Explorations of the effect of experience on preferences for a health-care service. *The Journal of Socio-Economics,* Vol. 39, No. 3, 2010, pp. 407-419.
[19] Ryan, M., and C. Ubach. Testing for an experience endowment effect in health care. *Applied Economics Letters,* Vol. 10, No. 7, 2003, pp. 407-410.
[20] Wirtz, D., J. Kruger, C. N. Scollon, and E. Diener. What to do on spring break? The role of predicted, on-line, and remembered experience in future choice. *Psychological Science,* Vol. 14, No. 5, 2003, pp. 520-524.
[21] Hoeffler, S., and D. Ariely. Constructing stable preferences: A look into dimensions of experience and their impact on preference stability. *Journal of Consumer Psychology,* Vol. 8, No. 2, 1999, pp. 113-139.
[22] Balbontin, C., and D. A. Hensher. Firm-specific and location-specific drivers of business location and relocation decisions.In *Working Paper*, Institute of Transport and Logistics Studies (ITLS), University of Sydney Business School, Sydney, Australia, 2018.
[23] Hensher, D. A., J. M. Rose, and W. H. Greene. *Applied Choice Analysis, Second Edition*. Cambridge University Press, Cambridge, 2015.