A methodological survey of future mobility literature: opportunities for design research

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Abstract

This research establishes that the study of mobility and transportation is multi-disciplinary and highly complex, involving the diverse interplay between infrastructural and psychological factors. Coincidently, a new paradigm in personal mobility is developing. A new generation of mobility solutions is becoming widely available in the form of car and ride sharing services. These services build on the assumption that customers no longer need ownership of a product in order to benefit from it. With the emergence of this new paradigm, this paper presents a methodological review of current practises used by the wider research community. Therefore, this research piece aims to explore methodological approaches involved in the study the effect of community on an individual's attitudes, perceptions and behaviours of future mobility solutions. The results of this review indicate that the majority of published literature uses quantitative methods as opposed to qualitative and even fewer studies have sought to understand the human factors in these new mobility solutions. This gap in knowledge is a valuable opportunity for design. Inherently qualitative and human focused, design research can fill this gap in knowledge by applying distinctly user-centred methods such as persona design, narrative storytelling, and in-depth observations to discover deeper human insights.

Mobility; Car Sharing; Ridesharing; Research Methods

Introduction

Researchers from many backgrounds have comprehensively studied the fields of transportation and mobility (Ory & Mokhtarian, 2009; Shaheen, Mallery, & Kingsley, 2012).. Within the field of design, numerous research papers on transportation examine aesthetics (Fu & Sun, 2012; Hekkert, Snelders, & van Wieringen, 2003), usability (S. Kim, Dey, Lee, & Forlizzi, 2011) and emotion (Gomez, Popovic, & Bucolo, 2004). Furthermore, the larger field of psychology has routinely explored the attitudes, perceptions and behaviours of individuals in relationship to private and public transport systems (Bamberg, Hunecke, & Blöbaum, 2007; Beirão & Sarsfield Cabral, 2007; Elias & Shiftan, 2012; Lovelock & Dobson, 2014; Ory & Mokhtarian, 2009; Paulssen, Temme, Vij, & Walker, 2013; Stanley, Hensher, Stanley, & Vella-Brodrick, 2011; Tertoolen, van Kreveld, & Verstraten, 1998; Thøgersen, 2006). However, a new transportation and mobility paradigm is upon us. Recent years have seen the development of new forms of mobility; new forms becoming increasingly commonplace, represented in the form of car share and ride share services (Cohen & Kietzmann, 2014). Although challenged by Belk (2014) as to a correct definition of sharing, these services have been popularised under the sharing economy and collaborative consumption movement championed by Botsman and Rogers (2010).

At present, these new mobility services are currently well studied from a mathematics, science and engineering perspective yet are vastly understudied from the broad social sciences and specifically design fields. Coincidently, it is both necessary and advantageous that design branch out from its occasionally restricted focus. Referred to by Muratovski (2015) as the 'death spiral in design', design needs to evolve from traditionally studying itself to adopting new content, ways of thinking and better integration with other disciplines (Zimmerman, 2003). New and future mobility solutions represent an opportunity for such expansion as the logistics of car sharing, ride sharing and even autonomous technology is being increasing understood and piloted, although there continues to be a lack of deep insight such as might be obtained from real world experimentation. Design research can aid in answering these unknowns. As described by Collins, Joseph and Bielaczyc (2004), design research differs from traditional research by asking theoretical questions of learning in a real world context; outside of the laboratory with real users.

Social science and design studies in the area are required. Therefore, this paper provides a comprehensive literature review into existing academic articles on the car and ride share perspective with a specific focus on methodology. The aim; to provide understanding of how these previous experiments have been conceptualised and conducted from a design perspective. In defining a design perspective, the authors refer to the larger paradigm of design research (Collins, Joseph, & Bielaczyc, 2004).. The outcome of this paper is a defined gap in knowledge for future study.

This paper is structured as follows; first is a brief discussion of literature in the mobility space and the emergence of new mobility solutions. Second is a detailed breakdown of the research method of this paper and the search protocols used. Third is an analysis of existing methods used and the results of the literature search. The paper concludes with a discussion on the limitation of current knowledge and the opportunities for future design research.

2.0 Relevant Literature

2.1 The Complexity of Mobility

To help demonstrate the complexity of mobility and transportation, literature has spent much time trying to simply explain this interconnectedness between people and systems. Scheiner and Kasper (2002) outline a model of interrelation between lifestyle and social structure, choice of housing location and daily mobility (Scheiner & Kasper, 2002, 2003); a concept later reiterated by Anable (2005). Scheiner and Holz-Rau (2007) expanded on this work to consider mobility systems to be made of five key concepts; life situation, location attitudes, location choice/urban form and travel behaviour. Hunecke et al. (2007) discuss the link between psychological, socio-cultural and infrastructural factors in the uptake of mobility systems. Van Acker, Mokhtarian and Witlox (2011) further demonstrate the role of subjective variables on the success of mobility systems. Santos, Behrendt, & Teytelboym (2010) provide a number of a number of policy suggestions to solve mobility solutions which require both *hard* and *soft* policy interventions (i.e. infrastructure and psychological changes). Finally, Brög, Erl, Ker, Ryle, and Wall (2009) provide a comprehensive literature review of the development of behaviour change strategies in order to change mobility.

This research suggests that transportation and mobility is a diverse construct involving infrastructure and people, objective and subjective factors full of macro and micro systems and interactions. Literature suggests that tackling this complex problem requires a multidisciplinary approach and humanity must engage with all elements and design across all fronts simultaneously (Banister, 2011). Several new mobility solutions have largely succeeded in this process, managing micro and macro factors, human and infrastructural. At present, these solutions are taking the form of car and ride sharing applications.

2.2 New Mobility - Car and Ride Sharing

As previously alluded to, new mobility solutions are emerging as a consequence of increased urbanisation, increased connectivity between individuals and a growing consciousness of burden of ownership and consumption. One such solution is the concept of car and ride sharing. Both solutions aim to repurpose existing infrastructure and assets to reduce car usage. Car sharing is defined as a system that provides members with access to a vehicle for short term use (Shaheen et al., 2012). All vehicles are owned by the provider and are distributed amongst a system where customers access vehicles by reservation and are charged for time and use (Shaheen et al., 2012). On the opposite side of the coin, ride sharing exists where two or more individual trips are executed simultaneously, in the same vehicle (Morency, 2006). Ride sharing firms own little to none of the assets. Their main function is facilitating a connection between riders (Agatz, Erera, Savelsbergh, & Wang, 2012).

The success or failure of these systems is of interest to many parties including city planners and policy makers through to entrepreneurs and designers. There have been number of studies in a variety of locations to test car and ride sharing solutions. These are have conducted in several continents, with most in North America and Europe (Abrahamse & Keall, 2012; Bruglieri, Ciccarelli, Colorni, & Luè, 2011; Potoglou & Kanaroglou, 2008; Rabbitt & Ghosh, 2013). A notable observation from these car and ride sharing case studies is that each study creates data that is context specific and many researchers acknowledge the individuality required in each solution. This theory matches with broader mobility knowledge, which initially highlighted the complexity and uniqueness of all transportation systems (Goldman & Gorham, 2006).

2.3 An Opportunity for Design – Understanding Real Users

Previous researchers have established that there is more to a successful mobility or transportation solution more than the physical infrastructure and efficient logistics. An individual's attitudes, feelings and perceptions have influence over modal choice and thus usage of transportation alternatives (Hunecke et al., 2007; Scheiner & Holz-Rau, 2007; Scheiner & Kasper, 2003). New mobility solutions such as car and ride sharing are a testament to this change. Increasingly, the dominance of the private car is slipping with sharing oriented alternatives flooding global markets. These successes deem it is vital to scope down and study the individual; understand the psychological side. This study of real users in context is an opportunity for design to provide further insight.

Many researchers since have sought to understand the individual psychological side of transport use and have since established the basis for the understanding of human factors within mobility (Bamberg, Hunecke, & Blöbaum, 2007; Beirão & Sarsfield Cabral, 2007; Lovelock and Dobson; Anable 2005). Most prominantly, Anable (2005) demonstrated that socio-demographic factors had little influence over the mode choice of individuals, rather attitudes and the way people think were a better way to segment the population. Shiftan, Outwater and Zhou (2008) go as far as to say that these variables can play an even more significant role than instrumental variables.

However, few practitioners and researchers in the field of design have tackled transportation and mobility looking specifically at end users. Richard, Burkhardt, & Lubart (2014) take aim at this factor as a core problem in the mobility problem; many mobility solutions are designed with 'little to no reference of users' viewpoints and actual experience and including real users earlier in the design process creates better results and ultimately advocate the use of design over hard science disciplines such as engineering. This research demonstrates the need to first connect with users on a deeper emotional level and integrate design into the study of mobility and transportation. Research by Price, Wrigley and Straker (2015) define several ways to connect with users on this deeper emotional level. Methods explored by Price, Wrigley and Straker (2015) lie at the core of what design research hopes to achieve. These methods investigate real users, operating in real contexts (Collins et al., 2004) with artefact or process (Hevner, 2007). The process involves much experimentation and testing in these real environments leading to Hevner's (2007) assertion of design science as the *pragmatic science.*

3.0 Research Method:

The goal of this research was to obtain scholarly publications specifically on the subject of community influence on an individual's perception of mobility with regard to future mobility solutions. Within this research, these are defined as car sharing, ride sharing, shared use vehicles or autonomous cars. To obtain this comprehensive knowledge, a literature search was performed across two databases; Scopus and Web of Science.

A Boolean search was conducted looking to obtain the research goal by providing a specific sample of papers in which to analyse their methodological approach. The Boolean search was developed with three constructs in mind to narrow the focus. The first phrase term was aimed to find sources that looked for the user / individual. The second was directed at the larger field of research; transportation or mobility. The third phrase aimed at the specific aspect of second construct with the intention to drastically scope down the research results (i.e. car share, ride share, autonomous vehicles). The search structure can be seen below in Table 1.

Individual Psychological Construct		Larger Content Construct		Specific Content Construct
	AND		AND	
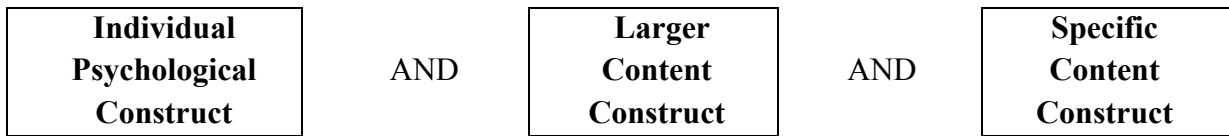
Table 1: Boolean Search Structure

Using this as a guide, a large range of synonymous words was inserted into the framework to help deliver results. The final Boolean search can be seen below in Table 2.

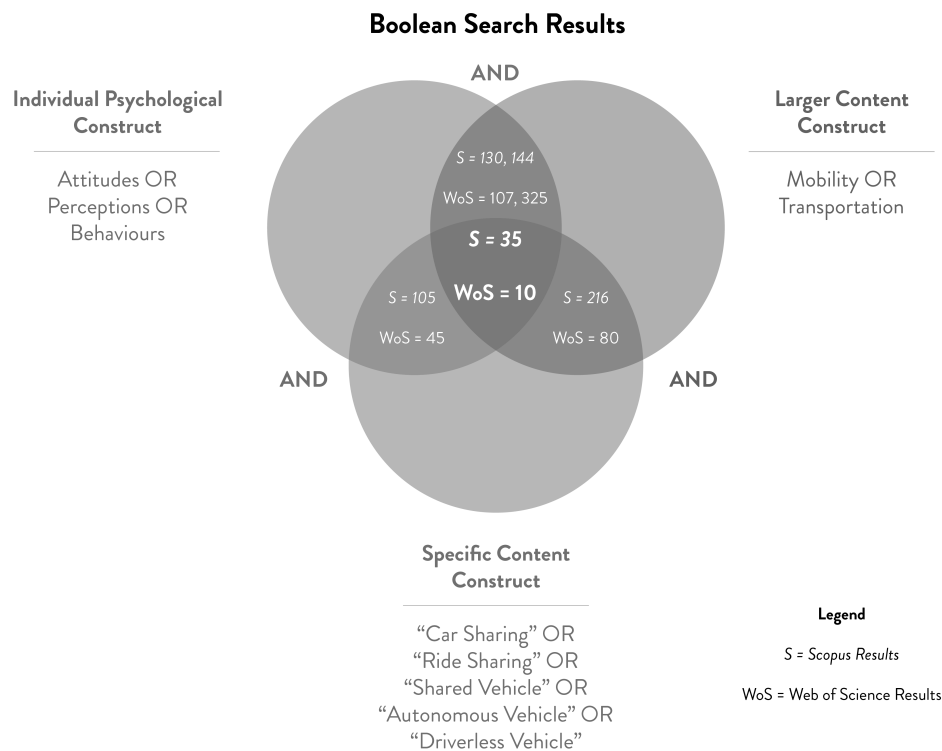| Individual Psychological Construct		Larger Content Construct		Specific Content Construct
(perception OR behaviours OR attitudes)	AND	*(mobility OR transport)*	AND	*("Car sharing" OR "Ride Sharing" OR "Shared Vehicle" OR "Autonomous Car" OR "Driverless Car")*
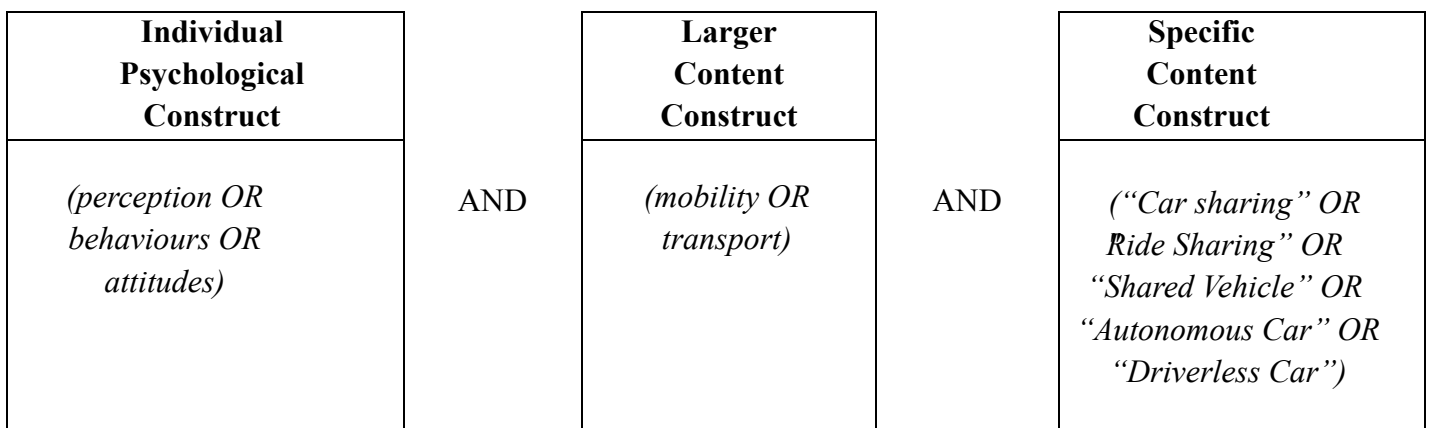
Table 2: Boolean Search

This Boolean search aimed at to look for specific words in the abstract, title or keywords within sources in the database. The search of Web of Science returned 10 results while the search of Scopus returned 35 results. Results of this search strategy are summarised in Table 3 with an expanded diagram of results in Figure 1 below.

Search ID	Boolean search	Database	Results
1	(perceptions OR behaviours OR attitudes) AND (mobility OR transport) AND ("Car sharing" OR "ride sharing" OR "Shared vehicle" OR "autonomous car" OR "driverless car")	Web of Science	17
		Scopus	33
2	(perceptions OR behaviours OR attitudes) AND (mobility OR transport) AND ("Car sharing" OR "ride sharing" OR "Shared vehicle" OR "autonomous car" OR "driverless car") **AND design**	Web of Science	2
		Scopus	3
3	(perceptions OR behaviours OR attitudes) AND (mobility OR transport) AND ("Car sharing" OR "ride sharing" OR "Shared vehicle" OR "autonomous car" OR "driverless car") **AND community**	Web of Science	3
		Scopus	2
4	(perceptions OR behaviours OR attitudes) AND (mobility OR transport) AND ("Car sharing" OR "ride sharing" OR "Shared vehicle" OR "autonomous car" OR "driverless car") **AND community AND design**	Web of Science	1
		Scopus	0

Table 3. Final Boolean search of Web of Science and Scopus

Boolean Search Results

AND

Individual Psychological
Construct

Attitudes OR
Perceptions OR
Behaviours

Larger Content
Construct

Mobility OR
Transportation

S = 130, 144

WoS = 107, 325

S = 35

WoS = 10

S = 105   S = 216

WoS = 45   WoS = 80

AND   AND

Specific Content
Construct

"Car Sharing" OR
"Ride Sharing" OR
"Shared Vehicle" OR
"Autonomous Vehicle" OR
"Driverless Vehicle"

Legend

S = Scopus Results

WoS = Web of Science Results

Figure 1: Boolean Search Results Expanded

Following these searches, all available papers within the combined search were read and analysed for their relevance to the research area. Unfortunately four papers could not be accessed due to access restriction. In this process, the research team applied two criteria to be considered for review.

1) The article must be relevant to the literature area. Although obvious, despite the narrow research search term, a number of articles were of little relevance to the research objective.
2) Research must be published after 1990.

In total, 39 articles were identified for examination. Identified articles were read a second time to extract data on the predetermined research question. *Which methodological approaches have been used to study the effect of community on an individual's attitudes, perceptions and behaviours of future mobility solutions?*

4.0 Results

Following a thorough analysis of all papers in the database search, eight distinct methodological approaches were identified from previous studies. These span across both quantitative and qualitative fields; (i) a mobility diary, (ii) quantitative survey, (iii) qualitative survey, (iv) interviews, (v) theoretical simulations / network theory / mathematics, (vi) car sharing or ride sharing pilot programme, (vii) position paper, (viii) secondary data analysis. These sources are categorised below in Table 4 with most relevant sources further summarised in Table 5. Several papers use multiple methods and are thus categorised in all columns in which their method was used.

The results show that very few sources have attempted to understand the effect of community on an individual's attitudes, perceptions and behaviours with respect to mobility and future mobility solutions. Furthermore, there has been even less use of design within this space. However, when the elements of community and design are removed, numerous sources have widely reported on individual's attitudes, perceptions and behaviours with respect to future mobility solutions such as car sharing, ride sharing and autonomous vehicles.

1. Mobility Diary	2. Quantitative Survey	3. Qualitative Survey	4. Qualitative Interviews	5. theoretical simulations / mathematic simulations	6. Car Share / Ride Share Pilot	7. Position Paper (No Data)	8. Secondary Data Analysis (i.e. Census Data, Customer Demographics, Government Policies)
(Huwer, 2004) (Grischkat, Hunecke, Böhler, & Haustein, 2014)	(Efthymiou, Antoniou, & Waddell, 2013) (Morency, 2006) (Kuemmerling, Heilmann, & Meixner, 2013) (Meijkamp, 1998) (Truffer, 2010) (Huwer, 2004) (Papon & Hivert, 2008) (Silvis & Niemeier, 2009) (G. Correia & Viegas, 2011) (Prettenthaler & Steininger, 1999) (Sioui, Morency, & Trépanier, 2013) (D. Kim, Ko, & Park, 2015) (Brand, Goodman, Ogilvie, 2014) (Guzman & Diaz, 2005) (Prettenthaler & Steininger, 1999) (Steininger, Vogl, & Zettl, 1996)	(Efthymiou et al., 2013) (Kuemmerling et al., 2013) (Huwer, 2004)	(Truffer, 2010) (Grischkat et al., 2014)	(Dubernet & Axhausen, 2013) (Cangialosi, Di Febbraro, & Sacco, 2013) (Martínez-Barberá & Herrero-Pérez, 2014) (Di Febbraro, Gattorna, & Sacco, 2013) (Martínez-Barberá & Herrero-Pérez, 2014) (Pérez, Nashashibi, Lefaudeux, Resende, & Pollard, 2013) (Boussier, Ion, Breuil, & Benhabib, 2005) (G. H. D. A. Correia, Jorge, & Antunes, 2014) (Ozguner, Redmill, Ogras, Dagci, & Launsbach, 2002) (Hrnčíř, Rovatsos, & Jakob, 2015)	(Ramazzotti, Liguori, & Dziekan, 2012)	(Santos et al., 2010) (Riener, 2014) (McGovern, 1998) (Rakotonirainy, Schroeter, & Soro, 2014)	(Coll, Vandersmissen, & Thériault, 2014) (Caulfield, 2009) (Giuliano, Hwang, & Wachs, 1993) (Fletcher-Morgan and Leyland, 2010) (Dowling & Kent, 2015) (Wood, 1982)

Table 4: Literature Categorised by Methodology

To further demonstrate this deconstruction of sources, a snapshot of available papers are summarised in Table 5 below. Each paper has been broken down into its aim, methodological approach and results. This provides a clear view of the current research landscape and how researchers have done this in the past.

Methodology Category	Author	Aim	Research Design	Results
1. Mobility Diary 2. Quantitative Survey 3. Qualitative Survey	(Huwer, 2004)	To assess how the innovation of carsharing diffuses through two German towns To make a case of greater integration between public transport and car sharing.	Participants: General Population Data Collection: 1. Questionnaires - 1193 responses 2. Mobility Diary - 48 Diaries 3. Personal Interview (both Quantitative and Qualitative) - 105 **Note: mobility behaviour primarily assessed through the mobility diary.**	**Mobility behaviour** Car Sharing is used seldom more than once a month Depends on life situation and activity High customer satisfaction
2. Quantitative Survey 3. Qualitative Survey	(Efthymiou et al., 2013)	To understand the factors affecting adoption of vehicle sharing systems of young adult drivers in Greece.	Participants: Young Adults from Greece aged 18-35 Data Collection: Online Survey – Structured in Four Parts: 1. Travel Patterns: - Mode use for daily trips - Perception of advantages and disadvantages of car and bike ownership - Satisfaction with current travel patterns - Familiarity with car and bike sharing 2. Car and Bike Sharing Schemes 3. Perceptions of the importance of factors for bikesharing and carsharing adoption 4. Demographics of Participants	Those with an income of 15,000 – 25,000 Euros are most likely to join a Car Share / Bike Share system in Greece. Car sharing most likely to persuade public transport users Bike sharing most likely to persuade foot traffic Aged 26 – 35 Those more environmentally conscious
4. Qualitative Interviews	(Truffer, 2010)	To understand the role of users in the spread of car sharing	Participants: 1. Car Sharing Managers 2. Car Sharing Users Data Collection: 1. Qualitative Interviews with Car Sharing Managers x 24 2. Qualitative Interviews with Car Sharing Users x 40 3. Quantitative Surveys from Car Sharing Organisation 4. Quantitative Surveys by Independent Researcher	Early users were environmentally conscious and financially sensitive Wanted to spread the word to the rest of the community
3. Qualitative Survey	(Kuemmerling et al., 2013)	With the rise of shared vehicles and intermodality, this paper investigates frequent drivers for the purposes of designing mobility profiles and greater personalisation across mobility platforms	Participants: Frequent Drivers Data Collection: 54 x Qualitative Surveys	Users responded positively toward the mobility profiles Saw the application within Shared Use vehicles Highlighted the need for security, good usability across car platforms, information systems and other minor settings
1. Mobility Diary 4. Qualitative Interviews	(Grischkat et al., 2014)	This study evaluates potential for the reduction of greenhouse gas emissions in the passenger transport sector achievable through the use of mobility services	Participants: Data Collection: quantitative survey (from Hunecke et al. 2010) 42 qualitative interviews 42 mobility diaries kept over 1 week	The study quantifies the environmental effects of new mobility services Used real data to make this calculation
2. Quantitative Survey	(Papon & Hivert, 2008)	To understand two research questions: 1. Who rents a car and why? 2. Which households share the driving of their cars	Participant: Parc-Auto Customers (France) However, does not ask about the use, only questions inter household sharing. Data Collection: 10,000 Quantitative Survey	Who: - Those houses with more license holders than cars - only 15 percent of single car, single user households - 58% of primary users are male 55% of secondary users are female
2. Quantitative Survey	(D. Kim et al., 2015)	To understand the factors affecting electric vehicle sharing programme participants attitudes about car ownership and programme participation	Participants: Participants of the Seoul electric vehicle sharing programme. Method: 533 Web-based, quantitative survey responses	- Reluctant to change ownership, however, have intentions to continue use of vehicle sharing programme age and income were factors in further use
2. Quantitative Survey	(Sioui et al., 2013)	To study the collective benefits of car sharing	Participants: Car Sharing Users General Population	Car sharing users had lower car use than the general population

			Method: 1. Web-based survey of car sharing users. 2. Large scale, regional, Origin-Destination survey of the general population.	Paints a snapshot of car sharing users
5. Theoretical Simulations / Mathematic Simulations	**(Dubernet & Axhausen, 2013)**	To understand how travel decisions are influenced by joint decisions and interactions with social contracts	Participants: No Participants Method: Use of state of the art simulation software, MATSim.	A mathematical model for achieving equilibrium in a two person sharing scenario
6. Car Share / Ride Share Pilot Programme	**(Ramazzotti et al., 2012)**	To test the role of incentives (a credit point scheme) by using a fully developed transport integration systems that integrates Public Transport, Car sharing or Ride sharing, Cycling	Participants: General Population Employees of a specific business (for Car Pooling) colBus users Method: Test pilot programme and record results	Incentives were very successful in spreading the initial vision of the programme Implemented a *challenge* system that helped foster a sense of community Incentives work but not alone
7. Position Paper	**(Santos et al., 2010)**	To review existing literature and government statistics on the outcome of government policies to create sustainable transport One of the is car sharing and ride sharing	Participants: No Participants Method: Literature Review Analysis of Secondary Data	Three Strands of Results: Hard Policy Soft Policy Knowledge Policy A complete snapshot of policy needed for sustainable transport
8. Secondary Data Analysis	**(Coll et al., 2014)**	To chart the diffusion of the car sharing phenomena in Quebec, Canada.	Participants: No Participants Method: Use of secondary quantitative customer data from a car-sharing provider. Cross referenced demographics with geographical data This data was then mapped the surrounding urban environment through Cervero and Kockelman's 5D model (density, diversity, design, distance to transit and destination accessibility).	It was found that car sharing did indeed follow previous studies of innovation diffusion However, socio-economic factors played a larger role

Table 5: Snapshot of Research Analysis

From these sources, two key findings were found though analysis of methodological approaches taken by previous researchers. These are:

1) Limited attempt to directly understand the user
2) Sporadic, limited understanding of a user

4.1 Limited Attempt to Understand the User

Many of the examined studies attempted to understand an individual's thoughts, perceptions and attitudes toward new and future mobility solutions. However, only three directly posed this area of study as their primary research aim. Papon and Hivert (2008) asked sought to ask, who rents a car and why, Efthymiou et al. (2013) sought to uncover the factors affecting vehicle adoption of young drivers in Greece and Kim et al. (2015) to unpack the factors affecting electric vehicle sharing programme participants attitudes about car ownership and participation in an electric vehicle sharing programme.

Within other studies, the end user was sometimes a data collection source, yet was rarely the focus of the study. Two studies demonstrate this well, Truffer (2010) and Sioui (2013). In Truffer (2010), users are studied in the context of innovation and a multi-stakeholder approach was taken yet only a small amount of information is revealed about the user. The main lens of the study examines what role users play in helping a new mobility solution progress. Sioui et al. (2013) present an interesting sample strategy, segmenting new mobility users (car sharers) and the general population to provide comparison. However, the aim was not to understand individuals, rather to chart the collective benefits of car sharing.

4.2 A Sporadic, Limited Understanding of a User

Building on the previous point, a lack of studies focusing on the user has led to a poor understanding of who these users or non-users are. Efthymiou et al. (2013) describes shared mobility users in Greece as those likely to be of low income, aged 26 to 35 with car sharing more likely to appeal to those frequent public transport users and bike sharing to those who often travel on foot. Furthermore, Huwer (2004) describes car sharing users as aged 26 – 43, from small households and are more likely to be male. Truffer (2010) continues the description, describing users "more environmentally conscious" yet the decision to adopt a new mobility service as making rational, financial sense. These people were advocates of the new mobility service. Papon and Hivert (2008) portray another vision of new mobility service users from investigating Parc-Auto customers in France. These customers are painted as from mainly working, high income and middle aged. These households usually have more than one tenant, one license and one wage. From a study in South Korea, Kim et al. (2015) describes participants in a electric vehicle sharing programme as more than likely male, aged between 20-30 and more likely to already own a car. Finally, Sioui et al. (2013) found car sharing users in Canada to be more likely to be younger, from a minimum two person household and likely to have young children. This existing literature culminates in a broad and haphazard understanding the users and non-users of new mobility solutions.

5.0 Discussion – Understanding What but not Why – A Design Approach is Needed

From examination of the findings it was found that the majority of the cases simply examine the phenomena of new mobility solutions, uncovering *what* is happening, however with little understanding of *why* certain events are occurring or the meaning behind the phenomena. The authors believe this is linked to the lack of in-depth qualitative methods in the research process. Zaltman (2003) argues that traditional market research techniques, such as quantitative surveys and questionnaires, work well when there is little change in the customer or when customers can readily articulate thoughts or needs. In their paper, Price, Wrigley and Straker (2015) further establish this weakness of quantitative methods. In a study of 13 companies, each deploying their own research activities, many firms found traditional market research techniques such as surveys, questionnaires and focus groups with existing customers failed to gather much beyond simple answers (Price, Wrigley and Straker,

2015). Qualitative approaches, specifically a deep customer insight approach, proved more valuable in understanding behaviours behind customer decisions. Researchers need to dig deeper.

The authors believe that this understanding of *what* but not *why* stems from a limited attempt to directly address the human needs at the centre of these complex transportation and mobility systems. Although necessary studies in proving how these systems work and will be optimised, they mostly neglect a fundamental piece of the puzzle, the human using the system. Current research goes against the vast history of previous mobility and transportation research that has already established that understanding transportation and mobility systems is more than simply infrastructure and vehicles; a comprehensive understanding of individual's thoughts, perceptions and attitudes toward mobility and transportation alternatives is required (Hunecke et al., 2007; Scheiner & Kasper, 2003). Understanding this is vital to the success of new systems and the improvement of old ones.

This lack of knowledge is an opportunity for design research. Inherently qualitative and human focused, design research can fill this gap in knowledge by applying distinctly user-centred methods such as persona design, narrative storytelling, in-depth observations to discover deeper human insights. These will create a better knowledge base, a better understanding of new and future mobility solutions and greater grounding for the design of further mobility systems.

6.0 Conclusion

Transportation and mobility have been well studied in the past, with previous research covering thoughts, attitudes and perceptions of individuals in relation to both private and public transportation. However, a new form of mobility is upon us, one that bridges the public / private divide. This paper sought to investigate *Which methodological approaches have been used to study the effect of community on an individual's attitudes, perceptions and behaviours of future mobility solutions?* The results were limited with less than a handful of papers emerging. When the search was slightly broadened, 39 papers were analysed which concluded a high use of quantitative methods and a limited understanding of people in the new mobility paradigm. The authors argue that this presents an opportunity for design research with design research methods specifically created to go beyond surface data and intimately understand people.

References:

Abrahamse, W., & Keall, M. (2012). Effectiveness of a web-based intervention to encourage carpooling to work: A case study of Wellington, New Zealand. *Transport Policy*, *21*, 45–51. doi:10.1016/j.tranpol.2012.01.005

Acker, V. Van, Mokhtarian, P. L., & Witlox, F. (2011). *Going soft: on how Subjective Variables Explain Modal Choices for Leisure Travel* (Vol. 11).

Agatz, N., Erera, A., Savelsbergh, M., & Wang, X. (2012). Optimization for dynamic ride-sharing: A review. *European Journal of Operational Research*, *223*(2), 295–303. doi:10.1016/j.ejor.2012.05.028

Anable, J. (2005). "Complacent Car Addicts" or "Aspiring Environmentalists"? Identifying travel behaviour segments using attitude theory. *Transport Policy*, *12*(1), 65–78. doi:10.1016/j.tranpol.2004.11.004

Bamberg, S., Hunecke, M., & Blöbaum, A. (2007). Social context, personal norms and the use of public transportation: Two field studies. *Journal of Environmental Psychology*, *27*(3), 190–203. doi:10.1016/j.jenvp.2007.04.001

Banister, D. (2011). Cities, mobility and climate change. *Journal of Transport Geography*, *19*(6), 1538–1546. doi:10.1016/j.jtrangeo.2011.03.009

Beirão, G., & Sarsfield Cabral, J. a. (2007). Understanding attitudes towards public transport and private car: A qualitative study. *Transport Policy*, *14*(6), 478–489. doi:10.1016/j.tranpol.2007.04.009

Belk, R. (2014). You are what you can access: Sharing and collaborative consumption online. *Journal of Business Research*, *67*(8), 1595–1600. doi:10.1016/j.jbusres.2013.10.001

Bonsall, P., Spencer, A., & Tang, W.-S. (1982). Ridesharing in Great Britain: Performance and Impact of the Yorkshare Schemes. *Transport Research Volume A*, *17*(3), 169–181.

Botsman, R., & Rogers, R. (2010). *What's Mine Is Yours: The Rise of Collaborative Consumption. What is mine is yours. PPT*. New York, New York, USA.

Boussier, J. M., Ion, L., Breuil, D., & Benhabib, S. (2005). Optimisation of car fleet exploitation using statistical and fuzzy logic approaches, *77*, 37–46.

Brög, W., Erl, E., Ker, I., Ryle, J., & Wall, R. (2009). Evaluation of voluntary travel behaviour change: Experiences from three continents. *Transport Policy*, *16*, 281–292. doi:10.1016/j.tranpol.2009.10.003

Bruglieri, M., Ciccarelli, D., Colorni, A., & Luè, A. (2011). PoliUniPool: a carpooling system for universities. *Procedia - Social and Behavioral Sciences*, *20*, 558–567. doi:10.1016/j.sbspro.2011.08.062

Cangialosi, E., Di Febbraro, A., & Sacco, N. (2013). On Promoting Modal Shift via Generalized Ride Sharing, 606–611. doi:10.1109/ICCVE.2013.85

Caulfield, B. (2009). Estimating the environmental benefits of ride-sharing: A case study of Dublin. *Transportation Research Part D: Transport and Environment*, *14*(7), 527–531. doi:10.1016/j.trd.2009.07.008

Cohen, B., & Kietzmann, J. (2014). Ride On! Mobility Business Models for the Sharing Economy. *Organization & Environment*. doi:10.1177/1086026614546199

Coll, M. H., Vandersmissen, M. H., & Thériault, M. (2014). Modeling spatio-temporal diffusion of carsharing membership in Québec City. *Journal of Transport Geography*, *38*, 22–37. doi:10.1016/j.jtrangeo.2014.04.017

Collins, A., Joseph, D., & Bielaczyc, K. (2004). Design Research: Theoretical and Methodological Issues. *Journal of the Learning Sciences*, *13*(March 2015), 15–42. doi:10.1207/s15327809jls1301

Correia, G. H. D. A., Jorge, D. R., & Antunes, D. M. (2014). The Added Value of Accounting For Users' Flexibility and Information on the Potential of a Station-Based One-Way Car-Sharing System: An Application in Lisbon, Portugal. *Journal of Intelligent Transportation Systems*, *18*(3), 299–308. doi:10.1080/15472450.2013.836928

Correia, G., & Viegas, J. M. (2011). Carpooling and carpool clubs: Clarifying concepts and assessing value enhancement possibilities through a Stated Preference web survey in Lisbon, Portugal. *Transportation Research Part A: Policy and Practice*, *45*(2), 81–90. doi:10.1016/j.tra.2010.11.001

Dowling, R., & Kent, J. (2015). Practice and public–private partnerships in sustainable transport governance: The case of car sharing in Sydney, Australia. *Transport Policy*, *40*, 58–64. doi:10.1016/j.tranpol.2015.02.007

Dubernet, T., & Axhausen, K. W. (2013). Including joint decision mechanisms in a multiagent transport simulation. *Transportation Letters*, *5*(4), 175–183. doi:10.1179/1942787513Y.0000000002

Efthymiou, D., Antoniou, C., & Waddell, P. (2013). Factors affecting the adoption of vehicle sharing systems by young drivers. *Transport Policy*, *29*, 64–73. doi:10.1016/j.tranpol.2013.04.009

Elias, W., & Shiftan, Y. (2012). The influence of individual's risk perception and attitudes on travel behavior. *Transportation Research Part A: Policy and Practice*, *46*(8), 1241–1251. doi:10.1016/j.tra.2012.05.013

Febbraro, a., Gattorna, E., & Sacco, N. (2013). Optimizing Dynamic Ride-Sharing Systems. *Transportation Research Board*, *4*(2359), 1–13. doi:10.3141/2359-06

Fu, L., & Sun, M. (2012). A study on the usage of material aesthetics in car design. In *New trends in mechanical engineering and materials : selected, peer reviewed papers from the 2012 international conference on mechatronics and materials engineering* (pp. 469–475).

Gensch, D. (1981). A PRACTICAL SEGMENTATION STRATEGY TO INCREASE RIDE SHARING. *Transportation Research Part A: General*, *IM*(Cd), 331–337. Retrieved from http://www.sciencedirect.com/science/article/pii/0191260781900157

Giuliano, G., Hwang, K., & Wachs, M. (1993). Employee trip reduction in Southern California: First year results. *Transportation Research Part A: Policy and Practice*, *27*(2), 125–137. doi:10.1016/0965-8564(93)90068-V

Goldman, T., & Gorham, R. (2006). Sustainable urban transport: Four innovative directions. *Technology in Society*, *28*(1-2), 261–273. doi:10.1016/j.techsoc.2005.10.007

Gomez, R. E., Popovic, V., & Bucolo, S. (2004). Driving: The emotional experience and automotive design. *Fourth International Conference on Design and Emotion*. Retrieved from http://eprints.qut.edu.au/1525/\nhttp://eprints.qut.edu.au/1525

Grischkat, S., Hunecke, M., Böhler, S., & Haustein, S. (2014). Potential for the reduction of greenhouse gas emissions through the use of mobility services. *Transport Policy*, *35*, 295–303. doi:10.1016/j.tranpol.2014.06.007

Guzman, M. P. D. E., & Diaz, C. E. (2005). Analysis of Mode Choice Behavior of Students in Exclusive Schools in Metro Manila : the Case of Ateneo De Manila University & Miriam College. *Transportation*, *5*, 1116–1131.

Hekkert, P., Snelders, D., & van Wieringen, P. C. W. (2003). "Most advanced, yet acceptable": typicality and novelty as joint predictors of aesthetic preference in industrial design. *British Journal of Psychology (London, England : 1953)*, *94*, 111–124. doi:10.1348/000712603762842147

Hevner, A. R. (2007). A Three Cycle View of Design Science Research A Three Cycle View of Design Science Research, *19*(2), 87–92.

Hrnčíř, J., Rovatsos, M., & Jakob, M. (2015). Ridesharing on Timetabled Transport Services: A Multiagent Planning Approach. *Journal of Intelligent Transportation Systems*, *19*(1), 89–105. doi:10.1080/15472450.2014.941759

Hunecke, M., Haustein, S., Grischkat, S., & Böhler, S. (2007). Psychological, sociodemographic, and infrastructural factors as determinants of ecological impact caused by mobility behavior. *Journal of Environmental Psychology*, *27*(4), 277–292. doi:10.1016/j.jenvp.2007.08.001

Huwer, U. (2004). Public transport and csar-sharing—benefits and effects of combined services. *Transport Policy*, *11*(1), 77–87. doi:10.1016/j.tranpol.2003.08.002

Kim, D., Ko, J., & Park, Y. (2015). Factors affecting electric vehicle sharing program participants ' attitudes about car ownership and program participation. *TRANSPORTATION RESEARCH PART D*, *36*, 96–106. doi:10.1016/j.trd.2015.02.009

Kim, S., Dey, A. K., Lee, J., & Forlizzi, J. (2011). Usability of car dashboard displays for elder drivers. *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI '11*, 493–502. doi:10.1145/1978942.1979011

Kuemmerling, M., Heilmann, C., & Meixner, G. (2013). Towards Seamless Mobility: Individual Mobility Profiles to Ease the Use of Shared Vehicles. In N. S. (Ed.), *IFAC Proceedings Volumes (IFAC-PapersOnline)* (Vol. 12, pp. 450–454). doi:10.3182/20130811-5-US-2037.00029

Lovelock, C. H., & Dobson, R. D. E. P. (2014). The Direction to of Causality and Travel Between Perceptions , Affect , Application Behavior : Behavior An, *6*(4), 370–376.

Martínez-Barberá, H., & Herrero-Pérez, D. (2014). Multilayer distributed intelligent control of an autonomous car. *Transportation Research Part C: Emerging Technologies*, *39*(w), 94–112. doi:10.1016/j.trc.2013.12.006

Mcgovern, E. (2015). ENVIRONMENTAL IMPACT OF TRANSPORT : TRAFFIC MANAGEMENT SCHEMES AND THEIR INFLUENCE ON SUSTAINABLE DEVELOPMENT, *30*(1998), 23–30.

Meijkamp, R. (1998). Eco-Efficient Services : an Empirical Study of Car Sharing in the. *Business Strategy and the Environment*, *7*, 234–244. doi:10.1002/(SICI)1099-0836(199809)7:4<234::AID-BSE159>3.0.CO;2-A

Morency, C. (2006). The ambivalence of ridesharing. *Transportation*, *34*(2), 239–253. doi:10.1007/s11116-006-9101-9

Muratovski, G. (2015). The Death Spiral in Design, *1*(1), 3–6. doi:10.1386/dbs.1.1.3

Musselwhite, C., & Haddad, H. (2010). Mobility, accessibility and quality of later life. *Quality in Ageing and Older Adults*, *11*(1), 25–37. doi:10.5042/qiaoa.2010.0153

Ory, D. T., & Mokhtarian, P. L. (2009). Modeling the structural relationships among short-distance travel amounts, perceptions, affections, and desires. *Transportation Research Part A: Policy and Practice*, *43*(1), 26–43. doi:10.1016/j.tra.2008.06.004

Ozguner, U., Redmill, K., Ogras, U., Dagci, O., & Launsbach, M. (2002). Autonomous vehicles in structured and semi-structured environments. *Proceedings of the 41st IEEE Conference on Decision and Control, 2002.*, *1*(December 2002). doi:10.1109/CDC.2002.1184479

Papon, F., & Hivert, L. (2008). Adulterous Behaviour Within the Car-Owner Couple. *IATSS Research*, *32*(2), 6–15. doi:10.1016/S0386-1112(14)60205-3

Paulssen, M., Temme, D., Vij, A., & Walker, J. L. (2013). Values, attitudes and travel behavior: a hierarchical latent variable mixed logit model of travel mode choice. *Transportation*, *41*(4), 873–888. doi:10.1007/s11116-013-9504-3

Pérez, J., Nashashibi, F., Lefaudeux, B., Resende, P., & Pollard, E. (2013). Autonomous docking based on infrared system for electric vehicle charging in urban areas. *Sensors (Switzerland)*, *13*, 2645–2663. doi:10.3390/s130202645

Potoglou, D., & Kanaroglou, P. S. (2008). Modelling car ownership in urban areas: a case study of Hamilton, Canada. *Journal of Transport Geography*, *16*(1), 42–54. doi:10.1016/j.jtrangeo.2007.01.006

Prettenthaler, F. E., & Steininger, K. W. (1999). From ownership to service use lifestyle: the potential of car sharing. *Ecological Economics*, *28*(3), 443–453. doi:10.1016/S0921-8009(98)00109-8

Price, R., Wrigley, C., & Straker, K. (2015). Not just what they want, but why they want it: Traditional market research to deep customer insights. *Qualitative Market Research: An International Journal*, *18*(2).

Rabbitt, N., & Ghosh, B. (2013). A study of feasibility and potential benefits of organised car sharing in Ireland. *Transportation Research Part D: Transport and Environment*, *25*, 49–58. doi:10.1016/j.trd.2013.07.004

Rakotonirainy, A., Schroeter, R., & Soro, A. (2014). Three social car visions to improve driver behaviour. *Pervasive and Mobile Computing*, *14*, 147–160. doi:10.1016/j.pmcj.2014.06.004

Ramazzotti, D., Liguori, G., & Dziekan, K. (2012). Civitas MIMOSA Project. Mobility Credit System in Bologna. *Procedia - Social and Behavioral Sciences*, *48*, 1568–1577. doi:10.1016/j.sbspro.2012.06.1132

Richard, P., Burkhardt, J.-M., & Lubart, T. (2014). Users ' participation to creative design of new solutions for mobility : An exploratory study. In *European Conference on Cognitive Ergonomics*.

Riener, A. (2014). Who cares about trust , grade of tra- veling & quality of user experience in a world of autonomous cars ?

Santos, G., Behrendt, H., & Teytelboym, A. (2010). Part II: Policy instruments for sustainable road transport. *Research in Transportation Economics*, *28*(1), 46–91. doi:10.1016/j.retrec.2010.03.002

Scheiner, J., & Holz-Rau, C. (2007). Travel mode choice: affected by objective or subjective determinants? *Transportation*, *34*(4), 487–511. doi:10.1007/s11116-007-9112-1

Scheiner, J., & Kasper, B. (2002). Lifestyles, choice of housing location and daily mobility. Retrieved from http://wuw-ruw.wu-wien.ac.at/ersa/ersaconfs/ersa02/cd-rom/papers/201.pdf

Scheiner, J., & Kasper, B. (2003). Lifestyles, choice of housing location and daily mobility: the lifestyle approach in the context of spatial mobility and planning. *International Social Science Journal*, *55*(176), 319–332. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/j.1468-2451.2003.05502011.x/full

Shaheen, S. a., Mallery, M. a., & Kingsley, K. J. (2012). Personal vehicle sharing services in North America. *Research in Transportation Business & Management*, *3*, 71–81. doi:10.1016/j.rtbm.2012.04.005

Shiftan, Y., Outwater, M. L., & Zhou, Y. (2008). Transit market research using structural equation modeling and attitudinal market segmentation. *Transport Policy*, *15*(3), 186–195. doi:10.1016/j.tranpol.2008.03.002

Silvis, J., & Niemeier, D. (2009). Social Network and Dwelling Characteristics That Influence Ridesharing Behavior of Seniors. *Transportation Research Record: Journal of the Transportation Research Board*, *2118*(2118), 47–54. doi:10.3141/2118-07

Sioui, L., Morency, C., & Trépanier, M. (2013). How Carsharing Affects the Travel Behavior of Households: A Case Study of Montréal, Canada. *International Journal of Sustainable Transportation*, *7*(May 2014), 52–69. doi:10.1080/15568318.2012.660109

Stanley, J. K., Hensher, D. a., Stanley, J. R., & Vella-Brodrick, D. (2011). Mobility, social exclusion and well-being: Exploring the links. *Transportation Research Part A: Policy and Practice*, *45*(8), 789–801. doi:10.1016/j.tra.2011.06.007

Steininger, K., Vogl, C., & Zettl, R. (1996). Car-sharing organizations in mobility behavior, *3*(4), 177–185.

Tertoolen, G., van Kreveld, D., & Verstraten, B. (1998). Psychological resistance against attempts to reduce private car use. *Transportation Research Part A: Policy and Practice*, *32*(3), 171–181. doi:10.1016/S0965-8564(97)00006-2

Thøgersen, J. (2006). Understanding repetitive travel mode choices in a stable context: A panel study approach. *Transportation Research Part A: Policy and Practice*, *40*(8), 621–638. doi:10.1016/j.tra.2005.11.004

Truffer, B. (2010). User-led Innovation Processes : The Development of Professional Car Sharing by Environmentally Concerned Citizens User-led Innovation Processes : the Development of Professional Car Sharing by Environmentally Concerned Citizens, (March 2015), 37–41. doi:10.1080/13511610304517

Zimmerman, J. (2003). Position Paper on Design in HCI Education Position. *Human-Computer Interaction*. Retrieved from http://repository.cmu.edu/hcii/244