

# **Examining the process of carsharing adoption in the Netherlands: roles of car ownership, motivations, barriers and mobility habits at different transition points**

Jingran Xu\*<sup>1</sup>, Dea van Lierop<sup>2</sup>, Dick Ettema<sup>3</sup>

<sup>1</sup> PhD student

<sup>2</sup> Assistant Professor

<sup>3</sup> Professor, Department of Human Geography and Spatial Planning, Utrecht University, the Netherlands

## **ABSTRACT**

The adoption of carsharing is considered as a dynamic process with multiple stages rather than a static representation. Research on factors influencing the stages and transitions between different stages is limited. This study aims to explore how socioeconomic status, car ownership, attitudes, motivations, barriers and mobility habits influence how individuals transition between different stages in carsharing adoption process. Based on data collected in neighborhoods with a high car-sharing prevalence in Utrecht, the Netherlands, our results suggest that between different adoption stages, sociodemographic variables play an effect and some of effects generally follow the kind of early-adopter profile found in earlier studies. The results also suggest that current car ownership inhibits the carsharing adoption at all stages to varying degrees, while past changes and expected changes in future play different roles at different transition points. There are different motivations, barrier and mobility habits explicitly related to adoption at different transition points.

**Keywords:** Carsharing adoption; process; car ownership; motivation; barrier; mobility habit

## **1. INTRODUCTION**

In recent years, carsharing has gradually developed into a much-discussed future urban transportation solution . However, like other innovative (shared) mobility services, carsharing faces the central question of how to stimulate widespread adoption . The adoption of carsharing services is considered as a dynamic process with multiple stages rather than a static representation (Jain et al., 2020). Research on mobility management shows that policies and measures that fully consider the series of behavioral change characteristics of a particular sustainable travel mode can help reduce resistance to change, break habits and motivate potential users to voluntarily switch travel modes. Therefore, it is necessary to understand the transition between different stages and their unique influencing factors in the process of carsharing adoption stages in order to effectively promote this new travel mode (Burghard & Dütschke, 2019).

This study uses the Transtheoretical Model (TTM) to understand the transitions of carsharing adoption. TTM conceptualizes behavioral change as a transition involving a series of distinct stages of change to summarize how a person is prepared for or engaged with change. In recent years this model has been effectively used in relevant research on the adoption process of innovative mobility services such as bike sharing (Biehl et al., 2019). Research on factors influencing these stages and transitions between different stages with respect to carsharing is limited. Current research focuses on different stages or different population segments related to carsharing adoption such as current carsharing users, current non-users, future potential users, future non-users

(Hjortset & Böcker, 2020), but does not take into account transitions from one stage to another in the context of the comprehensive adoption process. The complete adoption process includes from pre-contemplation to contemplation, from contemplation to action, from action to maintenance, and also from action to relapse, as well as action in the past but now abandon. If the different stages of change and the transitions between different stages (transition points) are considered more comprehensively and integrated in one sample, then how different transition points are intertwined with different influencing factors can be effectively distinguished.

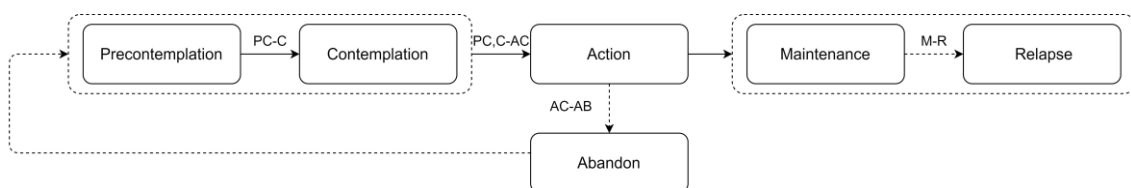
This study divides the process of carsharing adoption of neighborhoods in Netherlands into five stages of change and extract four key adoption transition points. Specifically, we ask: *How do socioeconomic, car ownership, attitude, motivation, barrier and mobility habits factors influence transitions between different stages in the carsharing adoption process?* Based on this, a series of binomial logit and ordinal logit model are applied to data collected using a survey in several typical neighborhoods with a high carsharing prevalence in Utrecht, the Netherlands. It complements existing literature in three ways: First, we extend previous findings on the change process by considering multiple stages of the adoption process within a single sample with a more comprehensive consideration of both stages and transitions between stages. Second, we provide an integrated analysis of carsharing adoption based on individual characteristics, attitudes, mobility habits, motivations and barriers. Third, in contrast to other studies, our survey takes place in a cluster of urban neighborhoods (14,000 households) in a medium-sized city with a high prevalence of carsharing membership up to 22%. This allows us to infer differences in the behavior of carsharing users and potential users, depending on the respective sample contexts.

## 2. METHODOLOGY

In June and October 2021, 8,000 postcards inviting people to participate in the online survey were distributed to households in the selected nine neighborhoods located west of the Utrecht city center. 512 respondents participated in the survey leading to 360 valid responses. The sociodemographic characteristics of the city of Utrecht and research area can be find in existing related study (Xu et al., 2024).

We propose a stage-identification procedure for carsharing adoption that attempts to distinguish and characterize potential stages of change based on mindsets and actions appropriate given the structure of the transport system. This procedure refers to previous research for carsharing and shared bikes, but refines based on the characteristics of carsharing and our research questions. The defined stages of change are (Figure 1): *Abandon* “someone who are current or previous carsharing member but no longer uses it”. *Pre-contemplation* “someone who never really thinks about and not even considers using carsharing”. *Contemplation* “someone who never used carsharing but interested to begin carsharing”. *Action* “someone who are currently using carsharing”. *Maintenance* “someone who are currently using carsharing and decided continue using it in the next 2 years”. *Relapse* “someone who are currently using carsharing and decided not continue using it in the next 2 years”.

**Figure 1: The stages of change about carsharing adoption**



Since our research question is to understand the role of sociodemographic, motivation, and barrier factors at different adoption transition points in stages of change about carsharing adoption, the ordinal and binary logistic regression model could compare each stage of change with the immediate next stage. We use two ordinal logistic and two binary logistic regression models for four transition points (*Precontemplation - Contemplation*, *Precontemplation and Contemplation - Action*, *Maintenance - Relapse*, *Action - Abandon*).

### 3. RESULTS

Table 1 shows the results of B and Exp(B) for the different models. The model *Pre-contemplation - Contemplation* focuses on the difference between non-users who have the intention to use and those who do not intend to try, the result reveals that potential adopters who are younger, have positive attitudes towards carsharing and private cars, have higher frequency of personal-vehicle trips with 1-4 times per month or above, have 2-6 public transport trips per week, and household car ownership is expected to decrease in the future show a positive likelihood of being in the contemplation stage rather than pre-contemplation. While potential adopters who have two or more private cars in household and cite ease of use carsharing vehicle as barriers show a negative likelihood of being in the contemplation stage rather than pre-contemplation. High frequency with personal vehicle and public transport means higher demand and possibility of long-distance trips where active transport is not suitable. For these people, the sufficient number of private cars and the perception of carsharing technology and facilities are not easy to use would undoubtedly inhibit them from considering trying carsharing.

The model *Pre-contemplation and Contemplation - Action* focuses on the difference between users and non-users, the results show that the following factors may lead to lower likelihood of being in the action stage compared to pre-contemplation and contemplation stage: having private cars, higher frequency of personal-vehicle trips and higher frequency of active transport trips with more than 1-4 times per month. With two or more licenses in household members, employed parttime, self-employed and student, decreased car ownership in the past 2 years, positive attitude towards carsharing, are positively associated to the action stage compared to the pre-contemplation and contemplation stage.

Based on the results of model *Relapse - Maintenance*, which focuses on the differences in users' willingness to continue using in the future owing private cars, household car ownership is expected to increase in the future, cite insufficient carsharing vehicle as barrier are more likely to decrease the likelihood of being in the maintenance stage as compared to being in relapse. While current adopters who being higher age, being woman, cite convenience as motivation of adopting carsharing and using carsharing once or more per month are significantly associated to being in the maintenance stage rather than relapse stage. Both the current car ownership and the expected future changes are closely related to the decision of whether to continue using carsharing. At the same time, current carsharing adopters are more concerned about the adequacy of the number of parking spaces than other barriers when considering future choices.

The results of model *Action - Abandon*, which focuses on the differences between current users and past abandoners, suggests that being woman and have private car are significantly associated to being in abandon stage rather than action stage. Surprisingly however, cite cost as motivators is strongly associated with a higher likelihood of being in the abandon stage than being in action stage.

**Table 1: Model result**

Considered independent variables (all sample)	Pre-contemplation - Contemplation (1-3)		Pre-contemplation and Contemplation-Action (ref=Pre-contemplation and Contemplation)		Relapse-Maintenance (1-3)		Action-Abandon (ref=Action)	
	B	Exp(B)	B	Exp(B)	B	Exp(B)	B	Exp(B)
<b>Intercept</b>	-	-	-0.608	-	-	-	-3.751	-
Level of intention to use = 1	-2.466*	0.085	-	-	5.689**	-	-	-
Level of intention to use = 2	1.631	5.109	-	-	7.944**	-	-	-
<b>Socio-demographics</b>								
Age (low to high)	-0.031*	0.969	0.020	1.020	0.056*	1.058	-0.012	0.988
Gender (ref = man)								
Woman	0.297	1.346	-0.055	0.946	1.235**	3.438	1.341**	3.824
Number of license in household (ref = 1 license)								
2 or more licenses	0.407	1.502	1.093**	2.983	0.882	2.416	-0.623	0.537
Number of child (ref = no child under 12 years old)								
1 or more child	-0.337	0.714	0.594*	1.812	0.241	1.273	0.416	1.516
Work status (ref = unemployed, retired and other)								
Employed fulltime	-0.387	0.679	0.949	2.583	1.889	6.613	-1.958	0.141
Employed parttime, self-employed and student	-0.315	0.730	1.510**	4.527	0.589	1.802	-0.656	0.519
Household income per month (ref = low or medium income)								
High income	-0.298	0.742	0.234	1.264	0.057	1.059	-0.050	0.951
<b>Household car ownership</b>								
Current car ownership (ref = no car)								
1 car	-1.014	0.363	-1.923***	0.146	-3.470***	0.031	4.718**	111.949
2+ cars	-1.929*	0.145	-3.263***	0.038			*	
Past car ownership change (ref = no change)								
Decrease	0.042	1.043	0.724*	2.062	0.629	1.876	-0.648	0.523
Increase	-0.471	0.624	0.731	2.077	0.478	1.613	0.372	1.450
Future car ownership change (ref = no change)								
Decrease	2.449**	11.577	0.998	2.713	1.561	4.764	-1.708	0.181
Increase	-0.257	0.773	0.451	1.570	-3.025**	0.049	0.973	2.645
<b>Attitude</b>								
Attitude towards carsharing (low to high)	0.895***	2.447	0.499**	1.646	-0.750	0.472	0.549	1.732
Attitude towards private cars (low to high)	1.444***	4.238	0.188	1.207	0.206	1.229	-0.239	0.787
<b>Motivation of carsharing</b>								
Available	-	-	-	-	-0.173	0.841	-0.496	0.609
Cost	-	-	-	-	0.360	1.433	0.375	1.456
Convenience	-	-	-	-	2.118**	8.314	0.293	1.341
Environment	-	-	-	-	-0.748	0.473	-0.368	0.692
<b>Barrier of carsharing</b>								
Insufficient carsharing vehicle	-0.584	0.558	-	-	-0.040	0.961	1.265	3.544
Insufficient parking	-0.224	0.799	-	-	-1.978*	0.138	-0.167	0.846
Expensive cost	-0.241	0.786	-	-	0.475	1.608	1.124*	3.077
Ease of use	-1.210*	0.298	-	-	-0.718	0.488	0.471	1.602
<b>Mobility habits</b>								
Frequency of all kinds of trips (ref = 1-6 times/week = 0)								
More than 6 times/week	-0.126	0.882	-0.062	0.940	0.726	2.067	0.166	1.181
More than 12 times/week	-0.484	0.616	0.004	1.004	0.395	1.484	1.098	2.999
Frequency of personal-vehicle trips (ref = 0-10 times/year)								
1-4 times/month	1.601**	4.958	-1.156**	0.315	-0.005	0.995	-0.831	0.436
2-6 times/week	1.352**	3.865	-0.898**	0.407	-0.261	0.770	0.211	1.235
Frequency of public transport trips (ref = 0-10 times/year)								
1-4 times/month	0.229	1.257	0.492	1.636	-0.428	0.652	0.364	1.439
2-6 times/week	0.741*	2.098	0.252	1.287	-0.421	0.656	-1.362	0.256
Frequency of active transport trips (ref = 0-10 times/year)								
1-4 times/month	-0.099	0.906	-1.188**	0.305	1.486	4.419	-0.252	0.777
2-6 times/week	-0.426	0.653	-1.759***	0.172	1.085	2.959	0.828	2.289
Frequency of carsharing (ref = less than 1 time/month)								
1 or more than 1 time per month	-	-	-	-	2.049**	7.760	-	-
N	215		360		102		145	
Nagelkerke R Square	0.519		0.484		0.540		0.591	
-2 Log Likelihood	250.912		325.811		154.077		98.304	
Note:								
1. * = p < 0.1; ** = p < 0.05; *** = p < 0.01.								
2. - = not included.								
3. In Relapse-Maintenance and Action-Abandon model, the value "1 car" and "2+ cars" of variable "current car ownership" are combined due to low frequency.								

#### 4. DISCUSSION AND CONCLUSIONS

This study identifies new and potentially important insights into the factors associated with car-sharing adoption. The analysis reveals that the effect of the various sociodemographic characteristics, household car ownership factors, attitude towards carsharing and private cars, mobility habits characteristics, perceived motivators and barriers varies among people in the different stages of change of carsharing adoption, which has major implications for targeting carsharing promotional strategies. Based on the change model, analysis of transition patterns from one stage to another can determine whether an intervention will be more successful for individuals in one stage rather than another. Furthermore, this approach helps to identify key influencing factors between different transition stages, thereby preparing more targeted measures to encourage the mode change to carsharing.

Here we summarize key findings across the four models for the different transition. On transition points between different adoption stages, sociodemographic variables play an effect and some of them generally follow the kind of early-adopter profile found in earlier studies (Prieto et al., 2017). Regarding the effect of age, while we observed a clear positive effect on future carsharing intention for current users, this effect disappears when examining current users and abandoned users as well as current users and non-users, and is reversed when examining the future carsharing intention for non-users. The model results show that being woman has positive effect on future carsharing intention for current users, and also a positive effect on becoming abandon user rather than current user. This suggests that once woman become carsharing users, they are more likely to become continued users.

Current car ownership inhibits the adoption of carsharing at all stages to varying degrees. The model results here reach a conclusion that is partly different to that of previous studies, as this study suggests that among current non-users of carsharing, private car owners have higher participation interest, unrelated recent participation intention and lower registration decision (Hjortset & Böcker, 2020). The difference in results may be due to differences in the popularity of shared cars across different regions and survey times, as the research area has a relatively high prevalence of carsharing membership (22%) and may have surpassed the “early adopters” stage toward the “early majority” stage (Rogers et al., 2014). Early adopters tend to “try” and do not have clear participation intention groups, while there may be a clear division of different participation possibility groups in early majority. At that stage, car owners firmly believe that carsharing cannot replace private cars, and do not consider using it in their intentions. For current non-users of carsharing, reducing the number of private cars in the future is positively related to intention to use carsharing, and for current users, increasing the number of private cars in the future is negatively related to intention to use carsharing. This means that regardless of whether there is actual experience in using carsharing, the decision to use carsharing is closely related to the decision to change private cars, and carsharing can partially replace or supplement the functions of private cars.

Congruent with some existing studies on carsharing motivation, we found that environmental consciousness is not the principal motivation for people to participate in carsharing (Schröder & Wolf, 2017). This resolves some of the ambiguity about the relationship between environmental consciousness and carsharing, as a high degree of environmental consciousness is generally considered an important contributor to carsharing adoption. Regarding barriers to carsharing adoption, there are different barriers explicitly related to adoption at different transition points. For current non-users, ease of use of carsharing facilities and technology is negatively related to future usage intentions, while for current users, the adequacy of carsharing parking spaces is negatively related to future usage intentions. The high price of using shared cars is the main reason for

abandoning carsharing. This means that carsharing services targeting different target groups or development stages require different service goals or policies.

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