

Sharing Rides in Autonomous Mobility-on-Demand-Systems Acceptability, Information Needs and Incentive Systems

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Motivation

Depending on the scenario the penetration of autonomous vehicles of SAE level 4+ traffic will either dramatically rise or significantly decrease. Raising the occupancy rate of autonomous mobility-on-demand-systems by ridesharing is an essential prerequisite for future sustainable mobility [1,2]. Yet, sharing rides with strangers in driverless vehicles might cause acceptance problems concerning privacy and safety issues. Flexible routing and increased travel times in shared autonomous mobility-on-demand-systems (SAMODS) associated with pick-up and drop-off of other passengers might further increase the users' feelings of uncertainty [3].

Research Questions

- 1) Is the willingness to use SAMODS affected by travel time changes and detours due to dynamic routing?
- 2) To what extent could a pricing system be used to incentivize sharing rides?
- 3) Which personal information about fellow travellers is suitable to increase the acceptability of sharing rides?

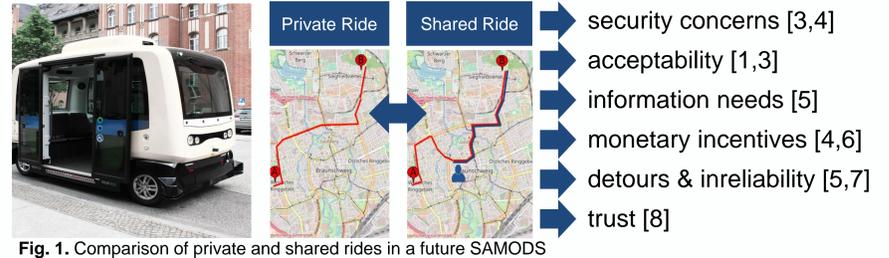


Fig. 1. Comparison of private and shared rides in a future SAMODS

Study 1

Travellers' Willingness to Share Rides in Autonomous Mobility on Demand Systems Depending on Travel Distance and Detour Factor [9]

Methods

In a stated choice experiment ($N = 151$, $M = 33.3$ years, $SD = 11.8$ years) participants completed 15 choice tasks asked for their willingness to accept a shared ride compared to a private ride in SAMODS depending on travel time and detour caused by pick-up and drop-off of further passengers (Fig. 2).

The Willingness to Accept (WTA) is defined as a form of compensation for being adversely affected by a change to the status quo [10] and was assessed as the amount respondents are willing to pay for a shared ride compared to the reference value for of a non-shared ride.

The independent variables were:

- 1) travel time: 10, 15 and 20 min (within)
- 2) detour factor: 1.1, 1.2, 1.3, 1.4, 1.5 (within)



Fig. 2. Exemplary choice set presenting a private ride (left) and a shared ride (right) with 10 min travel time and detour factor of 1.1.

Results

The WTA decreases when travel time ($t(1707) = -1.15$, $p < .001$) and detour factor ($t(1707) = -76.52$, $p < .001$) increase. Gender moderated the effect of detour factor on the WTA ($t(1707) = 17.25$, $p < .001$) in a way that men were more attentive to higher detours. Higher age and income, as well as female gender were associated to a lower WTA. The analysis of cumulative distribution revealed that a critical mass of 90% of respondents is reached by a discount of 50% when the detour factor is 1.1. As shown in Fig. 3, WTA decreases to 26.7% for a detour factor of 1.5.

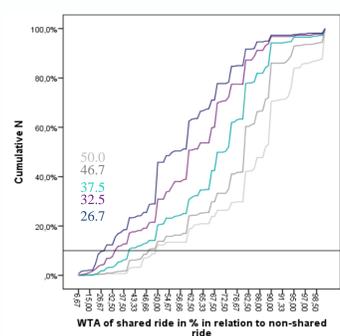


Fig. 3. Cumulative distribution of the WTA regarding detour factor with a reference line set to 10% to display 90% of respondents.

Regressor	No moderation model	Final moderation model
SS _{Regression}	22523.9	196032.5
SS _{Residual}	511004.4	392099.5
SS _{Total}	736258.3	588131.9
Intercept	174.65 (41.83)**	188.28 (33.19)**
Detour	-66.22 (-22.14)**	-76.52 (-18.32)**
Travel time	-1.29 (-12.80)**	-1.15 (-10.98)**
Female Gender		-21.12 (-2.61)**
Age		-2.84 (-2.82)**
Income		-3.21 (-3.32)**
DetourxFemale		17.25 (2.77)**
df_{model}	2	6
F	325.05	107.69
MSE	245.086	229.701
R^2	0.306	0.333

Methods

Using a stated choice experiment with 16 scenarios among members of Generation Y ($N = 154$, $M = 26.5$ years, $SD = 4.4$ years) the willingness to accept (WTA) a shared ride in terms of compensation demands was assessed depending on the quality of information provided about fellow passengers.

The independent variables were:

- 1) travel time (14 vs. 25 min., within)
- 2) Information about fellow travellers (bus stop sign, name, picture, rating, full profile, within)
- 3) information on gender (within)
- 4) degree of automation (between).



Fig. 4. Exemplary choice set presenting a private ride (left) and a shared ride (right) with full profile information.

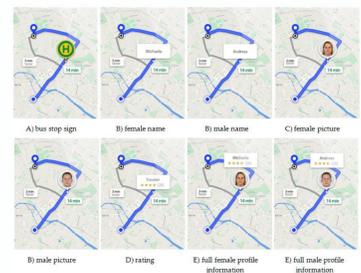


Fig. 5. Levels of information on passenger

Results

The overall compensation demands for sharing a ride was a reduction of approximately 25 % of the private reference price. The compensation demands were lower when they envisioned an autonomous mobility system compared to a conventional system with driver (table 2). Presenting a name only decreased the willingness to share rides ($\exp(\beta) = 0.171$, $p = .005$). The effect was particularly relevant when male names were presented ($\exp(\beta) = 10.794$, $p = .066$). Full profile information reduced the compensation demands ($\exp(\beta) = 4.250$, $p = .041$).

Table 2
Results of multilevel regression analysis

Regressor	β	$\exp(\beta)$	SE	t	p
Intercept	76.777	2.207	2.177	35.28	<.001**
Travel time	-0.519	0.595	0.054	-9.606	<.001**
Automation (with driver = 0)	5.093	162.88	2.751	1.851	.066
Dummy_name	-1.765	0.171	0.915	-1.929	.005*
Dummy_rating	0.694	2.001	0.915	0.759	.448
Dummy_full profile	1.447	4.250	0.709	2.042	.041*
Gender info (male = 0)	0.819	2.268	0.709	1.157	.247
Dummy_name x Gender info	2.379	10.794	1.294	1.840	.066

-2LL = -9921.6; AIC = 19865; BIC = 19929

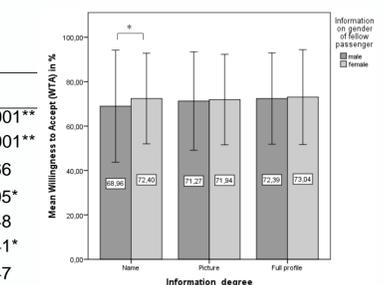


Fig. 6. Mean WTA according to information degree and gender of fellow passenger.

Conclusion

The contribution adds to the limited empirical findings concerning travellers willingness to share rides with strangers in SAMODS by a first explorative step to understand travellers' choice behaviour. The results of study 1 showed that the travel time added to the direct travel time associated with the pick-up of other passengers revealed to be a great barrier to share rides. The findings thus highlight the importance of a pricing system of SAMODS that is adjustable to travel time and detour to attract travellers to share rides with fellow passengers. Study 2 reveals that the presentation of full profile information proved effective in enhancing the acceptability of shared rides in SAMODS whereas presenting a name only reduced the willingness to share rides and increased compensation demands.

Main findings:

- Relevance of a detour-dependent pricing system
- Strong interpersonal differences in acceptability
- Need for a comprehensive information provision



Further research needs:

- Effectiveness of non-monetary incentive systems
- Willingness to share personal data
- Safety and security concerns in driverless shuttles