

USER ACCEPTANCE OF AUTONOMOUS VEHICLES AND STAKEHOLDER EVALUATIONS OF THEIR POTENTIAL IMPACT

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ABSTRACT

Urban mobility is challenged by road safety risks, urban space inequity and negative environmental impact. As travellers within the urban mobility system, the answer to tackling the challenges lies with a behavioural shift towards avoiding trips or using sustainable travel options. At the same time, the technological advancements in vehicle automation are expected to bring revolutionary changes to mobility, and anticipating the changes that will come with this new technology is key. First, autonomous vehicles are expected to increase traffic safety as human error or incapability to respond in high-risk situations will be eliminated. Second, autonomous vehicles are assumed to improve road capacity and reduce pollution through smooth reaction to traffic flows and disturbances. Third, autonomous vehicles are expected to enhance access to vehicle sharing thanks to their ability to

reposition themselves to pick up new travellers. When vehicle sharing is used in a ride-sharing system that does not negatively affect public transport ridership and active modes, the prospected benefits will include not only a smaller vehicle fleet, but also a strong reduction in total vehicle kilometres travelled. This would greatly reduce the impacts on the environment and could enable cities to repurpose urban space dedicated to road infrastructure. A key factor in ensuring that the potential benefits of automation can be realised is the widespread user uptake of autonomous vehicles and services. Therefore, this thesis aims to provide insight into users' intention to use autonomous vehicles and services and how they are expected to impact the transport system and society.

First, Chapter 2 focuses on the user acceptance of personal autonomous vehicles. We designed a survey study to capture theorised determinants of technology acceptance and intention to adopt new vehicle technologies. We used an experimental setup with pretest and post-test measurements to assess change before and after a test ride with a highly automated vehicle. We find that the experience does not significantly affect the intention to adopt personal autonomous vehicles. However, most behavioural determinants theorised to precede the intention to adopt show a significant positive increase. This suggests that experience with a highly automated vehicle has a potentially positive effect on the acceptance of autonomous vehicles. Simultaneously, it indicates that survey research that relies on textual or audio-visual descriptions of autonomous vehicles to capture user acceptance might underestimate the intention to adopt.

Second, in Chapter 3, we assess the user acceptance of shared autonomous passenger vehicles within the population of current users of car-sharing services. This user group is targeted, because of their experience with sharing vehicles. The survey questions to capture participants' intention to use autonomous cars and ride-sharing services are based on the Unified Theory of Acceptance and Use (UTAUT). Regression analysis shows that the model explains 63% of the variance of intention to use. The determinants of performance expectancy, effort expectancy and hedonic motivation are found to be significant predictors while facilitating conditions and social influence are not. Additionally, the study investigates respondents' preferences regarding ride-sharing with autonomous passenger cars. The results indicate a stronger interest in ride-sharing for commuting, travelling to leisure activities, and non-urban areas. The majority would be willing to share the ride with other passengers by day, regardless of them being people they know, that live in the vicinity or whether they are strangers to them. At night, still, almost half of the respondents would be willing to share with people that live in the vicinity, but fewer than one-third would be willing to share with strangers.

Third, Chapter 4 reports on the public opinion regarding autonomous shuttle vehicles in terms of user experience and intended future use. Survey data were collected at two different pilot sites after respondents experienced a ride with an autonomous shuttle. Overall, the passengers reported a generally positive experience and satisfaction with the comfort, the ease of entering and exiting and the driving behaviour of the shuttle. UTAUT-based items were applied to measure determinants of intention to use autonomous shuttles. While a high degree of respondents expressed an intention to use autonomous shuttle at both sites, the variance explained by the UTAUT-items differs between the two sites. While the determinants of performance expectancy, effort expectancy and hedonic motivation

were found to be significant factors, their contributions as theorised predictors of intention to use differ across the two samples. Respondents were also questioned about the future necessity of owning a personal car after the adoption of autonomous shuttles. Results from both sites show that they do not believe that cars will become less necessary. Even though respondents reported frequent usage of public transport as their primary mode of transport, this result is likely linked to their concerns regarding the feasible operation of shuttles outside of the pilot environment.

Last, Chapter 5 highlights different autonomous vehicle services and captures the stakeholder evaluations of these services in terms of context-specific criteria related to the stakeholders' objectives. Data were collected during several stakeholder consultation workshops using the Multi-Actor Multi-Criteria Analysis (MAMCA) approach. Separate consultations were organised for stakeholders from the mobility and logistics sector presenting sector-specific future autonomous services. Overall, positive impacts of autonomous vehicle services are expected in both sectors. Nonetheless, differences in the extent of the expected impacts are found across the evaluated services. The approach helps to understand the objectives and evaluation criteria of stakeholders in the assessment of autonomous services and facilitates impact assessment within a context where data on measurable indicators are not available yet.

In the concluding chapter, we reflect on the main insights from each study and provide a general conclusion of the conducted research. We also formulate recommendations towards policymakers and transport operators that could enhance public acceptance of autonomous vehicles and services or enable further research into their market potential and potential impacts. Additionally, we discuss our contributions to the literature on autonomous vehicle acceptance and argue the usefulness of multi-actor involvement in autonomous vehicle impact assessment. Finally, we present future research avenues in user acceptance of both autonomous mobility and shared ridership.