Autonomous Driving and the Elderly: Perceived Risks and Benefits

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Abstract

Autonomous driving offers possibilities to simplify and enhance the lives of many people. One group that could benefit a lot from autonomous driving is elderly people. In this contribution, we examine the opportunities and risks that elderly people see in autonomous driving. This was done by conducting semi-structured interviews with 10 participants which offered some insight into the acceptance of autonomous driving among elderly people. The identified perceived benefits and risks are validated by an online survey in which 113 people from 59 to 90 years of age have taken part. In general, elderly people are not rejecting the idea of using autonomous driving altogether. They see benefits in increased mobility and therefore greater independence at a higher age as it allows disabled people to regain lost mobility. However, our study also revealed privacy and security concerns, factors known to have a negative impact on technology adoption.

1 Introduction

The development of the age distribution in western European countries indicates that by 2050 the number of people older than 60 will more than double in size. This shift in population age will affect society in many areas (United Nations, 2006). With a higher number of elderly people, there will also be an increased demand for mobility at old age. Autonomous vehicles (AV) may be able to meet this demand, allowing older or disabled users to regain lost mobility and grant them increased independence (Rödel, Stadler, Meschtscherjakov & Tscheligi, 2014).

There are several papers which have researched the acceptance of autonomous vehicles. While some focused on different ages (Miltos, Happee & de Winter, 2015), this paper examines user acceptance among elderly people. We assume that autonomous driving holds great potential for elderly users as it could support mobility and social participation of user groups with physical disabilities. On the other hand older users are hesitant to adopt new technologies (Charness

Veröffentlicht durch die Gesellschaft für Informatik e. V. 2018 in
R. Dachselt, G. Weber (Hrsg.):
Mensch und Computer 2018 – Workshopband, 02.–05. September 2018, Dresden.
 https://doi.org/10.18420/muc2018-ws11-0524

& Boot, 2009). Therefore we want to understand the perceived benefits and risks of autonomous driving by elderly users.

Rödel et al. (2014) have conducted an online survey to examine the user acceptance and user experience of AVs at different levels of autonomy. Their results indicate that demographics such as age and gender influence user acceptance and user experience. With increasing age, elderly drivers show higher scores on the dimension *attitude towards using autonomous cars*. However, the perceived sense of control over the car is decreasing with higher levels of automation. Acceptance also differs with the level of autonomy as users are less familiar with the more advanced technologies (Rödel et al., 2014).

Abraham et al. (2017) point out that although the older population could benefit the most from fully automated vehicles, a feeling of comfort to use this technology is missing. However, the authors also state that older people are generally open to innovations in automotive technology. An explanation of this may be that older people have a lifelong experience in driving cars and are hesitant to hand over control to a system that they do not fully understand or that is perceived as inferior to their driving experience (Abraham et al., 2017).

2 Interviews

The first part of this study consisted of a semi-structured interview with ten users. The aim of this pre-study was to investigate the risks and chances that elderly people see in AVs. The findings from this pre-study were validated in a subsequent online questionnaire. Half of the pre-study subjects were female, the other male. The average age of the subjects was 71 years, with the youngest being 60 and the oldest 88 years old. The length of the interviews varied from 13 to 24 minutes. The interviews were conducted at the subjects' homes.

First, the demographic data of the subject was collected. Subjects were then asked about their preferred means of transportation and how often they use it. After this subjects were asked about their current knowledge of the state of development of AVs, and the perceived risks and benefits associated with AVs. To ensure as far as possible that all subjects had similar knowledge of AVs a brief description of the state of the art was given and an image of a potential interior is shown (see Daimler, 2015).

All interviews were conducted within one week. During this time, a fatal accident occurred involving an AV. A woman was hit by an autonomously driving car on the evening of March 18, 2018 as she crossed a four-lane street in dark, pushing her bike. An AV of the car manufacturer Volvo hit her while completing a test drive for the taxi service Uber. The test driver did not intervene (Werner, 2018).

This accident happened after the first two interviews had been conducted. In the remaining interviews, all subjects reported that they had heard about the accident in the news without being asked or prompted. These subjects had different opinions about the causes of that accident and this was reflected in their perception of safety of AVs. Some believed AVs are not safe at all and that the accident was ultimately the result of the technical difficulties that need

to be solved. Others said that while AVs may have flaws, so have humans and that accidents cannot be completely prevented. A third opinion expressed by one subject was that the accident couldn't have been avoided at all since the woman was in a blind spot and a human driver would not have been able to see her either.

To explore the attitudes towards autonomous driving the participants were asked to name and explain potential benefits or risks they associate with the new technology. The concerns that were mentioned are mostly related to security or privacy issues. The participants considered system failures, more or worse accidents, a questionable liability, a higher perceived risk as a road user, as well as surveillance and hacker attacks as potential risks. Beyond that the interviewees named loss of control and forgetting how to drive as more personal implications of autonomous driving.

Although the general attitude in the interviews towards AVs was negative, the benefits and possibilities offered by AVs that were mentioned were numerous. Safety was also seen as potential benefit: some participants expect fewer accidents and an increased feeling of safety. Furthermore shorter traveling times, cheaper driving, an automatic search for parking spaces and doing other tasks were named as practical advantages. Additional use cases of AVs were mentioned as beneficial such as using it as a taxi, alternative to public transportation or car sharing. Increased mobility was regarded as advantageous for the elderly, young people (without a driver´s license) and disabled people.

3 Survey

To validate the findings of the interviews a survey administered both through an online questionnaire and in paper form has been conducted. The first section of the questionnaire explains Autonomous Driving at SAE level 5 (SAE, 2016) with a simplified and short description and shows a picture of a potential interior of an AV (Daimler, 2015). The second part contains statements which describe perceived risks and benefits of AVs which had been acquired in the interviews. Subjects could indicate their level of agreement to these statements on a 5-point Likert scale. Subjects were asked about their level of prior knowledge of AVs and whether they would use AVs. For further investigations on the acceptance of AVs the study also assessed the acceptance as dependent variable using the items of the car technology acceptance model (CTAM, Osswald, 2012) and included several predictor variables such as affinity for technology or urbanity of the habitation. The analysis and results of these variables cannot be reported within the scope of this paper and will be reported elsewhere.

In total, 66 people participated in the online survey and 47 in the paper-based survey. Therefore, a total of 113 people took part in the survey. In the online survey, the median age is 65, with the youngest participant being 59 and the oldest 81 years old. In the analog survey, the median age is 70, with the youngest participant being 60 and the oldest 90 years old. 38 were willing to use AVs, 32 against and 44 had a neutral stance towards using it. With 109 out of 113, almost all participants held a driver's license. 31 of the participants live in big cities (more than 100.000 citizens), 10 are from medium sized city (between 20.000 and 100.000 citizens),

27 from a small sized city (between 5.000 and 20.000 citizens) and 45 are living in a municipality (less than 5.000 citizens). When asked if they have heard about the recent accident in the USA involving an AV, 76 answered positively.

The histograms in Figure 1 give an overview of the given answers. To validate the stated risks and benefits from the interviews we examined the means of the Likert scale responses ranging from 1 (= strongly disagree) to 5 (= strongly agree). The results will be interpreted in the following way: Statements with a means smaller or equal to 2 are interpreted as disagreement. Statements with scores ranging about 3 are interpreted as neutral or undecisive. Means equal or above 3.5 are interpreted as slight agreement and values equal or above 4 are regarded as agreement.

Most of the expected risks of AVs that were mentioned in the interviews can be validated. Risks such as the feeling of surveillance (M4.0, SD=1.21), becoming a victim of hacking attacks (M= 4.2, SD=1.08) or the potential failure of the complete system (M= 4.2, SD=1.01) are seen by a majority of participants as worrisome dangers. Some participants also think that the question of liability in case of accidents needs to be addressed more thoroughly (M= 3.9, SD= 1.19). Other perceived risks that share a tendency towards agreement are forgetting how to drive (M 3.8, SD=1.21) and the lost control over the car in general (M= 3.7, SD= 1.39). They also stated that they would feel less safe as a road user (M= 3.5, SD=1.23).

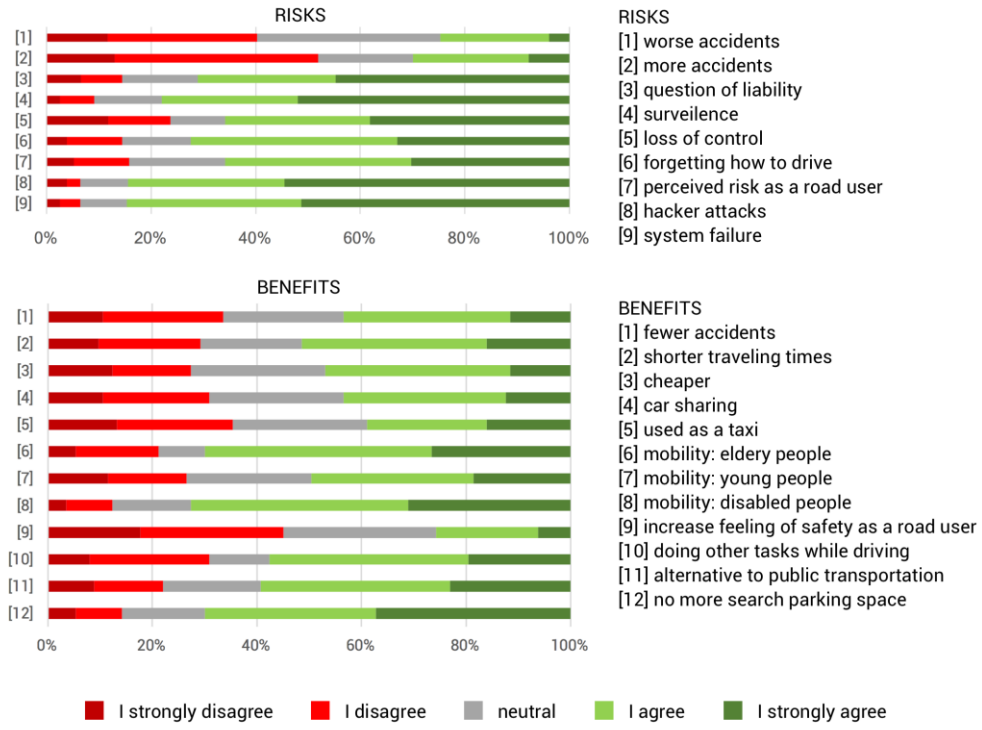

Figure 1.Stacked histograms of Perceived Risks and Benefits

Risks that participants were more dismissive of are the increase of accidents (M= 2.5) as well as their severity (M= 2.7, SD=0.98).
Most participants confirmed the perceived benefits of old (M= 3.7, SD=1.18) or handicapped people (M= 3.9, SD=1.06) maintaining their mobility. The score for mobility of younger people showed no clear agreement (M=3.3, SD= 1.26). A lot of participants agree that AVs can solve the issue of finding a parking space (M= 3.9, SD=1.17). Regarding the other practical advantages mentioned in the interviews such as shorter traveling (M= 3.3, SD= 1.23), cheaper driving (M=3.19, SD= 1.2), doing other tasks (M=3.38, SD=1.26) the scores around 3 are hard to interpret. The use of AVs as a taxi (M=3.06, SD=1.28) or for car sharing (M=3.14, SD=1.19) also show no clear tendencies. Whereas using autonomous driving as alternative for public transportation (M3.51, SD=1.23) yielded slight agreement.

A potential benefit that participants rather rejected is that AVs make other road users feel safer. With an average value of 2.7 (SD=1.16), this statement has received the lowest score in our study.

4 Discussion and Conclusion

An argument often fielded by experts in favor of AVs is that the number of accidents – and a fortiori accident-related deaths and injuries – will be greatly diminished if road traffic were to be based largely on AVs. This judgement is to some degree reflected in the sentiment of our study participants which on average perceived reduction of the number of accidents as a benefit or at least saw an increasing number of accidents due to AVs as only a moderate risk.

It is perhaps worth pointing out that the risks perceived to be the most pertinent ones fall into a category which may be described as "being at the mercy of someone/the system" (surveillance, hacker attack, system failure). The motive of loss of control is also present in the slightly less severely estimated risks of unlearning how to drive, lack of control of the vehicle and insecurity opposite AVs as a third party road user.

On the positive side AVs were perceived as an enabler of mobility for elderly and – even more so – disabled and handicapped users and – perhaps less importantly – as a contribution to solving the issue of finding a parking space. With regard to the proposed new use cases for AVs from the interviews, such as the use as a taxi or for car sharing, the survey answers showed some undecidedness. But participants tended to approve the use case of using autonomous driving as an alternative to public transportation.

Summing up, the results indicate that an elderly user group sees potential in using AVs for maintaining mobility. However, the privacy and security concerns revealed are known as factors negatively affecting the acceptance of new technologies. In a follow-up analysis we will attempt to assess the impact of the above-mentioned benefits and risks on user acceptance as measured by the CTAM questionnaire (Osswald, 2012).

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