

Investigating Public Acceptance of Shared Autonomous Vehicles: A Crowdsourcing Approach

Evgenia Christoforou¹, Carla Fabiana Chiasserini², Jahna Otterbacher^{1,3}

¹CYENS - Centre of Excellence, Nicosia, Cyprus

²CARS@Polito and Politecnico di Torino, Torino, Italy

³Open University of Cyprus, Nicosia, Cyprus

Abstract

As autonomous vehicles (AVs) are expected to be a major component of future mobility, it is essential to look into the conditions and user characteristics that correlate to their acceptance. To this end, researchers often conduct in-person studies and/or specifically recruit participants who have direct contact with AVs. However, such methods present significant challenges, given that AVs represent an emerging technology that is not yet in widespread use. We propose an alternative methodology for studying the public's perspective, using crowdsourcing. Rather than querying participants on their experience with AVs, we present them with a video-based scenario of an AV taxi, asking them under which conditions they would (or would not) use it. Our online study produced results that are in line with the current literature on acceptance and user demographics (i.e., who is most likely to use an AV and how). Interestingly, the results also show that female participants are more reluctant in ride-sharing and car swapping as compared to men, while the latter value more their money instead of time in terms of car swapping.

Introduction

Emerging technologies, such as nanotechnology, augmented reality, or even synthetic meat, promise new solutions to societal challenges, which depart radically from existing ways of doing things. Therefore, they typically face great barriers in their implementation and adoption by the public. For a complex technology like Autonomous Vehicles (AVs), much research is needed to understand the factors influencing the public's perception of the benefits and risks associated with the technology (Kyriakidis, Happee, and de Winter 2015). AVs are envisioned to become part of a greener, sustainable transportation system, as long as members of the public are willing to accept AV ride-sharing (Burghout, Rigole, and Andreasson 2015). Thus, there is a need for large-scale studies that explore the differences in perceptions and opinions across diverse groups of people, representing various demographics and having different preferences.

Research regarding the acceptance, perception and opinions of the public on AVs and shared AVs can be circumstantial, taking place because the technology was implemented in a certain geographical area (Piao et al. 2016;

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Etminani-Ghasrodashti et al. 2023) and the specific population is being surveyed. Additionally, some studies surveying the characteristics of the people regarding acceptance of the technology are held in an online-fashion and try to contact participants through mailing-lists held by universities, transportation organizations and companies or even by distributing QR codes in certain geographic locations (Lavieri and Bhat 2019; Acheampong and Cugurullo 2019; Yuen et al. 2020). Contrary to the above studies, we propose a methodology for generating studies to a larger and more diverse group of people through online-crowdsourcing platforms.

In addressing the above needs, our work aims:

- To explore the feasibility of leveraging online crowdsourcing platforms to explore the viewpoint of a large public on AV services and mobility constraints.

- To investigate the public's opinion on AV ride-sharing *and* to acquire knowledge about the information people would like to receive on the other passengers. Specifically, referring to the the Mobility as a Service model (Jittrapirom et al. 2017), our study focuses on AVs following a taxi-like on demand service (i.e., car sharing) and ride-sharing.

Related Work

Othman (Othman 2021) provides a review of recent studies focusing on the factors surrounding the acceptance of AVs and shared AVs, and their perception by the public. After providing an overview on the issues of safety and ethics (i.e., who is liable for AVs and the regulations surrounding their use), Othman surveys previous studies that considered demographic variables as predictors of the public's acceptance and perception. Although our work focuses on the public's opinions on the services and mobility characteristics of the shared AVs, we do compare our findings on the public's acceptance according to gender and age, with the ones reported in the literature survey by Othman. Results suggest that public's acceptance of AVs are in-line with the state of the art finding, thus providing an indication that crowdworkers exposed to the video prompt have comparable opinions to participants that have been exposed in person to AVs.

A number of studies have specifically looked into the factors impacting the adoption of shared AVs, such as ease of use of the technology, trust, and safety concerns (including users' anxieties regarding riding in AVs), their current commuting behaviors and, in general, their attitudes towards the

technology (Etminani-Ghasrodashti et al. 2023; Acheampong and Cugurullo 2019; Nazari, Noruzoliaee, and Mohammadian 2019; Yuen et al. 2020). These studies aimed at understanding the factors impacting the adoption of AVs according to the socio-demographic and other relevant behavioral factors of the participants. Some studies (Etzioni et al. 2021; Lavieri and Bhat 2019) considered specifically the conditions under which participants are willing to share a ride with other users. In our study, we rather focus on the information that participants would like to have while sharing an AV. Thus, our study focused on questions, more suitable for crowdworker participants, that is, questions where a participant's opinion is not drastically impacted by having or not direct contact with an AV.

The aforementioned studies either targeted specific groups of people with direct contact with AVs, or specific mailing lists or Facebook groups of people interested in AVs. Thus, it is reasonable to question whether such approaches can capture the views of the general public. Also, many demographic groups (e.g., older people) are likely underrepresented in previous studies taking place in the university context. In our study, participants were recruited through the Prolific¹ crowdsourcing platform, by providing a monetary compensation. Contrary to the state-of-the-art studies, using a crowdsourcing platform, like Prolific, allows us to reach diverse demographic groups. We only restricted the country of residence of our participants and required a balanced gender sample. The geographical restrictions were necessary, as it is well established that transportation habits depend on culture and physical infrastructure (Martens 2004).

A study by Nordhoff et al., (Nordhoff et al. 2018) did use the CrowdFlower platform (currently known as Appen), for conducting a large-scale, multi-national survey of the factors affecting the acceptance of AVs. Results from their study indicate that residents of countries with a lower economic status were more positively disposed towards AVs, as compared to those with higher economic status. As mentioned, our study focuses on the provided services on board shared AVs servicing as taxis and the mobility constraints of users. Additionally, in (Nordhoff et al. 2018) an image of an AV closely resembling a bus was used to provide a visual image of the technology. In contrast, we used a video prompt of a taxi-like service provided by AVs. Furthermore, as ours is a preliminary study, we focused our attention to collecting responses from participants in two European countries (Italy and Germany) before expanding to a larger audience.

Methodology

Study design. Our questionnaire was designed to assess participants' disposition towards AVs, as well as the services and information on board the vehicle that would be most desirable, for AVs providing taxi-like services. As mentioned, our main goal is to test the feasibility for crowdsourcing to aid AV researchers to tap into a large, diverse pool of participants, especially for features of the AVs that the crowd doesn't need to have physical contact with the technology. As an initial approach, we used a video prompt featuring

a number of AVs servicing as taxis in the streets of a city in China.² Using a video prompt of deployed AVs on the streets communicates an envisioned future of the shared mobility and the different ways one might take advantage of an AV. Further, this particular video, while promoting AVs, still offers a fairly neutral view of how AVs can be used.

The structure of our study is as follows:

(1) Participants are presented with an information sheet and an informed consent statement of participation.

(2) A short video prompt (approx. 2 minutes) is presented to the participants, together with a set of attention questions.

(3) Since our participants are not based in China, two questions record the participants' opinions of the deployment of a similar technology in a European country and the possible obstacles they would see in them being deployed (i.e., physical and legal obstacles or public's disapproval).

(4) Participants are asked to provide a set of words describing their anticipated emotions from riding once or multiple times in an AV. They are then asked about their willingness to ride and also to share such a vehicle.

(5) The next set of questions aim to understand the needs of participants on the information provided on board (e.g., shops, restaurants, public transport near destination) and their privacy concerns linked to the provided information.

(6) We also asked participants a set of questions to understand if they would like to share their ride and what type of information they would like to have on other users riding with them, as well as their motivation for potentially preferring an AV over a conventional taxi.

(7) Finally, we asked participants a series of questions to identify their anticipated use of the car-sharing service, i.e., on which roads, for what distances and trip situations (e.g., commuting to work, night time, etc.) they would use AVs. Also, we asked under which conditions they would accept switching vehicles to complete their trip to their destination.

(8) Demographic information and the current principal mean or transportation were also collected.

Participants. We posted our survey on Prolific and received 182 and 195 responses from German- and Italy-based participants, respectively. When recruiting our participants, we aimed for a balanced gender sample; we did not impose any further restrictions on the crowdworkers that could complete our survey, apart from knowing English. The study received ethical approval from the Cyprus National Bioethics Committee and crowdworkers were rewarded fairly according to the respective platform's instructions, respecting the average hourly salary per country. We processed the received responses for spam replies, our dataset consist of 360 responses (191 from Italy and 169 from Germany), out of which 178 female and 182 male participants.

Preliminary Results

Public acceptance. We grouped our participants into two categories, based on their responses to the question in section 4: (1) positively inclined to ride an AV; (2) negatively

¹<https://www.prolific.co/>

²https://www.youtube.com/watch?v=7GVL9Na1_9Q&ab_channel=AutoX

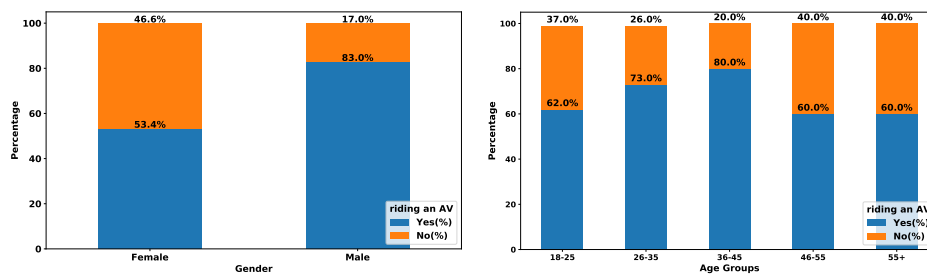


Figure 1: Responses to the question: *Would you ride an AV servicing as a taxi?*, by gender (left), by age (right)

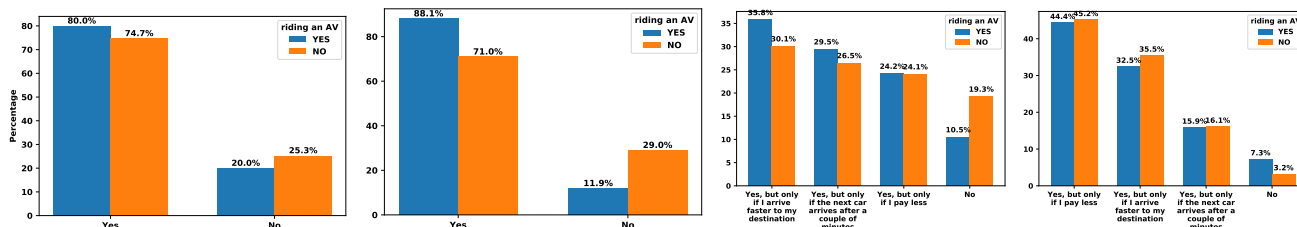


Figure 2: Responses to the question: *Would you share an autonomous vehicle with other passengers?*, female (left), male (center left). Response to the question: *To make their route more efficient they might ask you to step out of the car and wait for the next autonomous car to pick you up. Would you accept?*, female (centre right), male (right).

inclined to ride an AV. To record the acceptance of this technology by participants willing to ride on board an AV that is not their property, we asked participants: “Would you ride an AV servicing as a taxi?” To assess whether our proposed methodology is feasible, we compare the responses across demographic groups of participants, to the results reported in state-of-the-art studies on acceptance (Othman 2021).

Fig. 1 presents participants’ responses to the question on whether they would ride an AV servicing as a taxi, by gender (left graph). In line with the literature (Othman 2021), our responses indicate that males are more “optimistic” towards AVs. Additionally, the results shown in the right graph of Fig. 1 indicate that ages 26–35 and 36–45 are more positively disposed towards riding an AV; this observation only partially agrees with the literature (Othman 2021). Providing a one-to-one comparison was not possible due to the different set-up and goals of our survey, since we do not explore the option of participants owning the AV and the associated liabilities. An interesting observation is that ages 18–25 have a similar approach to AVs to that of ages 46+. We argue that this is due to the possibly limited contact of those ages with driving, or the logistics of getting to their work environment. In fact, 80% of the participants age 18–25 are students.

Ride-sharing and mobility constraints. We asked participants: “Would you share an AV with other passengers?” (see Fig. 2). Female participants positively inclined towards AVs are less prone to share an AV, compared to males with the same disposition. On the opposite side, male participants negatively inclined towards AVs appear to be less prone to share an AV compared to females. Thus, sharing an AV can be an issue for some female participants, who are positive to the technology in general, while for males that are not positive towards riding an AV, sharing it is one more limitation.

We then asked participants, under which conditions they would accept to swap AVs to reach their destinations (see Fig. 2). We notice that independently of whether the partici-

pants are positive or negative towards AVs, males value more their money compared to females who, on the contrary, value their time more. Interestingly, the second choice of females is not the option of paying less, but rather, the option of not having to wait long for the next vehicle to arrive, indicating a concern in terms of their personal safety when swapping vehicles. Finally, females, independently of whether they are positively or negatively inclined towards AVs, are more unwilling to swap AVs regardless the conditions.

Conclusion and Future Work

Our methodology produced results that are comparable, in terms of the participants’ characteristics and their acceptance of AVs, to the results of previous studies that recruited participants familiar with AVs. Hence, our preliminary results suggest that online studies can be useful for gauging the perception of the public towards this emerging technology. While we would not expect our crowdsourcing approach to replace previous methods, it can serve as a complementary means of assessing segments of the public that are underrepresented in current approaches. In this paper, we have also reported on some interesting initial findings. For instance, our responses to questions concerning ride-sharing and car swapping indicate gender differences, which warrant further in-depth investigation. Thus, we plan to expand our study to other countries as well as have a closer look at the correlation between the participants current transportation needs and their perspective on the use and services of shared AVs.

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