Influence of Autonomous Vehicles on Travel Behavior of 50+ Years Population

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Abstract

In this paper, we analyze the adoption of autonomous vehicles (AVs), using survey data collected from June 2019 - December 2019 on approximately 250 people who are over 50 years old in the USA. The model is explaining the impact of different factors and trust implementation in older adults. The result demonstrates that almost a third of participants are not accepting AVs because of several factors such as lack of trust in the technology, possibility of hacking the system, job replacement by technology, and safety. While 53% of the participants are supporting AVs as a personal vehicle or public transportation, and the rest are having a neutral attitude toward AVs. Among all the participants in this research, 20.57% show the interest in owning personal AVs, while 14.92% of participants like to lease it as their need rises, and 30.65% of the respondents like to use AVs in the form of taxis or public transit only.

Introduction

Autonomous vehicles (AVs) are merging into our daily lives as driverless transportation and delivery drones. The trend of driving is changing dramatically from manually controlled cars to fully AVs. AV allows drivers to participate in other activities during their journey. General Motors was the first company that came up with the idea of AVs for the future of transportation at 1939 New York World's Fair (Becker et al., 2014). However, this idea was imaginary and futuristic at first, but this imagination changed the whole transportation industry's mission (De Bruyne, 2020). The idea of AV has developed successfully recently because of two factors: first, AVs are more feasible for automobile industry because of the advancement of technology. The second reason is that the big automobile manufacturing companies such as Tesla, Mercedes Benz, GM, Toyota, and Fords, as well as high tech companies like Google and Apple, are working on autonomous cars/trucks (Harris, 2015; Hudson et al., 2019; Zmud et al., 2017).

Tesla Motor's semi self-governing driving innovation called Tesla Autopilot is changing how we explore and transport by fusing cutting edge current artificial intelligence, hardware technology, and improving the next generation AVs driving with ongoing driving updates. Tesla claims that autopilot gives drivers more certainty, expands the security on the road, and makes interstate driving enjoyable. While genuinely, AVs are still a couple of years away, Tesla Autopilot works a great deal like the frameworks that plane pilots use when conditions are clear. The driver is yet responsible for and at last in charge of the car. Additionally, Tesla gives the driver instinctive access to the data which it is utilizing to control its actions. Along with the combination of collision prevention technology, for example, Advanced Driver Assistance Systems (ADAS), which incites crisis guiding and braking, the autopilot innovation that powers the Tesla Model S and Model X electric vehicles empowers vehicles to self-governing direct, change lanes, follow vehicles and curves, and park automatically in the parking space (Ingle et al., 2016).

AV technology is leading public transportation to shift from old fashion vehicles to AVs. WEpods is an AV which designed by French AVs and robotic maker EasyMile.[1] This project brings real autonomous mobility technology to human's daily life. They are working on the localization system of these vehicles, based on advanced GPS, vehicles' sensors, wheel odometry, and an advanced laser solution (Hudson et al., 2019). Since June 2016, these EasyMile vans were tested to travel between the Ede-Wageningen railway and bus station and Wageningen University & Research Centre (Murgia, 2016). WEpods is a six-person cabin that is traveling short to medium distances and can travel almost 100 km per charge. The WEpods can travel attached, or separately depending on the rider's destination. Each pod is fitted with a battery that can last up to three hours and can be recharged over six hours. WEpods have a GPS onboard that was developed by the Department of Geoscience & Remote Sensing as well as 3D imaging and a radar system developed by 3ME and other partners. These technologies allow the vans to observe their surroundings and always stop for other road users.

[1] http://easymile.com

These systems are currently being calibrated in Civil Engineering and Geosciences' (CEG) garage. The Department of Transport and Planning at CEG is studying the safety aspects of the route the vans will travel and their integration into the transport system. This technology will give us freedom and state of mind while we are traveling by car.[2]

This progressive innovation has an incredible potential to improve mobility, safety, decrease travel time, offer extra portability choices to the elderly, and save lives by wiping out costly human mistakes. The leaving benefits of AVs are evaluated to approach $2000 to every year per AV, and may, in the long run, approach about $4000 when extensive accident costs are accounted as well (Fagnant et al., 2015; Medina-Tapia et al., 2019). Furthermore, AVs represent a pathway that could expand the mobility of the disabled populations and seniors by diminishing human contribution during driving (Anderson et al., 2014). AVs technology can improve traffic management both in large cities and on major highways, and it leads us to reduce fuel consumption and air pollution (Hudson et al., 2019).

In 2016, police-announced there were 34,439lethal auto collisions in the US alone – a 5.8% expansion from 2015. As indicated in an investigation by the ENO Center of Transportation, about 93% of the 5.5 million crashes in the US have ascribed to human errors. These statistics incorporate every single detailed accident, the majority of them without genuine consequences for the people involved. However, out of this 93% of human credited accidents, more than a third is brought about by intoxication (primarily liquor, and unlawful medications), speeding (30%), occupied drivers (20%), and other human mistakes because of external variables, for example, climate conditions or individual weaknesses for example absence of legitimate driving skills (Fagnant et al., 2015). Most specialists concur that the introduction of self-driving vehicles will bring down the overall number of auto collisions and deaths. Based on the evidence presently accessible, it appears to be reasonable to propose that the quantity of traffic-related passing will go down drastically as self-driving autos enter the market. Some believe that AVs will diminish auto collisions by 90% (Gao et al., 2014). [3]

In 2016, individuals 65 years and more US residents represented 6,764 fatalities and around 290,000 injuries because of a motor vehicle accident – making up 18% of all traffic fatalities and 10% surprisingly injured in that year. Between years 2006 to 2015, bike fatalities among older people expanded by 10% in general – an 8% expansion for males and a significant 38% expansion for females. Just 8% of older drivers associated with deadly car collisions had a blood liquor concentration of 0.08 or higher – the lowest level of all age groups. 74% of fatalities in crashes, including older people happened during the daytime. 70% happened on weekdays, and 67% included different vehicles. Drivers engaged with fatal crashes in 2016 ranged from a high of 5,257 in Texas to a low of 38 in the District of Columbia. Elderly drivers in Florida had the highest number of collisions involvement, which was 706, compared to the District of Columbia with one driver associated with a lethal accident. The District of Columbia had the lowest percentages of older drivers engaged with 2.6 percent, trailed by Texas, with 10.0 percent of all drivers associated with deadly crashes being 65 and older. Wisconsin had the most significant rate, 18.7 percent (Burns, 2018). [4]

AVs can expand the portability of currently underserved populations: non-drivers, those with medical movement limitations, and seniors. Older drivers may never again be safe behind the wheels, they are more likely to be injured or killed in car accidents because of age vulnerabilities. In the US, the senior population is expected to keep on developing (Harper et al., 2016). By 2030, it is anticipated that there will be about 74 million seniors living in the United States that will speak to nearly 26% of the total US population (Rosenbloom et al., 2002).

A considerable increase in the travel demand of seniors would raise many challenges for current transportation frameworks to change the system to be more compatible with demands in the market for older people. Among the present senior population, driving by car is the most popular and common method of transportation. About 89% of all excursions made by seniors are by car, and 80% of all travels made by those people with medical conditions are by car. Not many older Americans depend on strolling, biking, or public transportation, and this pattern is probably going to proceed (Santos et al., 2011). For instance, working adults who used public transportation for non-work trips before retirement, will, in general, depend on an automobile for these same excursions once they enter retirement.

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[2] https://www.wur.nl/en/project/WEpods-development-of-an-autonomous-transportation-system-in-Gelderland.htm

[3] *https://safer-america.com/car-accident-statistics/#US*

[4] *https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812500*

Hudson et al. (2019) research shows that individuals are slightly uncomfortable with the idea of driverless trucks and even more uncomfortable with driverless cars. Innovation and technology are, by all accounts advancing. Hudson search also showed that the old, retired, unemployment, less educated, and ladies would generally be progressively threatening AVs. While professionals and senior administration will, in general, be more in favor. Also, studies show that drivers who had collision experiences have a positive effect on their acceptance attitudes (Hudson et al., 2019). The territory is the other factor that is affecting the adjustment of AVs innovation; people in large towns and urban communities are most in favor.

The preferences of AVs are like to be identified with the chance of mobility for older people, for AVs drivers having the option to do different things while traveling; there is also the potential for the population to decrease and fewer car crashes. Then again, adopting AV innovation is raising a few issues, for example, the costs related to the perceived impact on unemployment in the transportation industry, and we will have increase in the price of cars, the potential for pollution to increase if more vehicle journeys are made and any other risks such as hacking and those related to privacy.

The main objective of the paper is to test how the older citizens of a city choose to respond to AVs and its possibilities. This study aims to extend the knowledge of

- How likely are people of 50 years and older to use AVs?
- What are the factors that appeal to these vehicles for this group of people?
- What are the main concerns around using AVs?
- What is the impact of AVs on travel, and auto ownership of people of 50 years and older?

The remaining part of this paper is organized as follows. In the methodology section, we describe the conceptual framework used in this study, and the participants and data collection. We then present the survey data and the results from our data analysis. At the end of the paper, we provide concluding remarks and suggestions for future research topics.

▪ Methodology

Data on the acceptance of the users are traditionally collected and analyzed with qualitative methods. To construct an understanding of the impact of AVs on elderly people we designed a conceptual model for this study. We then developed an online questionnaire based on this model to examine several critical topics related to AVs and the surveyors' approach toward them. The participants were asked questions that could measure their general attitudes toward these vehicles.

Based on the survey information, we divide the individuals into adopters and non-adopters' group. The adopter group can be divided into four major categories. Figure 1 depicts the conceptual framework to divide individuals based on their adoption patterns.

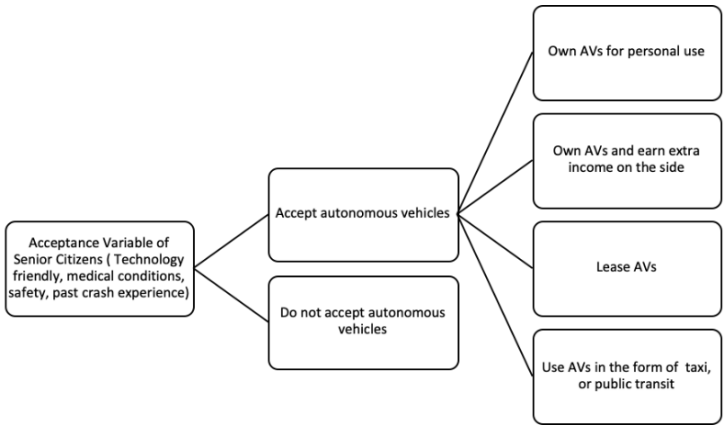

Figure 1. Conceptual Framework

▪ Participants and Data Collection

The data are collected from online questionnaires filled out by drivers of 50 years old or more in Portland, Oregon. The data from 250 respondents were collected. Among them, 52.4% were female users, 46.7% were male, and 0.9% were transgender. For our analysis, we grouped the participants by age (Figure 2). The population was broken down into three separate groups: the youngest senior (50 to 65), the middle senior (66 - 80), and the oldest senior (80+). Approximately 4.4% of users were between 50 to 65 years of age, 84.3% were 66 to 80, and 11.3% were older than 80. Regards to weekly vehicle travel mileage, 25.8%, 47.2%, and 27.0% are driving on average less than 10 miles, 10 to 30 miles, and more than 30 miles per week, respectively.

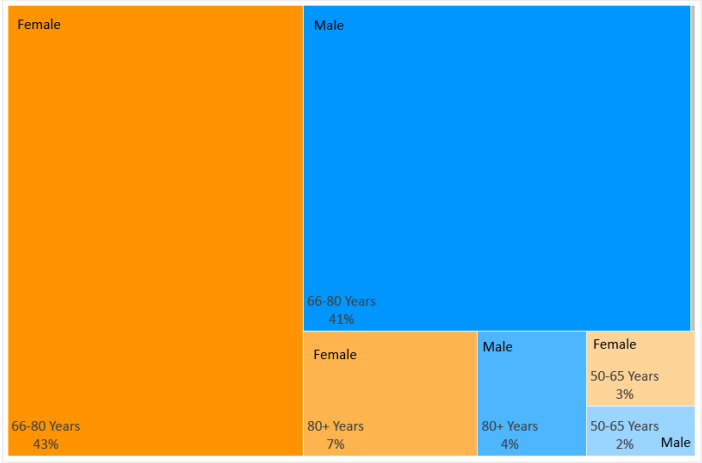

Figure 2. Sample breakdown

Results and discussion

Autonomous vehicles not only can affect the city design and transportation system, but also they will have a revolutionary impact on the travel behavior of the people. It is expected that AVs increase the mobility of underserved populations such as those with travel restrictions due to age or medical condition. Several studies show that automated vehicles could increase mobility by giving opportunities to seniors and disabled populations to travel independently. As a result, there will be a higher range of users that use (Smith et al, 2012; Anderson et al, 2014; Harper et al, 2016). However, many factors such as the cost of these vehicles, flexibility, efficiency, safety, and the attitude of the people toward the new technology can impact the willingness to adopt this technology for the seniors (Bansal et al, 2017;Martinez-Diaz et al, 2018;Pakusch et al, 2018;Medina-Tapia et al, 2019; Hudson et al, 2019).

Table 1 summarizes the perspective of the users by different socio-economic characteristics toward AVs. The values are shown as a percentage of respondents who have positive, negative, or neutral opinions toward these vehicles. For the sample, 53% of the respondents have a positive view of AVs and feel comfortable using these vehicles as either passenger cars or public transit.

Table 1. Perspective toward AVs.

	Positive	Negative	Neutral
Age			
50-65	3.9%	0.4%	0.0%
66-80	43.7%	28.4%	12.2%
80+	5.2%	3.5%	2.6%
Gender			
Female	27.5%	17.9%	7.0%
Male	25.3%	14.0%	7.4%
Other	0.0%	0.4%	0.4%
Mile Travel Per Week			
Less than 10 miles	11.35%	9.61%	4.80%
10 – 30 miles	24.89%	15.28%	6.99%
More than 30 miles	16.59%	7.42%	3.06%
Comfort Level Using Technologies			
Uncomfortable	6.1%	10.0%	2.2%
Somewhat Comfortable	10.0%	7.0%	3.5%
Comfortable	36.7%	15.3%	9.2%

On the other hand, 32% of respondents strongly disagree with the concept of AVs and don't see themselves using these vehicles. The other 15% of respondents have a neutral opinion about these vehicles and it is mostly because of the lack of information and knowledge about this technology. On average female drivers are more favorable toward AVs. The other important factor in the attitude toward AVs is the comfort level of the respondents to using high technology tools such as Smartphone, and TV. The users who are less familiar with the technology are more hesitant to use AVs. On the other hand, the users who are comfortable using high technology tools on their daily bases have a positive perspective toward these cars. However, most respondents consider themselves as of late adopters that adopt the technology after it adequately tested.

Different studies suggest various perspectives on AV ownership. Most studies show that AVs may decrease the number of vehicles owned per household especially if vehicle sharing becomes the significant travel mode. One AV can drop every member of a family to the school or work and park itself until it is time to pick them up. (Bischoff et al, 2016 ; Schoettle et al, 2015; Zhang et al, 2018; Diamandis, 2014; Fagnant et al, 2015). A survey study in Austin indicates that 13% of the respondents are willing to give up their personal vehicles and use exclusively shared AVs. (Bansal et al, 2017). As Clements and Kockelman claim, in future vehicle ownership is more of a luxury than a necessity.

In a multiple-choice question, we asked our surveyors to assume that the AVs can fully drive by themselves, and asked: *what would be their most preferred way to use AVs?*

The respondents had to choose one of the options below:

I. Own AVs and use them for personal use
II. Own AVs and earn extra income by making it available to other users when not needed
III. Rent AVs and the need arises
IV. Use AVs in the form of taxis, or public transit
V. Not interested in investing and using AVs

The first four options belong to the users who are adopting this technology and the last one is the non-adopters. In total, 66.13% of the respondents are interested in using AVs in the future, while 33.87% are not interested in owning or using these vehicles. The adopters mentioned that using AVs will let them travel stress-free while enjoying sightseeing, reading or watching TV. Nevertheless, the main reason for adopting this technology is independence. Most of the

respondents are concerned that as they age, they are more dependent on their family members, or friends to ride them around, and AVs help them to be independent and give them the freedom to travel safely anywhere at any time they want.

As Figure 3 shows, among the adopters, most of the respondents (30.65%) like the idea of AVs in public transits such as bus and train. The major factor for having AVs as transit, is improving road safety for pedestrians and cyclists. However, few respondents who liked the idea of AVs as public transit showed concerns about the job loss of train, bus, and taxi drivers. Among the non-adopters, a decrease in human contact and failure in the computer program are the top reasons to not be interested in using these vehicles.

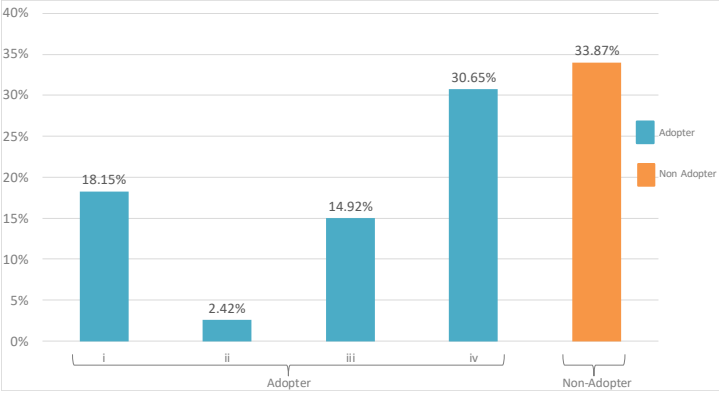

Figure 3. Autonomous Vehicle Ownership

Conclusion

AVs are promising to increase the mobility for many groups, including those over age 50, non-drivers, and people with medical conditions. This study focuses on how likely people of 50 years and older accept AVs. A survey method was conducted to collect the users' opinions. The result showed that one-third of participants are uncomfortable with the concept of the AVs in any form of transportation. The major reasons for someone to reject using AVs decrease in human contact and failure in the computer programs.

Moreover, about 66% of participants are interested in having AVs as their car or use it as public transportation. While the reason for accepting AVs varies person by person, independence is the major factor that makes these vehicles attractive for the respondents. In terms of vehicle ownership, only 20.57% of respondents like to own their AVs. The majority like to use automated technologies in public transportation. Some showed concerns about the job loss of the drivers, but they are most eager to use driverless buses and trains.

Future Work

Given significant uncertainties about the AVs future, some potential factors could impact the adaptability of the people toward AVs. The legislation and laws around these technologies can significantly impact the travel behavior and mode choice of the users. Although this paper produces estimates of the adaptability rate based on the survey on populations who usually have limitations to travel due to their age, some factors could impact the acceptance of these vehicles that are not accounted for. For example, the cost of vehicle ownership could cause people to have less interest in owning their personal vehicles. For future research, we would like to cover a larger population in the nation. We recognize that the state of Oregon may not be representative of all potential AV users. We also would like to cover other information in our surveys such as income and the number of vehicles owned per household.

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