Consumers' Perceptions towards Autonomous and Connected Vehicles: a Focus-Group Survey on University Population

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ABSTRACT

Autonomous and connected vehicles are an emerging technology which may prove to be the next big evolution in transportation. As of now, major vehicle manufacturing industries are developing their own prototype autonomous cars with plans to eventually release this technology to market, in full scale, up to 2030. Despite enthusiastic speculation about the potential benefits of autonomous and connected vehicles, to date little is known about the factors that will affect consumers' acceptance or rejection of this developing technology. Gaining acceptance from end users and consumers will be critical to the widespread deployment of autonomous-connected cars. In this context the present paper describes a survey conducted by means of a questionnaire methodology distributed to undergraduate and postgraduate university students in Greece. The responses from the people participated in this survey show that performance expectancy and trust in automation could be some of the key factors influencing public attitudes towards the implementation of autonomous and connected vehicles in future transportation scheme.

Keywords: autonomous-connected vehicles, consumers' perceptions, online survey approach, university population.

1 INTRODUCTION

Recent developments in vehicle automation technology (e.g. automatic braking, automatic cruise control, intelligent speed assistance, line keeping assistance, etc) are moving us closer to increasingly Autonomous and Connected Vehicles (ACVs). In this basis the impact of ACVs could be enormous. It could help to drastically reduce road fatalities as over 90% of the road accidents have been reported coming from human errors. Moreover, new transport services could also be developed especially when vehicles are provided with connectivity in addition to automation, e.g. traffic safety related warnings, traffic management, new possibilities for elderly people or impaired people, advanced individual comfort and convenience for drivers/users. It could also result in new business models, such as car sharing services and shared mobility which could lead to a strong decrease of vehicles on our roads [1].

All these potential societal benefits will not be achieved unless these vehicles are accepted and used by a critical mass of people; thus it will be important to understand consumers' acceptance before the arrival of ACVs on international market. In this context it is not yet clear to what extent users accept automation technologies in vehicles and what the factors and determinants of user acceptance of automation are [2].

Various researchers have previously conducted surveys on public opinion about the perception and adoption of vehicles with autonomous-connected driving technology. In 2014, Schoettle and Sivak [3] investigated public opinion about autonomous and self-driving vehicles among 1533 respondents in the United States of America,

the United Kingdom and Australia. The study showed that U.S. respondents expressed greater concerns than those from the United Kingdom or Australia regarding data privacy, interaction with non-self-driving vehicles, learning to use the vehicles and vehicle performance in poor weather conditions.

Also in 2014, Schoettle and Sivak [4] investigated public opinion about connected vehicles among 1596 persons over the age of 18 in the United States of America, the United Kingdom and Australia. The main implications of the results in this study are that the general public in the three countries surveyed feel positive about connected vehicles, have optimistic expectations of the benefits (while still maintaining some concerns), and generally desire connected-vehicle technology when it becomes available.

Kyriakidis et al. [5] carried out a survey on public opinion about automated driving among 4886 respondents in 109 countries in 2014. In this study respondents indicated that fully automated driving would be easier than manual, whereas partially automated driving was perceived as more difficult. Concerns focused on software hacking and misuse, legal issues, and safety.

Moreover, according to Hohenberger et al. [6], it was found that emotion and affective reaction towards autonomous vehicles indicate differences across gender towards the willingness to use automated vehicles. Specifically, it was found that men were more likely to anticipate pleasure and not anxiety which is associated with the willingness to use autonomous vehicles.

Also, as it was found in the study conducted by Haboucha et al. [7], older people tend to prefer private vehicles than autonomous vehicles. Similarly, people with higher level of education than others have a tendency towards autonomous vehicles than private vehicles. Moreover, according to Piao et al. [8], it was found that half of the 425 people surveyed they would consider using automated cars if they become available, with three quarters being interested in owing automated cars, and one quarter in sharing automated cars through services such as car-sharing, car-pooling, or taxis.

In addition, in 2017 Zmud and Sener [9] conducted an online survey with 556 residents of metropolitan Austin to determine intent to use autonomous vehicles. In this study the results indicated that individuals with a higher level of intent to use have any physical conditions that prohibit them from driving. They use new technologies (smartphones, text messaging, social media, transportation applications) and they are not concerned with data privacy about using online technology. Furthermore they think using self-driving vehicles would be fun, decrease accident risk, and easy to become skilful at using autonomous vehicles.

2 AIM OF THE PRESENT STUDY

The majority of studies towards connected and autonomous vehicles originate from developed countries. This is obvious due to the fact that the operation and implementation of ACVs needs high investments into infrastructure equipments and other supporting means. Moreover, the results of these surveys refer to the general population investigating the factors which influence behavioral intention towards the use of ACVs.

In the present study the selected group is university population. This selection has to do with the fact that universities are often a fertile ground for testing and early adoption of new emerging technologies.

Furthermore, university students represent the new generation and comprise a considerable share of future adopters of emerging technologies.

In this respect, the goal of this study was twofold. First, to investigate the perceptions of university population on autonomous and connected vehicle technologies and which aspects of ACVs they find most important. Second, to investigate whether the perceptions of university population were comparable with other studies reporting perceptions in the context of vehicles with autonomous and connected driving technology.

3   RESEARCH METHODOLOGY

A brief (10-item) on-line questionnaire survey was implemented to assess university students' behavioral intension to use/accept the ACVs technology. 3-items were used regarding the performance expectancy of ACVs which is defined as "*the degree to which an individual believes that using an ACV will help him or her to attain benefits in driving performance*". 3-items were used regarding the effort of expectancy of ACVs which is defined as "*the degree of effort which an individual believes he or she needs to spend on using an ACV*". Furthermore, 4-items were used towards trust about using ACVs which is defined as *"the degree to which an individual believes that will generally trust an ACV".* Responses about the 10-item measurement scale were made on a five-point measurement scale with the anchors "strongly disagree" and "strongly agree".

In our analysis the population studied in this survey was the number of both undergraduate and postgraduate students at Harokopio University of Athens (HUA) in Greece. The participants were ranging from college-aged individuals to older adults, mainly in postgraduate level.

The survey instructions informed the respondents that their answers would be anonymous and that the completion of the survey would take around 10 minutes. Moreover the purpose of the survey had been explained to the respondents and motivated them to reply personally. In addition, the instructions informed the respondents about ACVs as follows: *"An Autonomous-Connected Vehicle (ACV) is a motor vehicle equipped with devices to communicate with other surrounding vehicles or the road infrastructure via internet and capable to perform all driving functions in all traffic, road and weather conditions without any human intervention"*.

4   RESULTS

In total, one hundred and twenty-six students completed the above survey. Three different demographic groups were considered including gender, age and primary mode of transportation. Based on the above survey almost 70% of the respondents were male, and 30% were female (M = 1.29, SD = 0.45 on a scale from 1 to 2). With respect to age, almost 65% of the respondents were between 18 and 30 years old, 19% were between 30 and 40 years old, and 16% were more than 40 years old (M = 1.55, SD = 0.85 on a scale from 1 to 5). Due to their primary mode of transportation almost 52% of the respondents travel by public transportation means whereas 40% use automobiles as drivers or passengers and 8% use alternative modes of transportation, such as walking / biking (M = 1.69, SD = 0.66 on a scale from 1 to 4).

Moreover, of the people surveyed, almost 53% own or lease a vehicle (M = 1.47, SD = 0.50 on a scale from 1 to 2) and 39% of them drive or use their car vehicle every day (M = 2.36, SD = 1.27 on a scale from 1 to 4).

Moreover, almost 55% of the respondents feel not at all or somewhat safe when they are driving or using car vehicles today (M = 2.32, SD = 0.82 on a scale from 1 to 4). Furthermore the majority of respondents (73%) had heard of the autonomous-connected vehicles before (M = 1.32, SD = 0.55 on a scale from 1 to 3), and 58% of the university students surveyed had very positive or somewhat positive general opinion regarding ACVs (M = 3.74, SD = 0.93 on a scale from 1 to 5).

Furthermore, regarding concerns with the current technology trends , in responding to the question of "how concerned are you that your data are kept private when you use internet-enabled technologies or services today", almost 40% of the respondents answered that are moderately concerned, and 25% answered that are extremely concerned. The same characteristics stated also to the similar question of "how concerned are you that your data are kept resilient to common cyber security threats when you use internet-enabled technologies or services today".

With respect to the questions about the performance expectancy of ACVs, half of the respondents indicated that such cars will be useful in meeting their driving needs, as depicted in Figure 1. Furthermore, 47% of the respondents will be feeling safer on their driving trips, and 61% indicated that using ACVs accidents would be decreasing.
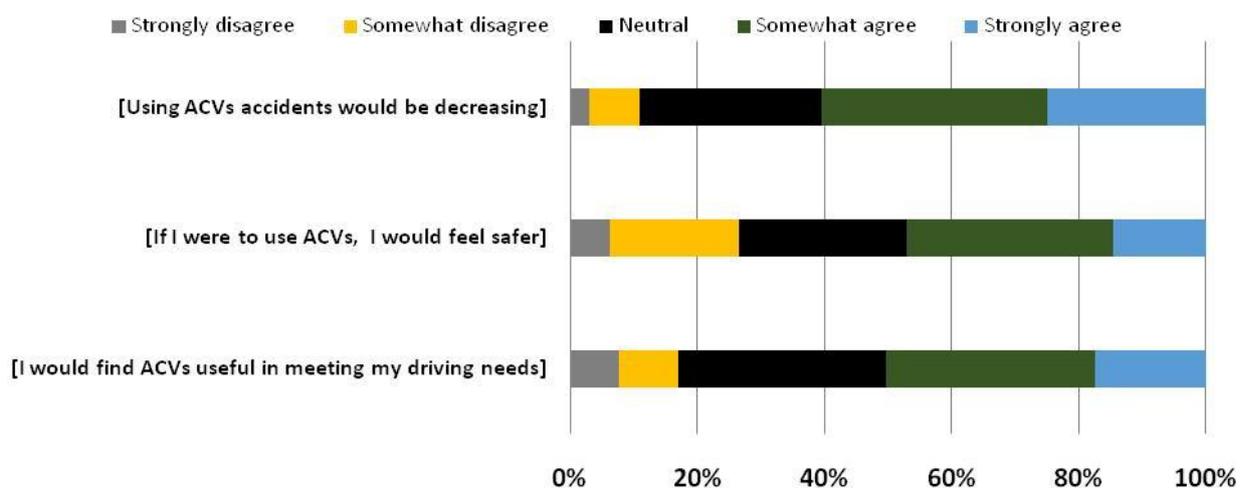

Figure 1 - Consumers' perceptions towards performance expectancy of ACVs

On the other hand, regarding the questions about the effort of expectancy of ACVs the majority of the respondents indicated that they are strongly agree or somewhat agree against the statements "learning to operate a ACV would be easy for me" (68%), "interactions with ACVs would be clear and understandable to me" (74%) and "it would be easy for me to become skillful at using ACVs" (70%), as depicted in Figure 2.

Moreover, with respect to the questions about the trust of ACVs the majority of the respondents (45%) stated that they are strongly agree or somewhat agree against the statements "I generally have concerns about using ACVs" and "I have concerns about safety of ACVs", and 51% stated neutral to the statement "I have concerns about system security and data privacy of ACVs". Furthermore, as depicted in Figure 3, only 22% of the people

surveyed answered that the technology of ACVs is somewhat frightening to them.
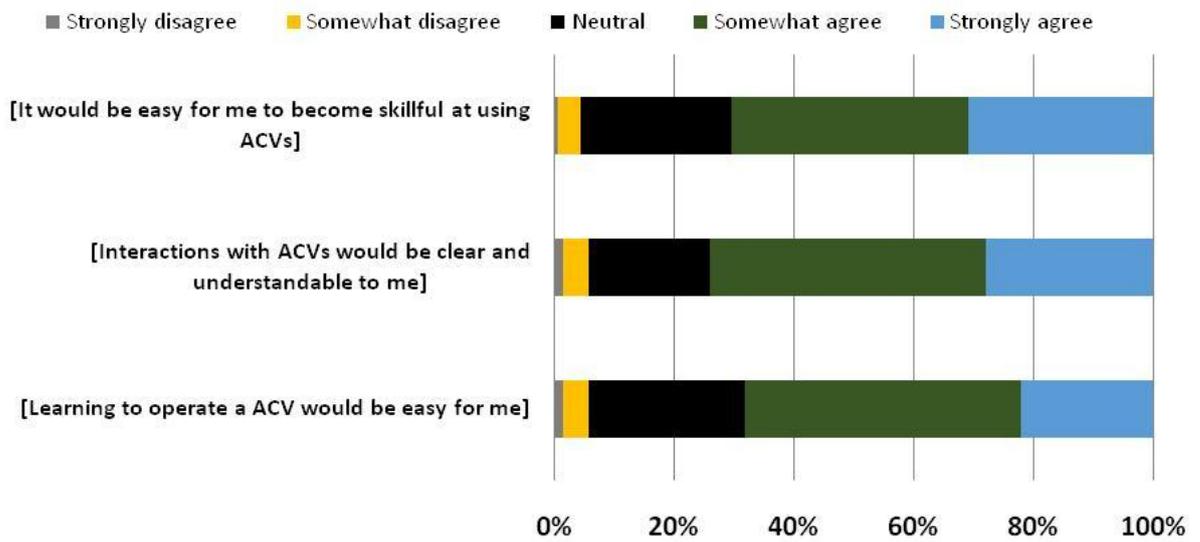

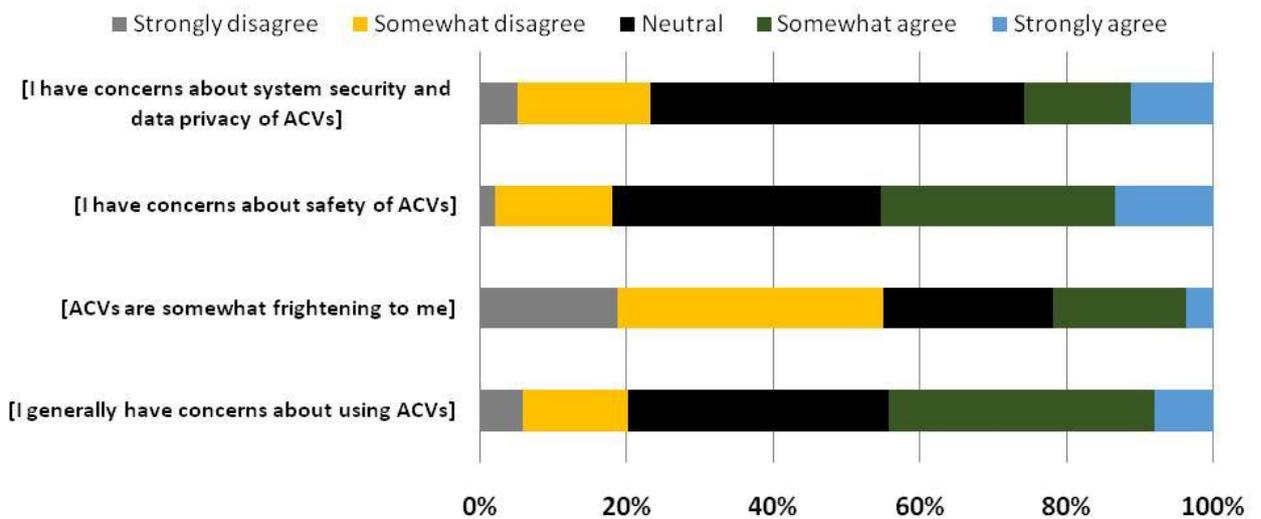**Figure 2 - Consumers' perceptions towards effort of expectancy of ACVs**

Figure 3 - Consumers' perceptions towards trust about using ACVs

5   DISCUSSION

As research into automation gains momentum and increasing amounts of money are invested from the vehicle industries into innovative automation and connectivity solutions, it is very important to study the factors that will impact consumers' intensions to use and adopt these technologies. This is something which has rarely been explored in the literature to date. The purpose of this study was to explore how the factors performance expectancy, effort of expectancy, and trust might affect the behavioral intension of potential customers (university students) to use ACVs.

With respect to the results towards the performance expectancy of ACVs, half of the respondents indicate that

such cars will be useful in meeting their driving needs, and almost 60% answered that using ACVs accidents would be decreasing. In this context university students who think that ACVs are useful tend to be more willing to use these technologies when they will be available on the market.

Furthermore, with respect to the results towards the trust of ACVs, half of the respondents stated neutral to the statement "I have concerns about system security and data privacy of ACVs". This implication has to do with the fact that individuals would use ACVs if they find that they can trust ACVs technology towards safety, data privacy and security protection concerns.

Moreover, with respect to the results towards the effort of expectancy of ACVs the majority of the respondents (almost 70%) indicated that they are strongly agree or somewhat agree against the statement "learning to operate a ACV would be easy for me". This surprising result has to do with the fact that young consumers like university students are more familiar with the ease of engaging in the mechanisms of new technologies.

The above implications are similar to what Choi and Ji [10] demonstrated that perceived usefulness and trust were necessary precursors to use an autonomous vehicle, with a very weak effect of perceived ease to use such a vehicle. Moreover the above findings confirm the results of what Ghazizadeh et al. [11] have studied about the important role of trust on automation. Additionally, almost two to third respondents are concerned about security and data privacy issues regarding online technologies or services that they use today, which is opposite to the results of what Zmud and Sener [9] have studied.

6   CONCLUSIONS

Autonomous and connected vehicles have enormous potential to enhance mobility. As our experiences with these technologies increase over the coming years, it is critical that we begin to better understand consumers' willingness to use or have ACVs. In this context, the range of experiences with autonomous-connected driving technologies are rapidly becoming a topic of international research, making studies of this nature an area of need.

Our survey results showed us people's perception of autonomous-connected vehicles. We found that the majority of participants responded neutrally against safety, data privacy and system security protection issues regarding ACVs. Further projects might study what exactly causes this neutral attitude on trusting ACVs.

It should be acknowledged that there were a number of limitations to this study. This study describes a survey which targets the university population. On this context, future efforts should be done on a nationally representative or an international sample to examine how attitudes may differ by age, education level, income, region, cultural background, car ownership status, etc. In addition, future studies should be done to delve deeper into secondary topics about ACVs such as productivity, efficiency, environmental impact, etc.

Moreover, it is important to note that our present findings should be interpreted carefully, because highly or fully autonomous and connected vehicles are not currently available on the market. Hence, the results of our survey rely to a large extent on people's imagination regarding the operation of ACVs in the future. In this direction real demonstrations are needed to test such vehicle technologies (e.g. in operational speed and under

different road/weather/traffic conditions) in order to convince the public what ACVs can do in real conditions. As communities and individuals learn more about these new vehicle-based technologies, their perceptions and expected/stated behavioral responses are likely to change, in some cases rapidly. As such, more work is required elsewhere in all countries, and over time.

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