Safety Perceptions of Self-driving Cars: A Survey Study in China and Pakistan

Amna Chaudhry[1(✉)], Peng Liu[2], Amjad Hussain[3], and Irum Sanaullah[1]

[1] Department of Transportation Engineering and Management, University of Engineering and Technology, Lahore 54890, Pakistan
{amnach, Irum.sanaullah}@uet.edu.pk
[2] Department of Industrial Engineering, College of Management and Economics, Tianjin University, Tianjin, China
pengliu@tju.edu.cn
[3] Department of Industrial and Manufacturing Engineering, University of Engineering and Technology, Lahore, Pakistan
chamjad@gmail.com

Abstract. The most critical concern with respect to the development of driverless vehicle technology is its safety and reliability. Inadequate technological advancements may lead to serious implications especially in terms of loss of human life. Moreover, technological advancements bring socio-technical complexities where the role of human, being the key element of a system, becomes highly important. Benefits of advanced technologies in driverless vehicles cannot be realized properly if safety related concerns have not been appropriately addressed in the design process. One possible way forward is to get feedback from the users of technology and incorporate design requirements accordingly. For acquiring the necessary information on various safety related issues that might be faced by the drivers, this public opinion based survey study has been conducted in China and Pakistan which mainly aims at capturing the public reliance level, perceptions and expectations on driverless vehicle system, more specifically on safety related issues. A web-based survey, containing some general questions about safety especially under some given driving scenarios, was launched in both the countries. The survey findings provide a useful insight for stakeholders towards user's expectations, their safety perceptions and differences in the level of trust on modern vehicle technologies between the people of an emerging economy (China) and low-income country (Pakistan). The results also direct towards the need for further exploration of safety related concerns so that the issues could be addressed pragmatically during the design process.

Keywords: Self-driving cars · Public opinion · Safety perceptions
Traffic scenarios · Future challenges

1 Introduction

As the automated vehicle technology is emerging and advancements are bringing new challenges, there is a need to explore how latest changes in the vehicle automation technology are being perceived by the users, most importantly, in terms of the safety

N. Stanton (Ed.): AHFE 2018, AISC 786, pp. 458–468, 2019.
https://doi.org/10.1007/978-3-319-93885-1_41

benefits of adopting this technology. In order to develop and introduce more advanced automated systems (especially for the next upcoming levels of automation) that can be effectively and safely adapted by the drivers, it is imperative for the designers and manufacturers to know how such systems influence driver's opinion, behavior and capabilities.

Additionally, since various automated functions (AF) are being used in many countries, the experiences of these users as well as comparison of opinion between different user-groups will be useful in terms of finding the influence of different factors like economic conditions on the user's perceptions and acceptance of the technology. Such information is valuable with respect to further technological advancements and implementation strategies. The most crucial aspects in this respect is related to safety and reliability of the system performance under different driving/traffic situations on road, particularly those where vehicle would have to make crash avoidance decisions. There could be many uncertainties with regard to relying on the self-driving vehicle technology in operating safely and efficiently in various situations on road such as the incident of Tesla Sedan S where its driver-assist autopilot technology failed to avoid collision with the side of a tractor-trailer resulting in a fatal crash. In the context of field experimentation, it is also necessary to know which type of experimentation and methods should be applied to assess the safety performance of this technology.

Keeping in view the technological happenings, future trends and challenges related to safety and reliability of the system, a web survey was designed so that a more comprehensive view point of potential users can be captured on safety perceptions about this technology. At the first stage, the survey was launched in China (emerging market) and Pakistan (developing), and the public response was collected. This paper presents views of people in China and Pakistan on safety aspects of self-driving vehicle technology.

2 Literature Review

Although self-driving vehicles offer great convenience, their safety and reliability is still a big concern. While more experimental testing is needed to identify safety related issues and safety-enhancing innovations, in the meanwhile public concerns, expectations, and perceptions regarding safety and reliability of the technology could also provide important information to technology-developers for successful advancements and implementation of the technology to maximize its safety benefits. As highlighted by a review of existing literature on autonomous driving [1], 91% of the existing research aims for development and advancements of the technology while only 1.3% topics in this field of research are related to user acceptance of the technology. This indicates that predominantly the research on autonomous vehicles is focused on technological development aspects and little is done on knowing the public perception, understanding, and acceptance of this technology. The following review presents some findings from previous public opinion surveys specifically related to people's expectations and concerns on the safety benefits of self-driving vehicle technology.

The continental mobility study [2] in Germany, China, Japan, and United States showed that 74% people in China, 50% in United States, 48% in Germany, and 43% in

Japan did not think that the automated driving would be reliable. However, several studies by researchers have also revealed that people in developed countries are expecting increased safety and convenience by adopting automated vehicle technology. For example, 75% people in Berkley California study [3] indicated safety as the most attractive feature and 61% chose convenience, while in the Worcester Polytechnic Institute Survey Study [4] in university setting, 82% chose safety as the most attractive feature in driverless vehicle technology. In another study, 70% people in US, UK, and Australia expected that crashes would be reduced due to this technology [5]. A recent study of Austin area residents [6] also revealed that people expect automated vehicles to be safer. Similar perceived safety benefits were indicated by people in the Global Automotive Consumer Study [7] and in the study conducted by Bansal et al. [8].

The findings of a recent review on public opinion surveys investigating the public acceptance of autonomous vehicles [9] showed more acceptance among young people, men and those with advanced driver assistance systems in their vehicles particularly in urban environments. The review also identified several studies where respondents either expected autonomous vehicles to be safer or indicated their concern about safety aspects of this technology. The authors further suggested investigating the relationship between safety level and the potential users of this technology.

Bansal and Kockelman in their case study of public opinion in Texas [10] suggests that respondents with more driving experience can better perceive safety benefits of connectivity. They also estimated that acceptability of the technology among the older persons, living in dense areas and away from bus stops, is much dependent on adoption of the technology by their friends

Zmud et al. study [11] of Austin metropolitan area residents showed perceived safety benefits and data privacy as the significant factors affecting the self-driving vehicles adoption. The respondents who were likely to use self-driving vehicles most frequently answered “being safer than human drivers” as the reason of using these vehicles.

It is evident from the findings of various public opinion surveys presented above that people not only have high expectations on safety benefits from the self-driving vehicle technology but also find it as the most attractive feature for adoption. However, there is a need to make further explorations on perceptions of the public regarding the system capabilities for avoiding collisions, making safer decisions than human drivers under different scenarios on road. Also, drivers’ opinion in countries with varied set of traffic conditions/driver behaviours (e.g. mixed traffic conditions) as compared to most of the developed countries, is also important to explore and useful for assessing the potential market of the technology in those countries.

3 Design of Survey Instrument

A web-based survey was developed using SurveyMonkey, a web survey tool (www.surveymonkey.com). For the part of study in China, the survey was translated to Chinese language using on online survey platform (https://www.sojump.com/), similar to Qualtrics web-based survey tools. The survey questionnaire started with a brief introduction on self-driving vehicles and explained different levels of automation with

their pictorial demonstration. The questionnaire was prepared covering wide range of questions on various factors including reliability, safety, concerns, preferences, convenience, training needs, foresight, willingness to purchase the technology etc. In this paper, public responses on only safety aspects of self-driving vehicles are presented.

Respondents were asked if they think that;

- Completely self-driving vehicle system will be capable of making safe and efficient decisions in various safety critical situations on road.
- Completely self-driving vehicle will be able to take better actions than human drivers in avoiding collisions/accidents.
- Completely self-driving vehicle will be able to cope with almost every situation on road?

Additionally, a few traffic situations (with illustrations) were included in the questionnaire and respondents were asked to indicate their trust on the system in avoiding collision under those situations. These included;

(a) Making a safe pass on an undivided two-lane, two-way roadway (avoiding potential head-on collision)
(b) Avoiding potential Collision with crossing passengers on road
(c) Operating efficiently and safely in congested traffic conditions
(d) Driving efficiently in an urban/city traffic environment
(e) Make efficient and safe decisions while driving through mixed-traffic conditions

The survey was conducted in two countries; China and Pakistan. Most of the audience included people from technical background, University students, and employees while others included people from non-technical background, staff members, and retirees. People from different age groups and education level (both males and females) were part of the sample in both countries. The findings are presented and discussed in the following section.

4 Demographics of the Participants

In Pakistan, total 149 surveys were received. In order to get reasonable opinion on the survey questions, mostly people from the technical background (holding either bachelor's degree or above) were targeted. The male and female population in the sample closely represent the driving ratios in the country.

In Chinese sample, 155 responses were collected. Most of population included people with undergraduate degree or above while others included junior college or below. The gender distribution in Chinese sample is representative of the country's population. The demographic information of the respondents from each country is presented in Table 1 below.

Table 1. Demographics of the survey participants in China and Pakistan

Demographics		China (n = 155)	Pakistan (n = 149)
		Percent (%)	Percent (%)
Gender	Male	51.6	75.2
	Female	48.4	24.8
Age	less than 18	0.6	0
	18–25	19.4	67.1
	26–30	36.8	16.8
	31–40	37.4	14.1
	41–50	3.9	0.7
	51–60	1.9	0.7
	>60	0	0.7
Education	Below high school	3.2	0
	High school	4.5	0
	Junior college	11.0	4.0
	Undergraduate	67.1	61.1
	Master degree or above	14.2	34.9
Driving experience	None	16.1	22.8
	Less than 1 year	16.8	21.5
	1–5 year	43.2	26.8
	5–10 year	23.2	20.1
	>10 year	0.6	8.7
Used any automated function in a vehicle before?	Yes	69.7	20.1
	No	30.3	79.9

Participants were also asked if they have used any automated function such as Cruise Control (CC), Adaptive Cruise control (ACC), Emergency Brake Assist (EBA), Lane Keeping Assist (LKA), or any other in a vehicle before to see how the opinion varies between different users. A large percentage of Chinese participants (almost 84%) were found to be automated function users while only 20% participants from Pakistan were either using or have used automated functions before (Table 1).

5 Survey Findings

Since it is important to keep track of the recent state of public awareness and interest in self-driving vehicle technology as well as regional differences and/or preferences, participants were first inquired about their knowledge and interest in completely self-driving vehicles. About 93.5% Chinese participants while 86% Pakistani participants were aware of the self-driving vehicle technology. Overall, the majority of the participants from both countries (88.4% Chinese and 74.5% Pakistani) indicated interest in

owning a completely self-driving vehicle instead of their current vehicle. Additionally, participants expressed interest in some level of automation as opposed to no automation at all. Chinese respondents were comparatively found to be more accepting or willing to use higher levels of automation (Table 2). This might be because of increased popularity and familiarity of Chinese participants with automated functions or driver assistance systems, as compared to the participants in Pakistan. Society of Automotive Engineers (SAE) definitions [12] have been used for describing different levels of automation in the survey questionnaire with various pictures displaying the functionality of the automation levels.

Table 2. Interest in level of automation

Level of automation	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Level 0	9	5.8	13	8.8
Level 1	23	14.8	27	18.2
Level 2	14	9	24	16.2
Level 3	40	25.8	41	27.7
Level 4	26	16.8	12	8.1
Level 5	43	27.7	31	20.9
Total	155	100	148	100

After collecting general information regarding the awareness and interest in self-driving vehicles, respondents were asked several questions related to their perceptions on the safety aspects of such vehicles. A few questions along with their responses are presented and discussed in the subsequent sections.

Most of the survey respondents from both countries were of the opinion that self-driving vehicles will improve roadway safety and reduce traffic crashes however, more number of Chinese participants (81.3%) were of this opinion as compared to the Pakistani respondents (62.4%), as illustrated in Table 3.

Table 3. Opinion on improving road safety and reducing crashes

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly disagree	2	1.3	11	7.5
Disagree	27	17.4	43	29.3
Agree	80	51.6	72	49.0
Strongly agree	46	29.7	21	14.3
Total	155	100	147	100

When the survey participants were asked if they feel their driving skill would be negatively affected if they were continuously driven by self-driving vehicle, majority of the participants in both countries expressed an agreement with it (Table 4).

Additionally, participants were also found to be of the view that due to being continuously driven by self-driving vehicle, they may not be able to stay vigilant enough to take the manual control if necessary, as shown in Table 5 (almost 81.2% Chinese respondents and about 70% Pakistani respondents).

Table 4. Participants' opinion about negative effect on driving skill due to being continuously driven by self-driving vehicle

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly disagree	11	7.1	8	5.4
Disagree	18	11.6	35	23.6
Agree	93	60	74	50
Strongly agree	33	21.3	31	20.9
Total	155	100	148	100

Table 5. Participants' opinion about impact on driver's vigilance to take manual control when necessary

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly Disagree	14	9	4	2.7
Disagree	15	9.7	38	26.0
Agree	94	60.6	84	57.5
Strongly Agree	32	20.6	20	13.7
Total	155	100	146	100

Participant's reliability on self-driving vehicles were further explored by asking if they feel that completely self-driving vehicles will be capable of making safe and efficient decisions in various safety critical situations on road. A large percentage of 84% Chinese respondents showed agreement to this statement (almost 84%) while relatively lesser survey respondents in Pakistan indicated their trust on the capabilities of self-driving vehicle technology under safety critical situations on road (Table 6). One reason of this could be increased familiarity and usage of advanced automated and driver assistance systems in China as compared to Pakistan. As indicated earlier in Table 1, about 70% of the Chinese participants were automated function users as compared to 20% in the Pakistani sample.

When participants were further inquired if they think the technology will be able to cope with almost every possible situation on road, the majority of Chinese people (about 73%) indicated their trust on the system capabilities while majority of people in Pakistani survey sample (about 68.5%) showed disagreement in this respect (Table 7).

A large percentage of 84% Chinese respondents (almost 84%) agreed when asked if they think completely self-driving vehicles will be able to take better actions than

human drivers in avoiding collisions/accidents, while lesser participants (about 56.4%) were of this opinion among Pakistani participants (Table 8).

Participants' responses in Tables 6, 7 and 8 direct towards further exploration of public reliability level with respect to safety performance of self-driving vehicles under various common driving situations on road. In order to test this, various driving situations were given in the survey questionnaire along with the pictorial representation, in the survey and people were asked to show their trust on the self-driving vehicle technology for taking safe decision or avoiding collision under the given scenario considering other vehicles on road as conventional vehicles. A few scenarios and the survey responses of the participants from both countries are presented in Table 9 below.

Table 6. Trust on the system capability for making safe and efficient decisions in various safety critical situations on road

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly disagree	6	3.9	9	6.2
Disagree	19	12.3	45	30.8
Agree	86	55.5	77	52.7
Strongly agree	44	28.4	15	10.3
Total	155	100	146	100

Table 7. Opinion on ability to cope with almost every situation on road

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly disagree	13	8.4	21	14.4
Disagree	29	18.7	81	55.5
Agree	67	43.2	39	26.7
Strongly agree	46	29.7	5	3.4
Total	155	100	146	100

Table 8. Opinion about self-driving vehicles being better than human drivers in avoiding collisions/accidents

Response	China		Pakistan	
	Frequency	Percent	Frequency	Percent
Strongly disagree	9	5.8	14	9.5
Disagree	16	10.3	49	33.3
Agree	88	56.8	72	49.0
Strongly agree	42	27.1	12	8.2
Total	155	100	147	100

Overall, much higher percentage of Chinese participants showed trust on the technology under the given driving situations as compared to the participants from Pakistan, particularly under congested, city, and mixed-traffic conditions (Table 9). The responses presented in Table 9 highlight a need of more detailed exploration of safety perceptions of self-driving vehicles under actual driving situations that a driver may encounter on road during travel.

Table 9. Participants' trust level on the technology under various driving scenarios

Driving scenario	Response	China		Pakistan	
		Frequency	Percent	Frequency	Percent
Making a safe pass on an undivided two-lane, two-way roadway (avoiding potential head-on collision)	Strongly disagree	12	7.7	12	8.5
	Disagree	30	19.4	47	33.3
	Agree	66	42.6	72	51.1
	Strongly agree	47	30.3	10	7.1
	Total	155	100	141	100
Avoiding potential collision with crossing passengers on road	Strongly disagree	2	1.3	9	6.5
	Disagree	13	8.4	39	28.3
	Agree	79	51	78	56.5
	Strongly agree	61	39.4	12	8.7
	Total	155	100	138	100
Operating efficiently and safely in congested traffic conditions	Strongly disagree	2	1.3	16	11.6
	Disagree	19	12.3	56	40.6
	Agree	83	53.5	48	34.8
	Strongly agree	51	32.9	18	13.0
	Total	155	100	138	100
Driving efficiently in an urban/city traffic environment	Strongly disagree	3	1.9	12	8.6
	Disagree	16	10.3	60	42.9
	Agree	80	51.6	58	41.4
	Strongly agree	56	36.1	10	7.1
	Total	155	100	140	100
Make efficient and safe decisions while driving through mixed-traffic condition	Strongly disagree	4	2.6	19	13.7
	Disagree	19	12.3	57	41.0
	Agree	84	54.2	53	38.1
	Strongly agree	48	31	10	7.2
	Total	155	100	139	100

6 Conclusions, Recommendations and Future Work

Generally, majority of respondents from both countries indicated their expectations from the self-driving vehicle technology in terms of improving roadway safety and reducing traffic crashes however much higher percentage of Chinese (81.3%) than Pakistani respondents (62.4%). Overall, Chinese respondents' trust level and safety perceptions about the technology was found to be much more positive, as compared to the participants from Pakistan, with regard to relying on the system and taking better decisions than human drivers in avoiding a potential collision under various safety critical situations on road. A large number of Chinese respondents (about 73%) also showed their trust on the system capabilities in coping with almost every possible situation on road whereas this was not the case with Pakistani respondents (about 68.5% disagreed). This might be concluded that respondents' economic conditions possibly drive their opinion and expectations. However, majority of the participants in both countries think that their driving skill will be affected negatively if they were continuously using self-driving vehicle and that they may not be able to stay vigilant enough to take the manual control if necessary in some situations.

Findings of the survey provide an insight towards people's expectations, perceptions and differences in trust level with reference to safety aspects of self-driving vehicles in emerging economy and low-income country. People in China seem to have higher trust level on the technology that might be attributed to their raised familiarity and experience of using automated functions, as about 70% of the Chinese participants in the survey were automated function users. The results of this survey study also direct towards further explorations of people's opinion and safety perceptions about the use of technology under various driving situations on road.

In future, a comprehensive web-based survey incorporating varied set of traffic conditions and driving scenarios will be distributed among the people of developed and developing countries, with a focus to capture the public reliance level and expectation on driverless vehicle system under safety critical driving scenarios. The findings will provide a valuable insight to designers, technology developers, planners, and manufacturers on safety related issues so that more reliable and efficient systems could be designed.

References

1. Rosenzweig, J., Bartl, M.: A review and analysis of literature on autonomous driving. E-J. Mak. Innov. (2015)
2. Sommer, K.: Continental Mobility Study (2013)
3. Howard, D., Dai, D.: Public perceptions of self-driving cars: the case of Berkeley, California. In: Proceedings of the Transportation Research Board 93rd Annual Meeting, Washington, D. C. (2014)
4. Casley, S., Jardim, A., Quartulli, A.: A study of public acceptance of autonomous cars (Bachelor thesis). Worcester Polytechnic Institute, Worcester, MA, USA (2013). https://web.wpi.edu/Pubs/E-project/Available/E-project-043013-155601/unrestricted/A_Study_of_Public_Acceptance_of_Autonomous_Cars.pdf

5. Schoettle, B., Sivak, M.: A survey of public opinion about autonomous and self-driving vehicles in the US, the UK, and Australia (Technical report No. UMTRI-2014-21). University of Michigan, Michigan (2014b)
6. Underwood, S.: Automated vehicles forecast vehicle symposium opinion survey. In: Automated Vehicles Symposium, San Francisco, CA (2014)
7. Brown, B., Drew, M., Erenguc, C., Hasegawa, M., Hill, R., Schmith, S., Ganula, B.: Global Automotive Consumer Study: The changing nature of mobility-Exploring consumer preferences in key markets around the world (Technical report), Deloitte (2014). https://www2.deloitte.com/content/dam/Deloitte/au/Documents/manufacturing/deloitte-au-mfg-2014-global-automotive-consumer-study-changing-nature-mobility-290914.pdf
8. Bansal, P., Kockelman, K.M., Singh, A.: Assessing public opinions of and interest in new vehicle technologies: an Austin perspective. Transp. Res. Part C: Emerg. Technol. **67**, 1–14 (2016)
9. Becker, F., Axhausen, K.W.: Literature review on surveys investigating the acceptance of automated vehicles. Transportation **44**(6), 1293–1306 (2017)
10. Bansal, P., Kockelman, K.M.: Are we ready to embrace connected and self-driving vehicles? A case study of Texans. Transportation **45**, 1–35 (2016)
11. Zmud, J., Sener, I.N., Wagner, J.: Consumer Acceptance and Travel Behavior 39 Impacts of Automated Vehicles, Technical report, Austin (2016)
12. SAE International: Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems, (Report SAE J3016) (2014). http://standards.sae.org/j3016_201401