

People perception of autonomous vehicles: Legal and ethical issues



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ABSTRACT

In past five years, self-driving or autonomous cars have achieved a great milestone that now they are commercially available as the Waymo Company emerged from Google autonomous car has started its service in suburbs of Phoenix from December 2018. Autonomous cars are able to sense their surrounding environment and their control system is able to interpret that information to identify navigation paths, road barriers and traffic signals. The journey of autonomous cars produced many questions regarding legal and ethical issues of autonomous cars. These cars combine a variety of information from its sensors including radars, lidar, sonar, GPS and odometry for real-time decision making. In this article, we have reviewed the literature to understand primary questions related to liability, ethics, and legal issues. From the last six years, 523 papers were selected, which were further shortlisted on the basis of relevance. Finally, 84 papers were shortlisted to conclude the discussion on tort liability, products, and strict liability. The utilitarianism, deontological and virtue ethics theories were discussed in terms of writing ethical code for designing autonomous cars. These cars are expected to decrease accidents by centralized traffic system through inter-vehicle communication. Furthermore, an online survey of 2021 participants was conducted in five different countries to understand perception and trust on different autonomy levels in self-driving cars. The participants showed their level of trust from a safety perspective, their concern about one time cost in the start, need of legislation by local governments and fear of rising in unemployment due to autonomous cars. The results indicate mix perception where people want this technology but are concerned about legal and ethical implications. The paper is helpful for researchers, manufacturers and law enforcement agencies in the implementation of autonomous cars.

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1. Introduction

Automobile industry is moving towards cars that can take decisions autonomously. One of the major motivations is to increase safety on roads as more than 90% of the road accidents are caused due to negligence of the driver (Duffy and Hopkins, 2013). There are many other factors including increased productivity, decreased congestion, decreased in driving errors, reduced dependency on drivers and many more. There has been a lot of work on self-driving cars (Hudda et al., 2013), however, a consolidated systematic literature review is still

missing. Cars are becoming more luxurious and safe day by day and automobile industry is continuously adding convenience for its customers by adding more features. Commercialization of automobile industry dates back to early 1890's, however, industry has evolved with time, as initially the major target of industry was to produce cars with basic features, but now the cars have more options than early days.

One of the features is driver assistance and engineers are working tirelessly to enhance user experience (Merat et al., 2014). This ranges from basic features like improved displays to a complete control (Waldrop, 2015) of the car by computerized system (Teoh and Kidd, 2017). The autonomous industry has progressed tremendously and many prototypes have been tested successfully (Coelingh et al., 2018), and cars are now available commercially for customers. In 2010, four self-driving cars travelled from Italy to China without

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drivers, these cars were completely autonomous and completed their journey successfully. Google's car has also completed its trial, the car was tested in multiple scenarios and remain successful. Fully self-driving car by Google came on public roads in 2015. In 2016, Google formed an independent company named Waymo (Bagloee et al., 2016) further it introduced fully self-driving Chrysler Pacifica Hybrid. The company plans to produce more than 20,000 cars and bring them to public roads. However, it is to be noted that there have been instances where these cars have been involved in accidents.

According to an independent survey, more two third respondents believed that market of self-driving cars will have more than 50% share in automobile industry by 2050, however, people were concerned about the hacking, safety and other issues (Zakharenko, 2016).

Another aspect of self-driving cars that has been investigated a lot is shifting of control back to the driver while driving (Meiring and Myburgh, 2015). These investigations can be classified into two conditions where the first shifting refers to a time based shifting and the control is transferred back according to the time interval (Politis et al., 2017). The second condition is dependent on the eye contact of driver with the road; this needs manipulation of time interval when the driver is ready to take control of the car and driver's focus is on road (Markwood and Liu, 2016). For second scenario, time required to regain the control of the car has to be calculated along with the complete eye tracking data of driver so that eye fixation of driver can be observed, recorded and detected (Liang et al., 2015).

The results were categorized in to two outcomes, first is the fixation of driver's eye away from road, where instable steering corrections were recorded and a variable eye movement was identified after the automated driving mode was switched off (Chen and Huang, 2017). In second situation, when transaction was made after a time interval, response was much stable. Hence, the transfer of control from automated to manual was much smooth and safe when a driver is expecting the transaction.

In 33 US states and district California have passed laws to allow these cars on roads. The first license was issued by NEVADA State is 2012. An internet program of Google named "Street View" used autonomous vans to take views of streets that are used in Google Maps (Enzweiler, 2015). Audi's self-driving car (Mocker and Fonstad, 2017) was sent to Pike's Peak Hill Climb Race (Duffy and Hopkins, 2013) and the results were encouraging.

In this paper next section describes related work. The selection of literature review and online survey are discussed in methodology section. In next section, discussion of online survey and debate about research questions has been presented respectively. Finally, conclusion of research work and directions to future work are presented.

2. Related works

Self-driving cars consist of highly sophisticated combination of sensors, cameras, short distance communication, computer vision and use of computing power. These cars have become a reality due to increase in computing power and advancements in electronics. Processing is done in real time and most decision making is done autonomously which make them a complete self-adaptive system (Mian and Ahmad, 2018).

These cars change their action according to the environment, they have capability to change their acceleration and manage their braking system according to environment (Shladaver, 2016) autonomously. Autonomous cars have become one of the most popular topics of research; however, there are a lot of concerns from the public over the safety (Nyholm and Smids, 2016; Sethumadhavan, 2017). These cars have the capability to steer, decide, navigate, foresee and act intelligently in critical situations. The cars have the capability to communicate with other vehicles and environment using short distance communication, this is categorized as vehicle to vehicle and vehicle to infrastructure communication technology (Blyth et al., 2015). No human involvement is required to take any decision by autonomous cars This decision is done on the basis of a lot of factors including the type of obstacle, the car speed, the road condition, distance to the car behind and overall goal of the system (Tariq et al., 2017). The level to which a car is automated can be categorized in 5 levels. According to National Highway Traffic Safety Administration (NHTSA, 2013; 2017), level 1 is similar to a standard vehicle where all controls are managed by the driver of car. In level 2 and 3, driver can transfer control of few major functions like steering and braking for limited time. At level 4, control can be transferred to computerized system, but driver has to be attentive where the car may transfer the control back to driver (Kumfer and Burgess, 2015). Level 5 means that the car is fully automated (Goodall, 2014) and all the controls are managed by the car itself. Environment sensing is essential for task of efficient navigation over long distances. In contrast, on a bumpy dirt road the car should constantly determine which bumps and holes should be negotiated and which should be avoided. These are called positive obstacle (Manduchi et al., 2005). Two main components which are used in autonomous cars are LIDAR (Verghese, 2017) and IMU. LIDAR is laser light range detecting instrument which detects range of road. The light detects the object and sends to system which would react according to situation. Internal Management Unit (IMU) (Jiang et al., 2015) is used in the replacement of GPS system because GPS system is less accurate to give position of vehicle and may not work in tunnels (Liang et al., 2015) or bad weather conditions. IMU gives an accurate information of sharp curves and also detects weather. All these requirements are equally important for a self-adaptive system (Mian and

Ahmad, 2017) to operate. The objective of this research is to provide a systematic literature review which explores the safety concerns, legal issues in case of accidents (Vellinga, 2017), registration procedure, security issues, ethical problems and monitoring problems (Diels and Bos, 2016).

3. Methodology

The methodology has two parts: a literature review conducted to answer the critical questions about the perception of people for legal and ethical issues in autonomous vehicles. Secondly a survey was conducted in different countries to understand the perception and trust of people.

3.1. Selection of literature review

To conduct Systematic Literature Review (SLR), the process has been followed as described by Petersen et al. (2008) which is illustrated as following:

- The identification and selection of primary studies
- The development of review protocol
- Reporting the results
- The data extraction and synthesis

The objective of this study is to answer the following research questions.

- RQ1. What are legal issues in automated technology and how responsibility will be fixed and who will be liable in case of accident?
- RQ2. What is role of ethics in decision making of self-driving cars?
- RQ3. What are advantages and disadvantages of autonomous vehicles?
- RQ4. Which are key challenges in self-driving cars?

a. Data Sources and Search Strategies: In the search strategies, different sources were included for searching papers such as electronic databases, manuals, surveys and conference papers are included. Electronic database such as following were explored:

- ACM Digital library (www.portal.acm.org/dl.cfm)
- Google Scholar (<http://scholar.google.com.pk/>)
- Springer Link (www.springerlink.com/)
- IEEEExplore (www.ieeexplore.ieee.org/Xplore/)
- Elsevier Science Direct (www.sciencedirect.com/)
- WileyInterScienc (www.interscience.wiley.com/)
- DBLP (<https://dblp.uni-trier.de/>)

The key journal papers, editorials, seminars and books have been explored on autonomous vehicles. The detailed selection process is summarized in Fig. 1.

In first level 523 papers were selected in last six years on the basis of electronic database given in Table 1.

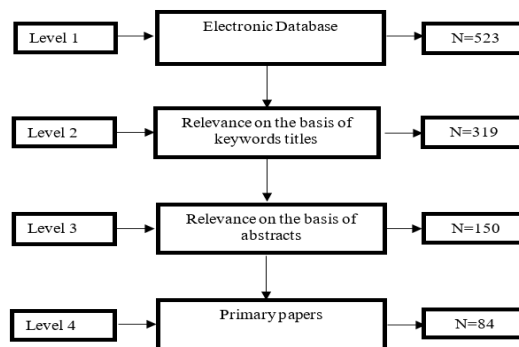


Fig. 1: The selection process of primary papers

Table 1: Search terms used in this review

Type	Category	Keywords
1	Self-driving vehicles	Self-driving automobiles
		Self-driving vehicles
		Driverless vehicles
		Automatic vehicles
		Autonomous vehicles
		Automatic driving
2	Self-driving Crashes	Autonomous cars
		Automated cars
		Accidents
3	Ethical Issues	Damages
		Liability
		Legal issues

In 2nd level 319 papers were selected and remaining was discarded as their keywords were irrelevant. In 3rd level, studied abstract of each paper and selected 150 papers on basis of relevance with research questions. Finally, 84 papers were selected for data extraction and synthesis phases.

b. Managing Studies and Inclusion Decisions: To make sure that only quality papers were selected and following quality criteria was followed.

In this paper following questions are used as inclusion and exclusion criterion. This was done to make sure that the selected papers are related to our topic.

- Whether the paper significantly contributes to self-driving cars technology?
- Whether the paper discussed the ethics amongst of an accident, crash and relationship?
- Whether the paper presents a survey on self-driving cars, presents any drawbacks or strengths?
- Whether the paper discussed any challenges or future implications of self-driving cars?

Recently published papers were included in this Systematic Literature Review. Table 2 shows that how much work is done on self-driving cars in the recent years which also indicate that there is dramatic increase in the interest of exploring and reporting this automated technology.

Table 2: Year-wise summary of extracted papers for systematic review

Year	2013	2014	2015	2016	2017	2018
No. of Papers	7	10	24	15	16	12
%	8%	12%	29%	18%	19%	14%

3.2. Online survey: Usage of autonomous vehicles

An online survey was conducted in five countries including Italy, Austria, UK, China and Pakistan. A questionnaire was developed to examine the perception of users about autonomous cars. Different key topics e.g. liability of accidents, ethics, benefits, drawbacks, perception and challenges etc. were selected to understand different aspects of autonomous cars. Information related to each respondent's such as gender, age and installation of autonomous vehicle technology was collected for analysis. Total 2021 participants were selected for study and data was collected by using online form.

4. Discussion about survey

Fig. 2 provides information about participants, their demographic location, their gender and level of autonomy in their vehicle. The survey values are calculated on the basis of autonomy levels as level 0 means no automation, level 1 means function specific automation, level 2 means combined function automation, level 3 means limited self-driving automation and level 4 means full self-driving automation. Furthermore, the users were grouped as per their usage experience into three

levels e.g. group1 includes people who never used autonomous cars, group2 includes users who used autonomous car for less than 6 months and group 3 includes people who used autonomous cars more than 6 months. Displaying outcome of this survey is to get the facts in context to number of males and females using autonomous vehicles inclusive of their individual opinions about the experience of using an autonomous vehicle.

This gender based survey clearly depicts the generic higher ratio of male users around these five countries. As per comparison number of people using autonomous vehicles since more than six months is much higher than the novice users of autonomous vehicles. If we enclose the graph in a statement it represents inclination in trending of autonomous vehicles by male users i.e., in UK alone number of male users using autonomous vehicles is much higher than in comparison of female users.

Fig. 3 illustrates the features of autonomous cars by five levels, depicting the opinion of people from five countries. Five levels are further categorized into four elements i.e., safety, cost, legislation and unemployment. The participants showed their level of trust from safety perspective, their concern about one time cost in start, laws defined by local governments and fear of rise in unemployment due to autonomous cars.

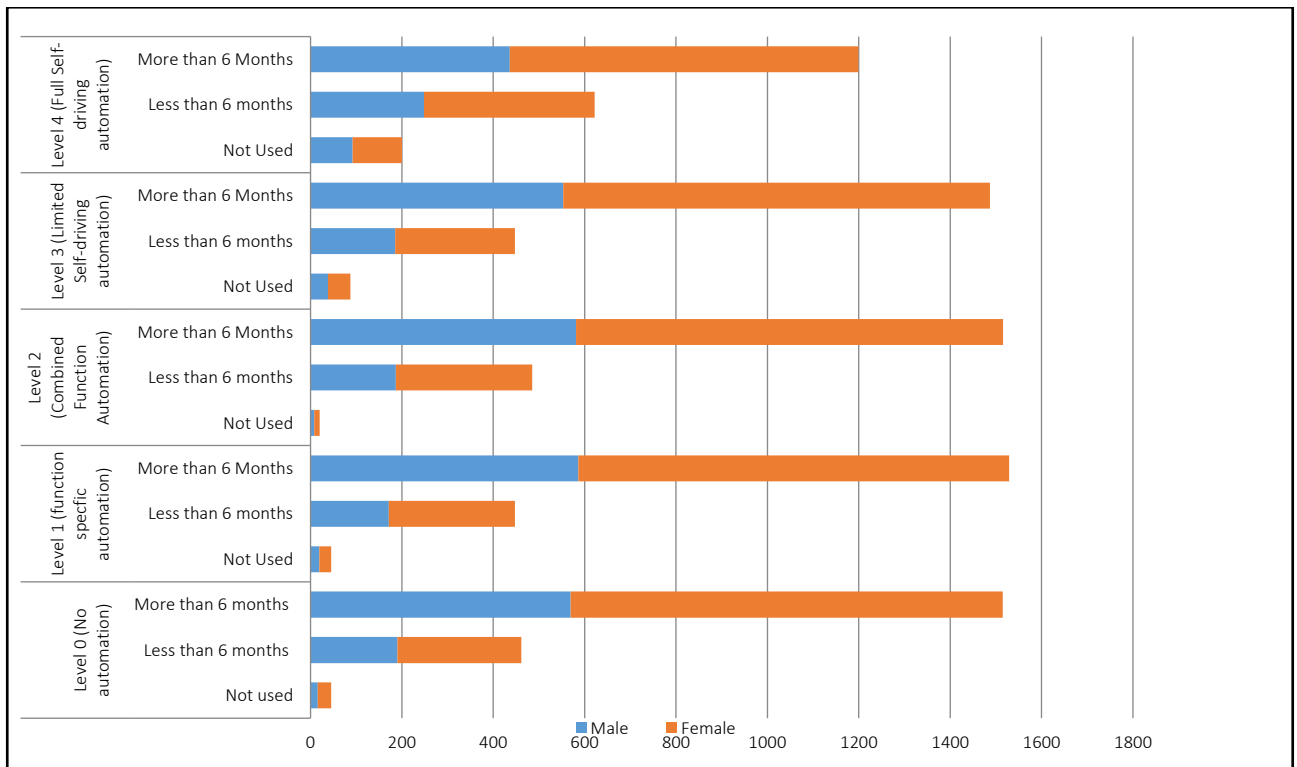


Fig. 2: Gender based summary of autonomous vehicle usage from five countries

This graphical representation clearly depicts inclination of target audience for fully autonomous cars rather cars which are partially automated. In Pakistan the target audience concerns about the cost of fully automated vehicles and few people used these cars. In UK concerns about legislations are high but more people used these cars and people of

Austria concerned about rise in unemployment. People in Italy are less concerned about security and most of them felt that automation also ensures higher level security. Overall the people of each country have their unique choices, opinions as the above data shows different trends.

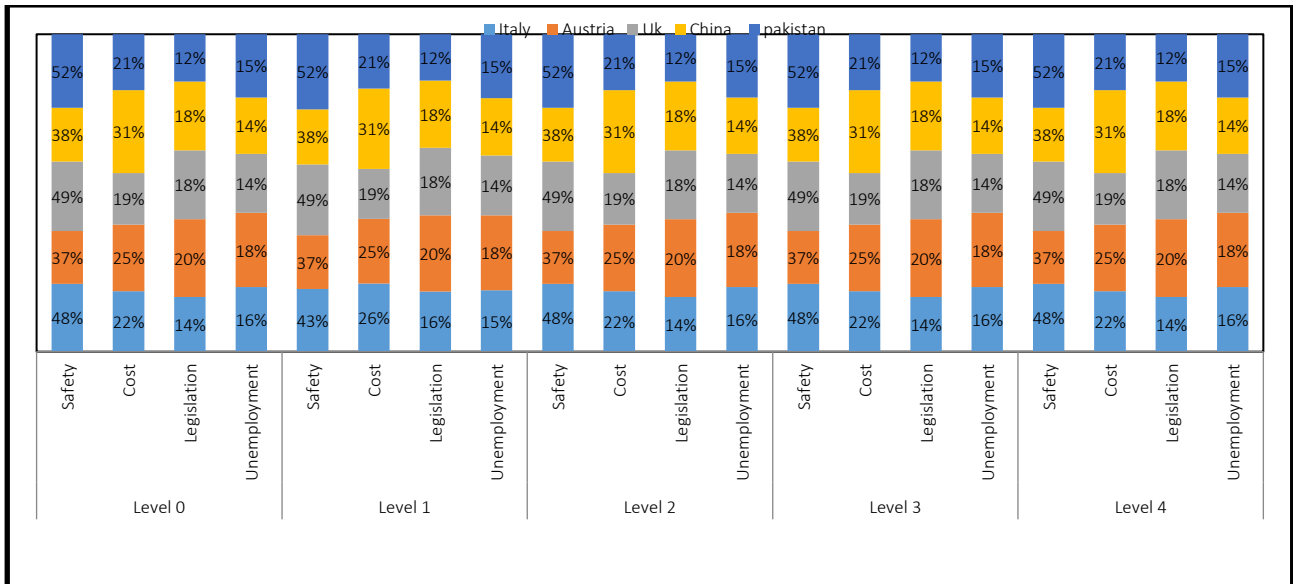


Fig. 3: Perception about autonomous vehicles on different levels from five countries

5. Discussion about research questions

As we already discussed in methodology section that 523 papers were studied to analyse different aspects of autonomous cars. Here the detailed discussion is presented regarding research questions in view of arguments presented in literature.

RQ1-Responsibility of Self-driving car accidents, who will be liable

Nowadays the autonomous vehicles are widely used technology. According to Santa Clara law (Douma and Palodichuk, 2012) the autonomous vehicles are involved in five different categories as following:

1. Human vehicle interfaces
2. Internal sensors providing data for autonomous control
3. External sensors which provide data about road and traffic
4. Fully automated control over vehicle
5. Artificial intelligence that integrate decision making

According to a study conducted in 2010 on self-driving cars (Coeckelbergh, 2016), the developers need to emphasize on providing more safety measures and the cars should be more reliable. Some issues have real concern about accident responsibilities. In already defined laws usually the responsibility relies on the performance of driver. In autonomous computer systems, mostly laws are applied in case of profit transactions. According to the liability law, the action that are performed by computer operator are more liable and give less weight to actual issue. The autonomous car should be treated as human's good friend (Hevelke and Nida-Rümelin, 2015). The autonomous cars should be considered like family vehicles that are more efficient and safe. There could be multiple reasons behind accidents as it may be occurring due to some

programming error or virus or failure of network. Most of companies are working on the technologies of autonomous cars to make them safer and secure. The Google car has successfully completed thousand miles, but it has only one incident due to the problem in car's sensor. If the automated cars moving on the roads, then in case of accident there could be scenario where either manufacturing company will be responsible for any crash or the driver will be liable for damage in case of semi-automated control if he has the authority and control to reduce the accident rate. Some recent laws talk about licensing and regulation issues but cannot measure the liability for an accident (Colonna, 2012).

In two different conditions the responsibility of the autonomous car was measured as (i) Driver liability: driver action responsible for the any damage such as careless over speeding or crossing traffic signal etc. (ii) Runway cars: The runway cars such as empty cars are not controlled by the human drivers in such situation who will be responsible for their maintenance? When some problem occurs in vehicle such as virus or fault in system then no driver can handle the vehicle. For the autonomous cars the law of computer system fails to provide full legal design. There are several reasons that the model of canine ownership liability is best for the autonomous cars because both are similar in their purpose. If the strict liability is imposed on the autonomous technology, then user will be desperate or will not buy the technology.

RQ2-Role of ethics in designing and decision making

There are many examples of vehicle incidents in daily life having variety of causes including inappropriate decisions, driver's inability to handle complex situation or multitasking during drive. Before analysing ethics for autonomous vehicles, it should be noted that already autonomous trains are successfully functioning in many countries. The autonomous trains are operating on 6% total transit

length of rails in all over the world. There is huge impact on staff saving which is up to 70% in case of autonomous trains and their service stops. The highest frequency is 42 trains per hour due to the efficiency in management while their rate of return is estimated up to 15% and 4 to 6% more space of passengers (Cohen et al., 2015). Designing algorithms in Self-driving vehicles sorting to ethics produce many complex scenarios. For understanding consider the Trolley problem in which a train is moving on a track and it is forecasted that the train could hit five persons standing on track. Now there is a choice whether a human driver take intelligent decision and put train on another track where there is a risk that one person could be compromised in effort to save other five men standing on main line. Now whether the driver should sit around and should take passive decision or should actively change the track and should hit a person which is principally standing on safer zone (Lin, 2013).

Consider another scenario, what if an animal appears suddenly on road? The humans usually take intelligent decisions, either it will find the path from front side of animal or will make way from backside or may apply full break, by considering that the vehicles behind that vehicle have safe distance. In a very critical situation to avoid the accident, the driver may take opposite route if he is not facing any traffic coming from front side. The programmers have the responsibility to analyse all such scenarios and should consider a better ethical choice to reduce the accident ratio. Another ethical concern is whether an autonomous car may harm its passengers, if there is doubt to crush couple of children crossing road? Whether the autonomous car will always save life of its passengers or will compare choices? Whether the people will buy such car which in certain conditions may harm them or will prefer their own safety always? There are some other serious ethical concerns, like what if autonomous car system is hijacked or controlled by someone else? Whether the sensors may be able to generate some alert or could access help from police? If autonomous cars took all measures of safety, then what will be the future of vehicle insurance companies? There is balance required in speed and decision making, if the autonomous car take extra safety measures, it may slow the speed of car or other drivers may deceive electronic car and will wrongfully bypass it by considering that such car will automatically stop. It is a difficult process to embed ethical decisions in programming logic. If there are good moral reasons behind development of autonomous cars then normative ethics employs that Government and industry should support this cause to make autonomous cars friendly peers of humans (Hevelke and Nida-Rümelin, 2015). The normative ethics are distributed into three categories as following:

1. Utilitarianism theory focuses on outcome, also known as consequentialism. The ultimate objective is pleasure and happiness. If the

autonomous cars are source of pleasure and secure then developers and investors should put effort to achieve more happiness.

2. Deontological ethical theory focuses on action and intention without caring outcome. Every action has its own reason. If the actions on autonomous cars are in positive direction to make them more secure then ultimately their design will be more improved and safer.
3. Virtue Ethics theory is different from previous two; it focuses on rules that do what the virtuous people do. Virtues are trained habits which include thinking, actions, desires and emotions. Virtue ethics comprehensively cover designing of autonomous cars that each action, our desire and emotions should be well designed and decisions should be well planned.

Embedding ethics in autonomous cars is challenging task for programmers. Every scenario is not necessary to be understood in advance, rather autonomous cars will learn from experience and it is obvious implication which is evident from learning curve of human drivers.

RQ3-Advantages and disadvantages of autonomous cars

The autonomous cars are attached with positive societal impacts as connected cars will be safer and will decrease transportation cost. These cars will be beneficial for old age people, disabled and for lower income households. The autonomous vehicle market will add from 0.2 to 1.9 trillion dollars annual value in society until 2025 (Bagloee et al., 2016). Google self-driving car which is now Waymo project has crossed 8 million mileage of self-driving until 2018. The Google autonomous car is now completing around 25 thousand mileage daily on busy streets, travelling just like a regular driver. The Google autonomous car is being considered safer than any other human driver and also reduces daily commuting time. The autonomous cars may alleviate traffic congestion time and can increase fuel efficiency. If autonomous cars have ability to interact with each other, then the chances of road accidents will also decrease. Autonomous cars decrease utilization of self-energy by automatically parking and retrieving them when required. In case of autonomous cars, parking space can be better utilized if cars move concurrently without interference of any human driver but finding the availability of nearest parking space and controlling such space require planning and management of data (Tariq et al., 2017; Wiseman, 2017).

The autonomous car can also be shared among multiple people that will optimize fuel consumption and reduce cost. The car can also optimize route planning by utilizing real time information from online maps (Gora and Rüb, 2016). The autonomous cars increase quality of life, reduce stress, provide more time for interaction, communication with each other and freedom to utilise time as per individual's

preferences. The autonomous cars will save humans from accidents, will reduce travel cost per head, will save energy in parking and will eventually add social value ranging from 2000\$ to 4000\$ per year (Fagnant and Kockelman, 2015). On the other hand, the general public is reluctant to adopt this technology due to fear of safety, liability and control. In a case study conducted on 107 potential adopters of self-driving cars in Berkeley, it is found that man was more concerned about liability while women have more concern on control while both have same concern over cost of such vehicles.

Table 3 summarizes these drawbacks, although nature and importance of these disadvantages vary as discussed already in survey results presented in methodology section regarding end user perception yet these drawbacks have minor effects if compared to advantages being offered. Self-driving cars are more beneficial for disadvantaged community especially for people who are unable to drive due to their limitation regarding vision, difficulty in concentration, over aged or under-aged, less mental abilities (Howard and Dai, 2013; Poczter and Jankovic, 2014). The autonomous vehicles in future will be connected with cloud thus forming internet of vehicles which will support storage, intelligence decision making, communication with traffic management system and coordination with other vehicles. Along many benefits of self-driving cars there are some drawbacks of these cars which are found in literature.

RQ4- Challenges faced by using Self-driving cars

The main issue in the autonomous vehicle is an unclear who, if the car is driverless then who should be responsible if something goes wrong. To solve these challenges, the traffic laws should decide how the vehicle should operate in the significant way. There are some challenges in the new technologies of autonomous cars that have been found at both vehicle level and system level (Blyth et al., 2015) which are listed as:

- 1.Tools reliability
- 2.Effects on city infrastructure
- 3.Constraints range on vehicle’s driving
- 4.Ethical effects for safety
- 5.Data privacy

The challenges are based on features such as quality of the technology and reliability of the developer.

The concept of automated systems has been used from years in different fields. In the automated system, if the failure occur then it made manageable by knowing the liability like their legal aspects and consequences (Brombacher, 2014). Generally, the statisticians of the automated cars made the system less complex by reducing the limitation factors and simplifying the model of autonomous cars. The possible challenges for the engineers is that they should provide models for the future risk, quality, flaws and reliability which is acceptable by the society: for example, if the autonomous car is running in the crowded area then single model cannot help to reduce the challenges occur during given situation. As the manufacturing of autonomous cars is increasing, the collaboration between the vehicle and driver become a major factor. The challenges faced by the aging drivers regarding self-driving cars are also important. Especially there are two key concerns related to safety and efficiency. Safety: According to different research, statistics show that more than 35,889 people were killed in the United States due to car crashes in 2010. The accident rate in whole world is approximately 2.6 million per year (Dertouzos, 1999). Recent study shows that the chances of road accidents increase due to dialling call on cell phone which is dangerous but depends on the type of autonomous car. Navigation GPS has already automated to measure the distance between two points. In the past, the drivers fully relied on the papers map which is now being replaced by the combination of verbal instructions and arrow indications in the automated vehicles.

Table 3: Autonomous car disadvantages literature review

Disadvantage	Literature Evidence	Discussion
Impact of cost	(Bösch et al., 2018; Fagnant and Kockelman, 2015)	Initial investment cost of 70000\$ Google Lidar (laser sensor) costs up to 75000\$, whole setup cost around 150,000\$
Liability and security	(Ma et al., 2017; Rödel et al., 2014; Taeihagh and Lim, 2019)	The car manufacturing company, sensor manufacturers or programmers will be liable in case of crash? Perceived security concern rises with level of autonomy.
Impact on associated business and unemployment of skilled workers	(Poczter and Jankovic, 2014)	Challenges for insurance, health care and manufacturing companies. Uber autonomous cars may deprive 10M jobs and could reshape economy in 2025.
Functional dependency on AI, weather and sensors	(Lin et al., 2017; Tian et al., 2018)	Deep neural network driven cars sometimes demonstrate inconsistent behaviour. Human intervention was required from 1300 miles to 5600 miles in average.
Laws and legislation	(Anderson et al., 2014; De Bruyne and Werbrouck, 2018; Taeihagh and Lim, 2019)	US (33 States), Germany, UK and China have passed some laws regarding autonomous car testing on public roads, but still legislation missing in many other countries.

Efficiency: According to research in the United States, only in 2007, around 2.8 billion gallons of fuel burnt which is unreasonable. As the ration of traffic

increases day by day in populated areas, it produces potentially unavoidable portion of the emission problem. Autonomous driving technology can help to

reduce traffic flow problem by controlling individual automobiles more precisely through anticipation and inter-vehicle collaboration. In this way the coordinating traffic presents some challenges to privacy and autonomy ultimately the automated vehicles can be controlled most efficiently where the overall traffic situation can be examined.

6. Conclusion

Self-driving cars are the future of automobile industry and have numerous benefits, especially the decrease in road accidents. However, currently the technology is at an early stage of development. Studies to understand user perception of these cars and expectations from this technology are very important in refinement of this technology. These studies will not only help in knowing the user perspective but also help in development of policies, defining rules and attracting future investments on this technology. This technology can revolutionize the user experience and will change the way the society interacts and perceives a transportation system. This study is an attempt to learn the views of the researchers and end users as of today.

According to the literature it can be concluded that well defined procedures and rules should be defined for operation of these cars and in case of an accident or failure of technology, who should be held liable. Another important point that was observed is that incorporating ethics and empathy is a challenging task for the programmers. It is important to mention here that no new technology comes without any limitations and drawbacks, so everyone needs to understand that same is the case of autonomous cars. Finally, according to literature the self-driving car technology will be beneficial in managing the traffic and reducing the overall load, but, there are a lot of challenges that need to be addressed for making this technology a reality for a normal user.

According to online survey conducted from 2021 users of five different countries including Italy, Austria, U.K. China, and Pakistan it was found that majority of respondents have heard about these cars and they have positive opinion about the technology. Users have high expectations from these cars and users believe that this technology will have a lot of benefits for the end user. Despite of knowledge and expectations, most users were very concerned about the safety issues, legal issues and ethical issues. Most of the respondents were willing to have this technology implemented in their cars; however, they were not willing to pay extra for technology. The data of respondents who were willing to pay for the extra features were almost similar in each country. Another finding of the survey was the concern that this technology will result in unemployment. Female respondents showed more concerns than males and were cautious about their expectations from self-driving cars. The autonomous technology is useful for individuals as well as society and people generally showed positive perception of these cars.

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Compliance with ethical standards

Conflict of interest

The authors declare that they have no conflict of interest.

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