

Towards the acceptance of autonomous vehicles: The role of government and vehicle manufacturers

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Abstract

Self-driving vehicles continue to attract scholarly attention, yet understanding beyond technological barriers is crucial. This study, using critical review and interviews with 21 participants, explores factors influencing UK user acceptance of autonomous vehicles (AVs) and the role of government and car manufacturers. Seventeen factors identified from literature were confirmed in interviews, with thirteen influencing users' AV acceptance. Notably, reduced traffic congestion, environmental impact, increased mobility for non-drivers, and job market impact had little effect on acceptance. Three additional factors—social policy framework, company reputation, and technology testing—emerged as key AV acceptance enablers. The study proposes implications for government and manufacturers to drive self-driving car adoption.

Keywords

autonomous vehicles, self-driving cars, perceived acceptance, social, ethical issues, technology adoption

Introduction

Self-driving or autonomous vehicles represent a potential solution to current transportation challenges and have the capacity to reshape mobility patterns (Mitchell and Brynjolfsson, 2017). Despite their potential benefits for safety and quality of life, some individuals exhibit reluctance toward adopting this technology (Fagnant and Kockelman, 2015; Foroughi et al., 2023), citing various concerns. For instance, the GATEway trial in south London raised public apprehension regarding road safety and cybersecurity implications (Topham, 2018), while incidents like the Uber self-driving car crash in Arizona underscore safety alarms (Levin, 2018). Concerns persist regarding the failure of autopilot sensors to distinguish objects (Yadron and Tynan, 2018). Insufficient data on public perception and acceptance in this technology-driven domain poses significant challenges (Novo et al., 2023), potentially leading to missed opportunities or industry setbacks (Wolmar, 2018). Moreover, car manufacturers have been accused of overselling the capabilities of autonomous driving systems and thus misleading the public (Solon, 2018) has led to instances of driver over-reliance and adverse outcomes (Waymo, 2021).

This study aims to identify and evaluate factors influencing user perception and acceptance of self-driving cars, examining implications for governments, car manufacturers, and technology firms. Despite existing scholarly and industrial research on perceived AV acceptance (e.g., Xie et al., 2023; Foroughi et al., 2023), comprehensive factors beyond trust and safety remain unexplored. To address this gap, we review literature to identify relevant factors, organising them into a conceptual framework based on the Unified

Theory of Acceptance and Use of Technology (UTAUT) and its extensions (Venkatesh et al., 2003). We conduct face-to-face, semi-structured interviews to validate these factors and potentially uncover additional ones. Updating the conceptual model with newfound factors, we discuss implications for governments and car manufacturers. While our research may not fully resolve identified challenges, it aims to contribute meaningfully to addressing these issues. Thus, our study seeks to answer the research question:

"What factors and underlying reasons impact user acceptance of autonomous vehicles, and what are their implications for government and vehicle manufacturers?"

The remainder of the paper comprises a literature review on factors influencing autonomous vehicle adoption, an overview of the data collection process, results, discussion, and implications for government and car manufacturers, concluding with acknowledgments of limitations and suggestions for future research directions.

Literature Review

In this section, we highlight literature on autonomous vehicles and the levels of driving autonomy currently available, followed by a review of the factors affecting the adoption of AV.

Autonomous (Self-driving) Vehicles and types

An autonomous vehicle is one that can maneuver with reduced or no human intervention, driving itself with no manual input from the driver (Manyika and Dobbs, 2013). To navigate by itself, the vehicle uses a combination of cameras, radar systems, sensors, and GPS receivers to determine its surroundings, and uses artificial intelligence to determine the quickest and safest path to its destination (Shanker et al., 2016). In our study, the terms ‘autonomous’ and ‘self-driving’ are used interchangeably, for reasons of familiarity with the terms. The five levels of driving autonomy from the least to the most identified are driver only, driver assistance, partial autonomy, high autonomy, and full autonomy (National Highway Traffic Safety Administration, 2024; Manyika and Dobbs, 2013). This study adopts the definition of autonomous vehicles as vehicles with partial autonomy to high autonomy. The study focuses only on autonomy levels four and five that are labelled by the SAE as automated driving systems because it is expected that user acceptance plays a significantly larger barrier for vehicles in these categories (Shanker et al., 2016; Xie et al., 2023).

Factors affecting the adoption of autonomous vehicles.

User acceptance is a construct that comprises of a variety of factors that may influence individual user’s perception and acceptance of the technology including self-driving vehicles. The authors extend the perceived usefulness and perceived ease of use constructs (Davis 1989; Venkatesh et al., 2003), by critically synthesising literature on adoption of autonomous vehicles to arrive at the following seventeen factors.

	Factors	Source
1	Trust in the technology	Nees (2016), Choi and Ji (2015), Howard and Dai (2013), Xie et al. (2023), Foroughi et al. (2023)
2	Knowledge of the technology	Nees (2016), Choi and Ji (2015)
3	Pleasure of driving	Nees (2016), Venkatesh et al. (2012)
4	Social influence (media/word of mouth)	Venkatesh et al., (2003), Foroughi et al. (2023)
5	Transition period	Schoettle and Sivak (2014), Bezai et al. (2021)
6	Ease of use	Venkatesh et al., (2003), Choi and Ji (2015), Nees (2016), Kyriakidis et al. (2015)
7	Amenities and convenience (e.g. autonomous parking,	Howard and Dai (2013), Venkatesh et al., (2003)

	multitasking while en route)	
8	Reduced traffic congestion	Fagnant and Kockelman (2015), Howard and Dai (2013)
9	Environmental impact (Reduced carbon footprint)	Fagnant and Kockelman (2015), Howard and Dai (2013)
10	Increased mobility for those unable to drive (e.g. impaired, elderly people)	Fagnant and Kockelman (2015), Howard and Dai (2013)
11	Loss of control	Fast and Horvitz (2017), Howard and Dai (2013), Nees (2016), Nordhoff et al. (2016), Choi and Ji (2015)
12	Safety and security	Choi and Ji (2015), Fagnant and Kockelman (2015), Howard and Dai (2013), Kyriakidis et al. (2015), Schoettle and Sivak (2014), Nees (2016) Novo et al. (2023)
13	Data privacy (e.g. location and destination tracking)	Fagnant and Kockelman (2015), Schoettle and Sivak (2014)
14	Cost of technology	Nees (2016), Fagnant and Kockelman (2015), Kyriakidis et al. (2015), Venkatesh et al. (2012)
15	Ethical concerns	Manyika and Dobbs (2013), Kyriakidis et al. (2015), Fast and Horvitz (2017)
16	Legal liability and safety laws	Schoettle and Sivak (2014), Fagnant and Kockelman (2015), Howard and Dai (2013)
17	Impact on the job market (job loss)	Manyika and Dobbs (2013), Fast and Horvitz (2017)

Table 1 Summary of factors affecting the adoption of autonomous vehicles.

The 17 factors identified (Table 1) demonstrate varying effects on users' willingness to accept self-driving cars, providing a conceptual model for the study. However, the comprehensiveness of this list and the extent to which these variables influence users' acceptance and intention to use autonomous vehicles upon formal introduction remain unclear. Notably, these factors align with the seven sub-themes identified by Venkatesh et al., (2003) in their Unified Theory of Acceptance and Use of Technology model (UTAUT). Utilising qualitative methods enables the authors to unveil the underlying reasons for the identified factors in AV acceptance, offering initial insights into their significance. Additionally, by integrating findings from both literature review and interviews, the study elucidates the role of other stakeholders such as government and technology manufacturers in technology acceptance, an aspect often overlooked. Hence, this study contributes significantly to the literature on the role of government and vehicle manufacturers in user acceptance of autonomous vehicles.

Methodology

The study adopts a qualitative methodology to investigate factors influencing user acceptance of self-driving cars. Unlike quantitative methods, qualitative research allows for a deeper understanding of participants' beliefs and experiences with AV and interprets the meanings of their responses (Rahman, 2016). The use of a qualitative approach to understanding why car users are influenced by a factor, and in doing so, addresses a methodological research gap in existing literature where almost all the studies used surveys and questionnaires (e.g. Foroughi et al., 2023; Xie et al., 2023).

Firstly, a comprehensive literature review was conducted, drawing from the UTAUT and other models (Choi and Ji, 2015). This phase aims to identify factors affecting AV acceptance. Secondly, the authors have chosen semi-structured interviews that allow in-depth exploration of participants' perceptions and experiences with autonomous vehicles (Rahman, 2016). The interviews, guided by Jacob and Furgerson's (2012) framework, aim to uncover nuanced insights into users' attitudes towards self-driving vehicles.

These methods can deliver breadth and generalisation instead of depth and specificity (Sharp and Peters, 2017).

Subsequently, semi-structured interviews were conducted with twenty-one UK working professionals, coded as I#1- I#21. The final interview was held in December 2023, using snowball sampling to achieve theoretical saturation (Guest et al., 2006). All interviewees were working professionals aged between 24 and 62, had a driving license for at least two years, had some experience with currently available autonomous technology such as parking assistance or lane switch assistance and were all residents of the UK.

Recorded interviews were transcribed and analysed using NVivo software (Maher et al., 2018). Thematic analysis, as advocated by Braun and Clarke (2006), was employed because it does not require the detailed theoretical knowledge of other qualitative approaches and is a proven technique for examining the perspectives of different research participants, highlighting similarities and differences, and generating unanticipated insights (Braun & Clarke, 2006). The coding categories used were identified based on the responses given in the interviews (subcategory) and the acceptance drivers (coding category) in relation to the UTAUT and factors identified in Table 1. The factors identified and the interviewees' feedback are categorised into the five acceptance determinants. Each determinant consists of several factors (subcategories) contributing to a car user's intention to accept a self-driving car. The same process is used to code the remaining factors. The number of the interviewee (e.g. I10) will be included in the quote.

Results from the Interviews

The findings from the interviews confirm the factors identified during the literature review (Table 1) that influence car users' intention to accept self-driving cars. These factors include trust in the technology, knowledge of the technology, pleasure of driving, social influence, transition period, ease of use, amenities and convenience, loss of control over the vehicle, safety and security, data privacy, cost of technology, ethical concerns, and legal liability and safety laws. Conversely, factors such as reduced traffic congestion, environmental impact, increased mobility for non-drivers, and impact on the job market are found to have little or no influence on people's willingness to use self-driving cars. Moreover, company reputation, social policy framework, and testing the technology through test drives emerge as critical to the acceptance of self-driving cars. The interviewees emphasized the significant role of government agencies and car manufacturers in driving the acceptance of AVs and a new transportation ecosystem. These factors identified from the interviews are organized into five themes and seven implications, as presented in Figure 1.

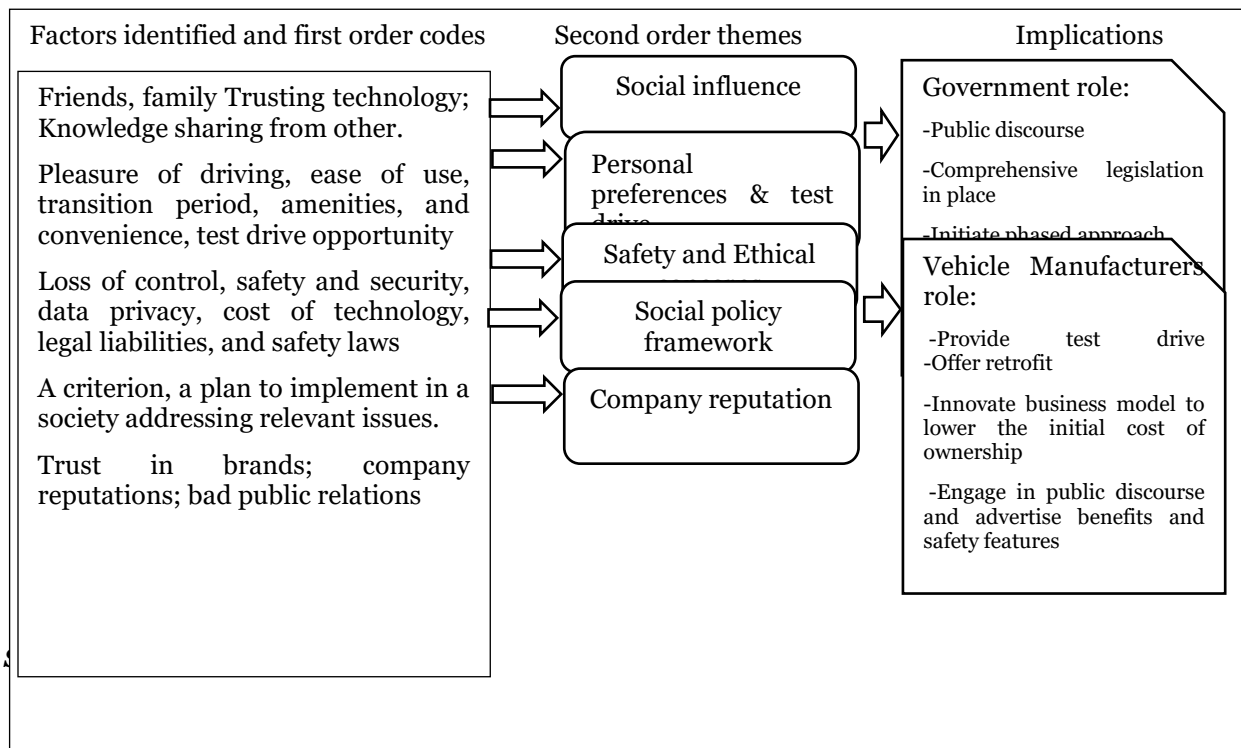


Figure 1 : Summary of findings from the interview.

Social influence is considered important in the eyes of the interviewees as 10 car users suggested that this factor may to some extent influence their intention to accept self-driving technology. In almost all cases, car users referred to this factor by stating their intention obtain feedback from people who they believe can trust such as friends, family members, and technology experts in the field of autonomous driving.

“When I am making the decision, I will look for the opinion of experts, friends, relatives who have used the technology” (I#16).

A few participants also suggested that they might be more willing to accept self-driving cars when they see and learn that more people use it *“I would accept the technology when I see other people using it, not before” (I#6).*

One participant said that he will rely on the government and legislators and may be influenced by their recommendations when deciding whether to accept or not the technology.

“I would rely on the government for recommendation and guidelines as to whether to buy a self-driving car or not as well as risks and benefits of the technology” (I#7).

Interestingly, the responses of some interviewees suggest a link between two separate factors, namely trust and social influence. The following quotes indicate the prerequisite for car users to trust the people who provide feedback, to affect their intention to accept and use the technology.

“If I trust someone and they recommend the technology, I will decide to try it” (I#19).

Nevertheless, one respondent claimed that social influence would not influence his opinion and willingness to accept self-driving cars.

“Seeing other people using self-driving cars won’t influence me and make me change my mind” (I#17).

Safety, Security, ethical and legal liability, data privacy are not compromisable.

The interview results revealed that many car users who were interviewed, expressed positive sentiments towards self-driving cars, although they expressed strong concerns about using self-driving technology more times than the benefits. The key concerns were bothered on safety and security of the driver and the road users, legal liability and safety laws as well as ethical concerns. For example, Safety and security are one of the first factors brought up by almost all the interviewees, 18 out of 21, during the open-ended questions, as I#7 argued:

“Safety is the top factor that I will be concerned with when deciding whether to use the technology. I will use the technology only after all known issues and glitches are sorted out” (I#7).

Other 9 interviewees echoed the same view on the need for extensive legal framework, and one of which highlighted ethics around technology making decisions: *“At the same time I’m concerned with the ethical question as to whether we should allow technology to be the one to make decision on the road, i.e. deciding what is right and what is wrong” (I#19).* Further five participants raised data privacy issues and the role of the government must be able to protect technology users’ data or he will not accept self-driving technology. The following statements illustrate this claim.

“The government must guarantee the protection of user’s data, or I will not consider accepting the technology” (I#6).

Company reputation, test drive and social policy framework

The company reputation factor was not found during the literature review but was identified rather at the interview stage. Some of the interviewees, those car users stated that company reputation may influence them and impact their intention to accept self-driving technology. Interviewees claim that they would check the reputation of the company that manufactures self-driving cars and decide not to accept the technology if they are not satisfied with it. The following statements illustrate this claim.

“The car manufacturer needs to have an excellent reputation for me to accept their technology” (I#3) & (I#4).

Another frequently mentioned factor is that self-driving car manufacturers and dealers should allow car users to try a self-driving car to encourage acceptance of the technology. One car user suggested car sharing as a good way to promote the use of self-driving technology.

“Car manufacturers and car dealers can offer free testing of self-driving vehicles to allow users to familiarise themselves with the technology” (I#6), (I#8) & (I#9).

Social policy framework is another factor that was identified during the interview stage and not during the literature review. Only 2 interviewees addressed this factor directly, but it reveals that many car users are not aware of it, or do not consider it important enough to mention it. Nevertheless, one car user emphasised the need to have a social policy in place that should include criteria, a plan and the implementation of self-driving cars and address issues such as incident responsibility to encourage people to accept the technology. Another interview participant claimed that he will be more willing to buy a self-driving car if there is a social framework that accompanies the technology.

“The government needs to have a social policy (5-10 year social plan) in place to facilitate the introduction of the technology. This Social policy should cover the criteria, plan and implementation of the technology” (I#12).

Role of government

With respect to the role of the government, many of the interviewees would expect the government to take an active role in the introduction and use of self-driving cars. The interview participants expressed their expectations on how the government can encourage self-driving technology acceptance. They argued that the government would provide detailed information about the technology, including how it works, safety and security implications to the public, and ethical considerations. Some of the interviewees suggested that the government should share that information by facilitating public discussions where information regarding the current stage of technology development and whether it is ethical to allow a machine to control a vehicle can be debated.

“I expect the government to facilitate public discussions about the ethical aspect of having self-driving cars on the road” (I#10).

Furthermore, some interviewees explicitly stated their expectations of having comprehensive legislation in place prior to the introduction of the technology which is currently missing, and they would expect the government and legislation authorities to address this issue to enable technology acceptance. The following quotes support this statement.

“I want to have a comprehensive regulatory framework in place before making the technology commercially available” (I#10).

Two people, one of whom is employed in the taxi services sector, expressed their concerns with jobs loss due to the use of self-driving cars and expressed their belief that authorities should step up and take actions to mitigate the negative impact on the job market to avoid delays in accepting the technology.

“This technology will affect all road users and all industries that deal with this, and the government should play an active role with respect to safeguarding jobs and users’ safety” (I#7).

Interestingly, 2 car users suggested that to encourage technology adoption, the authorities should aim for a two-phased introduction of self-driving technology, firstly introduced in public transport, followed by personal vehicles. One of the arguments that supports this claim is because the public transport is better regulated, thus more secure, than the privately-owned car market, and car users will see that there is little to be concerned about with respect to using the technology.

“I think there should be some sort of order with respect to the introduction of autonomous vehicles, where initially public transport and private transportation companies use the technology first, followed by personal vehicles. That is because there are a lot more regulations in place that govern these sectors” (I#20).

Lastly, 2 interviewees suggested that they would expect the public authorities to make changes to the road infrastructure to facilitate the use of self-driving cars and support car users’ acceptance of the technology.

“I think that self-driving cars are the future if the infrastructure is updated to accompany the use of this technology” (I#12) & (I#17).

Role of car manufacturers

For the role of self-driving car manufacturers, many interviewees would expect that car manufacturers support the introduction and use of self-driving cars. 8 interview participants expressed their expectations and shared their opinions on how companies can encourage car users' acceptance of self-driving technology.

Firstly, several interview participants suggested that car manufacturers should advertise the technology and emphasise the benefits of the technology, including improved safety, in their marketing efforts. In addition, 2 respondents confirmed that they will be encouraged to accept self-driving cars if companies had readily available information of the technology and examples of how it can benefit car users.

“Car manufacturers can market the technology to reduce the number of accidents and assist with upgrading the infrastructure to support self-driving cars” (I#10).

One interviewee stated that he would be encouraged to use self-driving technology if manufacturers allow for autonomous features to be retrofit to existing cars as a plug-in, so that it becomes easier and cheaper for car users who own a car to get access to the technology.

“The ability to retrofit existing vehicles with self-driving technology may replace lost jobs due to automation of driving jobs and may be a good way for the automotive industry to encourage people to use it” (I#12).

According to 2 other interview participants, a good way to encourage car users to accept and migrate to self-driving cars is to offer initial price reductions and free and continued maintenance support.

“It would be ideal for me if car manufacturers offer me a reduction in the price of a self-driving car if I turn in my old car and in addition, offer me free maintenance support” (I#11).

Lastly, one interviewee stated they would require reassurances and guarantees from self-driving car manufacturers that the technology is safe and would not harm the driver or others.

“I will expect reassurances and safety requirements that car manufacturers and technology companies will need to adhere to” (I#15).

Taking all these implications together, it becomes clear that the issue of self-driving technology acceptance is complex and difficult to solve due to various factors at play. Therefore, it is critical for the government as well as the automotive industry to carefully monitor the development of the technology as well as the public's perception of its use. What is more, the government and technology manufacturers should take actions to promote the benefit of using a self-driving car preferably by doing demonstrations and offering test drives.

Discussion and research implications

Our findings highlight the potential for national governments and self-driving car manufacturers to play a more proactive role in encouraging the acceptance of AV technology and addressing the concerns of potential users. In this section, we discuss car users' recommendations and their opinions on the roles that the government and technology manufacturers should assume. While many of our findings on safety and security, social influence, legal liability and safety laws, ethical issues, impact on the job market, and data privacy have been reported in earlier research (e.g., Schoettle and Sivak, 2014; Foroughi et al., 2023), our study adds insights into how each factor contributes to our understanding of AV acceptance.

Although discussions on the role of government in AV adoption have gained momentum in recent times (e.g., Tan and Taeihagh, 2021), most focus on barriers and policy frameworks (e.g., Bezai et al., 2021), lacking an inclusive perspective of potential users. Our findings shed light on how the government could address trust issues, legal and ethical concerns, and privacy ambiguities through increased public discourse on expected benefits and challenges. Moreover, proactive government actions to mitigate negative impacts on the transportation industry, such as in the taxi and truck sectors, while promoting positive societal impacts, are crucial. For instance, the government could initially introduce the technology in public transport before making it available in the privately owned vehicle market. As highlighted by our research participants, the government can safeguard jobs, reskill individuals, ensure user safety, and initiate trials on public transportation to bolster user confidence.

Our research unveils the significant role of incumbent car manufacturers in fostering trust and acceptance of AVs, with people favoring reputable brands over newcomers. This preference provides incumbents with

more opportunities to offer AVs, contrary to challenges highlighted in earlier studies (Taeiagh and Lim, 2019). Industrial practices, such as the demise of promising start-ups like Drive.AI and the slow uptake of Google's Waymo, underscore the prominence of AV offerings from established brands like Ford's Mustang Mach-E, even at level 3 autonomy (Topham, 2023).

These insights suggest that incumbent manufacturers, despite the influx of new technology companies, wield more power and opportunity in the AV market, offering safety and benefits-laden AV adverts and opportunities for test drives in their dealerships. Retrofitting existing vehicles, as indicated in our findings, proves more efficient and resource-friendly (Lin et al., 2019), opening up new industry ecosystems from software to various sensors and equipment required for AV conversion. However, literature on the significance of this industry in the transitioning phase and its contribution to the circular economy remains limited. Our research initiates this debate, although it must be acknowledged that a global approach to retrofitting existing vehicles may not be feasible, necessitating more localized strategies in some cases, as evidenced by previous failed attempts.

The results from the interviews validate the assertions of Fagnant and Kockelman (2015), who noted that some car users may perceive safety and security risks as too significant, particularly at early technology stages. This study also echoes the findings of Schoettle and Sivak (2014), indicating that car users express considerable concerns about system vulnerabilities and vehicle security (from hackers), despite assurances from technology companies regarding safety. However, based on interviewee responses, it is accurate to assert that a significant group of car users believe self-driving cars represent safety improvements over the status quo but are apprehensive about potential technology malfunctions, as identified by Howard and Dai (2013).

Furthermore, liability and safety laws defining users' legal responsibilities emerge as serious concerns for almost half of the interview participants, aligning with the findings of Kyriakidis et al. (2015), and Schoettle and Sivak (2014). Additionally, our study corroborates previous research by confirming the factors listed in Table 1. For instance, interview results support the assertions of Fagnant and Kockelman (2015) and Schoettle and Sivak (2014), who argue that providing personal travel data is viewed negatively and could hinder technology adoption. The authors also identify the government's need to responsibly safeguard such data to earn the trust of potential self-driving car users. However, concrete steps toward this end remain unidentified.

Although the results from the interviews suggest that the impact on the job market remains a highly controversial factor, there is insufficient evidence to assert that this factor would dramatically affect car users' intention to use self-driving cars. This partly aligns with the findings of Manyika and Dobbs (2013) and Frey and Osborne (2013) regarding the potentially disruptive effects of AVs on the transportation industry. However, it's worth noting that individuals with close connections to industries that may be negatively impacted could hold a negative opinion of the technology and may reject it, as noted by several interview participants.

Regarding ethical concerns, some car users worry that self-driving technology will make life-and-death decisions, while others are uncomfortable with the notion of leaving such decisions to technology or the manufacturing company's legal responsibility in case of accidents, rather than a human. Thus, it may influence car users' willingness to accept AV (Dodig-Crnkovic and Pelliccione, 2018; Fast and Horvitz, 2017). Overall, it can be argued that social influence may, to some extent, shape car users' opinions of self-driving cars and influence their intention to accept and use the technology, in line with Venkatesh et al.'s (2003) assertion that individuals' behavior can be influenced by the opinions of others. However, the evidence regarding the strength of this influence remains inconclusive.

Conclusion, Limitations and Future research

This study explored user acceptance of self-driving cars and addressed the limited qualitative research on this topic. The results elucidate factors influencing car users' willingness to accept self-driving technology and the implications for government, automotive industry, and technology manufacturers. One limitation is the sole reliance on qualitative research, precluding the use of quantitative methods to model relationships between factors. Future research could adopt a mixed methods approach for methodological robustness. Additionally, expanding the study's scope to diverse audiences, cultural backgrounds, and socioeconomic contexts could enhance generalisability. It's challenging to distinguish between factors serving as antecedents for self-driving technology acceptance and those merely good to have or avoid.

Although efforts were made to explore participants' perspectives, the overall impact of certain factors remains inconclusive. Future research could delve into identifying antecedents for acceptance of self-driving cars versus factors to be mindful of.

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