Shifting perspectives: the unexplored perception of secondary stakeholders on autonomous driving cars

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Abstract: In the rapidly evolving landscape of fully autonomous driving cars (level 5 automation, according to the Society of Automotive Engineers), the research has predominantly focused on direct users, often overlooking the perspectives of the secondary stakeholders – the subjects who may not necessarily be the primary adopters but that are inevitably impacted by this transformative technology. Following the stakeholder theory by Freeman and its latest developments, this work focuses on the perception of the impact of these vehicles from the viewpoint of these neglected stakeholders, encouraging a deeper understanding of the benefits' level because of their personal interpretation. The selected methodology is a literature review composed of a systematic search performed following the PRISMA model, and a conceptual review with the aim of discussing critically the results. This discussion is later enriched by the aggregate outcome of a survey aimed at collecting the common perception about this technology in the selected social tissue. To shape the analysis in a comprehensive way, Elkington's Triple Bottom Line concept was taken as a general guideline. Starting from this theoretical principle, the entire structure of this work has been built according to the typical three-partite subdivision: Environmental, Social and Economic. The main result of this research is to highlight the discrepancy between the recognition of benefits of such technological shift on a higher level, and their perception at a micro-level. This work underlines the significance of considering an additional perspective on advantages and disadvantages of autonomous cars' diffusion, including the individuals who will not be the immediate users. A shift in perspective emphasizes the micro-dimensions that influence secondary stakeholders' perception of this new technology. Inclusion of stakeholders is thus imperative, not only to mitigate the misalignment between technological assessment and personal perceptions, but also to facilitate initial engagements with this new mobility paradigm.

Keywords: Autonomous driving cars, Stakeholder theory, Secondary stakeholders, Triple bottom line, Systematic Review.

1.Introduction

Autonomous driving vehicles (ADVs), also known as self-driving or driverless vehicles, represent a paradigm-shifting technological innovation aimed at redefining the landscape of transportation (Martínez-Díaz and Soriguera, 2018). Relying on sophisticated technological infrastructures such as artificial intelligence, sensor arrays, and seamless connectivity, these vehicles can autonomously navigate and move through road networks without requiring human intervention. The conceptualization and development of autonomous vehicles have constituted a focal point both for academic and technological advancement crossing numerous decades. Recent studies in computational capabilities, machine learning methodologies, and sensor modalities have accelerated the progress within this domain (Padmaja et al., 2023).

In this new field, it is fundamental to underline the significance of sustainability: considering the exigencies boosted by climate change, environmental degradation, and resource depletion, the imperative of sustainability has ascended across all sectors, including transportation. The integration of sustainability aspects within the framework of autonomous driving vehicles represents an effective way to study the environmental, societal, and economic repercussions inherently associated with this new transportation paradigm (de Leo and Miragliotta, 2023; Silva et al., 2022). The taxonomy of autonomous driving, delineated by the Society of Automotive Engineers (SAE), must be specified. It categorizes autonomous vehicles into six distinct levels based on the degree of automation and on their operational modalities: level 0 refers to vehicles with no driving automation, so the human driver is responsible for all the aspects of driving, in level 1 vehicles equipped with steering or brake/acceleration support to the driver are included, in level 2 there is the combination of steering and brake/acceleration support to the driver, a level 3 automation makes the vehicle able to perform all driving tasks under certain conditions, but will require the driver to take over when these conditions are no longer met, with level 4 automation the vehicle can perform all driving tasks under limited conditions without requiring driver intervention, while with level 5 automation the vehicle can perform all driving tasks under

all conditions without human intervention. Within the ambit of this paper, the attention will be paid on cars with the highest degree of automation – level 5 automation – wherein vehicles exhibit complete autonomy under all operational conditions, effectively eliminating the necessity for human intervention.

ADVs offer a promise of increased safety on the roads, particularly benefiting individuals who are impaired by alcohol, fatigue, or distraction. The technology holds the potential to mitigate the risks posed by traditional human errors, safeguarding not only ADV users but also all the other users of the road (Greenblatt and Shaheen, 2015). Another social advancement is the prospect to provide transportation options for the elderly and disabled, who may otherwise be unable to drive. This inclusivity can redefine mobility for individuals with limited options (Haugland and Skjølsvold, 2020). The widespread adoption of ADVs could lead also to substantial reductions in societal costs, including medical expenses and insurance premiums, resulting from fewer accidents. This economic relief extends beyond direct ADVs' users, benefiting society as a whole (Martin, 2019). Moreover, this technology aims at contributing to reduced emissions and environmental impact (Rahman and Thill, 2023), stimulating job creation in industries related to autonomous vehicle technology, maintenance, and development too. Additionally, the technology's demand for improved infrastructure presents opportunities for driving investments in road networks (Tennant and Stilgoe, 2021).

For what concerns the disadvantages, the society may face challenges associated with job losses for professional drivers, necessitating economic and social measures to support those affected (Khan et al., 2023). Furthermore, ADVs' effectiveness may be compromised in specific weather conditions and complex urban environments, potentially raising safety concerns for both users and non-users alike (Lim and Taeihagh, 2018). Another major concern is the potential vulnerability of these vehicles to cyber-attacks, which poses threats to security and privacy (Coppola and Silvestri, 2019), as these vehicles gather extensive data. And moreover, ethical dilemmas arise from programming them to make life-or-death decisions in emergency situations (Milakis and Müller, 2021). Finally, the upfront costs associated with ADVs' development and implementation may contribute to increased consumer costs and the exacerbation of social inequality (Möller et al., 2019).

Considered that currently the most advanced autonomous driving capabilities available to consumers are at Level 2, with some experimental Level 3 and 4 systems in development, this research aims at anticipating a discussion about the benefits and the drawbacks related to fully autonomous level 5 vehicles even if these are not ready for the complete deployment, yet. Until now, the research has predominantly focused on the direct users' experiences, often overlooking the perspectives of the silent stakeholders – individuals who may not necessarily be the primary adopters but are inevitably impacted by this transformative technology. Analyzing the society at large, the instances raised by the secondary stakeholders can emerge. Secondary stakeholders have no formal claim on firms, but are affected by the outcome of their decisions (Freeman et al., 2010). A wide variety of secondary stakeholders can be identified, ranging from the non-users, potential future users and non-drivers, to cyclists, pedestrians, media, accident investigators and many others. This paper builds on the stakeholder and new stakeholder theory to advocate that organizations have responsibilities to multiple stakeholders, not only to their shareholders (Freeman, 1984; Freeman et al., 2010; Mcgahan, 2021). Thus, organizations and policymakers should focus on the benefits for the society at large, rather than only on profit-oriented objectives. The purpose of this work is to better understand the main issues from the standpoint of the secondary stakeholders on the widespread adoption of ADVs, by combining the existing literature and a survey. The results are reviewed through the lenses of the Triple Bottom Line framework, first proposed by Elkington (1998). This framework, referred to also as the Triple-P (People, Planet, Profit), proposes the subdivision in three main dimensions, which were adopted in the review of this paper, namely the social, the economic and the environmental dimensions.

1.1.Aims and objectives of the research

Through a comprehensive examination of existing literature and survey data analysis, this study seeks to delineate the multifaceted landscape surrounding ADVs, elucidating both the promises and the risks associated with their widespread adoption. By synthesizing insights gathered from the literature, encompassing not only direct users but also peripheral actors impacted by ADV deployment, this research aims to contribute to a more general understanding of the societal, economic, and regulatory dynamics shaping ADVs' integration into contemporary transportation ecosystems. Central in this investigation there is the exploration of stakeholders' attitudes towards safety, costs, legal frameworks, ethical considerations, and the implications of ADV proliferation on industries, employment, and the economy at large.

After an introduction about the state of the art of ADVs and stakeholder theory, the paper is organized as follows. In the methodology section, two steps of this work are presented, namely the systematic literature review performed, and the survey that is currently under development and that will provide further insights and data for the development of this line of research. In the following section, the key findings from the systematic literature review are illustrated and analyzed through the lenses of the Triple Bottom Line. Finally, the results are summarized in the conclusion section, which also discusses the limitations and future steps.

2.Methodology

2.1 Systematic Literature Review

A systematic literature review (SLR) employs a methodologically rigorous approach to identify, analyze, and interpret all available evidence pertinent to a specific research question in an unbiased and, to a degree,

repeatable manner. Systematicity is emphasized in SLRs, aiming to produce reviews that are rigorous, transparent, and replicable. By employing explicit and systematic methods, bias can be minimized, thereby ensuring the reliability of findings, and enhancing the legitimacy and authority of the resultant evidence (Fan et al., 2022).

To this end, a review was conducted following the PRISMA guidelines (Moher et al., 2009; Page et al., 2021), to identify and analyze the main challenges, opportunities and concerns connected to the widespread adoption of ADVs from the eyes of the non-users of this technology. The search was carried out relying on the Scopus database among articles published in English from 2018 to 2024. The search terms used included "autonomous driving vehicle", "AVs" and "ADVs", combined with "stakeholders", "user" and "non-user", to collect records considering the standpoints of the often-neglected actors. Further filters applied regarded the subject areas, coincidences among acronyms, simulations not focused on secondary stakeholders and other technical assessments which only marginally mentioned the role stakeholders.

Following the abstract review, 36 articles were selected and 13 were included in this review. The record selection process flowchart is shown in Figure 1.

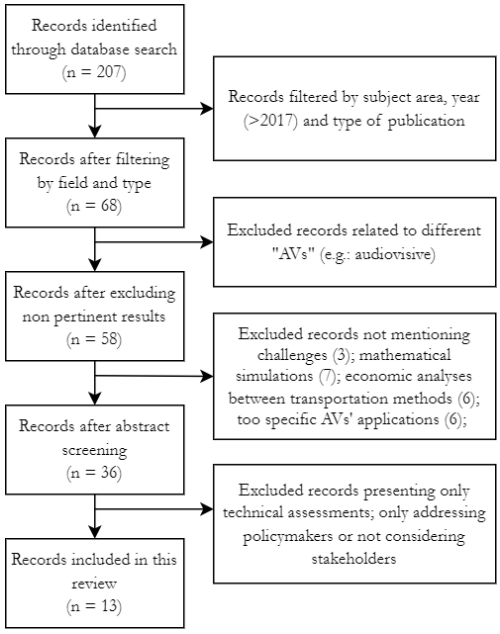

Figure 1: articles selection process flowchart.

2.2 Survey

Survey methodology is suitable for collecting data about stakeholders' perceptions of autonomous driving vehicles. Several studies have utilized surveys to understand public acceptance, attitudes, and concerns regarding these vehicles (Nastjuk et al., 2020; Thomas et al., 2020): surveys have been instrumental in identifying factors that influence stakeholders' views on ADV technology, such as safety, costs, laws, liability, and ethical considerations. Surveys allow researchers to gather quantitative data efficiently, enabling the analysis of trends, preferences, and priorities among different stakeholder groups. They provide valuable insights into the key drivers and barriers affecting the adoption and acceptance of autonomous driving technology.

Analyzing surveys data to understand stakeholders' perceptions of autonomous driving vehicles involves several key steps. Firstly, researchers can use statistical analysis techniques to identify trends, patterns, and correlations within the data. This includes descriptive statistics to summarize the data and inferential statistics to draw conclusions about the larger stakeholder population based on the survey sample. Secondly, researchers can employ factor analysis to identify underlying factors influencing stakeholders' perceptions, such as safety, convenience, or environmental impact. Additionally, a thematic analysis can be used to categorize open-ended responses and extract common themes or concerns expressed by stakeholders. Lastly, researchers can conduct regression analysis to determine the relationship between different variables and stakeholders' attitudes towards autonomous vehicles, providing insights into the factors driving acceptance or resistance among stakeholders.

By employing these analytical methods, researchers can gain a comprehensive understanding of stakeholders' perceptions on this theme.

Based on the search results, the key questions to ask stakeholders in a survey about autonomous driving vehicles include:

- Stakeholder acceptance and attitudes.

What are stakeholders' perceptions and concerns regarding the safety, costs, legal/regulatory issues, and ethical considerations of autonomous vehicles?

What factors influence stakeholders' trust and willingness to use autonomous vehicles?

How do stakeholders' demographic characteristics (e.g., age, gender) affect their attitudes towards autonomous vehicles?

- Stakeholder information needs and preferences.

What type of explanations or information do stakeholders (e.g., passengers, pedestrians, other road users) want from autonomous vehicles to understand their behaviour and decision-making?

How do stakeholders' information needs vary based on different driving contexts (e.g., near-miss incidents, special vehicle cases)?

What user interface designs or communication methods would be most effective in providing explanations to different stakeholder groups?

- Stakeholder roles and responsibilities.

What are stakeholders' perceptions of who should be responsible for the safety, regulation, and oversight of autonomous vehicles?

How do stakeholders think the transition to autonomous vehicles will impact different industries, jobs, and the economy as a whole?

What role do stakeholders think the public and private sectors should play in supporting the adoption of autonomous vehicles?

By addressing these key questions, survey data can provide valuable insights into stakeholders' perceptions, concerns, and information needs regarding autonomous driving vehicles.

3.Key findings

Through the systematic literature review, several key findings have emerged regarding stakeholders' perceptions of autonomous driving vehicles. Firstly, stakeholders express a spectrum of attitudes towards ADVs, ranging from enthusiasm for their potential safety benefits to skepticism regarding their reliability in adverse conditions and ethical implications in decision-making scenarios. Safety emerges as a paramount concern among stakeholders, with trust in this technology contingent upon assurances regarding robustness in real-world driving scenarios. Moreover, stakeholders' acceptance of ADVs is influenced by a myriad of factors including perceived costs, legal/regulatory frameworks, and societal readiness for widespread adoption. In fact, stakeholders exhibit diverse information needs and preferences, highlighting the necessity for transparent communication and tailored educational initiatives to address misconceptions and engender public trust. Furthermore, stakeholders underscore the need for clear delineation of roles and responsibilities, with implications for regulatory frameworks and industry standards. And ultimately, these findings highlight the imperative for collaborative efforts among policymakers, manufacturers, and the public to navigate the complexities of ADVs' integration and foster a sustainable, equitable mobility landscape.

In Table 1, a range of concerns and opportunities that surround these vehicles are presented, and they are reviewed according to the Triple Bottom Line of Sustainability by Elkington. In fact, this research highlights a range of social, economic, and environmental considerations surrounding the adoption of ADVs. The issues presented in Table 1 were listed as "concerns" or "opportunities" when the paper presented them as possible barriers or enabling factors to a more widespread diffusion of ADVs. In addition to that, other elements were marked as "challenges" when they were neutrally presented as relevant topics of discussion, which could spill elements that will act as barriers or opportunities according to the strategies adopted.

On the environmental side, ADVs have the potential to significantly reduce emissions since they are not bound by the limitations of human drivers and can operate more efficiently. Studies by Strömberg et al. (2021) point out that these vehicles can contribute to reduced emissions and environmental impact. This can lead to cleaner air and a healthier planet. However, there are also environmental concerns to address. The widespread adoption of ADVs may lead to increased traffic congestion if a shared ownership model is not adopted, as discussed by Hamadneh et al. (2022). This could negate the environmental benefits if there were more vehicles on the road.

Socially, Patel et al. (2023) focused on ADVs possibility to provide transportation options for the elderly and disabled, who may otherwise be unable to drive. This could offer greater independence and improve the quality of life for these demographics. Again on the social side, there are concerns about job losses for professional drivers, as Nikitas et al. (2021) pointed out. Measures would need to be implemented to support those who may be affected by the transition to ADVs. Moreover, especially in the transient period, on the micro-level the other divers who are non-users of ADVs could negatively perceive the driving behavior of the new vehicles, affecting their perception of safety.

There are also economic benefits to consider: autonomous driving vehicles have the potential to create new jobs in industries related to autonomous vehicle technology, maintenance, and development, as underlined by Nikitas et al. (2021). And additionally, the efficiency gains from ADVs could lead to increased productivity, as Islam et al. (2022) mentioned. Moreover, the upfront costs associated with these vehicles' development and implementation may contribute to increased consumer costs and exacerbate social inequality, as Waltermann and Henkel (2023) argue. There is a risk that ADVs may only be affordable to a select segment of the population. All these concerns can be addressed through careful planning and policy development. For instance, governments can introduce subsidies or tax breaks to encourage the development of affordable ADVs. Or even consistent investments in public transportation infrastructure can help to mitigate any potential increase in traffic congestion caused by these vehicles.

Overall, this technology has the potential to revolutionize transportation, but it is important to consider the potential drawbacks alongside the benefits. By carefully considering the social, environmental, and economic implications of ADVs through the TBL of sustainability framework, we can ensure that this technology can be adopted in a way that benefits all of society. In fact, by taking all three dimensions of sustainability into account, we can make informed decisions about the development and deployment of these vehicles.

By adopting this kind of approach, stakeholders can ensure that ADVs are integrated into the transportation landscape in a way that promotes equity, economic prosperity, and environmental responsibility. Furthermore, the ecosystem of stakeholders considered could and should be widened, to have a more thorough understanding of the challenges in place. Indeed, Ika and Pinto (2022) advocate that project success should be "complexified" rather than simplified. Embracing complexity is a necessary step to address issues with a more inclusive approach, reaching a more shared and optimal solution. Simplifying problems could be quicker and less resource-consuming, but it is as tempting as detrimental to the objective of jointly designing a tailored

solution. Thus, managers should devote attention to the process of stakeholder mapping, to properly identify the relevant actors from a more inclusive point of view. In literature, some examples already emerged: aside from pedestrian and cyclists (Pettigrew et al., 2020; Pyrialakou et al., 2020), other stakeholders were cited, such as disaster victims, socially excluded vulnerable people (Yoo et al., 2024), intended users without a driving license (Hamadneh et al., 2022), vulnerable road users (Pyrialakou et al., 2020), together with system auditors, accident investigators and insurers (Omeiza et al., 2022). Some countries are already recognizing this need, and Yoo *et al.* (2024) report that the Japanese government emphasized the necessity of "building a transportation system capable of resolving social problems by listening to the opinions of various stakeholders, including those of stakeholders for whom it is challenging to speak up in social situations". Omeiza *et al.* (2022) rely instead on a subdivision of stakeholders in three classes, namely Class A (End-users), Class B (Developers and technicians), and Class C (Regulators and insurers). Finally, among the external stakeholders, media play a pivotal role to influence the perception of local and national communities. Lesteven and Thébert (2022) analyzed for the French Ministry of Trasport the media discourse about ADVs in their country, and they brilliantly described the role of media stating that "Autonomous vehicles thus rapidly go from being a source of surprise

Reference	Concerns	Opportunities	Challenges
Straub and Schaefer (2019)	Policies related to interaction paradigms between AVs, users and non-users; communication (non-verbal negotiation); maximization of personal utility by non-users	Safe participation on the roadway	
Pettigrew *et al.* (2020)	Communication human-AV	Safety; vibrant cities; transport complementarity; reduced road rage; increased space	
Pyrialakou *et al.* (2020)	System failures; hacking; AV users' risk-taking behavior	Safety	
Alawadhi *et al.* (2020)			Safety; ethics; communication; road technology and traffic signs; policies; privacy; cybersecurity; consumer acceptance; cost; marketing; trust
Strömberg *et al.* (2021)	Safety; security; responsibility; cost; job loss; congestion; legislation	Enhanced driving experience; reduced emissions; reduced traffic; increased safety; increased accessibility to public transport; new jobs	
Nikitas *et al.* (2021)	Job loss; fair redistribution of jobs	Jobs requiring different skills; economic paybacks; productivity	
Lesteven and Thébert (2022)			Media and political representation of the issue; interest from the general public; words used in the debate
Omeiza *et al.* (2022)	Safety; trust		Transparency and accountability; trust; explanation and regulations
Islam *et al.* (2022)	Equipment or system failure (safety); privacy; cybersecurity; interaction with human drivers and other road users; performance (adverse weather); legal liability issues (crashes); price	Safety; accessible transportation options; reduced air pollution; productivity; less stressful driving experience	
Hamadneh *et al.* (2022)	Privacy; hacking; job losses; increase in traffic congestion if ownership model prevails; insurance infrastructure management; supportive policies	Reduced emissions; reduced crashes, deaths and injuries (safety); inclusivity for people with special needs; saving urban areas; decrease in traffic congestion (shared model)	
Patel *et al.* (2023)	Cost; travel and waiting time; safety	Reduce fatal crashes (safety); reduce emissions; reduce traffic; boost mobility for disadvantaged populations; improve fuel efficiency	Perception of safety, beliefs towards trust and risk
Waltermann and Henkel (2023)	Traffic safety; job losses; traffic congestion; cybersecurity; pricing; increase in taxation; ethics	Health benefits	Public acceptance; social acceptance
Yoo *et al.* (2024)	Fear of losing control (safety); environmental perception	Road and travel efficiency; reduced accidents; reduced emissions; maximization of benefits increasing inclusivity	

Table 1: Summary of concerns, opportunities and challenges emerged in the literature review

(catalysing the exchange of information) to being the subject of jokes and then a topic of debate, or even condemnation". Properly informing citizens about such a disruptive technology is indeed paramount, to enable conscious decisions and also because, as Pyrialakou *et al.* (2020), the perception of safety varies with the level of awareness about ADVs. This is strongly related to the challenges of transparency, trust and accountability, as stakeholders, according to the GDPR guidelines, should receive information in an intelligible way, clearly understandable (Omeiza et al., 2022). Finally, Waltermann and Henkel (2023) point out that overall, discussions are highly polarized between those in favor or against, or the perspectives adopted. A more extensive and inclusive process of information should thus be sought, to properly evaluate the diffusion of ADVs.

4.Conclusions and future developments

In conclusion, this paper aims to provide a comprehensive exploration of the landscape embracing autonomous driving vehicles, highlighting both the promises and the risks associated with their widespread diffusion. Through a systematic literature review and synthesis of existing knowledge, this research has underscored the importance of considering stakeholders' attitudes towards a series of aspects, and their broader implications for the proliferation on industries, employment, and the economy. Building on the challenges, concerns and opportunities emerged from the literature, on means as surveys, on stakeholder theory and on the need to "complexify" project success, managers, policymakers and the other primary stakeholders who are engaged in the introduction of ADVs can better identify and understand the needs of the whole ecosystem of stakeholders. Including a wider range of stakeholders, also considering the ones who are not involved in decision-making but will be impacted by the outcome of the technological transition, is a necessary first step towards a more shared and inclusive solution.

The next phase of this research will involve the design and implementation of the previously mentioned survey, aimed at gathering empirical data on stakeholders' perceptions, concerns, and information needs regarding these vehicles and their adoption. Indeed, one of the main limitations of this work is the lack of a firsthand validation of the results. Even if the challenges, concerns and opportunities emerged from the analysis of literature, which often means the analysis of secondary data on case studies, it would be crucial to complete it with primary data. Thus, this study will reach a more exhaustive form once the survey results will be available. By combining inputs from diverse stakeholder groups, including potential users, policymakers, industry professionals, and advocacy groups, this survey will provide valuable insights into the dynamics of ADVs' adoption and acceptance. Anticipating the future results of this study, the survey findings will be instrumental in informing policy development and industry practices related to these vehicles' integration. Through collaborative efforts and informed decision-making, we can harness the transformative potential of ADVs to realize a new future for the whole mobility system.

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