Public Policy on Road Safety for Autonomous Vehicles in the United States

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On my honor as a University Student, I have neither given nor received unauthorized aid on this

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Introduction

  In the streets of San Francisco, an unsettling event happened in early October 2023, marking a significant setback in the progression of autonomous vehicle integration into public roads. General Motors' subsidiary, Cruise, faced a critical moment when one of its autonomous vehicles, operating without a human driver, was involved in an incident that injured a pedestrian. While federal regulation presents a hands-off approach to autonomous vehicles and their testing, events like this lead to pauses in innovation until further legislation is put in place. This event, followed by decisive action from California regulators, led to the recall of all 950 autonomous cars from Cruise's fleet for a crucial software update (Associated Press, 2023). Events like this highlight the current subject of whether our current federal regulations on autonomous vehicles are adequate to keep people on our roadway infrastructures safe, while not stifling invitation. The incident not only cast a shadow over the safety of autonomous vehicles but also raised profound questions about the readiness of our public policy frameworks to integrate such advanced technologies into the fabric of urban life.

  This paper dives into the complex landscape of autonomous vehicle integration within the United States, with a specific focus on California's regulatory response to this evolving technology. As we begin to integrate new and constantly evolving technology, the incident in San Francisco serves as a stark reminder of the challenges that lie ahead. It underscores the need for a robust policy framework that not only fosters technological innovation but also ensures public safety and social acceptance. This research explores the complexities of regulating AVs, emphasizing the need for adaptability in legislation to address safety, innovation, ethical issues, and privacy concerns, with a particular focus on California's regulatory framework and federal policies.

Through a comprehensive analysis of existing literature, this research aims to unravel the complexities of autonomous vehicle technology, its potential benefits, and the myriad challenges it poses to urban planning, road safety, and legislative oversight. Using the Social Construction of Technology (SCOT) framework, this paper goes into detail about how relevant social groups, including vehicle manufacturers, government regulators, drivers, and passengers, shape and influence the development and regulation of autonomous vehicles. By examining federal stances by the Department of Transportation and National Highway Traffic Safety Administration, and the case of California's legislative and regulatory approach, this paper seeks to offer insights into the broader implications of autonomous vehicle policy on technological innovation, public safety, and societal acceptance.

In this paper, I look into the effectiveness of current public policy frameworks in the United States concerning the integration of autonomous vehicles (AVs) into our transportation system. While there is an emphasis by the Department of Transportation to "modernize regulations to remove unintended and unnecessary barriers to innovative vehicle designs," we must still do so in a proactive manner with caution toward the safety of individuals (United States Department of Transportation, 2021, p. 3). While existing federal policies, legislation, and measures, particularly evident in states like California, serve as a foundation, I argue that a more robust and adaptive framework is crucial for steering the development and integration of AVs effectively. This examination delves into the regulatory landscape to underscore the necessity for policies that not only foster innovation and ensure public safety but also address emerging challenges specific to AV technology. I begin with an overview of the prevailing federal policies and legislation that govern AVs, questioning whether these frameworks adequately support technological advancement while safeguarding public interests. Subsequently, I analyze the roles

of key federal agencies such as the National Highway Traffic Safety Administration (NHTSA) and the Department of Transportation (DOT) in crafting standards and guidelines, critiquing their effectiveness in keeping pace with rapid technological changes. This leads to case studies that illustrate the real-world application and limitations of these policies in mitigating challenges and leveraging opportunities presented by AV integration. I conclude by assessing these policies through the lenses of safety, innovation, and public acceptance, ultimately arguing for a revised regulatory approach that better aligns with the dynamic nature of autonomous technologies. Through this structured exploration, I aim to demonstrate the urgent need for a comprehensive and forward-thinking policy environment that can responsibly guide the integration of AVs into our transportation ecosystem.

Literature Review

The United States faces significant traffic challenges, including frequent accidents and poor infrastructure, primarily due to an over-reliance on personal vehicles. Studies such as the one by the AAA Foundation for Traffic Safety underscore the life-saving potential of Advanced Driver-Assistance Systems (ADAS), with Dan Zukowski reporting that these systems could prevent up to 37 million collisions and 14 million injuries from 2021 to 2050 (Zukowski, 2023). These ADAS include automatic emergency braking, blind-spot detection, and lane-departure warning (Zukowski, 2023). Also, researchers advocating for a risk-based road safety system recognize the importance of accommodating human errors, such as drivers and pedestrians (Ahmed et al., 2023).

As autonomous vehicle technology progresses quickly, the shift from conventional transportation to a possible future with driverless vehicles introduces a range of specific societal,

cultural, and political factors that influence this technological evolution. These factors, central to the Social Construction of Technology (SCOT) framework, include public safety concerns, cultural perceptions of automation, and political debates over regulations and infrastructure needs. Reports by Wevolver and insights from Ossian Muscad stress the technological progress and the necessity of clear communication about autonomous vehicle capabilities (Wevolver, 2020; Muscad, 2023). The emphasis on human performance research in automation design (Parasuraman, 2000) and the overview of shared automated vehicle (SAV) pilot projects (Stocker & Shaheen, 2018) further highlight the interactions between various social groups, manufacturers, regulators, and users, that guide AV development, a key focus of SCOT. Both articles find that a necessity for proactive legislation regarding self-driving autonomous vehicles (SAVs) is needed to steer toward favorable societal outcomes resulting from the rise of these services.

The negotiation and stabilization processes that come with technology's societal integration are reflected in the challenges that autonomous vehicles face, including technological limitations and integration issues, as described by Nikolaos Gavanas and covered in the IEEE Explore report (Gavanas, 2019; Katare et al., 2020). This is also seen in the regulatory landscape, where federal and state efforts, such as those detailed by the University of Kentucky Transportation Center, navigate the complex meshing of safety, innovation, and public welfare (Gibson & University of Kentucky Transportation Center, 2017). The studies detail the integration of autonomous vehicles, highlighting technological and regulatory challenges that require continuous adaptation to ensure safety and innovation.

The regulatory landscape for autonomous vehicles involves both state and federal efforts aimed at integration and cybersecurity. The University of Kentucky Transportation Center details

guidance from federal agencies and state-level legislative actions (Gibson & University of Kentucky Transportation Center, 2017). An article from ScienceDirect stresses the importance of proactive consumer protection policies against cyber breaches (Khalid Khan et al., 2023). Additionally, there has been some analytical review of the AV legislation across 33 states, highlighting the diverse approaches to regulation (Pillala et al., 2023).

California's leadership in AV regulation presents a strategic approach that balances innovation with public interests, an example of SCOT's advocacy for policies that reflect the diverse needs and perspectives of society (State of California, 2022; Fox-Sowell, 2023). Public skepticism about AI, as expressed by Khogali & Mekid and reflected in public polls, further shows the concept of interpretive flexibility and the critical role of societal acceptance in the technological development of AVs (Khogali & Mekid, 2023; Kisling, Nestico & Redick, LLC, n.d.).

Gaining public approval is crucial for the ethical integration of autonomous vehicles into society. Khogali & Mekid (2023) express skepticism about AI's social influence and its ability to uphold moral standards. According to a poll, almost half of polled Americans are uncomfortable inside a driverless car, citing safety as their biggest concern (Kisling, Nestico & Redick, LLC, n.d.). This hesitation goes beyond just drivers but also delves into the aspect of testing AVs on open public roads. Hemesath & Tepe (2023) examine citizens' attitudes toward the risks and regulatory implications of testing self-driving cars, providing insights into public perception and acceptance.

Using Pinch & Bijker's 1984 Social Construction of Technology (SCOT) framework provides a subtle lens for examining the development and integration of autonomous vehicles

(AVs). This approach underscores the importance of societal, cultural, and political influences beyond just technical advancements in shaping technologies. SCOT emphasizes interpretive flexibility, the idea that technology can have varying meanings and uses across different social groups, and the concept of relevant social groups, like manufacturers, regulators, and users whose interests and interactions guide the evolution of technology. Interpretive flexibility describes the concept that the meaning, use, and significance of technology can differ across various social groups. This idea is exemplified by the historical patent dispute between Spill and Hyatt over the use of camphor in nitrocellulose plastics, demonstrating how social and legal factors influence the development and dominant interpretation of a technological artifact (Pinch & Bijker, 2001).

In the context of AVs, applying SCOT enables a comprehensive analysis of how these vehicles are socially constructed through the interactions between different relevant social groups, ensuring policies reflect the diverse needs and perspectives of society. Relevant social groups are groups of individuals who share similar understandings and uses of technology. Their interactions and differing perspectives significantly influence the development, acceptance, and modification of that technology within society. This framework is perfect for studying AVs due to the technology's potential to reshape transportation (Pinch & Bijker, 1984). By focusing on the social dynamics at play, this approach aims to foster a more democratic and inclusive development and regulation of autonomous vehicle technology.

Through the lens of the SCOT framework, this literature review not only examines the technological and regulatory milestones of AV integration but also dives into how societal, cultural, and political forces shape this technology. This perspective offers valuable insights into

navigating the complexities of AV integration, ensuring that policies and technological advancements reflect the multifaceted needs and values of all stakeholders.

Methods

This research dives into the complex regulatory landscape for autonomous vehicle (AV) technology, focusing particularly on the policies set forth by the National Highway Traffic Safety Administration (NHTSA) and the United States Department of Transportation (DOT). The California State Transportation Agency is singled out as a pivotal case study mainly due to its forward-looking and stringent approach to AV regulation.

To achieve this, primary data were collected from a diverse collection of sources, including, but not limited to, official transcripts of California state government hearings dedicated to AV regulation, policy documents, and press releases issued by the NHTSA. This was complemented by a review of secondary literature, spanning from academic articles and industry reports to media articles, with almost all published between 2017 and 2023, with a few older sources that are used as sources for hindsight for what was to come with automation for our time. This timeframe was chosen to ensure the timeliness and relevance of the data in light of the rapid advancements in AV technology and regulatory changes. This thorough approach was designed to ensure a balanced perspective that encapsulates viewpoints from governmental bodies, academia, and the industry.

Analysis

Autonomous vehicles introduce a new era in transportation, fundamentally altering how traffic systems operate. Fagnant and Kockelman note that

AV operations are inherently different from human-driven vehicles. AVs can be programmed to not break traffic laws. They do not drink and drive. Their reaction times are quicker and they can be optimized to smooth traffic flows, improve fuel economy, and reduce emissions. They can deliver freight and unlicensed travelers to their destinations (Fagnant & Kockelman, 2015, p.169)

all things that make us have to rethink our current idea of how road traffic has been operating. However, the integration of these vehicles into public roadways presents multifaceted challenges, necessitating a dynamic regulatory approach that evolves with the technology. There are many aspects of autonomous vehicle barriers that can be looked at, including the following; vehicle costs, security, certification, liability, and privacy (Fagnant & Kockelman, 2015).

Current regulations for AVs highlight a significant focus on road safety, reflecting a proactive approach to mitigate the risks associated with this new technology. Studies by the AAA Foundation talk about the potential of AVs to significantly reduce traffic accidents, a prospect that hinges on rigorous safety standards and continuous technological refinement. These findings support regulations that not only support AV development but also prioritize safety protocols as their presence on the road becomes more prevalent. Over 40% of fatal crashes involve some combination of alcohol, distraction, drug involvement, and/or fatigue (Fagnant & Kockelman, 2015). According to the United States Department of Transportation (USDOT), "ADSs (Automated Driving Systems) could, if carefully integrated, positively impact mobility and operational efficiency for all users" (United States Department of Transportation, 2021, p. 6). USDOT says that the "deployment of mature ADS could reduce delays related to incidents or support independent travel by people with disabilities," supported by the technology that some

AVs currently possess (United States Department of Transportation, 2021, p. 6). For example, AVs can sense and possibly anticipate lead vehicles' braking and acceleration decisions (Fagnant & Kockelman, 2015). A vehicle with the ability to break on its own with a driver behind the wheel or no driver at all needs to have a set of regulations to ensure that it follows the same standards and practices as a responsible human driver. This is backed up by USDOT's position that "If developed and deployed safely, ADS have the potential to prevent or mitigate a large number of crashes involving driver error, judgment, or other human-related causes" (United States Department of Transportation, 2021, p. 6).

However, documented incidents involving AVs reveal critical technological and operational challenges, underscoring the necessity for ongoing regulatory adaptation. For example, in the Cruise case, the system "inaccurately characterized the collision as a lateral collision and commanded the AV to attempt to pull over out of traffic, pulling the individual forward rather than remaining stationary," the company said (Associated Press, 2023). Such incidents highlight flaws in the current frameworks, pointing to the urgent need for updates and improvements that ensure technology reliability and safeguard public safety. The state of AV technology seems likely to advance with or without legislative and agency actions at the federal level. However, how AV technologies progress and will eventually be implemented depends heavily on these efforts (Fagnant & Kockelman, 2015). The cooperative efforts of the United States Department of Transportation (USDOT) and the National Highway Traffic Safety Administration (NHTSA) in regulating both current and future vehicle technologies illustrate a foundational step toward addressing these challenges. *The Automated Vehicles Comprehensive Plan* (Comprehensive Plan) advances the United States Department of Transportation's (U.S. DOT) work to prioritize safety while preparing for the future of transportation (United States

Department of Transportation, 2021). These federal agencies have instituted legislation reflecting

AV deployment's immediate and long-term implications, offering a blueprint for balancing

innovation with safety considerations. This plan set forth by the USDOT has three main goals:

1. To promote access to clear and reliable information to its partners and stakeholders, including the public, regarding the capabilities and limitations of ADS (Automated Driving Systems)

2. Modernize regulations to remove unintended and unnecessary barriers to innovative vehicle designs, features, and operational models

3. Conduct, in partnership with stakeholders, the foundational research and demonstration activities needed to safely evaluate and integrate ADS, while working to improve the safety, efficiency, and accessibility of the transportation system.

According to the DOT, "each goal includes a discussion of key objectives, as well as associated

illustrative actions the Department is undertaking to address priorities while preparing for the

future" (United States Department of Transportation, 2021, p. 3).

The integration of AVs into society extends beyond technological and safety

considerations, raising significant ethical and privacy concerns. The USDOT claims that "The

U.S. Government will use a holistic, riskbased approach to protect the security of data and the

public's privacy" that we must hold them to, beyond just words (United States Department of

Transportation, 2021, p. 9). AI has a reputation for violating people's privacy, for example, by

recording images of the general population, facial-recognition cameras can violate privacy

(Khogali & Mekid, 2023). Public skepticism regarding data privacy and the security of AV

systems is notable, with a substantial portion of Americans expressing discomfort with the idea

of driverless cars, primarily due to safety concerns (Kisling, Nestico & Redick, LLC, n.d.).

Additionally, the ongoing debate around ethical programming for AVs in crises highlights the complexity of encoding moral decisions into machine algorithms. Issues such as "coded prejudice" frequently occur when machine learning programs are taught on data that solely represent demographic groups or reflect social biases (Khogali & Mekid, 2023). As we have seen in the United States throughout history, unintended bias in AI can result in critical mistakes that disproportionately affect a set of people. According to Friis and Riley, "Scientists investigating a widely used healthcare algorithm found that it severely underestimated the needs of Black patients, leading to significantly less care," which only sheds light on one instance where bias can affect a minority within the social group of consumers (Friis & Riley, 2023). The challenge of avoiding, planning, deciding, and executing related driving errors, as observed in numerous car accident reports, stresses the necessity for ethical frameworks within regulations. These frameworks must navigate moral dilemmas, ensuring that AV technology aligns with societal values and maintains public trust. U.S. DOT will promote access to clear and reliable information to its partners and stakeholders, including the public, regarding the capabilities and limitations of ADS (United States Department of Transportation, 2021, p. 3).

The rapid pace of AV technological advancements presents a significant challenge for existing regulations, which must remain relevant and effective in promoting public safety without impeding innovation. Although the USDOT has already considered that in their planning for the future of AVs.The U.S. DOT will modernize regulations to remove unintended and unnecessary barriers to innovative vehicle designs, features, and operational models, and will develop safety-focused frameworks and tools to assess the safe performance of ADS technologies (United States Department of Transportation, 2021, p. 3). The efforts by federal and state authorities to periodically update AV guidelines and regulations reflect an acknowledgment

of the necessity for regulatory frameworks to evolve in tandem with technological progress. This adaptive approach ensures that policies stay up-to-date on AV performance and safety data, facilitating a conducive environment for the responsible development of AV technology.

California's approach to AV regulation serves as a great case study in directing a balance between innovation and public safety. The state's Autonomous Vehicles Strategic Framework lays down guiding principles for AV deployment, emphasizing a holistic strategy that fosters innovation while protecting public interests. As the fifth-largest economy in the world, California continues to be at the center of many innovations in business and technology (State of California, 2022). California established an interagency workgroup to develop a comprehensive plan for integrating autonomous vehicles into daily life and the broader transportation network. This initiative examined the varied impacts of AVs on various social groups, aimed at enhancing their benefits while reducing potential drawbacks in areas such as the transportation system, employment, housing, climate, and public health. Additionally, it acknowledged AVs as one of several solutions to improve safety, mobility, job quality, equity, health, environmental sustainability, land use, and overall quality of life (State of California, 2022). This framework is telling of California's willingness to test new technologies while poking holes in the current federal regulation toward AVs.

Critics within the automotive industry argue against what they perceive as "overregulation," suggesting that stringent policies may stifle innovation and hinder the growth of the AV market. However, the primary objective of regulation is to ensure that technological advancements proceed in a manner that prioritizes public safety. Innovation and safety are not mutually exclusive. Rather, through careful policy crafting, it is possible to guide responsible

development that benefits society at large. Setting high industry standards, and regulations can spur companies to develop advanced, safer AV technologies, positioning the United States as a leader in the field.

Conclusion

In wrapping up the analysis and discussions laid out in this paper, it's clear that navigating the path forward for autonomous vehicle technology isn't just about technical innovation, it's about creating a balanced, dynamic approach to regulation that considers safety, ethics, and societal impact. This challenge, though complex, offers a unique opportunity to rethink how we manage emerging technologies and their integration into everyday life. Through examining current regulatory practices, particularly in California and by federal bodies like the NHTSA, we've seen a glimpse of what works and where improvements are needed. This insight is invaluable for guiding future steps in the realm of AV development and regulation.

Regardless, this study acknowledges several limitations that are inherent to its design and scope. Firstly, while focusing on California and federal regulations provides in-depth insights, it may not fully capture the diversity and possibility of AV regulatory approaches adopted in other states. Secondly, given the dynamic and rapidly evolving nature of AV technology and its regulatory environment, there is an inherent risk that the sources might quickly become outdated as new policies emerge and technologies advance.

Balancing innovation with safety has stood out as a key theme. AVs have the potential to change our roads, making them safer and more efficient. However, the road to this future is paved with challenges, including technological glitches and regulatory gaps highlighted by

recent incidents. These challenges underscore the need for regulations that are not only supportive of AV technology but also adaptable enough to evolve as the technology does.

California's strategy offers a practical model for how to balance fostering innovation with protecting public interests. Yet, the reality of implementing such regulations, as shown by the need for bans and recalls, points to the complexity of regulating a technology that's still finding its footing. This reality emphasizes the importance of having a regulatory framework that can quickly adapt to new challenges, ensuring public safety at every turn.

As AV technology continues to advance, the need for regulations to keep pace becomes increasingly evident. This calls for a regulatory approach that remains flexible and forward-thinking, capable of addressing both current safety concerns and future ethical dilemmas. The automotive industry's worries about overregulation highlight the need for a balanced approach that encourages innovation while ensuring safety.

Looking ahead, the journey of AV regulation is far from over. Researchers, engineers, policymakers, and other social groups play a crucial role in shaping this path. Future research should delve into refining ethical frameworks, enhancing cybersecurity measures, and exploring new regulatory models that encourage safety and innovation. Engineers and technologists need to work hand in hand with policymakers to ensure regulations reflect the true capabilities and challenges of AV technology, fostering a collaborative environment.

Policymakers, in turn, need to stay nimble, ready to update and adapt regulations in line with technological and societal shifts. Engaging with a wide range of stakeholders, including the public, industry experts, and ethicists, will be key to crafting comprehensive, effective policies. Our collective goal should be to steer the future of AV technology toward a scenario where it not only enhances mobility and safety but does so in a way that aligns with societal values and

ethical considerations. This paper, though just a starting point, aims to contribute to that ongoing dialogue and exploration, paving the way for a future where AV technology and regulation work in tandem for the betterment of society.

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