Building Trust in AVs Requires Transparency, Cooperation, and Communication Across the Network

A Research Paper submitted to the Department of Engineering and Society

Presented to the Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree

Bachelor of Science, School of Engineering

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Spring 2025

On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In 2023, 40,990 people lost their lives on roadways across the nation (U.S. Department of Transportation, 2024). To give a general idea of how many people that is, the seats of an entire professional baseball stadium could be filled. Autonomous vehicles (AVs) have the possibility to reduce the number of deaths and are advantageous to society as they "reduce crashes, energy use, pollution, and congestion while at the same time increase transport accessibility" (Bagloee et al., 2016, p. 284). However, public distrust is slowing their adoption. In fact, 56% of Americans would not want to ride in a driverless vehicle if given the chance, with safety concerns and lack of trust as the main reasons (Anderson and Smith, 2017).

Using the Actor Network Theory (ANT), I will analyze how four key actors shape trust in AVs: pedestrians, manufacturers, the media, and policymakers. I aim to examine the different power dynamics between these actors and where in the network these dynamics become "unstable" (Rodger et al., 2009, p. 647). Looking into these unstable dynamics is crucial for understanding how AVs can earn public trust and be adopted into society. AVs are currently in the "interessement" phase of translation, where the focal actor, which I believe is the manufacturer, is trying to convince the other actors, such as pedestrians, the media, and policymakers, to accept AVs in society (Rodger et al., 2009, p. 648). As for conceptual terms, I define public distrust as a sense of fear or anticipation of discomfort or danger when in or around an AV and an autonomous vehicle as a vehicle that can operate without human input.

Without public trust in the capabilities of AVs, fear and skepticism may hinder their widespread adoption. To overcome this challenge, I argue that all stakeholders within the AV network must prioritize transparency and collaboration to show how AVs can be safely and effectively integrated into society. In the sections that follow, I examine the role and influence of

key actors in the AV network through different case studies. This includes pedestrians' interactions with AVs and the several types of trust involved, the ethical responsibilities and power held by manufacturers, the media's portrayal of AVs to the public, and the role of policymakers in shaping AV regulations.

Pedestrians

Pedestrians are among the most vulnerable actors in the AV network. Therefore, understanding the trust dynamics between pedestrians and AVs is crucial to identifying the root fears and skepticism that contribute to instability within the AV network. In fact, "around 60% of pedestrians do not trust that human drivers will respond appropriately toward them" (Deb et al., 2017, p. 179). Applying this to AVs, pedestrians face the additional challenge of adapting their trust to vehicles without traditional human drivers.

To study this relationship, I will use a theoretical framework that outlines three types of trust, specifically focusing on pedestrian trust in AVs (Zhou et al., 2022). To give context, Zhou et al.'s (2022) research conducted a literature review on trust in automation, using four major library databases to find articles and research studies to help build their framework. Their paper is well-cited, peer-reviewed, and published in *IEEE Transactions on Human-Machine Systems*. The framework categorizes pedestrian-AV trust into three types: dispositional, situational, and learned trust. Dispositional trust is shaped by personality traits and prior experiences of the pedestrian, situational trust is influenced by specific contexts such as road conditions or if the pedestrian is distracted, and learned trust is developed through repeated interactions with AVs. While the researchers provide a detailed explanation of their theoretical framework, they do not apply it to real-life scenarios between AVs and pedestrians. Therefore, I intend to analyze two

specific pedestrian-AV crashes to demonstrate how these trust categories play out in real-world situations.

The first crash I will examine is known as the "first failure effect," which is defined as the phenomenon where an unexpected, unprecedented event dramatically shifts public perception (Tapiro et al., 2022). The crash happened in 2018 where an AV operated by Uber Technologies struck and killed a pedestrian in Arizona. During this time, a survey was created to study the “first failure effect” of an AV and see how public perceptions of AVs changed. The survey collected data on 1,409 individuals with their opinions of AVs before and after the crash. The research concluded that trust in AVs significantly declined following the crash and that negative experiences associated with automation failures affect a person’s expectations and trust in future interactions. Although this conclusion is expected, I want to add that this case shows concepts of both learned and dispositional trust from the theoretical framework.

To start, learned trust is broken up into two categories: “initial trust” and “dynamic trust” (Zhou et al., 2022, p. 494-495). Initial trust reflects pedestrian perceptions of AVs before any direct interaction so in this case, prior to the 2018 crash. Dynamic trust represents the evolving trust levels as pedestrians interact with AVs, which, following the crash, saw a substantial decline. The study’s survey concludes that trust levels eventually returned to their pre-crash state over time, suggesting a dynamic relationship influenced by how the AV network reacts (Tapiro et al., 2022). I argue that the initial decline was amplified by the first failure effect and that the AV manufacturers must prioritize transparency about such crashes. This means AV manufacturers must openly share the causes of the crash and the safety improvements they intend to make if they want to rebuild public trust.

Applying dispositional trust to the study, the survey collected variables for the participants such as age, gender, and educational background. Results showed that older individuals expressed greater skepticism toward AVs, men had more positive perceptions on AVs than women, and those with lower educational levels exhibited higher resistance to trusting AVs' decision-making capabilities. While the theoretical framework identifies age and gender as the primary variables influencing dispositional trust, I argue that in addition to age and gender, educational level also plays a significant role. These findings highlight how dispositional trust shapes attitudes across different demographic groups. To address these disparities, I suggest that AV manufacturers actively engage with groups exhibiting lower trust levels. By gathering this targeted feedback, manufacturers can adapt their AVs to foster a greater sense of inclusion and responsiveness, enhancing trust among the more skeptical populations.

The next crash I will examine occurred in the fall of 2023 and involved a traditional car (non-AV), an AV, and a pedestrian. In this crash, the traditional car struck a pedestrian crossing the road, causing the pedestrian to fall and end up underneath a nearby AV. Philip Koopman (2024) is an internationally recognized expert on AV safety whose work in the area spans over 25 years. He recounts this event in a conference paper, highlighting how Cruise, the AV's manufacturer, "failed to proactively disclose the pedestrian dragging portion of the mishap" (Koopman, 2024, p. 119). Although the AV was not the initial cause of the crash, this event raises critical questions about accountability. The absence of a human driver or passenger in the AV complicates the recollection of the event and its legal proceedings. Later in my paper, I will explore the role of manufacturers within the AV network and argue that General Motors, the owner of Cruise, bears significant responsibility in this crash. But for now, I would like to highlight how the pedestrian in this scenario crossed the road during a "Do No Walk" signal. Although Koopman (2024)

places much of the blame on the AV, which still is a key factor that I do not want to miss, the pedestrian's mistake is overlooked and just as crucial to study. We, as pedestrians, have a duty to follow traffic regulations and are at fault if we take the risk and cross the road when we are not supposed to, as happened in this scenario.

To apply the theoretical framework to this crash, situational trust becomes particularly relevant. There are two sources of variability in situational trust, one being the "external environment," such as traffic signals and road conditions, and another the "internal, context-based characteristics of pedestrians," such as whether they are distracted or not (Zhou et al., 2022, p. 494). Starting with external factors, the "Do Not Walk" signal is designed to enhance pedestrian safety as all vehicles, both autonomous and non-autonomous, are expected to follow the law. While the theoretical framework suggests that such traffic signals should strengthen trust in AVs, the pedestrian's decision to ignore the signal introduces a breakdown in that dynamic. This crash demonstrates how human unpredictability can undermine the situational factors meant to reinforce trust.

As for internal factors, the pedestrian involved in this crash was distracted. "Attentional capacity" is a significant variable that influences situational trust (Zhou et al., 2022, p. 494). A distracted pedestrian may not only increase the risk of a crash but also shift public perceptions of who is at fault. This complicates the trust dynamic between AVs and vulnerable road users like pedestrians. Despite the pedestrian's error, I support Koopman's (2024) argument that "having another road user initiate a mishap does not absolve the AV from a responsibility to react in a reasonable way to inherently unpredictable events" (p. 128). It is precisely these unpredictable events that play a crucial role in shaping public trust or mistrust in AVs. This incident shows how both external environmental cues and internal pedestrian behaviors interact to influence

situational trust, while also highlighting the AV's responsibility to respond effectively, regardless of human error.

Manufacturers

The next key actor in the AV network I will analyze is manufacturers. This includes the developers who create and help advance AVs. Their work goes beyond simply creating the AV but also shaping public perceptions and trust in AVs. As AVs become more popular, crashes receive more media attention, raising pressing questions about accountability. In this section, I investigate the motives behind different AV manufacturers, focusing specifically on General Motors and Tesla. I argue that they are the focal actor in the AV network because they aim to convince other stakeholders, like pedestrians, the media, and policymakers, to accept and trust their AVs for successful social integration. However, it is not clear whether these manufacturers recognize that earning public trust should be their primary goal. Their true motive could be profit or being the first to release the newest and most technologically advanced AV. If these motives are present, manufacturers may sacrifice transparency in their testing processes and standards. This lack of openness lowers public trust in AVs, as I will show through case studies. Therefore, to build public trust, I suggest that AV manufacturers adopt a cooperative approach with AV policymakers instead of an adversarial stance.

To start, I will analyze a crash I have already talked about earlier in my paper, but instead from the perspective of the manufacturer, not the pedestrian. In October of 2023, General Motors Cruise Division misreported a crash that led them to a $1.5 million fine and public scrutiny (AP News, 2024). To summarize, a traditional car struck a pedestrian who fell underneath an AV driving nearby. The crash caused no fatalities, only serious injuries, but it is important to note that "Cruise's report to the NHTSA omitted reference to its AV dragging the pedestrian"

(Shepardson, 2024). As a result of the investigation, Cruise's CEO and co-founder both resigned and the company cut a quarter of its workforce and fired nine executives (Shepardson, 2024). This case serves as a red flag. When a company like Cruise fails to take responsibility for its actions and misreports critical details, it raises significant questions about its motives. Rather than being upfront about the accident, Cruise's attempt to avoid a "negative media cycle" resulted in even harsher media criticism and a greater loss of public trust (Koopman, 2024, p. 132). Although Cruise eventually took responsibility by firing the leadership that mishandled the situation, the incident emphasizes the need for complete transparency. Therefore, trustworthy leadership is a vital step in ensuring that public safety remains the priority over profit.

The next AV manufacturer I am studying is Tesla and their controversial approach to AV deployment. Tesla has been deploying its Full Self-Driving (FSD) beta software, which they classify as a Level 2 system under the SAE standard. A Level 2 allows the vehicle to operate on its own, but the driver must remain alert and ready to take control at any time. However, it is believed that the system behaves more like a Level 4 system, which is defined as high automation that requires little to no human intervention (Widen and Koopman, 2022). This discrepancy in classification is problematic. It allows Tesla to conduct public road testing with drivers who may not be adequately trained, therefore putting lives at risk. This practice is both unsafe and legally questionable. Tesla treats "safety regulation as a classification game to be won or lost, without considering the safety consequences of winning this game, [which] provides a reason to withhold trust" (Widen and Koopman, 2022, p. 192). Tesla's focus on being first in the industry with the latest and most advanced technology seems to overshadow its commitment to correct internal testing. Instead of thoroughly testing new software in controlled conditions, Tesla seems to rely on its users as test subjects. While one could argue that real-world testing

offers valuable insights, this perspective overlooks the significant safety risks it poses to both users and other drivers on the road. These drivers may place too much trust in the vehicle's autonomous capabilities and not exercise enough caution toward their surroundings. Moreover, without adequate training, they may be less informed about the software's limitations and less prepared than professional test drivers operating in controlled environments. This approach to testing raises serious concerns about Tesla's ethical responsibility and legal accountability.

It is important to note that this Tesla case highlights a broader problem in the AV network, which is the lack of clear and consistent definitions. Terms such as "Level of Automation," "deployment," and "testing" are used inconsistently among manufacturers, policymakers, and the public. This uncertainty destabilizes the entire network. If all actors in the AV network could agree on precise definitions, it would help align expectations, improve communication, and foster a safer environment for AV integration. Widen and Koopman (2022) argue that "the shortcomings in the approach the industry uses to develop trust stem from an adversarial posture towards law, regulation, and disclosure" (p. 254). Therefore, to rebuild public trust, AV manufacturers should shift toward a cooperative stance with policymakers and commit to ethical principles that promote transparent and responsible design.

The Media and Policymakers

The last two actors I will analyze are the media and policymakers, both of whom hold considerable influence over public perception and the adoption of AVs. The media is important to study as it serves as the primary source of information for the public. Unfortunately for AVs, the media often amplifies fear and skepticism surrounding AVs by exaggerating isolated incidents. I will argue that this is a common issue with any emerging technology, as seen in the history of the rideshare service known as Uber (Hoenig, 2025). This noise fuels misconceptions

that disrupt the AV network, making it more difficult for the public to develop trust in AVs. Instead, a media narrative that prioritizes education about AV benefits and practical applications could help bridge this trust gap. Policymakers, on the other hand, play a crucial role in shaping the regulatory environment for AVs. I will analyze the different regulations policymakers have been involved with and their effectiveness. Based on my analysis of other actors in the AV network, I argue that policymakers should collaborate closely with manufacturers to establish clear, standardized definitions and regulations, ensuring a smoother integration of AVs into society.

While I acknowledge some AV accidents are truly devastating and should be addressed publicly, the media often amplifies AV failures in a way that creates unnecessary skepticism, overshadowing the broader benefits of AVs. Anania et al. (2018) examine in their research how media headlines influence people's emotional reactions and their willingness to ride in or use driverless vehicles. For example, the headline "*Our Driverless Dilemma: When Should Your Car Be Willing to Kill You*" (Greene, 2016) presents AVs in a sensationalized ethical light, while "*Experiments Show That a Few Self-Driving Cars Can Dramatically Improve Traffic Flow*" focuses on a benefit of AVs (Work, 2017). The study reveals that negative media coverage has a deeper and more lasting effect on attitudes towards AVs than positive coverage. This further emphasizes the importance of the media providing a more balanced narrative about AVs.

Mirroring the above study, another study focuses on sentiment analysis in different web and news articles over time. This study concludes that "overall negativity drastically spiked in 2018 because of the two crashes" that occurred in that year (Penmetsa et al., 2023, p. 3). The same year "had the highest scores for fear, anger, sadness, and disgust," showing how AV failures directly affect human reactions in a negative manner, potentially disrupting their trust in AVs

(Penmetsa et al., 2023, p. 4). I agree with when the researchers state that “a factual balance between the pros and cons of the technology should be provided to the public to help them make well-informed decisions” (Penmetsa et al., 2023, p. 5). One could argue that the media simply reports what captures public attention, but I argue that the media has a responsibility, especially as the primary source of information for most people, to cover AV advancements and regulatory efforts in a way that educates rather than promotes fear. Thus, policymakers and manufacturers should work more closely with the media to ensure AV-related issues are presented in the correct manner. The researchers state that “at the early state of any technological development, the public usually rely on the media to form their opinion,” transitioning to my next point (Penmetsa et al., 2023, p. 5).

The initial rejection of AVs is similar to the media and the public’s initial rejection of Uber rideshare services. When Uber launched in 2009, it encountered significant resistance from traditional taxi services and policymakers. Moreover, “the idea for Uber was so disruptive it was illegal in many cities,” just how AVs of level 3+ are banned in British Columbia (Hoenig, 2025). Uber also faced strikes in many cities led by taxi drivers, which were widely covered by the media. Public backlash against Uber intensified further during controversies like the viral “#DeleteUber movement,” where hundreds of thousands of users deleted their accounts after the company’s actions during a New York City taxi strike were perceived as unethical (Hoenig, 2025). This shows how quickly media coverage and public sentiment can shift against innovative technologies. This backlash from the public ended up being exactly what Uber needed to turn the corner and focus more on core operations and improving customer experience (Hoenig, 2025). Similarly, AV manufacturers, policymakers, and the media must recognize the critical role public perception plays in AV adoption and work proactively to build trust. Uber’s eventual

success shows that early backlash can be overcome when companies refocus on public concerns and improve transparency. For AVs, growth will require a coordinated effort between manufacturers, policymakers, and especially the media to highlight safety advancements, correct misinformation, and prioritize the public's trust at every stage.

Moving to policymakers' role in the AV network, I believe they have already begun crafting regulations to guide AV integration, but inconsistencies across different areas have contributed to increased public distrust. For example, while states like Arizona, Florida, Nevada, and Texas have laws that permit AV manufacturers "wide latitude" for testing, other states like California and New York rather "promote safety through law and regulation" (Widen and Koopman, 2022, p. 174). One myth believed to be debunked is that "local and state regulations need to be stopped to avoid a patchwork of regulations that inhibits innovation" (Widen and Koopman, 2022, p. 211). One reason for this is the AV manufacturers want to minimize regulation surrounding their AVs. The manufacturers threaten certain states' reputation for "being hostile to innovation and technology" (Widen and Koopman, 2022, p. 212). This patchwork regulation is a result of AV manufacturers' unstable negotiations with policymakers. This further shows how AV manufacturers and policymakers must take a more cooperative approach in working together.

Another key concern policymakers must address to gain public trust is liability in AV-related crashes. The absence of clear liability laws makes it difficult for consumers to trust AV technology because responsibility in crashes involving AVs is often contested between manufacturers, software developers, and human drivers. Michigan's 2016 SAVE Act (Safe Autonomous Vehicles Act) is one example of states correctly dealing with legal action. This act establishes guidelines for testing and deploying AVs, including clarifying that manufacturers are held responsible if an AVs automated system is at fault in a crash. The "bipartisan nature of the

bill and the public-private cooperation between industry, academia, and government…is a cooperative approach [that] is a testament to the type of collaboration necessary" for AV development and "serves as a model for other states to emulate" (Detroit Regional Chamber, 2016). However, broader federal action is needed to ensure uniformity in liability frameworks across all states, Michigan being a primary example to follow.

Beyond just legal frameworks, policymakers, in addition to the media, can also play a role in shaping education initiatives. Trust in AVs depends on the public's understanding of how these vehicles operate and their potential benefits. Policymakers should invest in public awareness campaigns that clarify the safety benefits of AVs, such as reducing human error in crashes and improving traffic flow (Widen and Koopman, 2022). I argue that partnering with universities, research institutions, and other industry leaders can further demonstrate AVs reliability to gain public trust.

Conclusion

AVs have the potential to transform transportation safety and efficiency, but public trust remains the key barrier to their widespread adoption. By analyzing the roles of pedestrians, manufacturers, the media, and policymakers through ANT, I argue that transparency, accountability, and cooperation among these actors are essential to stabilizing the AV network. Each stakeholder holds unique power in shaping how AVs are perceived and integrated into society and their mutual trust in each other is the only way AV integration will succeed. My analysis shows that beyond the technicalities of AVs, AV adoption depends on ethical leadership, clear communication, and shared responsibility. Public trust is only earned through purposeful and sustainable action by those who hold the power. These findings have broader

implications for other emerging technologies, like AI, where a user's trust is crucial for that technology's success.

Future research should explore how socio-economic factors influence public trust in AVs, particularly in how AV adoption may vary significantly between urban and rural communities. While many studies highlight how cultures and communities interpret risk and safety in automation, I found little research on how trust in AVs is defined and measure across diverse populations. More research in that area can prove how AV technology can evolve in ways that are both socially and ethically responsible.

References

Anania, E. C., Rice, S., Walters, N. W., Pierce, M., Winter, S. R., & Milner, M. N. (2018). The effects of positive and negative information on consumers' willingness to ride in a driverless vehicle. *Transport Policy, 72*, 218–224. https://doi.org/10.1016/j.tranpol.2018.04.002

Anderson, A. S. and M. (2017, October 4). 3. Americans' attitudes toward driverless vehicles. *Pew Research Center*. https://www.pewresearch.org/internet/2017/10/04/americans-attitudes-toward-driverless-vehicles/

Bagloee, S. A., Tavana, M., Asadi, M., & Oliver, T. (2016). Autonomous vehicles: Challenges, opportunities, and future implications for transportation policies. *Journal of Modern Transportation, 24*(4), 284–303. https://doi.org/10.1007/s40534-016-0117-3

Cruise to pay $1.5M penalty after failing to fully report crash involving pedestrian, NHTSA says. (2024, September 30). AP News. https://apnews.com/article/nhtsa-cruise-general-motors-gm-836c944e5bb7a877a302e135bd90007d

Deb, S., Strawderman, L., Carruth, D. W., DuBien, J., Smith, B., & Garrison, T. M. (2017). Development and validation of a questionnaire to assess pedestrian receptivity toward fully autonomous vehicles. *Transportation Research Part C: Emerging Technologies, 84*, 178–195. https://doi.org/10.1016/j.trc.2017.08.029

Detroit Regional Chamber. (2016, September 6). *Legislative Update: SAVE Act Paves Way for Autonomous Vehicle Testing in Michigan*. https://www.detroitchamber.com/legislative-update-save-act-paves-way-for-autonomous-vehicle-testing-in-michigan/

Greene, J. D. (2016). Our driverless dilemma. *Science, 352*(6293), 1514–1515. https://doi.org/10.1126/science.aaf9534

Hoenig, H. (2025). *The History of Uber*. Investopedia. Retrieved March 19, 2025, from https://www.investopedia.com/articles/personal-finance/111015/story-uber.asp

Koopman, P. (2024). Anatomy of a Robotaxi Crash: Lessons from the Cruise Pedestrian Dragging Mishap. In A. Ceccarelli, M. Trapp, A. Bondavalli, & F. Bitsch (Eds.), *Computer Safety, Reliability, and Security* (pp. 119–133). Springer Nature Switzerland. https://doi.org/10.1007/978-3-031-68606-1_8

Penmetsa, P., Okafor, S., Adanu, E., Hudnall, M., Ramezani, S. B., Holiday, S., & Jones, S. (2023). How is automated and self-driving vehicle technology presented in the news media? *Technology in Society*, *74*, 102290. https://doi.org/10.1016/j.techsoc.2023.102290

Rodger, K., Moore, S. A., & Newsome, D. (2009). WILDLIFE TOURISM, SCIENCE AND ACTOR NETWORK THEORY. *Annals of Tourism Research*, *36*(4), 645–666. https://doi.org/10.1016/j.annals.2009.06.001

Shepardson, D. (2024, November 15). GM self-driving unit Cruise admits to submitting false report, will pay $500,000 fine. *Reuters*. https://www.reuters.com/business/autos-transportation/gm-self-driving-unit-cruise-admits-submitting-false-report-will-pay-500000-fine-2024-11-15/

Tapiro, H., Wyman, A., Borowsky, A., Petzoldt, T., Wang, X., & Hurwitz, D. S. (2022). Automated Vehicle Failure: The First Pedestrian Fatality and Public Perception. *Transportation Research Record*, *2676*(8), 198–208. https://doi.org/10.1177/03611981221083297

The Roadway Safety Problem | US Department of Transportation. (2024). Retrieved March 25, 2025, from https://www.transportation.gov/NRSS/SafetyProblem

Widen, W. H., & Koopman, P. (2022). Autonomous Vehicle Regulation & Trust: The Impact of Failures to Comply with Standards. *UCLA Journal of Law and Technology*, *27*(3), 169–261.

Work, D. (2017). *Experiments show that a few self-driving cars can dramatically improve traffic flow*. Retrieved April 28, 2025, from https://cee.illinois.edu/news/experiments-show-few-self-driving-cars-can-dramatically-improve-traffic-flow

Zhou, S., Sun, X., Liu, B., & Burnett, G. (2022). Factors Affecting Pedestrians' Trust in Automated Vehicles: Literature Review and Theoretical Model. *IEEE Transactions on Human-Machine Systems*, *52*(3), 490–500. IEEE Transactions on Human-Machine Systems. https://doi.org/10.1109/THMS.2021.3112956