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Transportation Planning for Automated Vehicles—Or Automated Vehicles for Transportation Planning?

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Abstract

In recent years, philosophical examinations of automated vehicles have progressed far beyond initial concerns over the ethical decisions that pertain to programming in the event of a crash. In turn, this paper moves in that direction, focusing on the motivations behind efforts to implement driverless vehicles into urban settings. The author argues that the many perceived benefits of these technologies yield a received view of automated vehicles. This position holds that driverless vehicles can solve most if not all urban mobility issues. However, the problem with such an outlook is that it lends itself to transportation planning for automated vehicles, rather than using them as part of planning efforts that could serve urban mobility. Due to this condition, present efforts aimed at improving transportation systems should resist dogmatic thinking. Instead, they should focus on goals that keep topics such as human flourishing, sustainability, and transportation justice firmly in view.

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Introduction

When examining claims about the future and automated vehicles, a “received view” emerges holding that this technology has the possibility of solving numerous issues in transportation. In turn, we are left with a utopian view of urban mobility. This point suggests that it might be a good decision for municipal leaders to make transportation plans center on automated vehicles (AVs). While there is little doubt that we should champion advancements in research that can alleviate transport-related harm and improve urban mobility, there are reasons to be critical.

For instance, the uncertainties that come with the possible impacts, the time scale of implementation, and unknown challenges that pertain to AVs give us reason to have reservations about making all other transportation decisions revolve around driverless vehicles (Gonder, and Repac 2014; Walker and Marchau 2017; Stone, de Sio, and Vermaas 2019). Although we do have good reason to believe that AVs will launch, we ultimately cannot predict their impacts or when such effects will manifest. Instead of embracing driverless vehicles with trusting gusto, transportation professionals should consider them as another component of transportation planning instead of *the* transportation plan.

To make this case, I will examine some of the predictions that were made about transportation network companies (TNCs) that offer private mobility services (such as Uber and Lyft). Then, I exhibit several of the claims that have been made about AVs, arguing that both of these technologies rest on forward-looking arguments. Due to the likeness of such positions, a strong case can be made for following the advice of transport planners who remain focused on the best way to move people about cities without dogmatic adherence to technocratic idolization. In closing, I suggest some neighboring areas of research that could benefit cities in their efforts to deliver improved mobility services to urban residents.

The Received View of Automated Vehicles

To get an idea of the full range of the anticipated effects that driverless vehicles could have, several researchers have argued that their impacts will completely reshape society (Fraedrich, et al. 2015; Bagloe et al. 2016; Maurer et al. 2016). Due to these predictions, numerous papers that discuss automated vehicles are engaging with the ways that these technologies could improve transportation, along with the several challenges that deserve attention (e.g., Maurer et al. 2016). Such challenges are present in many of the explorations of driverless vehicles, which are not unique to any specific area of research, including fields such as engineering, urban planning, and philosophy.

When it comes to the ethical aspects that are associated with programming these vehicles, philosophers have thoroughly explored a myriad of issues, indicating numerous problematic areas (Lin 2015; Gerdes and Thornton 2016; Gogoll and Müller 2016; Nyholm and Smids 2016; de Sio 2017; Sparrow and Howard 2017). Yet, one could argue that the reason why philosophers address these ethical issues is that these technologies will emerge, becoming ubiquitous due to AV's many perceived advantages.¹

While such works advance our understanding of the moral dimensions that pertain to driverless vehicles, the point that I want to make does not involve debating any specific position that has been established in the literature, ethical or otherwise. I am not targeting any particular argument in what follows. Instead, I exhibit that there is a general trend when it comes to talking about self-driving vehicles, which consistently discusses their possible benefits across a wide range of disciplines, despite possible challenges. This point is obvious when industry leaders praise the assumed future of AVs.² It is the lure of these alleged advantages as to why the industry is trying to create this technology. The goal behind examining the received view is to reveal a pattern that is problematic in the grand sense of how we typically think about driverless vehicles' beneficial dimensions that *might* manifest in the future.

Although it is rare to find research articles or manuscripts that are entirely unwavering in their support of driverless vehicles, when examining several such works collectively, this received view emerges.³ It shows that these technologies have numerous advantages for

¹ This notion extends to several disciplines, suggesting that one reason why researchers are exploring the challenges that AVs will bring is because the positives of these technologies outweigh the possible negatives. This notion is also consistent with a Hearing for the Subcommittee on Highways and Transit of the Committee on Transportation and Infrastructure, House of Representatives, One Hundred and Thirteenth Congress, First Session, November 19, 2013. They acknowledge that the introduction of AVs will bring several challenges to society, but that these vehicles will improve roadway safety, decrease traffic, reduce auto emissions, and bolster the workforce. They show that driverless vehicles have support at all levels of government, which could someday deliver a mobility revolution in the United States. For more information, see Subcommittee on Highways and Transit; Committee on Transportation and Infrastructure. House (2013). How Autonomous Vehicles Will Shape the Future of Surface Transportation. Available online: <https://congressional.proquest.com/congressional/docview/t29.d30.hrg-2013-hti-0037?accountid=3611>

² Wanis Kabbaj's Ted Talk, "What a driverless world could look like," is a good example. Available online: <https://www.youtube.com/watch?v=OILFK8oSNEM>.

³ While industry representatives typically present such views, there are a few scholars in academia whose work supports and/or leans in the direction of the received view. For example, see Greenblatt, J., and Shaheen, S. (2015). Automated vehicles, on-demand mobility, and environmental impacts. *Current Sustainable/renewable Energy Reports*, 2(3), 74-81.

urban centers as described below, even in spite of obstacles. In turn, it would seem foolish not to pursue them with great enthusiasm. Most of these benefits appear as solutions to social and environmental problems that have been mainstays within typical transportation systems. Bearing in mind that these topics concern human health, quality of life, the public domain, and environmental issues such as climate change, it makes sense to look towards new and emerging technologies to solve these problems. AVs show great promise in this regard.

Consider, for example, that Austin Brown, Jeffrey Gonder, and Brittany Repac (2014) exhibit that AVs have great potential for safety, improving air quality, and decreasing crashes due to errors in drivers' judgment. They also illustrate how AVs could lessen the demand for urban land use and provide a way for vulnerable populations to access needed social services (*ibid.*) William Morrow *et al.* (2014) argue that driverless vehicles could help with building sustainable infrastructure and communities, supporting urban development, and reducing overall energy consumption. Taylor Stone, Filippo Santoni de Sio, and Pieter Vermaas (2019) point out that numerous researchers are focusing on topics such as how AVs could benefit public health and easing congestion on roadways (also, see Anders Eugensson *et al.* 2013).

Hubert Iglińska and Maciej Babiak (2017) figure that AVs will significantly reduce greenhouse gases, estimating a 40-60% reduction in some instances. Jeffery Greenblatt and Susan Shaheen (2015) explore numerous possibilities of driverless vehicles, from economic benefits to energy security to helping populations that have limited incomes achieve mobility. Armin Grunwald (2016) holds that AV can help senior citizens increase their mobility. Regarding social justice, Milos Mladenović and Tristan McPherson (2016) exhibit how we can engineer social justice into traffic controls for AVs. In a paper published elsewhere, I argue that, when carefully and critically deployed, driverless vehicles could support transportation justice (Epting 2018).

The above references are by no means an exhaustive list of the benefits that driverless vehicles could provide, but they do represent the kind of thinking that one could argue is present when examining the possible (positive) outcomes that could happen by introducing AVs into population centers. Hence, this reason is why I refer to the above collection of claims as the received view of automated vehicles. Although it is not wise to put all writings on AVs under the same umbrella, the implied notion is that we should adopt these technologies because of the results that they might produce, often in spite of any accompanying ethical challenges and/or downsides that they might bring with them.⁴

⁴ Through focusing on the (collective) positive appeal of AVs, I do not mean to discount the possible

Yet, depending on driverless vehicles to provide the above outcomes remains subject to the same criticisms that we find with consequentialist approaches in general. Briefly put, consequentialist positions in ethics basically hold that the consequences of an action determine if it is considered right or wrong, and the most common objection to this view is that it is impossible to know the future (Kagan 1998). Specifically, the problem with appealing to the promise of AVs as solutions to some or all of a city's mobility problems is that there is no guarantee that they will have any of these effects, either partially or fully. Moreover, they could make things worse due to the many uncertainties that cities will face when implementing AVs (Walker and Marchau 2017). An essential hurdle to knowing if these technologies will provide the predicted outcomes is that there is not a way to tell how they will fit in with existing transportation systems and other elements such as housing that they indirectly impact. Strict adherence to the received view of AVs could take attention away from socially and environmentally just ways to improve urban mobility that support areas such as human flourishing, urban sustainability, and/or transportation justice.

While these two reasons suggest that implementing AVs into transportation systems should be carefully executed, they do not get at a fundamental assumption of modern technology that Hans Jonas (1984) previously identified. Namely, that we must rid ourselves of the idea that technology without limitation, viewing it as the vehicle that could guide us to utopia, is inherently good, holding that we should balance such an outlook with a fear of an ecologically unsound dystopia that would imperil humankind (Jonas 1984).⁵ Yet, the fact remains: we must rely on new and emerging technologies to deliver

challenges that driverless vehicles will present. The underscored point here is that AV's benefits will make it worthwhile to develop solutions and/or workarounds to such challenges. For instance, one can argue that we would not need ethical frameworks or technical debates about how to incorporate AVs into society if the benefits were not assumed to be worth the cost of restructuring urban mobility. For a good example of the technical challenges, see Watzenig and Horn (2017). *Automated driving: safer and more efficient future driving*. Switzerland: Springer International Publishing. For challenges in transportation policy, see Bagloee *et al.* (2016). Autonomous vehicles: challenges, opportunities, and future implications for transportation policies. *Journal Modern Transport*, 24(4), 284–303. For the ethical challenges involved in the design of AVs and society, see Borenstein, J., Herkert, J. and Miller, K. (2017). Self-driving cars: ethical responsibilities of design engineers. *IEEE Technology and Society Magazine*, 36(2), 67-75. Also, see Thornton, S. *et al.* (2016). Incorporating ethical considerations into automated vehicle control. *IEEE Transactions on Intelligent Transportation Systems*, 18(6), 1429-1439.

⁵ Jonas (1984) addresses the charge of being against technology, holding that we should not entirely abandon technological pursuits. The spirit of the present critique of driverless vehicles should not be construed as a form of technophobia. In turn, I am also not accusing researchers or developers of having technophobia. For more information on these topics, see Drengson, A. (2010). Four philosophies of technology. In C. Hanks (Ed.), *Technology and values: Essential readings* (pp.26-37). West Sussex: Wiley-Blackwell.

us from the harms of our old transportation systems. When it comes to driverless vehicles, however, we cannot depend on clairvoyance—even when it is backed with scientific expertise and/or predictive modeling. We cannot foresee how they will fit in with existing cities and transportation systems.

One can argue that the best that we can do is to examine precedents, searching for cases in the past that might be able to inform the future. The unfortunate reality, however, is that such a precedent does not exist. There are no other examples of (widely used) driverless vehicles in history. Yet, we can examine similar events to discover how they fared, which would be transportation network companies (TNCs) that deliver private, personalized mobility services. At least in these cases, the user-as-driver was replaced, even though it was with another driver-as-operator. Due to this condition, I will examine the outcomes that we saw with TNCs to serve as a close-but-imperfect precedent for AVs in the following section. Although these cases differ, the comparison that can be drawn should provide some insights into the nature of the kind of problems that transportation professionals must deal with when wrestling with a future that includes driverless vehicles.

Transportation Network Companies as Imperfect Precedent Cases

While traditional, private mobility options such as taxicabs and limousines could be considered too costly for everyday travel, TNCs are relatively cheaper, providing an alternative form of transportation from buses, subways, and personally-owned automobiles. Early support for TNCs that offered ride-sourcing services was predicted to have several benefits, exhibiting that there were strong motivations for their acceptance as part for the cityscape (Rayle et al. 2014). For example, writing one of the first papers that examined TNCs, Lisa Rayle *et al.* (2014, 1) held: “Supporters view ridesourcing as part of a suite of transport options that serves previously unmet demand for fast, flexible, and convenient mobility in urban areas. By providing an attractive alternative to driving, these services can potentially reduce auto use, ownership, and environmental problems.”

This passage shows that early predictions indicated that advocates for ride-sourcing companies were already endorsing an approach with a consequentialist bent—a forward-looking argument. That is to say, through focusing on several positive outcomes, there is an implied argument that, with some unpacking, could easily support policy decisions that favor TNCs. Yet, legitimizing such claims depends on delivering outcomes that matched the initial declarations for their support, which failed in some ways and succeeded in other aspects. If TNCs would have lessened the number of vehicles on the road, reduced harm to the environment, improved air quality, and decreased the cost of urban living, then predictions about their positive effects would have held (Manjoo 2014).

Despite holding such promise, researchers argue that TNCs have harmful consequences on cities and urban dwellers (Schaller 2018; Erhardt et al. 2019; Roy 2019). For instance, due to the sheer number of ride-sourcing vehicles on roads in San Francisco, TNCs did not have a positive effect on transportation conditions (Erhardt et al. 2019; Roy 2019). A recent study by John Barrios, Yael Hochberg, and Livia Yi (2018) holds that ridesharing services (they specifically mention Uber) have increased the number of severe traffic accidents and fatalities. There are claims holding that TNC's pooling services that connect multiple riders could reduce congestion (Greenblatt and Shaheen 2015; Santos 2018).

However, in a recent report by Bruce Schaller (2018, 2) he argues: "Shared ride services such as UberPOOL, Uber Express POOL and Lyft Shared Rides, while touted as reducing traffic, in fact add mileage to city streets. They do not offset the traffic-clogging impacts of private ride TNC services like UberX and Lyft." Schaller's findings appear to be consistent with views of how TNCs impacted San Francisco. Although the case of San Francisco is an isolated incident and does not represent a sufficient sample size, it nevertheless can serve as an exemplar of the kind of outcome that other cities should aim to avoid. New York City's recent policy to limit the number of TNC drivers could be thought about as a measure to mitigate the kind of situation that emerged in San Francisco (Rubenstein 2019).⁶

The point here is not to vilify TNCs. While these claims challenge ideas holding that TNCs are a boon to cities, they did have several benefits that deserve attention. For instance, ride-sourcing companies were able to provide services to vulnerable people who lacked effective transportation services (Jin et al. 2018). Scarlett Jin *et al.* (2018) point out that TNCs were also able to make mobility feasible during late-night hours, improve economic efficiency, and relationships between transportation users and drivers. Considering that several cities' transport services must address the "last-mile" problem (getting residents from their homes to public transportation, e.g., bus or train stops), TNCs (such as Uber) maintain that they can help connect riders with public transit (Uber 2019). Although these reasons provide ample motivation for urban planners, engineers, and architects to favor them when planning for the future, they should have some reservations.

For example, when dealing with the last-mile problem, many municipalities began to rely on TNCs to connect transport users with transit services (Graber 2016; Shaheen and

⁶ It is worth mentioning that Uber has filed a lawsuit against New York City for their cap on on-demand drivers. For more information, see Rubenstein, D. (2019). Uber and Lyft stop accepting new drivers in New York City. *Politico*. Available online, <https://www.politico.com/states/new-york/albany/story/2019/04/29/uber-and-lyft-have-stopped-accepting-new-drivers-in-new-york-city-993270>

Chan 2016). Cities would subsidize these companies or form partnerships (Graber 2016; Shaheen and Chan 2016; Uber 2019). Metro Transit, the transportation service found in Minneapolis and the Saint Paul region, will reimburse users up to one hundred dollars or four trips via TNC or Taxicabs (Metro Transit 2019). The City of Dallas' transportation authority, Dallas Area Rapid Transit (DART) has partnered with Uber to help riders connect with transport services (Ball and Lyons 2015). While this move might sound like a practical solution to this problem, transit professionals such as Jarrett Walker (2019) have criticized such practices, remaining skeptical of TNCs motivations to deliver solutions. Instead of fixing existing transport systems with measures developed internally, one could argue that cities that engage in such practices are merely passing a public issue along to a private company, which might not have the people's interest serving as the primary motivation.

Bearing these notions in mind, TNCs are still in their early stages, meaning that developing corrective measures to mitigate harmful effects that immediately materialize could be wise for the long-term, especially considering that ride-sourcing services could evolve into operations wherein only AVs were used (Greenblatt and Shaheen 2015). That is to say, becoming well informed of the problems that one could expect to find with companies that deal with the public's transport needs could serve as close precedents for future transportation technologies that might have similar effects. This point suggests that we should not shy away from TNCs making the transition from human-driver to machine-driver, but that we could facilitate such a shift to include human values and socially just avenues to urban flourishing and sustainability.

In the section that follows, I show how employing the pattern of thinking behind TNCs to AVs could follow a similar, problematic course. Although these patterns are alike, the number of predictions increases with AVs, moving the inspiration behind them closer to utopian thinking than we saw with TNCs. In turn, consideration for uncertainty requires additional attention and scrutiny to determine if their promise, if unfulfilled, is worth the price that cities will pay for failed or delayed enthusiasm towards driverless vehicles. The goal is to reveal that some of the assumptions behind decisions that transport professionals will have to make regarding the future of AVs hold the possibility of harming urban residents in some cases, and they might exacerbate damages in other instances.

Automated Vehicles and an Uncertain Future

If we consider that TNCs were once held as having great promise for solving traffic woes, which led to policies that limited the number of TNC vehicles on the road, then this point suggests that AVs should not be thought about without limitations put on them. In

turn, it should not seem unrealistic to extend such considerations to the implementation of AVs onto *our* city streets. Despite having promise for improving the conditions for urban life, determining how and when AVs will deliver is a different matter. When it comes to the future of AVs, several researchers note that their future has uncertainties (William Morrow et al. 2014.; Brown, Gonder, and Repac 2014; Stone, de Sio, and Vermaas 2019). These uncertainties provide a strong reason to have reservations about viewing AVs as the transportation plan for the future of urban mobility.

As stated earlier, there is no guarantee if or when AVs will effectively and finally solve mobility problems. Consider, for instance, that AV researchers, industry leaders, transportation experts, and municipal officials cannot agree when driverless vehicles will become a feasible actuality (Greenblatt and Shaheen 2015). In a literature review by Jeffery Greenblatt and Susan Shaheen (2015), they show that there is significant disagreement on when AVs will be ubiquitous on roadways.⁷ Having a consensus is not a necessary condition for going forward with plans to include AVs into cities' transportation systems, but having such noticeable disagreement could suggest that experts cannot find common ground for one of the most basic details such as a timetable for their release.

This situation lends itself to the idea that AVs might not be available for public consumption for quite some time. Elon Musk, for instance, claimed—in 2016—that a driverless vehicle would make the journey from Los Angeles to New York City in 2017, but this event never occurred (Higgins 2019). This notion does not mean that transportation professionals should abandon plans to include AVs, but it does suggest that they might want to regulate the amount of attention that they receive, or at least make plans to include them as one piece of a much larger puzzle.

One could argue that the potential benefits of AVs are concerns that are best left up to the scientists, engineers, and professionals who have the technical expertise to make

⁷ Jeffery Greenblatt and Susan Shaheen (2015, 75), show that there is disagreement on when AVs will be a ubiquitous on roadways: “All manufacturers that have announced plans for AVs already offer or plan to release vehicles with some automated features by 2017, and level 3 systems are expected by 2017 to 2020. As mentioned above, Google has announced plans to release a level 4 system by 2017, and Tesla has announced its intention by 2020. Researchers disagree on when AVs will become generally available. IHS Automotive projects level 3 functionality by 2020, level 4 by 2025, and level 5 by 2030, with AVs reaching 9 % of sales in 2035 and 90 % of the vehicle fleet by 2055. Navigant Consulting was even more optimistic, expecting 75 % of light-duty vehicle sales to be automated by 2035, whereas the Insurance Information Institute claims that all cars may be automated by 2030.” Citations for the above estimations are in the original article by Jeffery Greenblatt and Susan Shaheen. To review these references, see Greenblatt and Shaheen (2015).

meaningful claims. Yet, the reality of such benefits, as seen above, remains dubious. For the worst case scenario, the technology ultimately fails to safely deliver a mode of personal transit that lacks the shortcomings that are commonly associated with our horseless carriages. All of our AV dreams are for nothing. Yet, the fact that AVs are currently in experimental phases suggests that the situation above is unlikely. However, the lack of consensus on the part of the experts suggests that it could be several decades until AVs are a permanent and ubiquitous part of cityscapes.

The problem is that transportation professionals could base their decisions to prioritize AVs on the predicted benefits listed earlier. It should be implied that they would be acting to achieve the desired result of moving people to and from their destinations to secure better outcomes than current models can provide. While this notion could hold when discussing any form of transportation, the issue is that the received view supports arguments wherein AVs could receive prioritized backing for their alleged benefits to society and the environment. Basing a decision on the hope that the expected results manifest in the predicted manner is not guaranteed. If the outcome diverges from the original plan or fails to materialize, then the intentions behind such decisions will not work for the solution that is required.

This element is the primary hindrance behind transportation planning for AVs, given the lack of consensus on when these new technologies will be ready for social integration, as indicated in the previous section. There is no assurance that the desired outcomes will manifest, or that they could happen at a much later date than anticipated, perhaps several years or decades. If these technologies do take extremely long periods to be ready for our city streets, then transportation professionals could miss opportunities to improve mobility systems (Saval 2019). If they could have known that AVs were not going to work, or that they would take decades to be ready for wide-scale application, then they could have financed other modes of mobility that could have supported sustainability, human flourishing, and social justice.

While giving so much attention to AVs might signal that transport planners are adequately giving emerging technologies attention, they are prioritizing future problems that do not fully exist ahead of issues that trouble urban residents today. This point does not suggest that planners should discount the importance of planning with emerging technologies such as AVs in mind, but they should balance such consideration with existing conditions, giving priority to the problems that already exist before addressing issues that are likely to emerge, eventually. Although this concern might seem rather straightforward to some people, it is a commonly held attitude that guides transportation planning (Martens 2016).

Consider, for instance, that Karel Martens (2016) argues that making these kinds of decisions are aligned with the typical type of actions that transport planners take when determining a city's transportation future. While it might seem wise to approach planning in this fashion, the problem with this approach is that preexisting issues that concern justice do not receive attention (*ibid.*). Harms that stem from ill-functioning and unjust transportation systems can continue, and the people living with such burdens do not receive much relief (*ibid.*). That is to say, if there is a discrepancy in the distribution of services, an issue that raises concerns for transportation justice, problems could persist indefinitely or worsen (*ibid.*).

Keeping this point in mind, it seems fitting to think that we should abandon the view that AVs can solve all of our transportation issues, making them the center of our thinking on the future of urban mobility. We should not be serving driverless vehicles. They should help us. This idea means that we should focus our efforts on ways to solve problems that currently exist—while keeping a keen eye on the future—a notion that seems consistent with Martens' view mentioned above. If AVs can provide relief to such problems, then there is no good reason why we should not use driverless vehicles to remedy such situations. In turn, thinking about AVs in this manner shows how they can be devices that work toward goals such as urban sustainability and transportation justice, rather than supporting AVs while hoping that they deliver the same results.⁸

Jarret Walker (2009) holds that transport planners should not be advocates for any particular mode of transportation, but instead they focus on the task of human transit. This idea underscores the importance of avoiding placing bets on predictions to come true when it comes to the future of transportation systems and AVs. In turn, discussions about AVs should focus on how or if they should fit in with existing transportation systems, not the opposite. Consider, for instance, that this notion remains consistent with approaches to transportation planning and engineering that champion for a multimodal approach (Litman 2001; Litman 2018). The idea behind such a course would employ modes of transportation that are best suited for the task. This approach is inherently resistant to dogmatic allegiances towards modes of transportation such as horseless carriages and driverless vehicles. It is open to any mode. Yet, engaging in such a practice is sure to raise additional concerns. For example, there are a few instances wherein people have voiced concerns about their lack of meaningful ability to weigh in on decisions that pertain to incorporating AVs into our cities. While such concerns are tangentially related to viewing AVs as utopian solutions, examining them could lead to new discoveries

⁸ To think about transportation justice in terms of theoretical frameworks, see Fraser, N. and Honneth, A. (2003). *Redistribution or recognition?: a political philosophical exchange*. London: Verso.

about driverless vehicles and society. Exploring this line of inquiry could help us learn if people desire AVs in the first place. In the last section, I will explore these possibilities as a way to improve how, when, where, and under what conditions that driverless vehicles are incorporated into existing transportation systems.

Future Research

It seems challenging to put forth arguments holding that residents whose lives will be significantly affected by driverless vehicles should not be able to voice their concerns on the future implementation of these technologies. Bearing in mind that researchers and industry leaders have argued that driverless vehicles will vastly restructure society, such positions imply that quality of life, along with the conditions for it, will drastically change for humankind. This notion has significant importance due to the reality that residents at present do not have the ability to weigh in on decisions that pertain to discovering how these vehicles will work in urban settings.

Concerns such as this one have already raised the ire of some citizens where companies are testing driverless vehicles. Consider, for instance, that Arizona residents have displayed violent behavior toward these technologies, which include slashing AV's tires, throwing rocks at these vehicles, and one man pointed a gun at an AV technician (National Public Radio 2019). While such incidents might give the impression that these people are anti-technology, that is not the motivation behind the attacks. For example, in an interview with *National Public Radio's* program, "All Things Considered," Ryan Ranzazzo (National Public Radio 2019), a reporter for the *Arizona Republic* explains some of the motivation behind people lashing out at AVs:

These events aren't triggered by mistakes on the roadway or [the] way the cars are driving. This is more of a general angst that some people have towards the technology being tested in their community. . . . They might have privacy concerns because there's cameras on these things. . . . [T]hey're often parked in front of people's homes. And people just seem very uncomfortable with this level of technology being tested on their streets.

This interview suggests that the future of research for implementing AVs into cities should include studies that focus on how to develop *meaningful* measures that allow residents to participate in local policies that will govern how AVs will help shape the futures of their cities. Keeping in mind that numerous philosophers are working on the ethics of AVs, shifting their focus to such concerns could benefit the issues mentioned above. Aside from this issue, living in a world that is facing climate change suggests that urban

leadership will have to tackle problems that they are not adequately prepared to fathom. Similar to viewing AVs as parts of the urban mobility puzzle, driverless vehicles can also play a role in other areas such as urban resilience and transportation infrastructure, showing how they will be a significant topic of interest for dealing with natural disasters (Ahmed, Dey, and Fries 2019).⁹ While this subject counts as only one possible concern that could arise, it emblemizes the idea that going against transportation dogma is required for dealing with problems that humankind has not yet encountered. If cities were static, then a permanent solution would make sense. However, as Achille Varzi (2019) notes, cities are an evolving process, always changing. Their transportation systems will, too. Considering that this notion will hold, the task of providing urban dwellers with a mobility system that is built for them has no end in sight.

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⁹ This subject also raises questions for social justice. For more information, see Nagenborg (2019).

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