



A SWOT Analysis of the Implementation of Fully Autonomous Vehicles by Transport for London

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Key Points

- With the potential to reduce road deaths by up to 94%, the implementation of fully autonomous vehicles in public transport must be considered.
- Autonomous transportation would provide enhanced efficiency and accessibility, which may justify the high cost of its development.
- Technological limitations and cybersecurity threats are obstacles in the development of safe autonomous technologies.
- Pre-existing, technical, and emergent bias are all relevant to autonomous vehicle technology and should be actively minimised.
- The wide range of ethical frameworks and values in society make creating a representative algorithm extremely difficult.
- The true environmental impact of autonomous vehicles is unclear and additional research is required to determine how the carbon impact of autonomous transport may be measured.

Overview of Technology

Autonomous Vehicles (AVs) are those which possess self-driving capabilities. SAE International (2021) has defined 6 levels of driving automation where Level 0 provides no automation and Level 5 represents full automation, with increasing quantity and complexity of features at each subsequent level (see Table 1). For clarity, AVs can be categorized as Levels 3-5, containing any ability to self-drive. As a subcategory of AVs, Fully Autonomous Vehicles (FAVs) specifically refer to Level 5 in which no driver is required and all driving operations are carried out using Artificial Intelligence (AI). This report advises Transport for London (TfL) about the possible implementation of FAVs in London's public transport network. Such systems are not currently legal in the UK but may reasonably be implemented as soon as 2027 with the rapid evolution of autonomous transport technologies such as Tesla's 'Robotaxi' and 'Robovan' (Tesla, 2024). The report is also relevant to the Minister for Transport, Department for Transport, and other regulatory bodies that work alongside TfL.

"Such systems are not currently legal in the UK but may be implemented as soon as 2027"



Table 1: Adapted from SAE levels of driving automation (SAE International, 2021)

SAE Levels	SAE Level 0	SAE Level 1	SAE Level 2	SAE Level 3 (AV)	SAE Level 4 (AV)	SAE Level 5 (FAV)
Automation	Human is driving			Human is not driving but must take control when requested	Human is not driving and will never be required to take control	
Features	Warnings and momentary assistance	Either steering or brake/throttle support	Both steering and brake/throttle support	Self-driving but only under certain conditions		Self-driving under all conditions

Strengths & Opportunities

Road Safety

It has been suggested that no automotive technology represents a more significant improvement in road safety than the development of FAVs (Fleetwood, 2016). This is because they have the potential to eliminate road deaths caused by human error, which account for an estimated 88-94% of all road fatalities (GOV.UK, 2022; Evans, 1996). AV technology must develop further to achieve benefits of this magnitude, but even in their current state AV's have been shown to reduce the likelihood of traffic accidents (Abdel-Aty & Ding, 2024) and are estimated to prevent 47,000 serious accidents and save 3900 lives in the UK by 2030 (SMMT, 2024). Transport for London (TfL) is committed to improving road safety, with their "Vision Zero" goal of eliminating all deaths and serious injuries across the transport network. With 252 people involved in a serious accident involving a TfL bus in 2023, significant progress is required (Transport for London, 2024). There is no doubt that the implementation of FAVs across the public transport network will be an essential development towards the Vision Zero goal.

"Even in their current state AVs have been shown to reduce the likelihood of traffic accidents"

Economy

FAV implementation in public transport will also contribute to long-term economic benefits. FAV production is estimated to bring £42 Billion to the UK economy by 2035 and produce 38,000 new skilled jobs (GOV.UK, 2022). Other estimates have suggested a £60 Billion opportunity in the implementation of Connected and Automated Mobility technologies between 2024 and 2040 (SMMT, 2024).

Efficiency

Connected vehicles are those which can communicate with systems outside the car including road infrastructure, traffic updates and other vehicles. FAVs are able to maximise the benefits of connected vehicle features because they can respond to updates in real time without the need to alert a driver. This can help reduce congestion and improve the efficiency of travel (Edward, 2023), allowing for an improved quality of life for commuters using autonomous public transport.

Environmental Benefits

The increased efficiency of FAVs in terms of congestion reduction could help contribute towards environmental targets, reducing urban fuel consumption by between 15% and 60% (Fagnant and Kockelman, 2015; Shladover et al., 2012). This increased efficiency also encourages people to use public transport instead of private cars, providing both environmental benefits and an economic boost to the public transport sector leading to further investment and development.

Accessibility Improvements

A publication by the International Transport Forum (2017) reported on inequality and social inclusion of public transport across 57 countries including the UK. They revealed that areas with high levels of poverty tend to have fewer public transport options, and the options that do exist tend to lack quality and comfort. They also acknowledged that transport fares represent a greater financial burden for those experiencing poverty compared with those who are not. Lack of accessibility to public transport, whether practical or financial, exacerbates the difficulties faced by those in poverty by making it more difficult to find and hold a job. This issue is known as transport poverty and is a widespread issue in the UK (Sun et al., 2021; Lucas, 2009). TfL must consider that the incorporation of FAVs in public transport will reduce labour costs and increase the efficiency of public transport, thus making fares more affordable and encouraging network expansion into underserved areas. This would be a vital development with the ability to assist those living in poverty by improving accessibility.

“The incorporation of FAVs in public transport will reduce labour costs and increase efficiency”

Weaknesses

Cost

Whilst the long-term economic benefits are clear, the initial cost of widespread FAV implementation is extremely high. This is because the government must consider algorithm development, small-scale trials, and legislative updates before implementation begins. It has been estimated that the development and validation of an FAV algorithm may cost over £700 million (McKinsey & Company, 2023). An investment of this scale should have clear justification and represent the priorities of society, particularly since the introduction of FAVs to public transport would be funded by, and implemented for, the public. As emphasized by Kennedy et al. (2022), it is not sufficient to simply communicate plans to the public. Instead, TfL must enter a genuine dialogue with the public to ascertain the true value of the project and the ways in which it may or may not be implemented.

“An investment of this scale should have clear justification and represent the priorities of society”

Technological Limitations

Another limitation of implementing FAVs in London is that, whilst AV technology is improving rapidly, London provides additional challenges due to its highly changeable network including unpredictable weather patterns and heavily pedestrianized areas. Research has found that AVs are currently less safe than human-driven vehicles in highly changeable conditions (Abdel-Aty & Ding, 2024), so it is possible that the highly dynamic environment of London will pose a significant challenge. There are also concerns that the narrow streets and high

quantity of cyclists pose significant risks, making London a “total nightmare” for FAVs (Eliseev, 2019). In lieu of these concerns, there is some technological progress still required before FAVs become reliable enough for widespread use.

Cybersecurity Risks

Due to the increasingly complex and wireless nature of AV software, cybersecurity is also a major consideration. Security researchers have demonstrated on multiple occasions the ease with which software bugs can be exploited in modern AVs (e.g., Eykholt et al., 2018), and there have also been claims of ransomware attacks where criminals have stolen confidential data from KIA motors (Abrams, 2021). A review by Kim et al. (2021) found that cyber-attacks on AVs are an increasing threat and emphasized the need to develop cybersecurity with the assistance of AI. Similarly, Kukkala et al. (2022) proposed that cyber-attacks may become “commonplace” in future AVs, and proposed steps that should be made towards developing secure AV technologies including the use of cybersecurity-aware design practices and advanced threat intelligence with the help of AI. It is vital that TfL considers these practices to ensure the safety and security of their services.

Threats to Society

Algorithmic Bias

Algorithmic bias refers to computer systems which systematically discriminate against individuals or groups. Freidman and Nissenbaum (1996) identified three types of algorithmic bias which materialize in different ways. Pre-existing bias occurs when systems replicate biases that already exist in society or institutions, technical bias occurs because of technical restraints in the hardware or software, and emergent bias arises after the system is deployed, as it interacts with users and society in unanticipated ways.

FAVs are not immune to these types of bias. Liu (2018) highlighted three types of discrimination present in FAVs which draw parallels with the three types of bias identified by Freidman and Nissenbaum. These include:

- 1. The deliberate, systematic privileging of certain persons in the event of an accident, based on pre-existing societal values (a form of pre-existing bias).**
- 2. Discrimination against certain individuals due to limitations in the way the software is coded, as well as the inevitability of trolley-problem scenarios in which the hardware is unable to avoid all casualties, forcing the algorithm to prioritise certain individuals over others (a form of technical bias).**
- 3. The infrastructural changes precipitated by AV's which may introduce or exacerbate discrimination in terms of access to public space (a form of emergent bias).**

Some of these biases have become apparent in recent years. For example, FAV algorithms have been shown to discriminate by age; Li et al. (2024) analyzed deep-learning-based pedestrian detectors used in AVs and found that miss-rates for children were 20.14% higher than those for adults. In this case, the discrimination was an example of technical bias whereby smaller bodies were less easily detected by pedestrian detection systems. Whilst Li et al. did not find any other discriminatory differences in miss-rates, TfL must consider the potential for other biases as FAV algorithms continue to evolve.

It has been suggested that any biases present in these systems will not induce inequality in isolation, but rather interact with existing inequalities to reproduce and deepen their effects (Bates, 2024a; Noble, 2018), and this concept becomes evident when one assesses the biases already present in society. For example, Bigman and Gray (2020) assessed people's attitudes towards situations where an FAV must choose to save one life over another. They found that, in the absence of equal treatment, 79.7% of participants would rather save a high-status individual over a low-status individual, and 94% would rather save a lawful individual over an unlawful one. Given that equal treatment is not always possible in real road accident scenarios, this represents a bias that could realistically be coded into FAV algorithms. This bias against the low-status and unlawful risks racial discrimination as algorithms of criminality have been shown to disproportionately impact Black and Latino individuals (O'Neil, 2016), and these individuals are also more likely to experience poverty (Bright et al., 2023). Thus, any FAV algorithm that makes decisions based on characteristics like criminality and status also has a high risk of exhibiting racial bias. Conversely, an algorithm that prioritises equality by making such decisions at random risks ignoring the values of society.

Ethical Dilemmas

Even without the threat of algorithmic biases, it is impossible to develop an algorithm that caters to the wide range of ethical frameworks and values present in society. For example, an FAV algorithm trained on consequentialist ethics may avoid a group of pedestrians on the road even if it means the mounting the pavement and killing one pedestrian, whereas one trained on deontological ethics may adhere strictly to the law by remaining on the road regardless of the consequences (see Docherty, 2024). This is a long-standing and complex philosophical dilemma that TfL must consider. In any case, it is recommended that FAV algorithms follow both the FATES framework (Wing, 2018) and the EU Artificial Intelligence Act (European Commission, 2024) to ensure optimal transparency and security of algorithms.

“It is impossible to develop an algorithm that caters to the wide range of ethical frameworks and values present in society”

Environmental Cost

As highlighted by Dhar (2020), there exists a duality in terms of the environmental impact of AI. On one hand, AI can increase efficiency in many industries and assist in producing low-emission infrastructure. However, the carbon impact of producing and sustaining AI is extremely high; there are massive amounts of electrical power required to build, maintain and operate AI algorithms (Kirkpatrick, 2023). In terms of FAVs, whilst they may be a more efficient mode of transport than non-autonomous vehicles, and benefit the local environment in that way, there is a massive carbon footprint associated with the AI required to sustain this efficiency. AVs have been referred to as “supercomputers on wheels” (Johnson, 2021) and

AV hardware producer NVIDIA has stated that just one of their AV computers provides processing power “equivalent to that of 150 MacBook Pros” (NVIDIA, 2016). As demonstrated by Sudhakar et al. (2023), the carbon impact of AV algorithms is an under-recognised and unregulated problem; this is due to the lack of research regarding the energy consumption of large AI models, as well as the lack of regulation surrounding carbon emission transparency for AI and computing manufacturers (Kirkpatrick, 2023). Sudhakar et al. estimated that global adoption of AVs would result in computing workloads that far exceed the likes of Facebook, unless the efficiency of the computing hardware can be significantly improved.

There are examples of AI models utilizing nuclear energy (bigscience, 2022), which does not emit carbon, but nuclear energy currently only accounts for around 15% of energy production in the UK, with many existing plants set to close by 2030 (Matthew & Walker, 2022). TfL must consider the carbon impact of the AI to be used in their FAVs, ideally utilizing pre-existing infrastructure and software. Furthermore, organizations like TfL should acknowledge that the environmental impact of their data is a form of power and, as suggested by Bates (2024b), the benefits and harms should be considered in this context. The production of a highly carbon-emitting algorithm for FAVs that benefits inhabitants of a wealthy capital city, whilst those in developing countries are disproportionately impacted by climate change from carbon emissions (Mendelsohn et al., 2006; Brainard et al., 2009) demonstrates an unbalanced power dynamic that may be inconsistent with the United Nations Sustainable Development Goals (United Nations, 2015) which TfL claims to align with (Transport for London, 2024).

Recommendations for Government Policy

- TfL should enter a collaborative dialogue with the public to determine the extent to which FAVs would benefit people. Feedback from the public should be at the forefront of this project and should guide TfL in the allocation of their resources. TfL must be held accountable by communicating the ways in which the needs of the public have informed their decision making, and by providing a detailed account of how this dialogue occurred.
- Cybersecurity is a real threat to FAVs that is likely to become increasingly widespread. Furthermore, The City of London provides additional challenges to AV technology that TfL must not be naïve to. It is the responsibility of TfL to ensure that the technology used in their transport networks is as safe and reliable as possible to maximise its benefits and keep people safe. The technology should undergo rigorous testing and be approved by the Centre for Connected and Autonomous Vehicles, a government organisation that works to ensure the safety of such vehicles.
- It is recommended that FAV algorithms used by TfL follow the FATES framework (Wing, 2018) and the EU Artificial Intelligence Act (European Commission, 2024). Whilst there is currently no UK-equivalent to the EU

AI Act, a principles-based framework is in the process of being developed.

TfL should communicate with the government to ensure that any developments in their FAV technology occur in conjunction with this framework.

- TfL must assess the carbon impact of the AI to be used in their FAVs. Further research will be required to determine this, which may be conducted alongside the Environmental Agency and should be peer-reviewed. TfL must subsequently communicate with the government to ascertain whether FAV implementation would provide a sufficient environmental benefit.

References

- Abdel-Aty, M., & Ding, S. (2024). A matched case-control analysis of autonomous vs human-driven vehicle accidents. *Nature Communications*, 15(1).
- <https://doi.org/10.1038/s41467-024-48526-4>
- Abrams, L. (2021) *Kia Motors America suffers ransomware attack, \$20 million ransom* [Online] Available: <https://www.bleepingcomputer.com/news/security/kia-motors-america-suffers-ransomware-attack-20-million-ransom/>. (Accessed: 8 January, 2025)
- Bates, J. (2024a). *INF6033 Algorithmic bias and discrimination* [powerpoint slides]. Blackboard. <https://vle.shef.ac.uk/>
- Bates, J. (2024b). *INF6033 Thinking like a social scientist: data, power and society* [powerpoint slides]. Blackboard. <https://vle.shef.ac.uk/>
- Bigman, Y.E., Gray, K. Life and death decisions of autonomous vehicles. *Nature* 579, E1–E2 (2020). <https://doi.org/10.1038/s41586-020-1987-4>
- bigscience/bloom-1b7 (2022). Huggingface.co. <https://huggingface.co/bigscience/bloom-1b7>
- Brainard, L., Jones, A. and Purvis, N. (2009) *Climate change and global poverty: a billion lives in the balance?* 1st ed. Washington, D.C.: Brookings Institution Press.

<https://books.google.co.uk/books?hl=en&lr=&id=roQ-5enJpesC&oi=fnd&pg=PP1&dq=Brainard>

Bright *et al.* (2023) *The fear of too much justice: race, poverty, and the persistence of inequality in the criminal courts*. New York, NY: The New Press.

<https://search.proquest.com/openview/3b19c8a50f439f9a55af7a4c1ed22328/1?pq-origsite=gscholar&cbl=35991>

C. Matthew and A. Walker (2022), “Nuclear energy in the UK”, post.parliament.uk,

<https://doi.org/10.58248/PN687>

Dhar, P. The carbon impact of artificial intelligence. Nat Mach Intell 2, 423–425 (2020).

<https://doi.org/10.1038/s42256-020-0219-9>

Docherty, N. (2024). INF6033 Legal Developments and Ethical Practice [powerpoint slides].

Blackboard. <https://vle.shef.ac.uk/>

Edward, K. (2023, July 29). *Goodbye Gridlock: How Autonomous Vehicles Can Revolutionize City Living*. Forbes. <https://www.forbes.com/sites/kyleedward/2023/07/29/goodbye-gridlock-how-autonomous-vehicles-can-revolutionize-city-living/>

Eliseev, A. (2019, May 31). *Why London’s streets are a total nightmare for self-driving cars*.

WIRED. <https://www.wired.com/story/driverless-cars-london-challenges-ai/> (Accessed: 10 January, 2025)

European Commission. (2024, October 14). *Regulatory framework on AI | Shaping Europe's digital future*. European Commission. <https://digital-strategy.ec.europa.eu/en/policies/regulatory-framework-ai>

Evans, L. (1996). The dominant role of driver behavior in traffic safety. *American Journal of Public Health*, 86(6), 784–786. <https://doi.org/10.2105/ajph.86.6.784>

Eykholt, K., Evtimov, I., Fernandes, E., Li, B., Rahmati, A., Xiao, C., Prakash, A., Kohno, T., & Song, D. (2018). *Robust Physical-World Attacks on Deep Learning Visual Classification*. Openaccess.thecvf.com. https://openaccess.thecvf.com/content_cvpr_2018/html/Eykholt_Robust_Physical-World_Attacks_CVPR_2018_paper.html

Fagnant, D. J., & Kockelman, K. (2015). Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. *Transportation Research Part A: Policy and Practice*, 77, 167–181. <https://doi.org/10.1016/j.tra.2015.04.003>

Fleetwood, J. (2017). Public Health, Ethics, and Autonomous Vehicles. *American Journal of Public Health*, 107(4), 532–537. <https://doi.org/10.2105/ajph.2016.303628>

GOV.UK (2022). *Self-driving buses, shuttles and delivery vans could soon hit UK roads thanks to £40 million government-funded competition*. GOV.UK.

<https://www.gov.uk/government/news/self-driving-buses-shuttles-and-delivery-vans-could-soon-hit-uk-roads-thanks-to-40-million-government-funded-competition>

ITF (2017), *Income Inequality, Social Inclusion and Mobility*, ITF Roundtable Reports, No. 164, OECD Publishing, Paris, <https://doi-org.sheffield.idm.oclc.org/10.1787/g2g7ae77-en>.

Johnson, K. (2021). *Why Not Use Self-Driving Cars as Supercomputers?* Wired.
<https://www.wired.com/story/use-self-driving-cars-supercomputers/>

Kennedy, H., Oman, S., Ditchfield, H., Taylor, M., Bates, J., Medina-Perea, I., Pinney, L., Fratczak, M. (2022). Data Matters Are Human Matters. University of Sheffield.
<https://livingwithdata.org/project/wp-content/uploads/2022/10/LivingWithData-end-of-project-report-24Oct2022.pdf>

Kim, K., Kim, J. S., Jeong, S., Park, J.-H., & Kim, H. K. (2021). Cybersecurity for autonomous vehicles: Review of attacks and defense. *Computers & Security*, 103(103), 102150.
<https://doi.org/10.1016/j.cose.2020.102150>

Kirkpatrick, K. (2023). The Carbon Footprint of Artificial Intelligence. *Communications of the ACM*, 66(8), 17–19. <https://doi.org/10.1145/3603746>

Kukkala, V. K., Thiruloga, S. V., & Pasricha, S. (2022). Roadmap for Cybersecurity in Autonomous Vehicles. *IEEE Consumer Electronics Magazine*, 1–1.

<https://doi.org/10.1109/mce.2022.3154346>

Lucas, K., Tyler, S., & Christodoulou, G. (2009). Assessing the “value” of new transport initiatives in deprived neighbourhoods in the UK. *Transport Policy*, 16(3), 115–122.

<https://doi.org/10.1016/j.tranpol.2009.02.004>

McKinsey & Company. (2023, January 6). *Autonomous driving's future: Convenient and connected*. <https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/autonomous-drivings-future-convenient-and-connected>

Mendelsohn, R., Dinar, A., & Williams, L. (2006). The distributional impact of climate change on rich and poor countries. *Environment and Development Economics*, 11(2), 159–178. <https://doi.org/10.1017/s1355770x05002755>

Noble, S. U. (2020). Algorithms of Oppression. *Algorithms of Oppression*.
<https://doi.org/10.18574/nyu/9781479833641.001.0001>

NVIDIA Newsroom. (2016). *NVIDIA Boosts IQ of Self-Driving Cars With World’s First In-Car Artificial Intelligence Supercomputer*. NVIDIA Newsroom Newsroom.
<https://nvidianews.nvidia.com/news/nvidia-boosts-iq-of-self-driving-cars-with-worlds-first-in-car-artificial-intelligence-supercomputer>

O'Neil, C. (2016) *Weapons of math destruction: how big data increases inequality and threatens democracy*. UK: Allen Lane.

SAE International. (2021, April 30). *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles - SAE International*.
https://www.sae.org/standards/content/j3016_202104/

Shladover, S. E., Su, D., & Lu, X.-Y. (2012). Impacts of Cooperative Adaptive Cruise Control on Freeway Traffic Flow. *Transportation Research Record: Journal of the Transportation Research Board*, 2324(1), 63–70. <https://doi.org/10.3141/2324-08>

Society of Motor Traders and Manufacturers (2024). *Connected and automated mobility revolution set to deliver £66 billion prize by 2040*. (2023, November 1). SMMT.
<https://www.smmt.co.uk/2023/11/connected-and-automated-mobility-revolution-set-to-deliver-66-billion-prize-by-2040/>

Sudhakar, S., Sze, V., & Karaman, S. (2022). Data Centers on Wheels: Emissions From Computing Onboard Autonomous Vehicles. *IEEE Micro*, 1–12.
<https://doi.org/10.1109/mm.2022.3219803>

Sun, Y., & Thakuriah, P. (Vonu). (2021). Public transport availability inequalities and transport poverty risk across England. *Environment and Planning B: Urban Analytics and City Science*, 48(9), <https://doi.org/10.1177/2399808321991536>

Tesla. (2024). *We, Robot* | Tesla United Kingdom. Tesla. https://www.tesla.com/en_gb/we-robot (Accessed: 10 January, 2025)

Transport for London (2024). *New statistics show lowest number of people killed on London's roads outside of pandemic years*. Transport for London. <https://tfl.gov.uk/info-for/media/press-releases/2024/may/new-statistics-show-lowest-number-of-people-killed-on-london-s-roads-outside-of-pandemic-years>

Transport for London (n.d.). Sustainability. Transport for London.
<https://tfl.gov.uk/corporate/about-tfl/sustainability?intcmp=67777> (Accessed: 10 January, 2025)

United Nations. (2024). *The 17 Sustainable Development Goals*. United Nations.
<https://sdgs.un.org/goals>

Wing, J (2018). *Data for Good: FATES, Elaborated*. (2018, January 23). The Data Science Institute at Columbia University. <https://datascience.columbia.edu/news/2018/data-for-good-fates-elaborated/>

Google Gemini response to “Provide a SWOT analysis of fully autonomous vehicles”:

Strengths:

- Enhanced Safety: AVs have the potential to significantly reduce accidents caused by human error, such as distracted driving, drunk driving, and fatigue.
- Increased Accessibility: AVs can provide transportation for people who are unable to drive, such as the elderly, disabled, or those without licenses.
- Improved Efficiency: AVs can optimize traffic flow, reduce congestion, and minimize fuel consumption.
- Reduced Emissions: AVs can contribute to a cleaner environment by reducing carbon emissions and improving air quality.
- Productivity Gains: Passengers can use travel time for other activities, such as working or relaxing, leading to increased productivity.

Weaknesses:

- High Initial Costs: The development and manufacturing of AVs are expensive, making them currently unaffordable for most consumers.
- Technological Limitations: Current AV technology is still under development and faces challenges in handling complex driving scenarios, such as adverse weather conditions and unexpected obstacles.
- Ethical Concerns: Issues related to liability, privacy, and data security need to be addressed before widespread adoption of AVs.
- Job Displacement: The widespread adoption of AVs could lead to job losses in the transportation industry, such as taxi drivers and truck drivers.
- Public Perception: Public acceptance of AVs is still evolving, with concerns about safety and reliability.

Opportunities:

- New Business Models: AVs can create new business models in transportation, such as ride-sharing services, autonomous delivery, and on-demand mobility.
- Economic Growth: The development and deployment of AVs can stimulate economic growth and create new jobs in related industries.

- Improved Quality of Life: AVs can enhance the quality of life for individuals and communities by providing safer, more convenient, and more affordable transportation options.
- Infrastructure Development: The deployment of AVs can drive the development of smart cities and intelligent transportation infrastructure.
- Global Leadership: Countries that lead in the development and deployment of AVs can gain a competitive advantage in the global economy.

Threats:

- Cybersecurity Risks: AVs are vulnerable to cyberattacks, which could compromise their safety and security.
- Regulatory Challenges: The development and deployment of AVs face complex regulatory challenges, including legal liability, data privacy, and safety standards.
- Competition: The global race for AV development is intense, with many companies and countries competing for market share and technological leadership.
- Unforeseen Consequences: The widespread adoption of AVs could have unforeseen consequences, such as social disruption and environmental impacts.
- Public Resistance: Public resistance to AVs could hinder their adoption and limit their potential benefits.