DOI: https://doi.org/10.52968/15065538
ISSN: 2805-3346

RESEARCH ARTICLE

Autonomous Cars and Sustainable Land Development in Nigeria

Love Gbenga-Fabusiwa

Afe Babalola University, Ado-Ekiti, Ekiti State, Nigeria

ABSTRACT

Self-driving car technology is no longer a novel idea. Given the rate at which the technology is developing, fully autonomous cars are predicted to become readily available over the next three decades. Self-driving vehicles offer numerous advantages, such as significantly reduced accidents, provision of automobile access to disabled people, traffic efficiency, easy parking and safety of movement. On a global scale, self-driving vehicles are being investigated to determine the legal, ethical and economic implications of their use. The widespread adoption of autonomous vehicles will undoubtedly alter land use and influence the interpretation of relevant land laws. It will also require major adjustments to the way roads are designed. The aim of this research is to examine the link between the transportation infrastructure readjustments required for the deployment of self-driving cars and sustainable land development in Nigeria. This study adopted the doctrinal research methodology, using qualitative research techniques to analyse primary sources of law such as the Nigerian Constitution, 1999, and the Land Use Act, as well as secondary sources of law such as books written by renowned scholars, peer-reviewed journals on self-driving cars and relevant policy frameworks to actualise its objectives. The study noted that transportation and land use are intertwined, as transportation infrastructure is one of the key amenities affecting the environment, community wellness, and land development. It is also notes that the introduction and adoption of self-driving cars will impact the growth of urban areas since the use of these vehicles will lead to more effective construction of infrastructure comprising parking lots, bridges, tunnels, railways, buildings, and roads. It is important to add, however, that the use of self-driving cars may influence the decision made by families regarding the proximity of their place of employment and their place of residence. Since passengers can focus on other tasks while in an autonomous vehicle, long trips will be considered less demanding. As a result, families may be more inclined to relocate away from urban areas and settle in places where land and rent are significantly cheaper. Thus, this research concludes that the rapid advancement of self-driving technology will result in foreseeable changes in land use, planning, and design. Therefore, the study recommends sufficient planning that will involve the modification of road infrastructure and the adjustment of policies that will enhance the functionality of self-driving cars and satisfy the specific demands of autonomous vehicles.

Received: 16 October 2024

Revised: 29 June 2025

Accepted: 27 July 2025

Published: 6 November 2025

Cite article as: Gbenga-Fabusiwa, L. (2025). Autonomous Cars and Sustainable Land Development in Nigeria. *African Journal of Housing and Sustainable Development, 6*(1), pp. 116-125.

Corresponding author: gbengafabusiwala@abuad.edu.ng

Keywords: Land, Self-driving cars, Sustainable land development, Transportation, Urban

1.0 Introduction

Since the invention of the first vehicle in the early 1800s, engineers, government officials and road designers have continuously reconsidered their approach to road construction and adopted fresh perspectives on infrastructure development. The era of short commutes and pedestrian pathways evolved into an age of broad roads, transnational routes and suburban expansion (Radwan, 2022). Today, we have entered a new era, as autonomous vehicles are already here and will be available globally in a few decades (Pisarov, 2020; UltraDrift, 2016). While some of such cars are already in the country, their use has not yet generally been permitted on public roads, owing to safety concerns. While there are discussions and potential for testing and pilot programmes, the current legal framework and infrastructure may not be suitable for handling autonomous vehicles safely and effectively.

No doubt, the introduction of self-driving vehicles will affect almost all aspects of our lives. It will significantly impact the expansion of the transportation sector and the development of sub-urban and urban areas. Specifically, the adoption of autonomous vehicles will influence human movement and transportation within cities by decreasing the need for personal vehicles, thus reducing road congestion and travel expenses. In the long run, it will lower the demand for parking facilities, increase network capacity and foster the decentralised development of cities (Rahman, 2023). It is therefore imperative to consider the potential impact of these technologies on sustainable land development. In that regard, this study will examine the effects of autonomous vehicles on urban land development.

2.0 Materials and Methods

This study adopted the doctrinal research methodology, using primary and secondary law sources to investigate the effects of self-driving cars on urban land development and urban land policies. Primary law sources such as the Constitution of the Federal Republic of Nigeria (1999, as amended) and the Land Use Act, as well as secondary sources such as books written by renowned scholars, peer-reviewed journal articles on self-driving cars and urban land development were consulted, alongside an assessment of relevant policy frameworks. The research placed particular emphasis on the implications of widespread use of self-driving vehicles on urban areas, especially in terms of parking facilities, public transport systems and the anticipated shifts in residential patterns as families rethink the place of proximity in their living arrangements. By applying these insights, the researcher seeks to contribute to the broader discourse on urban and land-use planning as well as the future of transportation in a rapidly evolving technological landscape.

Brief Overview of Self-Driving Cars

Generally, a vehicle is deemed autonomous if it can function for an extended duration without needinga human operator (Bartneck, 2021). Self-driving vehicles are equipped with the capacity to perceive their surroundings and navigate within designated lanes without human input (Yoganandhan, 2020). They use digital technologies to operate independently, hence their ability to drive and move on roadways by sensing environmental conditions. Their design is aimed at minimising road space, mitigating traffic congestion and reducing accident risks (Szikora, 2017).

According to SAE International, there are six levels of vehicle automation: zero to five. At level zero, the vehicle exhibits no automation whatsoever. Levels one and two pertain to semi-autonomous vehicles, which require a human driver to maintain a degree of engagement while the vehicle is in operation. Level three signifies vehicles with conditional automation, while level four are for vehicles equipped with high driving automation (Krysiuk, 2021). Level five means full driving automation, wherein the driver is not required to maintain control. Once an autonomous vehicle attains level five, it is presumed capable of operating independently under all conditions (Rosemadi, 2022).

Self-driving vehicles have a range of sensors and technologies for achieving autonomy (Campbell, 2018).One of such technologies is Light Detection and Ranging (LIDAR), a remote sensing technique that uses light beams to highlight an object and then examine its reflections to create a real-time three-dimensional map of the surrounding area (Bimbraw, 2015). LIDAR combines an emitter, a mirror and a receiver to create a comprehensive 360-degree mapping of the road structure (Yun, 2019). Another sensor deployed by self-driving vehicles is Radio Detection and Ranging (RADAR), which estimates the relative velocity between the vehicle and any potentially intrusive object, using electromagnetic waves (Ondrus, 2020). Unlike LIDAR, RADAR is limited in its ability to delineate the shape of the scanned area (Sarkan, 2017).

Autonomous vehicles also use ultrasonic sound waves to detect nearby obstacles and map out the surrounding environment (Raza, 2018). Video cameras are positioned near the rear-view mirror to provide a multidimensional, real-time image of the route ahead, thus allowing for the identification of potential hazards, including passersby and animals. These cameras also facilitate the recognition of road markings, such as lane delineations, signboards and traffic signals (Megha, 2019). Additionally, autonomous vehicles rely on the Global Positioning System (GPS) to obtain location information, including longitude and latitude, from satellites (Zhao, 2018). These vehicles are in use in many countries, e.g., the United Kingdom, Germany, China, and Japan. Some autonomous vehicles have also been found in Lagos, Nigeria. (Ultra Drift, 2019).

3.0 Urban Land Policies in Nigeria

Land is one of nature's most contentious assets and a resource of paramount significance upon which the entire economy of a nation relies. As such, any regulation concerning land can have either a positive or negative impact on the nation's economy, depending on how it is implemented (Uzoamaka, 2021). A piece of land is deemed urban if it is occupied by cities, towns, business organisations or semi-dense areas (Dijkstra, 2021). Urban development is often characterised by the establishment of policies, it encompasses a rise in population, expanding urbanisation, environmental concerns, the hunt for sustainability, and advancements in technology (Awuah, 2022).

It is worth noting that effective management and oversight of land ownership, possession and use cannot be accomplished without well-structured land laws and their efficient implementation (Ugonabo, 2023). In Nigeria, Section 43 of the 1999 Constitution is the fundamental law that guarantees the right of every citizen to own and acquire immovable property anywhere within the country. Similarly, Section 1 of the Land Use Act provides that every piece of land that is part of a state's territory in the federation belongs to the governor of that state and is held in trust and managed for the benefit of all Nigerians. Specifically, Section 2 vests the control and management of all urban areas in the governor of each state, while the local government in the area where the land is located is in charge of managing all other land.

However, it must be noted that the Land Use Act has not adequately established viable and sustainable mechanisms for land delivery (Kuma, 2017). Otubu (2018) identifies some gaps in the administration of the Act, noting that the administrative framework established by the Act lacks coherence and clarity in its functions and objectives, hence the need for legislative intervention to amend the Act's provisions. Udoekanem (2014) observes that the Act has unintentionally created various forms of tenure in an effort to unify the multiple land tenure systems that were previously in operation. This has resulted in concerns regarding the rights of occupancy conferred by the Act and the undue bureaucracy faced in gaining the governor's approval. Despite this, the reality is that the only specific federal land law in Nigeria remains the Land Use Act, 2004.

In addition to the Land Use Act, the National Building Code provides guidelines for the design of buildings, parking garages, public streets, and various other facilities. However, these regulations were primarily formulated with human users in mind, as autonomous vehicles had not emerged at the time. Undoubtedly, therefore, the advancement of self-driving car technology will induce drastic changes in the design of facilities, as infrastructure will henceforth have to be less human-centric to effectively adapt to autonomous driving (Radwan, 2022).

Furthermore, the increasing prevalence of self-driving vehicles will necessitate the construction of infrastructure not currently addressed by the building code. One such requirement is the development of charging stations for autonomous vehicles at various locations. The entrances of commercial buildings will also need to be redesigned to incorporate drop-off points where autonomous vehicles can safely discharge passengers before proceeding to their next destination (Stein, 2021). Moreover, the spread of autonomous vehicles will require the establishment of intelligent transportation systems, including smart traffic signals and vehicle-to-infrastructure communication networks.

4.0 Discussion

The development of land in urban areas will inevitably be impacted by the expanding use of self-driving cars. However, there have been arguments as to whether the disadvantages involved in the use of self-driving vehicles negate the impact that such vehicles will have on sustainable land development. One of these disadvantages include the lack of liability in the event of an accident involving autonomous vehicles. In simpler terms, who will be held liable if an autonomous vehicle is involved in an accident? Or who will be held liable if a car, driving itself, crashes into a major infrastructure as a result of some software glitch? While some scholars have argued that the manufacturer should bear such liability (Uzair, 2021), others believe it should be borne by the software developer (Gurney, 2013). Yet other scholars argue that the owner should bear the responsibility (Pagallo, 2013).

Accordingly, this study calls attention to the impact of self-driving vehicles on sustainable land development. As already observed, autonomous vehicles will significantly contribute to changes in road design, urban sprawl, re-purposing of parking facilities, migration, and changes in land laws.

Parking Spaces

It is clear that the average automobile spends over ninety percent of its lifetime parked. Nowadays people prefer to keep their private cars as close to themselves as possible, hence their utilization of spaces in the home, office, market or other locations that they visit (Levinson, 2015). Consequently, the demand for vehicle storage facilities has surged, prompting the construction of multiple car parks on valuable land (Nourinejad, 2018). However, the use of self-driving vehicles has made it possible for commercial autonomous cars to pick up passengers from their locations, transport them to their destinations and swiftly attend to the next passenger without any requirement for parking (Othman, 2022). Personal self-driving cars may opt to return home until the owner is ready to be picked up. In the light of this, it is evident that the need for roadside parking will decline dramatically with the integration of self-driving cars (Ribeiro, 2023).

The widespread use of these vehicles will not only decrease the need for parking facilities but will also present opportunities for repurposing existing spaces, potentially enhancing living standards within communities (Huajun, 2023). Vacating spaces that are being used for parking can facilitate operational improvements, attract investments in infrastructure and lead to modifications of land-use patterns and design (Fagnant, 2015). These car parks may be converted to urban gardens or to make space for additional roads (Nikhil, 2020). They could also be transformed to new public spaces for sustainable modes of transport such as bridges, tunnels and railways (Kirschner, 2020), green areas, extra lanes for traffic or sections designated for bikes or pedestrians (Silva, 2021).

Furthermore, converting parking areas into roadways will enhance mobility, which has historically contributed to urban development and expansion (Levinson, 2015). In view of this, it is essential for urban planners and policymakers to evaluate the implications of autonomous vehicles for parking infrastructure and land use in order to them to effectively adapt to these coming changes (Nikhil, 2020). In summary, the adoption of self-driving cars will result in fewer parking spaces, a situation that will have a huge impact on the layout of cities and how land is used (Zhang, 2017).

Migration

Self-driving vehicles classified as Level 3 and above are expected to decrease the amount of overall driving time or time related to driving activities (Skarbek-Zabkin, 2018). This transition allows drivers – now functioning as passengers – the opportunity to engage in alternative activities during their trips (Anderson, 2016). Time being a crucial commodity, autonomous vehicles will afford people more productive time (Lyons, 2007). Additionally, the capacity of self-driving vehicles to operate in close proximity and navigate narrower lanes is expected to reduce road congestion (Adam, 2019).

The combination of these two factors may encourage commuters to extend their travel distances to and from work, resulting in a tendency to reside further from urban centres. Indeed, the advent of autonomous vehicles is set to transform urban communities, as individuals and families may seek to relocate from central cities to more affordable areas (Nikhil, 2020). The underlying rationale for this shift is that if individuals can work while travelling, the perceived value of saving time diminishes compared to when they must concentrate solely on driving. Conversely, some scholars argue that the increase in travel demand may ultimately negate the time and cost savings associated with self-driving vehicles in the long term (Milakis, 2018). Nonetheless, at present, the reduction in travel time is likely to foster a willingness to live in locations farther from the workplace (Levinson, 2015).

Road Designs

Historically, road networks have been designed with human drivers as the primary consideration. The majority of road designs reflect the characteristics of human drivers, including factors such as reaction time and eye height, which significantly influence how roads and highways are structured (Othman, 2021).This indicates that the integration of autonomous vehicles into road systems will necessitate modifications to road design, as existing standards and guidelines may need to be revised and certain driver-centred requirements may become less relevant in the context of self-driving vehicles (Intini, 2019). Consequently, the transition from conventional vehicles to autonomous cars is likely to prompt changes in road geometric design parameters, including lane width and stopping sight distance (Pham, 2021).

Another crucial matter in driving is the stopping sight distance, which is the distance required by drivers to safely come to a complete stop in the event of a dire situation (Gargoum, 2020). It comprises the sum of distance travelled during the reaction time and the braking time (Ivancev, 2022). Research indicates that the average reaction time for human drivers is approximately two seconds, although it can be slightly less (Fambro, 1998).In contrast, autonomous vehicles are expected to demonstrate significantly faster reaction times. Dixit (2016) posits that the average reaction time for a self-driving car to regain control after disengagement is approximately 0.83 seconds. Othman (2021) suggests that the reaction time could be 0.5 seconds and Aryal (2020) offers a more aggressive reaction time of 0.2 seconds. These varying estimates underscore the necessity of re-assessing human driver characteristics as the market penetration of self-driving vehicles increases. It is therefore imperative to revise the road geometric design and associated guidelines, as certain driver-based requirements may diminish as a result of the shift from conventional to automated driving (Tenglimoglu, 2023).

Urban Sprawl

Urban sprawl refers to a pattern of unregulated development on the outskirts of a city. This concept entails a developmental process that alters land use patterns, resulting in a diverse array of shapes and sizes (Yasin, 2021). It can be characterised as the swift rise of towns or cities in undeveloped land surrounding a relatively populated city (Resnik, 2010). Urban sprawl often manifests as low-density residential developments, featuring clusters of population and economic activities at the urban fringe, which may lead to the establishment of business enterprises such as office buildings, retail spaces and even manufacturing facilities. It can also result from the sporadic construction of individual homes across previously rural landscapes (Nechyba, 2004). It bears noting that while these areas have lost their rural attributes, they cannot yet be classified as fully urban (Zuhal, 2016).

It has been previously established that the integration of self-driving vehicles will result in migration from urban centres to low-income housing on the outskirts, as commuters may be more inclined to travel longer distances while engaging in productive activities during their journey (Nikhil, 2020). This shift will cause less densely populated areas to become significantly more populated and developed, a situation that can contribute to urban sprawl (Milakis, 2018).The anticipated increases in travel utility resulting from self-driving vehicles will predominantly benefit suburban and exurban regions by improving job accessibility, potentially driving further urban sprawl in cities (Pimenta, 2023). In the end, self-driving cars will induce individuals' willingness to commute across longer distances, leading to possible sprawl aggravation and complication in the process of providing adequate transit services (Gruel, 2016).

Changes in Land Laws

Autonomous vehicles will significantly alter land use and the legal frameworks governing real estate. As previously noted, the prevalence of self-driving cars will result in a marked reduction in the necessity for parking facilities (Tscharaktschiew, 2022). Self-driving cars will drop off passengers at their destinations and subsequently navigate to remote parking areas, creating opportunities for the repurposing of spaces that were previously used as car parks (Heinrichs, 2016). This shift will necessitate significant modifications in roadway design (Park, 2021). Increased adoption of autonomous cars will also promote shared mobility, potentially replacing individual vehicle ownership with fleet-based systems (Othman, 2022). Concurrently, individuals will become more amenable to longer commutes, utilising this time for work while travelling (Zhong, 2020).

These changes associated with the use of self-driving vehicles will demand corresponding adjustments in urban policies and land-use law (Levine, 2023). For example, zoning regulations and building guidelines will require updates to accommodate the evolving parking landscape. The prospect of extended commutes may also necessitate more stringent environmental regulations. Jurisdictions must navigate these developments amidst considerable uncertainty, as the future adoption of various technologies remains unpredictable (Stein, 2021). Nonetheless, it is essential for government entities to modernise land-use laws to align with this technological and societal transformation.

One of the first countries to amend their road laws as a result of the rapid development of autonomous vehicles is Germany. The German Road Traffic Act was amended by Article 2 of the Act of 12 July 2021 through the insertion of sections 1d–11(Sever, 2024).Specifically, this section defines an autonomous vehicle to mean a motor vehicle that is able to autonomously perform the driving task in a determined operational area without the involvement of a driver; the vehicle must have satisfied the required conditions as provided by the Act. The determined operational area has also been defined by the Act to mean the geographically and spatially delimited public road environment in which a motor vehicle with autonomous driving functions is permitted to operate if the requirements set out in the Act are met. Additionally, if the requirements set out in the Act are met, the Federal Motor Transport Authority is expected to grant an operating permit for an autonomous vehicle upon request by the manufacturer. The filing of the application and the approval procedures have all been provided for in the amended Act.

In Japan, the regulations guiding traffic and traffic-related offences are contained in the Road Traffic Vehicle Act and the Road Traffic Act (Imai, 2019). These laws have been amended to accommodate autonomous vehicles (Chinen, 2024). One of these amendments is the addition of the term 'automatic operating device' to the inventory of equipment that, if installed in a vehicle, must meet safety standards. Specifically, Section 41 states that a driving recording device is a requirement for any vehicle equipped with an automatic operating mechanism. The Ministry of Land, Infrastructure, Transport and Tourism is empowered to set the conditions of use for each autonomous driving device based on the performance of the said device. The Road Traffic Vehicle Act also introduced the concept of specified maintenance, that is, the maintenance necessary for achieving autonomous driving (Section 49).

5.0 Recommendations

Self-driving vehicles are advancing rapidly, with their influence on urban policies and land development being unavoidable. The most prudent approach is to proactively adapt to these changes. Thus, this study recommends comprehensive planning to optimise the functionality of self-driving cars. A first step would be to revise policies by making them less human-centric and more accommodating to autonomous vehicles. Also recommended it the establishment of legal frameworks that facilitate the seamless incorporation of autonomous vehicles into current transportation systems. Such policies steps could include offering incentives to developers for providing infrastructure that supports self-driving cars, including dedicated drop-off zones and charging stations.

Additionally, urban planners should integrate the anticipated effects of self-driving vehicles into long-term land use and development strategies. This integration involves identifying opportunities to repurpose existing parking facilities into mixed-use spaces and green areas, thereby promoting more efficient land use. This study also stresses the need to modify infrastructure, e.g. roadways, to meet the specific requirements of autonomous vehicles. Cities should prioritise the development and installation of smart traffic lights and vehicle-to-infrastructure communication networks, while updating road signage to enhance safety and efficiency for autonomous vehicles.

6.0 Conclusion

The emergence of self-driving cars presents a profound opportunity to reshape urban land development in ways that enhance efficiency, accessibility and sustainability. As this technology continues to evolve, it is clear that its integration into urban environments will necessitate a re-evaluation of existing infrastructure, land-use patterns and transportation policies. The findings of this study show that self-driving vehicles could significantly reduce the demand for parking spaces, enabling cities to repurpose valuable land for more productive uses, such as parks and mixed-use developments.

Furthermore, the potential for improved traffic flow and increased accessibility highlights the importance of designing urban spaces that are inclusive and accommodating to all residents. However, realising these benefits will require proactive planning and collaboration among stakeholders, including urban planners, policymakers and community members. Navigating the complexities associated with the rise of autonomous vehicles will require a comprehensive approach. This includes the development of supportive infrastructure, investment in intelligent transportation systems and the establishment of clear regulatory frameworks. By embracing these changes, cities can create environments that not only meet the demands of emerging technologies but also enhance the quality of life for their inhabitants.

In conclusion, the impact of self-driving cars on urban land development represents both a challenge and an opportunity. With thoughtful planning and implementation, cities can transform this technological advancement into a catalyst for sustainable urban growth, paving the way for a future that is both innovative and equitable.

References

Adam, M. B. (2019).The autonomous vehicle parking problem. *Transport Policy, 75*(1), 99-108. http://dx.doi.org/10.1016/j.tranpol.2019.01.003.

Anderson, J. M., Nidhi K., Stanley, K. D., Sorensen, P., Samaras, C., & Oluwatola, A. O. (2016). *Autonomous Vehicle Technology: A Guide for Policy Makers*. RAND Corporation. https://www.rand.org/pubs/research_reports/RR443-2.html.

Aryal, P. (2020). *Optimization of geometric road design for autonomous vehicle*. [Degree Project, KTH Royal Institute of Technology].

Awuah, K. G. B., & Abdulai, R. T. (2022). Urban land and development management in a challenged developing world: An overview of new reflections. *Land*, 11 (1), 129. https://doi.org/10.3390/land11010129.

Bartneck, C., Lütge, C., Wagner, A., & Welsh, S. (2021). *An Introduction to Ethics in Robotics and AI.* Springer, Cham. https://doi.org/10.1007/978-3-030-51110-4_10.

Bimbraw, K. (2015, July 21-23). *Autonomous cars: Past, present and future - A review of the developments in the last century, the present scenario and the expected future of autonomous vehicle technology*. [Conference session]. 12th International Conference on Informatics in Control, Automation and Robotics, Colmar, Alsace, France. https://doi.org/10.5220/0005540501910198.

Campbell, S., O'Mahony, N., & Ors. (2018, June 21-22). *Sensor Technology in Autonomous Vehicles: A review.* [Conference session]. 29th Irish Signals and Systems Conference, Belfast, UK. https://doi.org/10.1109/ISSC.2018.8585340.

Chinen, K., Matsumoto, M., Chinen, A. (2024) Navigating the landscape of autonomous buses:

insights in Ibaraki, Japan. *Sustainability*, 16(8), 3351. https://doi.org/10.3390/su16083351.

Constitution of the Federal Republic of Nigeria1999 (Cap C23, Laws of the Federation of Nigeria).

Dijkstra L., Florczyk A. J., Sergio Freire S., Thomas Kemper T., Michele Melchiorri M., Pesaresi M., & Schiavina M. (2021). Applying the degree of urbanisation to the globe: A new harmonised definition reveals a different picture of global urbanization. *Journal of Urban Economics*, 125 (1), 103312. https://doi.org/10.1016/j.jue.2020.103312.

Dixit, V. V., Chand, S., & Nair, D.J. (2016). Autonomous vehicles: Disengagements, accidents and reaction times. Plos One 11(2) https://doi.org/10.1371/journal.pone.0168054.

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 (1), 167-181. http://dx.doi.org/10.1016/j.tra.2015.04.003.

Fambro, D. B., Koppa, R. J., Picha, D. L., & Fitzpatrick, K. (1998). Driver perception–brake response in stopping sight distance situations. *Transportation Research Record*, 1628(1), 1-7. https://doi.org/10.3141/1628-01.

Faster Capital. *The impact of vehicles on infrastructure development*. Retrieved September 22, 2024, from https://fastercapital.com/topics/the-impact-of-vehicles-on-infrastructure-development.html/1.

Gargoum, S. A., & El-Basyouny, K. (2020). Analyzing the ability of crash-prone highways to handle stochastically modelled driver demand for stopping sight distance. *Accident Analysis & Prevention*, 136 (1), 105395. https://doi.org/10.1016/j.aap.2019.105395.

Gruel, W., & Stanford, J.M. (2016). Assessing the long-term effects of autonomous vehicles: a speculative approach. *Transportation Research Procedia*, 13 (1), 18-29. https://doi.org/10.1016/j.trpro.2016.05.003.

Gurney, J. K. (2013). 'Sue my car not me: products liability and accidents involving autonomous vehicles' *University of Illinois Journal of Law, Technology and Policy*247.

Heinrichs, D. (2016). Autonomous Driving and Urban Land Use. In: Maurer, M., Gerdes, J., Lenz, B., & Winner, H. (Eds.), *Autonomous Driving*. (pp. 213-231). Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-662-48847-8_11.

Huajun, C., Caroline, J. E., Jeffery, W. S., Michael, H. Z., & Miguel, J. (2023). The impacts of automated vehicles on center city parking. *Transportation Research Part A: Policy and Practice*, 175 (1), 103764. https://doi.org/10.1016/j.tra.2023.103764.

Imai, T. (2019). Legal regulation of autonomous driving technology: Current conditions and issues in Japan. IATSS Research. *43*(4), 10. 10.1016/j.iatssr.2019.11.009.

Intini, P., Colonna, P., Berloco, N., & Ranieri, V. (2019). Rethinking the main road design concepts for future automated vehicles native roads. *European Transport*, 73 (3), 1-28.

Ivančev, C. A., Dragčević, V., & Džambas, T. (2022, May 11-13). *Road infrastructure requirements to accommodate autonomous vehicles* [Conference session]. 7th International Conference on Road and Rail Infrastructure, Pula, Croatia. https://www.researchgate.net/publication/360620664_Road_infrastructure_requirements_to_accommodate_autonomous_vehicles.

Kirschner, F., & Lanzendorf, M. (2020). Support for innovative on-street parking policies: Empirical evidence from an urban neighborhood. *Journal of Transport Geography*, 85 (1), 102726. http://dx.doi.org/10.1016/j.jtrangeo.2020.102726.

Krysiuk, C. (2021). Autonomous cars, development of modern transport technology. *Journal of Civil Engineering and Transport*, 3(1), 17-27.

Kuma, S. S. (2017). Land policy and land delivery system in Nigeria. In Nuhu, M. B., Ajayi, M. T. A., Olatunjki, I. A., & Udoekanem, N. B. (Eds.), *Emerging issues in urban land use and development* (pp.1-24). University of Abuja Press, Abuja, Nigeria.

Land Use Act 2004 (Cap L5, Laws of the Federation of Nigeria).

Levine, M., & Segev, L. L. (2023). Impact of driverless vehicles on real estate: Ethical and legal issues. The Counselors of Real Estate, 47(1) 1-14.

Levinson, D. (2015). Climbing mount next: The effects of autonomous vehicles on society. *Minnesota Journal of Law, Science and Technology*, *16*(2), 804.

Lyons, G., Juliet, J., & David, H. (2007). The use of travel time by rail passengers in Great Britain. *Transportation Research Part A: Policy and Practice*, *41*(1), 107-120. http://dx.doi.org/10.1016/j.tra.2006.05.012.

Megha, M., Namratha, S.T., & Kumar P.E. (2019). Working of autonomous vehicles. *International Research Journal of Engineering and Technology*, *6*(12), 13-18.

Milakis, D., Kroesen, M., & Wee, B. V. (2018). Implications of automated vehicles for accessibility and location choices: Evidence from an expert-based experiment. *Journal of Transport Geography*, *68*(1), 142-148. https://doi.org/10.1016/j.jtrangeo.2018.03.010.

Nechyba, T. J., & Walsh, R. P. (2004). Urban sprawl. *Journal of Economic Perspectives* 18 (4), 177–200. http://dx.doi.org/10.1257/0895330042632681.

Nikhil, S. Y., & Kasim, A. K. (2020). Impact of autonomous vehicles on parking spaces. *Journal of Architectural Environment and Structural Engineering Research*, 3(1), 1834. https://doi.org/10.30564/jaeser.v3i1.1834.

Nourinejad, M., Bahrami, S., & Roorda, M. J. (2018). Designing parking facilities for autonomous vehicles. *Transportation Research Part B Methodological*, *109*(1), 110-115. http://dx.doi.org/10.1016/j.trb.2017.12.017.

Ondruš, J., Kolla, E., Vertaľ, P., & Šarić Z. (2020). How do autonomous cars work? *Transportation Research Procedia*, *44*(1), 226-233. https://doi.org/10.1016/j.trpro.2020.02.049.

Othman, K. (2021). Impact of autonomous vehicles on the physical infrastructure: Changes and challenges. *Designs,* 5(3), 40. https://doi.org/10.3390/designs5030040.

Othman, K. (2022). Exploring the implications of autonomous vehicles: a comprehensive review. *Innovative Infrastructure Solution,* 7 (2), 165. https://doi.org/10.1007/s41062-022-00763-6.

Otubu, A. (2018). The land use act and land administration in 21st century Nigeria: Need for Reforms. *Journal of Sustainable Development, Law and Policy*, *9*(1), 81-108.

Szikora, P., & Madarász, N. (2017, November 14-16). *Self-driving cars — The human side*. [Conference session]. 14th International Scientific Conference on Informatics, Poprad, Slovakia. https://doi.org/10.1109/INFORMATICS.2017.8327279.

Pagallo, U. (2013.)*The Laws of Robots: Crimes, Contracts and Torts* (1st ed.). Springer Dordrecht.

Park, J. E., Byun, W., Kim, Y., Ahn, H., & Shin, D. K. (2021). The impact of automated vehicles on traffic flow and road capacity on urban road networks. *Journal of Advanced Transportation,* 2021 (1), 8404951. https://doi.org/10.1155/2021/8404951.

Pham, S., Truong, L., & Nguyen, N. (2021, December 8-10). *Impacts of autonomous vehicles on road and pavement design* [Conference session]. Australasian Transport Research Forum, Brisbane, Australia. https://australasiantransportresearchforum.org.au/wp-content/uploads/2022/05/ATRF2021_Resubmission_113-1.pdf.

Pimenta, A. R., Kamruzzaman, M. D., & Currie, G. (2023). Long-term effects of autonomous vehicles on the built environment: a systematic scoping review towards conceptual frameworks. *Transport Reviews,* 43(6), 1083-1117. https://doi.org/10.1080/01441647.2023.2189325.

Pisarov, J., & Mester, G. (2020). The Future of Autonomous Vehicles, *FME Transactions*, *49*(1), 29-35.

Radwan, A. H., & Morsi, A. A. G. (2022). Autonomous Vehicles (A.V.s) & changing the Future of the Cities. Technical & urban perspectives. *Journal of Urban Regeneration and Renewal, 16*(1), 85-108. https://doi.org/10.69554/NVPL8330.

Rahman, M. M., & Thill, J-C. (2023). Impacts of connected and autonomous vehicles on urban transportation and environment: A comprehensive review. *Sustainable Cities and Society, 96*(1), 104649. https://doi.org/10.1016/j.scs.2023.104649.

Raza, M. (2018). Autonomous vehicles: Levels, technologies, impacts and concerns. *International Journal of Applied Engineering Research*, *13*(16), 12710-12714.

Resnik, D. B. (2010). Urban sprawl, smart growth, and deliberative democracy. *AM J Public Health, 100*(10), 1852–1856. https://doi.org/10.2105%2FAJPH.2009.182501.

Ribeiro, P. A., Kamruzzaman, M.D., & Currie, G. (2023). Long-term effects of autonomous vehicles on the built environment: a systematic scoping review towards conceptual frameworks. *Transport Reviews, 43*(6), 1083–1117. https://doi.org/10.1080/01441647.2023.2189325.

Road Traffic Act (Law No. 20, 2019. Enacted 28th May 2019, enforced 5th June, 2019.)

Road Traffic Vehicle Act (Law No. 14, 2019. Enacted 17th May 2019, enforced 24th May, 2019.)

Rosemadi, J. F., Khong, W. K., & Radhakrishna, G. (2022). Civil liability of autonomous vehicles: A review of literature' *International Islamic University Malaysia Law Journal*, *30*(2), 158.

SAE International, *Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles.* Retrieved 21st September, 2024, from https://www.sae.org/standards/content/j3016_202104/.

Šarkan, B., Stopka, O., Gnap, J., & Caban, J. (2017). Investigation of exhaust emissions of vehicles with the spark ignition engine within emission control. *Procedia Engineering*, *187*(1), 775–782. https://doi.org/10.1016/j.proeng.2017.04.437.

Silva, D., Foldes, D., & Csiszar, C. (2021). Autonomous vehicle use and urban space transformation: A scenario building and analysing method. *Sustainability*, *13*(6), 3008. https://doi.org/10.3390/su13063008.

Skarbek-Żabkin, A., & Szczepanek, M. (2018, April 18-20). *Autonomous vehicles and their impact on road infrastructure and user safety* [Conference session]. XI International Science-Technical Conference Automotive Safety, Žastá, Slovakia, https://ieeexplore.ieee.org/document/8373343.

Stein, G. M. (2021).The impact of autonomous vehicles on urban land use patterns. *Florida State Law Review*, *48*(1), 193.

Tengilimoglu, O., Carsten, O., & Wadud Z. (2023). Implications of automated vehicles for physical road environment: A comprehensive review. *Transportation Research Part E: Logistics and Transportation Review, 169*(1), 102989. https://doi.org/10.1016/j.tre.2022.102989.

Tina S., Giuseppe C. (2024). Automated driving regulations – where are we now? *Transportation*

Research Interdisciplinary Perspective, *24*(1), 101033. https://doi.org/10.1016/j.trip.2024.101033.

Tscharaktschiew, S., & Reimann, F. (2022). Less workplace parking with fully autonomous vehicles? *Journal of Intelligent and Connected Vehicles*, *5*(3), 283–301. http://dx.doi.org/10.1108/JICV-07-2022-0029.

Udoekanem, N. B., Adoga, D. O., & Onwumere, V. O. (2014). Land ownership in Nigeria: Historical development, current issues and future expectations. *Journal of Environment and Earth Sciences, 4*(21), 182-188.

Ugonabo, C. U., Egolum, C. C., & Sado, R. O. (2023). Nigerian land policy: Issues, challenges and the way forward. *Global Journal of Politics and Law Research*, *11*(4), 57-77. https://doi.org/10.37745/gjplr.2013/vol11n4119.

UltraDrift. (2016, July 4). *Nigerians See A Self-Driving Car For The First Time*. [Video] YouTube. https://www.youtube.com/watch?v=C0JH3fN_eXE.

Uzair, M. (2021). Who is liable when a driverless car crashes? *World Electric Vehicle Journal*, *12*(2) 62.

Uzoamaka, O. E., Nwosu, C. C., & Nnamdi, U. A. (2021). Critique of Nigerian Land Use Act of 1978. *International Journal of Engineering Science and Computing*, *11*(6), 28115- 28120.

Yasin, M. Y., Yusoff, M. M., Abdullah, J. &, Noor, N. M. (2021). Urban sprawl literature review: Definition and driving force. *Malaysian Journal of Society and Space, 17*(2), 116-128.

Yoganandhan, A., Subhash, S. D., Hebinson, J. J., & Mohanavel, V. (2020). Fundamentals and development of self-driving cars. *Materials Today: Proceedings*, *33* (7), 3303-3310. https://doi.org/10.1016/j.matpr.2020.04.736.

Yun, H. S., Kim, T. H., Park, T. H., (2019). Speed-Bump Detection for Autonomous Vehicles by Lidar and Camera. *Journal of Electrical Engineering Technology*, *14*(1), 2155–2162. https://doi.org/10.1007/s42835-019-00225-7.

Zhang, W. W., & Guhathakurta, S. (2017). Parking spaces in the age of shared autonomous vehicles: How much parking will we need and where? *Transportation Research Record: Journal of the Transportation Research Board*, *2651*(1), 80-91. https://doi.org/10.3141/2651-09.

Zhao, J., Liang, B., & Chen, Q. (2018). The key technology toward the self-driving car. *International Journal of Intelligent Unmanned Systems, 6*(1), 2-20. https://doi.org/10.1108/IJIUS-08-2017-0008.

Zhong, H., Li, W., Burris, M. W., Talebpour, A., & Sinha, K. C. (2020). Will autonomous vehicles change auto commuters' value of travel time? Transportation Research Part D: Transport and Environment, *83*(1), 102303. https://doi.org/10.1016/j.trd.2020.102303.

Zuhal, K. (2016). The concept of urban sprawl and its causes. *Journal of International Social Research, 9*(45), 815-818. http://dx.doi.org/10.17719/jisr.20164520658.