of street design—one potentially featuring tracks of reinforced concrete grade beams for the AVs to navigate [6].
Also, integrating autonomous vehicle (AV) technology promises substantial convenience for elderly individuals or those with disabilities within the societal context [7].

3. Methodology

This academic study seeks to assess the preparedness of the existing infrastructure for autonomous vehicles through an in-depth analysis built upon existing literature reviews. The study will examine pertinent literature to establish a robust foundation for comprehending the interplay between autonomous vehicles and the infrastructure supporting them. The analysis will focus on evidence of human-based design differences and autonomous vehicles. Through this approach, the paper aims to contribute valuable insights into understanding infrastructure design and transport planning, laying the groundwork for future research on autonomous vehicle technology and investigating the impact on infrastructure.

4. Levels of driving automation

The Society of Automotive Engineers (SAE) classifies driving automation into six levels. Levels 0, 1, and 2 denote situations in which the driver is actively driving, even with the engagement of driver support features. This remains true even if the driver's feet are disengaged from the pedals and active steering is not required. In contrast, levels 3, 4, and 5 signify instances where the driver is not actively driving, even though they are seated in the driver's seat when automated driving features are in operation [8].

5. Vehicle to Infrastructure Communication

Vehicle-to-infrastructure (V2I) communication transfers data between vehicles and transportation infrastructure elements like road sensors, signs, and lighting systems. It serves to notify drivers about potential issues such as collisions, traffic jams, sharp curves, and inappropriate speeds. As an illustration, this system can signal the driver to reduce speed when approaching a curve with a speed exceeding the optimal limit, thereby preventing potential accidents [9].

Figure 1 V2I communication mechanism

Source: Adapted from [14]

6. Infrastructure readiness

The advancement of self-driving or autonomous vehicles extends beyond basic automation, evolving into novel automotive technology. This evolution involves improved manufacturing processes, a unique supply chain, and urban infrastructure development tailored specifically for autonomous vehicles[10]. The widespread integration of self-driving cars into urban areas hinges on the preparedness of consumers, manufacturers, and the global infrastructure supporting autonomous driving. It is essential to understand the anticipated infrastructure needs of autonomous vehicles (AVs) and their consequent impact on current road infrastructure. This is crucial for evaluating the readiness of the existing road network and devising effective plans for future road development.
According to a market study conducted by H+C, a mobility consulting organization, 74% of customers believe that roads are not fully equipped for self-driving cars. Only 11% of respondents believe the opposite, demonstrating a significant gap in public view of road infrastructure readiness for autonomous car integration [11].
Analysis of the market study reveals that the prevailing sense of insecurity stems from public awareness, where individuals express unease attributed to various factors. Notably, concerns arise from the insufficient readiness of infrastructure to support the full and secure utilization of autonomous vehicles. This underscores the significant influence of infrastructure preparedness on public perceptions, directly impacting the adoption rate of autonomous vehicles. This emphasizes the critical importance of ensuring infrastructure readiness to facilitate the safe and widespread use of autonomous vehicles.
Tom Fisher's research revealed that autonomous vehicles rely on GPS and other navigational aids to follow exact paths consistently. This practice of using the same route consistently poses challenges for the road surface. Additionally, studies indicate that pavement condition is a significant risk factor for accidents.[12] According to statistics:

- Pavement is identified as a contributing factor in 31% of total crashes [12].
- It is associated with 52% of fatalities resulting from accidents [12].
- It contributes to 38% of non-fatal injuries resulting from accidents [12].

These findings underscore the critical importance of road surfaces for ensuring the safe operation of autonomous vehicles.
Society of Automotive Engineering (SAE) projections regarding the timeline for introducing various Autonomous Vehicles (AVs) levels in diverse driving environments.

Environment	SAE LEVEL 1	SAE LEVEL 2	SAE LEVEL 3	SAE LEVEL 4	SAE LEVEL 5
Everywhere	2020s	2025s	-	-	2075s
General urban	2010s	2025s	2030s	2030s	-
Pedestrian Zone	2010s	2020s	2020s	2020s	-
Limited-Access Highway	2010s	2010s	2020s	2025s	-
Separated Guideway	2010s	2010s	2010s	2010s	-

Table. 1 SAE estimated timeline for autonomous vehicles [13].

According to (SAE) estimates, the implementation of autonomous vehicles in every environment is projected until approximately 2075 [13]. This extended timeframe underscores the considerable duration involved in achieving widespread deployment.

7. Exploration of Literature Findings and Interpretations

Considering the research findings, it is observed that autonomous vehicles exhibit a reduced and consequently more permissive minimum curve length, and design controls based on autonomous vehicle (AV) parameters for vertical curves demonstrate greater tolerance compared to those relying on human drivers. This prompts the question of universal applicability across various situations and road alignment designs. Is the observed trend consistent, or does it necessitate further investigation? Engineers have historically addressed challenges over an extended period, and the established parameters for contemporary infrastructure and roadway design are grounded in extensive studies. However, the transition to autonomous vehicles lacks a comparable body of evidence to assert the technology's trustworthiness in all scenarios unequivocally. The potential impact of sensor failures and the role of Vehicle-to-Infrastructure (V2I) information exchange is particularly concerning. While aiming to mitigate human-based errors that lead to accidents, there is a critical need to assess whether this approach introduces new types of errors, potentially resulting in more severe accidents and fatalities. The discussion thus prompts a call for a more comprehensive exploration of the feasibility of integrating autonomous vehicles into existing infrastructure.

8. Conclusion

Understanding the anticipated infrastructure requirements for autonomous vehicles is crucial. This paper highlights the necessity of researching the adaptability of current infrastructure to autonomous vehicles. The findings indicate significant differences and impacts on autonomous vehicles due to existing infrastructure. The current parameters for roadway design may not entirely align with the needs of autonomous vehicles. In scenarios involving mixed traffic, critical road design parameters may require reassessment. Therefore, this paper emphasizes the importance of identifying an optimal and seamless approach to transforming the current infrastructure to ensure its full compatibility with autonomous vehicles for safety.

Moreover, according to SAE estimations, we are almost half a century away from the widespread implementation of autonomous vehicles in any environment. This highlights a substantial gap in both infrastructure and technology. The papers also stress the significance of road surfaces and the materials used, emphasizing the need for a sustainable and durable infrastructure for future autonomous vehicle usage. The conclusion drawn is that substantial time investment or alternative solutions are imperative to provide a feasible answer to infrastructure adaptation for autonomous vehicles.

6. References

[1] O. Tengilimoglu, O. Carsten, and Z. Wadud, “Implications of automated vehicles for physical road environment: A comprehensive review,” *Transp Res E Logist Transp Rev*, vol. 169, p. 102989, Jan. 2023, doi: 10.1016/J.TRE.2022.102989.

[2] Insurance Institute for Highway Safety (IIHS), “Self-driving vehicles could struggle to eliminate most crashes.” Accessed: Nov. 18, 2023. [Online]. Available: https://www.iihs.org/news/detail/self-driving-vehicles-could-struggle-to-eliminate-most-crashes

[3] S. Pillath, “Briefing European Parliamentary Research Service,” 2016.

[4] X. Ye, X. Wang, S. Liu, and A. P. Tarko, “Feasibility study of highway alignment design controls for autonomous vehicles,” *Accid Anal Prev*, vol. 159, p. 106252, Sep. 2021, doi: 10.1016/j.aap.2021.106252.

[5] J. Khoury, K. Amine, and R. Abi Saad, “An Initial Investigation of the Effects of a Fully Automated Vehicle Fleet on Geometric Design,” *J Adv Transp*, vol. 2019, pp. 1–10, May 2019, doi: 10.1155/2019/6126408.

[6] Robert L. Reid, “How autonomous vehicles will change road designs,” Civil Engineering magazine. Accessed: Nov. 26, 2023. [Online]. Available: https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/article/2021/08/how-autonomous-vehicles-will-change-road-designs

[7] H. Sun, P. Jing, M. Zhao, Y. Chen, F. Zhan, and Y. Shi, “Research on the mode choice intention of the elderly for autonomous vehicles based on the extended ecological model,” *Sustainability (Switzerland)*, vol. 12, no. 24, pp. 1–22, Dec. 2020, doi: 10.3390/su122410661.

[8] SAE International, “SURFACE VEHICLE RECOMMENDED PRACTICE Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles,” United States, 2021. doi: https://doi.org/10.4271/J3016_202104.

[9] D. Kanthavel, S. K. B. Sangeetha, and K. P. Keerthana, “An empirical study of vehicle to infrastructure communications - An intense learning of smart infrastructure for safety and mobility,” *International Journal of Intelligent Networks*, vol. 2, pp. 77–82, 2021, doi: 10.1016/j.ijin.2021.06.003.

[10] E. L. Olson, “Will songs be written about autonomous cars? The implications of self-driving vehicle technology on consumer brand equity and relationships,” *International Journal of Technology Marketing*, vol. 12, no. 1, p. 23, 2017, doi: 10.1504/IJTMKT.2017.081506.

[11] Selika Josiah Talbott and Dr. Martin Adler, “Readying Infrastructure for Autonomous Vehicles.” Accessed: Nov. 27, 2023. [Online]. Available: https://www.forbes.com/sites/selikajosiahtalbott/2021/02/22/are-us-roads-built-for-an-autonmous-vehicle-future/?sh=173f62554874

[12] S. Mostowfi and W. G. Buttlar, “Vehicle-to-Infrastructure and Human-to-Infrastructure Models for Smart Civil Infrastructure Systems,”

2020, pp. 147–155. doi: 10.1007/978-3-030-50943-9_20.

[13] H. Wang, “INTEGRATING DRIVING SIMULATOR EXPERIMENT DATA WITH A MULTI-AGENT CONNECTED AUTOMATED VEHICLES SIMULATION (MA-CAVS) PLATFORM TO QUANTIFY IMPROVED CAPACITY FINAL PROJECT REPORT,” 2020. [Online]. Available: www.pactrans.org

[14] “Channel Modelling of 6G Mobile Networks.” Accessed: Dec. 02, 2023. [Online]. Available: https://www.telecomhall.net/uploads/db2683/original/3X/8/9/8967d5dfb886f137ba8dabced7abf5c30d5105a6.png