Analysis of the Current Status of Enacted Legislation on Autonomous Vehicles in the United States

Soujanya Pillala, Kasim Korkmaz, and Hyun Jeong Koo

Abstract — **Autonomous Vehicles (AVs) have the potential to increase efficiency, safety, environmental benefits, and equity in the transportation area. However, these benefits are not guaranteed until design, planning, policy, and implementation frameworks play their roles in bringing these benefits to the community. This paper presents a bibliometric and systematic review of the legislation on AVs in the U.S. to analyze the definition, evolution, and enacted legislation to help understand the current status of this research area and provide the future research direction. Investigation of existing legislation mainly focuses on 33 states in the U.S. that have enacted legislation, and the information from 2012 to 2022 was collected. Then, the collected information was categorized into seven categories for further analysis. From this study, the authors found out that state rules primarily govern testing rather than its general use. Even though testing is currently the top priority, the National Highway Traffic Safety Administration (NHTSA) anticipates AV legislation to evolve rapidly and desires to issue new regulations annually in preparation for deployment. There is a trend in going through the state governments implementing AV legislation by evaluating current laws and regulations to address unnecessary impediments to testing and deployment. This trend should have cooperated with all states to avoid a patchwork of inconsistent state laws. This study shows that the states have been moving toward passing legislation to test and enact policies to be ready to implement AVs on the highways.**

Keywords — **Autonomous Vehicles (AV), Highway System, Transportation, Legislation.**

I. Introduction

Autonomous driving and vehicles are the most actively researched and widely followed transportation-related technologies [1]. AV term is defined as a vehicle that can sense its surroundings and navigate without human input [2]. Based on the driving levels of automation, the monitoring shifts from humans to the automated system. The Society of Automated Engineers (SAE) recommended six levels of automation ranging from Level 0-No Automation to Level 5-Full Automation. However, only levels 3 through 5 support autonomous driving [3]. Level 3 indicates conditional automation, Level 4 indicates robust automation, and Level 5 indicates complete automation. Multiple studies in the literature have examined the adoption intention of Level 3, conditional automation [4]-[6], Level 4, high automation [7]-[9], and Level 5, which is full automation, and the last stage in autonomy [10]-[14].

Historically, in the 1920s, AVs first gained widespread attention as radio-controlled cars in New York City, U.S. [15]. Before the turn of the century, there had been little progress toward to fully autonomous. The first radio-controlled car was used in Manhattan in 1925 that could start, shift, and honk. But the operator lost control twice and crashed into another vehicle. The first self-driving radio-controlled electric car that ran on magnetized road spikes was generated in 1939. This model was introduced in 1958 with sensors that could detect a wire's current, and the steering wheel could be turned with the current. In 1961, researchers began thinking about how to land on the moon. James Adams created the Stanford Cart, which uses cameras to detect and follow a line. This was the first-time AV used cameras, a vital component today [15]. In 1977, Japanese researchers improved this idea with a camera system that sent data to a computer. This led to the world's first self-driving passenger vehicle, which could reach 20 mph. [16]. Researchers at Carnegie Mellon University began building self-driving cars in 1990, integrating neural networks into image processing and steering controls. They attended a competition from Pittsburgh to San Diego in 1995, where a driver only controlled speed and braking.

The "Park Shuttle" a public, closed-loop commuter bus, first ran in the Netherlands in 1999 [17]. In the early 21st century, AVs were first used commercially in controlled environments [16]. Later, a mining operation company started using autonomous trucks in 2014, and they transported 100 million metric tons of soil [18].

In addition, several competitions were held to develop a driverless car. Defense Advanced Research Projects Agency (DARPA) funded AV competitions since 2004. In 2004, the final round of the first event featured 15 teams. In the Mojave Desert, Nevada, unmanned self-driving vehicles had to complete a 150-mile course on dirt roads, flats, and mountain passes. Five teams completed the 132-mile course the following year, demonstrating rapid progress in this field. After six hours and 54 minutes, Stanford University's robot car won. Next, the 2007 DARPA Urban Challenge occurred at an abandoned military base. The teams navigated four-way intersections, blocked roads, and parking lots with other self-driving and human-driven vehicles. The first AV traffic jam and minor robot car collision occurred at this event. For the first time, researchers heavily relied on high-resolution lidar sensors and maps [19].

Submitted on February 21, 2023.
Published on May 02, 2023.
S. Pillala, Eastern Michigan University, Construction Management Program, Ypsilanti, MI, USA.
(e-mail: spillala@emich.edu)
K. Korkmaz, Eastern Michigan University, Construction Management Program, Ypsilanti, MI, USA.
(e-mail: kkorkmaz@emich.edu)
H. J. Koo, Wayne State University, Civil and Environmental Engineering, Detroit, MI, USA.
(e-mail: hjkoo@wayne.edu)

Since it is predicted that 20% of driving will be automated by 2025 in the U.S. [20], the next 5–10 years will be crucial for testing and preparing for AV deployment [21]. Autonomous technologies, including AVs, will alter transportation systems and networks significantly. Among the many advantages of AVs, the most frequently discussed ones include the potential to increase safety through fewer accidents, the environmental benefits of switching to electric power, and a decrease in traffic because of their efficient operations [22]. To accommodate the AVs on the roads not only for personal use but also for service, policies, and legislation are required for AV testing, operation, insurance, taxes, launching, and other additional purposes.

Despite the numerous advantages, the rapid development of AV technology and its rapid adoption will be disruptive. Individual autonomy, information privacy, and surveillance are mentioned as negative issues once AVs hit the streets. As such automation takes over transportation, it is vital to keep track of the safety of autonomous ecosystems to avoid any potential attack vectors and data abuse.

These attacks and abuse could spring from competitors, nation-state actors, hacktivists, and script kiddies. Therefore, risk analysis and preventative measure implementation should be critical considerations to secure the innovative effort from the design stage of vehicles. Ultimately, AVs must protect users' privacy before they become common and exposed to many people, so necessary policies should be in place [23]. To help this circumstance with all its all components, this study focuses on examining the definition of an AV and the status of the legislation in the U.S. From this analysis, this study contributes to the AV and transportation legislation research domain. Also, by providing such important information and critical analysis results for AV legislation, it provides an opportunity for future directions.

II. Definition of AVs

To prevent accidental limitations on current, semi-autonomous technology, the term "autonomous vehicle (AV)" should be precisely defined. An AV is described as "a motor vehicle that uses artificial intelligence, sensors, and global positioning system coordinates to drive itself without the active intervention of a human operator" in the original legislation passed by Nevada's Assembly Bill 511.91. Also, in other studies, AVs are defined as automobiles with motion and action capabilities that do not need a driver or teleoperation control [24]. The Society of Automotive Engineers [25] has proposed the term "Automated Driving Systems" (ADS) to refer to cars with varying degrees of automation to avoid several definitions [26].

III. Benefits of AVs

All facets of society will be benefited from AVs. First, the income of the service centers will be impacted by the fact that AVs have fewer moving parts and require less maintenance. Also, in terms of environmental perspectives, AVs will contribute to reducing carbon emissions and fuel consumption. The strongest argument for promoting the deployment of AV technology is probably the enhancements to public safety brought forth by these cars. Since autonomous vehicles run by themselves, car-related accidents are predicted to be reduced. Every year, 1.35 million people perish in automobile accidents worldwide, and there are more than 5 million accidents in the U.S. More than 2 million people are injured, and over 30,000 people die because of those incidents.[27]. AV implementation will contribute to reducing these accidents. In addition to improving public safety, using AVs brings major economic advantages by decreasing accidents. The American Automobile Association examined crash data from the 99 major cities in USA in 2009 and calculated the expenses to be 300 billion dollars [28].

By removing many of the inefficiencies associated with human drivers, autonomous cars would enable the recapture of the waste associated with traffic congestion and trip time. According to research from Texas A&M University, traffic congestion costs almost 5 billion hours of wasted time annually, or roughly 5,700 lives or 15,200 full-time, thirty-year careers [29]. Typical drivers spend nearly 300 hours per year behind the wheel. Over 200 million drivers spend approximately 65 billion hours behind the wheel [30].

IV. AV Legislation

For a better understanding of the current status of the states regarding AV legislation in the U.S., this research explored the enacted legislation in the 33 states in the U.S., including Alabama, Arkansas, California, Colorado, Connecticut, District of Columbia, Florida, Georgia, Indiana, Iowa, Kentucky, Louisiana, Michigan, Mississippi, Nebraska, North Carolina, North Dakota, Nevada, New Hampshire, New York, Ohio, Oklahoma, Oregon, Pennsylvania, South Carolina, South Dakota, Tennessee, Texas, Utah, Virginia, Vermont, Washington, and Wisconsin by reviewing House Bills and legislative bills for those states.

Table I is an index of the categorization of enacted legislation. According to Table I, there are seven categories in index definitions. Each state may have a different definition based on their used terminology. These definitions are generally developed based on experimental and epistemological information that each state has developed.

TABLE I: Index for Categorization of Enacted Legislation

#	Category
1	Define terms
2	Create legislation/ Legislative committee
3	Establish standard and regulation establishment/ Performance requirement/ Policy recommendation
4	Test AV/ launch test program
5	Funding issued/ Approval of bills
6	Tax/ Insurance related issues
7	AV Operation

Fig. 1 shows a bar chart with the number of states where the legislation defines the categories. It is a presentation of the categories versus a number of states. Table II represents the categories that are associated with each state.

After this section, the identification of the state legislation with qualitative analysis notes is presented with the information about the status of legislation levels for autonomous vehicles in each state.

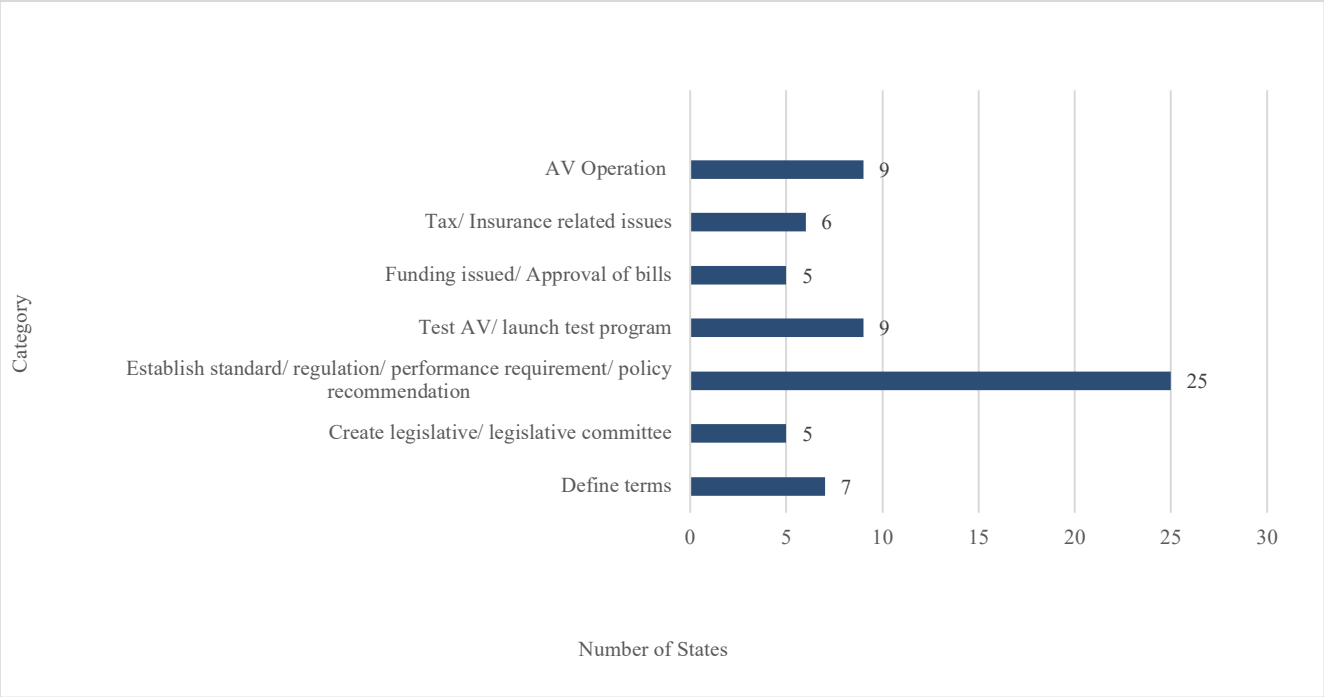

Fig. 1. The Count of States in Categories

TABLE II: COMPARISON OF CATEGORIZATION OF ENACTED LEGISLATION FROM 2011 TO 2022

2022	2021	2020	2019	2018	2017	2016	2015	2014	2013	2012	2011	States
-	-	-	3	3	-	2	-	-	-	-	-	**Alabama**
-	-	-	1,4	-	4	-	-	-	-	-	-	**Arkansas**
-	2	2	5	3, 4, 6	3, 4, 5	4	-	4	-	3	-	**California**
-	-	-	5	-	1, 2	-	-	-	-	-	-	**Colorado**
-	-	-	3	-	3	-	-	-	-	-	-	**Connecticut**
-	-	-		3, 4	-	-	-	-	3	-	-	**District of Columbia**
-	5	3	3	-	-	7	-	-	-	2, 4	-	**Florida**
-	3,6	-	-	-	1, 3, 6, 7	-	-	-	-	-	-	**Georgia**
-	-	-	-	1, 7	-	-	-	-	-	-	-	**Indiana**
-	-	-	3	-	-	-	-	-	-	-	-	**Iowa**
-	-	-	-	1, 3	-	-	-	-	-	-	-	**Kentucky**
-	-	-	3	3, 7	-	-	-	-	-	-	-	**Louisiana**
-	-	3	-	3	6	3, 4, 7	-	6	4, 6	-	-	**Michigan**
-	-	-	-	1,7	-	-	-	-	-	-	-	**Mississippi**
-	3, 4	-	-	3	-	-	-	-	-	-	-	**Nebraska**
-	3	-	-	-	3	-	-	-	-	-	-	**North Carolina**
-	-	-	3	-	3	-	3, 6, 7	-	-	-	-	**North Dakota**
-	5	-	-	-	3, 6, 7	3	-	-	3, 6	-	3, 5	**Nevada**
-	-	-	4	-	-	-	-	-	-	-	-	**New Hampshire**
-	-	-	-	3, 4	3, 4, 6	-	-	-	-	-	-	**New York**
-	-	-	-	-	3,5	-	-	-	-	-	-	**Ohio**
5	-	-	3	-	-	-	-	-	-	-	-	**Oklahoma**
-	-	-	-	3	-	-	-	-	-	-	-	**Oregon**
-	-	-	-	3	-	-	-	-	-	-	-	**Pennsylvania**
-	-	-	-	-	3	-	-	-	-	-	-	**South Carolina**
-	-	-	3	-	-	-		-	-	-	--	**South Dakota**
-	-	-	-	-	3,7	-	-	-	-	-	--	**Tennessee**
-	3	-	-	-	3	-	-	-	-	-	--	**Texas**
-	-	-	3	1	-	-	-	-	-	-	--	**Utah**
-	5	-	-	-	-	-	-	-	-	-	--	**Virginia**
-	-	-	3, 4	-	3	-	-	-	-	-	-	**Vermont**
-	3	-	-	3	-	-	-	-	-	-	-	**Washington**
-	-	-	-	2	-	-	-	-	-	-	-	**Wisconsin**

V. Analysis for the US States

In the research, all states were investigated in detail. A short summary is presented here for each state between 2011 and 202 for enacted legislation.

- Alabama:
  2016. Study self-driving cars.
  2018. Truck platoon" is defined.
  2019. Created a Legislative.
- Arkansas:
  2017. Truck platooning systems.
  2019. Establishes the terms fully autonomous vehicles and autonomous vehicles.
- California:
  2012. Permitted autonomous vehicles to be operated and tested on public roads.
  2014. DMV autonomous vehicle tester program was established.
  2016. Allowed to test autonomous vehicles.
  2017. Advanced funding to accommodate advanced automotive technologies.
  2018. A driverless program is established. Vehicle testing, licensing, and registration were enacted. Authorized the City and County to set a lower tax rate.
  2019. Vehicle testing is enacted.
  2020. Solicited public opinion on autonomous vehicle difficulties and concerns, make policy recommendations, and update continuously.
  2021. By 2030, it will be unlawful to operate new autonomous vehicles that are not zero-emission.
- Colorado:
  2017. DOT defined autonomous driving, dynamic driving, and human operator. Need additional testing for non-compliance vehicles.
  2019. Legislation approved for stakeholder groups to study the impact of new and emerging technologies on transportation.
- Connecticut:
  2017. Requires a pilot program to test fully autonomous vehicles with an operator and $5 million insurance.
  2019. Made changes to the reporting requirements and scheduling for the task force.
- District of Columbia:
  2013. Required a human driver to take control. Addressed the liability of the original manufacturer.
  2018. Requires DOT to have a study publicly available for one year to make recommendations regarding autonomous vehicles under eight specific categories.
- Florida:
  2012. Declared legislative intent to encourage the development, testing, and operation of autonomous vehicles. Required a valid driver's license and insurance of operators. The draft report containing new legislation for the safe testing and operation of autonomous vehicles is to be submitted by February 12, 2014.
  2016. Permitted operation of AVs on public roads by individuals with a valid driver's license. Eliminated the requirements that it be a testing vehicle and have a driver present. Required autonomous vehicles to meet federal safety standards.
  2019. Driverless AVs are allowed on public roads. Accelerate the building of regional corridors that are designed to house multiple forms of infrastructure and transportation.
  2020. Signage for autonomous vehicles.
  2021. Enacted Autonomous Vehicle operation on public roads.
- Georgia:
  2017. The restriction against following too closely does not apply to the platoon's non-leading vehicle. Defines fully autonomous vehicles, minimal risk conditions, and operational design domain. Specifies insurance and registration requirements.
  2021. Reduces the registration fee for low-speed alternative-fueled vehicles.
- Indiana:
  2018. Describes "Vehicle platoon". The measure exempts vehicle platooning from the 300-foot rule.
- Iowa:
  2019. Establishes regulations for motor vehicles operated by an automated driving system.
- Kentucky:
  2018. Defines platoons, planned to ride with a transportation network, and standards for commercial motor vehicles to operate as a platoon.
- Louisiana:
  2018. Allows non-lead vehicles in a platoon to follow closely.
  2019. Specifies autonomous commercial motor vehicles, establishes a controlling authority, applications to operate one, operator requirements, accident reporting, and remote drivers and teleoperation systems.
- Michigan:
  2013. Permitted testing of automated vehicles under conditions and addressed the liability of the vehicle manufacturer.
  2014. Limited liability of the manufacturer for damages resulting from modifications made to an automated vehicle.
  2016. Open operation of CAVs testing. Passengers are connected to transportation options by on-demand AV networks. Allowed autonomous vehicles to operate without a driver. Allowed mobility research centers for automated technology testing. manufacturers of automated technology are given immunity when alterations are made without their permission.
  2017. Made mechanics and repair shops exempt from liability when fixing automated vehicles.
  2018. Established state infrastructure council to collect data on infrastructure system.
  2020. Created Michigan office of future mobility.
- Mississippi:
  2018. Defines platoon, exempts some vehicle operators in a platoon from certain laws requiring distances between traveling vehicles, and requires platoon plans to be filed with the Department of Transportation.
- Nebraska:
  2018. Adjusts transportation provisions. Authorizes automated driving system-equipped vehicles, automated driving systems, driverless capable vehicles, and on-demand driverless capable vehicle networks

2021. Permitted to test self-driving vehicles that are operating in compliance with traffic and motor vehicle safety laws.

- North Carolina:
  2017. Amendment relating to a non-leading commercial motor vehicle traveling in a platoon. Amends the general statutes, Establishes regulations and committees for fully autonomous vehicles on public highways.
  2021. Defines and authorizes the operation of neighborhood occupant-less vehicles and provides for restrictions, regulations, and equipment requirements.
- North Dakota:
  2015. The transportation agency must study automated driving technologies and the data they collect and assessment of current licensing, registration, insurance, data ownership/use, and inspection requirements.
  2017. Demands review of present licensing, registration, insurance, data ownership and use, and inspection rules and how they should relate to autonomous driving vehicles.
  2019. Permit Autonomous vehicles to operate on public highways and must be capable of operating in compliance with federal and state law. A person not operating an autonomous vehicle is exempt from licensing requirements. Defines platoons.
- Nevada:
  2011. The first state to authorize the operation of AVs. Directed DMV to adopt rules for license endorsement, operation, and safety standards and testing for AVs.
  2013. Required proof of insurance from AV operators and that the vehicle meets state standards. Made the manufacturer of a 3rd party converted vehicle immune from liability.
  2016. First AV-restricted driver's license issued in the country.
  2017. First fully autonomous shuttle in the US to operate on a public street. Allowed use of autonomous platooning on highways. Required crashes be reported to the DMV within 10 days of resulting in damages over $750. Allowed a fine of up to $2,500 for violations of AV regulations. Allowed fully autonomous vehicles without a human operator. Specified that the following distance rule doesn't apply to vehicles in a platoon. Imposed an excise tax on autonomous vehicles used for transportation services. Permitted AV use by carriers and taxi companies under conditions.
  2021. Enacted provisions for fully autonomous vehicles.
- New Hampshire:
  2019. Provides an Automated Vehicle Testing and Deployment Commission and a pilot program for automated vehicle testing. Requires the State transportation council to assess automated vehicle testing and deployment.
- New York:
  2017. Allowed the commissioner of motor vehicles to approve AV tests and demonstrations. Required police supervision for testing and report on testing and demonstration. Specified requirements for operation, including insurance of $5 million.
  2018. Requires AV testing to follow guidelines from the police superintendent.
  2019. Requires AV testing to follow guidelines from the police superintendent. A law enforcement interaction plan must be included in the application, including how first responders should interact with AVs in emergency situations.
- Ohio:
  2017. A law enforcement interaction plan must be included in the application, including how first responders should interact with AVs in emergency situations.
- Oklahoma:
  2019. Only the state may enact laws or regulations on autonomous driving systems, pre-empting the jurisdiction of local legislation.
  2022. Bill permits the Department of Public Safety to create guidelines, requires fully autonomous vehicles to present proof of financial responsibility, and compels them to remain at the site of certain incidents.
- Oregon:
  2018. Allow wine board members to use vehicle registration plates from any regular series rather than specially designed government series for vehicles owned or operated by state departments, institutions, or Wine Country agencies. Allows autonomous vehicles to operate on state highways in certain circumstances, requires commercial autonomous vehicle owners to obtain additional motor vehicle liability insurance policies, and directs the Department of Transportation to adopt rules for autonomous vehicle operation on state highways.
- Pennsylvania:
  2018. Amends vehicle-related regulations, adds more road restrictions in general, addresses platooning, and allows for highly automated vehicles.
- South Carolina:
  2017. Minimum following distance laws for vehicles traveling along a highway do not apply to the operator of any non-leading vehicle traveling in a platoon, according to the US National Highway Traffic Safety Administration (NHTSA).
- South Dakota:
  2019. Authorized the Transportation Commission to promulgate rules to allow certain motor vehicles to follow another motor vehicle on a state highway more closely than otherwise permitted by law.
- Tennessee:
  2017. Permits platoon operating on streets and highways after notifying DOT and DHS. Creates the AV Act. Changes laws on unattended automobiles, child restraints, seat belts, and crash reporting for ADS-operated vehicles. License-free ADS vehicles. If certain conditions are met, ADS-operated vehicles can drive on state roads without a driver.
- Texas:
  2017. Allows connected braking to maintain vehicle spacing. "Connected braking system" means a system that electronically coordinates braking between vehicles. Local governments can't regulate automated cars and driving systems. Allows an autonomous motor vehicle to operate in the state if certain standards are met.
  2021. Relates to a study on the impacts of using certain motor vehicle technologies.

- Utah:
  2018. Defines "connected platooning system. 2019. Adjusts provisions relating to traffic laws, licensing, and titling requirements and adds provisions relating to the operation of autonomous vehicles; allows the operation of a vehicle in the state by an automated driving system; exempts a vehicle with an engaged automated driving system from licensure; and establishes protocol in the event of an autonomous vehicle accident.
- Virginia:
  2021. Relates to Budget Bill, amends the 2020 Special Session I Acts of Assembly.
- Vermont:
  2017. Legislation signed into law by President Donald Trump calls for meetings to be held with authorities on various aspects of automated vehicles and must be disclosed by the secretary of transportation to the House and Senate committees.
  2019. Requires the Department of Motor Vehicles to provide written forms, applications, and tests translated into certain languages.
- Washington:
  2018. Established Legislative and executive teams to provide recommendations for state policy regarding the use of autonomous cars on public roads. A budget of 150,000 was granted.
  2021. Enforces autonomous vehicle workgroup suggestions, defines autonomous, and removes a restriction that prohibits driving a vehicle with visible video screens.
- Wisconsin:
  2018. Defines platoons. A truck with a gross weight of more than 10,000 lbs must maintain 500 ft behind the vehicle in front of it and exempts platoons from this.

VI. Conclusion

To explore the current status of AV legislation in the U.S., this paper extensively reviewed the previous literature. It analyzed the information by focusing on 33 states in the U.S. that enacted their AV legislation. This study identified that the legislation and house bills passed range from infrastructure, testing, liability, and insurance. However, it is necessary to have more specific and consistent terminology, insurance liability, licensing requirements, and safety standards. A few automakers and tech companies started using low-level AVs before the guidelines were published. It will probably take a while before fully AVs are commonplace on our highways and roads. To ensure the safety of AVs in road conditions, states should only pass legislation permitting of autonomous vehicle testing in specific geographic areas. In addition, by regulating the technology, a government can monitor its development and enhance road safety.

Privacy concern is receiving significant attention in publications, so legislative relating to privacy is important. Before the vehicles are released, the federal government can easily regulate the new technology by passing regulations. The present study is an introduction to the enacted legislation of the states that need to be enhanced and investigated with qualitative analyses.

Consequently, for future studies, an in-depth analysis of the legislation of these states should be carried out by conducting a survey of legislators in different states, and the survey results can give a better understanding of the current state and necessary future steps. Furthermore, a common language should be created nationwide, and it requires a nation-level consul.

References

[1] Noor AK, Beiker SA. Intelligent and Connected. Mechanical engineering (New York, N.Y. 1919) [serial online]. 2012;134:32-37.
[2] Dolgov D, Thrun S, Montemerlo M, Diebel J. Path planning for autonomous vehicles in unknown semi-structured environments. *The International Journal of Robotics Research*, 2010; 29(5), 485-501. https://doi.org/10.1177/0278364909359210.
[3] Kaye S, Lewis I, Forward S, Delhomme P. A priori acceptance of highly automated cars in Australia, France, and Sweden: A theoretically informed investigation guided by the TPB and UTAUT. *Accident analysis and prevention*. 2020;137:105441-105441.
[4] Zhang T, Tao D, Qu X, Zhang X, Zeng J, Zhu H, Du M. Automated vehicle acceptance in China: Social influence and initial trust are key determinants. *Transportation Research Part C-emerging Technologies*, 2020; 112: 220–233. https://doi.org/10.1016/j.trc.2020.01.027.
[5] Zhang B, de Winter J, Varotto S, Happee R, Martens M. Determinants of take-over time from automated driving: A meta-analysis of 129 studies. Transportation research. *Part F, Traffic psychology and behaviour*. 2019;64:285-307.
[6] Xu Z, Zhang K, Min H, Wang Z, Zhao X, Liu P. What drives people to accept automated vehicles? Findings from a field experiment. Transportation research. *Part C, Emerging technologies*. 2018;95:320-334.
[7] Dai J, Li R, Liu Z. Does initial experience affect consumers' intention to use autonomous vehicles? Evidence from a field experiment in Beijing. *Accident analysis and prevention*. 2021;149:105778-105778.
[8] Madigan R, Louw T, Wilbrink M, Schieben A, Merat N. What influences the decision to use automated public transport? Using UTAUT to understand public acceptance of automated road transport systems. Transportation research. *Part F, Traffic psychology and behaviour*. 2017;50:55-64.
[9] Du H, Zhu G, Zheng J. Why travelers trust and accept self-driving cars: An empirical study. *Travel, behaviour & society*. 2021;22:1-9.
[10] Baccarella CV, Wagner TF, Scheiner CW, Maier L, Voigt K. Investigating consumer acceptance of autonomous technologies: the case of self-driving automobiles. *European Journal of Innovation Management.* 2021;24:1210-1232.
[11] Rahman MM, Deb S, Strawderman L, Burch R, Smith B. How the older population perceives self-driving vehicles. Transportation research. *Part F, Traffic psychology and behaviour*. 2019;65:242-25.
[12] Choi JK, Ji YG. Investigating the Importance of Trust on Adopting an Autonomous Vehicle. *International Journal of Human-Computer Interaction*. 2015;31:692-702.
[13] Gopinath K, Narayanamurthy G. Early bird catches the worm! Meta-analysis of autonomous vehicles adoption – Moderating role of automation level, ownership and culture. *International Journal of Information Management*. 2022;66:102536.
[14] Murthy C. *Autonomous vehicles | Past, present and. Medium.* Published December 8, 2017. Retrieved from: https://medium.com/advanced-interaction-service-design-concepts/autonomous-vehicles-past-present-and-90a9eb3483bc.
[15] Reiser A. *History of Autonomous Cars.* TOMORROW'S WORLD TODAY®. August 9, 2021. Retrieved from: https://www.tomorrowsworldtoday.com/2021/08/09/history-of-autonomous-cars/.
[16] Iclodean C, Cordos N, Varga BO. Autonomous Shuttle Bus for Public Transportation: A Review. *Energies (Basel)*. 2020;13:2917.
[17] Smyth J. *Rio Tinto shifts to driverless trucks in Austra*lia. Financial Times. Published October 19, 2015. Retrieved from: https://www.ft.com/content/43f7436a-7632-11e5-a95a-27d368e1ddf7.
[18] Kuhn W. *The history of the future - Virtual Vehicle*. Virtual Vehicle. May 7, 2018. Retrieved from: https://www.v2c2.at/history-of-the-future/.
[19] Möller T, Padhi A, Pinner D, Tschiesner A. *The future of mobility is at our doorstep*. McKinsey Insights [serial online]. 2019.

[20] Protalinski E. *Google's self-driving cars have autonomously driven over 1 million miles*. VentureBeat. June 3, 2015. Retrieved from: https://venturebeat.com/business/googles-self-driving-cars-have-driven-over-1-million-miles/.
[21] Fagnant DJ, Kockelman K. Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. *Transportation research. Part A, Policy and practice*. 2015; 77: 167-181.
[22] Schoonmaker J. Proactive privacy for a driverless age. *Information & Communications Technology Law*. 2016; 25: 96-128.
[23] Frazzoli E, Dahleh MA, Feron E. Real-Time Motion Planning for Agile Autonomous Vehicles. *Journal of Guidance, Control, and Dynamics.* 2002; 25(1): 116-129. http://www.mit.edu/~dahleh/pubs/2.Real-Time%20Motion%20Planning%20for%20Agile%20Autonomous%20Vehicles.pdf.
[24] SAE J3016 automated-driving graphic. *SAE J3016 automated-driving graphic*. January 7, 2019. Retrieved from: https://www.sae.org/site/news/2019/01/sae-updates-j3016-automated-driving-graphic.
[25] Fatima HS, Abbas AN, Bawany F, Zia H, Yusuf SA, Khurram M. Autonomous vehicle navigation using high-definition maps through CARLA-ROS simulator bridge. *Journal of Physics. Conference series*. 2022;2330:12016.
[26] NHTSA. *Automated Vehicles for Safety | NHTSA*. Retrieved from: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety.
[27] Road Safety Facts & mdash; *Association for Safe International Road Travel. Association for Safe International Road Travel*. Retrieved from: https://www.asirt.org/safe-travel/road-safety-facts/.
[28] Cambridge Systematics, Inc. Crashes vs. Congestion – What's the Cost to Society?; 2011.
[29] Schrank SRSD, Albert AREL, Eisele SREB, Lomax RFT. 2021 URBAN MOBILITY REPORT. The Texas A&M Transportation Institute with cooperation from INRIX; 2021.
[30] U.S. Energy Information Administration - *EIA - independent statistics and analysis* [Internet]. Eia.gov. 1993 [cited 2023 Apr 26]. Available from: https://www.eia.gov/outlooks/archive/aeo93/pdf/0383(93).pdf.

Soujanya Pillala is a Ph.D. candidate and has been working with Eastern Michigan University as a graduate assistant since 2020. In her research, she has been working on the implementation of autonomous vehicles in the construction field and their effects on the field. She is an active researcher and has many publications in the area.

Kasim Korkmaz is working with Eastern Michigan University as an Associate Professor in Construction Management and Civil Engineering. He is the current Interim Associate Dean of the College of Engineering and Technology. His research field is mainly in structural engineering and construction management areas. He has completed various research projects with his expressed interest in the field.

Hyun Jeong Koo is working with Wayne State University as an Assistant Professor of Civil and Environmental Engineering. Her research field is Civil Engineering and Construction Management. She has published several articles in the field and actively working on various fields in construction and engineering.