# Development of Driver Behavior Research on Vehicles: Article Review

*Suroto* Munahar[1*], *M.* Munadi[2], *Bagiyo Condro* Purnomo[1], and *Husni Rakhmawan* Fatoni[3]

[1]Department of Automotive Engineering, Universitas Muhammadiyah Magelang, Magelang, Indonesia
[2]Department of Mechanical Engineering, Diponegoro University, Semarang, Indonesia
[3]Laboratory of Automotive Engineering, Universitas Muhammadiyah Magelang, Magelang, Indonesia

**Abstract.** Driver behavior is a variable that significantly influences fuel use, which is a very concerning issue due to the high cost of fossil fuels caused by the limited amount of energy in the market. Therefore, several breakthroughs have been conducted to realize vehicles with high fuel efficiency. This is in addition to the continuous study of electric, hybrid, gas, and fuel cell vehicles, as well as the development of intelligent control systems. Research on driver behavior has been carried out with several variables, however, none have been conducted on this factor related to fuel consumption. This research aims to review the development of driver behavior as the supporting variable in vehicles. Data were collected from dozens of scientific articles stored in search engines, such as Science Direct, Scopus, Springer link, and ProQuest. The articles found were then filtered based on the closeness with the themes discussed, hence only 13 were reviewed and grouped into five research theme areas. These include car, safety systems, vehicle and emission control, as well graphic display themes. The results provided an overview of the potential development of driver behavior in the future.

## 1 Introduction

Developing a vehicle control system to boost fuel economy is relevant [1,2]. Meanwhile, the Russia-Ukraine war has significantly impacted the increase in fossil energy prices, its availability in the market, and uneven or imbalanced demand [3,4]. Furthermore, the energy produced by both OPEC and non-OPEC countries continues to decline [5,6]. Several steps have been adopted to improve the automotive sector, especially in terms of reducing its dependence on fossil energy. These include the design of Electric Vehicles (EVc), Hybrid Vehicles (HVc) [7], Compressed natural gas (CNG) vehicles [8,9], fuel cell [10], and control systems.

The current application of EVc is quite intense because it guarantees the achievement of zero emissions. However, this innovation tends to trigger several issues, such as the lengthy

* Corresponding author: suroto@ummgl.ac.id

battery charging time [11], therefore it is distinctively considered by users. Ownership is quite expensive compared to gasoline vehicles with the same engine capability [12,13]. Its vulnerability to short-circuit hazards [14], especially in tropical climate regions, causes some users to loss interested. Presently, in some European countries, electrical energy prices are quite expensive [15].

Another development is the emergence of HVc technology, which was introduced to the market on a massive scale in early 2000. Although this vehicle offers high fuel economy and low emissions, it has some drawbacks. The price of ownership or maintenance is relatively high, and minute power, considered less prone to short circuit hazards, is also produced. Unfortunately, these conditions led to the improper development of HVc in the market.

The research on CNG vehicles, both as an energy source and power generator of fuel cell automobiles, is continuously being investigated. It has been used in vehicles such as LNG, CNG, and LPG [8,9,16]. This technology is extremely valuable in terms of low emissions and high octane numbers. However, CNG vehicles tend to experience several issues, including insufficient power acceleration, inadequate infrastructure, and the danger of explosion due to gas leaks making this technology less desirable. Fuel cell technology has the potential to replace EVc in the future. It has certain advantages, such as producing extremely short electrical energy and achieving zero emissions. Fuel cells lack adequate infrastructure, and the policies proposed by the stakeholders are unclear, thereby hindering it from being massively produced.

The development of control systems to improve fuel economy continues to be pursued, considering its several advantages. This includes its rapid functionality with computer and works intelligence systems. The development of this technology in vehicles has been carried out, including controlling the ignition [16], its utilization as an alternative energy [17], supporting engine system [19,20], as well as fuel regulation [20]. It also has other advantages, such as improving the fuel economy, being applied on a wide scale, and having a fairly affordable price.

Research on fuel control systems to improve their economy is consistently being conducted. Diverse topics have been discussed, including controlling AFR fuzzy logic [20] [21] adding forced air through a turbocharger system [22], achievement of AFR stoichiometry [23], application of machine learning [24], and AFR normalization [25]. Fuel consumption in vehicles depends on innumerable conditions, including the type, mass of the vehicle, driver behavior, etc.

Driver behavior in terms of increasing or reducing the vehicle's speed significantly affects fuel utilization [26]. Additionally, Xing [26] conducted research examining and predicting the impact of fuel consumption on driver behavior. This research focused on analyzing and predicting energy consumption's effect on driver behavior changes. The results realized are an index of future energy consumption by considering different driver behaviors. However, this research is only a prediction that failed to investigate the changes in driver behavior and its impact on fuel consumption. Current studies have not discussed the relationship between fuel consumption and driver behavior. The reviewed articles discussed in this chapter focus on investigating driver behavior trends.

## 2 Method

This review was carried out in several stages, and the initial one entails searching for scientific articles published in the past 10 years. Finally, studies carried out within this period were realized because it is referred to as the golden phase, where world research experts were interested in discussing the investigated topic. Therefore, the exploration of scientific articles on driving behavior was carried out through the search engine "Science Direct, Scopus, Springer link, and ProQuest" which led to the realization of relatively 80 journals. These were then filtered based on their closeness to the themes discussed, 13 articles were obtained and then reviewed in this study. These were further grouped into five theme areas, namely the following car, safety system, vehicle, and emission control, as well as graphic display, as shown in **Fig. 1** and **2**.

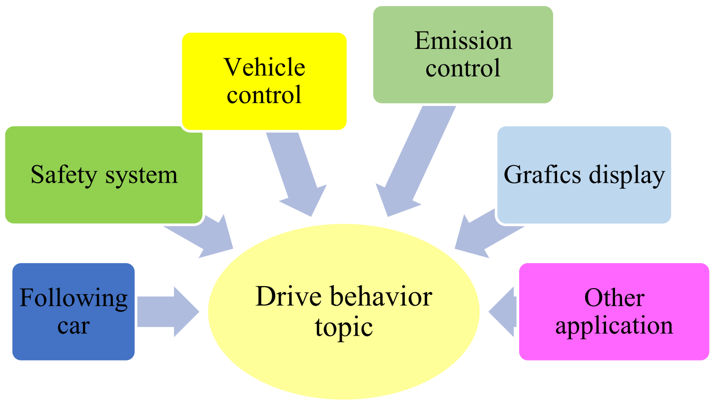


**Fig. 1.** Distribution of research theme areas reviewed

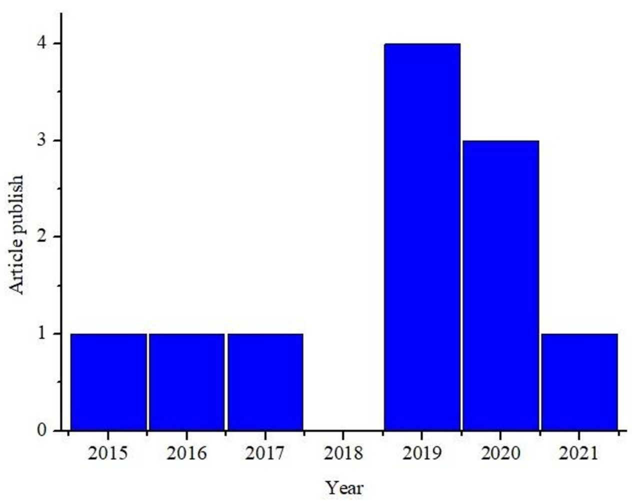


**Fig. 2.** Articles reviewed for the last three years.

# 3 Literature review

## 3.1 Research theme areas on following car

Several research have monitored driver behavior related to *following car*, and these were carried out when driving EVc and Autonomous Vehicles (AV). For example, when driving a driverless vehicle (AV), drivers usually behave differently. According to Zhao [27], they feel slightly anxious because the AV could have some sort of error or issues. Meanwhile, another research tried to observe this variable associated with *following car* using CVDS-IDM. It is a simulator tool that depicts Connected Vehicle Driving Strategy With Intelligent Driver Model [28]. This device records driver behavior by providing several stimulants, while the acquired results tend to model the variable when near or behind AV vehicles, as well as provide safer patterns.

### 3.2 Research theme areas on safety system

Grove [29] and Fung [30], designed a security trigger based on a drowsy driver behavior because this variable is used to improve vehicle safety systems. In the initial stage, these two studies recorded the driver behavior when drowsy, and the results obtained were stored in a database. The system was designed in such a way that when the driver behind the wheels is recognized, it provides feedback, and driving immediately causes a break or changes the way of driving to make it safer.

Hong [31] assessed safe driving and driver behavior that is harmful to motorists. In addition, the results were followed up in order to obtain a comprehensive review. Some other research used this variable to prevent vehicle theft [32]. In the present research, sensors were installed to recognize driver behavior. When the recognized action is not the same as the database, the system turns off the engine because it is presumed that the vehicle was stolen.

Errors in driver behavior were evaluated by partially using the following attributes, extreme and rough braking incidents, including over speeding [33]. Meanwhile, Silver and Lewis [33] assessed this variable in heavy vehicles because these are usually susceptible to accidents. In addition, some research examined how to prevent collisions due to errors in driver behavior [34]. This led to the introduction of adaptive Forward Vehicle Collision Warning (FCW), used to recognize abnormal actions while driving.

### 3.3 Research theme areas on vehicle control

This research theme area discusses driver behavior with respect to the development of automatic vehicle control. Ashkrof [35] used this variable to select road routes in EV vehicles. This behavior in relation to the battery capacity and the charging time was observed. However, some other research used cloud models and reasing to regulate the lateral steering system control in AV vehicles [36]. The present research examined and utilized the developed cloud model system to recognize driver behavior, to enable rapid recognition. Another research formulated a variable driving safety system by limiting vehicle speed in hazardous areas [33,37].

### 3.4 Research theme areas on vehicle emission

Emissions from vehicles in areas where there is traffic light are strongly influenced by driver behavior [38]. However, certain characteristics related to changes in vehicle emissions were investigated. Stogios [38] studied driver behavior relating to changes in vehicle emissions on the highway. These can be reduced by relatively 26% under certain conditions based on driver behavior.

### 3.5 Research theme areas on graphic display

The present research discusses driver behavior using various graphical displays or writings on the vehicle dashboard [39]. The observed variable is an image or text often appearing on this control panel. The results show that the graphical display on the vehicle dashboard significantly affects driver behavior. The higher the frequency of the graphical display, the more the driver glances at the image. Unfortunately, this condition reduces focus and makes it less safe when driving.

### 3.6 Synthesis and discussion

A summary of research articles discussing driver behavior in vehicles is shown in **Table 1**.

**Table 1**. Research articles on the topic of driver behavior part one.

| No | Author | Research Focus | Method | Analysis of Results | Finding |
|---|---|---|---|---|---|
| 1. | Zhao [40] | The effect of driver behavior on AV vehicles | Experiment on driver behavior while following the vehicle (AV) and Human-driven Vehicles (HV). | The results show that the driver's response to the following AV vehicle depends on subjective beliefs. | This research focuses on investigating driver behavior while following AV and HV. However, studies on the behavior regarding fuel energy consumption have not been conducted. |
| 2. | Sharma [28] | The effect of driver behavior on AV vehicles | Using the Connected Vehicle Driving Strategy With Intelligent Driver Model (CVDS-IDM) simulator to observe driver behavior. | This research produces information that allows the driver to operate the vehicle safely and efficiently in a comfortable environment. | This research uses CVDS-IDM to observe driver behavior. However, this tool is limited to model research and has not been included in real-vehicle scale research. |
| 3. | Fadhloun [41] | Driver behavior on the security system | Using the car mode safely. | Fadhloun stated that driver behavior is only limited to developing a safety system using the car mode. | This research focuses on observing driver behavior when following other vehicles. However, it did not consider the relationship between driver behavior and fuel control. |
| 4. | Grove [29] | Driver behavior on the security system. | Analyzing driving behavior to control vehicle speed. | The developed system can warn the driver when operating the vehicle unsafely. | Although the developed system can provide feedback, the energy to drive the vehicle on driver behavior has not been observed. |
| 5. | Fung [30] | Driver behavior on the security system | Observing driver behavior with recognition variables and the camera | Fung and Dick designed a system capable of providing feedback when driver behavior falls into the sleepy category. | Research focuses on cameras installed to recognize driver behavior but has not analyzed the relationship between driver behavior and energy consumption. |
| 6. | Hong [31] | Driver behavior on the security system | Providing an assessment of driver behavior toward the vehicle | Hong examined the driver's pattern in controlling the vehicle. Driver behavior is clustered as the basis for | The assessment used to determine the pattern of driver behavior is carried out sequentially. However, changes |

| No | Author | Research Focus | Method | Analysis of Results | Finding |
|---|---|---|---|---|---|
| | | | | determining the assessment. | in driver behavior in real-time have not been conducted. |
| 7. | Martinelli [32] | Driver behavior on the security system | Recording driver behavior via sensors installed in vehicles. | Martinelli examined the recognition of driver behavior against an existing database. The study shows that the vehicle's engine will be turned off when the recognition is not in accordance with the database because it is considered that the vehicle is being stolen. | A vehicle safety system is built based on the suitability of driver behavior data. However, the introduction of driver behavior for energy system control has not been conducted. |
| 8. | Yuan [34] | Driver behavior on security system | Introducing adaptive Forward Vehicle Collision Warning (FCW) as a warning system. | This activity combines monocular distance measurement and precise vehicle detection. It is oriented toward driver behavior for vehicle safety control. | Yuan introduced the use of FCW as a warning system for vehicle control. Nevertheless, the activities conducted have not taken into account the economic aspects of energy. |
| 9. | Ashkrof [35] | Driver behavior on vehicle control patterns | Driver behavior for electric car driving route selection | Ashkrof observed the type of driver behavior when selecting vehicle routes. This behavior is related to the strategy of charging electric car batteries. | This research observed driving behavior in electrified vehicle route selection. However, the activities conducted have not observed driver behavior on the use of electrical energy for vehicle propulsion. |
| 10. | Hongbo [36] | Driver behavior on vehicle control patterns | Development of lateral control controls based on driver behavior. | Hongbo observed driver behavior on AV vehicles. The control system is designed for lateral control of the steering based on driver behavior. | This research examined the impact of lateral control system applications based on driver behavior. However, the activities conducted are only limited to AV vehicles. |
| 11. | Silver [33] | Driver behavior on vehicle | Development of automatic driver | The purpose of the developed system is to limit and provide | Silver and Levis focused on developing an |

| No | Author | Research Focus | Method | Analysis of Results | Finding |
|---|---|---|---|---|---|
| | | control patterns | behavior recognition system. | feedback to the driver who controls the vehicle beyond the safety limit. | automated driver behavior recognition system used for vehicle control. However, they have not been able to develop any that controlled fuel energy. |
| 12. | Yansong [37] | Driver behavior on vehicle control patterns | Developing automatic recognition of driver behavior | Yansong designed the automatic recognition of driver behavior to be stored in the database. | This activity tries to improve the automation system for recognizing driver behavior, as a basis for filling out the database. However, study on the behavior recognition assessment has not been conducted. |
| 13. | Stogios [38] | Driver behavior on emissions | Investigating driver behavior on changes in road emissions | Stagios observed driver behavior when operating a vehicle at a traffic light. The results indicated that under certain conditions, the resulting emission decreases by up to 26%. | The focus is only on the area of emission monitoring based on driver behavior but not on the use of led to emission control. |
| 14. | Kohl [39] | Driver behavior on graphical displays | Effect of the graphical display of driver's behavior on vehicle dashboard. | Kohl studied the graphical displays that often appear on vehicle dashboards. The results showed that the driver's concentration would be disturbed by the graphical display that often appears on the vehicle's dashboard. | Driver behavior is observed based on concentration when operating the vehicle based on the graphical display. However, the correlation variable of fuel efficiency on driver behavior has not been observed. |

Drivers in operating vehicles have different behaviors depending on their character. Research on driving behavior has so far focused on five theme areas, including following cars, safety systems, vehicle control, emission control, and graphic display themes. However, the five research areas have not considered fuel control based on driver behavior. According to Xing [26]driver behavior is closely correlated with fuel use. This researcher observed the behavior of drivers with various vehicles on fuel consumption. The need for energy-efficient vehicles for now and in the future is essential. Based on Xing's opinion [26], research on driving behavior has the potential to become a control system as a fuel controller. This control system can control fuel based on the character of each driver to increase driving comfort.

Driving comfort can be observed and analyzed from various points of view, such as fulfilling fuel economy and meeting engine power requirements. Artificial intelligence can also be applied to improve the accuracy of driving behavior recognition. The concept of a control system that considers driver behavior has the potential to be applied and developed in oil-fueled, gas-fueled, electric, hybrid, and others.

## 4 Conclusion

In conclusion, studies on driver behavior comprise several themes, including following cars, safety, and vehicle control systems, emissions, and graphic displays. From the articles used, two, six, four, and one discussed the following car, safety systems, vehicle control systems, and emissions and displays, respectively. The most and least studied theme areas are driver behavior on safety systems as well as emissions and display, respectively. Studies on driver behavior have been carried out with various variables, however there is none on the effect of driver behavior on fuel use, economy, vehicle power requirements, driving comfort, and road conditions. These variables have the potential to be applied to several types of vehicles, such as electric, gas/liquid-fueled, hybrid, and fuel-cell vehicles. Consequently, the theme driver behavior has great potential to be developed in the future.

Acknowledgements. The authors are grateful to the BRIN Research and Technology for funding this research as well as the Research institutions and community service of the Muhammadiyah University of Magelang for supporting the research.

## References

1. Uslu, S.; Celik, M.B. Performance and Exhaust Emission Prediction of a SI Engine Fueled with I amyl Alcohol-Gasoline Blends : An ANN Coupled RSM Based Optimization. *Fuel* **2020**, *265*, 116922. https://doi.org/10.1016/j.fuel.2019.116922, doi:10.1016/j.fuel.2019.116922.
2. Karagiorgis, S.; Glover, K.; Collings, N. Control Challenges in Automotive Engine Management. *European Journal of Control* **2007**, *13*, 92–104, doi:10.3166/ejc.13.92-104.
3. Singh, D. Russia-Ukraine war: How rising crude oil prices impact us in ways we don’t quite notice.
4. Turner, B. Energy crisis: Europeans ’must lower thermostats to prepare for Russia turning off gas supplies.
5. Al-fattah, S.M. Non-OPEC conventional oil : Production decline , supply outlook and key implications. *Journal of Petroleum Science and Engineering* **2020**, *189*, 107049. https://doi.org/10.1016/j.petrol.2020.1070, doi:10.1016/j.petrol.2020.107049.
6. Kutlu, O. Global oil production declines in June 2020.
7. Chen, Z.; Zhang, H.; Xiong, R.; Shen, W.; Liu, B. Energy management strategy of connected hybrid electric vehicles considering electricity and oil price fluctuations : A case study of ten typical cities in China. *Journal of Energy Storage* **2021**, *36*.
8. Biswal, A.; Gedam, S.; Balusamy, S.; Kolhe, P. Effects of using ternary gasoline-ethanol-LPO blend on PFI engine performance and emissions. *Fuel* **2020**, *281*, 118664. https://doi.org/10.1016/j.fuel.2020.118664, doi:10.1016/j.fuel.2020.118664.
9. Mehra, R.K.; Duan, H.; Luo, S.; Rao, A.; Ma, F. Experimental and arti fi cial neural network ( ANN ) study of hydrogen enriched compressed natural gas ( HCNG ) engine under various ignition timings and excess air ratios. *Applied Energy* **2018**, *228*, 736-

754. https://doi.org/10.1016/j.apenergy.2018.0, doi:10.1016/j.apenergy.2018.06.085.

10. Xiong, H.; Liu, H.; Zhang, R.; Yu, L. An energy matching method for battery electric vehicle and hydrogen fuel cell vehicle based on source energy consumption rate. *International Journal of Hydrogen Energy* **2019**, *44*, 29733-29742. https://doi.org/10.1016/j.ijhydene.20, doi:10.1016/j.ijhydene.2019.02.169.
11. Loveday, S. How Long Does It Take to Charge an Electric Car?
12. Poullikkas, A. Sustainable options for electric vehicle technologies. *Renewable and Sustainable Energy Reviews* **2015**, *41*, 1277–1287, doi:10.1016/j.rser.2014.09.016.
13. Canepa, K.; Hardman, S.; Tal, G. An early look at plug-in electric vehicle adoption in disadvantaged communities in California. *Transport Policy* **2019**, *78*, 19–30, doi:10.1016/j.tranpol.2019.03.009.
14. Qiao, D.; Wei, X.; Fan, W.; Jiang, B.; Lai, X.; Zheng, Y.; Dai, H.; Tang, X. Toward safe carbon–neutral transportation: Battery internal short circuit diagnosis based on cloud data for electric vehicles. *Applied Energy* **2022**, *317*, 119168, doi:https://doi.org/10.1016/j.apenergy.2022.119168.
15. Reed, S. Why Europe's Electricity Prices Are Soaring.
16. Irina, J.; Benjamin, P.; Benjamin, P.; Benjamin, P.; Benjamin, P.; Irina, P.J. Model-based residual gas fraction control Model-based residual gas fraction control with spark advance optimization. *IFAC PapersOnLine* **2021**, *54*, 108–113, doi:10.1016/j.ifacol.2021.10.149.
17. Liu, W.; Safdari, M.; Tlili, I.; Maleki, A.; Bach, Q. The effect of alcohol – gasoline fuel blends on the engines' performances and emissions. *Fuel* **2020**, *276*, 117977, doi:10.1016/j.fuel.2020.117977.
18. Hunicz, J.; Mikulski, M.; Kosza, G.; Ignaciuk, P. Detailed analysis of combustion stability in a spark-assisted compression ignition engine under nearly stoichiometric and heavy EGR conditions. *Applied Energy* **2020**, *280*, 115955, doi:10.1016/j.apenergy.2020.115955.
19. Li, Y.; Khajepour, A.; Devaud, C.; Liu, K. Power and fuel economy optimizations of gasoline engines using hydraulic variable valve actuation system. *Applied Energy* **2017**, *206*, 577–593, doi:10.1016/j.apenergy.2017.08.208.
20. Wang, Y.; Shi, Y.; Cai, M.; Xu, W. Predictive control of air-fuel ratio in aircraft engine on fuel-powered unmanned aerial vehicle using fuzzy-RBF neural network. *Journal of the Franklin Institute* **2020**, *357*, 8342-8363. https://doi.org/10.1016/j.jfranklin.202, doi:https://doi.org/10.1016/j.jfranklin.2020.03.016.
21. Deng, B.; Li, Q.; Chen, Y.; Li, M.; Liu, A.; Ran, J.; Xu, Y.; Liu, X.; Fu, J.; Feng, R. The effect of air / fuel ratio on the CO and NOx emissions for a twin-spark motorcycle gasoline engine under wide range of operating conditions. *Energy* **2019**, *169*, 1202-1213. https://doi.org/10.1016/j.energy.2018.1, doi:10.1016/j.energy.2018.12.113.
22. Gianfranco Gagliardi; Mari, D.; Tedesco, F.; Casavola, A. An Air-to-Fuel ratio estimation strategy for turbocharged spark-ignition engines based on sparse binary HEGO sensor measures and hybrid linear observers. *Control Engineering Practice* **2021**, *107*, 104694, doi:https://doi.org/10.1016/j.conengprac.2020.104694.
23. Ahmed, S.; Al, F. Analyzing and predicting the relation between air – fuel ratio ( AFR ), lambda ( λ ) and the exhaust emissions percentages and values of gasoline - fueled vehicles using versatile and portable emissions measurement system tool. *SN Applied Sciences* **2019**, *1*, 1-12. https://doi.org/10.1007/s42452-019-1392–5, doi:10.1007/s42452-019-1392-5.

24. Wong, P.K.; Gao, X.H.; Wong, K.I.; Vong, C.M.; Yang, Z.X. Initial-training-free online sequential extreme learning machine based adaptive engine air–fuel ratio control. *International Journal of Machine Learning and Cybernetics* **2019**, *10*, 2245–2256, doi:10.1007/s13042-018-0863-0.
25. Sardarmehni, T.; Aghili Ashtiani, A.; Menhaj, M.B. Fuzzy model predictive control of normalized air-to-fuel ratio in internal combustion engines. *Soft Computing* **2019**, *23*, 6169-6182. https://doi.org/10.1007/s00500-018–3270, doi:https://doi.org/10.1007/s00500-018-3270-2.
26. Xing, Y.; Lv, C.; Cao, D.; Lu, C. Energy oriented driving behavior analysis and personalized prediction of vehicle states with joint time series modeling. *Applied Energy* **2020**, *261*, 114471.https://doi.org/10.1016/j.apenergy.2019.114, doi:10.1016/j.apenergy.2019.114471.
27. Zou, P.; Liu, J.; Zhou, X.; Chen, Z.; Luo, B.; Shen, D.; Duan, X.; Fu, J. Effect of a novel mechanical CVVL system on economic performance of a turbocharged spark-ignition engine fuelled with gasoline and ethanol blend. *Fuel* **2020**, *263*, 116697, doi:10.1016/j.fuel.2019.116697.
28. Sharma, A.; Zheng, Z.; Bhaskar, A.; Haque, M. Modelling car-following behaviour of connected vehicles with a focus on driver compliance. *Transportation Research Part B* **2019**, *126*, 256-279.https://doi.org/10.1016/j.trb.2019.06.008, doi:https://doi.org/10.1016/j.trb.2019.06.008.
29. Grove, K.; Soccolich, S.; Engström, J.; Hanowski, R. Driver visual behavior while using adaptive cruise control on commercial motor vehicles q. *Transportation Research Part F: Psychology and Behaviour* **2019**, *60*, 343-352. https://doi.org/10.1016/j.trf.2018.10.013, doi:10.1016/j.trf.2018.10.013.
30. Fung, K.C.; Dick, T.J. System and method for responding to driver behavior 2016, *2*.
31. Hong, Z.; Chen, Y.; Wu, Y. A driver behavior assessment and recommendation system for connected vehicles to produce safer driving environments through a " follow the leader " approach. *Accident Analysis and Prevention* **2020**, *139*, 105460. https://doi.org/10.1016/j.aap.2020.105460, doi:10.1016/j.aap.2020.105460.
32. Martinelli, F.; Mercaldo, F.; Orlando, A.; Nardone, V.; Santone, A.; Kumar, A. Human behavior characterization for driving style recognition in vehicle system R. *Computers and Electrical Engineering* **2020**, *83*, 102504. https://doi.org/10.1016/j.compeleceng.2017, doi:https://doi.org/10.1016/j.compeleceng.2017.12.050.
33. Silver, A.; Lewis, L. Automatic identification of a vehicle driver based on driving behavior 2015, *2*.
34. Yuan, Y.; Lu, Y.; Wang, Q. Adaptive forward vehicle collision warning based on driving behavior. *Neurocomputing* **2020**, *408*, 64-71. https://doi.org/10.1016/j.neucom.2019.11.02, doi:10.1016/j.neucom.2019.11.024.
35. Ashkrof, P.; Homem, G.; Correia, D.A.; Arem, B. Van Analysis of the effect of charging needs on battery electric vehicle drivers ' route choice behaviour : A case study in the Netherlands. *Transportation Research Part D* **2020**, *78*, 102206. https://doi.org/10.1016/j.trd.2019.102206, doi:10.1016/j.trd.2019.102206.
36. Hongbo, G.; Guotao, X.; Hongzhe, L.; Xinyu, Z. Lateral control of autonomous vehicles based on learning driver behavior via cloud model. *The Journal of China Universities of Posts and Telecommunications* **2017**, *24*, 10-17. http://dx.doi.org/10.1016/S1005-8885(17)601, doi:10.1016/S1005-8885(17)60194-8.
37. Yansong, R.; O'Gorman, L.; Wood, T.L. Driver behavior monitoring systems and

methods for driver behavior monitoring 2019, *2*.

38. Stogios, C.; Kasraian, D.; Roorda, M.J.; Hatzopoulou, M. Simulating impacts of automated driving behavior and traffic conditions on vehicle emissions. *Transportation Research Part D* **2019**, *76*, 176-192. https://doi.org/10.1016/j.trd.2019.09.020, doi:10.1016/j.trd.2019.09.020.
39. Kohl, J.; Gross, A.; Henning, M.; Baumgarten, T. Driver glance behavior towards displayed images on in-vehicle information systems under real driving conditions. *Transportation Research Part F: Psychology and Behaviour* **2020**, *70*, 163-174. https://doi.org/10.1016/j.trf.2020.01.017, doi:10.1016/j.trf.2020.01.017.
40. Zhao, X.; Wang, Z.; Xu, Z.; Wang, Y.; Li, X.; Qu, X. Field experiments on longitudinal characteristics of human driver behavior following an autonomous vehicle. *Transportation Research Part C* **2020**, *114*, 205-224. https://doi.org/10.1016/j.trc.2020.02.018, doi:10.1016/j.trc.2020.02.018.
41. Fadhloun, K.; Rakha, H. A novel vehicle dynamics and human behavior car-following model : Model development and preliminary testing. *International Journal of Transportation Science and Technology* **2020**, *9*, 14-28.https://doi.org/10.1016/j.ijtst.2019.05.004., doi:10.1016/j.ijtst.2019.05.004.