Viability Of Autonomous Vehicles in Indonesia : A survey

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Abstract

This article explores the potential and challenges of introducing Autonomous Vehicles (AVs) in Indonesia through a Systematic Literature Review. The study examines the interaction of AVs with pedestrians, particularly jaywalkers, and the impact of Indonesia's underdeveloped road infrastructure on AV safety and viability. It highlights the importance of a multifaceted strategy involving government, industry, and academia to address these challenges for successful AV adoption in Indonesia. The authors discuss the safety and overall viability of AVs, proposing a comprehensive approach to overcome the infrastructural and regulatory hurdles. Emphasizing the need for better road infrastructure and strict pedestrian regulations, the paper suggests that the government's role is crucial in promoting AV technology. Public perception, safety concerns, and the necessity of enhancing AV algorithms to ensure public safety are also discussed. The study underscores the importance of addressing these issues to pave the way for the integration of AVs into Indonesia's transportation system, with a focus on improving public awareness and regulatory frameworks.

Keyword : Autonomous Vehicle Sensor, Autonomous vehicle Algorithm, Autonomous vehicle safety and cyber security

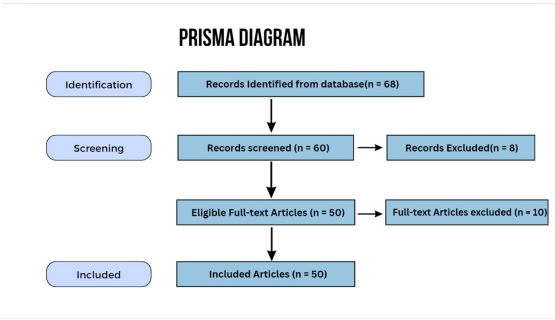
I. INTRODUCTION

Autonomous vehicles, also called self-driving automobiles, are outfitted with cutting-edge technology that enables them to navigate and function without the need for human interaction. These cars sense their environment, analyze traffic, and make judgments about steering, braking, and acceleration using a combination of sensors, cameras, radar, and artificial intelligence algorithms. The safety of this relatively new technology is still being questioned by many, and surveys and other material we have seen statistically support the notion that most individuals are not yet able to use autonomous vehicles[1]. Road indications, which are lines on the road, are necessary for autonomous vehicles' sensors to detect and direct the vehicle to the desired location [2]. Since most of Indonesia's roads are still underdeveloped, the majority of "fully developed roads" with line indicators are restricted to Jakarta, the country's capital, and other developed cities [3]. In tandem with the development of better roads throughout Indonesia, autonomous vehicles will become more widely accepted there with the help of additional research and advancements in their technology.

The government is still unable to manage the traffic in Indonesia's industrial cities, raising concerns about the safety of using autonomous vehicles [1]. Even though a car can be driven by an artificial intelligence (AI) system, autonomous vehicles still need to be developed to prevent accidents and increase public safety [2]. Autonomous vehicles prioritize safety above everything else, therefore these requirements must be satisfied with near-perfect safety and highly accurate AI that the general public can use. In order to save energy, these autonomous vehicles' efficiency must also be maintained during traffic. This indicates that the AI in these vehicles needs to be upgraded in order to identify better routes to drive through to have the shortest displacement to save energy.[1]

In addition to often jaywalking, pedestrians might not always follow the law and stay on sidewalks or other authorized areas. The artificial intelligence (AI) of autonomous cars has to be able to identify the common routes and patterns of pedestrians in order to improve pedestrian safety; nevertheless, the presence of jaywalkers could compromise the AI's intelligence [2]. Jaywalking poses a serious risk to autonomous vehicles because it is not only exceedingly hazardous but also common in Indonesia and rarely punished. This suggests that the government may decide to postpone approving the development of autonomous vehicles until further notice in order to ensure that the AI in these vehicles is accurate and safe for everyone.

II. Methodology



This study uses the application of systematic literature review (SLR) where the method is applied in this study and is based on a large number of references in international publication. The rationale for selecting the study methodology we used is PRISMA, stems from the established standard for disclosing information evidence in systematic reviews and meta-analyses. The PRISMA framework will direct the identification, selection, assessment, and synthesis of prior research on this topic.

The primary focus on this study is to perceive the effectiveness of autonomous vehicle in Indonesia through analysis of systematic literature review to see how autonomous vehicle interact with pedestrian and jaywalkers in Indonesia.

A. Search Strategies

This research was completed using the keywords "Autonomous Vehicle," "Autonomous Vehicle Safety," and "Autonomous Vehicle in Indonesia." These keywords were important for identifying significant academic publications that contributed to this literature review. The keywords were used to create a framework for identifying two fundamental concepts: autonomous vehicle algorithms (including how autonomous vehicles interact with streets and jaywalkers) and autonomous vehicle safety. This research utilized sources from ScienceDirect and Mendeley within the timeframe from 2019 to 2024.

B. Eligibility Criteria

In order to exclude the irrelevant studies, we filtered all the articles and evaluated them based on their titles, abstracts, and keywords after discarding duplicate papers. We only used articles that were related and appropriate for our paper. The categories of items that were not included in this phase were like research papers focusing on autonomous vehicles outside the scope of traffic safety and infrastructure, Articles not available in full text , etc.

C. Data extraction

This research uses the full – text articles or journal. the data collected by several key elements such as year of publication, the title, the classification of autonomous vehicles, especially for interaction with street and study design. Based on an examination of subjective autonomous vehicles obtained by the writers using the most popular strategy and model across all articles. From the article and journal that will be conducted to identify the common patterns related to our research paper that is required to answer our research questions.

III. Research Questions

RQ 1: Are Autonomous Vehicles viable In Indonesia ?
RQ 2 : How to promote the safety of Autonomous Vehicles?
RQ 3: What are the public perceptions and concerns about AV safety in Indonesia?

- Autonomous Vehicle background

Autonomous vehicles, or AVs, are a revolutionary technology that have the potential to completely change transportation networks all over the world.[2][3] . One of the important part of the AV's is the decision making there are a several step in AV's before make a decision like the first is perception where the AV's use the sensor to perceive the environment then the AV's predicting the future behaviour next the AV's Motion planning and control these are the Common decision Algorithm in AV's [4], according to another research where the AV's need to integrating various method to improve the safety and the efficiency in decision making [5].multi attribute decision making in AV's is effectively increase the decision making in AV's [6].But AV's have struggles with uneven infrastructure throughout its various areas, varied topography, and inconsistent driving conditions [2]. Even though big cities like Jakarta have reasonably developed road networks with identifiable traffic signs and lane markings, large portions of the nation still lack even the most basic road infrastructure. [3]. A significant barrier to the widespread use of AVs is this stark infrastructure gap.[7] Advanced sensor technologies, such as LiDAR, radar, and cameras, which allow cars to sense their environment and navigate on their own, are essential to the development of autonomous vehicles.[8], Each of the three sensors mentioned above has benefits of its for Cameras perform badly in bad weather, but they excel in object categorization and image clarity. LiDAR is expensive but provides very accurate and precise 3D mapping. Although RADAR lacks detailed imaging, it is excellent at identifying object speed and distance in all types of weather. [9]Pedestrian behaviour poses a significant challenge to the safe integration of Autonomous Vehicles (AVs) into urban environments, particularly in countries like Indonesia where jaywalking is prevalent, and enforcement of pedestrian laws may be insufficient. [10] where the presence of jaywalkers complicates this task, potentially endangering the intelligence of AV systems and undermining public confidence in autonomous transportation [11] In Indonesia. there is another study that show relation between AV's and pedestrian where pedestrian participate and influence the decision making of AV's where in many case AV's can anticipate but according to this paper the is

room for impairment between two of this[12] , where jaywalking is a common occurrence and enforcement of pedestrian regulations may be inconsistent, the expansion of AV technology faces heightened scrutiny[13]. AV's need a adequate regulation and enforcement measures, because without them the risk of accidents involving jaywalkers and AVs remains a pressing concern.[14] Consequently, the approval and widespread adoption of AVs may be contingent upon the implementation of more stringent pedestrian regulations and enforcement mechanisms to ensure the safety of all road users.[15] AV's adaptability can improve with Human-like driving where By simulating human social intelligence, the AV's system can increase AVs' ability to adjust to actual road conditions [16]

- Autonomous Vehicle Viable In Indonesia

Due to Indonesia's involvement in the worldwide trend of utilizing AV technology to improve road safety and lower human error, autonomous vehicles (AVs) are regarded as feasible in the nation.[17] Although there are no laws specifically governing autonomous vehicles (AVs; instead, the Traffic and Road Transport Law governs them), the absence of such laws does not preclude their usage but could discourage investment in their advancement. Deploying AVs in Indonesia is hampered by the country's uneven roads, irregular traffic patterns, and unofficial transportation options. This will be the challenge for AV's in Indonesia where according to research we found that AV's have a significant connection to road infrastructure where the AV's need to coordinated with the road this is also connected to digital map and road surface quality to increase the safety for AVs.[18] However in now days AV's algorithm can detect pothole and speed breaker[19] in road use the Cam of AV's where according the research that we found that the accuracy is good for detecting the pothole and speed breaker[20] where another research found that the uses of YOLOv5 for detecting potholes and speed breaker it reveals to be incredibly accurate [21], The improvements in technology and localization could make them viable in particular contexts or use cases. Research shows that AVs are generally accepted by the public, especially when it Respondents acknowledged that AVs might provide advantages such enhanced accessibility, less traffic, and safer travel.[22] Adoption success depends on addressing public concerns about security[23], employment displacement, hacking risks, legal challenges, and possible fare rises.[24] The study emphasizes that there are substantial prospects for AV adoption in Indonesia due to its fast growing middle-class population and critical role in the worldwide shift to electric vehicles (EVs). The results, which highlight the need of addressing issues and enhancing perceived advantages, indicate that perceived benefits strongly predict public acceptance when using the Technology Acceptance Model (TAM) and the Unified Theory of Acceptance and Use of Technology (UTAUT). A potential future for AVs in Indonesia's transportation system is also suggested by the development of AI-integrated camera systems that limit AV speed based on weather conditions[25]. These developments show continued efforts to adapt AV technology to the Indonesian setting. Furthermore, the implementation of AVs is in line with the Indonesian government's efforts to advance smart city ideas.[26] Cities like Bandung, Surabaya, and Jakarta are already making investments in digital infrastructure, which might make it easier to integrate AV by offering the platforms for real-time data sharing and sophisticated traffic control, among other support systems. As shown by a number of pilot projects and alliances with global IT companies specializing in AV and smart infrastructure.[27] Cooperation between the public and private sectors is essential in this regard. The regulatory structure is a noteworthy problem. Although the current Traffic and Road Transport Law provide a fundamental legal framework, extensive laws designed with autonomous vehicles (AVs) in mind are necessary to handle liability concerns, safety requirements, and operational guidelines.[28] As was already mentioned, public acceptance is a critical component. Citizens of Jakarta's favourable opinion of autonomous vehicles (AVs) for public transportation points to a preparedness for AV integration—so long as security, job displacement, and data privacy issues are sufficiently handled. Promoting public awareness of the advantages and drawbacks of AV technology through educational initiatives and open dialogue can be very effective in increasing public trust.[29]

- Autonomous Vehicle Safety

Drawing from extensive frameworks in nations like Germany and South Korea, it is imperative to establish clear legislative standards that address liability in accidents and the risk of hacking in order to improve the safety of autonomous vehicles (AVs) in Indonesia[30]. These consist of AV insurance plans, operational testing grounds, and technological specifications. A multifaceted strategy is required, including stringent AV system testing and validation.[31] Strong cybersecurity safeguards, public awareness campaigns, and the creation of safety guidelines are also necessary for a range of driving situations. Addressing safety concerns and fostering public trust need cooperation between the public sector, business community, and academic institutions[32]. The cybersecurity in AV's must be improved in order to raise security and lower the risk of cyberattacks[33] .Thorough testing prior to deployment is required to guarantee AVs can safely handle a range of road conditions.[34] Improving public acceptance requires addressing safety concerns, including perceived hazards associated with autonomous vehicles (AVs), system failure, and occupant and road user safety.[35] It is crucial to create AV-friendly architecture, legislation, and infrastructure in addition to educating the public about the advantages and safety features of AV technology.[30] AV safety can be improved by using systems that employ deep learning algorithms to identify weather conditions and modify vehicle speed in order to reduce risks associated with bad weather.[36] AV's also need to aims the pedestrian safety where according to this paper that AV's not only detect pedestrian but also predict their behaviour to avoid mitigate collisions.[37]. According to the research using a Bayesian Extreme Value Theory Modelling Framework to increase the of autonomous vehicle where from that research found that The block maxima approach, when using autonomous vehicle sensor data, is a promising method for corridor-wide pedestrian crash risk assessment. The framework can efficiently identify pedestrian crash risk zones in transport networks [38].in Another research also found that digital twin where refers to a virtual representation of a physical system where in autonomous vehicle it means When utilizing a real

autonomous car, the virtual component keeps operating and gathers data from the real car, which can improve security[39]. Using machine learning to increase the safety where In this study, ISO26262, which focuses on minimizing risks due to electrical and electronic faults, and ISO/PAS 21448, which addresses performance limitations and guarantees the safety of machine learning components in unexpected scenarios, are used to enhance the safety of autonomous vehicles through machine learning [40]. It is crucial for very advanced AI to assess their surroundings to be able to identify their surroundings within a short period of time and predict a good outcome.[41] Gaining public acceptance and guaranteeing the effective integration of AVs in public transportation will be further aided by addressing legal obligations and enhancing the benefits that are regarded as having been achieved by AVs, such as enhanced safety and efficiency.[42]] to promote the safety of autonomous vehicle another study show that AV safety and predictive capacities are greatly increased by combining integrating advanced computer vision and neural network approaches. Three thorough case studies are included in the study to show how well the proposed algorithms work in practical situations[43]. In order to reduce the probability of collisions, these case studies concentrate on enhancing lane detection for both straight and curved roadways and forecasting the trajectories of nearby cars.[11]

- Public perception about autonomous Vehicle

According to the document, public opinions and concerns regarding the safety of autonomous vehicles (AVs) in Indonesia are probably similar to those in other nations. These concerns include the dependability of AV technology, the possibility of accidents, the loss of jobs in the transportation industry, privacy issues, and potential ethical and legal ramifications. It is implied that Indonesians are worried about autonomous vehicles' (AVs) ability to drive safely, vulnerability to hacking, and liability in accidents, even though this isn't expressed clearly. Indonesia must create a legal framework that supports autonomous vehicle safety, carries out thorough testing, and conveys the advantages of AV technology—such as fewer traffic accidents and more transit efficiency—in order to allay public fears and win over the public.[44] Large-scale studies on public acceptance across varied locations are crucial, as evidenced by the impact of characteristics such as gender, safety perceptions, and the frequency of transportation modes on public perceptions.[45] The survey reveals an underlying acceptance of autonomous vehicles (AVs) because of their potential to improve accessibility and quality of public transportation, particularly for non-drivers. Participants underlined that before adoption, stringent government testing is required. Safety concerns may be further allayed by the development of safety systems, such as deep learning algorithms for weather detection.[46] and speed adjustment.[47] Another aspect is the detection of traffic signs for the navigation of the Autonomous Vehicles, to promote safety and allow further advancement in the technology to be able to abide by traffic laws.[48] All things considered, calming public concerns, showcasing the advantages of the technology, and maintaining open lines of communication are essential for AV adoption to be effective in Indonesia.[49]

IV. Conclusion

The viability and difficulties of deploying autonomous vehicles (AVs) in Indonesia are examined in this article. The authors contend that although AVs might be practical in large cities like Jakarta, where the roads are reasonably well-developed and have distinct indicators, the absence of road infrastructure and indicators makes it extremely difficult to install AVs in smaller cities and rural areas. The uneven development of infrastructure throughout the nation presents a significant obstacle to the widespread use of AVs in Indonesia.

The article highlights the serious problem of jaywalking's ubiquity in Indonesia, which puts AVs' safety at serious danger. Developing dependable AI systems for autonomous vehicles is made more difficult by the unpredictability of pedestrian behavior, particularly that of jaywalkers. The authors suggest that the government may need to enforce stricter pedestrian laws to ensure the safety and effectiveness of AV systems.

The significance of public acceptance and perception of autonomous vehicles (AVs) is also covered in the document. This acceptability is influenced by worries about cybersecurity, job displacement, safety, and legal ramifications. The authors suggest a multipronged strategy combining the government, business community, and academic institutions to resolve these issues. This strategy should focus on improving public education, establishing clear legislative requirements, and thoroughly testing AV technology.

In summary, autonomous vehicles (AVs) have the potential to significantly improve transportation in Indonesia's larger cities; however, their implementation in smaller cities is impeded by insufficient road infrastructure and the pressing need to tackle pedestrian safety, including the problem of jaywalking. In order to overcome these obstacles and clear the path for the appropriate integration of autonomous vehicles (AVs) into Indonesia's transportation system, the authors propose a comprehensive plan.[50]

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