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Exploring Policy Interventions to Support the Introduction of Autonomous Vehicles in Indonesia

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Sandhi Wiedyanoe[1*], Achille Fonzone[2], Jonathan Cowie[3], Dhanan Utomo[4]

[1, 2,3]School of Engineering and Built Environment, Edinburgh Napier University, Edinburgh, United Kingdom
[4]Edinburgh Business School, Heriot-Watt University, Edinburgh, United Kingdom
Corresponding Email: *sandhi.wiedyanoe@napier.ac.uk

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Abstract

This paper aims to analyze policy interventions regarding the implementation of autonomous vehicles (AV) in Indonesia. The research takes place in Jakarta due to its unique characteristics and status as one of the most congested cities in the world. The paper employs the qualitative approach to understand policy intervention for AV implementation. The methods used in this research are the combination of Focus Group Discussions (FGDs) and Semi-Structured Interview. This research elaborates that AV implementation in Indonesia should come in the form of AV buses in the initial stage. Thus, it is necessary in the context of AV buses to construct dedicated lanes, provide onboard stewards, and give government incentives in a way that ensures the adoption's success rate. Furthermore, the thematic analysis of the research also emphasizes several themes in the context of AV implementation, such as implementation, accessibility, regulatory framework, sustainability, local characteristics, and annotation. These themes could provide a comprehensive understanding related to the policy intervention that should be taken by the Indonesian government regarding the AV implementation in Indonesia.

Keywords: Autonomous Vehicles, Policy Framework, Road Safety, Air Pollution, Emerging Economies

INTRODUCTION

According to data released by the Indonesian National Traffic Police, human error is often considered the most likely cause of traffic accidents, with Indonesia leading the ASEAN region in this regard (INTP, 2019; Radam et al., 2022). This alarming trend underscores the urgent need for innovative solutions to improve road safety. Concurrently, Jakarta, the capital city, has been grappling with severe air pollution, ranking among the world's most polluted cities since May 2023 due to chronic traffic congestions (Reuters 2023). The confluence of high accident rates and severe pollution necessitates systemic interventions to address these intertwined challenges.

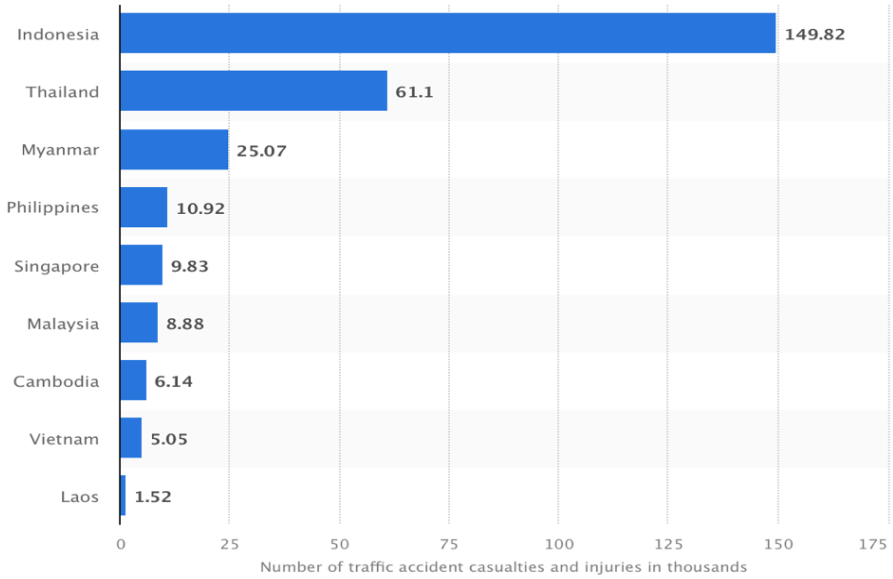

Figure 1. Estimated number of traffic accident casualties in ASEAN in 2019, by country (in 1,000s)

To overcome those problems stated in the previous paragraph, Autonomous vehicles (AVs), particularly those with level 4 and 5 automations, present a promising solution. These advanced vehicles are designed to minimize human errors, which are a significant cause of accidents. Beyond enhancing safety, AVs, especially electric ones, offer substantial environmental benefits. Studies indicate that electric AVs could reduce air pollution by 17-30% (Brown and Dodder 2019; Taiebat et al., 2019). Given Indonesia's high road accident rate, where 13 accidents occur per hour and result in three fatalities nationally between 2019 and 2021 (Statista 2022), the deployment of AVs could significantly improve both road safety and environmental quality.

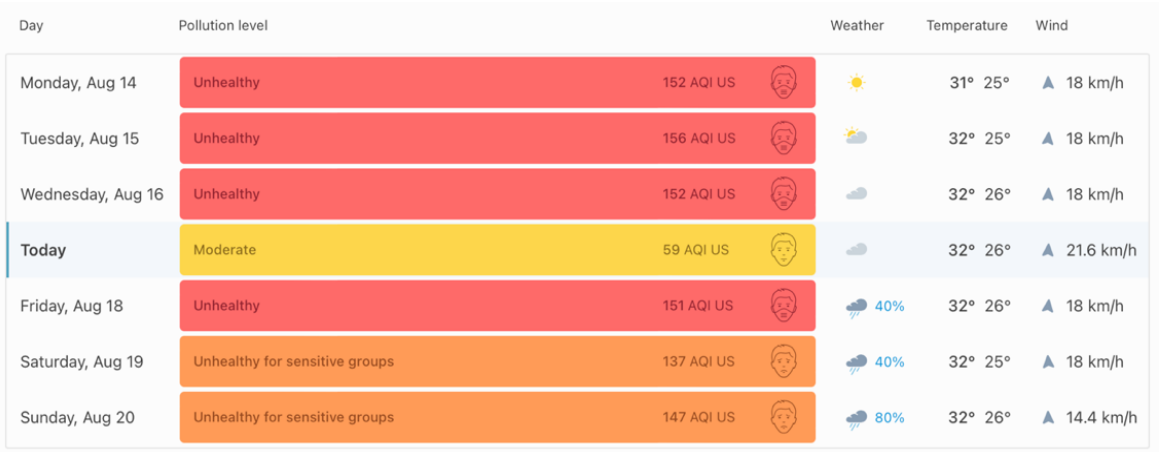

Figure 2. Air pollution in Jakarta between 14 and 20 August 2023 (Source: IQAir)

Despite these potential benefits, the introduction of AVs in Indonesia presents considerable challenges. Unlike the United Kingdom and the United States, where AVs have been integrated into various forms such as buses, delivery vehicles, and robot taxis (Figliozzi 2020; Fonzone et al., 2023), there is limited research on AV adoption in Asian emerging economies. Studies related to measuring the effectiveness and efficiency of AV policy implementation are predominantly conducted in Europe and the United States, thus creating a gap of understanding in different socioeconomic and cultural contexts (Carrone et al., 2021, Kapser et al., 2021). In an attempt to understand about socio-economic and cultural contexts of AV implementation, it is crucial to experiment with relevant policies in Indonesia.

Past literature has undressed the dynamics of AV implementation, which consists of several factors, such as public perception, technological infrastructure, and the readiness of regulatory framework. The studies of Bosch et al., (2018) and Wadud and Mattioli (2021) have emphasized the necessity of incentives to improve the AV adoption in Europe and the United States. However, the unique socio-economic variables of Jakarta and its driver behavior which could pose a hindrance in implementing AV policy are not covered specifically in these studies. In addition, the study of Aarhaug and Olsen (2018) explains the need to adapt regulations in the dawn of emerging technologies, in which their findings primarily draw on the case of more developed regions, leaving a gap in the applicability of AV implementation for developing countries, such as Indonesia.

The pursuit of AV implementation requires an understanding of the factors that underpin policy implementation. These factors, which include local conditions, traffic patterns, the regulatory environment, and public attitudes toward new technologies, are classified in a comprehensive policy framework. These aspects, when properly combined, have the potential to improve AV implementation in Indonesia. By examining the Indonesia's early AV implementation policy from the viewpoint of experts and policymakers, this study seeks to comprehend and close the gaps. This study will attempt to provide comprehensive insight into the adoption of AVs in Indonesia by employing the qualitative approach. In addition, the choice of nation. which is Indonesia might address the issues that cannot be resolved in a Western setting.

This study aims to identify the obstacles that the implementation of autonomous vehicles in Indonesia presents. Since there is still no academic literature suggesting that Indonesia and other emerging economy countries should implement the AVs, this research could prove its significance in the academic literature on AV implementation. Thus, this research might help the implementation of AVs which in the long run might reduce the number of casualties in road accidents thus creating a safer transportation means in Indonesia. Furthermore, the AV implementation could reduce the pollution created by fuel vehicle transportation, thus increasing the public health level in Indonesia. This claim is supported by research by Mayastinasari & Lufpi (2022), which shows that technology implementation plays a significant role in enhancing road safety measures. For instance, the

Indonesian police's Electronic Traffic Law Enforcement (ETLE), which tracks drivers' actions, is effective in lowering the number of traffic accidents. As a result, the introduction of autonomous vehicles (AVs), the next technological advancement in road transportation, will undoubtedly increase road safety and security (Mayastinasari and Lufpi, 2022).

METHOD

This study employs the qualitative approach to elaborate policy intervention in early-stage implementation of AVs. The use of the qualitative approach is meant to explore a deeper understanding from the source (Yadav, 2022) which is the arguments of the experts and policymakers that are encapsulated during FGDs and interview. This research then combines the data which are gathered from focus group discussions (FGDs) and semi-structured interviews. This combination allows a better triangulation, furthermore enhancing the reliability and validity of the results (Braun and Clarke, 2021).

The following paragraph is an explanation of the steps involved in the research procedure. Firstly, the authors conduct a focus group discussion with a group of experts which are selected based on their capabilities in the field of transport and policy making, the selection of the experts is based on the PESTLE framework (Political, Economic, Social, Technical, and Environmental). The PESTLE framework is prominent in ensuring a diverse source of argument from different experts in transport and policy-making fields (Tagesse et al., 2024). Due to the geographical boundaries, the FGDs are done by using virtual meeting platforms, such as Ms. Teams, Zooms, and Miro Board.

The FGDs are conducted with several topics including the SWOT (strength, weakness, opportunities, and threats) analysis of AV implementation in Indonesia, the challenges of public, private, and shared transportation in AVs, and lastly, the early-stage steps which should be taken to address the AV implementation in Indonesia. The selection of topics is based on the aims of the study which is to elaborate the policy intervention that is needed in employing AV in Indonesia. After conducting FGDs, the next step is gathering answers from the experts and policymakers in the form of semi-structured interviews. The use of semi-structured interviews is prominent to further elaborate and produce relevant data which could be triangulated in the analysis to gain an depth analysis regarding the policy intervention to implement AV in Indonesia.

The results of the FGDs and interviews are recorded with the permission of the participants. The recording is further transformed into a dataset using the help of NVivo, and then systematically constructed by using thematic analysis. The use of thematic analysis to construct the result of this research is prominent to gain an understanding by making several recurring themes, patterns, and narration (Braun and Clarke, 2021). Regarding the AV implementation in Indonesia, the ethical approval of this study was gained from the relevant institutional review board to ensure the ethics protocols are followed in this research. The participants were informed regarding the purpose and

aims of the study. Moreover, their rights were also told before the process of FGDs and interviews. This step ensures the confidentiality and anonymity of the research.

RESULTS AND DISCUSSION

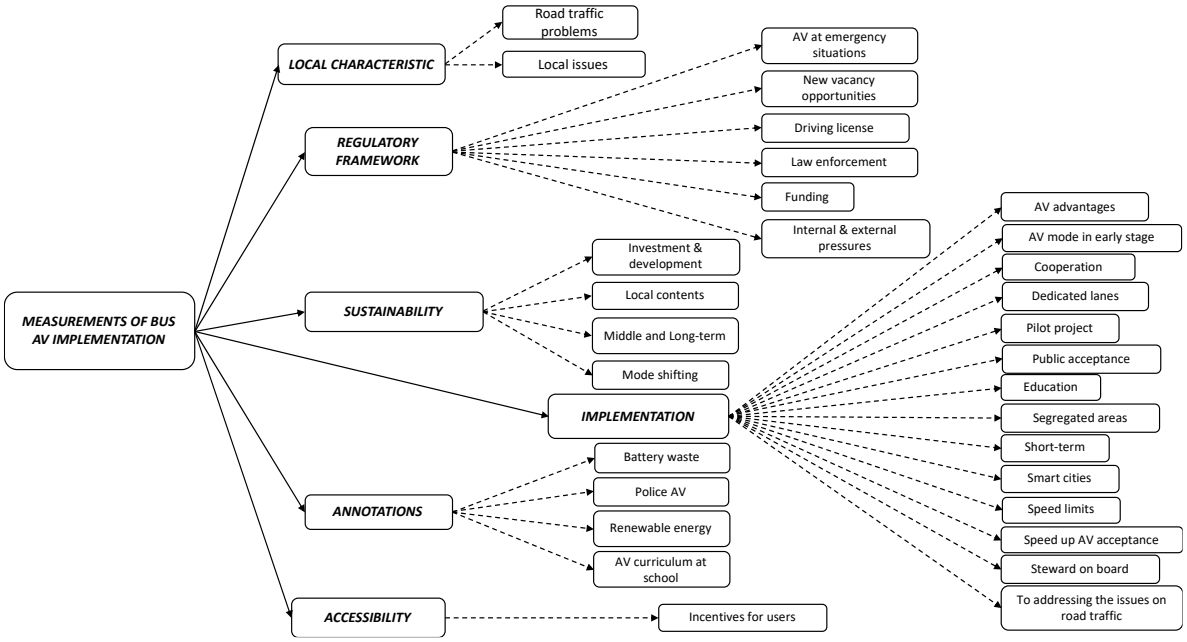

Figure 3. Measures to Support Automated Buses Deployment in Jakarta

This section provides the results and discussions regarding the research that has been conducted using FGDs and interviews with Indonesian experts and policymakers in the field of transportation. The results are then classified into six sub-themes which consist of implementation, accessibility, regulatory framework, sustainability, local characteristics, and annotation. These sub-themes are generated using thematic analysis which triangulates the data extracted from the FGDs and interviews. Furthermore, each of the sub-themes will be elaborated in the paragraph as follows:

Implementation

According to the FGDs and interviews with experts and policymakers in Indonesia, it can be understood that the early application of AVs in Indonesia should be done in the form of AV buses. These results align with the statement of Fonzone et al. (2023) and Iclodean et al. (2020) which stated that autonomous buses are preferred for the initial implementation of autonomous vehicles. The use of AV buses will be a relevant solution in the implementation of AVs in Indonesia. However, two factors need to be addressed in implementing AV buses in Indonesia. The first is the construction of dedicated lanes, and the second is the presence of human stewards or stewardesses inside the AV

buses. These two factors are highly important. The use of dedicated lanes is important for a reason: one of the reasons is that dedicated lanes will set boundaries between traditional vehicles and autonomous vehicles (AVs) because a combination of autonomous buses and non-autonomous vehicles on an open road may increase the likelihood of accidents and congestion (Loder et al., 2019). Furthermore, a dedicated lane will also decrease the likelihood of road accidents, because it could gatekeep the AV buses from the erratic behavior of Indonesian drivers. In addition, the use of dedicated lane will increase the efficiency of AV buses. These statements regarding the importance of dedicated lanes are implied by the experts as “dedicated lanes are needed to ensure AV buses could operate safely and efficiently given the characteristics of the traffic environment, including driving behaviors in Jakarta" (FGD-4, 2024).

The next factor is the presence of a steward or stewardess inside the AV buses. The steward could become a human bridge that connects the traditional means of transportation, such as the manual vehicle with an autonomous vehicle. This statement aligns with the results of the FGD which connotes that "a steward could help bridge the gap between traditional and autonomous system; provide reassurance to passengers; and address pressing issues inside the AV buses" (INT-3, 2024). Furthermore, the presence of a steward will ensure the regulations inside the bus are properly implied by the passengers, thus increasing the security of the AV buses (FGD-1, 2024).

Accessibility

Theme focuses on emphasizing the efforts to increase the access of AV buses to all roads in Jakarta, and encourage the use of AV buses compared to private vehicles. From the FGDs and interviews, both experts and policymakers agree that to increase the use of AV buses certain policies include giving incentives in the form of ticket discounts, tax benefits, and subsidies for the AV bus providers. This statement is further elaborated as “incentives for AV bus users and disincentives for private vehicle users are predicted to be very effective in changing public transport preferences” (INT-2, 2024).

Giving incentives is arguably profound and efficient in increasing the number of passengers, this could happen by making the economic rational choice much easier for people (FGD-2, 2024). Aside from giving incentives, it is also a proponent of public awareness campaigns about the benefits of AV buses. The campaign's importance is described as "Public campaigns should focus on the tangible benefits of AV buses, such as increased safety and reduced emissions. This will help in garnering public support and acceptance,” (FGD-2, 2024).

Experts and policymakers believe that including the narration of EVs inside school curriculum will play a bigger factor in increasing the awareness of EV importance in reducing congestion and air pollution. These findings are aligned with the research of Bösch et al. (2018) and Wadud and Mattioli (2021). Furthermore, the example from cities like Los Angeles and London

proves that a good incentives strategy bonded with an effective public awareness campaign could alternate the public transport preferences and shift the public away from private transportation into public transportation (Smith & Jones, 2021; Brown & Thomas, 2019).

Regulatory Framework

Based on the findings of the FGDs and interviews, legislation to enable its implementation addresses several critical issues, such as responsibility, financing, and new job prospects. According to one respondent, several clear regulations are necessary to determine the responsibility for accidents. This demonstrates that when an accident occurs, the person in charge has a problem of accountability. A clear responsibility is also required to improve the trust of the people who will utilize autonomous vehicles as well as developers who will invest in Indonesia. Then, financing is critical in creating this technology. An expert stated that, “Funding from the private sector is important and effective in making this program a success in the long term" (FGD, 2024). A policymaker also mentioned that, “Here it is not only the private sector that plays an important role, with government policies on tax relief and subsidies, this technology will also be successful" (FGD, 2024). This conversation emphasizes the importance of collaboration between the government and the business sector in the process of implementing this technology. Several countries have successfully implemented this collaboration, including Germany (Müller & Schneider, 2020). Furthermore, the presence of AVs will create several new job opportunities in a variety of industries, some of which require as the expert says, "There will be job opportunities that are very specific to certain areas so that skills are also needed that can meet the challenges of the job. The need for training to hone the abilities of job seekers so that they can compete globally"(FGD, 2024). Moreover, this statement is emphasized by the argument of the policymakers which stated that, "We already understand very well that this is something new so that new or special skills are needed so that it has implications for new training too"(FGD-3, 2024). With a well-planned training, job seekers will be able to meet the demands of work that will be available later. The government needs to collaborate with both domestic and foreign campuses to provide training or even create new majors to meet this challenge. New job opportunities will also appear alongside the implementation of AVs which is aligned with the research of Emory et al., (2022) and Hilgarter and Granig (2020). Moreover, with the increasing establishment of vocational training centers due to the implementation of the AV industry, Indonesia could increase the workforce which is in correspondence with the rise of the AV industry (Kim and Lee, 2021).

Sustainability

The term sustainability, as used in this research, refers to an effort to comprehend and control the effects of AV adoption. Williams et al. (2020) stated that the environmental, social, and economic

aspects of AV sustainability can be covered. As a result, this part will attempt to explore sustainability issues from the viewpoint of Indonesian experts and policymakers. The first topic to be covered here is the environmental sustainability of AV buses. While it is stated explicitly that using AV buses will benefit the environment, improper use of AV buses could result in even more harmful environmental disasters., This might occur in a situation where individuals in Jakarta cannot easily use the AV buses, which would lead to a new issue where people would prefer to utilize private vehicles instead of the AV buses (FGD-2, 2024).

The second aspect of sustainability that will be discussed is the social aspect which covers the social impact of AV bus implementation in Jakarta, as we discussed earlier in the Local Context section Jakarta's social condition could be defined as a unique social condition which includes a seemingly erratic behavior of the driver, and low effectivity of transportation modes which are provided by the government (FGD-2, 2024). This unique social condition could hinder the development of AV buses in Jakarta if not handled and compromised correctly. According to Williams et al., (2020), autonomous vehicles should be incorporated into people's social lives to foster long-term sustainability in the context of autonomous vehicle development.

The final component of sustainability to be covered is the economic component, which consists of both public and private sector investment. One pertinent example of this is the Japanese government's consistent investment in the development of autonomous vehicles (AVs), which includes funding for infrastructure development and research (Tanaka & Ito, 2020). The Japanese government investment program could become a model for Indonesia. This argument is emphasized in the FGD (2024) as "Indonesian government must create a systematic investment program of AV implementation. This could manifest in the form of research fund and infrastructure development." However, investment alone would not be sufficient; another important factor that should be addressed which is economic regulation. Economic regulation could appear in the form of policy that impacts the economic condition, one such is the policy that should be taken to prioritize the employment of local human resources (INT-1, 2024). This policy will eventually strengthen the local economy and in the long run will become beneficial for the nation economy (FGD-1, 2024).

Local Characteristics

The local characteristics theme focuses on the unique behaviors which are shown by Jakarta's Road users and how these unique behaviors impact AV implementation. Experts and policymakers from Indonesia argue that *"The driving behavior in Jakarta is unpredictable, which can hinder AV operations. Dedicated lanes and driver education programs are necessary to mitigate these challenges"* (FGD-4, 2024). Thus, it is important to address this problem by increasing the regulatory framework through the implementation of stricter laws. This stricter law could also benefit the application of dedicated lanes.

The discussion also highlighted the need to understand the importance of addressing the travel behaviors of Jakarta's residents to design effective AV policies. The expert suggests that "*Understanding the travel behavior of Jakarta's residents is essential for designing AVS policies that meet their needs and preferences. This includes factors such as travel patterns, mode choices, and preferences for public transport"* (FGD-1, 2024).

Annotation

The theme "annotation" refers to the fresh ideas and concepts that are being recorded through the FGDs and interviews. These fresh ideas are meant to increase the likelihood of implementation regarding the AV buses in Jakarta. These ideas were sculpted by the experts and policymakers in Indonesia and its consists of battery waste, Police AVs, and AV curriculum at school. Furthermore, this section will try to elaborate each of these ideas.

One of the issues that emerged in the FGD was battery waste. As we all know, autonomous vehicles (AVs) run on electricity, which makes them more environmentally friendly than fossil fuel-powered vehicles. However, the electricity required to power AVs requires a reservoir called a battery, and these batteries are becoming problematic due to their non-recyclable nature (Bellekom et al., 2012). Though some experts argue that the issue of battery waste will eventually resolve itself (FGD-5, 2024), both academics and policymakers are optimistic that advancements in the technology supporting battery cells will occur in the future.

The next subtheme is police in AVS. This concept arose around the discussion of the regulatory framework in which some experts argue that "the implementation of AV buses will inevitably need the assistance from police as a physical embodiment of law in the context of AV implementation" (FGD, 2024). This argument is relevant to the positive law theory which states that law exists as a tool of the government that protects and safeguards the nation's interest (Kelsen, 2017). Moreover, Hutapea's research (2023) demonstrates that police should leverage technology to thwart the creation of safety measures, as big data has the potential to spur police innovation (Hutapea, 2023).

The last subtheme is AV curriculum at school. Some experts argue that the need to add AVs to school curriculum could boost the development of AVs in Indonesia. This argument is elaborated by the experts as "We need to add AVS into the school curriculum. This steps will indirectly boost the development of AVs in Indonesia by nurturing future generation about the needs of AVs in Indonesia for a better and safer means of transportation" (FGD-5, 2024).

CONCLUSION

From the findings of this research, it is prominent to notice that there are several options of steps that could be taken to ensure early-stage implementation of AVs in Indonesia. The research has

stated that the first form of AVs that should be used in Indonesia is AV buses. Expert from the transport and policymakers in Indonesia argues that the use of AV buses is necessary in the early development of AVs in Indonesia, However, it should be understood that two complementary factors should be considered: the first factor is the need for dedicated lanes and the second factor is the need of attendant inside the AV buses to help people and to make sure the AV buses are operated in a safe secure condition. The attendant presence should also fill in the gap in the transition process from the traditional means of vehicle and autonomous vehicle system.

From the accessibility and regulatory framework themes, it can be concluded that the AV buses should be accessible on all roads in Jakarta and distinct and clear law regulations should be provided by the government. The clear and distinct law regulations are needed due to the unique behavior of Indonesian people which are quite erratic compared to the developed country. Furthermore, superficial to give incentives in the forms of reduced ticket prices, tax reductions, and subsidiaries for the AV buses operator. These incentives are important to increase the awareness and provoke society to try AV buses. However, the need to raise public awareness should not be taken for granted; the need to monitor and adapt the needs of the public is important to increase and maintain public awareness.

In the long term the development of AV transportation in the form of AV buses could address the congestion and pollution problems in Jakarta. These findings are aligned with the 'Sustainability' themes. The 'Local Characteristics' themes connote that there is the need to understand the local context which includes the driving culture of Indonesian people which is often described as quite erratic. This should be taken for the measure to reduce the risk of malfunctions and accidents which could happen due to the erratic driving behavior in Indonesia. Furthermore, there is a need to address the erratic driving behaviors in Indonesia. This should be done in the form of crafting an AV curriculum in the school. This development of this AV curriculum in the long run should increase the understanding of Indonesian people regarding the AVs and its development.

The next stage of the research is to conduct an online survey to investigate the AV buses acceptance if the government implemented dedicated lanes, stewards on board, and price incentives. The survey deployment will be in December 2023, with a target of 1000 respondents. Qualtrics is the survey data entry platform, and the results will be analyzed using SPSS statistics software. This survey will provide quantitative data to complement the qualitative findings of this study, offering a more comprehensive understanding of public acceptance and refining future AV policies for optimal implementation, as implementing efficient methods for data recording and analysis is crucial for monitoring and improving AV operations, which was highlighted by Waspada, Hamid, & Syafruddin (2023).

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