Attitude Towards and Intention to Use After Experiencing Autonomous Vehicles: Evidences from Indonesia

Asnan Furinto
Doctoral Research Management, School of Business Management, Bina Nusantara University
Jakarta, Indonesia
afurinto@binus.edu

Alvin Putradi Sasmita and Armendra
School of Business Management, Bina Nusantara University
Jakarta, Indonesia
alvin.sasmita@binus.ac.id; armendra@binus.ac.id

Dewi Tamara
MM Executive, Management Departement, BINUS Business School Master Program
Bina Nusantara University
Jakarta, Indonesia
dtamara@binus.edu

Abstract

Autonomous Vehicles (AV) are expected to solve transport congestion in big cities as well as increasing safety for road users and improving mobility efficiency for the public. Thus, it is only natural that smart cities would like to adopt AV as part of their development. One such smart city is Bumi Serpong Damai (BSD) City, located in Tangerang, Banten, Indonesia. The purpose of this paper is to provide insights into adoption factors that are important for public perceptions towards AV and their influences toward intention to use AV based on the Technology Acceptance Model. The researchers did quantitative surveys to people that have experienced AV first-hand on perceptions of the benefits, both personal and social benefits, mobility-related efficiencies, and safety concerns as the key AV adoption factors. The researchers understand that AV have been tested on several developed countries before, but this is the first trial run for public in a developing country. This study found several evidences on factors that that have positive correlation with the public attitude towards and intention to use AV as a new technology in a developing country.

Keywords
Autonomous Vehicles, Public Transport, Perception, Attitude, Intention to Use

1. Introduction
Our world is seeing a wave of urbanization that has changed the area where people live. In present time, there are more people living in big cities instead of rural areas. (Ritchie, H. & Roser, M., 2019). Based on data from United Nation, it is estimated that 55% of the world's population is living in urban areas around the world and it is estimated that this number will rise to 68% by 2050.

Indonesia, as a developing country in the ASEAN region (World Bank, 2022), is also following that trend. It is estimated that around 56% of Indonesians live in urban areas and that this number is estimated to continue to grow up to 73% by 2050. (United Nations, 2018).

With this wave of urbanization, mobility has become one of the key factors affecting urban areas or big cities citizens' well-being and life-quality (Melis et al., 2015). In addition, by considering our highly motorized and car-reliant society, urban mobility is also a source of major problems in urban areas, such as: traffic congestion, air pollution, travel time and several other factors associated with moving people and goods around (Antonialli, 2019). These major challenges need to be tackled on so that they will not pose as threats to urban living (Clausen, 2017), and big cities

© IEOM Society International

around the world are coming to the realization that they may need to spend more efforts to develop more sustainable transportation systems for the best interest of their citizens (Pancost, 2016).

Autonomous Vehicles (AV) are seen as one of the modern technologies that could make a dramatic impact as the future of transportation in smart cities (Chehri & Mouftah, 2019). Smart cities should be sustainable by providing a technology backbone to incorporate future possible services (Mitthal & Sethi, 2018). One such services is AV in various forms. In her paper, Attias (2017), stated that revolution of urban areas will mainly occur through the arrival of autonomous vehicles, thus building a new paradigm of urban mobility and smart cities. AV are expected to change urban mobility in cities to be better, by improving traffic efficiencies, reducing the number of accidents, lowering transportation costs and time, as well as promoting social inclusion for everyone (Mutz et al., 2016; Alazzawi et al., 2018). AV are also believed to be able to develop a better traffic condition at smart cities as well as improving users' productivity, and create better environment with less pollution (Bansal et al., 2016; Manfreda et al., 2018). These expectations are supported further by the report from Boston Consulting Group (Lang et al., 2016) and Allied Mineral Research (2019) that reported that over the last decade, AV has been adopted by more companies around the globe for its prospect to reduce road traffic and road accidents, as well as its prospect to address numerous social problems and environmental problems. Many transportation watchers also believe that AV technology would help to improve means of transportation (Government Technology, 2021).

Since AV adoption has long-term implications, awareness of AV early adopters and knowledge about the factors of AV adoption are important (Pettigrew et al., 2019), however most of the researches done on AV are limited to conceptual research since the number of people that have experienced AV first-hand are very limited due to the technology being relatively new and usage were limited mostly to trial runs. Furthermore, in a report written by KPMG in 2019 there were indications that many various countries, such as the United Kingdom (UK), New Zealand, Canada, and Japan, have expressed their concerns about the readiness of the general public to adopt AV when they become available to the public for the first time. Therefore, this paper aims to contribute by gathering valuable insights of the adoption of AV as it is based on a survey that was conducted on people that have experienced riding AV for the first-time or very early adopters (Mitsubishicorp, 2021).

The researchers' objective is to understand whether the public in a developing country is ready to accept the use of AV as a future method of public transportation by highlighting certain AV adoption factors to the public such as perception of benefits, both personal and social, mobility-related efficiencies, and safety as the principal AV adoption factors.

The structure of this paper starter with introduction of the background, followed by literature reviews of the variables and of AV themselves, as there are various levels of autonomous driving that exist at present. Based on literature reviews, hypotheses were developed followed by research model. Once the method of the quantitative study was determined, data from respondents were collected to be analysed and the findings were discussed. This paper is concluded based on the evidences gathered and limitations of the study were explained for further studies.

2. Literature Review

Autonomous Vehicles (AV)

The International Society of Automation or ISA (2021; p.1) defines automation as ''The creation and application of technology to monitor and control the production and delivery of products and services. Thereafter, various definitions of Autonomous Vehicles have been used to describe AV, but to put it into context, The US National Highway Traffic Safety Administration (NHTSA, 2020) defines an Autonomous Vehicle as One that is able to operate itself and perform necessary functions without any human intervention, through ability to sense its surroundings. The Society of Automotive Engineers or SAE further classified automation in the context of AV into six levels: 0–5 (2021). Level 0 means that the drivers perform all the driving tasks; meanwhile, level 5 means that AV can perform all the driving functions under all circumstances. Drivers have the option to take control of their vehicles if they want to. Currently, level 5 AV is unavailable.

The Institute of Electrical and Electronics Engineers or IEEE (2020) reported that level 3 AV permitted drivers to safely disengage from the driving tasks under limited road conditions was introduced in 2020. American National Standards Institute or ANSI provide further definition on AV. They look further from the SAE six levels of automation based on Dynamic Driving Task or DDT (blog.ansi.org). Hence, the breakdown of the six levels of Automation is listed below:

Level 0: No Driving Automation
Level 1: Driver Assistance
Level 2: Partial Driver Assistance
Level 3: Conditional Driving Automation
Level 4: High Driving Automation
Level 5: Full Driving Automation

The AV to be used in the trial run as a mean of transportation in BSD City is called ARMA. It has dimensions of 4,7 meters x 2,1 meters which has a capacity of 15 people, 11 seated and 4 standing. It is equipped with a variety of sensors ranging from Global Positioning System (GPS), Light Radar (LIDAR) sensor combined with a high-resolution camera for analysis (Jakartaglobe, 2022). Based on these observations, we conclude that the AV in this research, ARMA, is an AV with level 3 Automation level based on definition from SAE, IEEE and ANSI. (Jakartadaily, 2021).

Personal Benefits
Based on past studies, it was found that most prospective users think AV to be fun and enjoyable (Kyriakidis et al., 2015). Users found that trips with AV as a new form of leisure time activity and associate the trips with AV with leisure related trips. It was also found that the personal benefits of AV include relieving the stress of driving, higher productivity of people while travelling, and facilitating mobility for any member of population (Bansal, et al., 2016; Manfreda et al., 2018). According to Montoro et al. (2019), potential new users would rather focus on what might personally benefit their daily life than on any social benefits, meaning that for now, AV adoption depends strongly on the factors that are associated with each individual user.

In this study, we define the benefits of being able to maximise the usage of personal phone while riding AV such as talking and texting, watching movies or playing games, as personal benefits. Other personal benefits include being able to sleep or work while riding AV, and being able to enjoy the view out of the window while riding AV. In this study, we argue that personal benefits have impact on Perceived Usefulness and Perceived Ease of Use of the people riding the AV.

Social Benefits
Past studies have reasons to believe that AV could be incorporated into public transport (Skeete, 2018; Whittle, et al., 2019). Successful incorporation of shared AV as public transport services could reduce private vehicle ownership levels that leads to less traffic congestion. While incorporating AV as public transport might need upgrade on existing infrastructure that might require pricing and funding reforms (Pettigrew et al., 2019), it could also lead to a better traffic condition at smart cities (Manfreda et al., 2018) and better environment with less pollution (Bansal et al., 2016). Researchers also mentioned that shared AV public transport as a future alternative to current transportation are expected to be electric vehicles (Jadaan et al., 2017; Jin et al., 2020). The general public like to use 100% electric vehicles as they are seen as environmentally friendly and do not produce pollutant emissions.

In this study, we define social benefits as benefits that will have effect for the public and environment such as lower emissions of AV, lesser traffic congestion, lower public transportation cost, and faster travelling time for road users. In this study, we argue that social benefits have impact on Perceived Usefulness and Perceived Ease of Use of the people riding the AV.

Mobility Related Efficiencies
Benefits of AV that are very appealing for users are those linked to time and financial savings (Whittle et al., 2019). Improvement on mobility-related efficiencies that may be achieved with AV includes shorter travel times, reduced road congestion and improved fuel efficiency (Manfreda et al., 2018). Shorter travel times to increase mobility efficiencies could be realized through the following means: more optimal driving, better prediction of road situations, better speed adjustments and choosing less trafficked roads (Bansal et al., 2016; Manfreda et al., 2018).

In this study, we focus on the improvements that AV could bring when compared to existing transport options as mobility related efficiencies. We want to learn if the public think that AV will have the following impacts: better fuel efficiencies, better judgement on choosing routes, more optimal driving compared to human drivers, more optimal speed adjustment compared to human drivers. We argue that mobility related efficiencies have impact on Perceived Usefulness and Perceived Ease of Use of the people riding the AV.

© IEOM Society International

Safety

Several studies done in the past also considered safety factor and perception towards AVs. Bansal and Kockelman (2017) surveyed 1088 people in Texas to determine their opinions about AVs considering the respondents' demographics, travel, and crash histories. The results suggest that experienced licenced drivers and older people are more reluctant toward AV technologies while younger people are more open toward AV technologies. In other studies, the respondents were most concerned with legal issues, software hacking/misuse, and safety (Kyriakidis et al., 2015; Lee et al., 2017) while optimism regarding AV safety was a key factor to be considered for AV adoption (Manfreda et al., 2018).

Findings from other studies revealed that respondents with direct experience of interaction with AV reported significantly higher expectations of AV safety advantages in comparison to respondents without experience of AV interaction (Penmetsa et al., 2019; Montoro et al, 2019). Furthermore, it is also revealed that the public is engaging more with AV technologies. They also found that as the automation level of the AV increases, the possible perception of safety increases as well. Finally, they concluded that positive sentiments towards AV's safety are more common than uncertain and negative sentiments (Das et al., 2020).

In this study, we want to see if the people riding the AV think that AV is safe for its users, whether AV is safe for pedestrians, whether AV system is dependable, whether AV system is likely to get hacked, and whether AV is more likely to follow road rules and regulations that will lead to less accidents on the road. We argue that safety have impact on Perceived Usefulness and Perceived Ease of Use of the people riding the AV.

Perceived Usefulness and Perceived Ease of Use

In the Technology Acceptance Model (TAM), Perceived Usefulness (PU) is the extent to which a person believes a technology will enhance job performance, and Perceived Ease of Use (PEU) is the extent to which a person believes that using the technology will be effortless. (Lewis, 2019; Davis et al., 1989). Furthermore, Perceived Usefulness is defined by Davis as the degree to which a person believes that using a particular system would enhance their job performance. It means whether someone perceives that technology to be useful for what they want to do. Perceived Easy-to-use is defined by Davis as the degree to which a person believes that using a particular system would be free from effort. It means if the technology is easy to use, then the barriers conquered. If it is not easy to use and the interface is complicated, no one has a positive attitude towards it.

Past research has confirmed that the new technology adoption process as stipulated by the TAM approach applies to the adoption process of new technology (Constantinides et al., 2013). It means the perceived ease of use of AV should have a positive effect on the perceived usefulness of AV and both variables have a positive and direct influence on the intention to use AV and an indirect effect on the intention to use through the attitude towards AV. Based on literature, we believe that perceived ease of use of AV have a positive impact on perceived usefulness of AV. Furthermore, perceived ease of use and perceived usefulness of AV have a positive impact on people's attitude towards AV.

Attitude Towards and Intention to Use

According to the Technology Acceptance Model (TAM), the adoption of new products generally has three parts: attitude, intention, and behaviour or actual usage (Davis et al.). In his research back in 2009, Park correlates satisfaction as a factor that improves users' attitude towards a new technology. In this study, the attitude toward AV is defined as people' general evaluations of AV's potential capability based on their impression. Based on TAM theory, a general positive attitude will result in a positive intention to use. In the context of AV, users may evaluate what they gain or lose from shifting toward using AV (Rahimi et al. 2020).

In their research done in 2013, Constantinides et al., stated that users' attitude towards a new technology are important in predicting intention to use. According to Payre, et al. (2014), research concerning AV must consider the attitude toward AV as it is the predictor of the intention to use AV in the future. Moreover, Yap et al. (2016) concluded in their research that the attitudes regarding certain aspects of AV, such as its trustworthiness, played an important role in the attractiveness of AV. Attitudes towards AV based on several factors such as personal and social benefits, mobility related efficiencies and safety of AV would influence the public intention to use AV based on their perceived ease of use and perceived usefulness of the AV (Haboucha et al., 2017; Nazari et al., 2018; Jin, et al 2020). Therefore, based on previous studies, we argue that the attitude towards AV has a positive impact on the intention to use AV. In this study, the intention to use AV is defined as public readiness to accept AV as an optional mode of transportation.

© IEOM Society International

Hypotheses Development
Based on the literature reviews above, we propose the following hypotheses:
H1. Personal benefits of using AV have a positive effect on the perceived usefulness of using AV.
H2. Personal benefits of using AV have a positive effect on the perceived ease of using AV.
H3. Social benefits of using AV have a positive effect on the perceived usefulness of using AV.
H4. Social benefits of using AV have a positive effect on the perceived ease of using AV.
H5. Mobility related efficiencies related to AV have a positive effect on the perceived usefulness of using AV.
H6. Mobility related efficiencies related AV have a positive effect on the perceived ease of using AV.
H7. Safety concerns of using AV have a positive effect on the perceived usefulness of using AV.
H8. Safety concerns of using AV have a positive effect on the perceived usefulness of using AV.
H9. The perceived ease of use of AV has a positive effect on the perceived usefulness of using AV.
H10. The perceived ease of use of AV has a positive effect on the attitude towards AV.
H11. The perceived usefulness of AV has a positive effect on the attitude towards AV.
H12. The attitude towards AV has a positive effect on the intention to use AV.
H13. The attitude towards AV has a positive and moderating effect between Perceived Usefulness and the intention to use AV.
H14. The attitude towards AV has a positive and moderating effect between Perceived Ease of Use and the intention to use AV.
Research Model in Figure 1.

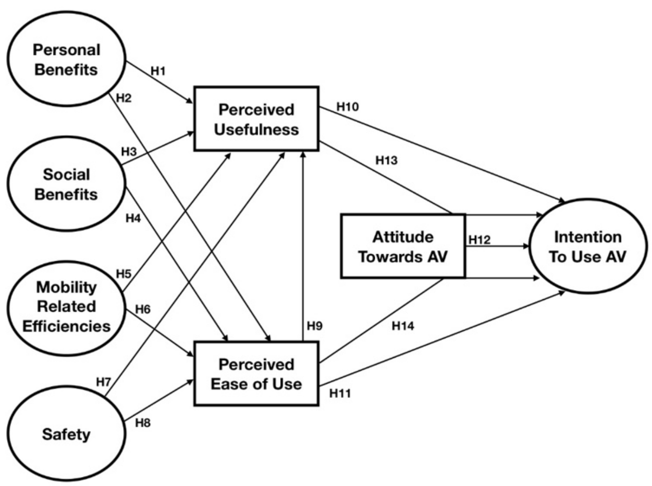

Figure 1. Proposed Research Model

3. Methods

The respondents were drawn using a probability method by simple random sampling method. Table 1 below shows the constructs used in our research adapted from previous studies and were all measured by multiple items five-points Likert-type scales. The respondents were given a barcode that will take them to the list of the questionnaires and filled the questionnaires on Google form through their own mobile devices.

4. Data Collection

For this study we did a direct survey presented to a group of individuals that have experienced first-hand riding ARMA Autonomous Vehicle in BSD City during the second week of July 2022. In this first ever AV open for public test run in Indonesia, the AV in use, ARMA, circled a shopping complex called Qbig located in BSD City, Tangerang. ARMA would take passengers from one lobby to another lobby, going through a route that goes for around 2 kilometres long, with a cruising speed between 10 – 20 km/h. A total of 350 people participated in the study, of which 5 of them did not submit valid data, either by not finishing the questionnaire or accidentally picked to participate despite being not old enough (aged 15 years old minimum). The final sample consisted of 345 people aged from 15 years old and above, of which 161 or 46,7% were males and 184 or 53,5% were females. 39,7% of the respondents were between 15-24 years old, 44,1% of the respondents were between 25-34 years old, 13,6% of the respondents were between 35-44 years old and 2,6% were 45 years old or above. 60,6% of the respondents live in Tangerang area (the city where the study was done), while the rest of respondents live in neighbouring cities (Jakarta, Bogor, Depok, or Bekasi).

Table 1. Operationalization of Variables (in English)

Code	Indicator	Scale
Personal Benefits (Bansal, et al, 2016)		
PB01	I could text or talk while riding AV.	Likert 1-5
PB02	I could sleep while riding AV.	Likert 1-5
PB03	I could work while riding AV.	Likert 1-5
PB04	I could watch movies or play games while riding AV.	Likert 1-5
PB05	I could enjoy the view out of the window while riding AV.	Likert 1-5
Social Benefits (Bansal, et al, 2016; Manfreda 2018; Jin et al 2020)		
SB01	AV generates lower vehicle emissions.	Likert 1-5
SB02	AV could lead to lesser traffic congestions.	Likert 1-5
SB03	AV could make travelling cost cheaper.	Likert 1-5
SB04	AV could make travelling faster for road users.	Likert 1-5
Mobility Related Efficiencies (Manfreda 2018)		
MRE01	AV have better fuel efficiency.	Likert 1-5
MRE02	AV could save time by choosing less congested road.	Likert 1-5
MRE03	AV could save time due to more optimal driving.	Likert 1-5
MRE04	AV could save time to faster speed adjustment.	Likert 1-5
Safety (Das, et al, 2020; Bansal, et al, 2016; Manfreda 2018)		
SA01	AV is safe for its users.	Likert 1-5
SA02	AV is safe for pedestrians.	Likert 1-5
SA03	AV system failure is unlikely to happen.	Likert 1-5
SA04	AV computer system is unlikely to get hacked.	Likert 1-5
SA05	AV is more likely to follow road rules and regulations.	Likert 1-5
SA06	AV will cause less accidents on the road.	Likert 1-5
Perceived Usefulness – Technology Acceptance Model (Davis, et al, 1989; Lewis, 2019)		
PU01	Using AV will get me to where I need to be quicker.	Likert 1-5
PU02	Using AV improves my transportation experience.	Likert 1-5
PU03	Using AV improves my productivity.	Likert 1-5
PU04	Using AV improves my transportation effectiveness.	Likert 1-5
PU05	Using AV makes it easier for me to be where I need to be.	Likert 1-5
PU06	I found AV to be useful.	Likert 1-5
Perceived Ease of Use – Technology Acceptance Model (Davis, et al, 1989; Lewis, 2019)		
PEU01	I found it easy to get AV to do what I want it to do.	Likert 1-5
PEU02	My interaction with AV has been clear and understandable.	Likert 1-5
PEU03	I found AV to be flexible to interact with.	Likert 1-5
PEU04	It was easy for me to become skilful in using AV.	Likert 1-5
PEU05	I found AV easy to use.	Likert 1-5
Attitude Towards AV – TAM (Davis, et al, 1989, Park, 2009, Constantinides, 2013)		
AT01	Taking AV as a transportation is a good idea.	Likert 1-5
AT02	Using AV as a transportation is fun.	Likert 1-5
AT03	It is nice to participate in using AV as a transportation.	Likert 1-5
AT04	I agree with AV as a transportation option.	Likert 1-5
AT05	I am positive towards AV as a transportation option.	Likert 1-5
Intention To Use AV – TAM (Davis, et al, 1989, Park 2009, Constantinides, 2013)		
IU01	I intend to check new routes for AV frequently.	Likert 1-5
IU02	I intend to use AV more in the future.	Likert 1-5
IU03	I will recommend others to use AV.	Likert 1-5

© IEOM Society International

5. Results and Discussion

Reliability Assessment

The structural equation modelling (SEM) techniques were applied using the statistics software SmartPLS3. After the first calculation, 3 indicators from 3 variables are excluded in the final data calculation due to them having validity value < threshold of 0.7 (Hair, et al., 2010). Those 3 indicators are as follow: SA05 (AV is more likely to follow road rules and regulations), MRE01 (AV have better fuel efficiency) and AT04 (I agree with AV as a transportation option). After those 3 indicators are removed, leaving a total of 35 indicators, another calculation of the model was run again using the same parameters as before and the calculation result could be seen Table 2:

Table 2. Results of Reflective Measurement Model

	Items	Loading Factor	Cronbach's Alpha	Composite Reliability	AVE
Attitude Towards (AT)	AT01 AT02 AT03 AT04 AT05	0.812 0.785 0.795 0.634 0.810	0.830	0.887	0.663
Intention to Use (IU)	IU01 IU02 IU03	0.840 0.849 0.815	0.783	0.873	0.697
Mobility Related Efficiencies (MRE)	MRE01 MRE02 MRE03 MRE04	0.635 0.836 0.866 0.813	0.825	0.896	0.742
Perceived Ease of Use (PEU)	PEU01 PEU02 PEU03 PEU04 PEU05 PEU06	0.744 0.786 0.817 0.733 0.803 0.739	0.863	0.898	0.595
Perceived Usefulness (PU)	PU01 PU02 PU03 PU04 PU05	0.789 0.713 0.814 0.790 0.824	0.845	0.890	0.619
Personal Benefit (PB)	PB01 PB02 PB03 PB04 PB05	0.807 0.821 0.853 0.807 0.681	0.857	0.896	0.633
Safety (SA)	SA01 SA02 SA03 SA04 SA05 SA06	0.830 0.822 0.775 0.801 0.587 0.762	0.870	0.906	0.660
Social Benefit (SB)	SB01 SB02 SB03 SB04	0.720 0.838 0.682 0.826	0.768	0.852	0.592

To assess the measurement models, convergent validity and internal consistency reliability is tested. Convergent validity is evaluated by examining the outer loadings of the indicators to determine the average variance extracted

© IEOM Society International

(AVE) from each construct. Outer loading value of 0.5 is regarded as acceptable, while variable with loading value of less than 0.5 should be dropped (Chin, 1998; Hair, et al., 2010). As presented in Table 2 above, it was found that all loading factors in the analysis have value higher than 0.5, thus all indicators presented are regarded as acceptable.

Internal consistency reliability was traditionally assessed by using Cronbach's alpha; (Hair et al., 2017). As a rule of thumb, according to Sarstedt et al. (2021), a Cronbach's alpha value higher than 0.7 indicates high internal consistency reliability. From Table 2 above, it could be seen that all the variables involved have Cronbach's alpha value higher than 0.7. This means that all variables presented have high internal consistency reliability.

Validity Assessment

Table 3. Fornell-Larcker Discriminant Validity

Efficiencies	AT AV	IU AV	MRE	PEU	PU	PB	SA	SB
AT AV	0.814							
IU AV	0.787	0.835						
MRE	0.617	0.582	0.861					
PEU	0.795	0.736	0.782	0.771				
PU	0.750	0.691	0.791	0.869	0.787			
PB	0.414	0.429	0.453	0.463	0.524	0.796		
SA	0.592	0.560	0.740	0.776	0.757	0.466	0.812	
SB	0.640	0.639	0.769	0.735	0.779	0.555	0.730	0.769

AT = Attitude Towards, IU = Intention to Use, MRE = Mobility Related Efficiencies, PEU = Perceived Ease of Use, PU = Perceived Usefulness, PB = Personal Benefits, SA = Safety, SB = Social Benefits

Discriminant validity test was done with Fornell-Larcker criterion. From Table 3 above, it could be seen that each variable scores the highest towards itself save for Perceived Usefulness that have a higher coefficient than Perceived Ease of Use, indicating that these two variables are tied-in together as could be further seen from H9 in the model that stated the perceived ease of use of AV has a positive and significant effect on the perceived usefulness of using AV.

Hypothesis Testing

The proposed conceptual model was tested using structural equation modelling. The overall fit of the model is acceptable because the goodness of statistics shows values greater than the commonly accepted. In the next paragraphs, each hypothesis will be justified according to results obtained; these can be observed in Table 4 and Figure 2.

Table 4. Result of hypothesis testing

Hypothesis	Path	Path Coefficient	Standard Deviation	p-values	Decision
H1	PB → PU	0.079	0.031	0.012	Supported
H2	PB → PEU	0.033	0.041	0.435	Rejected
H3	SB → PU	0.179	0.051	0.001	Supported
H4	SB → PEU	0.168	0.064	0.009	Supported
H5	MRE → PU	0.160	0.067	0.017	Supported
H6	MRE → PEU	0.365	0.081	0.000	Supported
H7	SA → PU	0.061	0.056	0.279	Rejected
H8	SA → PEU	0.368	0.056	0.000	Supported
H9	PEU → PU	0.529	0.057	0.000	Supported
H10	PU → IU	0.079	0.081	0.328	Rejected
H11	PEU → IU	0.242	0.093	0.010	Supported
H12	AT → IU	0.535	0.070	0.000	Supported
H13	PU → AT → IU	0.130	0.047	0.006	Supported
H14	PEU → AT → IU	0.313	0.056	0.000	Supported

AT = Attitude Towards, IU = Intention to Use, MRE = Mobility Related Efficiencies, PEU = Perceived Ease of Use, PU = Perceived Usefulness, PB = Personal Benefits, SA = Safety, SB = Social Benefits

From Table 4 above we could see that 3 out of our hypotheses were rejected while 11 of our hypotheses were supported. We then analysis the result further by projecting the numbers from the analysis into our research model. The result of our research model could be seen in Figure 2 on the following page where all 3 of the rejected hypotheses are marked with red arrows while all 11 of the supported hypotheses are marked with black arrows.

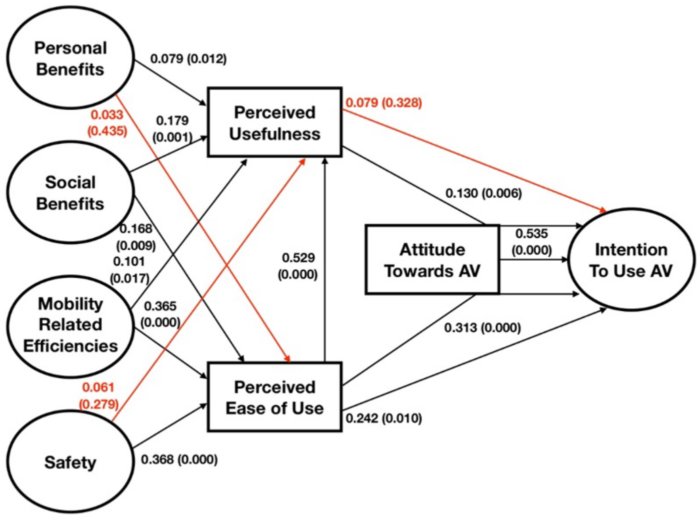

Figure 2. Result of Path Analysis Testing

Based on our data analysis, we would discuss each of our hypothesis as follow:

H1. Personal benefits of using AV have a positive effect on the perceived usefulness of using AV.
H2. Personal benefits of using AV have a positive and effect on the perceived ease of using AV.

Based on our data analysis, H1 is supported while H2 is rejected. These imply the following:
Most of the respondents found that AV are useful for them as individuals. Our findings supported the statement from previous studies that stated users associated AV with leisure related trips as more than 80% of our respondents replied that the most benefiting aspect of AV for their personal benefits was that they could enjoy the view along the AV route (Bansal, et al., 2016; Manfreda et al., 2018). The second most benefiting personal benefits according to the respondents was that they could freely talk and text on their phones (68%) followed closely by the benefit that they could freely play games and watch movies on their phones (65%).

Personal benefits do not have a significant effect on the Perceived Ease of Using AV as it seems that potential new users would rather focus on what might personally benefit their daily life or how useful AV could be for them without worrying about technological barrier or their flexibility interaction with the AV itself.

H3. Social benefits of using AV have a positive effect on the perceived usefulness of using AV.
H4. Social benefits of using AV have a positive effect on the perceived ease of using AV.
Based on our data analysis, both H3 and H4 are supported. These imply the following:
As almost 80% of respondents believe that AV would be more environmentally friendly, they see AV as a method of transportation that could be useful in reducing pollution. This support finding from previous studies (Bansal et al., 2016; Jin et al., 2020). Almost 73% of respondents believe that AV would make transportation cost cheaper, making AV a useful transportation option for the general public. Majority of the respondents also think that AV could help create less traffic congestion (67%) and shorten travel time (65%). These findings further support statements from previous studies that stated AV could be implemented as public transport (Skeete, 2018; Whittle, et al., 2019; Pettigrew et al., 2019). These obvious benefits for society at large proved to have a significant effect of the Perceived Ease of

Using AV by the respondents, implying that future AV as a public transport should be designed in ways that will benefit everyone while also paying attention to the positive contribution to the environment.

H5. Mobility related efficiencies related to AV have a positive effect on the perceived usefulness of using AV.
H6. Mobility related efficiencies related AV have a positive effect on the perceived ease of using AV.

Based on our data analysis, both H5 and H6 are supported. These imply the following:
Our analysis found that while vast majority of the respondents (82%) believe that AV could have better fuel efficiency, this factor should be discarded as it has low validity value. This might be because the AV in use that was tried by the respondents was an electrical AV. Most of the respondents (75%) also believe that AV could save traveling time due to better acceleration and speed adjustment while 71% of the respondent believe that AV could choose less congested road due to the technologies incorporated within the AV. These results support the finding of previous researches that stated benefits of AV that are very appealing for users are those linked to time savings and shorter travel time (Bansal et al., 2016; Manfreda et al., 2018; Whittle et al., 2019).

H7. Safety concerns of using AV have a positive effect on the perceived usefulness of using AV.
H8. Safety concerns of using AV have a positive effect on the perceived usefulness of using AV.

Based on our data analysis, H7 is rejected while H8 is supported. These imply the following:
Although there were studies that raised concerned regarding AV operational system and its vulnerability to hacking and cyber-attack, 76% of the respondents stated that they believe in the capability of the AV operational system. While 16% of the respondents raised concerns about hacking, 61% of the respondents still believe that the AV system would not be hacked easily. Most of the respondents (66%) also believe that AV is safe for its users, and most of the respondents (65%) also believe that AV is safe for pedestrians. There are slight concerns raised by 15% of the respondents regarding the safety of its users and pedestrians, this might be due to the heavy breaking done by the AV when pedestrians suddenly appear near the AV. It is worth noting that the radar and sensor of ARMA was set to break whenever there is a sudden movement within 3 meters of it and it is also worth mentioning that although the rest run was done in a closed environment, visitors to the shopping mall increased exponentially during the weekends and that they might not be aware that there is an AV in operation. It is also worth mentioning that most pedestrians in Indonesia are not accustomed to follow traffic signs and that they could cross the road anywhere without much heed to their own safety (Hikmah, B., 2015). One important note is that although 82% of the respondent believe that AV would follow road regulations better, this factor should be discarded as it has low validity value, the implication is because the AV route being in a closed environment. From these findings, it could be concluded that the safety factors of AV, although they did not score as high as other factors, are still mostly in favour of using AV.

H9. The perceived ease of use of AV has a positive effect on the perceived usefulness of using AV.
H10. The perceived ease of use of AV has a positive effect on the attitude toward AV.
H11. The perceived usefulness of AV has a positive effect on the attitude toward AV.

Based on our data analysis, H9 is supported while H10 is rejected and H11 is supported. These imply the following:
The Perceived Ease of Use of AV have a positive and significant effect on the Perceived Usefulness of AV. As confirmed in past research, TAM approach applies to the adoption process of new technology (Constantinides et al., 2013); meaning the perceived ease of use of AV should have a positive effect on the perceived usefulness of AV. Our study supports this confirmation as well since the Perceived Ease of Use of AV does have a positive effect on the Perceived Usefulness of AV. It also means that the users found that it was easy to use the AV in operation, indicating that either the technology barrier is low or the AV maker has managed to make a functional AV that could reached out to the general public without them having to make significant efforts. It is also worth noting that vast majority of the respondents (83.8%) were young adults aged between 15-34, hence it also supported other research result that stated younger people are more open to AV technologies (Bansal & Kockelman, 2017) as there is no significant technology barriers for them. Our findings support the theory that stated if the technology is easy to use, then the barriers are conquered. As most respondents found that AV was easy to use and the interface is not complicated, most of the respondents have positive attitude towards it.

However, it is worth noting that the users of the AV that were questioned were first time users of AV who must queue and filled questionnaires to be able to try to ride the AV. Once they reached their turn to ride the AV, they could enter the AV on a first come first served basis so that they could not choose to sit if the seats (11 in total) have been filled

© IEOM Society International

by other passengers. A total of 15 passengers could ride the AV at once. The seated passengers must wear seatbelts while the standing passengers are required to hold to the safety rails (please see exhibit 3 for details of the inside of ARMA – the AV in use). These factors might result in the users feeling that the requirements to ride their first AV were not flexible and that their first interaction with AV was not clear due to very limited information on the actual capacity of the AV. It is also worth noting that only 1 AV was in operation, resulting in users rather join the ride regardless of their seating preference than wait another 20 minutes in the same spot for another chance to ride the AV (please see exhibit 4 for the detail route of the AV in operation in Qbig area in BSD City), which is another inflexible experience for them. Hence these experiences might impact their perceived usefulness of AV as there were some inflexible experiences that they must overcome in order to be able to try and ride the AV.

Based on our data, this research further supported the Perceived Usefulness of the AV based on TAM model since this research confirmed that other variables such as Personal benefits, Social benefits and Mobility related efficiencies all have positive and significant effect on the Perceived usefulness of AV by our respondents, implying that most respondents find that AV will benefit them personally, by allowing them to do other activities such as texting, working, or playing games and that AV will benefit society and increase mobility related efficiencies by saving travelling time and help reducing traffic congestion. Our data gathered also served to support other findings from previous study that found perceived usefulness of AV users to have a positive effect on their attitude towards AV as users concluded that they may gain more benefits for themselves by shifting their travels toward using AV (Rahimi et al. 2020).

H12. The attitude towards AV has a positive effect on the intention to use AV.
H13. The attitude towards AV has a positive and moderating effect between Perceived Usefulness and the intention to use AV.
H14. The attitude towards AV has a positive and moderating effect between Perceived Ease of Use and the intention to use AV.

Based on our data analysis, H12, H13 and H14 are supported. Based on our study, we learned the following:
Based on our study, 83% of the respondents stated that riding an AV was a fun experience for them. 78% of the respondents declared that they were happy to be able to participate in the AV test run and 81% of the respondents think that AV is a good transportation option. 77% of the respondents believe that AV would be a good public transport option while 74% of the respondents believe that AV would be a good private transport option. Based on these findings, it could be concluded that majority of the respondents have a positive attitude towards AV. Furthermore, this study found that 77% of the respondent intent to use AV in the future as well as promoting AV to their family and friends. Based on TAM theory, a general positive attitude will result in a positive intention to use, therefore it could be stated that this study further enhances this theory as well as reinforcing the findings from other studies that supported this theory (Constantinides., 2013; Delhomme et al., 2014; Yap et al., 2016; Haboucha et al., 2017; Nazari et al., 2018; Jin, et al 2020).

It is worth mentioning that while Perceived Usefulness does not have a significant effect on Intention to Use AV, a positive Attitude towards AV is proven to have a full mediating effect on the Intention to Use AV.
It is also worth to be noted that while Perceived Ease of Use does have a positive impact on Intention to Use AV, a positive Attitude towards AV proves to have a strong mediating effect on the Intention to Use AV.

6. Conclusion

This study's objective is to understand whether the general public in Indonesia is ready to accept the use of AV as a future method of transportation by highlighting certain AV adoption factors to the public such as perception of benefits, both personal and social, mobility-related efficiencies, and safety as the principal AV adoption factors. Based on quantitative data gathered and analysed by this research, personal benefits, social benefits, and mobility-related efficiencies are factors that have positive impacts on the perceived usefulness of AV by the general public while social benefits, mobility-related efficiencies and safety are supportive factors that have positive impacts on the perceived ease of use of AV by the general public.

The general public think that AV is useful and easy to for them to use, and this thinking generates a positive attitude for the public towards using AV. Positive attitude, in return has a very strong mediating impact on whether the public intent to use AV as although the public think AV is useful, this does not prompt their intention to use AV straight away, but a positive attitude towards AV help to increase their intention to use AV.

© IEOM Society International

The public also believe that AV is easy to use, and this partially impact their intention to use AV, but with a positive attitude towards AV, their intention to use AV is even higher. Based on the predominantly positive attitudes towards AV and intention to use AV from members of the general public that have tried riding AV, this study concludes that majority of the public in Indonesia welcome the idea of using AV as an alternative of future method of transportation. Finally, findings in this study imply that public attitude towards AV is very important on their intention to use AV. Thus, future test runs, be it from the private sector or from the government, should focus on factors that could increase public positive attitudes toward AV, such as further proving that AV could help reduce traffic congestions in general roads or that usage of AV could help to reduce pollution in big cities in Indonesia. Future providers of AV should also take into account factors that have been proven to increase public positive attitude towards AV, and increase them to next level, for example no mandatory seatbelts could imply that AV are as safe as other public transports, as most public transports currently in use do not force their passengers to wear seatbelts.

The first limitation to note is that although the testing was done in a mix traffic condition, in reality the AV was running in a closed environment with only 2 stopping points. The implication of this condition is that we should wait for the AV to be tested running on a more public road to study whether both the attitude and intention to use AV from the public remain positive. The other implication is that it remained to be seen whether more stopping points will generate more interest from the public to use AV.

Second, as this run was an initial public test, it was free for the public. Further studies on how efficient it is to run the AV as a public transport in comparison to other existing public transports should be conducted, as pricing or the willingness to pay factor could be an important factor on the public's attitude and intention to use AV (Skeete, 2018; Pettigrew et al., 2019).

Last, due to this trial run for the public was done with ARMA, an AV that is meant as a public transport, the perceptions of the respondents were limited to the usage of AV as a public transport. We would like to recommend for further studies to be conducted to study the public perception on AV for private use or whether people that have tried AV would like to own an AV of their own.

References

Alazzawi, S., Hummel, M., Kordt, P., Sickenberger, T., Wieseotte, C., Wohak, O., Simulating the Impact of Shared, Autonomous Vehicles on Urban Mobility - A Case Study of Milan. EPiC Series in Engineering, 2, 94-110, 2018. https://doi.org/10.29007/2n4h

Allied Market Research, Autonomous Vehicle Market Outlook – 2026.2019. Retrieved from: https://www.alliedmarketresearch.com/press-release/autonomous-vehicle-market.html

American National Standards Intitute, Defining Automated Driving Systems in SAE J3016-2021, 2019 Retrieved from: https://blog.ansi.org/defining-automated-driving-systems-sae-j-3016-2021/#gref

Antonialli, Fabio., International benchmark on experimentations with Autonomous Shuttles for Collective Transport. 27th International Colloquium of Gerpisa, Feb 2019, Paris, France. https://hal-centralesupelec.archives-ouvertes.fr/hal-02489797v2/document

Attias, Danielle, The automobile world in a state of change: from the automobile to the concept of auto-mobility, 2017. http://dx.doi.org/10.1007/978-3-319-45838-0_2

Bansal, P., Kockelman, K. M., & Singh, A., Assessing public opinions of and interest in new vehicle technologies: An Austin perspective. Transportation Research Part C: Emerging Technologies, 67, 1–14, 2016. https://doi.org/10.1016/j.trc.2016.01.019.

Bansal, P., and K. M. Kockelman.. Forecasting Americans' Long-Term Adoption of Connected and Autonomous Vehicle Technologies. Transportation Research Part A: Policy and Practice 95: 49–63. 2017. https://doi.org/10.1016/j.tra.2016.10.013.

Chehri, A., & Mouftah, H. T. , Autonomous Vehicles in The Sustainable Cities, The Beginning of a Green Adventure. Sustainable Cities and Society, 51, 101751, 2019. https://doi.org/10.1016/j.scs.2019.101751

Clausen, Christian., Niche management of Autonomous Vehicles for positive environmental outcomes in Copenhagen: Evaluating the feasibility of purposive measures through scenario analysis. Lund University, Sweden. 2019. https://lup.lub.lu.se/luur/download?func=downloadFile&recordOId=8927449&fileOId=8927496

Constantinides, E., Lorenzo-Romero, C., & Alarcon-del-Amo, M., Social Networking Sites as Business Tools: A Study of User Behavior. Business Process Management. 2013. http://dx.doi.org/10.1007/978-3-642-28409-0_9

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R., User Acceptance of Computer Technology: A Comparison of Two Theoretical Models. Management Science, 35(8), 982–1003, 1989. https://doi.org/10.1287/mnsc.35.8.982

Government Technology, Experts: Fleets, Public Transport Would Benefit from AV Tech. Retrieved from 2021.https://www.govtech.com/fs/experts-fleets-public-transit-would-benefit-from-av-tech

Haboucha, C. J., Ishaq, R., & Shiftan, Y., User preferences regarding autonomous vehicles. Transportation Research Part C: Emerging Technologies, 78, 37–49, 2017. https://doi.org/10.1016/j.trc.2017.01.010.

Hikmah, B, Crossing The Street The Indonesian Way. 2015. Retrieved from: https://www.qureta.com/post/crossing-street-indonesian-way

IEEE. The Institute of Electrical and Electronics Engineers , New Level 3 Autonomous Vehicles Hitting the Road in 2020. Retrieved from: https://innovationatwork.ieee.org/new-level-3-autonomous-vehicles-hitting-the-road-in-2020/

International Society of Automation (ISA). , What is Automation? 2021. Retrieved From https://www.isa.org/about-isa/what-is-automation/

Jadaan, K., Zeater, S., & Abukhalil, Y. , Connected vehicles: An innovative transport technology. Procedia Engineering, 187, 641–648, 2017.. https://doi.org/10.1016/j.proeng.2017.04.425.

Jakarta Globe, 2021 , Retrieved from: https://jakartaglobe.id/special-updates/indonesia-kicks-off-first-autonomous-electric-vehicle-trial-in-bsd-city

Jakarta Daily. 2021. Retrieved from: https://www.jakartadaily.id/tech-media/pr-1622129104/unmanned-electric-vehicle-trial-to-be-conducted-in-bsd-city

KPMG, Autonomous Vehicles Readiness Index: Assessing Countries' Preparedness for Autonomous Vehicles. 2019. Retrieved from: https://assests.kpmg/content /dam/kpmg/nl/pdf/2019/sector/autonomous-vehicles-readiness-index-2019.pdf

Kyriakidis, M., Happee, R., & de Winter, J. C. F. , Public opinion on automated driving: Results of an international questionnaire among 5000 respondents. Transportation Research Part F: Traffic Psychology and Behaviour, 32, 127–140, 2015. https://doi.org/10.1016/j.trf.2015.04.014.

Lang, N., Rübmann, M., Mei-Pochtler, A., Dauner, T., Komiya, S., Mosquet, X., Doubara, X, Self-Driving Vehicles, Robo-Taxis, and the Urban Mobility Revolution. (Boston Consulting Group report). 2016. Retrieved from: https://www.bcg.com/publications/2016/automotive-public-sector-self-driving-vehicles-robo-taxis-urban-mobility-revolution

Lee, C., C. Ward, M. Raue, L. D'Ambrosio, and J. F. Coughlin. Age Differences in Acceptance of Self-Driving Cars: A Survey of Perceptions and Attitudes. International Conference on Human Aspects of IT for the Aged Population, pp. 3–13. 2017. .Springer, Cham. https://doi.org/10.1007/978-3-319-58530-7_1

Lewis, James, R, Comparison of Four TAM Item Formats: Effect of Respond Option Labels and Order. Journal of Usability Studies. Vol. 4, Issue 14, pp 224-236. 2019. https://uxpajournal.org/wp-content/uploads/sites/7/pdf/JUS_Lewis_August2019.pdf

Manfreda, A., Ljubi, K., Groznik, A, Autonomous Vehicles in The Smart Cities Era: An Empirical Study of Adoption Factors Important for Millenials. International Journal of Information Management. 4th International Scientific – Business Conference LIMEN 2018 – Leadership & Management: Integrated Politics of Research and Innovations, Belgrade – Serbia, Dec 13, 2018. https://doi.org/10.31410/limen.2018.419.

Melis, A., Mirri, S., Prandi, C., Prandini, M., Salomoni, P., Callegati, F., CrowdSensing for smart mobility through a service-oriented architecture. 2016. https://doi.org/10.1109/ISC2.2016.758086

Nazari, F., Noruzoliaee, M., & Mohammadian, A. (Kouros), Shared versus private mobility: Modeling public interest in autonomous vehicles accounting for latent attitudes. Transportation Research Part C: Emerging Technologies, 97, pp. 456–477, 2016. https://doi.org/10.1016/j.etran.2019.100008.

Smart Cities Conference (ISC2) IEEE Conference, Trento, Italy. 2016 https://www.researchgate.net/publication/310464641_CrowdSensing_for_Smart_Mobility_through_a_Service-Oriented_Architecture

Mitsubishi Corporation. , Retrieved from: Mitsubishi Corporation - Press Room - 2021 - MC J/V Launches PoC Autonomous-Driving Pilot Project in Jakarta's BSD City | Mitsubishi Corporation, 2021.

Mittal, S., & Sethi, M, Smart and Livable Cities: Opportunities to Enhance Quality of Life and Realize Multiple Co-benefits. Mainstreaming Climate Co-benefits in Indian cities: Post-habitat III innovations and reforms (pp. 245–263), 2018. Singapore: Springer Singapore. https://link.springer.com/chapter/10.1007/978-981-10-5816-5_10

Montoro, L., Useche, S. A., Alonso, F., Lijarcio, I., Bosó-Seguí, P., & Martí-Belda, A. , Perceived safety and attributed value as predictors of the intention to use autonomous vehicles: A national study with Spanish drivers. Safety Science, 120, 865–876, 2019. https://doi.org/10.1016/j.ssci.2019.07.041.

Mutz, F., Veronese, L. P., Oliveira-Santos, T., de Aguiar, E., Cheein, F. A. A., & De Souza, A. F. , Large-scale mapping in complex field scenarios using an autonomous car. Expert Systems with Applications, 46, 2016. https://doi.org/10.1016/j.eswa.2015.10.045

National Highway Traffic Safety Administration, 2020. Retrieved from: https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety

Pancost, Richard. D. , Cities lead on climate change. Nature Geoscience, 9, 264–266, 2016. https://doi.org/10.1038/ngeo2690

Park, Sung. Y, An Analysis of the Technology Acceptance Model in Understanding University Students' Behavioral Intention to Use e-Learning. Educational Technology & Society. Vol 12, No. 3, 2009. https://www.jstor.org/stable/jeductechsoci.12.3.150

Payre, W., Cestac, J., & Delhomme, P, Intention to Use a Fully Autonomous Car: Attitudes and a Priori Acceptability. Transportation Research Part F: Traffic Psychology and Behaviour, 27, 252–263, 2009. https://doi.org/10.1016/j.trf.2014.04.009

Penmetsa, P., Adanu, E. K., Wood, D., Wang, T., & Jones, S. L, Perceptions and expectations of autonomous vehicles – A snapshot of vulnerable road user opinion. Technological Forecasting and Social Change, 143, 9–13, 2019. https://doi.org/10.1016/j.techfore.2019.02.010.

Pettigrew, S., Dana, L. M., & Norman, R. , Clusters of Potential Autonomous Vehicles Users According to Propensity to Use Individual Versus Shared Vehicles. Transport Policy, 76, 13–20, 2019. http://doi.org/10.1016/j.tranpol.2019.01.010

Rahimi, A., Azimi, G., & Jin, X. , Examining Human Attitudes Toward Shared Mobility Options and Autonomous Vehicles. Transportation Research Part F: Traffic Psychology and Behaviour, 72, 133–154, 2020. http://dx.doi.org/10.1016/j.trf.2020.05.001

Ritchie, H. & Roser, M., Urbanization. Our World in Data. 2019.. Retrieved from: https://ourworldindata.org/urbanization#what-share-of-people-will-live-in-urban-areas-in-the-future

Skeete, J.-P, Level 5 autonomy: The new face of disruption in road transport. Technological Forecasting and Social Change, 134, 22–34, 2018. https://doi.org/10.1016/j.techfore.2018.05.003.

Society of Automotive Engineers, SAE Levels of Driving Automation Refined for Clarity and International Audience. , 2021. Retrieved from: https://www.sae.org/blog/sae-j3016-update

United Nations. World Urbanization Prospects 2018. Retrieved from: https://population.un.org/wup/Country-Profiles/

Whittle, C., Whitmarsh, L., Hagger, P., Morgan, P., & Parkhurst, G, User decision making in transitions to electrified, autonomous, shared or reduced mobility. Transportation Research Part D: Transport and Environment, 71, 302–319, 2019. https://doi.org/10.1016/j.trd.2018.12.014.

World Bank. The World Bank in Indonesia. 2022. .Retrieved from: https://www.worldbank.org/en/country/indonesia/overview

Yap, M. D., Correia, G., & Van Arem, B. , Preferences of Travellers for Using Autonomous Vehicles as Last Mile Public Transport of Multimodal Train Trips. Transportation Research Part A: Policy and Practice, 94, 1–16, 2016. https://doi.org/10.1016/j.tra.2016.09.003

© IEOM Society International