Research in Management of Technology and Business Vol. 4 No. 1 (2023) 685–701

RMTB

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/rmtb
e-ISSN : 2773-5044

A Foresight Study on the Adoption of Autonomous Public Transport in Malaysia: Case Study in Kuching

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DOI: https://doi.org/10.30880/rmtb. 2023.04.01.047
Received 31 March 2023; Accepted 30 April 2023; Available online 01 June 2023

Abstract: Autonomous vehicles are getting common and being a hot topic in this technological era. However, autonomous public transport is still new phenomenon in Malaysia. As a result, there is uncertainty over the adoption of autonomous public transport. The question arises as to whether a combination of automated driving and public transportation is a flexible and efficient mobility option that may also attract former non-customers to use public transportation in Malaysia. Hence this study is aimed to identify the drivers, the level of consumer perceptions, and future images of the autonomous public transport in Malaysia. Social, Technological, environmental, Economic, Political, Value (STEEPV) analysis is used in the first phase for identifying the issues and drivers of adopting autonomous public transport in Malaysia. The impact-uncertainty of autonomous public transport in Malaysia is analysed using questionnaire distribution and SPSS statistical analysis in the second phase. A total amount of 382 questionnaires were distributed to the community in Kuching. 211 responses were gathered and the response rate was 55.23%. Based on the impact-uncertainty analysis, the results show that the two drivers with highest impact and uncertainty were government policy and effective and efficient of autonomous public transport. The scenario analysis was constructed with the two drivers which illustrates the four alternative possibilities in the future. The ideal scenario is where government policy and effective and efficient must coexist in order to generate positive future for adoption of autonomous public transport in Malaysia.

Keywords: Autonomous vehicles, Driverless vehicle, Public transport, Adoption

1. Introduction

Autonomous vehicles are getting common and being a hot topic in this technological era. Some of the researchers have carried out a study on the autonomous public transport. Private automated vehicles is suitable for rural areas. However, automated buses, trains and trams are best suited for urban areas with major public transportation grid (Nenseth *et al*., 2019). The development of Autonomous Vehicle

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(AV) technology has the great potential to significantly change the way human travel. Personal and Public vehicles with this technology is likely to minimize accidents, energy consumption, and pollution (Anderson *et al*., 2016). Autonomous vehicle (AV) technology is clearly conceptualized using the National Highway Traffic Safety Administration's (NHTSA) with five levels of functionality. These five different level of automation brings benefits of technology at various levels of automation. Level 0: The human driver has entire control over the car's functionality; Level 1: One function is automated; Level 2: Multiple functions are automated concurrently such as steering and acceleration, but the driver must maintain constant awareness; Level 3: The driving functions are automated to the point where the driver can safely carry other activities; Level 4: Without a human driver, the car can drive itself (Anderson *et al*., 2016). According to CNN, Institute of Electrical and Electronics Engineers (IEEE) recently announced forecasts that in 2040, autonomous vehicles will contribute for up to 75 percent of vehicles on the road. Besides, IEEE believes that full deployment of autonomous vehicle could potentially eliminate the necessity for driver's licenses. In recent years, the implications of Autonomous vehicle (AV) have been studied exhaustively. While automated vehicles are predicted to bring a huge advantages, they are also associated with a greater risk or disadvantages (Othman, 2021). Moreover, according to The Malaysian Reserve, Malaysia is expected to be the first country in Southeast Asia with a fully automated driverless bus system (Birruntha, 2021). Furthermore The Star Online (2021) also stated that i-City in Shah Alam will be planning to launch a completely driverless bus service and is expected to be completely operational by 2024. Apart from that, based on New Straits Times (2022), researchers at UMP are in the process of building a driverless, computerised (self-driving) vehicle to transport students around campus and the development of this vehicle is in the final stage (Alagesh, 2022). I-Berhad and Huawei Technologies (Malaysia) may have collaboration and expected to develop and autonomous bus system for I-Berhad. The bus shuttle service will be moving around i-City for visitor's convenient (Kaur, 2021). In summary, autonomous vehicles seems to bring various benefits to the community in Malaysia. However, the question arises as to whether a combination of automated driving and public transportation is a flexible and efficient mobility option that may also attract former non-customers to use public transportation in Malaysia.

Accidents and injuries in vehicles are a global public problem. The number of traffic-related deaths worldwide remains to be high, considerably far from the Zero Vision that implement by many countries (Martínez-Díaz & Soriguera, 2018). According to the Ministry of Transport Malaysia Official Portal shows the latest data of road accidents and fatalities in Malaysia for year 2010-2019. The data shows that the number of Malaysia's traffic accident rate has grown in that 10 years period which is 414,421 cases in year 2010 to 567,516 cases in year 2019. The data are considered to be highly reliable because they were collected from official source. Long-term factors are constantly influenced by driver behaviour and biological characteristics, such as inexperience and decreasing of cognitive and psychomotoric function due to older age. Whereas short-term factors are influenced by extremely unstable and altering variables, such as a limited vision or inattention (Bucsuházy *et al*., 2020).

Muhamad Nazri Borhan *et al*. (2019) has conducted a research about why public bus is a less attractive mode of transport in Putrajaya. The findings stated that respondents were disappointed from taking public transportation due to the long travel duration. This prolonged travel time results in stress, which has led customers to switch to private cars in order to reduce the additional stress. Besides, Frequency and punctuality of the buses are critical variables in a user's decision to use public transportation or not. This has led up to 80% of vehicle owners chose to drive to work since bus service is frequent. Many complained that they were forced to wait a prolonged period for the bus. Furthermore, service hours are a critical aspect in a user's decision to use public transportation. Respondents claimed that they are dissatisfied with the lack of service especially off-peak hours such as evening and weekend service hours. Safety is a crucial factor when deciding to use transportation. One woman stated that on one occasion that the bus driver disobeyed traffic regulations. This could put user's life in danger (Muhamad Nazri Borhan *et al*., 2019).

The development of autonomous vehicle technology has the potential to have a significant impact on safety, traffic congestion, energy consumption, and, ultimately, land usage (Anderson *et al*., 2016). The number of road accidents has decreased in the most of developed countries as car technology has improved such as Driver Assistance Systems and Active Safety Systems. Two significant criteria must be considered in order for this success to achieve: i) the penetration rate of fully AVs must be high and ii) cooperative traffic management strategies must work adequately (Martínez-Díaz & Soriguera, 2018). According to CNN, IEEE also believes that the primary obstacle to full deployment of driverless automobiles would be public acceptance, not technology.

Therefore, the research objectives are to identify the drivers on adoption of autonomous public transport in Malaysia, to identify the level of consumer perceptions of the autonomous public transport in Malaysia and to study the future images of autonomous public transport in Malaysia.

The aim of this study is to identify the level of consumer perceptions towards autonomous public transport in Kuching. This research study was conducted in Kuching. The focus group of this study was community in Kuching who ever used public transport in Kuching and ages above 17. Questionnaire was distributed to identify the driver that influence the adoption of autonomous public transport in Malaysia. This foresight analysis was conducted out keeping in view the time horizon from now to future 15 years which in other words in year 2022 to year 2037. This research scope examines the current and future images in the adoption of autonomous public transportation in Malaysia.

2. Research Methodology

2.1 Research Design

In order to achieve the aims of this research, primary data and secondary data were used. Primary data were generated through questionnaire whereas secondary data were obtained through journals, articles, books, newspaper, and website. Quantitative are define as a type of research that collects numerical data and analysis the data using mathematically-based methods (Kamolson, 2007). Whereas, Apuke (2017) defines quantitative research methods as the examination of an issue or event by collecting data in numerical form and evaluating it using mathematical methods (Apuke, 2017). In this study, questionnaire will be distributed through Google form to Kuching community and the data will be analyse using numerical data for high accuracy of this study. This approach was used to identify driver on adoption of autonomous public transport and the level of consumer perceptions of autonomous public transport among community in Kuching with keeping in view the time horizon from now to future 15 years which in other words in year 2022 to year 2037. Descriptive research is to precisely and systematically analyse a population, phenomenon or situation. Descriptive research is useful when the objective is to determine characteristics, frequency, and trends (McCombes, 2022). Therefore, descriptive research was used in this research.

2.2 Research Flow-Chart

The research flow chart outlines the stages of completing this research. This flow-chart is a framework that will assist the researcher to have a clear picture about the approaches and works on each stage.

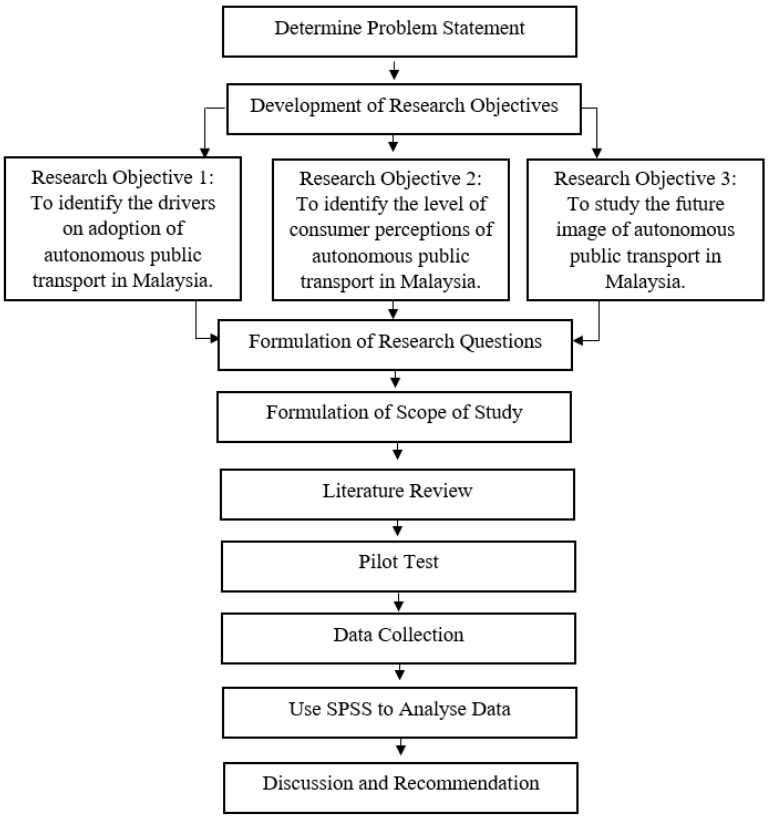

Figure 1: Research Flowchart

2.3 Population

The study population is a subset of the population from which the actual sample is chosen. It is possible to describe the sample frame as an operationalized version of the research population. According to Macrotrends (2022), Kuching's metro population in 2022 is 631,000, a rise of 1.61 percent from 2021.

2.4 Sampling Method

According to Stat Trek (2022), sampling method are defined as a technique for identifying relevant samples from a population. Purposive sampling is determined at the researcher's discretion. Researchers strictly consider the aim of the research, as well as their awareness of the targeted audience (Fleetwood, 2022). Besides, purposive sampling requires the researcher to apply their expertise to select a sample that will be most beneficial to the research objectives. It is usually applied in qualitative research, in which the researcher seeks detailed information about a particular phenomenon rather than statistical inferences (McCombes, 2022). Therefore, purposive sampling was used in this research. The questionnaire was given only to the community that have ever used public transport in Kuching.

2.5 Research Instrument

According to Discoverphds (2020), the word research instrument refers to a tool that can be used to collect information or obtain data, measure data, and carry out analysis relevant data to the research topic. A research instrument's format includes questionnaires, surveys, and interviews. The researcher will determine which particular research instrument to utilise. Questionnaire surveys were used in this study. The questionnaires were tested through Pilot test for validity and reliability.

2.6 Questionnaire

A questionnaire is a research instrument that consists of a series of questions for the aim of collecting information from respondents. Questionnaires are a relatively inexpensive, fast, and efficient method for collecting huge volumes of data from a large population sample. Questionnaires can be a cost-effective and time-efficient method for measuring the behaviour, preferences, attitudes, views, and intentions of respondents in a large number (Mcleod, 2018). In this research, close-ended questions were used to construct the questionnaire. Google forms were used as a medium to distribute online questionnaire to respondents that have experience using public transport in Kuching. The data obtained from the survey were analyse through SPSS.

2.7 Pilot Test

A pilot study is a smaller version of a full-scale study or a test conducted before to the complete research (Kawano, 2002). The data collected from questionnaire were analyse using Statistical Package for the Social Sciences (SPSS) in terms of Cronbach's Alpha. The closer Alpha to 1, the greater the reliability and accuracy of Cronbach Alpha.

2.8 Impact-Uncertainty Analysis

The Impact-Uncertainty Grid is a compact cluster of relevant factors that allows participants of a scenario project in order to identify two significant uncertainties that they can apply to design four distinct scenarios. (Brands & Meissner, 2011) In this study, the top two key drivers with the highest level of impact uncertainty were chosen for scenario analysis.

2.9 Scenario Analysis

Scenario analysis is conducted in order to examine the impacts of potential future events on the system performance by taking into account various different outcomes. Scenario analysis can be used to estimate the system's behaviour in reaction to an uncertain situation, as well as to examine the changes in system performance in a best-case (optimistic) or worst-case (pessimistic) theoretical scenario (Balaman, 2019). The intention of scenario development was to identify future implications of autonomous public transport in Kuching, including future challenges, issues, trends, and futures-related development. The top two drivers from the impact-uncertainty analysis were used to formulate the scenario analysis. Four different potential scenarios reflecting the future consequences of autonomous public transport trends were developed.

3. Literature Review

The STEEPV analysis is applied to categorize issues and key drivers of prior studies towards adoption of autonomous public transport. Journals, articles, thesis, books, and websites are the primary informational resources used to obtain relevant information. The relevant influencing factors of the adoption of autonomous vehicles have been identified through STEEPV. STEEPV refers to Social, Technological, Economical, Environmental, Political, and Values elements.

3.1 Social

In general, perceived usefulness is positively linked with attitude and intention to use autonomous vehicle (Nastjuk *et al*., 2020). More frequent drivers are willing to spend more for an autonomous vehicle. Besides, respondents found manual driving are more enjoyable (Kyriakidis *et al*., 2015). Demographic factors such as gender, age, education level can affect the perception toward autonomous vehicles (Bansal *et al*., 2016; Haboucha *et al*., 2017; Schoettle & Sivak, 2014). Autonomous vehicles

not just able to significantly reduce overall accident and fatalities (Fagnant & Kockelman, 2015; Haboucha *et al*., 2017; Pakusch & Bossauer, 2017) but also are able to eliminates accident form human error (Hulse *et al*., 2018; Martínez-Díaz & Soriguera, 2018; Othman, 2021; Piao *et al*., 2016). Majority of people concerns regarding the safety of autonomous vehicles, including system failure, system breaching, and safety concerns linked with unoccupied moving cars, are main concern by individuals (Caldwell, 2014). Autonomous vehicles can strongly affect travel behaviour and provide a new travel alternative for persons who are unable to drive, like the disabled and the elderly, which can increase their mobility (Anderson *et al*., 2016; Fagnant & Kockelman, 2015). Fully autonomous public transportation has a lower error and accident rate, better availability as a result of decreased dwell times and improved timeliness (Pakusch & Bossauer, 2017). Self-driving buses have the ability to increase service frequency without significantly increasing total expenses (Othman, 2020).

3.2 Technological

Using a combination of sensors, radar, cameras, and artificial intelligence, autonomous vehicles (AV) are able to perceive their environment and navigate to various destinations (Chehri & Mouftah, 2019). Autonomous vehicles are able to locate itself and navigate a network without human interaction (Piao *et al*., 2016) and equipped with advanced driver-assistance systems to handle all dynamic driving responsibilities (Erskine *et al*., 2020). When the autopilot is enabled, the driver is overtaken by a computer based system that improves certain aspects of driving, such as safety, traffic flow, ecology, and economics (Chan & Lee, 2021; Chehri & Mouftah, 2019). Connected autonomous vehicles (CAV) can communicate with surrounding vehicles and infrastructure via vehicle-to-everything (V2X) by using the high speed and quick reaction of 5G technology (Zhang *et al*., 2019). When the degree of automation is high, driving safety can be enhanced because inter-vehicle safety distances are followed even more strictly than during manual driving (Jamson *et al*., 2013).

3.3 Economic

Autonomous vehicles have the potential to significantly lower expenses because human drivers are replaced by artificial intelligence systems (Prideaux *et al*., 2019). Autonomous buses fares are cheaper because no of no driver cost and per-passenger-per-kilometer cost is anticipated to be 50% less than that of conventional automobiles (Litman, 2022; Ongel *et al*., 2019; Piao *et al*., 2016). Commercial vehicle owners are more possible to be early adopters since they can save money on driver expenses and high ratio of benefits to costs (Andersson & Ivehammar, 2019). Even though the initial cost of purchasing an autonomous car is expensive, it is believed that decreased fuel consumption and less frequent maintenance could compensate over long-term (Chan & Lee, 2021).

3.4 Environment

Autonomous vehicle technology are able to minimise traffic congestion and fuel consumption (Fagnant & Kockelman, 2015). Autonomous vehicle are able to reduce and minimize the pollution emission that are create from transportation. (Greenblatt & Shaheen, 2015; Piao *et al*., 2016; Soriguera *et al*., 2017). Connected autonomous vehicle can reduce roadside pollutants, resulting in at least a 25% decrease in fuel use for automobiles (Andersson & Ivehammar, 2019). Autonomous vehicles have potential for increased road use and decreased parking needs in urban area (Greenblatt & Shaheen, 2015).

3.5 Political

Policymakers need to offer guidelines for a consistent regulatory strategy that prioritise safety and stimulate innovation in CAV technology (Chan & Lee, 2021). Policymakers should cooperate with academics and manufacturers to establish safety standards and ensure developers carefully follow to them (Zhang *et al*., 2019). Besides, government plays significant role in exploring regulations like

cybersecurity, safety protection, and data privacy for future of autonomous vehicle and also active involve in establishing new regulations and improving the existing legal system (Chan & Lee, 2021). Politics must focused on promoting the automotive industry in order to increase the acceptance of autonomous vehicle (Pakusch & Bossauer, 2017).

3.6 Value

Autonomous vehicle weakness in human interaction which includes in conversation, human intuition, and human knowledge (Dubljević *et al.*, 2022). Autonomous vehicles able to increase the mobility of disable and elderly which enable them to go where they wanted without a human driver (Fagnant & Kockelman, 2015). The automation of public transportation also provides new opportunities and has the capability to increase competitiveness of public transport (Pakusch & Bossauer, 2017). Autonomous vehicle equipment can improve the level of comfort when using public transport (Othman, 2020).

3.7 Table of Drivers

The key term are merged in order to develop drivers. Ten issues and drivers will be included in questionnaires for data collection purposes. Issues and drivers are shown as follows:

Table 1: Table of Drivers

No.	Drivers
1	Readiness in adoption of autonomous vehicles
2	Environment friendly
3	Effective and efficiency
4	Safety concerned
5	Government policy
6	Degree of Automation
7	New era
8	Trust in technology advancement
9	Perceived benefits
10	New transport alternative with lower cost

3.8 Conclusion

STEEPV analysis was applied using journals, articles, thesis, books, and websites as references to identify the key drivers of the adoption of autonomous public transport. Through the merging process, ten most influential key drivers were constructed. Key drivers are used to construct questionnaire in order to evaluate the level of consumer

4. Data Analysis and Findings

The outcome of the data collection that was conducted through the distribution of questionnaires to identify the adoption of autonomous public transport in Malaysia through social media applications. SPSS was used to analyse the collected data to gather demographic information and the mean of each individual issues and drivers. There are four sections. The result was then sorted in descending order, and the top 5 of drivers with the greatest mean were constructed for impact-uncertainty analysis to identify the futures most impactful and uncertainty drivers. From the outcome, two drivers with the greatest influence and unpredictability are utilised to build a scenario analysis.

4.1 Results

Table 2: Reliability Test

	Cronbach's Alpha	Number of Respondents	N of Items
Pilot test	0.934	15	30
Actual Research	0.954	211	30

(a) Pilot Test

Pilot test are used to test the reliability of the questionnaire in this study. Hence, 15 sets of questionnaires were distributed to randomly to 15 respondents of community of Kuching. Consequently, the results were tested using SPSS to obtain the reliability result and were referred to Cronbach's Alpha value. The outcome of pilot test is showed in Table 2. Based on the value in Table 2, the Cronbach's Alpha of pilot test was greater than 0.9, indicating that the results were excellent. Hence, the research was reliable and continued.

(b) Actual Research Result

The result of the actual research reliability test was obtained by analysing the respondent's data. In this study, 211 respondents provided responses to the questionnaire. The outcome of actual research is showed in Table 2.

(c) Demographic Analysis

Table 3 shows the demographic profile of the respondents.

Table 3: Demographic Analysis

Demographic	Details	Frequency	Percentage (%)
Gender	Male	101	47.90
	Female	110	52.10
Age	17-20 years-old	9	4.30
	21-30 years-old	122	57.80
	31-40 years-old	39	18.50
	41-50 years-old	11	5.20
	51 years-old and above	30	14.20
Race	Malay	35	16.60
	Chinese	144	68.20
	Indian	3	1.40
	Others	29	13.80
Education Level	SPM	28	13.30
	Diploma	66	31.30
	Degree	98	46.40
	Master	14	6.60
	PHD	2	0.90
	Others	3	1.50
Current employment status	Employed	93	44.10
	Self-employed	62	29.40
	Retired	18	8.50
	Unemployed	5	2.40
	Student	33	15.60
Monthly Income	Below RM1,000	39	18.50
	RM1,000-RM3,000	70	33.20
	RM3,000-RM5,000	81	38.40
	RM5,000-RM10,000	16	7.60
	RM10,000 and above	5	2.30

Ever heard about autonomous public transport	Yes	166	78.70
	No	45	21.30
Considered about using autonomous public transport as main transport in the future	Yes	165	78.20
	No	46	21.80

In this research, 101 people (47.90%) are male and 110 people (52.10%) are female. For age, the highest frequency were 21-30 years-old with the frequency of 122 (57.80%) respondents while the lowest frequency were 17-20 years-old with the frequency of 9 respondents (4.30%). For race, the highest frequency were Chinese with the frequency of 144 respondents (68.20%) and the lowest frequency were Indian with the frequency of 3 respondents (1.40%). For education level, the highest frequency were Degree level with the frequency of 98 respondents (46.40%) while the lowest frequency were PHD level with the frequency of 2 respondents (0.90%). For current employment status, the highest frequency were employed with the frequency of 93 respondents (44.10%) and the lowest frequency were unemployed with the frequency of 5 respondents (2.40%). For monthly income, the highest frequency were between RM3,000 - RM5,000 with the frequency of 81 respondents (38.40%) while the lowest frequency were RM10,000 and above with the frequency of 5 respondents (2.30%). 166 respondents (78.70%) ever heard about autonomous public transport whereas 45 respondents (21.30%) never heard about autonomous public transport. 165 respondents (78.20%) considered about using autonomous public transport as main transport in the future whereas 46 respondents (21.80%) did not considered about using autonomous public transport as main transport in the future.

(d) Mean of Top Five Drivers Based on Level of Importance

Table 4 shows the mean value of the top five leading drivers based on importance.

Table 4: Mean of Top Five Drivers Based On Level of Importance

No.	Issues and Drivers	Mean
1	Government Policy	4.3081
2	Perceived Benefits	4.2275
3	Environment Friendly	4.2227
4	Effective And Efficiency	4.2085
5	New Era	4.1943

For the mean of value of the top five leading drivers based on importance, “Government Policy” has the highest mean value (4.3081) whereas “New Era” has the lowest mean value (4.1943).

(e) Mean of Drivers based on Level of Impact

Table 5 below shows the mean value of the top five leading drivers based on impact.

Table 5: Mean of Top Five Drivers Based On Level of Impact

No.	Issues and Drivers	Mean
1	Government Policy	4.2417
2	Perceived Benefits	4.2038
3	Environment Friendly	4.1564
4	Effective And Efficiency	4.2085
5	New Era	4.1280

For the mean of value of the top five leading drivers based on impact, “Government Policy” has the highest mean value (4.2417) whereas “New Era” has the lowest mean value (4.1280).

(f) Mean of Drivers based on Level of Uncertainty

Table 6 below shows the mean value of the top five leading drivers based on uncertainty.

Table 6: Mean of Top Five Drivers Based On Level of Uncertainty

No.	Issues and Drivers	Mean
1	Government Policy	4.0521
2	Perceived Benefits	3.9621
3	Environment Friendly	4.0474
4	Effective And Efficiency	4.0474
5	New Era	4.0900

For the mean of value of the top five leading drivers based on uncertainty, "New Era" has the highest mean value (4.0900) whereas "Perceived Benefits" has the lowest mean value (3.9621).

(g) Impact-Uncertainty Analysis

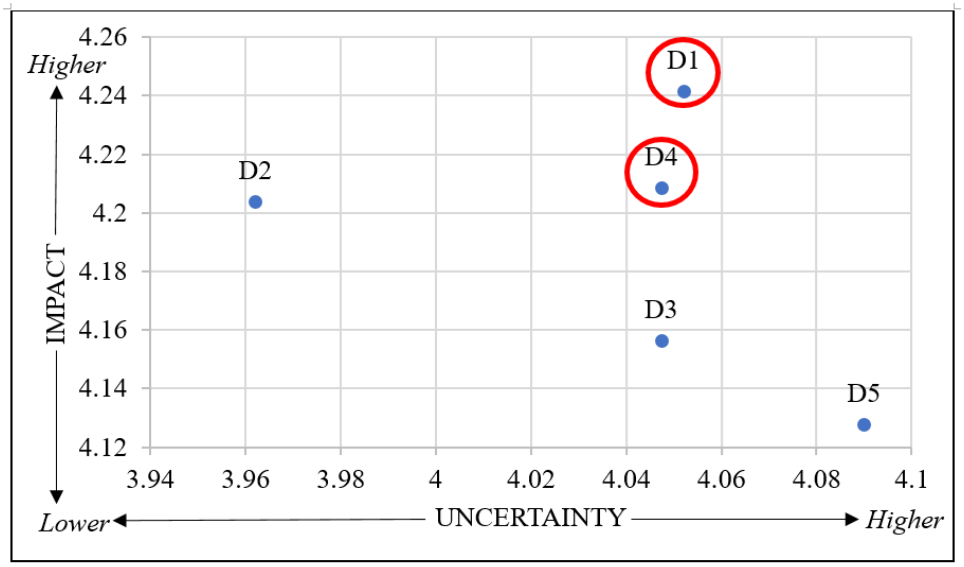

Figure 2: Impact-uncertainty analysis

The Impact-Uncertainty Analysis result was illustrated in figure 4.1. The decision will be based on the two most significant impact and uncertainty driver. Coordinates of D1 (4.0521, 4.2417) and D4 (4.0474, 4.2085) were selected. This is due to D1 is the driver with the highest level of impact whereas D4 is the driver with the highest level of uncertainty which represents 'Government policy' and 'Effective and efficient' respectively. Hence, these two drivers were chosen as the top driver and would be used to construct scenario-building analyses.

4.2 Discussion

(a) The STEEPV Factors That Influence the Adoption of Autonomous Public Transport in Malaysia

The first objective of this research was to identify the STEEPV drivers of autonomous public transport in Malaysia. The STEEPV drivers are important to study the factors that may influence the users of autonomous public transport to correspond with the adoption and diffusion of autonomous public transport in the future. Based on the results of the impact-uncertainty analysis, the two key drivers were obtained and selected. The top two drivers are the most impactful and uncertain in terms of influences on the adoption of autonomous public transport in Malaysia. The top two drivers that are selected through impact-uncertainty analysis are discussed in the following section. It illustrates how

impactful and uncertain the future is and how it will affect the future of autonomous public transport in Malaysia. The top two selected drivers were discussed more in detail.

(b) Government Policy

This driver received the most votes in terms of importance and was the most impactful driver compared to the other drivers. It had mean value of 4.0521 and 4.2417 in terms of uncertainty and impact respectively out of the total score of 5. In the perspective of respondents, this drives were considered to be the most impactful as government could give a huge impact towards autonomous public transport in Malaysia. Policymakers need to offer guidelines for a consistent regulatory strategy that prioritise safety and stimulate innovation in autonomous technology and government plays significant role in exploring regulations like cybersecurity, safety protection, and data privacy for future of autonomous vehicle and also active involve in establishing new regulations and improving the existing legal system (Chan & Lee, 2021). Apart from that, policy makers should cooperate with academics and manufacturers to establish safety standards and ensure developers carefully follow to them (Zhang *et al*., 2019). Therefore is clear that government policy make an significant impact towards autonomous public transport in Malaysia

(c) Effective and Efficiency

The second driver which had the fifth highest mean value in importance while being the most uncertain drivers compared to the rest of the drivers is effective and efficiency. It had mean value of 4.0474 and 4.2085 in terms of uncertainty and impact respectively out of the total score of 5. The respondents considered this driver to be the most uncertain and unpredictable in the future development and the impact it will have on the future prospect of autonomous public transport in Malaysia. Self-driving buses have the ability to increase service frequency without significantly increasing total expenses (Othman, 2020). A Fully autonomous public transportation has a lower error and accident rate, better availability as a result of decreased dwell times and improved timeliness (Pakusch & Bossauer, 2017). Furthermore, commercial vehicle owners are more possible to be early adopters since they can save money on driver expenses and high ratio of benefits to costs (Andersson & Ivehammar, 2019). Hence, high effective and efficiency on autonomous public transport is necessary, yet is the most uncertain driver among the adoption of autonomous public transport.

(d) The Level of Consumer Perceptions of Autonomous Public Transport in Malaysia

This research was carried out in the community of Kuching. The study results indicate that 78.7% of respondents ever heard about autonomous public transport. Besides, 78.2% of respondents ever considered about using autonomous public transport as main transport in the future. This match the previous study stated that people lives in living in the urban area have higher Autonomous Vehicle acceptance (Shabanpour *et al*., 2018).

4.3 Scenario Building

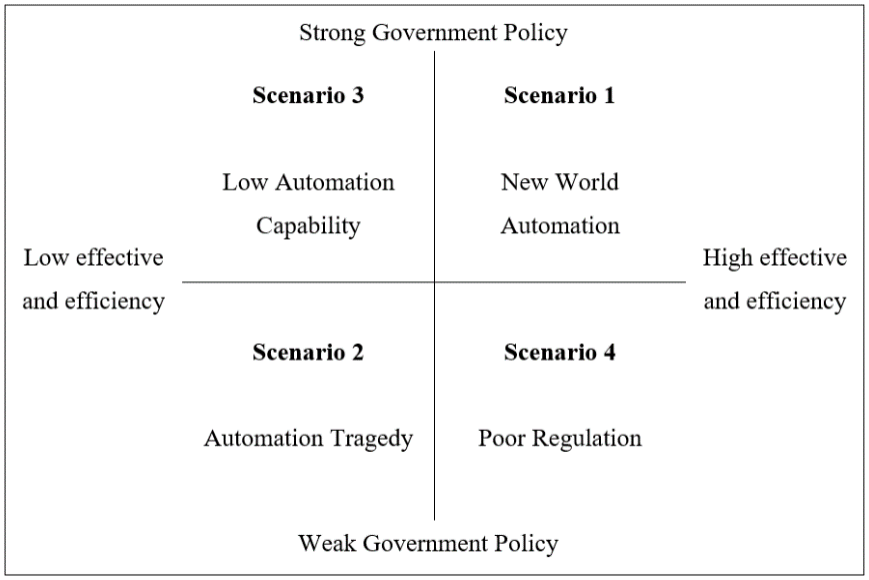

Figure 3: Scenario Building

(a) Scenario 1 "New World Automation"

In this scenario, there is a strong relationship between strong government policies and high effective and efficiency autonomous public transport. This scenario is named "New World Automation" because of the strong government policy that supports and create high effective and efficiency autonomous public transport. This situation is considered as the most ideal scenario for the adoption of autonomous public transport by which this scenario will form a new type of situation whereby Autonomous Vehicles is develops and prospers as a common and main selection of public transport service providers.

Government implement a strong policy to support the usage of autonomous public transport and achieve highly effective and efficient autonomous public transport. Therefore, strong support of government policy enhances the effectiveness and efficiencies of the autonomous public transport. According to Green Car Congress (2017), buses use less area, utilise fewer resources, and can carry a higher number of passengers than cars. This offers tremendous benefits for mobility efficiency and environmental impact reduction. A strong government policy is required a continuously improving and enhancing policy related to autonomous vehicle. Besides, government should also consider that autonomous public transport allows for increased usability and a more efficient use of urban space by making parking spaces accessible for other purposes such as reducing the number of automobiles manufactured would minimize energy and natural resource usage (Oorni, 2020). Provide additional efficient public transport services (high frequency or demand-based) during prolonged operation hours at a cheaper cost (Poinsignon *et al*., 2022). The principles of any city or area are to provide inhabitants with safe, green, accessible and affordable mobility. New technologies should be utilized to assist cities in meeting government policy objectives (Aneshensel *et al*., 2011). Therefore, Malaysian government must develop a legislative framework to ensure that AVs benefit cities and that the stated criteria are followed.

Shared autonomous shuttles will be incredibly cost-effective, as there will be no driver costs, Autonomous public transport have highly flexible and efficient (Aneshensel *et al*., 2011). Therefore, community will be able to select the optimal mobility option through an integrated mobility platform that provides mobility as a service in an integrated public transport system.

(b) Scenario 2 "Automation Tragedy"

In this scenario, government policy and low effective and efficiency for adoption of autonomous public transport. This scenario will form a worst situation. This scenario is named "Automation tragedy" because it can be describe as in a very bad situation for autonomous vehicle. As supposedly, new technology that are introduces and implemented in the future should be have its own value brings benefit to human. However in this scenario, government have weak policy that supports autonomous public transport and also autonomous public transport have low in terms of effectiveness and efficiency. This will lead to a decrease in the intention to use autonomous public transport.

Government is aiming to enhance the transportation policy and increase the effectiveness and efficiency of adopting autonomous public transport. Government plays an important role in commercializing autonomous public transport, however if weak government policy exists, it will be hard to trigger the usage of autonomous public transport. Currently, not enough local governments are actively engaged in AV-related discussions and actions (Fraedrich *et al*., 2019). This supports the statement that currently there are no federal restrictions specific to autonomous vehicle technologies (Anderson *et al*., 2016). Besides that, low effective and efficiency make autonomous public transport to be less valuable. Besides, those who believed that public AVs were more efficient and performed better than existing public transportation were significantly more likely to be prepared to use them (Brown *et al*., 2022). Furthermore, electric keeps autonomous public transport running, therefore there are possible that autonomous public transport run out of battery while service hours. According to News 18 (2021), Tesla runs out of battery caused traffic congestion for 3 hours. This will lead to low effectiveness and efficiency of autonomous public transport.

It can be concludes that if this particular scenario happens in the future, autonomous public transport will not be fully utilize, and consequently will be eliminate and replace by other new advance technology.

(c) Scenario 3 "Low Automation Capability"

In this scenario, strong government policy and low effective and efficiency for adoption of autonomous public transport. This scenario is named "Low Automation Capability" because low effective efficient of autonomous public transport. This scenario have ineffective government policy whereby strong government policy that implements in low effectives and efficiency autonomous public transport. This will cost a lot of money and afford to implement a policy that have low in effective and efficiency.

This situation is unfavourable because government should not spend the time and funds to create a policy to encourage the community to use autonomous public transport that have low effective and efficiency. Besides, one of the key attraction of public transport is that public transport allow the user to read or use the smartphone while waiting to the destination. However, if these activities can be performed in a private autonomous vehicle, fewer persons may use public transportation. This can relate to the statement that autonomous vehicle will reduce the usage of public transport and may lower fare revenue and cause public transit agencies to either reduce services or increase fares, which may create a decreasing of citizen using public transport (Anderson *et al*., 2016). Furthermore, electricity enables autonomous public transport to function. According to Oriental daily (2022), a man drove a Tesla on the highway and encountered a traffic congestion and ran out of electricity and he had to call a tow truck. If this situation happen to the autonomous public transport, it is not effective and efficient whereby the consumers will stuck in the jam and cannot reach their destination in time.

It can be concluded that government have strong policy on that encourage citizen to use autonomous public transport, but have autonomous public transport low effective and efficiency, therefore it is not suitable to be use as commercialize public transport.

(d) Scenario 4 "Poor Regulation"

In this scenario, weak government policy and strong effective and efficiency for adoption of autonomous public transport. This scenario is named as "Poor Regulation" because government have poor policy yet the autonomous public transport have high efficiency.

Government did not focus on policy that encourage consumers to use autonomous pubic transport although autonomous public transport bring various of benefits to the user. As autonomous vehicles are adopted, governments must understand more by increase more research and development, study and analyse it regularly, and make any required adjustments to assure energy and environmental objectives are accomplished (Anderson *et al*., 2016). Inconsistent federal regulations may increase expenses and hinder the adoption of this technology in a way that affects social welfare for little apparent gain (Anderson *et al*., 2016). Careful policymaking will be required to maximise the social benefits enabled by this technology while reducing its disadvantages (Anderson *et al*., 2016).

According to National Research Council (2010), With Level 2, 3, and 4 automation, fuel economy will be further improved. This can relate to the statement that Anderson *et al*., (2016) stated that due to efficiency and prospective transitions to cleaner alternative fuels by autonomous vehicle, the energy consumption and environmental impacts of the vehicle will continue to decrease. Besides, the existence of autonomous vehicle is to improve transportation service quality, significantly reduce operating costs, improve vehicle efficiency, and increase transportation service frequency with low operating costs (Othman, 2020).

In this scenario, it can be conclude that government that have weak policy on autonomous should be enhance. For example, the government should focus on enhancing policy related to autonomous public transport in terms of addressing safety, health, and environmental problems.

5. Conclusion

In conclusion, this research aims to identify the drivers of the adoption of autonomous public transport, study the future trend of autonomous public transport and identify the level of consumer perceptions of autonomous public transport in Malaysia. Autonomous vehicle gain fame and recognition in the automotive sector.

There were various methodology that used in this research such as STEEPV analysis, SPSS statistical analysis, impact-uncertainty analysis and scenario building analysis in order to study and identify the drivers in terms of importance, impact and uncertainty on the corresponding future of autonomous public transport in Malaysia. The two drivers that have the highest in terms of impact and uncertainty is government policy and effective and efficiency for the adoption of autonomous public transport in Malaysia. The objectives of this research were achieved with the identification of the top two drivers and four alternative future images that illustrated the interrelationship between government policy and effective and efficiency.

Government policy and effective and efficient have strong relationship in shaping the future of autonomous public transport in Malaysia. Both of this drivers are significantly important to create an ideal scenario like "New World Automation" where more people adopt and use autonomous public transport.

Acknowledgement

The authors would like to thank the Faculty of Technology Management and Business, Universiti Tun Hussein Onn Malaysia and MIGHT for their support.

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