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ASSESSING THE POTENTIAL DEMAND FOR AUTONOMOUS SHUTTLE BUSES AT UUM: A STUDY ON TECHNOLOGY ACCEPTANCE FOR STUDENT PERSPECTIVE

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ABSTRACT

Autonomous vehicles (AVs), particularly autonomous shuttle buses, are emerging as sustainable and cost-effective transportation solutions, with the potential to reduce travel costs by 6%–11%. At Universiti Utara Malaysia (UUM), the current shuttle service is plagued by overcrowding, delays, and inconsistent driver behavior, negatively affecting the student commuting experience. Despite the potential advantages of AVs, user acceptance remains limited due to concerns about safety, trust, and system reliability—especially in unfamiliar settings. This study aims to assess the potential demand for autonomous shuttle buses among UUM students, focusing on four key determinants: perceived usefulness, perceived ease of use, trust, and safety. Data were collected from 380 student respondents and analyzed using IBM SPSS software for descriptive statistics, correlation, and regression analysis. The findings reveal that perceived ease of use, trust, and safety significantly influence the intention to use autonomous shuttle buses. However, perceived usefulness, while positively associated, does not have a statistically significant impact on demand, suggesting that students are more influenced by functional reliability and confidence in the system. These results offer valuable insights for universities and transport technology developers. To ensure successful implementation, initiatives should prioritize trust-building, system safety, and user-friendly designs to support the adoption of autonomous mobility in campus environments.

Keywords: *Autonomous Vehicles (AVs), Self-driving Vehicles, Sustainable Transportation, Autonomous Buses*

INTRODUCTION

Efficient transportation is critical in large university campuses, ensuring smooth movement of students and staff between academic buildings, residential areas, and other facilities. However, traditional shuttle services are often plagued by long waiting times, limited availability, and overcrowding during peak hours. Universities are now turning to autonomous vehicles (AVs) as an innovative solution to modern transportation challenges. Autonomous shuttle buses are gaining attention for their ability to operate without human drivers, potentially minimizing transportation issues (Shen et al., 2023). The adoption of autonomous shuttle buses is a promising direction for campuses seeking to enhance transportation efficiency. However, introducing such technologies requires careful consideration of user demand and acceptance. Perceived usefulness and ease of use are primary factors influencing whether students adopt new technology. According to Xiao and Goulias (2022), students' willingness to use autonomous shuttles increases when they believe the technology is easy to navigate and improves their daily routines.

Several universities globally have begun piloting autonomous shuttles to improve transportation. Yavuz (2024) found that students respond positively to such trials when they experience fewer delays and enhanced convenience through real-time tracking apps. These experiments highlight the importance of early exposure in driving technology acceptance among students, supporting the theory that positive experiences foster adoption (Wu et al., 2021). The Technology Acceptance Model (TAM) further describes how perceived usefulness and ease of use predict user behavior, but additional variables like trust play a significant role in defining students' willingness to adopt autonomous shuttles (Golbabaei et al., 2022). To overcome transportation challenge at UUM, exploring new solutions is essential. Autonomous shuttles could address these issues by offering frequent and reliable services, reducing dependency on human drivers, and contributing to UUM's sustainability goals through electric-powered vehicles (Rombaut et al., 2024). This study purposes to assess the potential demand for autonomous shuttle buses at UUM, concentrating on factors such as perceived usefulness, ease of use, trust, and safety. The research will employ the TAM framework to evaluate student perceptions and predict their willingness to adopt the service.

Research Question

1. What is the potential demand for autonomous shuttle buses among UUM students?
2. How do technology acceptance factors, like ease of use, usefulness, trust, and safety, influence students' intention to use autonomous shuttle buses at UUM?
3. What advantages do students see in autonomous shuttle buses compared to the current shuttle service in solving their transportation issues?

Research Objective

1. To assess the potential demand for autonomous shuttle buses among UUM students.
2. To investigate the role of technology acceptance factors in shaping students' intention to use autonomous shuttle buses at UUM.
3. To analyze the perceived advantages of autonomous shuttle buses over the existing shuttle service in addressing student concerns.

PROBLEM STATEMENT

Universities worldwide face increasing challenges in managing transportation systems effectively. Common issues such as overcrowding, delays, and inconsistent schedules are widespread and significantly impact student experiences (Loo & Tsoi, 2024). As student populations grow, these inefficiencies become more acute, affecting not only academic performance but also the general quality of campus life (Gbadamosi, 2013). At Universiti Utara Malaysia (UUM), these challenges are already apparent with students experiencing difficulties commuting efficiently between residential halls, academic buildings, and other facilities. This issue supported by a study by Misiran et al. (2021) highlights several issues, including unreliable schedules, insufficient facilities, and inconsistent driver behavior, all of which negatively impact student satisfaction in UUM. Students are often hesitant to trust driverless systems, particularly in unfamiliar settings, and concerns about safety and reliability remain significant obstacles (Kayikci & Kabadurmus, 2022). Furthermore, the lack of exposure to autonomous technologies creates uncertainty, making students reluctant to switch from traditional transportation systems (Classen et al., 2023). These barriers show the importance of understanding user concerns to ensure the successful implementation of autonomous shuttle buses at UUM.

LITERATURE REVIEW

Potential Demand for Autonomous Shuttle Buses

AVs aim to improve road safety by minimizing human errors and enhancing traffic efficiency through intelligent systems (Jing et al., 2019). The demand for autonomous shuttle buses is shaped by multiple factors, including service efficiency, user satisfaction, and ease of digital integration. Research shows that autonomous shuttles are capable of improving transportation service quality by offering optimized scheduling, frequent trips, and minimal waiting times (Cao & Ceder, 2019). Furthermore, automated transportation systems reduce the possibility of human error, resulting in more reliable services (Milakis et al., 2020). Global trends demonstrate that users show greater acceptance when autonomous shuttles integrate with real-time tracking apps and booking platforms (Nordhoff et al., 2018). For instance, trials of autonomous vehicles in European cities show that public satisfaction increases when shuttles offer timely services and seamless digital access to information (Litman, 2020).

Perceived Usefulness

Perceived usefulness is the degree to which users trust that a service will improve their transportation experience (Davis, 1989). Dong et al. (2024) initiate that passengers are more likely to adopt autonomous buses if the service offers time-saving benefits and better scheduling. Quinones et al. (2024) emphasize that on-demand services increase usefulness by ensuring frequent and timely trips. Transportation services that provide optimized routes and easy access have higher perceived usefulness (Wu et al., 2021).

Perceived Ease of Use

Ease of use is critical for the adoption of autonomous transportation services. Research shows that intuitive booking platforms and real-time information tools lower barriers to adoption (Shen et al., 2023). Additionally, Alotaibi et al. (2023) emphasize that user-friendly systems are essential for

ensuring a positive first-time experience with autonomous shuttles, as perceived complexity can deter adoption.

Trust and Safety

Building trust in the safety and reliability of autonomous vehicles is essential for driving demand. Wu et al. (2021) argue that trust in safety features, such as automated braking and obstacle detection systems, is critical to encouraging adoption. Cheng and Lai (2023) found that passengers are often skeptical about autonomous systems initially, but exposure through pilot trials increases trust over time. Similarly, Mouratidis and Serrano (2021) emphasize that pilot programs and demonstrations build public confidence by showing the reliability of autonomous shuttles. Trust and safety remain essential components of user acceptance, especially for technologies that involve autonomous operation.

Theoretical Framework

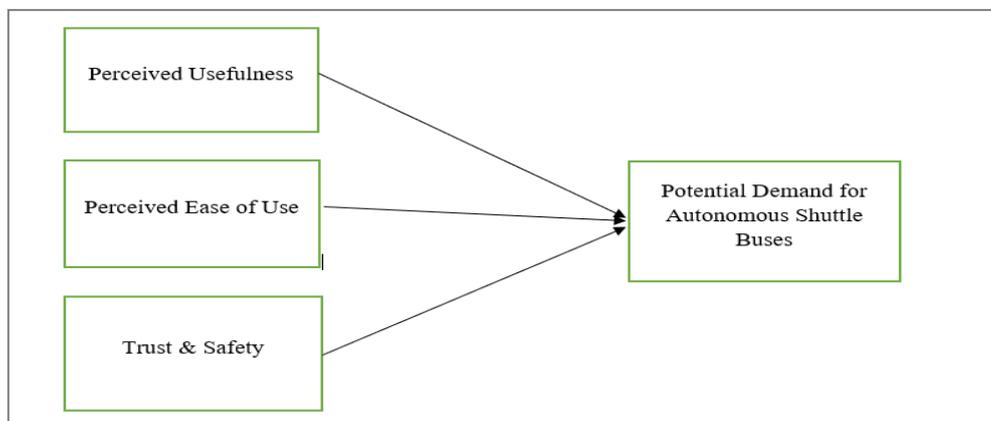


Figure 1
Framework of the Potential Demand for Autonomous Shuttle Bus

Hypothesis Development

The hypothesis statement below has been developed by past research and is based on the research framework in Figure 1.

H1: Perceived usefulness has a positive relationship with the potential demand for autonomous shuttle bus.

H2: Perceived ease of use has a positive relationship with the potential demand for autonomous shuttle bus.

H3: Trust and safety have a positive relationship with the potential demand for autonomous shuttle bus.

RESEARCH METHODOLOGY

Research Design

This research is quantitative research. It's a process of collecting and analyzing numerical data to trial theories and make predictions. According to Creswell (2017), The researcher chooses the study's topic, formulates and refines research questions, collect quantitative data from respondents, and uses statistics

to analyse the data in quantitative research, a subset of educational research. Other than that, in quantitative research, the research issues are presented as hypotheses.

Population and Sample Size

This study may investigate the phenomena that have capability to generate insights by performing questionnaire surveys to the respondent are UUM students. As of October 2024, the population of this study will include 30,149 undergraduate and postgraduate students of Universiti Utara Malaysia. According to Krejcie and Morgan (1970), the sample size is 379 respondents from University Utara Malaysia students for this survey. The formula was developed based on rigorous statistical theory, incorporating confidence level, population proportion and margin of error. This ensures that the sample size generated by the result is statistically reliable to produce precise estimates that reflect the target population.

Data Collection

This study employs a data collection method in survey form using a structured questionnaire distributed through Google Forms. The survey targets UUM students to collect data on their perceptions, attitudes, and willingness to use autonomous shuttle buses. To ensure maximum reach, the survey will be shared via online platforms such as WhatsApp, Instagram, and Facebook, allowing students to respond at their convenience. The questionnaire is separated to four sections, covering demographics and key variables, including perceived usefulness, perceived ease of use, trust, and safety. Responses are measured on a 5-point Likert scale, ranging from "Strongly Disagree" to "Strongly Agree," to capture students' attitudes accurately.

Data Analysis

The data collected through the survey will be analysed using IBM SPSS software to derive meaningful insights. Several statistical analyses will be conducted to meet the objectives of the study. First, descriptive analysis will summarize the key characteristics of the data, such as the demographic profile of the respondents and the distribution of responses across key variables. This step helps identify general patterns and trends within the dataset. Next, normality analysis will be performed to ensure the data follows a normal distribution, a necessary assumption for conducting more advanced statistical tests. Following this, correlation analysis will be applied to examine the strength and direction of relationships between the variables, such as the relationship between trust and students' willingness to use autonomous shuttles. This analysis will help determine how closely the variables are associated with one another. Finally, regression analysis will be used to predict the effect of independent variables, like usefulness, ease of use, trust, and safety, on the dependent variable, which is the demand of autonomous shuttle buses. This method will provide insights into which factors have the most influence on students' intention to adopt the new transportation service. Together, these data gathering and analysis methods ensure a comprehensive approach to understanding the potential demand for autonomous shuttle buses at UUM and provide meaningful insights for decision-making.

RESEARCH FINDINGS

Reliability Test

In this study, the reliability analysis was performed on four constructs: Perceived Usefulness, Perceived Ease of Use, Trust and Safety, and Potential Demand. Cronbach's Alpha was employed to evaluate internal consistency, a widely accepted method for assessing reliability. All of the data records indicate the data values are good since the values are in the range of 0.70 to 0.89. The reliability of the study's measurement tools is supported by these results, which imply that the items within each construct are closely connected and measure the same underlying notion.

Table 1

Results of reliability test

Variables	Cronbach's Alpha	N of Items
Perceived Usefulness	0.854	5
Perceived Ease of Use	0.826	4
Trust and Safety	0.855	5
Potential Demand	0.796	5

Table 1 shows the results of the reliability of the variables. The Cronbach's Alpha for Perceived Usefulness was 0.854, based on five items. This high value presents a strong level of internal consistency, indicating that the items are well-correlated and effectively measure the construct. Perceived ease of use Cronbach's Alpha was 0.826, derived from four items. This demonstrates good reliability, confirming that the items consistently indicate the concept of ease of use. Next, the reliability coefficient for Trust and Safety was 0.855, with four items contributing to this construct. This high value reflects superior internal consistency, indicating that the measurement items dependably assess the respondents' perceptions of trust and safety. Moreover, the Cronbach's Alpha for Potential Demand was slightly lower at 0.796, based on five items. While this value is slightly below the threshold for excellent reliability, it still falls within the acceptable range, suggesting a reliable measurement.

Correlation Test

Table 2

Result of Correlation Coefficients (N=380)

Variable	Coefficients (r)
1. Perceived Usefulness	0.462***
2. Perceived Ease of Use	0.522***
3. Trust and Safety	0.518***

Note. Pearson correlation coefficient: *** $p < 0.001$

The results in Table 2 show statistically significant correlations between Potential Demand and the three independent variables which are a moderate and positive correlation ($r = 0.462$, $p < 0.001$) was observed between Perceived Usefulness and Potential Demand. Consequently, Hypothesis 1 (H1) is supported. Next, the Pearson correlation coefficient ($r = 0.522$, $p < 0.001$) indicates a moderate and positive relationship. Consequently, Hypothesis 2 (H2) is supported. The analysis discloses a moderate and positive relationship ($r = 0.518$, $p < 0.001$) between Trust & Safety and Potential Demand. As a result, Hypothesis 3 (H3) is supported. Overall, the findings indicate that all three independent variables play significant roles in shaping the demand for the autonomous shuttle bus.

Regression Analysis

The result of the multiple linear regression produced an F-value of 61.999 with a p-value of < 0.001 . This determines that the regression model is statistically significant and that the independent variables, as a group, have a meaningful influence on Potential Demand. Table 3 summarizes the full results of the regression analysis.

Table 3
Result of Multiple Linear Regression

Relationship	β	T	Sig.	R ²	Results
H1: Perceived Usefulness \rightarrow Potential Demand	0.088	1.809	0.071		Not significant
H2: Perceived Ease of Use \rightarrow Potential Demand	0.211	4.230	0.001	0.326	Significant
H3: Trust and Safety \rightarrow Potential Demand	0.196	4.549	0.001		Significant

Note. Two-tailed test

Based on Table 3 shows that the model yielded an R-value is 0.575, which indicates a moderate positive correlation between the independent variables and Potential Demand. This is because Perceived Usefulness is not significant relationship with Potential demand because students recognized other reasons such as time savings and sustainability to use autonomous bus. The adjusted R-squared value was 0.326, showing that 32.6% of the variance in Potential Demand is described by the independent variables. Table 3 also revealed that perceived usefulness towards potential demand has a p-value of 0.071, which means it is not statistically significant for potential demand. The perceived ease of use has a p-value of < 0.001 , which significantly predicts potential demand. Next, trust and safety, which have a p-value of < 0.001 , are another significant predictor. The largest beta coefficient is found in perceived ease of use ($B=0.211$), followed by trust and safety ($B=0.196$) and perceived usefulness ($B=0.088$). For this study, ease of use and trust and safety have relatively stronger effects compared to perceived usefulness, making them priorities for actionable insights.

DISCUSSION

H1: No Significant Relationship Between Perceived Usefulness and Potential Demand

While perceived usefulness had some influence, it was not as strong or significant as ease of use or trust and safety in driving demand for autonomous shuttle buses. Students recognized benefits such as time savings and sustainability, but these alone were not enough to increase demand. Similarly, Yuen et al. (2020) initiate that perceived usefulness is important but often mediated by other reasons, such as trust and perceived ease of use, in shaping public acceptance of autonomous vehicles. Their study highlights that while usefulness contributes to perceived value, ease of use and trust have stronger direct effects on acceptance. This suggests that to encourage adoption at UUM, more emphasis should be placed on improving.

H2: Significant Relationship Between Perceived Ease of Use and Potential Demand

This research found a clear and positive relationship between perceived ease of use and the demand for autonomous shuttle buses. Among the factors studied, ease of use had the strongest influence on whether students were likely to adopt the new transportation system. This result aligns with the Technology

Acceptance Model (TAM), which highlights ease of use as a critical element in adopting new technology. Previous studies, such as by Mouratidis and Serrano (2021), also found that when users find a system simple and intuitive, their willingness to adopt it increases significantly.

H3: Significant Relationship Between Trust and Safety and Potential Demand

Trust and safety were also exposed to have a significant positive result on the potential demand for autonomous shuttle buses. Students were more likely to consider using the shuttles if they felt confident about their safety and reliability. Similar findings have been observed in other research, such as by Wu et al. (2021), who noted that trust in safety features is crucial for public acceptance of autonomous vehicles.

CONCLUSION

The study successfully displayed that perceived ease of use had the strongest influence on potential demand for autonomous shuttle buses among UUM students, followed by trust and safety factors, and perceived usefulness was the least influenced. Through regression analysis, these key determinants were identified, which allow students value intuitive interfaces, user friendly systems, and robust safety measures over general convenience benefits. However, findings may not generalize since the research was done in a single university in Malaysia. Further research should be conducted on multiple universities for a comparative analysis, and other variables (perceived risk, attitude etc.) should be investigated to open up the study of autonomous vehicle adoption in university contexts. The study suggests that (AVs) interfaces can be made more user-friendly, and developing trust through protocols rather than solely focusing on promoting utilitarian benefits. To enhance adoption, it is recommended that universities provide hands-on experience with the shuttles and comprehensive information about their features and functionality, ultimately supporting both mobility needs and sustainability goals. The study assist (AVs) field understand student perception to enhance AVs performance.

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