



Traffic Accident Prevention Through Acceptance of Advanced Driver Assistance System (ADAS) among Urban People

Edi Purwanto^{1*}, Dede Suleman¹, Rachman Sjarief¹, Dewi Sri², Muhammad Daffa Juliansyah²,
Muhammad Iqbal Revilliano Trisandri²

¹ Department of Management and Jaya Launch Pad, Universitas Pembangunan Jaya, South Tangerang 15413, Indonesia

² Department of Management, Universitas Pembangunan Jaya, South Tangerang 15413, Indonesia

Corresponding Author Email: edi.purwanto@upj.ac.id

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ABSTRACT

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Lead Indonesia's accident cases are caused mainly by human error, which can be reduced by implementing an Advanced Driver Assistance System (ADAS) technology. Protection motivation and acceptance of technology are generally a concern for drivers adopting ADAS. Therefore, this research aims to build a model of the Combined Protection Motivation Theory and Unified Theory of Acceptance and Use of Technology (C-PMT-UTAUT) to determine the factors that encourage drivers and owner-drivers' interest in using the ADAS. This research method applies quantitative research to a population of automotive users in Jakarta and Tangerang. A survey was conducted with a sample of 220 automotive users in Jakarta and Tangerang. Determination of the sample using the convenience sampling method and the samples collected and used were 220 samples. The data is then processed using Smart-PLS. The research results prove that perceived vulnerability affects the positive attitude of automotive users to use ADAS, likewise, with the performance expectancy and effort expectancy variables. Furthermore, the study's results also prove that attitude significantly affects the intention of automotive users to add ADAS features to their vehicles. The research results prove that the perceived vulnerability is proven to positively and significantly affect attitudes to ADAS. Likewise, the effect of performance expectancy on attitude toward ADAS is proven to be positive and significant. The effort expectancy also positively and significantly affects the attitude toward ADAS. One factor that has yet to be proven to be a concerned driver is severity because the perceived severity has not been proven to influence attitudes toward ADAS significantly. Then, the attitude positively and significantly affects the intention to use ADAS. The findings of this study have important practical implications for policymakers, car manufacturers, and technology developers working on ADAS. Policymakers can promote awareness, education and implement incentives. Car manufacturers can enhance perceived vulnerability, improve performance expectancy, and simplify the user experience. Technology developers can emphasize usability and address concerns about severity.

1. INTRODUCTION

A release from the National Police regarding the level of traffic accident cases at the end of 2020 shows that the province of DKI Jakarta is ranked fifth with a total of 73 incidents. Compared to DKI Jakarta, Central Java is in first place with 336 cases. East Java is in second place with 332 cases, West Java is in third place with 180 cases, and DI Yogyakarta is in fourth place with 91 cases [1]. Kominfo reports that, on average, three people die every hour due to traffic accidents. According to this news, 61 percent of the causes of traffic accidents are due to the human factor related to the ability and character of the driver, 30 percent due to infrastructure and environmental factors, and only 9 percent due to the vehicle's worthiness factor [2]. So based on this information, 61 percent of traffic accidents are caused by the ability and behavior of the driver. Interestingly, the province of DKI Jakarta does not occupy the first position for the number of traffic accident cases, but instead, it is in the fifth position. The large number of new car users in Jakarta who

have used the Advanced Driver Assistance System (ADAS) technology is likely why the rate of accident cases is below Central Java, East Java, West Java, and DI Yogyakarta.

Advanced Driver Assistance Systems (ADAS) technology plays a crucial role in addressing the challenges of road accidents in urban areas [3]. With the rapid growth of population and vehicles in big cities, the risk of accidents and traffic congestion has become a pressing concern [4]. ADAS offers a range of features such as collision warning, lane departure warning, automatic emergency braking, and adaptive cruise control, which can significantly assist drivers in navigating busy city streets and avoiding potential collisions. Using sensor-based technologies, ADAS enhances driver awareness, provides real-time feedback, and enables proactive safety measures. This technology is essential in mitigating human errors, which are often the primary cause of accidents in urban environments. Integrating ADAS into vehicles and promoting its adoption can significantly reduce the number of accidents, improve road safety, and create a safer driving environment for both motorists and pedestrians in large cities

[5].

The problem in Indonesia, especially Jakarta and Tangerang cities, is that very few cars are equipped with ADAS, for example, Wuling Almaz, Daihatsu Rocky, Toyota New Raize, and the latest Honda BRV.

Several previous studies tested PMT for the context of acceptance of green products [6], health [7], information security protection [8], protecting environmental sustainability [9], ethnic restaurants [10], mobile emergency warning apps [11], but it is still challenging to find PMT testing to test ADAS acceptance. Therefore, Jun et al. [12] wrote a systematic literature review of PMT and suggested testing this model in the context of ADAS acceptance. Severity and vulnerability are considered essential factors in preventing road accidents. Therefore this study includes the PMT factors to test attitudes and intentions to use ADAS.

The UTAUT model is a model commonly used to test technology acceptance. Because ADAS is a form of innovation or technology, the UTAUT factors are essential for testing ADAS acceptance. However, comparing previous studies on testing ADAS acceptance using the UTAUT model is still challenging. Most of the technology adoption tested with UTAUT was primarily, for example, acceptance of M-banking [13], e-learning [14], m-health service [15], and other fields. However, the model's UTAUT factors are essential for testing ADAS acceptability; therefore, this study includes UTAUT factors. Because the PMT and UTAUT factors are crucial factors that can influence users to adopt ADAS, this research combines the PMT and UTAUT models to become Combined PMT-UTAUT.

ADAS refers to a collection of features and technologies designed to assist drivers in enhancing safety, reducing accidents, and improving the overall driving experience. ADAS aims to augment the driver's abilities and mitigate potential risks by providing real-time information, alerts, and automated assistance. ADAS enhances driver awareness by utilizing sensors and cameras to monitor the surroundings, detecting potential hazards, and alerting the driver accordingly. It includes features such as forward collision warning, lane departure warning, and blind-spot detection, which help prevent accidents caused by human errors or inattention. ADAS also improves driver responsiveness through features like adaptive cruise control, which automatically adjusts the vehicle's speed to maintain a safe distance from the vehicle ahead. It reduces the likelihood of rear-end collisions and enhances traffic flow efficiency.

Furthermore, ADAS assists in mitigating the severity of accidents through features like automatic emergency braking and pedestrian detection. Overall, ADAS technology significantly reduces traffic accidents, injuries, and fatalities by providing drivers with advanced warning systems, assistance in critical situations, and increased situational awareness.

The specific objectives of this research are: (1) to create a C-PMT-UTAUT conceptual model and test it, (2) to produce market research that constitutes Basic Research that will become the basis for applied research and development research which is helpful for automotive companies to complement their new products with ADAS, and start-up companies to create Mobile-ADAS technology for cars that are not yet equipped with ADAS.

The urgency of this research is because the facts and data have confirmed that the highest cause of traffic accidents is caused by the human factor [1], so the development of ADAS

is expected to be able to reduce the rate of traffic accidents due to these human errors. For this reason, it is necessary to research the community's intention to use ADAS and the factors that influence it.

2. LITERATURE REVIEW

The Advanced Driver Assistance System (ADAS) is a set of technology systems that can be used to develop vehicle products that help drivers use their cars safely and automatically. The ADAS concept began to be realized in the 1980s when the European Union initiated DRIVE (Dedicated Road Infrastructure for Vehicle Safety in Europe), a project to reduce the risk of traffic accidents on the road and improve the cognitive abilities of drivers [12]. As a result, the number of cars using ADAS continues to increase, and automation with the ADAS system continues to grow over time [12].

The ADAS system currently embedded in several car products in Indonesia includes: (1) Adaptive Cruise Control (ACC), an automatic system that adjusts speed according to the speed of the car in front of it. (2) Bend Cruise Assistance (BCA), an automatic system that helps reduce speed when the vehicle enters a bend. (3) Traffic Jam Assistance (TJA), an automatic system capable of assisting a safe distance from the vehicle in front of it when there is a traffic jam. (4) Intelligent Cruise Assistance (ICA) and Lane Departure Warning (LDW), which automatically give a warning when the vehicle leaves the safe lane. (5) Lane Keeping Assistance (LKA) automatically corrects the steering direction to return to a safe lane. (6) Safe Distance Warning (SDW) automatically warns that the vehicle in front is too close, and several other ADAS systems. (7) Forward Collision Warning (FCW) is a system that detects potential collisions on the front by giving a warning in the form of a sound or visual display. The brakes will automatically adjust to the level of danger that will occur. (8) Automatic Emergency Braking (AEB), a system that works when the driver does not respond to a collision hazard warning, in which case this system will automatically apply emergency braking. (9) Intelligent Hydraulic Braking Assistance (IHBA), a system that will adjust automatic braking according to the risk of danger. (10) Collision Mitigation System (CMS), a system that will reduce the vehicle's speed to minimize the severity of injury or damage to the car due to a collision. (11) Intelligent Head Beam Assistance (IHMA), a system that will automatically adjust the height of the leading light to adjust the lighting conditions in the surrounding environment [16].

This research examines the factors that influence people's intention to use ADAS as a complement to driving safety. Using the Protection motivation theory (PMT) and the Unified Theory of Acceptance and Use of Technology (UTAUT), apart from finding the driving factors of these intentions, a C-PMT-UTAUT model will also be built.

Protection motivation theory (PMT) was previously mainly applied in the field of health sciences. Rogers [17] initially put forward this theory to explain changes in individual attitudes and behavior related to health. This theory explains psychological fear and individual responses to health threats. Psychological fear raises the motivation to find protection from threats. This protective motive will affect the individual's actual behavior [12]. Even though initially PMT was a theory used to research protective motivation related to health problems, then Jun et al. [12] wrote a treatise recommending the use of PMT to test people's intentions to use the advanced

driver assistance system (ADAS) to protect themselves from the threat of traffic accidents.

As far as searching the literature on reputable international journal databases, previous research related to PMT has not found the use of this theory to test motivation to protect oneself from traffic accidents by utilizing an advanced driver assistance system (ADAS). For example, even though Jun et al. [12] wrote a literature review on the acceptance of ADAS using PMT, empirical field research has yet to be carried out. Other researchers who have used PMT include Gao et al. [18] in the context of healthcare acceptance in China. Likewise, Ibrahim and Al-Ajlouni [6] tested PMT in the context of green products in Saudi Arabia, Sabzmakan et al. [7] in the context of health hazards from tobacco in Iran, Menard et al. [8] in the context of information security protection in the United States, Kothe et al. [9] in the context of protecting environmental sustainability, Lee et al. [10] in the context of ethnic restaurants in South Korea, and Fischer-Preßler et al. [11] in the context of the adoption of mobile emergency warning apps in Germany.

The UTAUT model was developed by Venkatesh et al. [19] in 2003 and the UTAUT2 model was also developed by Venkatesh et al. [20] in 2012. Many researchers use the UTAUT model to examine factors that influence the intention to use various innovative technologies in various countries, for example, testing the UTAUT model in the context of acceptance of computer-assisted audit techniques and tools (CAATTs) [21], online tax filling [22], e-learning by Lwoga and Komba [13], Arif et al. [23], Thongsri et al. [24], Gunasinghe et al. [25], Buabeng-Andoh and Baah [26], mobile library by Chang [27], Wu and Wu [28], e-government service [29], m-health service [14], acceptance of digital payment platforms by Tarhini et al. [12], Kuciapski [30], Sivathanu [31], Sobti [32], Gupta et al. [33], Rahi et al. [34], Giovanis et al. [35], Odooom and Kosiba [36] and other fields. Then, our previous research tested Combined UTAUT-IRT intending to use a digital fishery platform [37, 38]. As far as searching the database of reputable journal publishers has not found research on the intention to accept ADAS, either using the UTAUT model or the PMT-UTAUT combination (see Figure 1).

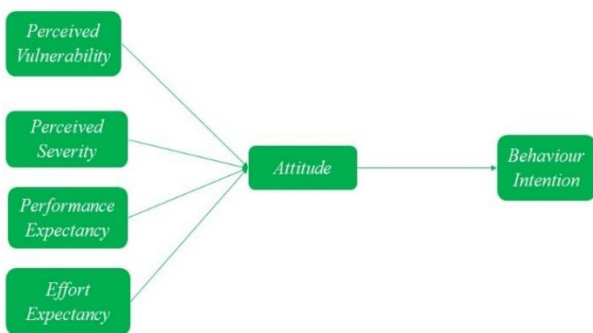


Figure 1. Conceptual framework

Compared to the results of previous studies, this research has its characteristics because the context studied has never been investigated or researched in previous studies. Previous research in various countries has tested the Protection Motivation Theory (PMT) in the context of tobacco acceptance and protecting information security, but what has yet to be done is in the context of ADAS acceptance. Even though Jun et al. [12] wrote about the PMT-UTAUT2 hypotheses regarding the acceptance of ADAS, this

publication is only in the form of a literature treatise, not the results of field research. Previous research in various countries has tested UTAUT in the context of acceptance of e-computer-assisted audit techniques and tools (CAATTs), online tax filing, e-learning, mobile libraries, e-government services, m-health services, and digital payments, but what has not been done is in the context of ADAS acceptance. Therefore, it's not just testing related to ADAS acceptance that has never been tested using PMT and UTAUT or other theories; more specifically, the novelty of this research will test the combination of C-PMT-UTAUT.

Then the hypotheses of this research are:

H1. The perceived vulnerability will influence attitude to ADAS.

H2. The perceived severity will influence attitude toward ADAS.

H3. The performance expectancy will influence attitude toward ADAS.

H4. The effort expectancy will influence attitude toward ADAS.

H5. The attitude will influence Behaviour Intention to use ADAS.

3. RESEARCH METHODOLOGY

The research method, which includes research stages, research locations, observed/measured variables, models used, research design, as well as data collection and analysis techniques, can be described as explained below:

3.1 Research process

Figure 2 is the research process.

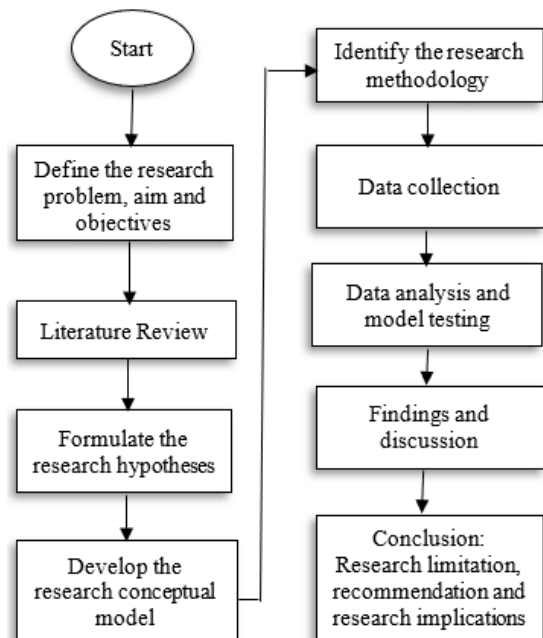


Figure 2. Research process

3.2 Research location

The research locations are Jakarta and Tangerang. The basis for choosing Jakarta as the research location was because Jakarta is a city where four-wheeled traffic flows from

supporting cities. Tangerang was selected as the following research location because automotive users in Tangerang City, South Tangerang City, and Tangerang Regency are buffer cities contributing significantly to traffic jams in DKI Jakarta.

3.3 Population and sample

The population is all car owners who drive their cars (owner drivers) in Jakarta, Tangerang City, South Tangerang City, and Tangerang Regency. Samples will be taken from the population.

3.4 Data collection technique

Because the exact number of owner drivers is unknown, the sampling technique used is convenience or non-probability. The sample size for non-probability sampling Hair et al. [39] suggests multiplying the number of indicators multiplied by 5 to 10. The number of indicators in this study is 22 items; if multiplied by ten, the total sample is 220, which meets the minimum sample size.

3.5 Measurement instrument

The measurement instrument for the severity variable adopts four items developed by Johnston and Warkentin [40] in the study of Jun et al. [12]. Likewise, the measurement instrument for the vulnerability variable also adopts the four items developed by Johnston and Warkentin [40] in the study of Jun et al. [12]. Meanwhile, the research instrument for the variable Performance expectancy, Effort expectancy, was adapted from a questionnaire developed by Venkatesh et al. [19].

3.6 Data analysis method

This study will use the PLS-SEM analysis technique with the help of SmartPLS version 3.0 software. SEM-PLS data analysis will include outer model evaluation measurements to test reliability and validity and structural models or inner model evaluations to statistical T-tests or hypothesis tests [41]. Finally, the test results will be analyzed in depth to find the research results.

The analysis technique of this study uses PLS-SEM because PLS-SEM allows for estimating models with many constructs and items, even when the sample size is limited [42]. Hair et al. [42] said that unlike traditional approaches, PLS-SEM calculates the relationships between measurement and structural models separately, enabling application in situations where nonnormal data is prevalent. While this is a notable advantage for social science studies that often encounter nonnormal data, it alone does not justify its use sufficiently.

In a structural equation model with latent constructs, there are two components. The first component is the structural model, which shows the relationships between the latent constructs and only allows for recursive relationships. If the T-Statistic value > 1.96 and the P-value < 0.05, then the hypothesis is proven significant [43].

The second component is the measurement models, which include the relationships between each latent construct and its observed indicators. PLS-SEM permits only unidirectional relationships, with each indicator associated with a single latent construct. The outer model includes indicator reliability (outer loading > 0.70), convergent validity (AVE > 0.50),

Composite Reliability (> 0.70), and discriminant validity using the Fornell-Larcker Criterion test [43].

4. RESULT AND DISCUSSION

The research results, which are the results of statistical processing of the data collected from the field, are presented in two presentations of the test results, namely the results of the outer model test and the results of the inner model test from the Structural Equation Model-Partial Least Square (SEM-PLS) analysis.

4.1 Outer model evaluation

The results of the outer model test show that all items or indicators of each research variable have outer loadings or factor loadings > 0.70 [44], as shown in Table 1. All indicators of each research variable are proven valid or meet indicator reliability.

Table 1. Factor Loading

Perceived Vulnerability	
VN1	0.803
VN2	0.845
VN3	0.866
Perceived Severity	
SV1	0.756
SV2	0.852
SV3	0.724
Performance Expectancy	
PE1	0.906
PE2	0.917
PE3	0.931
PE4	0.899
Effort Expectancy	
EE1	0.833
EE2	0.898
EE3	0.891
EE4	0.884
Attitude	
ATT1	0.932
ATT2	0.948
ATT3	0.936
ATT4	0.939
ATT5	0.923
Behaviour Intention	
BI1	0.922
BI2	0.921
BI3	0.930

Table 2. Construct reliability and validity

	Cronbach's Alpha	Composite Reliability	Average Variance Extracted (AVE)
Attitude	0.964	0.972	0.875
Behaviour Intention	0.915	0.947	0.855
Effort Expectancy	0.900	0.930	0.769
Perceived Severity	0.700	0.822	0.607
Perceived Vulnerability	0.791	0.876	0.703
Performance Expectancy	0.934	0.953	0.834

Table 3. Discriminant validity-ornell-larcker criterion

	AT	BI	EE	PE	PU	PE
AT	0.936					
BI	0.770	0.925				
EE	0.628	0.615	0.877			
PE	0.444	0.392	0.292	0.779		
PV	0.175	0.172	0.227	0.304	0.838	
PE	0.820	0.701	0.635	0.535	0.289	0.913

AT: Attitude; BI: Behaviour Intention; EE: Effort Expectancy; PE: Perceived Severity; PV: Perceived Vulnerability; PE: Performance Expectancy

Table 4. Path coefficients

	Hipotesis	Original Sample (O)	T Statistics (O/STDEV)	P Values
H1	Perceived Vulnerability ->Attitude	-0.083	2.190	0.029
H2	Perceived Severity ->Attitude	0.037	0.867	0.386
H3	Performance Expectancy ->Attitude	0.704	12.243	0.000
H4	Effort Expectancy ->Attitude	0.189	3.523	0.000
H5	Attitude ->Behaviour Intention	0.770	19.726	0.000

The results of the outer model test also prove that each variable is valid, as evidenced by all Average Variance Extracted (AVE) values for each variable >0.50 [45], as shown in Table 2. In addition to each variable being proven valid, each variable in this study is also proven to be reliable, as demonstrated by the results of Composite Reliability values and Cronbach's Alpha values >0.70 [46], as shown in Table 2.

The results of the Fornell-Larcker Criterion test show that the value of each variable is greater than the correlation value with other variables, as shown in Table 3. So each variable is proven valid or fulfills discriminant validity.

4.2 Inner model evaluation

The results of the inner model test prove that only one hypothesis is not proven, namely H2, because perceived severity does not affect the positive attitude of automatic users towards the Advanced Driver Assistance System (ADAS). After all, the T-Statistic value is $0.867 < 1.96$, and the P-value is $0.386 > 0.05$ (see Table 4). Therefore, apart from H2, all hypotheses are proven.

The non-significant effect of perceived severity on attitude toward ADAS suggests the presence of other underlying factors that may have influenced individuals' attitudes in this context. While previous research has indicated a positive association between perceived severity and attitudes toward safety-related technologies [6], our findings deviate from this trend. But previous study by Sabzmakan [7], as well as Menard et al. [8] and Lee et al. [10] find that the severity was not significant factor of PMT. One possible explanation for this non-significant effect could be the participants' pre-existing attitudes and beliefs about ADAS. It is plausible that individuals already held well-established attitudes toward ADAS, rendering the impact of perceived severity less influential in shaping their overall attitude. Furthermore, the non-significant effect of perceived severity on attitude toward ADAS suggests considering alternative variables that might mediate or moderate this relationship. For instance, individual

differences in risk perception or prior exposure to ADAS technologies could influence the extent to which perceived severity impacts attitude formation. Investigating these potential mediators and moderators could provide valuable insights into the complexities of the perceived severity-attitude relationship.

The implications of this non-significant effect extend beyond theoretical contributions. From a practical standpoint, understanding the factors that shape individuals' attitudes toward ADAS is crucial for effectively implementing and accepting these systems. Therefore, acknowledging the absence of a direct effect of perceived severity on attitude highlights the importance of considering other influential factors in developing persuasive communication strategies or interventions to promote positive attitudes toward ADAS. Therefore, the unsupported hypothesis H2 regarding the effect of perceived severity on attitude toward ADAS necessitates further elaboration and exploration. The potential explanations discussed above offer directions for future research in order to uncover the underlying factors and mechanisms that shape attitudes toward ADAS. This enhanced understanding will aid in developing effective strategies for promoting the acceptance and adoption of ADAS technologies in the context of road safety.

Table 4 shows that the T-statistic value of H1 is $2.190 > 1.96$, and the P-value is $0.029 < 0.05$, so it can be stated that perceived vulnerability has a positive and significant effect on the positive attitude of automotive users towards ADAS. Furthermore, the effect of performance expectancy on the positive attitude of automotive users towards ADAS is also proven to be positive and significant, as indicated by the T-statistic value of $12.243 > 1.96$ and the P-value of $0.000 < 0.05$, and thus H3 is confirmed. Furthermore, the effect of effort expectancy on the positive attitude of automotive users towards ADAS has also proven positive and significant, as evidenced by the T-statistic value of $3.523 > 1.96$ and the P-value of $0.000 < 0.05$, so H4 is also confirmed. Furthermore, the effect of attitudes on the intention of automotive users to use ADAS also proved positive and significant, as indicated by the T-statistic value of $19.726 > 1.96$ and the P-value of $0.000 < 0.05$. Thus, H5 was confirmed.

Table 5. Specific indirect effects

	Original Sample (O)	T Statistics (O/STDEV)	P Values
Effort Expectancy ->Attitude ->Behaviour Intention	0.146	3.399	0.001
Perceived Severity ->Attitude ->Behaviour Intention	0.029	0.868	0.385
Perceived Vulnerability ->Attitude ->Behaviour Intention	-0.064	2.208	0.027
Performance Expectancy ->Attitude ->Behaviour Intention	0.542	9.547	0.000

Table 5 shows that attitude is proven to mediate the effect of effort expectancy on the intention of automotive users to use ADAS, as indicated by a T-statistic value of $3.399 > 1.96$ and a P-value of $0.001 < 0.05$. Likewise, attitude is proven to mediate the effect of perceived vulnerability on the intention of automotive users to use ADAS, as indicated by the T-statistic value of $2.208 > 1.96$ and P-value of $0.027 < 0.05$. Then,

attitude is also proven to mediate the effect of performance expectancy on the intention of automotive users to use ADAS, as indicated by a T-statistic value of $9.547 > 1.96$ and a P-value of $0.000 < 0.05$.

The results of this study indicate that the higher the vulnerability to the risk of traffic accidents, the more positive the attitude of car users towards the use of the ADAS driver assistance system. The finding confirms the result study of Yıldırım et al. [46], González-Castro et al. [47], and De Coninck et al. [48]. As we understand it, ADAS is a technology designed to help drivers reduce the risk of traffic accidents through warning and action when a potentially hazardous situation is detected. Self-perceived vulnerability is a concept that has been studied extensively in health psychology and health-related human behavior. This concept refers to a person's awareness of their health risks and ability to avoid or reduce them. In the context of a traffic accident, a person with a high perceived vulnerability is more aware of the potential risks of an accident and more open to using ADAS technology that can help reduce that risk. This study found that the vulnerability factor had a positive and significant effect on the attitude of drivers toward ADAS. This shows that the higher the perceived vulnerability, the more positive drivers' attitudes toward using ADAS technology to reduce the risk of traffic accidents.

The second discussion of this study found that the performance expectations of the Advanced Driving Assistance System (ADAS) technology could have been more optimal to affect the positive attitude of drivers toward driver assistance systems. In this context, performance expectation refers to the user's belief in the ability of ADAS technology to improve vehicle performance and driving safety. This study confirms the results of study by Siswanto et al. [49], Shara and Widodo [50], and Razzak and Jassem [51]. The higher the performance expectations of users in this study, the more positive the attitude of drivers toward driver assistance systems.

This can be explained by the user's belief that ADAS technology can increase vehicle efficiency and improve driving safety. In this case, car users who have more confidence in the ability of ADAS technology to improve vehicle efficiency and driving safety tend to be more optimistic about this technology. This study also shows that drivers' education level and age influence performance expectations and attitudes toward the ADAS system. Younger and more educated drivers tend to have higher performance expectations and positive attitudes toward the ADAS system.

The third discussion in this study shows that the user's effort expectancy for the ease of use of ADAS technology affects the positive attitude of automotive users towards ADAS. This study confirms the results study by Siswanto et al. [49], Shara and Widodo [50], and Razzak and Jassem [51]. In this context, effort expectancy refers to the user's belief about the ease of use of ADAS technology and the user's readiness to deal with changes in driving behavior. In this study, the higher the user's perceived level of effort expectancy, the more positive the attitude of automotive users toward ADAS. This can be explained by the user's belief that ADAS technology is easy to use and does not require the user to make significant changes in driving behavior. In this case, automotive users who feel more comfortable with ADAS technology and believe it is easy to use tend to have a more positive attitude.

The results showed that effort expectancy or user expectations for the ease of use of ADAS technology affect the attitude of automotive users towards ADAS. In this case, the

attitude in question is an attitude that includes the user's trust, assessment, and evaluation of ADAS technology. This research shows that the higher the level of effort expectancy felt by the user, the more positive the attitude of automotive users toward ADAS. This can be explained by users' belief that ADAS technology is easy to use and does not require significant changes in driving behavior.

In this context, effort expectancy mediates between other factors, such as performance expectancy and user attitude towards ADAS. In other words, the higher the user's perceived level of effort expectancy, the stronger the relationship between performance expectancy and the user's attitude toward ADAS.

The fifth discussion in this study is that the positive attitude of automotive users towards ADAS has a positive and significant effect on their intention to use the technology. This means that the more positive the user's attitude towards ADAS, the more likely they are to use the technology in driving. This finding confirms the result of study by Hussein and Wahid [52], Hussein [53], Sari et al. [54], Pertamina and Sukaatmadja [55], and Sari [56].

The results of this study, taken as a whole, may have important implications for automakers and policymakers in designing more effective marketing campaigns and product development strategies. In this regard, manufacturers must consider factors such as performance expectations and demographics when designing more effective marketing campaigns and product development strategies. On the other hand, policymakers can use the results of this research to increase public awareness of the benefits of ADAS technology and encourage the use of this technology as part of efforts to improve driving safety.

5. CONCLUSIONS

Based on the research results, it can be concluded that, except for Hypothesis 2, all hypotheses are proven. The perceived vulnerability variable is proven to have a positive and significant effect on the attitude of automotive users toward ADAS because its T-Statistic is more than 1.96, and its P-value is lower than 0.05. Likewise, the performance expectancy variable is proven to have a positive and significant effect on the attitude of automotive users toward ADAS because its T-Statistic is more than 1.96, and its P-value is lower than 0.05. The effort expectancy variable has also been shown to have a positive and significant effect on the attitude of automotive users toward ADAS because its T-Statistic is more than 1.96, and its P-value is lower than 0.05. Finally, the attitude of automotive users toward ADAS has a positive and significant effect on their intention to use ADAS because its T-Statistic is more than 1.96, and its P-value is lower than 0.05. So only the variable perceived Severity is not proven to have a positive and significant effect on the attitude of automotive users towards ADAS.

The study's findings have significant practical implications for policymakers, car manufacturers, and technology developers involved in Advanced Driver Assistance Systems (ADAS). Policymakers can raise awareness and educate the public about ADAS benefits while incentivizing adoption through tax benefits and reduced insurance premiums. Car manufacturers can enhance perceived vulnerability by emphasizing risks associated with traditional driving methods, improve performance expectancy through continuous research

and development, and ensure user-friendly experiences to increase positive attitudes towards ADAS. Technology developers should prioritize usability by designing user-centered ADAS and address concerns about severity to influence attitudes towards ADAS positively. These implications aim to create an environment conducive to ADAS adoption, enhancing road safety and reducing accidents.

The theoretical benefit of this research is the creation of a C-PMT-UTAUT conceptual model, which future researchers can then test. In addition, the results of this market research can also serve as a basis for future Applied Research and Development Research.

Further research in the ADAS context should investigate the relationship between perceived severity and attitudes towards ADAS, considering potential mediators or moderators such as risk perception and personal accident experiences. Longitudinal studies are needed to assess the stability of attitudes and intentions towards ADAS over time and their impact on adoption and sustained usage. Additionally, research should focus on user experience and usability aspects of ADAS to identify areas for improvement, considering users' perceptions, challenges, and preferences related to the interface, system feedback, and adaptability in various driving conditions. Exploring the influence of cultural and contextual factors on attitudes towards ADAS is crucial for tailoring strategies globally by examining the interaction of cultural norms, driving habits, and regulatory frameworks with attitudes and acceptance of ADAS. Addressing these areas will provide a deeper understanding and inform targeted strategies for promoting ADAS adoption and usage.

The study has several limitations. Firstly, it has a limited geographical scope, focusing only on Jakarta and Tangerang, which may limit the generalizability of the findings to other locations. Secondly, convenience sampling was used, introducing potential bias and limiting the sample's representativeness. Nonresponse bias and the absence of qualitative data further affect the generalizability and depth of understanding. Furthermore, the findings may not apply to other contexts due to specific factors. Lastly, the study needs formation on the timeframe of data collection and the stability of relationships over time, potentially impacting the dynamic nature of attitudes and intentions towards ADAS.

Future research can address the study's limitations by expanding the geographical scope to include a broader range of cities or regions, allowing for a more comprehensive understanding of attitudes and intentions toward ADAS. Implementing diverse sampling techniques, such as random or stratified sampling, can enhance the sample's representativeness and improve the findings' validity and reliability. Future studies should provide information on response rates and incorporate qualitative data through interviews, focus groups, or observational studies to mitigate nonresponse bias, providing richer insights into car owners' experiences and perspectives. Considering contextual factors, such as cultural norms and technological advancements, can enhance the applicability of the findings to different contexts. Employing longitudinal designs and assessing stability over time will capture the dynamic nature of attitudes and intentions towards ADAS, identifying trends and factors influencing relationships. Transparent reporting of the data collection timeframe will facilitate comparisons across studies, contributing to a comprehensive understanding applicable across diverse locations and contexts.

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REFERENCES

- [1] Ahdira, A. (2020). 5 provinsi dengan jumlah kecelakaan terbanyak di Indonesia, korban jiwa capai 295 orang. *Pikiran Rakyat*. <https://www.pikiran-rakyat.com/otomotif/pr-01807920/5-provinsi-dengan-jumlah-kecelakaan-terbanyak-di-indonesia-korban-jiwa-capai-295-orang>.
- [2] Kominfo, (2017). Rata-rata tiga orang meninggal setiap jam akibat kecelakaan Jalan. *Kominfo.go.id*. https://kominfo.go.id/index.php/content/detail/10368/rata-rata-tiga-orang-meninggal-setiap-jam-akibat-kecelakaan-jalan/0/artikel_gpr.
- [3] Masello, L., Castignani, G., Sheehan, B., Murphy, F., McDonnell, K. (2022). On the road safety benefits of advanced driver assistance systems in different driving contexts. *Transportation Research Interdisciplinary Perspectives*, 15: 100670. <https://doi.org/10.1016/j.trip.2022.100670>
- [4] Akyüz, E. (2015). The solutions to traffic congestion in Istanbul. *The Journal of Academic Social Sciences*, 3(16): 442-449. <https://doi.org/10.16992/ASOS.792>
- [5] Tengilimoglu, O., Carsten, O., Wadud, Z. (2023). Implications of automated vehicles for physical road environment: A comprehensive review. *Transportation Research Part E: Logistics and Transportation Review*, 169: 102989. <https://doi.org/10.1016/j.tre.2022.102989>
- [6] Ibrahim, H., Al-Ajlouni, M.M.Q. (2018). Sustainable consumption: Insights from the protection motivation (PMT), deontic justice (DJT) and construal level (CLT) theories. *Management Decision*, 56(3): 610-633. <https://doi.org/10.1108/MD-05-2016-0323>
- [7] Sabzmakan, L., Ghasemi, M., Asghari Jafarabadi, M., Kamalikhah, T., Chaleshgar Kordasiabi, M. (2018). Factors associated with tobacco use among Iranian adolescents: An application of protection motivation theory. *Substance Use & Misuse*, 53(9): 1511-1518. <https://doi.org/10.1080/10826084.2017.1415356>
- [8] Menard, P., Bott, G.J., Crossler, R.E. (2017). User motivations in protecting information security: Protection motivation theory versus self-determination theory. *Journal of Management Information Systems*, 34(4): 1203-1230. <https://doi.org/10.1080/07421222.2017.1394083>
- [9] Kothe, E.J., Ling, M., North, M., Klas, A., Mullan, B.A., Novoradovskaya, L. (2019). Protection motivation theory and pro-environmental behaviour: A systematic mapping review. *Australian Journal of Psychology*, 71(4): 411-432. <https://doi.org/10.1111/ajpy.12271>
- [10] Lee, J.H., Mustapha, A., Hwang, J. (2019). Enhancing ethnic restaurant visits and reducing risk perception: The effect of information and protection motivation. *Journal of Hospitality and Tourism Insights*, 2(4): 341-357. <https://doi.org/10.1108/JHTI-10-2018-0068>
- [11] Fischer-Prefler, D., Bonaretti, D., Fischbach, K. (2022).

- A protection-motivation perspective to explain intention to use and continue to use mobile warning systems. *Business & Information Systems Engineering*, 64(2): 167-182. <https://doi.org/10.1007/s12599-021-00704-0>
- [12] Jun, J., Park, H., Cho, I. (2019). Study on initial adoption of advanced driver assistance system: Integrated model of PMT and UTAUT 2. *Total Quality Management & Business Excellence*, 30(sup1): S83-S97. <https://doi.org/10.1080/14783363.2019.1665820>
- [13] Tarhini, A., El-Masri, M., Ali, M., Serrano, A. (2016). Extending the UTAUT model to understand the customers' acceptance and use of internet banking in Lebanon: A structural equation modeling approach. *Information Technology & People*, 29(4): 830-849. <https://doi.org/10.1108/ITP-02-2014-0034>
- [14] Lwoga, E.T., Komba, M. (2015). Antecedents of continued usage intentions of web-based learning management system in Tanzania. *Education+Training*, 57(7): 738-756. <https://doi.org/10.1108/ET-02-2014-0014>
- [15] Alam, M.Z., Hu, W., Hoque, M.R., Kaium, M.A. (2020). Adoption intention and usage behavior of mHealth services in Bangladesh and China: A cross-country analysis. *International Journal of Pharmaceutical and Healthcare Marketing*, 14(1): 37-60. <https://doi.org/10.1108/IJPHM-03-2019-0023>
- [16] Wuling, (2021). Teknologi advanced driver assistance system (adas) untuk keamanan berkendara. *Auto Tips*. <https://wuling.id/id/blog/autotips/teknologi-advanced-driver-assistance-system-adas-untuk-keamanan-berkendara/>.
- [17] Rogers, R.W. (1975). A protection motivation theory of fear appeals and attitude change 1. *The Journal of Psychology*, 91(1): 93-114. <https://doi.org/10.1080/00223980.1975.9915803>
- [18] Gao, Y.W., Li, H., Luo, Y. (2015). An empirical study of wearable technology acceptance in healthcare. *Industrial Management & Data Systems*, 115(9): 1704-1723. <https://doi.org/10.1108/IMDS-03-2015-0087>
- [19] Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly*, 27(3): 425-478. <https://doi.org/10.2307/30036540>
- [20] Venkatesh, V., Thong, J.Y.L., Xu, X. (2012). Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology. *MIS Quarterly*, 36(1): 157-178. <https://doi.org/10.2307/41410412>
- [21] Mahzan, N., Lymer, A. (2014). Examining the adoption of computer-assisted audit tools and techniques: Cases of generalized audit software use by internal auditors. *Managerial Auditing Journal*, 29(4): 327-349. <https://doi.org/10.1108/MAJ-05-2013-0877>
- [22] Carter, L., Christian Shaupp, L., Hobbs, J., Campbell, R. (2011). The role of security and trust in the adoption of online tax filing. *Transforming Government: People, Process and Policy*, 5(4): 303-318. <http://doi.org/10.1108/17506161111173568>
- [23] Arif, M., Ameen, K., Rafiq, M. (2018). Factors affecting student use of web-based services: application of utaut in the Pakistani context. *The Electronic Library*, 36(3): 518-534. <https://doi.org/10.1108/EL-06-2016-0129>
- [24] Thongsri, N., Shen, L., Bao, Y.K., Alharbi, I.M. (2018). Integrating UTAUT and UGT to explain behavioural intention to use m-learning: a developing country's perspective. *Journal of Systems and Information Technology*, 20(3): 278-297. <https://doi.org/10.1108/JSIT-11-2017-0107>
- [25] Gunasinghe, A., Hamid, J.A., Khatibi, A., Azam, S.F. (2020). The adequacy of UTAUT-3 in interpreting academician's adoption to e-Learning in higher education environments. *Interactive Technology and Smart Education*, 17(1): 86-106. <https://doi.org/10.1108/ITSE-05-2019-0020>
- [26] Buabeng-Andoh, C., Baah, C. (2020). Pre-service teachers' intention to use learning management system: An integration of UTAUT and TAM. *Interactive Technology and Smart Education*, 17(4): 455-474. <https://doi.org/10.1108/ITSE-02-2020-0028>
- [27] Chang, C.C. (2013). Library mobile applications in university libraries. *Library Hi Tech*, 31(3): 478-492. <https://doi.org/10.1108/LHT-03-2013-0024>
- [28] Wu, C.G., Wu, P.Y. (2019). Investigating user continuance intention toward library self-service technology: the case of self-issue and return systems in the public context. *Library Hi Tech*, 37(3): 401-417. <https://doi.org/10.1108/LHT-02-2018-0025>
- [29] Al Mansoori, K.A., Sarabdeen, J., Tchanchane, A.L. (2018). Investigating emirati citizens' adoption of e-government services in abu dhabi using modified UTAUT model. *Information Technology & People*, 31(2): 455-481. <https://doi.org/10.1108/ITP-12-2016-0290>
- [30] Kuciapski, M. (2017). A model of mobile technologies acceptance for knowledge transfer by employees. *Journal of Knowledge Management*, 21(5): 1053-1076. <https://doi.org/10.1108/JKM-03-2016-0136>
- [31] Sivathanu, B. (2019). Adoption of digital payment systems in the era of demonetization in India: an empirical study. *Journal of Science and Technology Policy Management*, 10(1): 143-171. <https://doi.org/10.1108/JSTPM-07-2017-0033>
- [32] Sobti, N. (2019). Impact of demonetization on diffusion of mobile payment service in India: antecedents of behavioral intention and adoption using extended utaut model. *Journal of Advances in Management Research*, 16(4): 472-497. <https://doi.org/10.1108/JAMR-09-2018-0086>
- [33] Gupta, K.P., Manrai, R., Goel, U. (2019). Factors influencing adoption of payments banks by Indian customers: Extending UTAUT with perceived credibility. *Journal of Asia Business Studies*, 13(2): 173-195. <https://doi.org/10.1108/JABS-07-2017-0111>
- [34] Rahi, S., Mansour, M.M.O., Alghizzawi, M., Alnaser, F.M. (2019). Integration of UTAUT model in internet banking adoption context: The mediating role of performance expectancy and effort expectancy. *Journal of Research in Interactive Marketing*, 13(3): 411-435. <https://doi.org/10.1108/JRIM-02-2018-0032>
- [35] Giovanis, A., Assimakopoulos, C., Sarmaniotis, C. (2019). Adoption of mobile self-service retail banking technologies: The role of technology, social, channel and personal factors. *International Journal of Retail & Distribution Management*, 47(9): 894-914. <https://doi.org/10.1108/IJRDM-05-2018-0089>
- [36] Odoom, R., Kosiba, J.P. (2020). Mobile money usage and continuance intention among micro enterprises in an emerging market-the mediating role of agent credibility.

- Journal of Systems and Information Technology, 22(1): 97-117. <https://doi.org/10.1108/JSIT-03-2019-0062>
- [37] Purwanto, E., Sjarief, R., Anwar, C. (2021). The effect of the innovation resistance factors on the digital fishery platform acceptance in developing country. *Review of International Geographical Education*, 11(5): 507-518. <https://doi.org/10.48047/rigeo.11/5/53>
- [38] Purwanto, E., Sjarief, R., Anwar, C. (2021). Driving and restricting factors of the behavior intention of the digital fishery platform adoption in new normal: combine utaut-irt model. *Review of International Geographical Education Online*, 11(8): 1089-1103. <https://doi.org/10.48047/rigeo.11.08.93>
- [39] Hair, J.F., Black, W.C., Babin, B.J., Anderson, R.E. (2010). *Multivariate data analysis*, 7th ed. New Jersey: Pearson Education.
- [40] Johnston, A.C., Warkentin, M. (2010). Fear appeals and information security behaviors: an empirical study. *MIS Quarterly*, 34(3): 549-566. <https://doi.org/10.2307/25750691>
- [41] Hair, J.F., Ringle, C.M., Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. *Journal of Marketing Theory and Practice*, 19(2): 139-152. <https://doi.org/10.2753/MTP1069-6679190202>
- [42] Hair, J.F., Risher, J.J., Sarstedt, M., Ringle, C.M. (2019). When to use and how to report the results of PLS-SEM. *European Business Review*, 31(1): 2-24. <https://doi.org/10.1108/EBR-11-2018-0203>
- [43] Tjiu, M., Purwanto, E. (2017). Guanxi and the leader-member exchange in the Chinese supervisor and subordinate relationship. *Journal of Applied Economic Sciences*, 8(54): 2218-2232.
- [44] Purwanto, E., Purwanto, A.D.B. (2020). An investigative study on sustainable competitive advantage of manufacture companies in Indonesia. *Business: Theory and Practice*, 21(2): 633-642. <https://doi.org/10.3846/btp.2020.12256>
- [45] Purwanto, E., Utama, C., Wijaya, B. (2018). The effects of shock advertising on purchase intentions and behavior of cigarettes in collectivistic culture. *Journal of Advanced Research in Law and Economics*, 9(2): 625-638. [https://doi.org/10.14505/jarle.v9i2\(32\).26](https://doi.org/10.14505/jarle.v9i2(32).26)
- [46] Yıldırım, M., Geçer, E., Akgül, Ö. (2021). The impacts of vulnerability, perceived risk, and fear on preventive behaviours against COVID-19. *Psychology, Health & Medicine*, 26(1): 35-43. <https://doi.org/10.1080/13548506.2020.1776891>
- [47] González-Castro, J.L., Ubillos-Landa, S., Puente-Martínez, A., Gracia-Leiva, M. (2021). Perceived vulnerability and severity predict adherence to COVID-19 protection measures: the mediating role of instrumental coping. *Frontiers in Psychology*, 12: 674032. <https://doi.org/10.3389/fpsyg.2021.674032>
- [48] De Coninck, D., d'Haenens, L., Matthijs, K. (2020). Perceived vulnerability to disease and attitudes towards public health measures: COVID-19 in Flanders, Belgium. *Personality and Individual Differences*, 166: 110220. <https://doi.org/10.1016/j.paid.2020.110220>
- [49] Siswanto, T., Shofiati, R., Hartini, H. (2018). Acceptance and utilization of technology (UTAUT) as a method of technology acceptance model of mitigation disaster website. In *IOP Conference Series: Earth and Environmental Science*, IOP Publishing, 106(1): 012011. <https://doi.org/10.1088/1755-1315/106/1/012011>
- [50] Shara, P.V., Widodo, T. (2018). Penerapan model unified theory of acceptance and use of technology (UTAUT) untuk menganalisis minat pengguna smartphone di Kota Bandung. *Sosiohumanitas*, 20(1). <https://doi.org/10.36555/sosiohumanitas.v20i1.49>
- [51] Razzak, M.R., Jassem, S. (2021). Mobile-assisted language learning for EFL: A conceptual framework based on the meta-utaut model. *Asia-Pacific Journal of Educational Management Research*, 6(2): 15-32. <https://doi.org/10.21742/AJEMR.2021.6.2.02>
- [52] Hussein, Z., Wahid, N.A. (2018). The effects of user's attitude on the intention to purchase and to revisit in game advertising. *Asian Journal of Behavioural Studies*, 3(13): 161-168. <https://doi.org/10.21834/ajbes.v3i13.153>
- [53] Hussein, Z. (2017). Leading to intention: The role of attitude in relation to technology acceptance model in e-learning. *Procedia Computer Science*, 105: 159-164. <https://doi.org/10.1016/j.procs.2017.01.196>
- [54] Sari, R.L., Habibi, A.B., Hayuningputri, E.P. (2022). Impact of attitude, perceived ease of use, convenience, and social benefit on intention to use mobile payment. *Asia Pacific Management and Business Application (APMBA)*, 11(2): 143-156. <https://doi.org/10.21776/ub.apmba.2022.011.02.2>
- [55] Pertamina, N.P.A., Sukaatmadja, P.G. (2021). The role of user's attitude mediating the effect of perceived ease of use and social influence towards the continuance usage intention of TikTok. *SSRG International Journal of Economics and Management Studies*, 8(1): 98-104. <https://doi.org/10.14445/23939125/IJEMS-V8I1P110>
- [56] Sari, N.N. (2022). The use of technology acceptance model to explain brand attitude and loyalty intention in e-commerce: The gamification case. *ASEAN Marketing Journal*, 14(1): 5. <https://doi.org/10.21002/amj.v14i1.1151>