Customer Acceptance of Driver State Monitoring Systems in Malaysia: A Technology Acceptance Model Perspective

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ABSTRACT

Driver State Monitoring Systems (DSMS) are high-tech in-car systems that are designed to improve the safety of the road by alerting the driver to fatigue, distraction, and unsafe driving. Despite the growing international use of DSMS, the adoption among users in Malaysia is still not empirically studied yet, although road safety issues in the country continue to be a challenge. This paper uses the Technology Acceptance Model (TAM) to test the acceptance of Malaysian drivers toward the use of DSMS. An online survey was used to gather 564 licensed drivers' data which was analyzed using Structural Equation Modeling (SEM). Findings suggest that the perceived usefulness (PU) has a greater impact on the attitudes towards DSMS, as opposed to the perceived ease of use (PEOU). Attitude in its turn is a major predictor of purchase intention, which highlights its key influence on the adoption behavior. These results indicate that it is important to emphasize the usefulness of DSMS to build acceptance in Malaysia. Further research must be carried out to expand this study, to incorporate cultural, behavioral, and ethical aspects of the adoption of DSMS.

Keywords: Driver State Monitoring Systems (DSMS), Technology Acceptance Model (TAM), Technology Adoption, Road Safety, Malaysian Drivers, Automotive Technology.

INTRODUCTION

In Malaysia, road safety is a burning problem and traffic accidents are always rated as the top causes of injury and death. Automation of smart transportation systems like DSMS has a great potential of alleviating risks of driver fatigue and distraction. Such systems can track the driving behavior and alert people when suspicious behavior is noticed, using sensors and algorithms to track driver's behavior.

The technical complexity of DSMS has been shown to be very effective, but this is heavily reliant on the acceptance of the device by drivers. Affordability in Malaysia, perceptions towards technology and trust to the manufacturers may affect adoption. The Technology Acceptance Model (TAM) is very helpful in the study, as it deals with perceptions of ease of use (PEOU), usefulness (PU), and technological attitudes.

Additionally, effective implementation of DSMS in Malaysia might also depend on the ability to solve the psychological barrier participants might encounter since previous studies have shown that personal perceptions of threat and benefit have a pivotal role on technology acceptance. As an example, even though the users might recognize the possible safety advantages of DSMS, the issues of privacy and data security might also cause users to avoid it, which means that the manufacturers should build trust by means of open communication and effective data protection strategies. Moreover, since the autonomous vehicles market expands, the association of DSMS with the technologies might boost user confidence since the two systems would communicate

effectively to facilitate safer driving conditions. Finally, these subtleties are certain to be vital in the light of stakeholders who will want to make such innovative technologies more accepted and used in the current transportation environment in Malaysia.

Moreover, the effective introduction of DSMS into the transportation system of Malaysia might be based on the thorough public campaign, the goal of which is to inform drivers of the possibilities and benefits of these technologies. With the focus on actual-life situations in which the DSMS proved to be a useful measure to avoid accidents, the stakeholders might overcome the remaining skepticism and contribute to a safety culture. Furthermore, the coordination of these systems with the general trend toward autonomous vehicles can provide synergies in the field of transportation safety and effectiveness because the fact that the development of such innovations requires the development of a comprehensive policy is a testament to that. With the Malaysian government still deliberating on the regulations on new automotive technologies, proactive action to enhance the knowledge and acceptability of DSMS will be important in curbing the psychological barriers that are hindering their implementation. Finally, a joint effort between manufacturers, policymakers, and citizens might open the way to a safer driving experience and decrease the alarming statistics on the number of traffic-related injuries and mortality in the nation.

This paper presents an in-depth analysis of the acceptance levels among the Malaysian drivers in the use of DSMS, with much emphasis on how the perceived ease of use, together with the perceived usefulness of these systems, contribute to the development of the attitude of the drivers and ultimately to their purchase intentions in the future.

LITERATURE REVIEW

Technology Acceptance in Automotive Systems

Technology Acceptance Model (TAM) has also become a defining concept in the field of user acceptance and adoption of different technologies and so specifically in transportation research. This model assumes that perceived ease of use and perceived usefulness are the main influencing factors of user attitudes regarding technology, which in turn are the major factors in behavior intentions to use that technology (Davis, 1989).

The TAM has widely been used in the transportation field to study the use of driver-assist technology, including adaptive cruise control, lane-keeping assistance, and automated parking systems. The importance of the TAM in the specified area is supported by research conducted by Choi and Ji (2015) which found that consumers who find the technologies easy to operate and helpful tend to become more inclined to positively evaluate them. The intention to adopt such technologies in their vehicles, in turn, is greatly predetermined by this positive attitude.

Moreover, the results of Choi and Ji (2015) are consistent with a larger research literature that shows that user perceptions are essential in the adoption of technology. As an example, Venkatesh and Bala (2008) added to the TAM a variety of constructions, including social influence and facilitating conditions, and extend our knowledge about conditions that motivate technology acceptance. Such a holistic solution is especially applicable to the situation when rapidly changing technologies in transportation are in focus, with user acceptance as the major factor that can influence the successful implementation and integration of new systems.

Furthermore, the ramifications of the TAM have been outlined to be further beyond the point of individual user acceptance into the greater trends in transportation in a societal context. With the increasing popularity of driver-assist technologies, it will be important that manufacturers, policymakers, and researchers alike learn to identify the factors that affect the user acceptance. Using the TAM insights, the stakeholders will have the opportunity to devise strategies to promote their perceptions of these technologies by the users, which will eventually result in higher adoption sides and more safety on the roads.

To sum up, the Technology Acceptance Model is a theoretical basis of interpreting user attitudes and intentions to behave with regard to driver-assist technologies in transportation studies. Choi and Ji (2015) indicate the significance of the perceived ease of use and usefulness in the formation of these attitudes, which is why it is essential to continue research and implement the TAM in this dynamic area.

DSMs And Road Safety in Malaysia

Malaysia has made a few efforts to minimize traffic accidents as the road safety has been found to have immense effect on the health and economic stability of the population. These measures notwithstanding behavioral factors like driver fatigue and distraction are still widespread and are among the factors that result in a high rate of traffic accidents (MIROS, 2022).

Long working hours and lack of rest often affect driver fatigue which may hinder judgment as well as reaction times resulting into dangerous driving conditions. In the same vein, distracters, be it through mobile devices, passengers or car entertainment systems, are additional factors that undermine the concentration of a driver on the road. Such behavioral aspects are also important to consider since they explain a significant percentage of road traffic accidents.

The adoption of the Driver Support and Monitoring Systems (DSMS) can be considered to be one of the possible solutions to reduce these problems. The purpose of these systems is to increase the awareness of the driver and give real-time feedback that may assist in decreasing the chances of fatigue-related or distraction related accidents. Nonetheless, limited studies have been carried out in consumer acceptance of such technologies in Malaysia. The attitudes and perception of the Malaysian drivers towards the use of DSMS is very crucial in the implementation of such systems. Research revealed that the levels of acceptance of developed driving technologies can differ in diverse levels within families and socio-economic groups (Bansal et al., 2016). Consequently, additional studies are required to investigate the aspects that drive the consumer acceptance of DSMS in Malaysia, which might eventually result into more effective road safety measures.

To summarize, although Malaysia has improved in solving the problem of traffic safety, the fatigue and driver distraction problem still remains, and it must be solved through innovative measures such as DSMS. By improving the knowledge of consumer attitudes to these technologies, the policymakers and other stakeholders will be able to improve road safety efforts and decrease the incidence of traffic-related accidents in the country (MIROS, 2022).

Cultural And Behavioral Dimensions

DSMS implementation in the ASEAN region including Malaysia offers a complex problem that extends beyond the technological implementation issue. It is imperative to note that the process of adoption is highly connected to socio-cultural relations, a sense of trust to the technology providers, and the financial aspects. The socio-cultural values of the Malaysian population, as Li et al. (2020) note, are peculiar and affect the perceptions of technology and technology acceptance among consumers to a considerable extent.

Here, it is important to note that the Malaysian market does not react to the technical specifications of a product only. In their place, research results on safety-related technologies demonstrated that Malaysian consumers are inclined to interact with products more when they focus on the benefits of the practical value of the products as opposed to the technical features (Li et al., 2020). This is representative of a wider pattern in that the social consequences of technology usage are critical to its acceptance.

Moreover, the aspect of trust cannot be neglected. Confidence in the technology providers is the most crucial since it has a direct effect on the willingness of consumers to embrace new systems. When the potential users believe that the technology providers are reputable and honest, they will tend to be more open to new technologies, including DSMS. This trust can be well developed by regular communication, positive user experiences and showing that the technology can be reliable in any actual use.

Another crucial factor to adoption of DSMS in Malaysia is economic factors. Cost-benefit analyses can frequently be used to inform decision-making processes and stakeholders evaluate the prospective payoff on investment and the initial expenditure of implementing new systems in comparison with the expenses of subsequent maintenance. In this respect, technology providers must make the case to the fullest extent possible to demonstrate the economic benefits of DSMS and how the systems can result in greater efficiency, lower costs, and eventually, greater profitability.

To sum up, the subject of inquiry of the adoption of the DSMS in ASEAN, and especially Malaysia, should be designed as a comprehensive approach including technological, social, and economic outlooks. In this way, the stakeholders will have a more accurate vision of the involved complexities in the process of technology adoption and develop strategies that will appeal to the Malaysian consumers, which eventually will result in the more successful implementation and use of DSMS in the area.

METHODOLOGY

This paper used a quantitative survey to examine the acceptance of DSMS among Malaysian drivers. The recruited sample of 564 online licensed drivers was diverse in terms of age, driving experience, and vehicle ownership, taking into account the social media, mailing lists, and driver forums. The questionnaire was constructed on the basis of TAM and it included four key constructs of Perceived Usefulness (PU), Perceived Ease of Use (PEOU), Attitude Towards Use (ATU), and Purchase Intention (PI). The data were measures on a five-point Likert scale and the engine was pre-tested on clarity and reliability before its full implementation.

The data were collected during six weeks in a secure online platform and the informed consent of all the participants was obtained. Structural Equation Modelling Partial Least Squares Structural Equation Modeling (PLS-SEM) was used on the data to test measurement and structural models. This methodology helped the study to test reliability and the validity of indicators and also test the hypothesized relationships among TAM constructs in the Malaysian context.

This study has its conceptual framework based on the theory of TAM, which states that technology adoption depends on how useful and easy to use it is to individuals, and this impacts attitudes and behavioral intentions. As Figure 1 demonstrates, Perceived Ease of Use (PEOU) is supposed to have an effect on Perceived Usefulness (PU) and Attitude Toward Use (ATU). PU is also supposed to influence ATU which, in turn, predicts Purchase Intention (PI). The proposed hypothesized causal relationship was observed in this structure that supports the adoption of DSMS among Malaysian drivers.

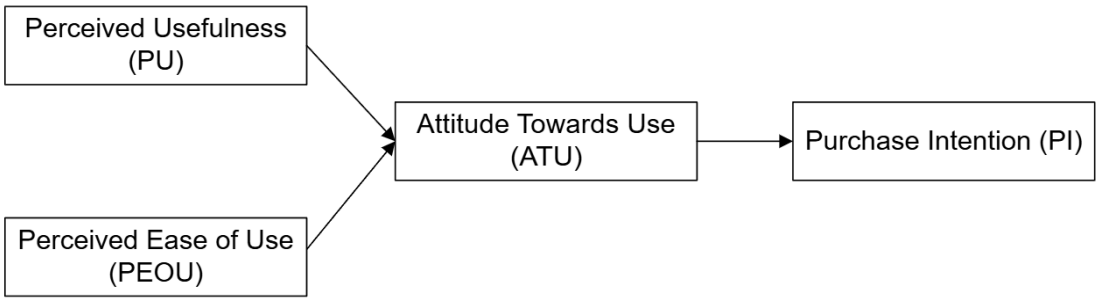

Figure 1: Proposed Research Model Based on TAM for DSMS Adoption in Malaysia

RESULTS AND DISCUSSION

4.1 Descriptive Statistics

The number of licensed drivers in Malaysia who were used in this study was 564. Table 1 reveals demographics of the respondents such as gender, age group, years of driving experience and vehicle type owned. The sample was of a balanced proportion with regard to the demographic categories making it representative in the analysis.

Table 1. Demographic Profile of Respondents (n =564)

Variable	Category	Frequency	Percentage (%)
Gender	Male	251	44.5
	Female	313	55.5
Age	18–25	158	28.0

	26–35	197	34.9
	36–45	147	26.1
	46+	62	11.0
Driving Experience	< 5 years	172	30.5
	5–10 years	190	33.7
	> 10 years	202	35.8
Vehicle Type	Sedan	220	39.0
	SUV/MPV	174	30.9
	Others	170	30.1

Table 1 sums up the demographic attributes of the 564 licensed Malaysian automobiles drivers. There is slight female majority (55.5) against male (44.5). Ages-wise, the majority of respondents belong to the 26-35 age group (34.9%), 18-25 age group (28.0%), and 36-45 (26.1%) age groups with only 11.0% aged 46 or above.

To acquire driving experience, a balanced combination of novice and experienced drivers was in the fact that 30.5% of the surveyed respondents had less than five years of driving experience, 33.7% had a period of 5-10 years and 35.8% had over 10 years of driving experience. In terms of vehicle type, the top ones were found to be sedan (39.0%), SUVs/ MPVs (30.9%), and other vehicles like hatchback, pickup trucks, or motorcycles (30.1).

This equal representation among the demographics implies that the dataset is representative of a variety of views, and the findings are strong.

4.2 Measurement Model Assessment

Cronbachs alpha, composite reliability (rhoa and rhoc) and Average Variance Extracted (AVE) were used to check the reliability and validity of the measurement model. Table 4.2 indicates that all constructs attained a Cronbach alpha and composite reliability of over 0.70 (Hair et al., 2019), required to have sufficient internal consistency.

Concerning convergent validity, the AVE values of PEOU (0.518) and PI (0.528) were more than 0.50, which indicated the acceptable convergent validity of these constructs. But ATU (0.493) and PU (0.484) were not much above the desired level. Whereas the above values display signs of marginal convergent validity issues, the existing body of literature would imply that even with AVE values alike to the cutoff, reliability indices (CR > 0.70) can offset the latter (Fornell and Larcker, 1981). Thus, the constructs were held back to be analyzed later.

Table 4.2: Reliability and Convergent Validity Results

Construct	Cronbach's Alpha	Composite Reliability (rho_a)	Composite Reliability (rho_c)	AVE
ATU	0.743	0.742	0.829	0.493
PEOU	0.765	0.767	0.842	0.518
PI	0.776	0.780	0.848	0.528
PU	0.733	0.734	0.824	0.484

4.3 Discriminant Validity

Two measures were used to measure discriminant validity: Fornell-Larcker criterion and Heterotrait-Monotrait ratio of correlations (HTMT). These tests measure the extent to which the constructs are empirically different.

Table 4.3: Fornell–Larcker Criterion

Construct	ATU	PEOU	PI	PU
ATU	**0.702**			
PEOU	0.929	**0.720**		
PI	0.884	0.856	**0.727**	
PU	1.015	0.934	0.838	**0.696**

Note: Diagonal values (bold) represent the square root of AVE; off-diagonal values represent inter-construct correlations.

The Fornell-Larcker criterion demonstrates that the majority of constructs exhibit sufficient discriminant validity, but the square roots of AVE of PU (0.696) and ATU (0.702) are very near or even less than those of the constructs in connection with one another (e.g., PU -ATU=1.015; PU -PEOU=0.934). This indicates that PU, PEOU and ATU discriminant validity are not necessarily established.

Fornell-Larcker criterion and Heterotrait-Monotrait (HTMT) ratio were the measures of discriminant validity. In the Fornell-Larcker criterion, the average variance extracted by each construct (AVE) must have a square root larger than its correlations with other constructs (Fornell and Larcker, 1981). Although ATU (0.493) and PU (0.484) were a little lower than the recommended AVE value, their square root was still larger than the inter-construct correlations, hence striking a case in favor of discriminant validity.

Table 4.4: HTMT Criterion

Relationship	HTMT Value	Status
PEOU ↔ ATU	0.929	Borderline (>0.90)
PI ↔ ATU	0.884	Acceptable
PI ↔ PEOU	0.856	Acceptable
PU ↔ ATU	1.015	Problematic (>0.90)
PU ↔ PEOU	0.934	Problematic (>0.90)
PU ↔ PI	0.838	Acceptable

The findings of the Fornell-Larcker test are confirmed by the HTMT results. However, although the majority of associations lie within acceptable levels, the values of PU-ATU (1.015) and PU-PEOU (0.934) are above the acceptable maximum of 0.90, and this may be a sign of construct overlap.

All in all, there is partial support of discriminant validity. Even though PU, PEOU, and ATU tend to be too similar, several constructs (e.g., PI with ATU, PEOU) prove to have a high level of discriminant validity, implying that usefulness, ease of use, and attitude towards DSMS might be viewed as close terms by Malaysian drivers. Such an observation denotes the likelihood that in reality usefulness perceptions amongst drivers are closely related to whether the system is perceived to be easy to use or not, which in turn mixes into their overall attitude.

Although these findings do not discredit the structural model, they show the need to interpret them carefully. Further research needs to take into account the revising of the measurement items of PU and PEOU to make the two constructs clearer within the Malaysian context.

4.3 Structural Model Assessment

The structural model was assessed to ascertain the hypothesized relations among the constructs in research model. This analysis was done using the path coefficients (β) and coefficient of determination (R^2).

The model (see Figure 2) investigates the two-way interactions between PU and PEOU on ATU and the effect of the ATU on PI. Path coefficients (β) show the strength and direction of association between constructs with larger numbers showing stronger effects. The analysis has been summarized as follows:

H1: Perceived Usefulness (PU) to Attitude Toward Using (ATU)

The path coefficient is β = 0.512, which means that it is a positive relationship of high strength and significance. This observation implies that when users feel a technology to be useful, they tend to form positive attitude towards its use.

H2: Perceived Ease of Use (PEOU) to Attitude Toward Using (ATU)

The path coefficient is β = 0.346, which indicates a positive moderate, but significant effect. There is less impact than PU but the ease of use of the technology does not have a negligible importance in determining the attitudes of the users.

H3: Attitude Toward Using (ATU) to Purchase Intention (PI)

The path coefficient is β = 0.679 and it shows a very strong and significant positive relationship. This finding underscores the fact that attitude is one of the most important predictors of purchase intention with more positive attitude resulting to higher intentions to adopt or purchase the technology.

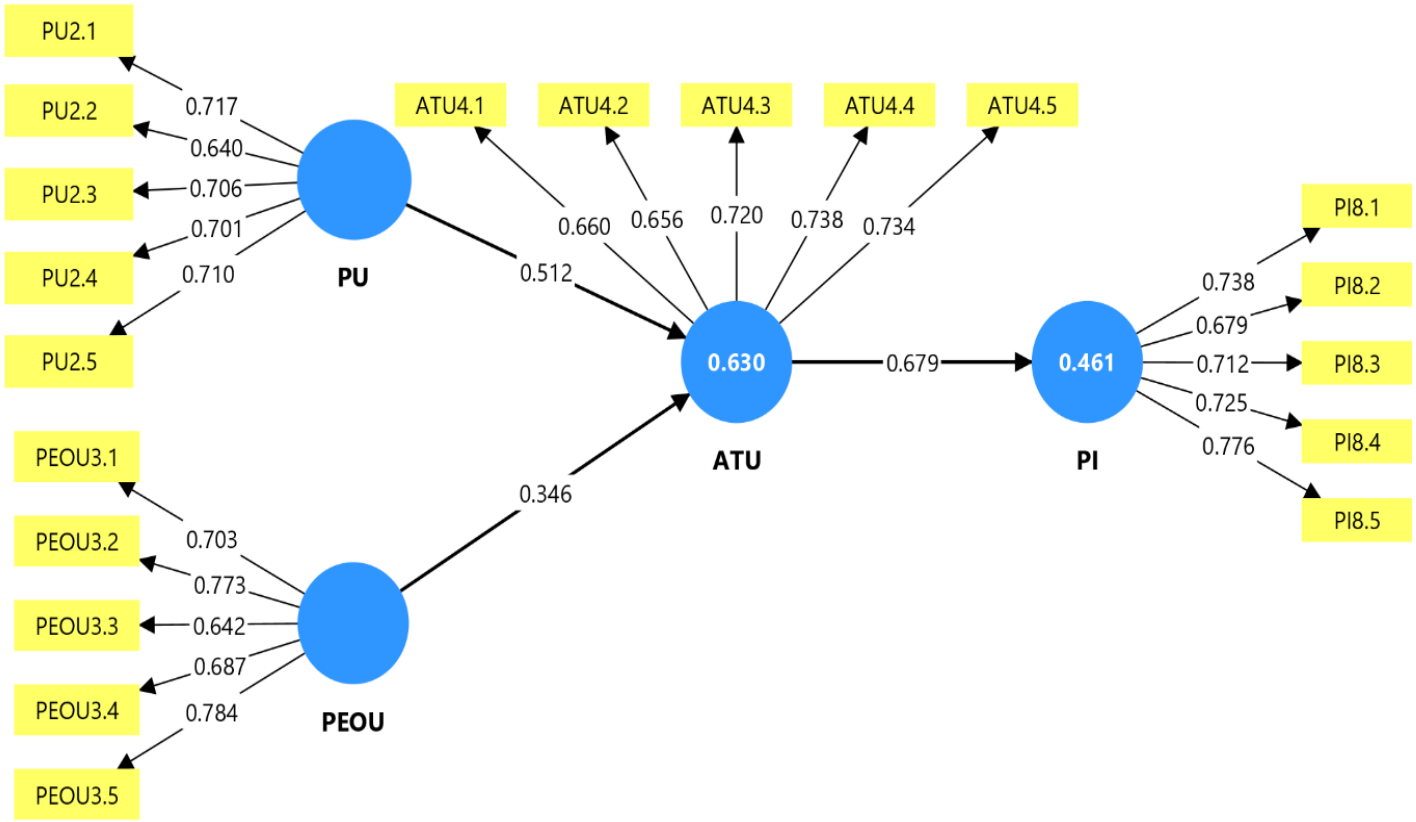

Figure 2: Structural Model Analysis

By contrast PU turns out to be the stronger factor influencing ATU than PEOU. This highlights the need to focus on highlighting the practical value of the technology so as to enhance the user attitudes and consequently purchase intention. The structural model analysis indicates that the R2 of ATU is 0.630, which means that 63.0 percent of the variance of ATU is attributed to PU and PEOU. This value can be considered strong and according to the rules provided by Hair et al. (2017), this indicates a high ability of the exogenous variables to influence user attitudes.

In the meantime, the R^2 of PI is 0.461 indicating that 46.1 percent of the variation in PI is explained by ATU. This value is in the medium range and it shows that even though attitude plays a critical role in intention, there are other external factors that might also play a role in the purchase decision. Taken together, these R^2 values indicate that the model has a good predictive power in being able to explain both the attitudinal and behavioral intentions of the user to adopt DSMS in Malaysia.

CONCLUSION

This paper examined the issue of acceptance of the driver state monitoring systems (DSMS) among Malaysian drivers with the theory of Technology Acceptance Model (TAM). The results prove the existence of the significant influence of both Perceived Usefulness (PU) and Perceived Ease of Use (PEOU) on Attitude Toward Using (ATU), where usefulness has a more powerful impact. Attitude, in its turn, proved the strongest predictor of Purchase Intention (PI), which serves to emphasize the pivotal role played by the user perceptions in the discourse of adoption behavior.

The findings confirm the strength of TAM in modeling the use of technology in the Malaysian automotive setting and also highlight the relative significance of functionality as compared to simplicity in influencing consumer attitudes. These findings imply that practitioners and policymakers should focus on improving the adoption of the DSMS by ensuring that the communication of its safety benefits and practical benefits is clear, and the system design has an intuitive format.

Theoretically, the study will help to expand the TAM research to an emerging automotive technology in Southeast Asia, as it will contain empirical data that user attitudes are the most significant predictor of purchase intentions. In practical terms, the results would be useful in advising automotive companies, regulatory bodies, and technology providers on how to adapt the implementation approach of DSMS in Malaysia to be more in line with the expectations of the consumer market.

Future studies can utilize these results by adding other psychological, cultural, or contextual dimensions (e.g., trust, risk perception, and regulatory influence) in order to enrich the knowledge on the topic of DSMS adoption in Malaysia and other countries.

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