VEHICLE ADAS LANE DEPARTURE WARNING AWARENESS AND SAFETY IMPROVEMENT

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DECLARATION

I declare that this Choose an item. entitled "Vehicle ADAS Lane Departure Warning Awareness and Safety Improvement" is the result of my own research except as cited in the references. The Choose an item. has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : ....

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Date : 10/1/2025

APPROVAL

I hereby declare that I have checked this thesis, and, in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor of Mechanical Engineering Technology (Maintenance Technology) with Honours.

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Date : 10/01/2025

DEDICATION

This thesis is dedicated to the journey of self-discovery and intellectual exploration that has led me to this point. To the countless hours spent researching, writing, and learning and to those who believed in me, even when I did not believe in myself.

ABSTRACT

Lane Departure Warning Systems (LDWS) are a key component of Advanced Driver Assistance Systems (ADAS) are intended to reduce the number of road incidents that result from unintentional lane departures. The objective of LDWS is to enhance driver awareness and increase safety outcomes by delivering timely alerts. This study examines the factors that influence the implementation and utilization of LDWS by Malaysian drivers, drawing upon constructs from the Unified Theory of Acceptance and Use of Technology (UTAUT). Performance Expectancy (PE) which perceived for usefulness, Effort Expectancy (EE) which an ease of use, Social Influence (SI), Facilitating Conditions (FC) which an availability of support and infrastructure as well as their impact on Behavioral Intentions (BI) and ultimately, actual Use Behavior (UB) of LDWS are all considered by the model. The data was analyzed using Structural Equation Model (SEM) and the Statistical Package for the Social Sciences (SPSS) to evaluate the relationship between these variables. A survey was conducted with 415 participants in Malaysia. The findings suggest that the UB of LDWS is significantly influenced by BI, which are in turn significantly influenced by PE, EE, SI and FC. These results provide valuable insights for policymakers, researchers, and automotive industry professionals who are interested in promoting a more comprehensive understanding and implementation of LDWS technology to improve road safety in Malaysia.

ABSTRAK

Sistem Amaran Penukaran Lorong (LDWS) merupakan komponen utama dalam Sistem Bantuan Pemandu Lanjutan (ADAS) yang bertujuan mengurangkan jumlah insiden jalan raya akibat penukaran lorong yang tidak disengajakan. Objektif LDWS adalah untuk meningkatkan kesedaran pemandu dan mempertingkatkan hasil keselamatan melalui pemberian amaran yang tepat pada masanya. Kajian ini meneliti faktor-faktor yang mempengaruhi pelaksanaan dan penggunaan LDWS oleh pemandu di Malaysia, dengan menggunakan konstruk dari Teori Penyatuan Penerimaan dan Penggunaan Teknologi (UTAUT). Konstruk yang dikaji termasuk Jangkaan Prestasi (PE) iaitu persepsi terhadap keberkesanan, Jangkaan Usaha (EE), yang bermaksud kemudahan penggunaan, Pengaruh Sosial (SI), dan Keadaan Penyokong yang bermaksud ketersediaan sokongan dan infrastruktur serta kesannya terhadap Niat Tingkah Laku (BI) dan seterusnya, Tingkah Laku Penggunaan Sebenar (UB) LDWS. Data dianalisis menggunakan Model Persamaan Struktur (SEM) dan perisian Statistical Package for the Social Sciences (SPSS) bagi menilai hubungan antara pemboleh ubah ini. Tinjauan telah dijalankan melibatkan 415 peserta di Malaysia. Dapatan kajian menunjukkan bahawa UB terhadap LDWS dipengaruhi secara signifikan oleh BI, yang pada gilirannya dipengaruhi secara signifikan oleh PE, EE, SI, dan FC. Hasil ini menyediakan pandangan yang bernilai untuk penggubal dasar, penyelidik, dan profesional industry automotive yang berminat untuk mempromosikan pemahaman dan pelaksanaan teknologi LDWS secara lebih komprehensif bagi meningkatkan keselamatan jalan raya di Malaysia.

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In the Name of Allah, the Most Gracious, the Most Merciful

This thesis represents the culmination of countless hours of dedication, perseverance, and support. I am deeply grateful to the individuals who have made this journey possible.

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Finally, I want to thank myself for surviving in this degree life. I acknowledge my own dedication, resilience, and passion for this research. This thesis is a testament to my commitment to exploring this topic and contributing to the field.

To everyone who has touched my life and contributed to this accomplishment, I offer my deepest gratitude.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADAS	Advanced Driver-Assistance System
LDWS	Lane Departure Warning System
LCAS	Lane Changing Assist System
IP	Image Processing
HUDs	Head-up display
FCW	Forward Collision Warning
UTAUT	Unified Theory of Acceptance and Use of Technology
SEM	Structural Equations Modelling
PE	Performance Expectancy
EE	Effort Expectancy
SI	Social Influence
FC	Facilitating Conditions
BI	Behavioral Intentions
UB	Use Behavior
SPSS	Statistical Package for the Social Sciences
AMOS	Analysis of Moment Structures
NFI	Normed Fit Index
CFI	Comparative Fit Index
TLI	Tucker-Lewis's Index

RMSEA	Root Means Square Error of Approximation
GOF	Goodness of fit
CR	Cronbach’s alpha and composite
AVE	Average Variance Extracted

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CHAPTER 1

INTRODUCTION

1.1 Background

Advanced Driver-Assistance Systems (ADAS) play an important role in advancements of automotive industries around the world to pursuit safer roads (Mehta, A et al., 2024). Lane Departure Warning Systems (LDWS) and Lane Changing Assist systems (LCAS) are two systems that stand out as an essential part for improving driver awareness and safety (Visvikis, C et al., 2008). This research study explores the crucial role of LDWS and LCAS in reducing the risks in lane departures and lane changes that ultimately will contribute to a safer driving environment.

However, lane departures and dangerous lane changes continue to be one of the major causes of traffic accidents. These incidents are mostly caused by distracted driving, fatigue and careless driving including poor road conditions (Shawky, M., 2020). As a result, both ADAS technologies have been implemented to actively assist and provide timely warnings as well as steering interventions to prevent potential traffic accidents (Cartrack, n.d).

In addition, the evolution and functioning of LDWS and LCAS will be discussed in this research study along with drivers' behavior, the integration as well as driver acceptance towards these systems. It also aims to contribute to the development of ADAS into a safer and more efficient transportation system in the future.

1.2 Problem statement

Despite the advancements in LDWS technology, a critical gap remains between the drivers according to their understanding, perceptions, and interaction of these systems. The demographics groups such as age, gender, driving experience and cultural background as well as unexpected risks need to be considered even though the implementation of the LDWS has a lot of potential to improve road safety.

Furthermore, if these demographics are not considered, it could lead to systems efficacy reduction due to lack of trust, comfort, and adaptability to the technology. It also can increase fear and resistance towards LDWS which would hinder the acceptance and the usage of the system. As a result, this problem can lead to preventing their realization of its safety potential.

1.3 Research objectives

The purpose of this research is to close the understanding gap between the drivers on their perceptions and interactions with LCAS. In particular, the objectives are:

a) To design and develop research instruments (questionnaire).
b) To conduct survey data collection on factors influencing driver trust and reliance based on real drive experience.
c) To analyze survey data evaluating the impact of LDWS on driver behavior and safety.

1.4 Scope of research

The scope of this research is as follows:

- Conduct surveys to gather data on drivers' knowledge, perceptions, and behaviors towards LDWS.
- Conduct in-depth interviews with drivers to understand their personal experiences, beliefs, and preferences regarding LDWS.
- Data collection on driver demographics, driving behaviors, and experiences with LDWS at service center.
- Compare the findings across different demographics groups to identify significant differences in behaviors, perceptions, and usage patterns.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

LDWS have become an essential part of the ADAS in modern vehicles. It helps to improve driver awareness and reduce accidents caused by unintended lane departures. The evolution and technology of LDWS are studied in this literature review, with an emphasis on its technologies which are early based-camera system, advancements in image processing and computer vision as well as machine learning and human interface. This literature review also explores drivers and their driving behavior with the integration of LDWS and LCAS.

In this chapter, the LDWS and LCAS impact on road safety and accident reduction will be discussed along with the importance of driver acceptance of LCAS and its safety enhancements. Finally, this literature review will highlight the limited research conducted on LDWS and LCAS to understand its full potential and address remaining gaps in knowledge.

2.2 Evolution and technology of LDWS

In the automotive industry, passive systems work to reduce the effects of accidents, whereas active safety systems work to prevent them from happening. LDWS are one of the main active safety systems in the industry. It functions to alert drivers by using acoustic, visual, or haptic feedback if he accidentally leaves the current lane (Galvani, 2019). It also functions to detect the lines of the vehicle lane and compares them with ego-vehicle direction by using a forward-looking camera (Galvani, 2019). Figure 2.1 shows the lane departure warning systems overview (Galvani, 2019).

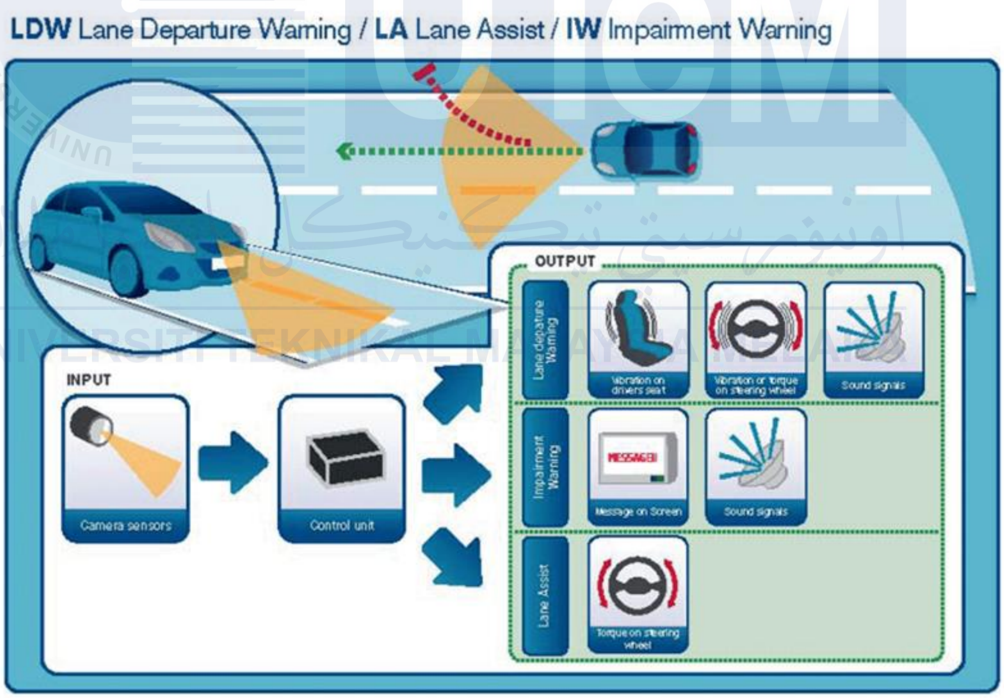


Figure 2.1 LDWS overview (Galvani, 2019).

The evolution of LDWS has been largely influenced by technological advancements and an increasing awareness of drivers' behavior. This evolution can be broadly categorized into three stages.

2.2.1 Early camera-based systems

In the late 1990s and 2000s, the first LDWS systems have been introduced by relying on a single camera mounted on the windshield to detect lane markings (Kwon et al., 2019). These devices identify lane surroundings and alert the vehicle by using simple processing algorithms (Galvani, 2019). Although these early systems have major improvement in terms of driver safety, they are still prone to false alarms in difficult situations such as faded lane markers, heavy rain, or uneven roads. Additionally, simple image processing algorithms have limited accuracy as its inability to handle complex road geometries. Figure 2.2 shows a camera-based blind spot system (Kwon et al., 2019).

Figure 2.2 Camera-based blind spot system (Kwon et al., 2019).

2.2.2 Advancements in image processing and computer vision

What is image processing? It is a process of using digital computers to process images which is also known as IP (Khan et al., 2021). Based on this method, algorithms for improving image quality can be used to retrieve information from the image. Meanwhile, computer vision is the process of capturing, analyzing and recognizing images using multiple methodologies, algorithms, and techniques (Nidamanuri et al., 2022). Figure 2.3 illustrates the essential elements of several advanced computer vision systems, methodologies, and techniques for the development of ADAS (Nidamanuri et al., 2022).

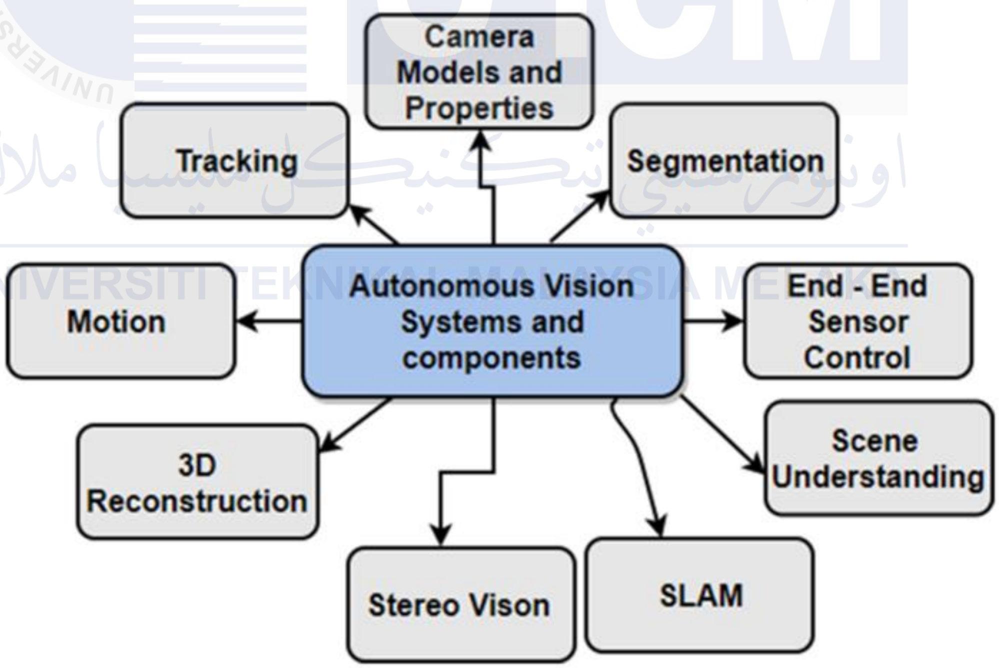


Figure 2.3 Autonomous vision systems – an integrated view (Nidamanuri et al., 2022).

The use of image processing and computer vision techniques provides major advantages over conventional monitoring in analyzing complicated road traffic conditions (Nidamanuri et al., 2022). For instance, essential camera setups, eye gazing and head pose estimation are covered in the following areas for effective system assisted driving development.

Furthermore, advancements of these techniques have been implemented in LDWS technology by using multiple cameras wider field of view which provides better coverage of the road ahead. Even in challenging conditions, these cameras can detect and track lane markers due to their high-resolution image function. For example, Volkswagen uses Touarage front camera which is a camera technology that provides an image processing control module (J851) to process the images . Figures 2.4 and 2.5 below represent the Touareg front camera and its mechanisms.

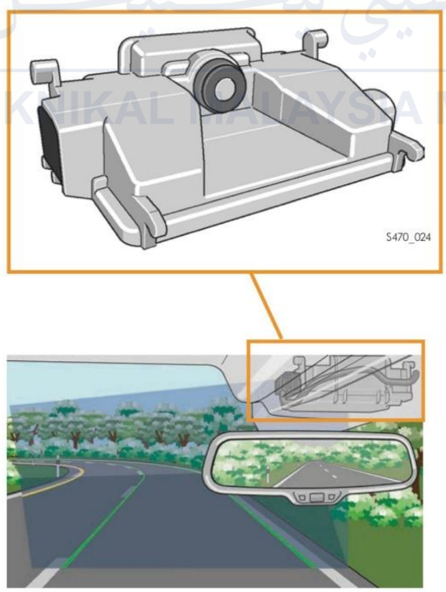


Figure 2.4 Touareg front camera.

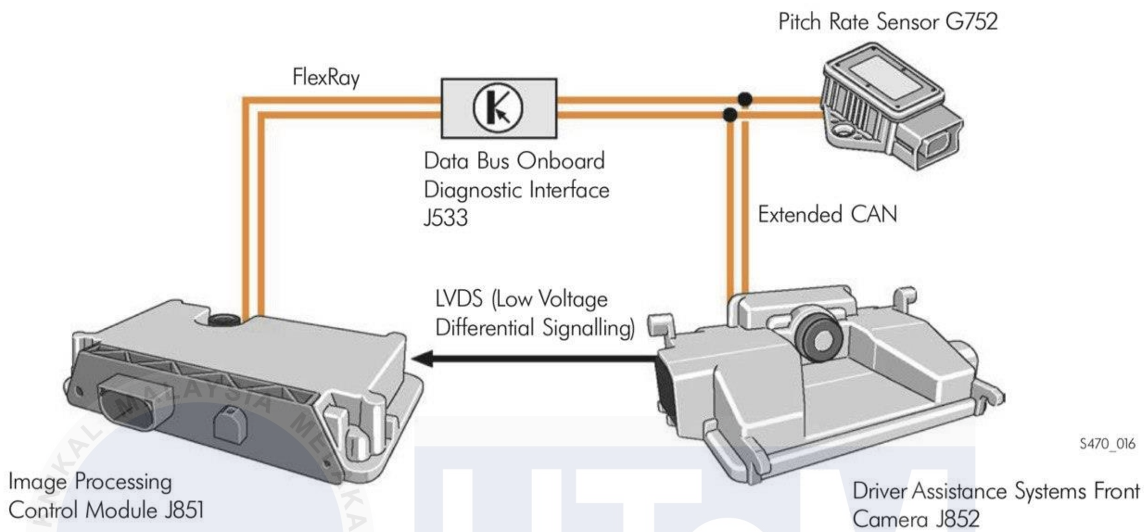


Figure 2.5 The mechanism of Touareg front camera.

2.2.3 Machine learning and human interface

The integration of machine learning, adaptive alarms, and enhanced human interfaces resulted in a considerable evolution of ADAS in the late 2010s and beyond. These days, machine learning algorithms analyze vehicle behavior, road conditions, and driving patterns to predict possible lane deviations and provide personalized alerts (Khan et al., 2021). These systems can modify the level warnings based on the drivers' behavior, reducing driver fatigue, and encouraging safe driving (Nidamanuri et al., 2022). In this case, head-up displays (HUDs) and integrated voice warnings are examples of advanced human interfaces that further improve the driving experience by clearly and intuitively displaying important information. Figure 2.6 shows an illustration of various sensing and communication such as RADAR and LiDAR mechanisms for V2X environments in terms of machine learning and human interface in ADAS (Nidamanuri et al., 2022).

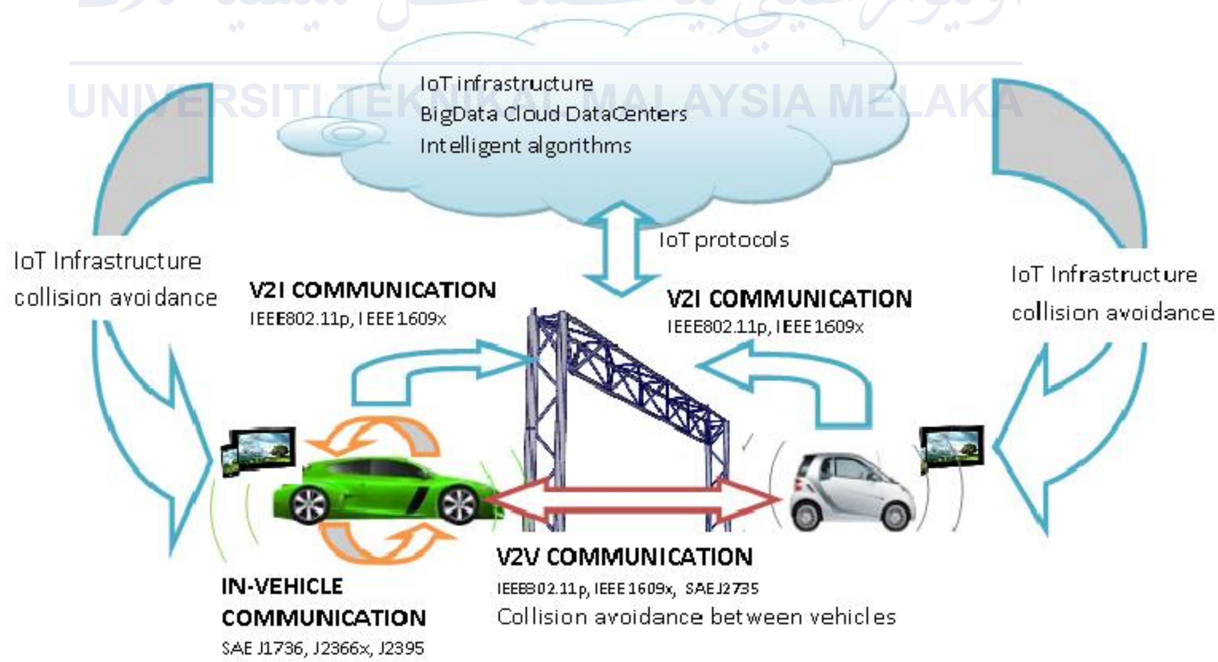


Figure 2.6 V2X approach in ADAS (Nidamanuri et al., 2022).

In the end, these developments aim to improve driver safety and comfort by offering timely and relevant warnings which eventually lead to a more efficient and personalized driving experience (Nidamanuri et al., 2022). However, the integration of machine learning in ADAS creates concerns regarding data privacy and security which requires careful consideration and robust mitigation strategies (Mehta et al., 2024).

2.3 Drivers and their driving behaviors

Human error is considered as the lead cause of 90% of traffic crashes around the world (Karacasu et al., 2011). Numerous research efforts have investigated the correlation between risky driving behavior and the occurrence of traffic crashes (Shawky, 2020). Most of this research focused on the most dangerous driving behaviors that cause fatal crashes such as speeding, tailgating, drinking and driving, using hand-held mobile devices, and failing to obey traffic signs (Shawky, 2020) . However, the unsafe lane changing behavior of the drivers has not received the same amount of attention from the researchers (Shawky, 2020). These studies can relate in Figure 2.7 which shows the type of crash and total crash numbers due to drivers and their driving behavior in several countries (Wang et al., 2020).

The Average Percentage of Each Crash Type and Total Crash Number.

Percentage(%) Types	Australia	Canada	India	New Zealand	UK	USA
Rear-end	13.51	15.15	9.90	8.41	31.60	14.79
Off-road or object	8.38	5.11	14.85	28.40	2.74	7.53
Lane change	12.97	9.03	11.55	2.46	1.13	14.63
Pedestrian	1.77	0.59	10.00	8.83	0.13	1.16
Animal	1.64	0.20	4.00	0.82	0.01	4.56
Intersection	53.70	49.50	45.00	25.80	38.40	45.00
Others	8.03	20.44	4.70	25.27	25.99	12.33
Percentage	100.00	100.00	100.00	100.00	100.00	100.00
Total Crash Number (year)	18226	311243	489667	9508	259532	5991600

Figure 2.7 The type of crash and total crash number of drivers and their driving behavior in several countries (Wang et al., 2020).

2.3.1 Lane change behavior

Lane change behavior is affected not only by road traffic conditions and other external environments but also by the personal characteristics of drivers (David and Soffker , 2022). For example, rear-end crashes, scrapes, and other traffic errors can easily result from a motorist changing lanes if the driver judgement of the distance and relative speed between the vehicles is not accurate enough as shown in Figure 2.8 below (Y. Zheng and Hansen, 2017).

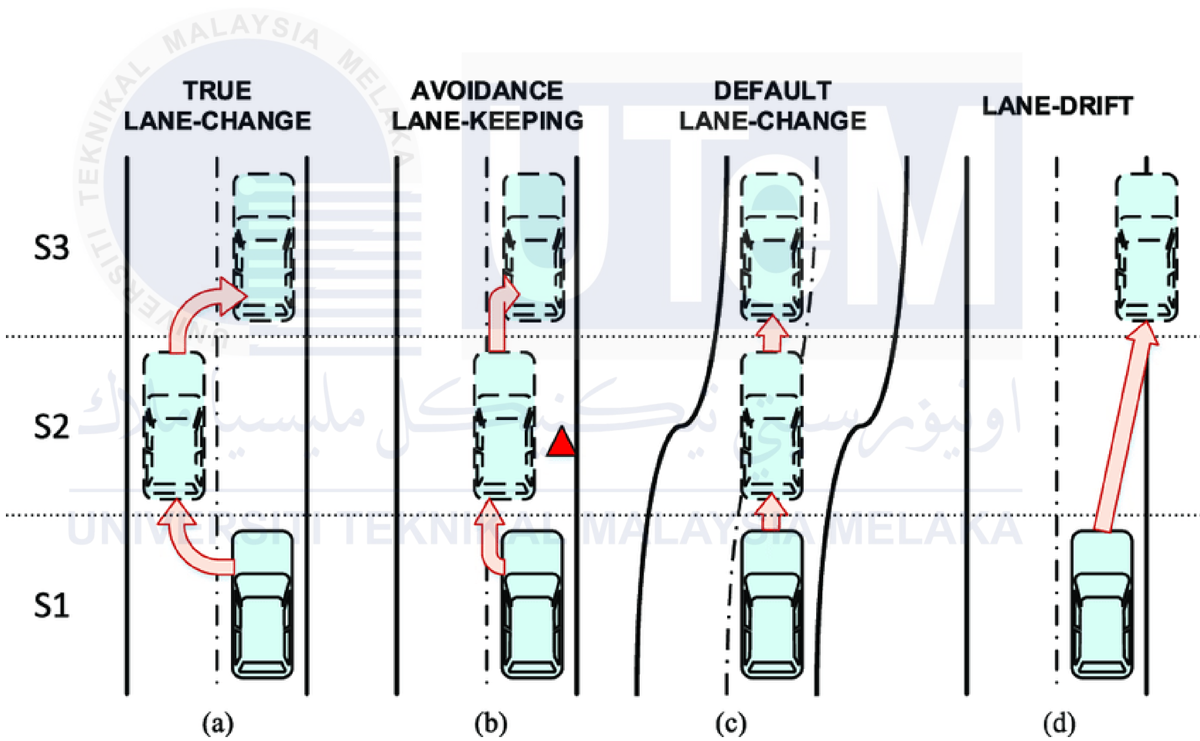


Figure 2.8 The lane change behavior in various conditions (Y. Zheng and Hansen, 2017).

Similarly, if the driver's observation or interpretation of the surrounding information can be not accurate enough. In this case, several reviews have demonstrated that human demographics, especially drivers' behavior, are the factors of the majority traffic accidents (David and Soffker, 2022). It is because different drivers have different times for lane changes and levels of awareness to environmental signals (David and Soffker, 2022). As a result, the way drivers change lanes is largely influenced by their personal characteristics. Figure 2.9 represents the causes of lane changes in various conditions including drivers' behavior (Shawky, 2020).

Location and surrounding conditions for lane change and other crashes causes.

Variables			Lane change crashes		Other crashes	
			Frequency	Percentage	Frequency	Percentage
Road and crash location characteristics	Road type	rural	2270	88.7%	6628	57.6%
		urban	290	11.3%	4876	42.4%
	Road speed limit	40	315	12.7%	3245	20.6%
		60	515	20.7%	4381	27.9%
		80	396	15.9%	4872	31.0%
		100	490	19.7%	1659	10.6%
		120	772	31.0%	1561	9.9%
	Intersection-related location	2	650	45.7%	2562	35.9%
		3	348	24.5%	2690	37.7%
		4	399	28.0%	1628	22.8%
		5	30	1.9%	299	3.6%
		at/near intersection	140	5.7%	2444	21.0%
		roundabout	93	3.8%	939	8.1%
		near U-turn	48	2.0%	300	2.6%
		non-junction	2158	88.5%	7941	68.3%
	Light condition	daytime	1686	62.4%	7560	57.4%
		night with good light	798	29.5%	4599	34.9%
		night without light	219	8.1%	1017	7.7%
	Road surface condition	dry	2413	92.1%	11,999	93.6%
		wet	81	3.1%	216	1.7%
		sand covered	48	1.8%	153	1.2%
		not paved	78	3.0%	448	3.5%
Weather condition		clear	2576	95.3%	12,662	96.1%
		rainy	79	2.9%	188	1.4%
		fog	21	0.8%	186	1.4%
		stormy	28	1.0%	139	1.1%
Vehicle type		light vehicle	2159	90.8%	10,124	88.5%
		heavy vehicle	219	9.2%	1313	11.5%

Figure 2.9 The cause of lane changes in various conditions including drivers' behavior (Shawky, 2020).

2.4 Integration of LDWS and LCAS

The integration of LDWS and LCAS is to provide drivers with proactive warnings and assistance during lane changes. It is also one of the integrations that forms a comprehensive safety net. When a car unintentionally leaves its lane, LDWS notifies the driver by employing cameras or other sensors to track lane markers (Chen et al., 2020). It also enables faster reaction times and reduces the probability of traffic accidents.

On the other hand, LCAS works in conjunction with LDWS by utilizing radar or other sensors to identify blind spots and possible crashes during lane changes. The LCAS helps in terms of steering to avoid collisions by providing visual and audio alerts to the driver during lane changes (Visvikis et al., 2008). Moreover, this integration enhances safety by detecting potential hazards before they become critical. Subsequently, making drivers think carefully with informed decisions and avoiding traffic accidents (Nidamanuri, J et al., 2022).

In addition, these systems have been evolving with a combination of AI-powered features and adaptive alerts to deliver customized warnings and even predict the possible risks before the driver sees them (Yang et al., 2024). Hence, this integration is one of the major developments in driver assistance technology which encourages safer and enjoyable driving for the driver.

2.5 The LDWS and LCAS impact road safety and accident reduction

Various research has been conducted to determine the impact of LDWS and LCAS on real-world road safety. These studies typically involve large-scale observational data analysis or controlled trials. The analysis showed a positive effect of the LDWS in reducing lane departure crashes. In Sweden, the system works in reducing head-on and single-vehicle injury crashes with speed limits between 70 to 120 km/h including dry and wet conditions (Sternlund et al., 2016). Meanwhile, Volvo Cars has reported that their LCAS system called ‘Pilot Assist’ had reduced rear-end collisions by 49% during a large-scale trial involving thousands of vehicles (Volvo Cars, 2024) . Figure 2.10 illustrates Volvo Cars’ Pilot Assist’ system.

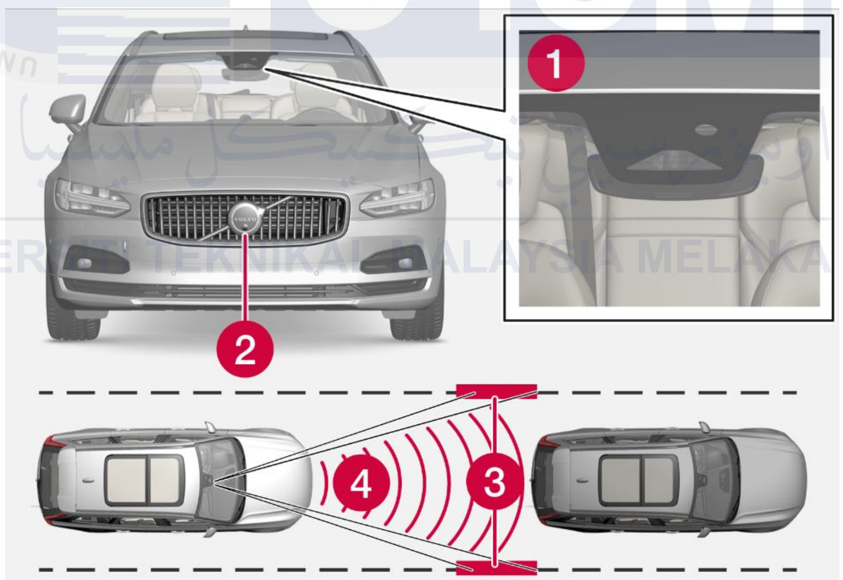


Figure 2.10 Volvo Cars 'Pilot Assist’ system (Volvo Cars, 2024).

2.6 Driver acceptance of LCAS and safety enhancement

The system of lane change assistance must rely on driver acceptance and efficient human-machine communication for it to be successful. The system must be trusted by drivers, who should view it as a useful tool rather than a replacement of their own judgement (Karacasu, et al., 2011). To reduce uncertainty among the drivers, the LCAS system needs to have user-friendly interfaces including visual cues, auditory signals, and minimal distractions. Moreover, the system should give clear warnings to the drivers to ensure that they are prepared regarding the system limitations and potential hazards (Nidamanuri et al., 2022).

However, the risk of the driver losing awareness and become too depended on the system can be a main concern due to over-reliance and fatigueless. This concern can be seen among the older adult drivers that tend to over-rely on the longitudinal warning at shorter headway distances (Souders et al., 2020). As a result, other systems in ADAS such as FCW are rarely activated (Souders et al., 2020).

To reduce the risk, the introduction of automation and awareness campaigns that emphasis the system usage should be engaged to the drivers (Gershon et al., 2021). So, the LCAS can create a trustworthy relationship between humans and machines by focusing user-centric design, transparency, and proactive steps to improve driving safety in the future.

2.7 Regulatory and ethical considerations in LDWS

Lane departure warning systems (LDWS) are becoming more popular as they offer safety benefits for most of the modern vehicles today. As they are becoming more popular, it is also important to raise important regulatory, ethical, and data privacy concerns. Even though global standards like UNECE Regulation No. 157 and SAE J3164 provide guidance on performance requirements and testing, standardization in this system remains a challenge. Similarly, concerns about ethics include drivers relying too much on the system, the possibility of system breakdowns, and the privacy effects of collecting data on driver's behavior also remains a challenge.

Moreover, data privacy and security are very important because LDWS continuously collects sensitive data that must be protected from being hacked or used in the wrong way. A thorough literature review that focuses on regulatory frameworks, ethical issues, data privacy concerns, and future trends will help to gain a better understanding of the complexity of LDWS and their impact on road safety, driver behavior, and data privacy.

2.7.1 Current regulations and standards for LDWS

The regulatory landscape for LDWS is dynamic and differs by area. Several countries and regions have implemented rules and regulations to ensure safe and responsible use of these ADAS systems as shown in Table 2.1 (Bhawin Ameta and Dr. Vinita Mathur, 2023).

Table 2.1 List of countries and regions that have implemented rules and regulations in LDWS technologies (Bhawin Ameta and Dr. Vinita Mathur, 2023).

No.	Country or Region	Rules and regulations
1.	United States (U.S)	• The National Highway Traffic Safety Administration (NHTSA) regulates ADAS in the U.S. • Specific ADAS elements are covered by several safety standards and recommendations, which place an important focus on testing and validation procedures to ensure compliance with safety regulations.
2.	European Union (E.U)	• The ADAS features are encouraged by the European New Car Assessment Program (Euro NCAP), which rates cars according to safety standards. • The EU has defined rules regarding autonomous driving systems that provide framework for testing and implementation.
3.	China	• Has implemented regulations through the Ministry of Industry and Information Technology (MIIT). • The nation has committed to advocating ADAS technologies, and these regulations cover many areas of vehicle safety. • For innovation and safety, the Chinese government priorities collaboration between industry stakeholders and regulatory organizations.

2.7.2 Challenges and opportunities in regulatory frameworks in LDWS

The rapid advancement of LDWS technologies expresses challenges for regulators in keeping up with new developments and creating thorough regulations. Even though there are a wide variety of manufacturers and technological advancements, it is still difficult to ensure compatibility across various LDW systems and standardize communication methods. In addition, user information must be protected by regulatory frameworks that address issues with cybersecurity and data privacy as LDWS involves the collection and processing of sensitive data (Bhawin Ameta and Dr. Vinita Mathur, 2023).

In terms of opportunities in the LDWS regulatory framework, international collaboration has the potential to harmonies regulatory standards, promoting consistency and interoperability across borders. Moreover, the regulators can promote the integration of safety features by providing frameworks that encourage manufacturers to implement as well as enhance LDWS technology. Finally, regulatory agencies can help the public to understand the advantages and restrictions of LDWS in terms of the system usage to improve road safety (Bhawin Ameta and Dr. Vinita Mathur, 2023). Figure 2.11 represents the key regulatory framework that needs to be implemented in LDWS technology in Australia (NTC, 2022).

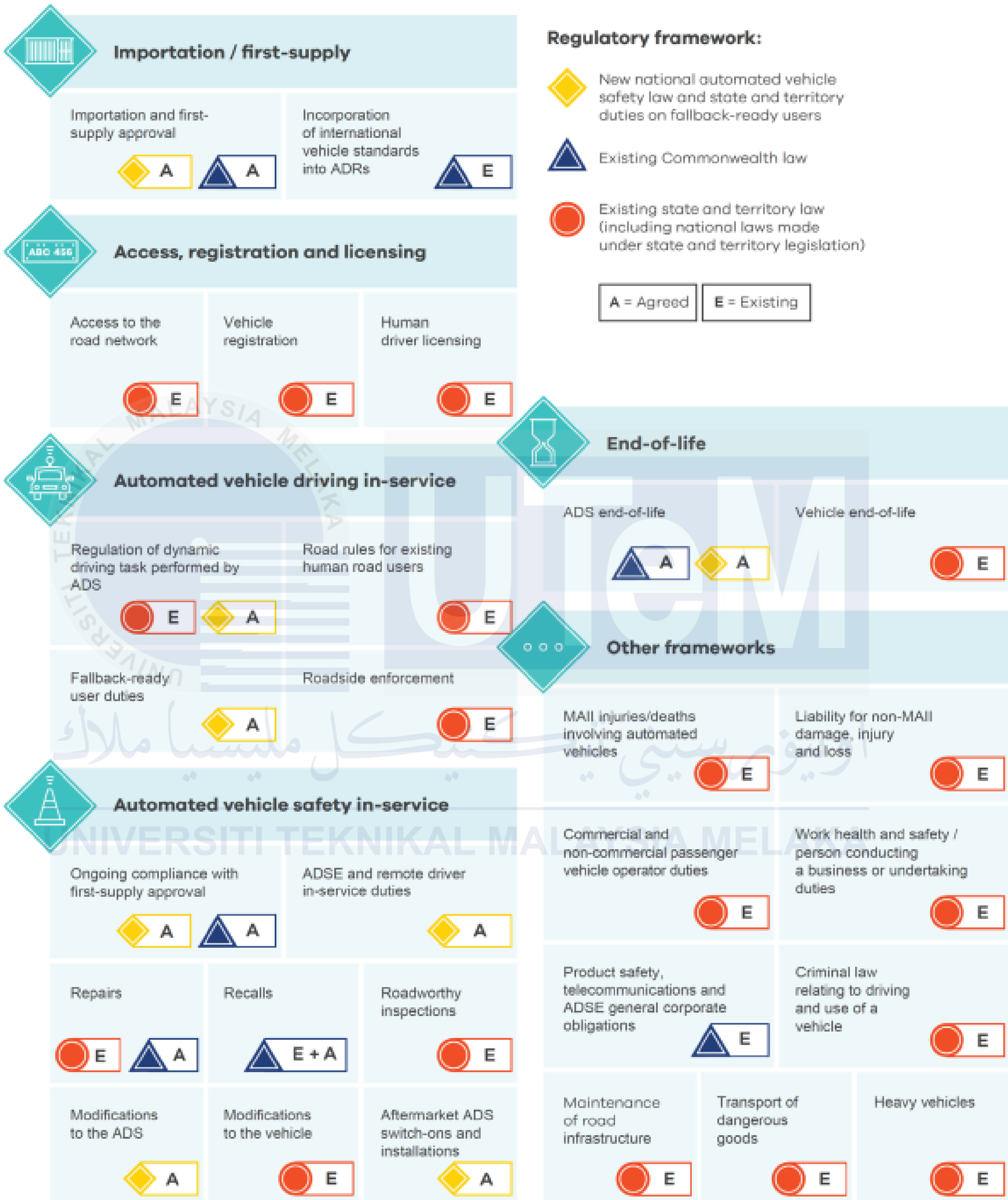


Figure 2.11 Key regulatory frameworks for LDWS technology in Australia (NTC, 2022).

2.7.3 Ethical issues involving LDWS

As the use of LDW system technology becomes more pervasive, there are several ethical issues that must be considered. These considerations are especially necessary as technology continues to advance and evolve. Thus, the development of fully automated vehicles is likely to be realistic in the future.

Liability is one of the main ethical issues revolving around LDWS technology. Could an LDWS technology vehicle be involved in an accident? This kind of question will come up as it could be challenging to figure out who has the responsibility. For instance, who oversees the LDW system – the manufacturer or the driver – should an accident happen while a vehicle is in autonomous mode? Consequently, this issue raises important questions around liability and the allocation of responsibility in the event of an accident (Bhagat et al., 2023).

Furthermore, it is necessary to deal with potential gaps in the availability of LDWS as this issue can beat the safety benefits of LDWS due to poor driving skills and increased risk-taking. Similarly, the potential for system failures such as false positives, negatives, and system malfunctions can also be one of the ethical concerns that need to be considered to ensure fair access to these technologies among different demographic groups (Bhawin and Vinita, 2023).

Overall, a multifaceted approach such as clear regulations, driver education, privacy safeguards, and ongoing research is required in ethical considerations. These concerns must be addressed to ensure that LDWS are implemented responsibly and ethically, thus contributing to a safer and more responsible future for transportation.

2.7.4 Data privacy and security concerns

Although LDW systems aim to enhance road safety, they also raise concerns regarding data privacy and security. It is because there is a possibility that this information could be used inappropriately or without the driver's consent as these systems continue to process large amounts of data regarding the drivers and their behavior. For example, insurance companies may seek to use data collected by the systems to determine policy rates or investigate claims (Bhagat et al., 2023). This has raised concerns regarding the acquisition, storage, and the usage of data. In this case, the need for clear guidelines and regulations around data privacy and security needs to be highlighted. By highlighting these concerns, LDW systems can contribute to road safety while respecting the driver's rights and protecting their sensitive information.

2.7.5 Future regulatory trends and implications

The future of LDWS is intertwined with evolving regulations and technological advancements. The probability of this occurring is that global regulatory will advocate for the further standardization of LDWS standards and testing procedures which will ensure consistent performance across various manufacturers and regions. In addition, it is anticipated that LDWS will integrate more complex features such as automated lane keeping assist and adaptive cruise control. In this case, the features will further erode the gap between autonomous driving and driver assistance (Bhawin and Vinita, 2023).

As these systems become more advanced, the process of determining liability in the event of accidents will become more complicated, which means the establishment of clear legal frameworks for system accountability and driver responsibility is in demand.

2.8 Limited past research

While the potential of ADAS systems such as LDWS and LCAS for enhancing driver awareness and safety is widely acknowledged, comprehensive research on its effectiveness remains limited. The methodology of this research often focuses on lane keeping or driver behaviors in which there are difficulties in obtaining real-world driving conditions and real-world data. Furthermore, it is challenging to completely evaluate the impact of ADAS alerts because of the lack of long-term data access and the inconsistency of driver responses.

Despite all these drawbacks, the research that is currently available points to some possible advantages including enhanced lane keeping capabilities, increased driver awareness of lane limits and the possibility of lower accident rates. However, future research must overcome these challenges by employing real-world data as well as conducting long-term studies to comprehend the long-term implications on driver's behavior and safety. Moreover, this study can have a better understanding of the true potential of LDWS and LCAS by addressing all these gaps. Therefore, this can enhance driver awareness and safety which will eventually lead to safer roads for everyone.

2.9 Research gap

Research on LCAS and LDWS identifies a few important gaps that need to be filled. First, lack of long-term and real-world data limits current research, making it challenging to thoroughly assess these systems' performance under various driving scenarios (Navarro et al., 2023). Second, the need for additional in-depth research into the ways ADAS affects driver safety and awareness is highlighted by inconsistent driver responses as well as difficulties evaluating the behavioral impact of these systems (Navarro et al., 2023). Furthermore, the lack of interoperability standards and knowledge of how LDWS and LCAS work together to improve road safety presents challenges to their integration into a coherent system (Mansor et al., 2020).

Another important research gap is related to privacy, ethics, and regulations. Issues such as responsibility, excessive dependence on automation, and equitable access to ADAS technologies require well-defined frameworks (Wani and Kumari, 2024). Consequently, standardization and broad use of LDWS are hindered by the uneven international regulations (Khan et al., 2024). Moreover, considering the sensitive nature of the data gathered by these devices, issues of data security and privacy have not been addressed. For better understanding, public acceptance and behavior future studies should also take demographic aspects such as age and driving experience into account. Researchers can progress the creation of integrated, approachable, and morally sound technologies that improve traffic safety by filling in these gaps.

2.10 Chapter summary

With the use of RADAR and LiDAR, lane departure warning systems (LDWS) have advanced from simple camera-based systems to more complex systems that provide improved detection accuracy and ADAS feature integration. According to research, LDWS notifications may have an impact on drivers such as improving lane keeping practices and reducing the number of lane departure occurrences.

On the other hand, drivers' behavior is likely to differ as some drivers may potentially lead to over-reliance or even ignoring these systems. A complete solution for safe lane changes may be possible with the integration of LDWS and LCAS as LDWS provides awareness of lane limits and LCAS helps in the actual lane changes. Furthermore, research also suggests that there is a potential correlation between LDWS to reduce accident rates especially in lane departures even though there is limitations research on the impact of LDWS and LCAS.

To completely comprehend LCAS and drivers' behavior as well as overall road safety, further research is necessary. A lot of things need to be considered as LDWS and LCAS have a lot of potential to improve driver awareness and road safety. Also, contribution to a safer driving environment should be focused more on terms of integration impact of these systems using real-world data and long-term studies to fully understand these technologies.

2.11 Summary table

Table 2.2 provides a summary of previous research findings, highlighting essential methodology, primary outcomes and significant contributions to the subject and also offering a framework for comprehending current research gaps.

Table 2.2 Summary of previous research finding.

No.	Author	Title	Research findings
1.	(Galvani, 2019)	History and future of driver assistance.	• Overview of active safety systems in automotive industry. • Focus on Advanced Driver Assistance Systems (ADAS).
2.	(Kwon et al., 2019)	A study on the development of the camera-based blind spot detection system using the deep learning	• Developed camera-based blind spot detection system using deep learning. • Achieved 99.43% training accuracy and 98.99% testing

		methodology.	accuracy.
3.	(Khan et al., 2021)	Machine Learning in Computer Vision: A Review.	• Machine learning (ML) plays an important role in extracting information from images in computer vision (CV). • ML techniques used for feature extraction, pattern recognition, and object detection.
4.	(Nidamanuri et al., 2022)	A Progressive Review: Emerging Technologies for ADAS Driven Solutions	• Review of ADAS technologies, focusing on computer vision and machine learning. • Address research gaps and propose real-time recommendation system for ADAS.
5.	(Mehta et al., 2024)	Securing the Future: A Comprehensive Review of Security Challenges and Solutions in Advanced Driver Assistance Systems.	• Address challenges in data security for Advanced Driver Assistance Systems (ADAS). • A collaboration across regulators is needed for handling some security challenges.
6.	(Karacasu et al.,	An analysis on	• Understanding how age and

	2011)	distribution of traffic faults in accidents, based on driver's age and gender.	gender can impact traffic accidents helps to develop targeted road safety measures. • Age and gender significantly influenced traffic fault distribution with young males and older drivers being high-risk groups.
7.	(Shawky, 2020)	Factors affecting lane change crashes.	• Lane changes are influenced by various factors including driver behavior, environmental conditions, and roadway features. • Distractions such as mobile phone usage are the main contributors to unsafe lane changes.
8.	(Wang et al., 2020)	How many crashes can connect vehicle and automated vehicle technologies prevent: A meta-analysis.	• Connected and automated vehicles (CAV) can reduce the number of crashes with AV technologies having a greater impact compared to CV technologies.

9.	(David and Soffker, 2022)	A Study on a HMM-Based State Machine Approach for Lane Changing Behavior Recognition.	• Explore an innovative approach combining an HMM with a state machine model to improve the accuracy and reliability of lane-changing behavior recognition.
10.	(Y. Zheng and Hansen, 2017)	Lane-Change Detection From Steering Signal Using Spectral Segmentation and Learning-Based Classification.	• Utilize vehicle dynamic signals such as steering angle and vehicle speed. • Achieved detection accuracy of the steering signals with 80.36% for left changes and 83.22% for right changes.
11.	(Chen et al., 2020)	Lane departure warning systems and lane line detection methods based on image processing and semantic segmentation: A review.	• Lane departure warning systems have significantly improved with advances in image processing and deep learning. • Combining traditional and modern methods offers a great solution for real-time and accurate lane detection which can enhance driving safety with

			different conditions.
12.	(Visvikis et al., 2008)	PROJECT REPORT PPR 374 Study on lane departure warning and lane change assistant systems Final report.	• Focuses on the effectiveness and implementation of lane departure warning and lane changing assist systems. • The systems are essential in preventing accidents due to lane departures and unsafe lane changes.
13.	(Yang et al., 2024)	Comprehensive Assessment of Artificial Intelligence Tools for Driver Monitoring and Analyzing Safety Critical Events in Vehicles.	• Reviews on application of AI in improving driver safety and monitoring. • AI can increase vehicle safety by predicting risky behaviors, monitoring driver states, providing real-time alerts and assistance.
14.	(Sternlund et al., 2016)	The effectiveness of lane departure warning systems—A reduction in real-world passenger car injury crashes.	• Investigate the effectiveness of lane departure warning and lane keeping aid systems in reducing real-world passenger car injury crashes. • The study was based on a

			relatively small data set, suggesting a need for further research to validate the results under varied real-world conditions and across different manufacturers' technical solutions.
15.	(Souders et al., 2020)	Aging: Older Adults' Driving Behavior Using Longitudinal and Lateral Warning Systems.	• Evaluate the impact of using FCW and LDW vehicle warning systems on the driving behavior of older adults. • The research indicates that the combined use of FCW and LDW systems does not have a negative impact on longitudinal driving performance or personal fatigue, while FCW systems can improve safety by increasing Time-to-Collision for older drivers.
16.	(Gershon et al., 2021)	Driver behavior and the use of automation in real-world driving.	• This study offers an in-depth analysis of how drivers interact with semi-automated vehicles

			in real-world driving. • Highlights that control transitions are dynamic combinations between the driver and the automation system.
17.	(Bhawin and Vinita, 2023)	Advanced Driving Assistance Systems.	• Provide detailed explanations of ADAS functionalities which can increase user trust and confidence. • Address issues on current regulations and ethical considerations of ADAS.
18.	(Bhagat et al., 2023)	A Comprehensive Review of Advanced Driver Assistance Systems (ADAS).	• Provides a detailed examination of ADAS which highlights their technological advancements, benefits, and limitations.
19.	(Navarro et al., 2023)	Visual and steering behaviors during lane departures : a longitudinal study of interactions between	• Focuses on LDWS effectiveness and visual or steering behavior during lane departures.

		Lane Departure Warning System, driving task and driving experience.	
20.	(Mansor et al., 2020)	Lane Departure Warning and Lane Keep Assist Assessment based on Southeast Asian Environmental Conditions: Preliminary Investigations.	• Highlights the need for further research on LDW and LKA systems in Southeast Asia. • Addressing environmental factors and road conditions, while emphasizing the importance of real-world testing to evaluate their effectiveness and improve driver safety.
21.	(Wani and Kumari, 2024)	Ethics in the Driver's Seat : Unravelling the Ethical Dilemmas of AI in Autonomous Driving.	• Emphasizes the need for clear ethical and legal frameworks addressing liability, accountability, and privacy concerns in autonomous driving.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter gives a full summary of the research technique used in this study. It describes the processes that are taken, beginning with the thorough design and creation of survey questions. Moreover, the question wording, response formats, and general structure will be carefully considered during this initial phase to ensure the instrument of survey validity and reliability.

The following phase will focus on the systematic collection of data after the survey instrument has been finalized, which includes distributing the survey to the intended audience and collecting results. The collected data will next be thoroughly and systematically analysed. In this case, appropriate statistical approaches and analytical tools were used to derive significant insights and patterns from the data.

3.2 Research instrument design and development

This study aims to investigate the user acceptance of LDWS using a precisely built instrument based on the Unified Theory of Acceptance and Use of Technology (UTAUT). The questionnaire is designed on specific topics such as demographic and UTAUT factors which are performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), behavioral intention (BI) and use behavior (UB). This designed questionnaire uses Likert scales to assess the acceptability of LDWS in vehicles and its impact on intention to use the technology (Joseph et al., 2021).

Table 3.1 contains the demographic characteristics and driving-related information of the respondents. This includes gender, age, race, marital status, level of education, and job scope which were among the main variables highlighted in this table. The table detailed the respondents' driving experience in years, the type of car they drive (owned or rented), the frequency of driving in the city and on highways as well as whether they possessed a class D driving license.

Additionally, the participants' formal training in the automotive industry and their involvement in any car accidents while driving was also included. This comprehensive table established the foundation for comprehending the potential intersections between familiarity and attitudes towards ADAS vehicles and these various factors, thereby offering a comprehensive profile of the survey's participants and their driving habits.

The development of the instrument consists of a significant pilot testing phase to ensure clarity and relevance, followed by thorough validity and reliability assessments to verify measurement accuracy. The data collected from this instrument has been analyzed using Structural Equation Modelling (SEM) which is a powerful tool to unveil the complex relationships between UTAUT constructs and its impact on behavioral intention and actual use of LDWS.

This multifaceted approach provides useful quantitative insights into the drivers of user acceptance in identifying key factors that influence user acceptance and usage patterns of LDWS. Furthermore, this research is essential in understanding the requirements for this technology, which will ensure safe use of LDWS, like how requirements for vehicle-pedestrian interaction have been defined (Woodman et al., 2019). Also, this research seeks to contribute to the body of knowledge on technology implementation in automotive safety by providing insights that may be used to guide LDWS design, marketing, and legislation. Finally, the findings highlighted areas for improvement to encourage greater use and potentially improve road safety.

Table 3.1 Demographic characteristics and familiarity with ADAS vehicles.

Variables	**Items**	**Variables**	**Items**
Gender	Female Male	**Do you own a class D driving license?**	Yes No
Age	18-25 26-35 36-45 46 and above	**Driving experience (year)**	≤ 2 3 to 5 6 to 10 10 ≥
Race	Melayu Cina India Others	**Type of car drive**	Owned Rent
Marital status	Single Married Others	**Frequency of driving in the city**	Everyday Weekdays only Weekend only Drive if necessary
Level of education	SPM Diploma	**Frequency of driving on highways**	Everyday Weekdays only

	Bachelor's degree Master's degree PhD		Weekend only Drive if necessary
Job scope	Government Private Freelance/Self employed Student	**Have you ever been involved in a car accident while driving?**	Yes No
Have you received formal training in the automotive industry?	Yes No		

3.3 Hypotheses development

Based on the path of the relationship between variables in the UTAUT model, and previous research multiple , hypotheses are put forward (Joseph et al., 2021). Therefore, the following hypotheses are focused on factors most influenced by use behavior (UB) with the strongest impact of experiencing LDWS. Table 3.2 shows factors of LDWS awareness involving hypotheses development.

Table 3.2 Factors of LDWS awareness involving hypotheses development.

Factors	LDWS awareness
Performance Expectancy (PE)	The LDW system is beneficial in improving my driving safety.
	The LDW system improves my overall driving performance.

	The LDW system is effective in preventing unintentional lane departure.
	My driving confidence on highways increases when using LDW system.
	The LDW system effectively alerts me to possible lane departures.
Effort Expectancy (EE)	I have no difficulty understanding the operation of the LDW system.
	The LDW system is highly accessible.
	The notifications and alerts provided by the LDW system are clear and automatic.
	The LDW system can be easily activated or deactivated while driving.
	Responding to notifications from the LDW system requires minimal effort.
Social Influence (SI)	The LDW system is recommended by my family and acquaintances.
	There are other drivers whose opinions I respect who suggest that I implement the LDW system.
	My decision to employ the LDW system is influenced by the support of automotive experts.
	I often discuss the benefits of the LDW system with other drivers.
	The opinions from my peers have a positive impact on my perception of the LDW system.

Facilitating Conditions (FC)	My vehicle is well-equipped to support the LDW system.
	I have access to technical support when I encounter problems with the LDW system.
	The LDW system operates consistently in any driving conditions.
	The information provided by the manufacturer about the LDW system is sufficient.
	I am able to easily locate and understand the user manual for the LDW system.
Behavioral Intention (BI)	I intend to use the LDW system every time I drive.
	I plan to use the LDW system frequently in the future.
	I am willing to recommend the LDW system to the other drivers.
	I am willing to rely on the LDW system for lane departure warnings.
	I prefer vehicles that are equipped with the LDW system when purchasing a new vehicle.
Use Behavior (UB)	I frequently use the LDW system while driving.
	I consistently activate the LDW system on highways.
	I often use the LDW system in city driving.
	I rely on the LDW system for lane departure alerts.
	I deactivate the LDW system during bad weather conditions.

H1. PE: Greater reliance on the LDWS for lane departure alerts lead to stronger perceptions that the system is effective in preventing unintentional lane departures.

The LDWS detection capabilities can lead to stronger perceptions of its effectiveness in preventing unintentional lane departures. Greater reliance on the LDWS indicates that a driver is actively allowing the system to guide them through lane departure. Instead of simply turning it on and ignoring it, the driver actively relies on it to warn them before a lane departure occurs (Jeong et al., 2024). Similarly, they will start believing it is more effective at preventing lane departure which leads to a higher performance expectancy of the LDWS. This is a significant component of the hypothesis where it is not just about using technology, but how much the driver relies on the alerts. Therefore, a driver who relies more will exhibit higher use behavior and implies the relationship between how often one relies on the system as well as how strong their perceptions of its effectiveness are.

H2. PE : Consistent activation of the LDWS on highways leads to higher driving confidence on highways when using the system.

In this hypothesis, it explores the impact of LDWS on a driver's subjective experience rather than just its functionality. This hypothesis emphasizes that the success of safety technology extends beyond simply preventing accidents. It explains that it is essential to understand how the LDWS makes drivers feel more confident and secure, which will promote technology implementation and use. Furthermore, this hypothesis also focuses on how continuous LDWS activation on roads increases driving confidence as the effectiveness of LDWS remained stable during prolonged use and its system's reliability (Jordan et al., 2023).

H3. PE: More reliance on the LDWS for lane departure alerts lead to stronger perceptions in terms of LDWS effectively notifying the driver to potential lane departure.

Hypothesis H3 is important because it determines a direct link between actual use behavior, specifically reliance on the LDWS for lane departure alerts, and perceptions of the effectiveness of the system in carrying out its primary function of notifying drivers of potential lane departure (Yang et al., 2020). This link implies that real-world experience gained through reliance influences the driver's view of the system's capabilities. By emphasizing the significance of the fundamental purpose, it emphasizes the necessity for accurate and dependable warnings which informs the design and development of LDWS to promote reliance. Moreover, this hypothesis highlights the possibility of a feedback loop in which increased reliance leads to higher perception of system efficacy. Hence, it can drive further reliance and improve overall system implementation with a focus on the specific functionality of timely and accurate lane departure alerts.

H4. EE : More frequent use of the LDWS while driving leads to stronger perceptions that the system is highly accessible.

This statement is based on the powerful impact of real-world experience. As a driver interacts with the LDWS more frequently, familiarity develops which can lead to a deeper understanding of its functionality, controls, and alert mechanisms. The user understanding of LDWS is influenced by perceived system performance and usefulness, which can lead to stronger perceptions of accessibility with more frequent use (Julia et al., 2020). Additionally, regular use provides invaluable real-time feedback that validates the accessibility of the system in various driving situations as well as reducing perceived barriers to implementation. Eventually, this greater familiarity and practical input strengthens perceptions of high accessibility by enhancing trust in LDWS's capabilities and the driver's ability to utilize it efficiently.

H5. EE : Increased reliance on the LDWS for lane departure alerts lead to stronger perceptions that responding to its notifications requires minimal effort.

Hypothesis H5 emphasizes the key connection between usage behavior and perceived use with a particular emphasis on the impact of the act of relying on the LDWS for lane departure alerts on a driver's perception of the effort necessary to respond to notifications. This also emphasizes the necessity of providing a pleasant user experience in which warnings are intuitive and require minimal mental and physical effort. Thereby, this can prevent drivers from perceiving them as burdensome or difficult to manage. By addressing potential hurdles caused by perceived effort, the hypothesis leads LDWS design and development towards intuitive and easy warnings with the goal of increasing system usage through reduced perceived effort

H6. SI : More frequent use of the LDWS while driving leads to more frequent discussions about the benefits of the LDWS with other drivers.

The power of social proof is utilized in hypothesis H6, which acknowledges that the beliefs and behavior of others are significantly influenced by personal experiences with technology. The initial positive experiences likely encourage drivers to discuss its advantages with peers (Navarro et al., 2023). Moreover, it progresses beyond the casual observation of technology usage to underscore the significance of conversations and shared experiences which are more effective in increasing the system's value. In summary, H6 emphasizes the importance of social side of technology implementation, illustrating how the usage behavior of an individual can directly influence the perceptions and awareness of others.

H7. SI : Consistent usage of the system leads to stronger perceptions that the opinions of their peers have a positive impact on their perception of the LWDS.

Emotional expressions from peers can significantly affect observers' perceptions of information systems, leading to increased acceptance and usage (Goren & Hareli, 2016). For instance, users who witness positive emotional responses from peers are more likely to develop favorable attitudes towards the system which reinforces their engagement and usage patterns. Moreover, this implies that the recurrent use of technology can change the way in which individuals evaluate the opinions of others in their overall attitude formation. Eventually, as users actively pursue or pay more attention to external validation of their internal experiences.

H8. FC : Increased use of the LDWS while driving lead to stronger perceptions that the vehicle is well-equipped to support the system.

Rather than relying on theoretical knowledge or manufacturer claims, this hypothesis underscores the significance of real-world validation that illustrates the confidence of driver in the vehicle's capacity to support LDWS which is influenced by consistent and practical experience. For instance, as drivers become accustomed to LDWS, their trust in the vehicle's safety features increases, which leads to a perception that the vehicle is equipped with advanced safety technology. However, reliance on LDWS can lead to complacency, where drivers may underestimate their own situational awareness and responsiveness (Tan and Zhang, 2019). As a result, the hypothesis implies a feedback cycle in which the perception of facilitating conditions can be strengthened by increased use as it reaffirms the necessity of the seamless integration of technology into the vehicle infrastructure to ensure positive implementation and perception.

H9. FC : Increased use of the LDWS while driving lead to stronger perceptions that the vehicle is well-equipped to support the system.

Rather than relying on theoretical knowledge or manufacturer claims, this hypothesis underscores the significance of real-world validation that illustrates the confidence of driver in the vehicle's capacity to support LDWS which is influenced by consistent and practical experience. For instance, as drivers become accustomed to LDWS, their trust in the vehicle's safety features increases, which leads to a perception that the vehicle is equipped with advanced safety technology. However, reliance on LDWS can lead to complacency, where drivers may underestimate their own situational awareness and responsiveness (Tan and Zhang, 2019). As a result, the hypothesis implies a feedback cycle in which the perception of facilitating conditions can be strengthened by increased use as it reaffirms the necessity of the seamless integration of technology into the vehicle infrastructure to ensure positive implementation and perception.

H10. FC : Consistent usage of the LDWS leads to stronger perceptions that the system operates consistently in any driving condition.

This hypothesis highlights the fundamental significance of real-world performance which emphasis the technology's reliability to be demonstrated beyond controlled testing to function effectively across a wide range of environmental factors and driving conditions. The higher system reliability correlates with increased driver compliance, the quicker response times to warnings (Taylor et al., 2023). In this case, it emphasizes the importance of a system that is not limited in its efficacy, but it is generalizable to various conditions that drivers encounter daily. It also highlights that system reliability in any driving condition is paramount, as inconsistency will quickly erode driver trust and impede implementation.

H11. BI : More frequent use of the LDWS while driving leads to stronger intentions to use the LDWS every time they drive.

H11 is important because it indicates a correlation between past use and prospective behavioral intentions. It concentrates on the use of behavior rather than any other external influencing factors. The hypothesis emphasizes the importance of direct experience in influencing user behavior and transforming it into a habitual intent by proposing that more frequent use of the LDWS results in stronger intentions to use it every time. In addition, the system's acceptability can be improved by personalized algorithms that consider the characteristics of driver's behavior, suggesting that customized experiences may encourage habitual use (Xu et al., 2015).

H12. BI : More frequent use of the LDWS while driving leads to a higher willingness to rely on the LDWS for lane departure warnings.

In this hypothesis, it demonstrates that the willingness to rely on technology is not merely determined by awareness of its features or potential benefits but is shaped by repeated usage and consistent positive performance. Studies indicate that LDWS effectiveness remains stable even with prolonged use, suggesting that drivers continue to benefit from the system. It also stated that enhanced visual search patterns during lane departures are observed, indicating that drivers become more attuned to their driving environment with frequent LDWS use (Navarro et al., 2023). The hypothesis emphasizes that increased utilization will result in a greater reliance on technology and greater confidence in its efficacy. It also highlights the necessity of systems that are well-designed and dependable and that drivers will be willing to rely on to ensure their safety. This emphasizes the significance of user behavior in the establishment of reliable relationships.

3.4 Pilot survey

One of the most important factors to evaluate is the efficacy of survey and other data collection methods. It is important to utilize time and effort in the most effective way possible to achieve success in conducting surveys, particularly those that involve a substantial number of participants. A pilot survey determines a questionnaire by employing a sample size that is less than the desirable size. The accuracy of the instructions is also assessed in a pilot survey by determining whether all respondents in the pilot sample can comply with the guidelines precisely.

Additionally, it offers additional information regarding the efficacy of this survey for research purposes. Therefore, we conducted a pilot survey online with 30 adult participants to gather responses to this survey. Through this pilot survey, we were able to evaluate the clarity question and obtain enough indicators based on the opinions of the respondents. The overall scale and reliability of the question were analyzed by computing Cronbach's Alpha reliability coefficient using the results of the pilot survey. Finally, we were able to eliminate the item that impacted the reliability measurement by assessing the contributions of each answer item.

3.4.1 Cronbach's alpha

Cronbach's alpha (α = coefficient alpha) measures reliability or internal consistency by Lee Cronbach in 1951. Reliability is another term for consistency. The reliability of multi-question Likert scale survey is evaluated using Cronbach's alpha. These enquiries evaluate latent factors or qualities that are concealed or unobservable including an individual's psychopathology, conscientiousness, and openness. These are exceedingly challenging to quantify. Therefore, Cronbach's alpha determines the degree of clustering among a collection of test items. Also, Cronbach's alpha is the formula employed for analysis. For instance, a general rule of thumb for a dichotomous question with two potential responses or a Likert scale question. Finally, the score is considered appropriate if it exceeds 0.7. According to certain authors, values between 0.90 and 0.95 are indicative of superior quality. Table 3.2 shows the value of Cronbach alpha and internal consistency (Mat Nawi et al., 2020).

Table 3.3 Value of Cronbach's alpha and internal consistency (Mat Nawi et al., 2020).

Cronbach's alpha	**Internal consistency**
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.7 > \alpha \geq 0.8$	Acceptable
$0.6 > \alpha \geq 0.7$	Questionable
$0.5 > \alpha \geq 0.6$	Poor
$0.5>\alpha$	Unacceptable

3.5 Main survey

The survey questionnaire was modified based on the result and feedback from pilot study before distributed to the public and people works or study in automotive industry in Malaysia between August and October 2024. A total of 415 respondents participated in the online survey which was carried out via Google Forms. The query was extended to the respondent for completion.

Data analysis is the most critical component of any research project, as it involves the use of logical reasoning and analytical methods to identify patterns, trends, and correlations. The statistical analysis was conducted using a two-stage structural equation design. The analysis in this study is conducted using the IBM SPSS V26 software program and its extension, AMOS V26. The data screening process, which is a critical stage in the data preparation process to ensure data quality, was initiated by IBM SPSS V26. Subsequently, the data were analyzed to determine the correlation between the variables. This approach evaluates the degree of connectivity between two variables. Following that, analyzing fit indices such as normed fit index (NFI), comparative fit index (CFI), Tucker-Lewis's index (TLI), and root mean square error of approximation (RMSEA) were then used to evaluate the fit indices of the tested model by using AMOS V26. Hence, the goodness of fit (GOF) metrics was crucial to evaluate the validity and adequacy of the model. The association between all variables was eventually revealed by utilizing the SEM model that was generated.

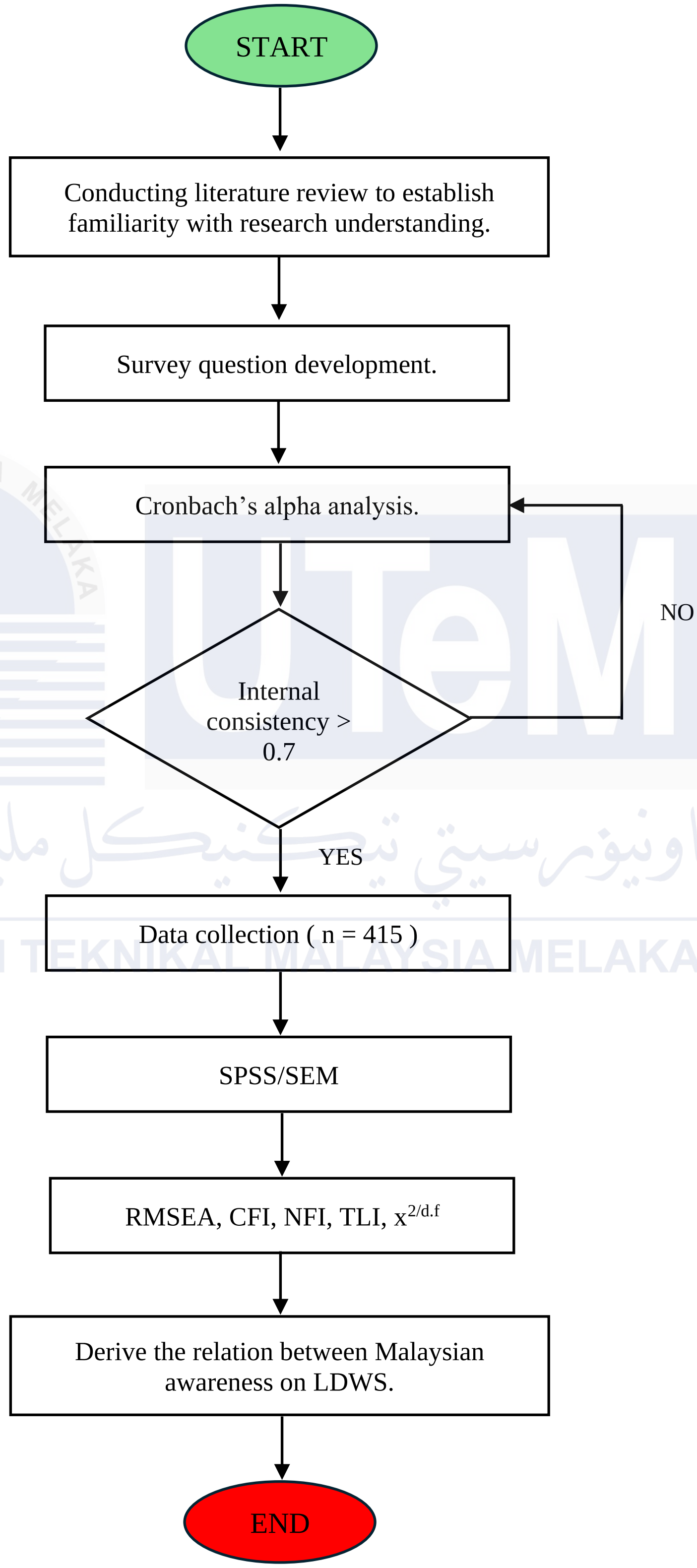


Figure 3.1 Flow chart of the research.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter focusses on the Malaysian awareness of LDWS in relation to purchasing intentions by analyzing and evaluating a variety of factors to estimate Malaysian awareness. Moreover, it is beneficial to recognize the limitations and deficiencies of this investigation. The subtopic below provides a description of the anticipated outcome of this research study.

4.2 Descriptive statistics of respondent

The descriptive statistics of the survey respondents are presented in Table 4.1. The sample is primarily male which is 62.9% and relatively young with the largest age group being 18-25 years old that is 38.3%. Most respondents are of Malay ethnicity (75.2%) with a significant number of them possessing a bachelor's degree (42.7%). Moreover, the sample is almost evenly divided between individuals who have received formal automotive training and those who have not, indicating a wide variety of backgrounds. Also, most of respondents (97.1%) were in possession of a class D driving license and owned the vehicles they drove (88.7%) that highlights a diverse range of driving experience.

The frequency of driving on highways is more diverse, with a greater proportion of individuals driving, when necessary (42.7%), compared to the city, where a significant number of individuals drive daily (48.0%). Finally, 48.0% of the respondents reported being involved in a car accident. In general, the table below offers an extensive analysis of the respondents, which is essential for the purpose of interpreting and comprehending the following analyses.

Table 4.1 Descriptive statistics of respondents.

Variables	**Items**	**Frequency**	**Percent (%)**
Gender	Male	261	62.9
	Female	154	37.1
Age	18-25	159	38.3
	26-35	80	19.3
	36-45	106	25.5
	46 and above	70	16.9
Race	Melayu	312	75.2
	Cina	43	10.4
	India	45	10.8
	Others	15	3.6
Education level	SPM	53	12.8
	Diploma	138	33.3
	Bachelor’s degree	177	42.7
	Master’s degree	41	9.9
	PhD	6	1.4
Have you received formal training in the automotive industry?	Yes	204	49.2
	No	211	50.8
Job scope	Government	113	27.2

	Private	111	26.7
	Freelance/ Self employed	71	17.1
	Student	120	28.9
Marital status	Single	241	58.1
	Married	174	41.9
	Others	-	-
Do you own a class D driving license?	Yes	403	97.1
	No	12	2.9
Driving experience (year)	≤ 2	89	21.4
	3 to 5	113	27.2
	6 to 10	68	16.4
	10 ≥	145	34.9
Type of car drive	Owned	368	88.7
	Rent	47	11.3
Frequency of driving in the city	Everyday	199	48.0
	Weekdays only	24	5.8
	Weekend only	81	19.5
	Drive if necessary	111	26.7
Frequency of driving on highways	Everyday	123	29.6
	Weekdays only	17	4.1
	Weekend only	98	23.7
	Drive if necessary	177	42.7
Have you ever been involved in	Yes	199	48.0

car accident while driving?	No	216	52.0

4.3 Reliability and validity of factors

Researchers typically employ questionnaires as a solution to quantify numerous aspects of the human factor that are not directly quantifiable. The analyzing model was created to evaluate convergent validity, discriminant validity, and indicator reliability. Initially, Cronbach's alpha and composite (CR) were determined for each factor to evaluate its reliability. The values above 0.8, as illustrated in Table 3.2, indicate that the factors are reliable. Furthermore, Cronbach's alpha is typically employed to assess the degree of observational consistency among distinct items within the same dimension, particularly when employing Likert scales. Then, convergent validity was evaluated using two criteria which are Average Variance Extracted (AVE) and loading. For each item, the standardized factor loading must be 0.6 or higher, and the AVE must be greater than 0.5 to be accepted.

In this case, Table 4.2 represents the analysis of the reliability and validity of six factors which are PE, EE, SI, FC, BI and UB. Each factor is measured using multiple scale items, with the results showing strong reliability and validity. Cronbach's alpha values, ranging from 0.95 to 0.993 indicate an excellent internal consistency for all factors. The CR values, all above 0.92, further support the reliability of the factors. In terms of AVE values, it ranges from 0.665 to 0.746, demonstrates adequate convergent validity for all factors. Additionally, the factor loadings for each scale item are high and range from 0.598 to 0.895, indicating that the items effectively measure their respective factors. To conclude, this table provides strong evidence for the reliability and validity of the measurement model used for this study.

Table 4.2 Reliability and validity of factors.

Factor	**Scale Item**	**Cronbach's Alpha**	**CR**	**AVE**	**Factor Loading**
Performance Expectancy	PE1	0.97	0.92	0.746	0.873
	PE2				0.875
	PE3				0.852
	PE4				0.878
	PE5				0.84
Effort Expectancy	EE1	0.993	0.93	0.738	0.84
	EE2				0.866
	EE3				0.876
	EE4				0.843
	EE5				0.87
Social Influence	SI1	0.976	0.94	0.713	0.853
	SI2				0.852
	SI3				0.844
	SI4				0.807
	SI5				0.864
Facilitating Conditions	FC1	0.969	0.93	0.665	0.794
	FC2				0.792
	FC3				0.849
	FC4				0.818
	FC5				0.823
Behavioral Intention	BI1	0.95	0.93	0.732	0.877
	BI2				0.86
	BI3				0.856
	BI4				0.845
	BI5				0.839
Use Behavior	UB1	0.971	0.93	0.688	0.878
	UB2				0.876
	UB3				0.895
	UB4				0.861
	UB5				0.598

4.4 Discriminant validity of the factors

Based on Table 4.3, it can conclude that the factor in this model demonstrates good discriminant validity of the factors according to the Fornell-Larcker criterion. The high diagonal values relative to the correlations between constructs indicate that the factors are distinct from one another and that the measurement tool is indeed measuring what it was designed to measure. This aligns with the study by (Henseler, Hubona, and Ray, 2016) and strongly supports the validity of the construct measurements that ensure both reliability and accuracy.

Table 4.3 Discriminant validity of the factors.

	PE	**EE**	**SI**	**FC**	**BI**	**UB**
PE	**0.839**					
EE	0.956	**0.857**				
SI	0.867	0.863	**0.867**			
FC	0.86	0.931	0.867	**0.85794**		
BI	0.9	0.895	0.821	0.864	**0.856**	
UB	0.795	0.802	0.812	0.896	0.826	**0.853**

Notes: PE, Performance Expectancy; EE, Effort Expectancy; SI, Social Influence; FC, Facilitating Conditions; BI, Behavior Intentions; UB, Use Behavior.

4.5 Summary of hypotheses development

According to Table 4.4, the hypotheses evaluate the impact of LDWS utilization on the perceptions and intentions of drivers in a variety of critical domains. Hypotheses H1,H2, and H3 investigate the impact of reliance on the LDWS on the perceived effectiveness of the system in preventing lane departures and notifying drivers of prospective departures, thereby addressing PE. Consequently, the impact of LDWS use on driving confidence is also considered in these hypotheses. They collectively propose that the belief in the effectiveness of the LDWS is strengthened by the consistent and increased use of the system. The concept of EE, which is the focus of the hypotheses H4 and H5, is centered on the perceptions of system accessibility and the effort necessary to respond to notifications. It is suggested that more frequent use results in stronger beliefs of accessibility and a reduction in effort.

Additionally, the hypotheses analyze the practical and social implications of the use of LDWS. H6 and H7 discuss the impact of LDWS use on social interactions and the influence of peer opinions, which is referred to as SI. H6 claims that the positive impact of peer opinions on LDWS perceptions is enhanced by consistent utilization, whereas H7 claims that increased use leads to more discussions about the LDWS benefits. The relationship between the perceptions of vehicle support and system reliability in various conditions and the use of LDWS is investigated in H8 and H9 which indicates FC. Therefore, the analysis of BI through H10 and H11 demonstrates a correlation between the use of LDWS and future intentions. This suggests that more frequent use is associated with stronger intentions to rely on and use the system.

In essence, these hypotheses collectively propose a framework wherein increased use and reliance on LDWS positively influence various perceptions and behavioral intentions, ultimately leading to greater acceptance and utilization of technology.

Table 4.4 Summary of hypotheses development.

Hypothesis			Estimate	Significant level	Support
Use Behavior	←	Performance Expectancy	0.795	Moderate	Accepted
Use Behavior	←	Effort Expectancy	0.802	High	Accepted
Use Behavior	←	Social Influence	0.812	High	Accepted
Use Behavior	←	Facilitating Conditions	0.896	High	Accepted
Use Behavior	←	Behavioral Intention	0.826	High	Accepted

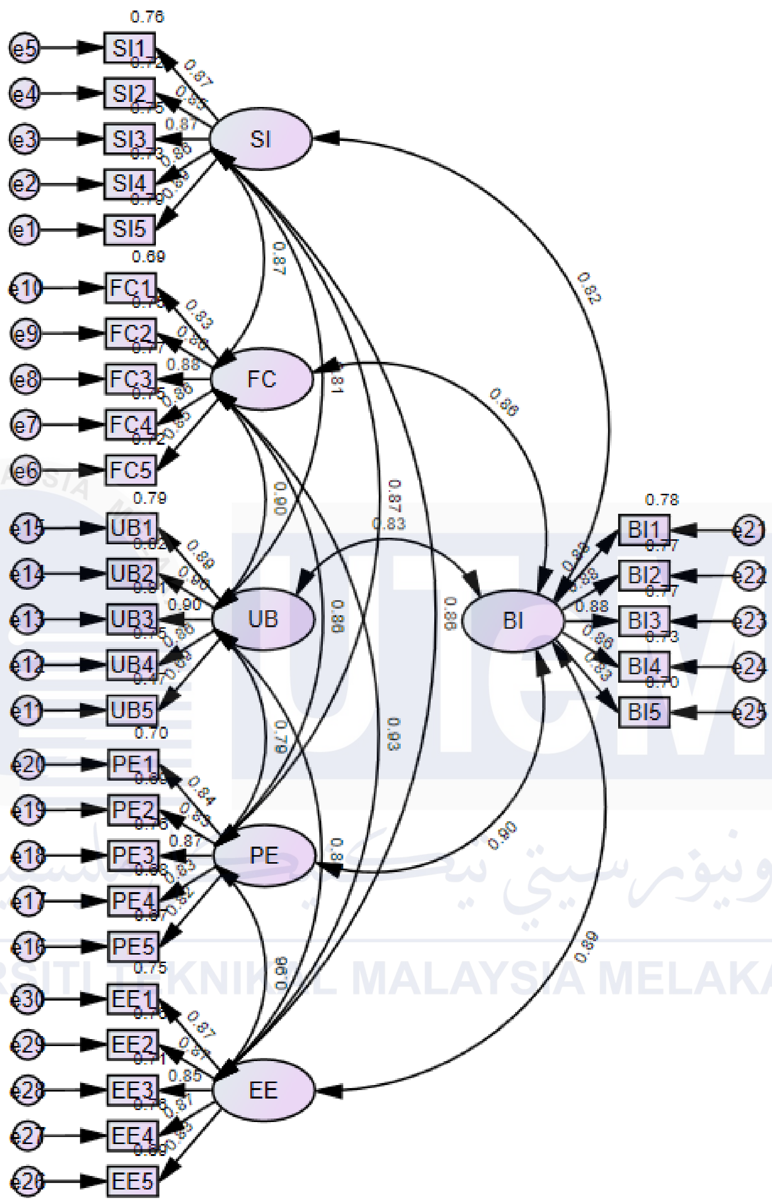
4.6 Structured model fit indices of the factors

The model fit was analyzed using fit indices, including the Goodness of Fit Index (GFI), Normed Fit Index (CFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square of Error Approximation (RMSEA), Chi-square /df, and chi-square. The primary discovery suggests that the model's fit is adequate, even though most of the indices do not exceed the threshold value of 0.9. They continue to satisfy the criteria of SEM analysis (Haron@shafiee et al., 2023).

Table 4.5 Goodness of indicators.

Name of Category	Fit Index	Level of acceptance	Full Measurement
Absolute fit	chi-square	P-value > 0.05	1651.318
	RMSEA	RMSEA < 0.08	0.088
Incremental fit	CFI	CFI > 0.90	0.91
	NFI	NFI > 0.90	0.886
	TLI	TLI > 0.90	0.90
Parsimonious fit	$\chi^{2/d.f}$	Chi-square/df < 3.0	4.234

Notes : RMSEA, root mean square of approximation; CFI, comparative fit index; NFI, normed fit index; TLI, tucker-lewis index; $\chi^{2/d.f}$. chi squared divided by degree of freedom.



Notes: PE, Performance Expectancy; EE, Effort Expectancy; SI, Social Influence; FC, Facilitating Conditions; BI, Behavior Intentions; UB, Use Behavior.

Figure 4.1 Structured model fit indices of the factors.

4.7 Correlation between factors

The Pearson coefficient is a type of correlation that indicates the relationship between two variables that are measured on the same interval or ratio scale. The Pearson coefficient is a matrix that is used to determine the intensity of a relationship between two continuous variables as shown in Table 4.6.

In this case, the Pearson correlation analysis demonstrates strong positive relationships between all pairs of variables, with most of the correlations are within the range of 0.8 to 0.95. This suggests that as one variable increases, the other tends to increase as well. For example, the correlation between PE and EE is impressive (0.956), while the correlation between FC and UB is 0.896. Moreover, all these correlations are statistically significant at $p < 0.001$ which indicates that the relationships are not the result of coincidence. The analysis is strong as each correlation is based on a sample size of 415.

Table 4.6 Correlation between factors using Pearson correlation.

		PE	EE	SI	FC	BI	UB
PE	Pearson Correlation	1	0.956	0.867	0.860	0.900	0.795
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
EE	Pearson Correlation	0.956	1	0.863	0.931	0.895	0.802
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
SI	Pearson Correlation	0.867	0.863	1	0.867	0.821	0.812
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
FC	Pearson Correlation	0.860	0.931	0.867	1	0.864	0.896
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
BI	Pearson Correlation	0.900	0.895	0.821	0.864	1	0.826
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001

	N	415	415	415	415	415	415
UB	Pearson Correlation	0.795	0.802	0.812	0.896	0.826	1
	Sig. (2-tailed)	0.001	0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415

Notes: PE, Performance Expectancy; EE, Effort Expectancy; SI, Social Influence; FC, Facilitating Conditions; BI, Behavior Intentions; UB, Use Behavior.

4.8 Significant factors of LDWS

Figure 4.2 shows a significant factor of LDWS that influenced public acceptance. The central focus is UB which represents the frequency of system usage. The arrows indicate that PE, EE, SI, FC and BI directly impact UB.

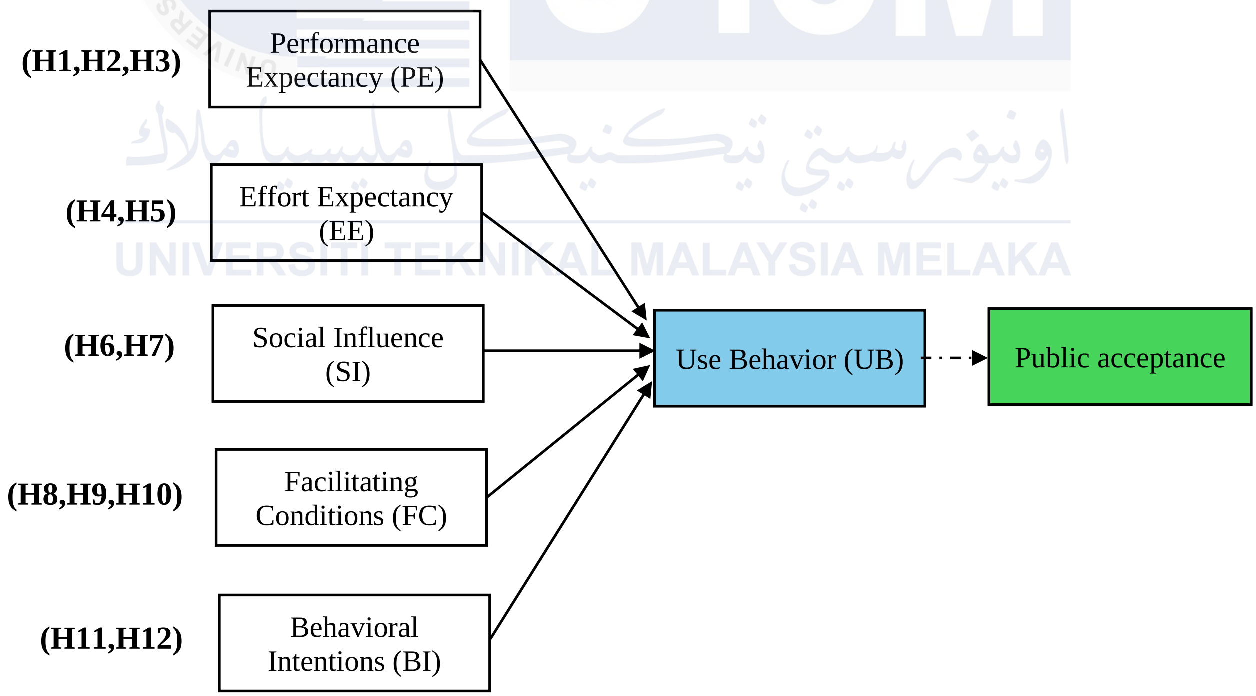


Figure 4.2 Significant factors of LDWS influenced public acceptance.

Essentially, the more positive the perceptions of drivers are regarding these factors, the more likely they are to actively use the LDWS. This means when a driver feels the system is effective, easy to use, well regarded by others, and well supported by the car as well as intending to keep using it, they are more likely to rely on it as represented in Table 4.7. This suggests a domino effect, where positive attitudes and perceptions across these key areas lead to greater reliance on the system.

Table 4.7 The factors influencing use of behavior.

Factors	**Explanation**
PE	This refers to the driver's perception of the system's benefits and efficiency greatly influences its use. Confidence in its ability to prevent lane departures and provide effective notifications increases the likelihood of implementation.
EE	This refers to the driver's perception of the system's user-friendliness. The likelihood of their utilization is increased when the system is straightforward to comprehend, operate, and respond to. It also refers to the system's ease of use and convenience.
SI	This refers to the extent to which the driver's decision to employ the system is influenced by the opinions of others. The driver may be more inclined to utilize it if it is recommended or discussed favorably by friends, family, or other drivers.
FC	The reliability of the vehicle and its ability to support LDWS influence driver utilization. Drivers are more likely to use vehicles with consistent system functionality, appropriate features, and reliable technical support for sustainable operation.
BI	This refers to the extent to which the driver intends to continue employing the system in the future. The extent to which they are currently utilizing the LDWS is influenced by their strong intention to continue using it in the future. It is contingent upon the driver's future willingness to utilize it.

4.9 Chapter summary

Using the UTAUT framework, the study analyzed the acceptance and use of LDWS. It shows a positive perception of PE, SI, and FC significantly increase drivers' intention to use and rely on LDWS. This promotes improved road safety. However, limitations such as the use of survey data that is subject to bias, limited demographic applicability, and lack of qualitative insights point to areas that require improvement. To provide more thorough understanding of LDWS implementation, the study recommends that future research should include longitudinal designs, real-world data collecting, and a more thorough investigation of psychological and environmental aspects.

Furthermore, recommendations center on user-centered design with clear interfaces and focused communication tactics can improve system usability and trust. Barriers to LDWS implementation may be overcome by placing a strong emphasis on thorough user training, demographic-specific communication, and consistent system reliability. Developing treatments to increase drivers' understanding and comfort with LDWS, resolving concerns about its limitations, and improving its long-term efficacy in a variety of circumstances should be the top priorities for future research and development.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

To conclude, this study highlights the critical importance of understanding drivers' interactions with LDWS. By using the UTAUT framework, the study identifies key factors such as PE, EE, SI, FC, BI and UB that affect drivers' implementation and dependence on LDWS. The findings emphasize that positive perceptions among these factors increase the system usage and acceptability.

In terms of PE, it refers to the belief that LDWS will increase driving safety and experience as well as accurate and real-time feedback of the effectiveness of the system. With EE, it relates to the system's usability which a simple and intuitive design minimizes learning requirements while ensuring drivers' comfort and trust. Meanwhile, SI highlights the role of social norms and peer influence, where positive perceptions from others can encourage the implementation.

Moreover, FC involves the availability of resources such as training, support, and upgrades to help ensure that the system operates as intended. Finally, BI predicts actual usage since drivers are more likely to utilize LDWS when their intentions are positive and impacted by the factors mentioned above. By addressing these factors, LDWS can be more widely accepted and relied upon, which automatically will increase road safety.

5.2 Limitation and future research

The study faces several limitations that may affect how reliable its findings. The use of self-reported survey data raises the possibility of response bias, which could reduce the capacity of data to fairly represent driving behaviors in the actual world. Furthermore, the applicability result to larger driving populations is limited by the demographic focus. Although Likert scales offered quantifiable and organized insights, the investigation of complex behaviors and perceptions about LDWS was limited. Additionally, the study did not thoroughly investigate environmental and psychological aspects that can affect the use of LDWS. Finally, the lack of qualitative techniques such as in-depth interviews reduced the depth of understanding regarding drivers' subjective experiences with the system.

Future study on LDWS should focus on longitudinal studies to observe how drivers' perceptions and behaviors change over time as they utilize the system. Drivers' interactions with LDWS may be better understood by combining quantitative and qualitative techniques such as focus groups or interviews, which can help identify both statistical patterns and individual experiences. Its worldwide applicability will also be improved by investigating demographic variations, which will help in identifying regional and cultural differences that affect LDWS acceptance (Zhang et al., 2024). To improve system design and communication tactics, research should also investigate psychological factors like risk perception and trust in automation. Lastly, a more precise and comprehensive evaluation of LDWS performance and its influence on driver behavior would be possible by combining real-world data from sensors with realistic research (Sagar, 2024).

5.3 Recommendations

To increase the implementation and effectiveness of LDWS, a user-centered design approach should be implemented by simplifying system interfaces to improve effort expectancy. It also includes integrating intuitive and easily interpretable notifications for a better user experience (Zhang et al., 2024). For maximum outreach and implementation, customized communication strategies should be created to target the demands of demographics and emphasize the advantages of LDWS such as preventing lane departures (Puphal et al., 2024).

In addition, social impact can be strengthened by using recommendations and testimonies from reliable people such as peers and automotive professionals in technology (Salazar, 2022). Also, enhancing performance in a variety of driving scenarios would assist that ensure system dependability and increasing user confidence in enabling circumstances (Salazar, 2022). Drivers should get thorough user training on the features and limitations of LDWS to encourage safe use as well as avoid over-reliance (Jha and Singh, 2024). Lastly, ongoing research and development should be focused on refining LDWS technology based on user feedback and addressing identified limitations to ensure wider and more effective implementation. Hence, it will also eventually contribute to safer driving environments.

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APPENDICES

APPENDIX A – Gantt Chart

ACTIVITY	WEEKS														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Data collection															
Learn software (AMOS etc.)															
Run on software															
Run on simulation															
Results data analysis															
Identify the factors influenced															
Conclusion															
Weekly e-Logbook															
Report progression															
Submission (Draft report, Technical report, Declaration form)															
Presentation															

PLAN	
ACTUAL	

APPENDIX B – Google Form Questionnaire – Section A : Demographics

[ENG] Survey On Vehicle ADAS Lane Keeping Awareness and Safety Improvements

t

Not shared

* Indicates required question

SECTION A : Demographics

Please answer the following questions about. Your responses only meant for categorisation purposes only.

A1 : Gender. *

- Male
- Female

A2 : Age. *

- 18-25
- 26-35
- 36-45
- 46and above

A3 : Race.*

- ○ Melayu
- ○ Cina
- ○ India
- ○ Others

A4 : Education level.*

- ○ SPM
- ○ Diploma
- ○ Bachelor's Degree
- ○ Master's Degree
- ○ Doctor of Philosophy (PhD)

A5 : Have you ever received formal training in the automotive industry*?

- ○ Yes
- ○ No

A6 : Job scope:*

- ○ Government servant
- ○ Private employee
- ○ Freelance / Self-employed
- ○ Student

A7 : Marital status:*

- ○ Single
- ○ Married
- ○ Other:

A8 : Do you have a Class D driving license?*

- ○ Yes
- ○ No

A9 : Driving experience:*

- ○ 2 years and below
- ○ 3 to 5 years
- ○ 6 to 10 years
- ○ More than 10 years

A10 : Type of car driven. *

- ○ Owned
- ○ Rent

A11 : Frequency of driving in the city. *

- ○ Everyday
- ○ Only on weekdays
- ○ Only on weekends
- ○ Drive if necessary

A12 : Frequency of driving on highways. *

- ○ Everyday
- ○ Only on weekdays
- ○ Only on weekends
- ○ Drive if necessary

A13 : Have you ever been involved in a car accident while driving? *

- ○ Yes
- ○ No

APPENDIX C – Google Form Questionnaire – Section C : LDW

[ENG] Survey On Vehicle ADAS Lane Keeping Awareness and Safety Improvements

* Indicates required question

SECTION C : Level of acceptance of the *Lane Departure Warning* system *(LDW)* using UTAUT analysis.

Please indicate your level of agreement or disagreement with the following statements on a scale of 1 (Strong Disagree) to 5 (Strongly Agree).

PERFORMANCE EXPECTANCY (PE) *

C1 : The LDW system is beneficial in improving my driving safety.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

PERFORMANCE EXPECTANCY (PE) *

C2 : The LDW system improves my overall driving performance.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

PERFORMANCE EXPECTANCY (PE) *

C3 : The LDW system is effective in preventing unintentional lane departures.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

PERFORMANCE EXPECTANCY (PE) *

C4 : My driving confidence on highways increases when using LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

PERFORMANCE EXPECTANCY (PE) *

C5 : The LDW system effectively alerts me to possible lane departures.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

EFFORT EXPECTANCY (EE) *

C6 : I have no difficulty understanding the operation of the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

EFFORT EXPECTANCY (EE) *

C7 : The LDW system is highly accessible.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

EFFORT EXPECTANCY (EE) *

C8 : The notifications and alerts provided by the LDW system are clear and automatic.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

EFFORT EXPECTANCY (EE) *

C9 : The LDW system can be easily activated or deactivated while driving.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

EFFORT EXPECTANCY (EE) *

C10 : Responding to notifications from the LDW system requires minimal effort.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

SOCIAL INFLUENCE (SI) *

C11 : The LDW system is recommended by my family and acquaintances.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

SOCIAL INFLUENCE (SI) *

C12 : There are other drivers whose opinions I respect who suggest that I implement the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

SOCIAL INFLUENCE (SI) *

C13 : My decision to employ the LDW system is influenced by the support of automotive experts.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

SOCIAL INFLUENCE (SI) *

C14 : I often discuss the benefits of the LDW system with other drivers.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

SOCIAL INFLUENCE (SI) *

C15 : The opinions from my peers have a positive impact on my perception of the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

FACILITATING CONDITIONS (FC) *

C16 : My vehicle is well-equipped to support the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

FACILITATING CONDITIONS (FC) *

C17 : I have access to technical support when I encounter problems with the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

FACILITATING CONDITIONS (FC) *

C18 : The LDW system operates consistently in any driving conditions.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

FACILITATING CONDITIONS (FC) *

C19 : The information provided by the manufacturer about the LDW system is sufficient.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

FACILITATING CONDITIONS (FC) *

C20 : I am able to easily locate and understand the user manual for the LDW system.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

BEHAVIORAL INTENTION (BI) *

C21 : I intend to use the LDW system every time I drive.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

BEHAVIORAL INTENTION (BI) *

C22 : I plan to use the LDW system frequently in the future.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

BEHAVIORAL INTENTION (BI) *

C23 : I am willing to recommend the LDW system to the other drivers.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

BEHAVIORAL INTENTION (BI) *

C24 : I am willing to rely on the LDW system for lane departure warnings.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

BEHAVIORAL INTENTION (BI) *

C25 : I prefer vehicles that equipped with the LDW system when purchasing a new vehicle.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

USE BEHAVIOR (UB) *

C26 : I frequently use the LDW system while driving.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

USE BEHAVIOR (UB) *

C27 : I consistently activate the LDW system on highways.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

USE BEHAVIOR (UB) *

C28 : I often use the LDW system in city driving.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

USE BEHAVIOR (UB) *

C29 : I rely on the LDW system for lane departure alerts.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

USE BEHAVIOR (UB) *

C30 : I deactivate the LDW system during bad weather conditions.

	1	2	3	4	5	6	7	
Strongly Disagree	○	○	○	○	○	○	○	Strongly Agree

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Tuan

PENGKELASAN TESIS SEBAGAI TERHAD BAGI TESIS PROJEK SARJANA MUDA

Dengan segala hormatnya merujuk kepada perkara di atas.

2. Dengan ini, dimaklumkan permohonan pengkelasan tesis yang dilampirkan sebagai TERHAD untuk tempoh **LIMA** tahun dari tarikh surat ini. Butiran lanjut laporan PSM tersebut adalah seperti berikut:

Nama pelajar: NUR LIYANA AMEERA BINTI AHMAD FAIRUZ (B092110092)
Tajuk Tesis: VEHICLE ADAS LANE DEPARTURE WARNING AWARENESS AND SAFETY IMPROVEMENT

3. Hal ini adalah kerana IANYA MERUPAKAN PROJEK YANG DITAJA OLEH SYARIKAT LUAR DAN HASIL KAJIANNYA ADALAH SULIT.

Sekian, terima kasih.

“BERKHIDMAT UNTUK NEGARA”
“KOMPETENSI TERAS KEGEMILANGAN”

Saya yang menjalankan amanah,

NAMA
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