VEHICLE ADAS LANE KEEPING ASSIST AWARENESS AND SAFETY IMPROVEMENTS

FAREEN FARHANNA BINTI ABDUL MANAN

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FAREEN FARHANNA BINTI ABDUL MANAN

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DECLARATION

I declare that this Choose an item. entitled "Vehicle ADAS Lane Keeping Assist Awareness and Safety Improvements" 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 :

Name : Fareen Farhanna Binti Abdul Manan

Date : 31 December 2024

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.

TS. DR. NOR AZAZI BIN NGATIMAN
Ketua Program Sarjana Muda Tek. Kej. Mekanikal
(Teknologi Penyelenggaraan)
Fakulti Teknologi Dan Kejuruteraan Mekanikal
Universiti Teknikal Malaysia Melaka (UTeM)

Signature : ....

Supervisor Name : Ts. Dr. Nor Azazi Bin Ngatiman

Date : 1 January 2025

DEDICATION

This thesis is devoted to my wonderful parents, whose dreams of continuing their own education were halted, yet those whose unwavering support and encouragement have been my greatest source of inspiration. Your immense sacrifices, tireless hard work, and strong faith in the value of education have profoundly shaped my journey. I am deeply and eternally grateful for the countless opportunities you have afforded me to pursue my dreams.

ABSTRACT

Lane Departure Warning (LDW) and Lane Keeping Assist System (LKAS) are advanced driver assistance technologies that enhance vehicle safety and prevent unintentional lane departures. Vehicles that are moving out of the lane without their turn signals on can be detected by the cameras, sensors and onboard computers in the systems. LDW systems provide the driver with visual, audible, or haptic (vibration) warning when the vehicle departs from its designated lane, also enabling the driver to redirect the vehicle. LKAS extend their capabilities by autonomously applying steering or braking inputs to assist in maintaining the position of vehicle within the lane. This study aims to determine Malaysian awareness of the LKAS. All the factor in this research is adaption Unified Theory of Acceptance and Use of Technology (UTAT) for ADAS vehicles. In this model consist of performance expectancy, effort expectancy, social influence, facilitating conditions, behavioural intention and Use behaviour. Public awareness could be predicted through the factor had been developed. A survey of 415 participant was conducted in Malaysia and the data were analysed using g Statistical Package for the Social Sciences (SPSS) and Structural Equation Modelling (SEM) to find the relationship of the hypothesis, correlation, and regression. The result of this study suggests that behavioural intention, facilitating conditions, social influence, performance expectancy and effect expectancy influence public awareness. This study proves that the significant of factors which contribute in order to identity the awareness level of LKAS are behavioural intention (0.847) and facilitating conditions (0.833). The finding of this study provides useful information to government. researchers and practitioners interested in increasing user awareness of ADAS vehicle in the future.

ABSTRAK

Sistem Amaran Pelepasan Lorong (LDW) dan Sistem Bantuan Menjaga Lorong (LKAS) ialah teknologi bantuan pemanduan termaju yang meningkatkan keselamatan kenderaan serta menghalang sekiranya kereta terlepas dari garisan lorong jalan raya yang tidak disengajakan. Kenderaan yang bergerak keluar dari lorong tanpa isyarat membelok boleh dikesan oleh kamera, alat pengesan, dan komputer di dalam system. Sistem Amaran Pelepasan Lorong (LDW) memberikan pemandu amaran secara visual, pendengaran atau haptic (getaran) apabila kenderaan terlepas dari lorong yang ditetapkan juga membolehkan pemandu mengubah hala kenderaan. Sistem LKA dapat meningkatkan keupayaan dengan menggunakan input stereng atau brek secara autonomi bagi membantu mengekalkan kedudukan kenderaan di dalam lorong. Kajian ini bertujuan untuk menentukan kesedaran rakyat Malaysia terhadap LKAS. Kesemua faktor dalam penyelidikan ini adalah penyesuaian daripada model Teori Penerimaan dan Penggunaan Teknologi Bersepadu (UTAUT) untuk kenderaan ADAS. Dalam model ini terdiri daripada jangkaan prestasi, jangkaan usaha, pengaruh sosial, keadaan yang memudahkan, niat tingkah laku dan tingkah laku pengguna. Kesedaran orang ramai boleh diramalkan melalui faktor yang telah dibangunkan. Tinjauan terhadap 415 peserta telah dijalankan di Malaysia dan data dianalisi menggunakan Statistical Package for the Social Sciences (SPSS) dan Structural Equation Modelling (SEM). Hasil kajian ini mencadangkan bahawa niat tingkah laku, keadaan memudahkan, pengaruh sosial, jangkaan prestasi dan jangkaan kesan mempengaruhi kesedaran orang ramai. Kajian ini membuktikan bahawa faktor signifikan yang menyumbang untuk mengenal pasti tahap kesedaran LKAS ialah niat tingkah laku (0.847) dan keadaan memudahkan (0.833). Dapatan kajian ini memberi maklumat berguna kepada Kerajaan, penyelidik dan pengamal yang berminat untuk meningkatkan kesedaran penggunaan kenderaan ADAS pada masa hadapan.

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Finally, I want to thank myself for surviving through the degree journey. I solemnly honor myself for the self-compassion I have practices, adapt and remain committed to my personal and professional growth. This thesis meaningful to me as reminder to continue striving for excellence.

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LIST OF SYMBOLS AND ABBREVIATIONS

ADAS	Advanced Driver Assistance Systems
Ai	Artificial Intelligence
AMOS	Analysis of Moment Structures
DAQ	Data Acquisition
EEG	Electroencephalography
EPS	Electric Power Steering
FFA	Force Fedback Actuator
ft	Feat
HMI	Human Machine Interface
IBM	International Business Machines
IP	Imaging Processing
LDW	Lane Departure Warning
LKAS	Lane Keeping Assist System
MIIT	Ministry of Industry and Information Technology
NCAP	New Car Assessment Program
NHTSA	National Highway Traffic System Administration
SAE	Society of Automotive Engineer
SPSS	Statistical Package for the Social Sciences
SEM	Standard error of the mean
UNECE	United Nation Economic Commission for Europe

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CHAPTER 1

INTRODUCTION

1.1 Background

To improve road safety and prevent accidents, this system involves a variety of active safety features (Carsten et al., 2023). ADAS utilizes sensors such as radar and cameras to detect its surroundings and provide the information to the driver based on its findings. (Gouribhatla & Pulugurtha, 2022) Even while Advanced Driver Assistance Systems (ADAS) have a lot of potential to improve driving conditions and road safety, as the market grows quickly, a number of important issues are starting to surface. Driver complacency and overreliance are becoming major concerns as drivers may become dependent on ADAS capabilities and neglect safe driving procedures (Gouribhatla & Pulugurtha, 2022) . Because ADAS are meant to support drivers, not to take their place, and because it is important to recognize their limitations, this risk exists (Palac et al., 2021).

The fact that technology is developing quickly and that drivers might not be completely aware of the advantages and disadvantages of the newest systems contributes to the situation. Developing approaches that inform drivers about ADAS technology, encourage appropriate use, and highlight the value of continuing to be an engaged driver even when utilising technological support systems is critical (Capodieci et al., 2021).

1.2 Problem Statement

Malaysia is a rapidly developing country with potential for future technological growth. The development and deployment of effective Advanced Driver Assistance Systems (ADAS) rely heavily on understanding how drivers perceive and interact with the technologies. A significant gap exists in people understanding of driver awareness and attitudes towards Lane Keeping Assist Systems (LKAS) are crucial components in ADAS (Adnan et al., 2018). Besides, some people did not realize that they are having and using LKAS in the vehicles.

As the use of lane-keeping assist system expands day by day, there is still major concern in understanding how different driver demographics may be influenced. For instance, age, gender, driving experience and cultural background all have significant effects on driver behavior, trust and adaptability towards ADAS features (Wang et al., 2020). The design and implementation of LKAS may have unexpected results for demographic groups if this diversity is neglected to be considered. This can lead to fear about safety, decreased efficacy, and resistance to implementing the potential advantages of technology.

1.3 Research Objective

The main aim of this research is to increase the awareness of LKAS among people either in rural or urban areas, and also to improve the LKAS safety. Specifically, the objectives are as follows:

a) To design and develop research instrument (questionnaire).
b) To conduct survey data collection on factors influencing driver trust and reliance based on real drive experiences.
c) To analyse survey data of evaluating the impact of LKA on driver behaviour and safety.

1.4 Scope of Research

The scope of this research are as follows:

a) Determine the relation between Malaysian acceptance of LKAS in the vehicles.
b) Determine the trust and preparation on LKAS usage.
c) Conduct surveys and focus groups to gather data on driver experiences and perceptions of LKAS.
d) Analyse accident data before and after the implementation of LKAS in various vehicle models.
e) Investigation of combination effects of integrating LKAS with other ADAS features on overall vehicle safety.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

In today’s modern society, safety systems in vehicles are identified as key strategies to optimize driving behavior, reduce environmental impact through features such as lane keeping assist and traffic sign recognition. Human factors and psychology are putting greater emphasis on finding ways to reduce road accidents which are stated by Paliotto et al. (2022). For systematic planning and evaluation of driver’s awareness of ADAS lane keeping assist system, it is important to develop effective strategies to evaluate the impact of the driver behavior and the effectiveness of preventing accident correctly and efficiently in the system (Dangisso, S. S., 2023). With comprehensive and precise information, challenges and limitations associated with implementation can be planned and executed correctly, and in a timely and effective manner.

2.2 Driver Awareness and Engagement

Lane Keeping Assist System devices are meant to make driving safer which require a lot of attention and involvement from the driver. According to research, these technologies might cause automation bias and complacency that would reduce situational awareness and driver attention (Perrozzi et al. 2023). According to Taylor et al. (2023), drivers' trust and reliance on lane-keeping systems are influenced by various factors, including perceived usefulness, system dependability, and personal driving preferences. The driver's comprehension of the system capabilities and limits must be strengthened for safe and efficient operation. Individualised training was used by Rath et al. (2019), to obtain automated features. A comprehensive strategy that considers system architecture, driver education, and government initiatives is generally necessary to maximise the benefits of lane-keeping systems while minimising potential risks.

2.3 Human Factor and User Experience

In order to design LKA systems which are user friendly and efficient, it is important to consider human aspects and experience. Research has explored the human-machine interface (HMI) design of LKA has impact on user experience (Lee & Lee, 2019). According to the studies, it is critical that drivers react appropriately to LKA alerts and interventions in various driving scenarios. The user trust and acceptance of a system can be significantly influenced by several aspects, including its responsiveness, predictability, and intuitiveness (Slater & Doyle, 2018). Moreover, driver behavior such as reaction times and response accuracy play a significant role in LKA effectiveness (Kim & Lee, 2017). Studies have revealed the possibility of drivers becoming comfortable and relying excessively on LKA, which could result in a reduction in concentration and a compromise in safety (Parasuraman & Riley, 2017). This emphasizes the requirement for technologies that support acceptable levels of automation while encouraging driver engagement.

2.3.1 Human Machine Interface Design

Driver acceptability and the efficiency of the LKA systems are significantly impacted by the design of the HMI. Research emphasizes the significance of thoughtfully created alerts and feedback systems, such as auditory alerts that provide relevant details without being distracting and visual signals like Lane Departure Warnings (LDW) system and steering wheel vibrations as shown in Figure 2.1 (Nunes et al. 2020). Haptic feedback can improve auditory and visual signals by offering minor directional assistance, such as experiences in the steering wheel (Kim & Lee, 2017). Drivers should be able adjust the system and change the sensitivity and control levels through the HMI because it promotes user trust (Parasuraman & Riley, 2017).

To determine user acceptance, trust, and overall system effectiveness, it is important to investigate how drivers engage with lane keeping alerts and interventions in various driving conditions. As of 2019, several facets of the driver LKA interaction have been studied in research, presenting insights into the challenges of human-machine cooperation in dynamic driving settings.

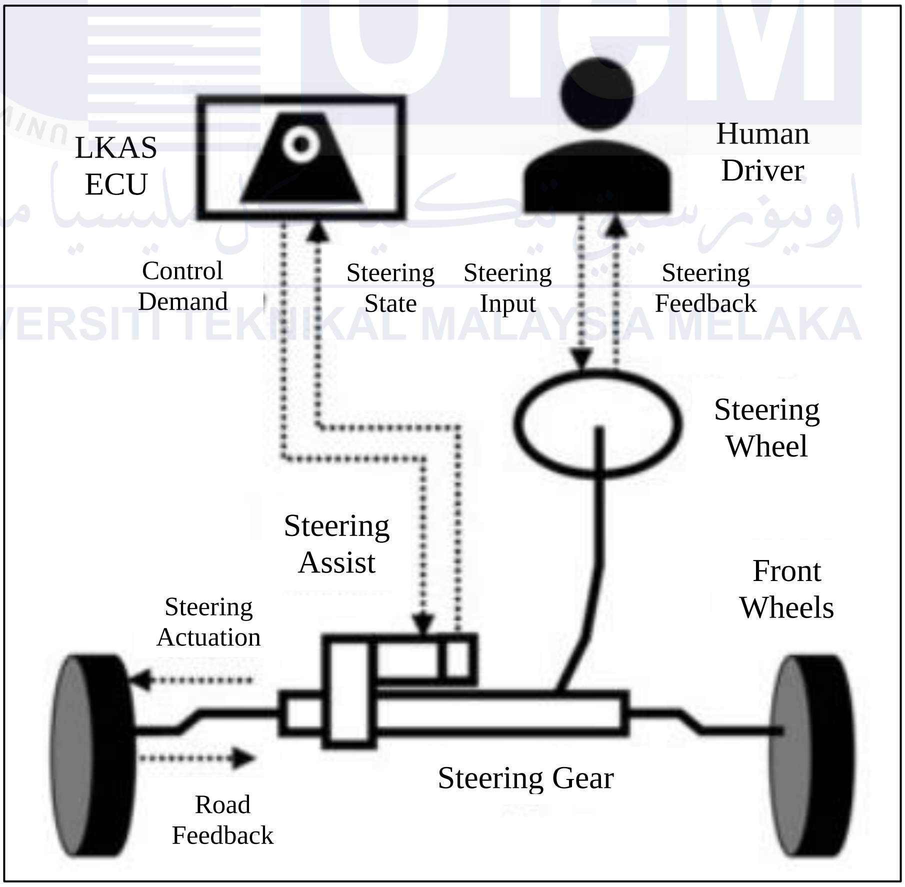


Figure 2.1 Steering feel of LKAS

2.3.2 Driver Response to Alerts

Based on the research, it stated that there are variety of situations which influence the drivers respond towards lane keeping (Nunes et al., 2020). Besides, the different drivers react differently depending on the kind of alert which includes how serious the situation is, and the traits of each individual driver. For instance, drivers may respond aggressively to audio alarms compared to visual ones, and their reactions may be impacted by the level of driving experience and LKA familiarity (Lee & Lee, 2019).

2.4 Mechanism and Evolution of LKA Systems

In recent years, the LKA systems experienced major improvement due to the advancements in artificial intelligence, image processing, and sensor technology. LKA systems mostly used monocular cameras for vision-based lane recognition during 2018. Even though it was cheap, this method had problems when lighting was not good and road signs were not maintained (Alazzawi et al., 2023). According to (Wei et al., 2023), they are working on making lane detection algorithms better, identifying the types of sensors such as stereo cameras for better depth perception, and looking into different ways to warn drivers, like using audio, visual, and haptic feedback.

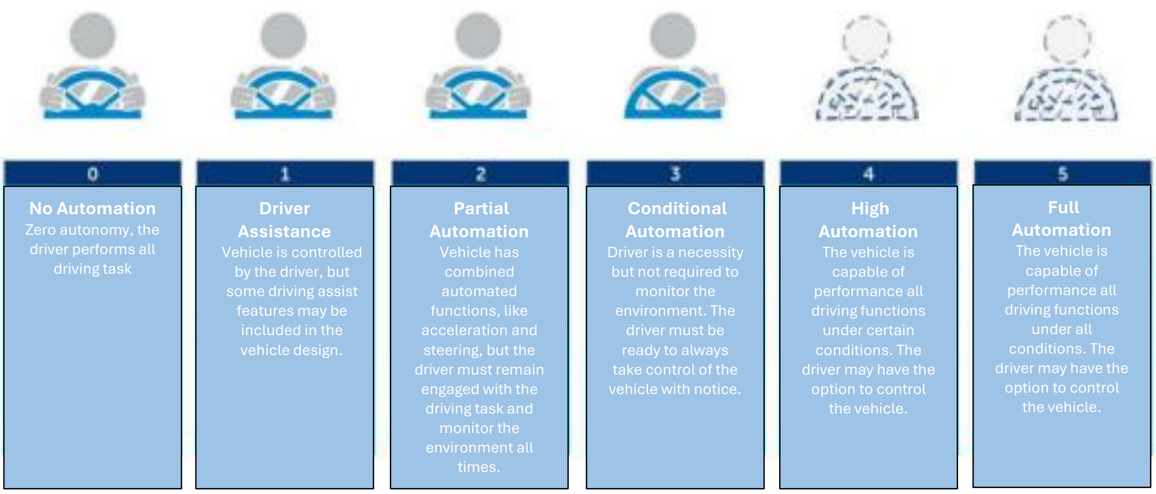


Figure 2.2 ADAS system automation level

Based on figure 2.2, it shows the amount of automation recommended by The Society of Automotive Engineers (SAE). It starts from fully operational by driver the advanced level which optional for the driver to control the vehicle in terms of ADAS.

Also, the accuracy and dependability of LKAS systems have been improved by using LIDAR, which stands for Light Detection and Range. Three-dimensional mapping and radar for finding objects make this combination work. Furthermore, the utilization of Artificial Intelligence (Ai) and machine learning algorithms facilitates the identification of unclear or damaged road markings through robust lane detection.

2.5 Driving Simulator of LKA Scenario

The driving simulator, as Figure 2.3 shows the realistic and quality have advanced significantly in the last few years. To effectively assess LKA systems, (Jami et al., 2022)emphasized that the requirement of simulations is highly detailed in mimicking real driving circumstances. It shows that realistic simulations could provide reliable data on system performance and driver behavior which are essential for the development of LKA systems efficiently.

Figure 2.3 The driving simulator

A wide range of difficult and variety scenarios have been also developed recently for LKA testing in simulators. To assess the durability of LKA systems, an extensive collection of scenarios including different weather, road types, and traffic situations which constructed by Wei et al. (2023). Based on the findings, it showed that through scenarios testing in simulators it is possible to find system faults that might not be obvious in routine road tests.

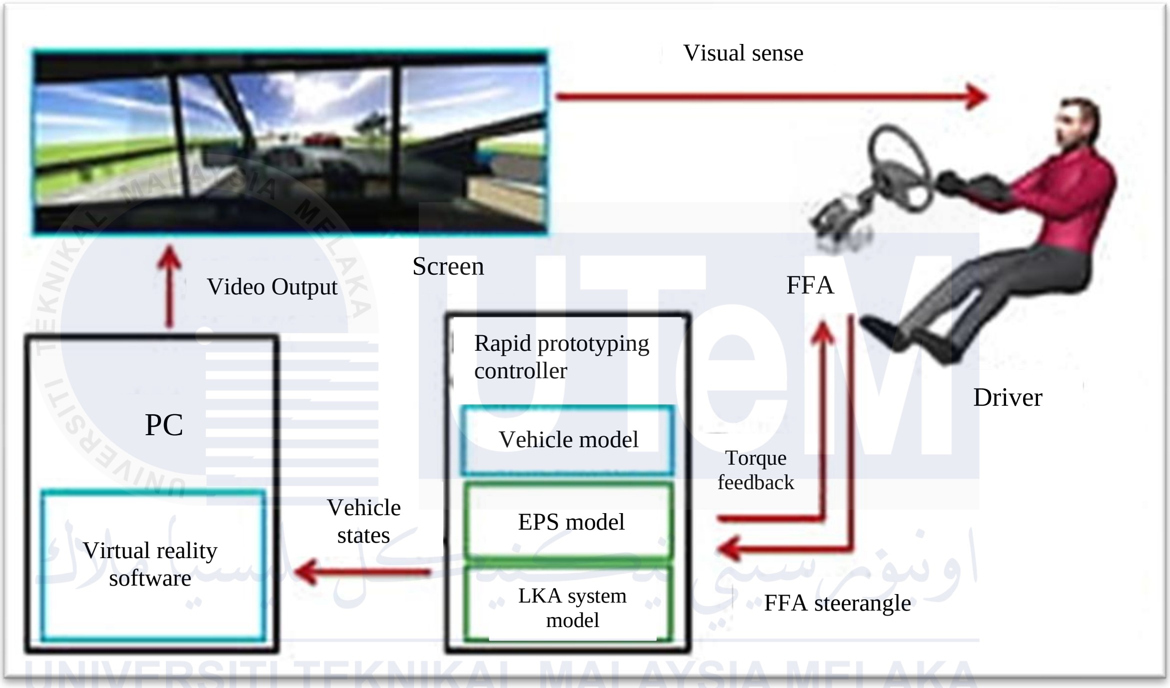


Figure 2.4 Example of LKAS simulation flow

Chen et al. (2024) carried out the simulation flow based on Figure 2.4 by using a driving simulator with fixed bases. There are three primary parts are a computer with a screen for creating virtual reality environments and simulating traffic flow, a steering feedback simulation device made up of a Steering-Force-Fedback Actuator (FFA) system, a fast-prototyping controller for vehicle dynamics, an EPS model and LKA controller computations.

2.5.1 Innovations In Image Processing and Computer Vision

LKAS heavily rely on image processing and computer vision techniques to perceive lane markings and guide vehicles safely within their lanes. The process of processing images using digital computers is known as image processing or computer vision (Abdel-Aty et al., 2023). Otherwise known as IP. This approach can be used to collect significant data from images using algorithms for enhancing image quality. These techniques have been improved in LDW systems technology using multiple cameras with a wider field of view, which provides more comprehensive coverage of the road ahead (Al Noman et al., 2023). The high-resolution picture feature of these cameras allows them to identify and track lane markers even in difficult situations.

Camera technology provides an image processing control module (J851) which the purpose is to process the image such as Toureg front used by Volkswagen. The camera control module (J852) controls the process images and sends the image information through a fast low voltage differential signaling (LVDS) line. In addition, the Toureg camera reduces stopping distance by 196 ft ir 60 meters, provides lane assistance by 262 ft or 80 meters, and indicates traffic sign recognition. Figures 2.5 and 2.6 represent the Toureg front camera and how the operations.

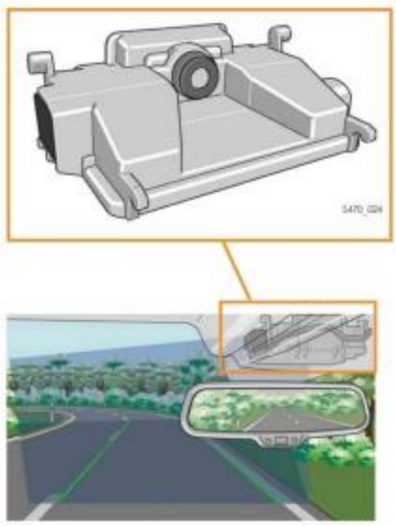


Figure 2.5 Toureg front camera

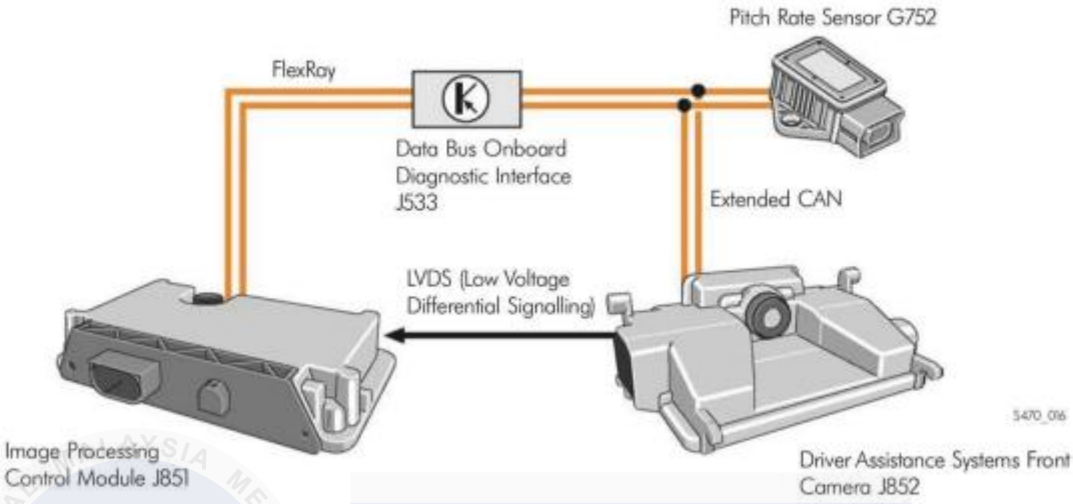


Figure 2.6 Toureg front camera systems

2.6 Regulatory and Ethical Consideration

LKAS have become more common in modern vehicles which provide essential support for drivers through helping them stay within the lane and prevent unintended lane departures (Ameta & Mathur, 2023). Despite the existence of worldwide standards such as in Figure 2.7 shows UNECE Regulation No. 157 and SAE J3164, which offer guidance on performance requirements and testing, achieving standard in the system continues to be a challenge. Other than that, LKAS has the potential to greatly improve road safety, there are important ethical and regulatory concerns that need to be thoroughly investigated before its use. Also, the ethical problem concern drivers excessively relying on the system, the potential for system malfunctions and the privacy implications of gathering data on driver activity, which also create a challenge (Wei et al., 2023).

Additionally, the protection of sensitive data from hacking or improper use is of essential importance, as LKAS is in the process of collecting it on a continuous basis. A comprehensive literature study that addresses ethical issues, data privacy issues, legal frameworks, and emerging trends will be beneficial in enhancing comprehension of the complexity of LKAS and its influence on driving practices, road safety, and data privacy (Alazzawi et al., 2023).

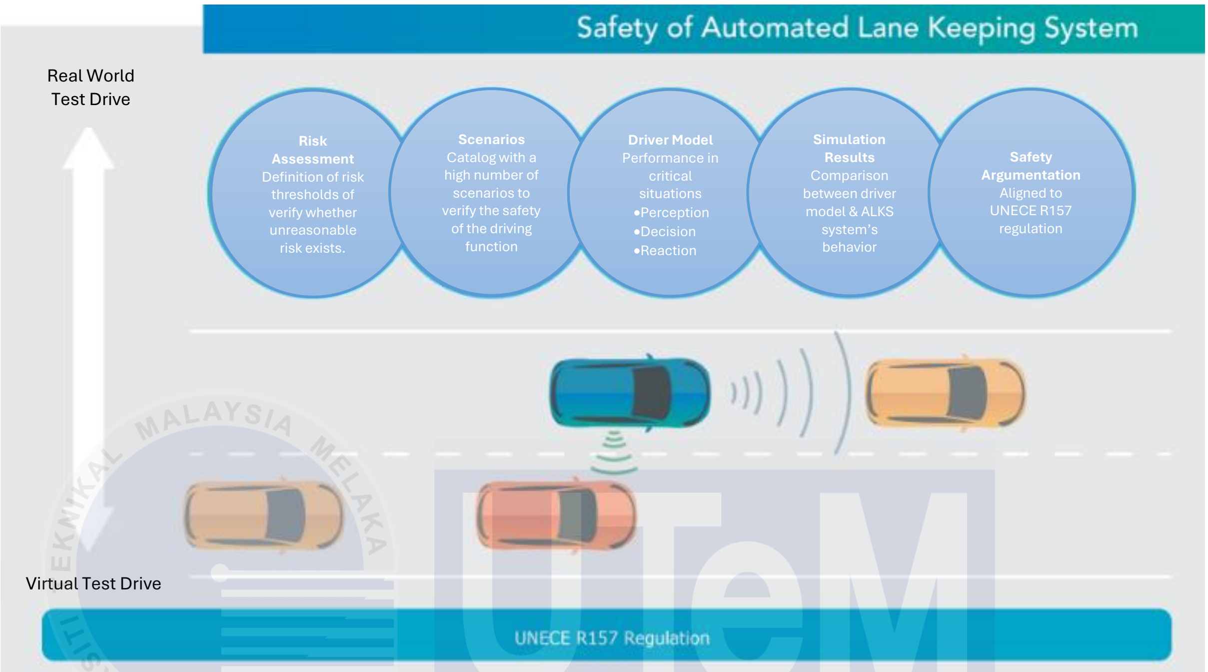


Figure 2.7 UNECE Regulation No. 157 on safety lane keeping assist system

2.6.1 Current Regulations and Standards for LKAS

The regulatory landscape for LKA is dynamic and varies across regions. In order to guarantee the safe and responsible deployment of LKA technologies, numerous countries and regions have implemented regulations and standards. Ameta & Mathur, (2023) emphasize the importance of global cooperation and alignment in ensuring the effectiveness and safety of these systems. The list of countries and regions implement the rules and regulations in LKAS technology shown in Table 2.1.

Table 2.1 List of countries and regions that have implemented rules and regulations in LKA technologies.

No.	Country or Region	Rules and Regulations
1	China	• Implementation by the Ministry of Industry and Information Technology (MIIT) • The nation is dedicated to the development of ADAS technologies, and these regulations incorporate a wide range of vehicle safety concerns. • The government prioritise on the collaboration between regulatory organisations and industry associate to promote safety and innovation.
2	European Union (E.U)	• The European New Car Assessment Programme (Euro NCAP) promotes the implementation of ADAS features, which are evaluated to comply with safety standards. • The European Union has established regulations for autonomous driving systems that establish guidelines for testing and implementation.
3	United States (U.S)	• National Highway Traffic Safety Administration (NHTSA) is responsible for the regulation of ADAS. • A selection of safety standards and recommendations address specific ADAS components, with a significant emphasis on testing and validation procedures to ensure implementation to safety regulations.

2.6.2 LKAS Regulation Challenges and Prospects

The regulatory framework associated with Lane Keeping Assist Systems (LKAS) is complex and causes many issues. Clear and standardised performance measurements for systems using varied algorithms and sensor technologies are a major challenge (Ameta & Mathur, 2023). Due to numerous manufacturers and technological progress, ensuring transparency and driver awareness of LKAS capabilities and standardising communication techniques across systems is difficult. LKAS operations collect and process sensitive data, therefore regulatory frameworks must address cybersecurity and data privacy issues to secure user data (Benyahya et al., 2022). Compatibility and integration with other ADAS systems and adjusting LKAS for changing road conditions, weather, and lighting are tough. However, these limits may encourage safety features by creating frameworks that encourage manufacturers to develop LKAS technology, improving road safety which stated by Thomas Rosenstatter (2019).

LKAS regulation offers promising road safety and autonomous driving opportunities. Ameta et al., (2023) determined that the harmonised international regulations could improve standardisation and testing. Analysing real-world driving data can improve system performance and highlight opportunities for improvement. Public education and awareness help drivers trust LKAS and understand its capabilities and limitations. Sensor technologies, machine learning, and AI can increase system performance, object detection, lane recognition, and driver aids. Automobile manufacturers, technology providers, research institutes, and government agencies can work together to design and execute reliable Lane Keeping Assist Systems. These opportunities may help the regulatory framework securely and responsibly integrate LKAS into the driving ecosystem (Thomas Rosenstatter, 2019).

2.6.3 Ethical Issues Involving LKAS

A strong ethical framework is essential to the development of LKAS because it is a key step towards autonomous driving. These technologies have the potential to improve road safety and driver experience, but usage raises several ethical issues that must be considered (Martinho et al., 2021). Ethical considerations are essential to the proper development and implementation of LKAS technology, from system design equality to privacy and biases.

First, ethical issues highlight liability, which is legal and financial responsibility for system accidents or failures. This includes the manufacturer's responsibility to ensure system safety and reliability, the driver's responsibility to maintain control and attention despite system assistance, and potential shared liability if system failure and driver negligence cause an incident (Luparev et al., 2023). It also incorporates insurance coverage, risk assessment, and culpability and expense allocation in the event of an accident.

Next, LKAS raises ethical concerns about performance and implementation shortcomings. Inclement weather or poorly marked roads could cause system failures and increase accident risk; therefore, system reliability and accuracy are the major concerns (Perrier et al., 2021). Due to concerns about driving complacency and LKA overuse, this may impair driver alertness and reaction times. Since the driver, car manufacturer, or software developer may be at fault in accidents, accountability is also important.

Last but not least, in developing LKAS requires a strong ethical framework to meet its lots of barriers. These technologies can improve road safety and driver experience, but liability, system performance, and driver behaviour must be considered to enable responsible and appropriate use. Developing public confidence and maximising LKAS technology's beneficial social impact requires a holistic approach that combines innovation and ethics.

2.6.4 Data Privacy and Security Concerns

The deployment of LKAS raises significant concerns regarding data privacy and security (Ma et al., 2021). These systems gather extensive quantities of data on driving behaviour, encompassing location, speed, steering habits, and even driver reaction times. Although the purpose of collecting and storing this data is to improve system performance and safety, there are concerns about the possibility of it being misused. There are worries about data breaches that may reveal sensitive information, which could result in identity theft or the use of driving habits for targeted advertising or insurance pricing (Wei et al., 2023). Moreover, the absence of clarity regarding the methods for obtaining data and the possibility of government or corporate monitoring give rise to moral and legal circumstances. This demands strong measures and user agreement procedures to guarantee the responsible handling and safeguarding of this valuable personal data (Costantino et al., 2023).

2.6.5 Future Regulatory Trends and Implications

LKAS will have a future interconnected with changing legal trends meant to strike a balance between innovation and safety and ethical issues (Alazzawi et al., 2023). Regulatory organisations are increasingly focusing on standardised LKAS performance testing processes that account for a wide range of driving circumstances and scenarios. This will urge manufacturers to create more dependable and strong systems, therefore fostering better public confidence and safety (Alkhaiwani & Alsamani, 2023). Moreover, rules are probably going to solve issues related to data privacy and security, such requiring strong cybersecurity measures to safeguard private driving data, data shielding methods, and straightforward user consent practices (Sharma et al., 2023). Regulators will have to handle accountability and responsibility as LKAS technology get more advanced, so perhaps creating frameworks that define the duties and obligations of drivers, manufacturers, and software developers in the case of accidents. These improvements to the law will help LKAS technology's future course to be shaped such that innovation reflects ethical values and benefits the community.

2.7 Summary Table

Table 2.2 Summary of previous research findings

No.	Author	Title of Project	Research Findings
1	(Paliotto, et al. 2022)	Human Factors in Road Design	It focuses on the psychology and human factors during driving vehicles.
2	(Dangisso, S. S., 2023)	Effect of Human Factors on Road Traffic Accidents	Study the human factors which can lead to road traffic accident such as fatigue.
3	(Perrozzi, et al., 2023)	Driver Assisted Lane Keeping with Conflict Management Using Robust Sliding Mode Controller	Determine cooperative control strategy to minimise conflict between driver and autonomous controller.
4	(Taylor et al., 2023)	Reliable and transparent in-vehicle agents lead to higher behavioural trust in conditionally automated driving systems	It studies on driver trust towards LKAS influenced by perceived usefulness and dependability.
5	(Rath et al., 2019)	Personalised lane keeping assist strategy: adaptation to driving style	Personalised lane keeping assist strategy with driver-specific adaptation for maximizing benefits and minimizing risks in systems.
6	(Lee & Lee, 2019)	A study on the usability and safety of lane keeping assist systems based on driver behaviour and eye movement analysis.	Utilize Human Machine Interface (HMI) to identify the influence towards LKAS.

7	(Slater & Doyle, 2018).	Trust and Acceptance on Lane Keeping Assistance Systems	Review of several aspects which can gain driver's trust and acceptance of LKAS.
8	(Kim & Lee, 2017)	Effects of driver behaviour on the effectiveness of lane keeping assistance systems	The investigations about driver behaviour such as reaction times and response of the driver during unintentionally lane changing.
9	(Parasuraman & Riley, 2017)	Automation bias: A review of the literatures.	The approach of concentration and compromise in safety based on driver's condition.
10	(Nunes et al., 2020)	User experience in advanced driver-assistance systems	Summary of the previous research about different situations give variety experience to driver while using LKAS.
11	(Alazzawi et al., 2023)	A lightweight security and key agreement protocol based on an identity for vehicular communication	Review of LKA systems improved with Ai, image processing, sensor technology advancement
12	(Wei et al., 2023)	Ongoing Research in Assessment Methods for LKAS	Investigation of making lane detection algorithms better by improve the usage of sensor.
13	(Jami et al., 2022)	Augmented Driver Behaviour Models for High-Fidelity Simulation Study of Crash Detection Algorithms	Utilize the simulations which mimicking the realistic experience driving of using LKAS.
14	(Chen et al., 2024)	A Method to Develop the Driver-Adaptive Lane-Keeping Assistance System Based on Real Driver Preferences	Analyse the simulation flow of driving simulator with fixed bases of LKAS.

15	(Abdel-Aty et al., 2023)	Advances and Applications of Computer Vision Techniques in Vehicle Trajectory Generation and Surrogate Traffic Safety Indicators.	Summary the process of processing images using digital computers.
16	(Al Noman et al., 2023)	A computer vision-based lane detection technique using gradient threshold and hue-lightness-saturation value for an autonomous vehicle.	Review the method to collect data from images using algorithms for enhancing image quality with a wider field of view.
17	(Ameta & Mathur, 2023)	Pratibodh Advanced Driving Assistance Systems	Summary of the implementation and responsible of LKA regulation in variety of countries.
18	(Thomas Rosenstatter, 2019).	Standardised Framework of Securing Connected Vehicle	Factors that influenced ADAS system (LKAS) in terms of compatibility and framework that encourage manufacturer to develop LKAS technology.
19	(Martinho et al., 2021)	Ethical issues in focus by the autonomous vehicles industry	Analysis of ethical framework is essential to the development of Lane Keeping Assist Systems (LKAS) towards autonomous driving.
20	(Luparev et al., 2023)	Principles of legal liability of owners (proprietors) of vehicles equipped with components of artificial intelligence	Review the manufacturer role to ensure the system are in safety and reliability, the driver's responsibility.

2.8 Research gap

The knowledge of drivers regarding functionality, limitations, and appropriate interaction with LKAS is significantly lacking. This problem needs to be fixed by studying how to communicate clearly so that people can believe the system (Brown et al., 2021). In order to optimize the effectiveness of LKAS, it is essential to implement customized communication strategies that account for these individual differences. Also, the way LKAS alerts are made and when they are sent has a big effect on how aware and responsive drivers are (Chen et al., 2024). For effective warnings without distraction or overwhelm, optimize alert design, frequency, and intensity.

From literature, when an LKAS notice is received, drivers respond in a variety of ways, from immediately correcting the driver to ignoring the warning. Optimizing system design requires an understanding of the variables impacting driver response, such as individual variations, situational context, and alert characteristics. Although lane-keeping performance can be enhanced by LKAS, there are worries about unexpected consequences such as increased driver workload or complacency. It is necessary to conduct research on the overall effects of LKAS on driving performance, safety, and behavior. Moreover, additional research is necessary to fully understand the impact of long-term LKAS exposure on driver awareness and behavior (Taylor et al., 2020). It is fundamental to conduct research on potential adaptability, routine, and changes in reliance over time.

CHAPTER 3

METHODOLOGY

3.1 Introduction

In this chapter will discuss the flow, and method of the research that will be used. First, design and develop the survey questions to be used in this research. Then collect data to perform follow by analysis. A flow chart is summarizing the overall flow of this research in figure 3.1.

3.2 Research Instrument Design and Development

The research instrument will be developed. The instrument consists of a series of survey question based on factor in framework figure 2.3 before distributing the instrument to a large audience, it will to be administered to a small number of respondents to avoid semantic issues. Ambiguity and vagueness about the clarity of questions, the length of instruments, the scope of material, and structure were addressed based on the feedback received.

This survey was divided into 7 in each section were focusing on a specific topic Demographic, performance expectancy (PE), effort expectancy (EE), social influence (SI), facilitating conditions (FC), behavioural intention (BI) and use behaviour (UB). In this survey the questionnaire was collected from previous study and analysed to see the question related to this study. In table 3.1 and 3.2 present the items for measuring this construct and their sources.

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

Table 3.2 Construct and questionnaire Driver Behaviour Model item

Variable	No	Item
Performance Expectancy	1	The LKA system is useful in enhancing my driving safety.
	2	The LKA system improves my driving performance.
	3	The LKA system is effective in preventing unintentional lane departures.
	4	My driving confidence on highways increases when using LKA system.
	5	The LKA system helps in reducing driver fatigue on long journeys.
Effort Expectancy	1	I have no difficulty understanding the operation of the LKA system.
	2	The LKA system is highly accessible.
	3	The notifications and alerts provided by the LKA system are clear and automatic.
	4	The LKA system can be easily activated or deactivated while driving.
	5	Responding to notifications from the LKA system requires minimal effort.
Social Influence	1	The LKA system is recommended by my family and acquaintances.
	2	There are other drivers whose opinions I respect who suggest that I implement the LKA system.
	3	My decision to employ the LKA system is influenced by the support of automotive experts.

	4	I often discuss the benefits of the LKA system with other drivers.
	5	The opinions from my peers have a positive impact on my perception of the LKA system.
Facilitating Conditions	1	My vehicle is well-equipped to support the LKA system.
	2	I have access to technical support when I encounter problems with the LKA system.
	3	The LKA system operates consistently in any driving conditions.
	4	The information provided by the manufacturer about the LKA system is sufficient.
	5	I am able to easily locate and understand the user manual for the LKA system.
Behavioural Intention	1	I intend to use the LKA system every time I drive.
	2	I plan to use the LKA system frequently in the future.
	3	I am willing to recommend the LKA system to the other drivers.
	4	I am willing to rely on the LKA system for lane departure warnings.
	5	I prefer vehicles that equipped with the LKA system when purchasing a new vehicle.
Use Behaviour	1	I frequently use the LKA system while driving.
	2	I consistently activate the LKA system on highways.
	3	I often use the LKA system in city driving.
	4	I rely on the LKA system for lane departure alerts.
	5	I deactivate the LKA system during bad weather conditions.

3.3 Hypothesis Development

There are several study hypotheses that are based on the UTAUT model's link between variables, prior studies based on LKAS (Awanto et al., 2020), and other relevant works by Joseph et al. (2021). As a result, the following theories concentrate on the elements that use behaviour (UB) influences the most and have the most effects on LKAS experience.

H1. PE: Greater reliance on the LKAS for lane keeping assist alerts lead to stronger perceptions that the system is effective in preventing unintentional lane changing.

The LKAS detecting capabilities can result in greater views of its efficacy in preventing inadvertent lane changes (Camilo & Zaina, 2024). A driver who uses the LKAS more frequently is actively letting the system direct them through lane keeping assist. Rather than just activating it and ignoring it, the driver actively depends on it to alert them before to lane assist. They will also come to believe that it is more successful in avoiding lane assist, which raises the LKAS's performance expectations. The rate to which the driver depends on the alerts is a crucial part of the concept, which goes beyond simply utilizing technology. As a result, the driver who depends more will utilize the system more frequently, which suggests a correlation between users' perceptions of its efficacy and how often they rely on it.

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

This hypothesis examines the impact of LKAS on a driver's subjective experience rather than its functionality. This theory highlights that safety technology's effectiveness goes beyond only avoiding accidents. It clarifies that in order to encourage the adoption and usage of technology, it is critical to comprehend how the LKAS boosts drivers' sense of security and confidence. Additionally, as LKAS's efficacy and system dependability remained consistent throughout time, this theory also emphasizes how constant LKAS activation on roadways boosts driving confidence (Sullivan & Flannagan, 2019).

H3. PE: More reliance on the LKAS for lane keeping assist alerts lead to stronger perceptions in terms of LKAS effectively notifying the driver to potential lane changing.

Hypothesis H3 is significant because it establishes a direct link between actual use behaviour, specifically reliance on the LKAS for lane keeping assist alerts, and perceptions of the system's effectiveness in carrying out its primary function of notifying drivers of potential lane changing (Park et al., 2019). This link suggests that the driver's perception of the system's capabilities is influenced by practical experience obtained through dependence. By highlighting the importance of the core goal, it highlights the need for precise and trustworthy warnings, which guides the creation of LKAS to encourage dependability. Furthermore, this theory raises the prospect of a feedback loop whereby greater dependence results in a greater perception of system efficacy. With an emphasis on the particular capability of prompt and precise lane keeping assist notifications, it can thereby increase reliance and enhance system implementation overall.

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

The strong influence of practical experience serves as a basis for this statement. With increased interaction with the LKAS, a driver becomes more comfortable with its functionality, controls, and alert mechanisms, fostering a deeper understanding over time. The comprehension of LKAS is shaped by the perceived effectiveness and utility of the system, which may result in enhanced perceptions of accessibility with increased usage

(Camilo & Zaina, 2024). Furthermore, consistent utilization offers essential immediate insights that confirm the system's accessibility across different driving scenarios while also minimizing perceived obstacles to its implementation. Ultimately, this increased understanding and hands-on experience strengthen perceptions of high accessibility by improving confidence in LKAS's functions and the driver's proficiency in using it effectively.

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

Hypothesis H5 highlights the important relationship between usage patterns and perceived use, focusing in particular on how a driver's perception of the effort required to respond to notifications is affected when they rely on the LKAS for lane keeping assist alerts. This further highlight how important it is to create a positive user experience where warnings are clear and require little mental or physical work. As a result, drivers may not view them as onerous or challenging to control. In order to increase system usage through decreased perceived effort, the hypothesis guides LKAS design and development towards clear and simple warnings by resolving potential obstacles brought on by perceived effort.

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

Hypothesis H6 makes use of the power of social proof, acknowledging that individual experiences with technology have a substantial impact on other people's opinions and behaviour. Drivers are probably encouraged to talk to their peers about its benefits because of the first good experiences (Cunha et al., 2013). Furthermore, it goes beyond simply observing how technology is used to emphasize the importance of discussions and shared experiences, which are more successful in raising the system's worth. In conclusion, H6 highlights the significance of the social aspect of technology deployment by showing how a person's usage habits can have a direct impact on other people's views and awareness.

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 LKAS.

According to Goren and Hareli (2016), observers' opinions of information systems can be greatly influenced by their peers' emotional responses, which can result in more acceptance and use. For example, users who observe their peers reacting emotionally positively are more likely to have good opinions about the system, which strengthens their participation and usage habits. Furthermore, this suggests that frequent use of technology may alter how people assess other people's viewpoints while forming their own attitudes. Users will eventually actively seek out or focus more on external confirmation of their internal experiences.

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

Instead of relying on theoretical knowledge or manufacturer claims, this hypothesis emphasizes the importance of real-world validation, which demonstrates the driver's confidence in the vehicle's ability to support LKAS, which is influenced by consistent and practical experience. Drivers who are used to LKAS, for example, have a greater trust in the car's safety features, which creates the impression that it has advanced safety technology. Drivers who depend too much on LKAS, however, risk becoming complacent and underestimating their own situational awareness and response (Putter et al., 2023). Therefore, the hypothesis suggests a feedback loop whereby more use might reinforce the idea of facilitating conditions, as it reiterates the need for technology to be seamlessly integrated into the automotive infrastructure to promote positive implementation and perception.

H9. FC: Consistent usage of the LKAS leads to stronger perceptions that the system operates consistently in any driving condition.

The underlying importance of real-world performance is emphasized by this hypothesis, which emphasizes the technology's dependability to be shown beyond controlled testing to operate efficiently under a variety of driving circumstances and environmental elements. Taylor et al. (2023) found that faster reaction times to warnings are associated with higher system dependability and increased driver compliance. In this instance, it highlights the significance of a system that is not restricted in its effectiveness but can be used to a variety of situations that drivers face on a regular basis. It also emphasizes how crucial system dependability is in all driving situations because inconsistent operation will undermine driver confidence and make implementation more difficult.

H10. BI: More frequent use of the LKAS while driving leads to stronger intentions to use the LKAS every time they drive.

H10 is important because it indicates a correlation between past use and prospective behavioural intentions. The focus is on behaviour as opposed to any external influencing factors. The hypothesis highlights the significance of direct experience in shaping user behaviour and converting it into habitual intent, suggesting that increased frequency of LKAS usage leads to stronger intentions for consistent use. Furthermore, enhancing the system’s acceptability can be achieved through personalized algorithms that consider various aspects of driver behaviour, indicating that customized experiences might promote regular usage (Weber et al., 2020).

H11. BI: More frequent use of the LKAS while driving leads to a higher willingness to rely on the LKAS for lane keeping assist.

This hypothesis illustrates that the tendency to depend on technology is influenced not just by an understanding of its features or possible advantages, but rather by ongoing usage and reliable positive outcomes. Investigations reveal that the effectiveness of LKAS remains consistent over extended periods of use, indicating that drivers consistently gain advantages from the system. The findings indicate that improved visual search patterns during lane keeping assist are noted, suggesting that drivers become increasingly aware of their driving surroundings with regular use of LKAS (Chu, 2023). The hypothesis suggests that higher usage will lead to a stronger dependence on technology and increased assurance in its effectiveness. This emphasizes the importance of well-designed and reliable systems that drivers can trust to guarantee their safety. This highlights the importance of user behavior in developing relationships that are reliable.

3.4 Pilot Survey

The effectiveness of survey and other data collection methods is an important variable to consider. To obtain success in conducting surveys, particularly those requiring a significant number of participants. It is important to utilize time and effort in the most effective way possible. A pilot survey evaluates a questionnaire with a sample size that is smaller than the intended size. A pilot survey also checks the accuracy of the instructions by evaluating if all respondents in the pilot sample can follow the guidelines exactly.

Furthermore, it also provides more information on whether this type of survey is effective for research purposes. Hence, we administered a pilot survey online to 40 sample adults to answer this survey. This pilot survey tested the clarity question and generated a reasonable number of indicators based on respondent feedback. Utilizing the findings from the pilot survey, we computed Cronbach's Alpha reliability coefficient in order to evaluate the overall scale and reliability of the questions. Thus, we were able to remove the item that affected reliability measurement by evaluating the contributions of each answer item.

3.4.1 Cronbach Alpha

Cronbach's alpha (α = coefficient alpha) measure reliability or internal consistency by Lee Cronbach in 1951. Consistency also known as reliability. The Cronbach's alpha test is used in order determine the reliability of a survey that contains of multiple Likert scale questions. Using these questions, latent characteristics or qualities that are hidden or unobservable are evaluated. Some examples of these include a person's openness, anxious, and conscientiousness. In reality, these are difficult to quantify. So, Cronbach alpha determines how closely related a set of test items are as a group. For instance, a standard rule for a Likert scale inquiry or a binary question with two possible answers. Lastly, if the score is higher than 0.7 considers acceptable. Some author state that higher values of 0.90 to 0.95. **Table 3.3** shows the value of Cronbach Alpha and internal consistency.

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 work or study which having driving license in Malaysia. The online survey was obtained 415 respondents, and it was conducted via google form. The respondents were invited to complete the question.

Finding the correlations, patterns, and trends in data through analytical and logical reasoning is the most important aspect of any research project. Two-stage structural equation design was employed for the statistical analysis. In this study, IBM SPSS V26 software package and its extension AMOS V26 has been used to perform analysis. This analysis began with data screening by using IBM SPSS V26, data screening is crucial step in data preparation process to ensure data quality. Then, the data were analysed to get the correlation between the variables. This method evaluates the degree of correlation between two variables. Next, analysing fit indices such as, the normed fit index (NFI), comparative fit index (CFI), Tucker-Lewis 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. It was important to investigate the goodness of fit (GOF) metrics, which allowed the model's validity and adequacy to be tested. The created SEM model was then utilized to reveal the association between all variables.

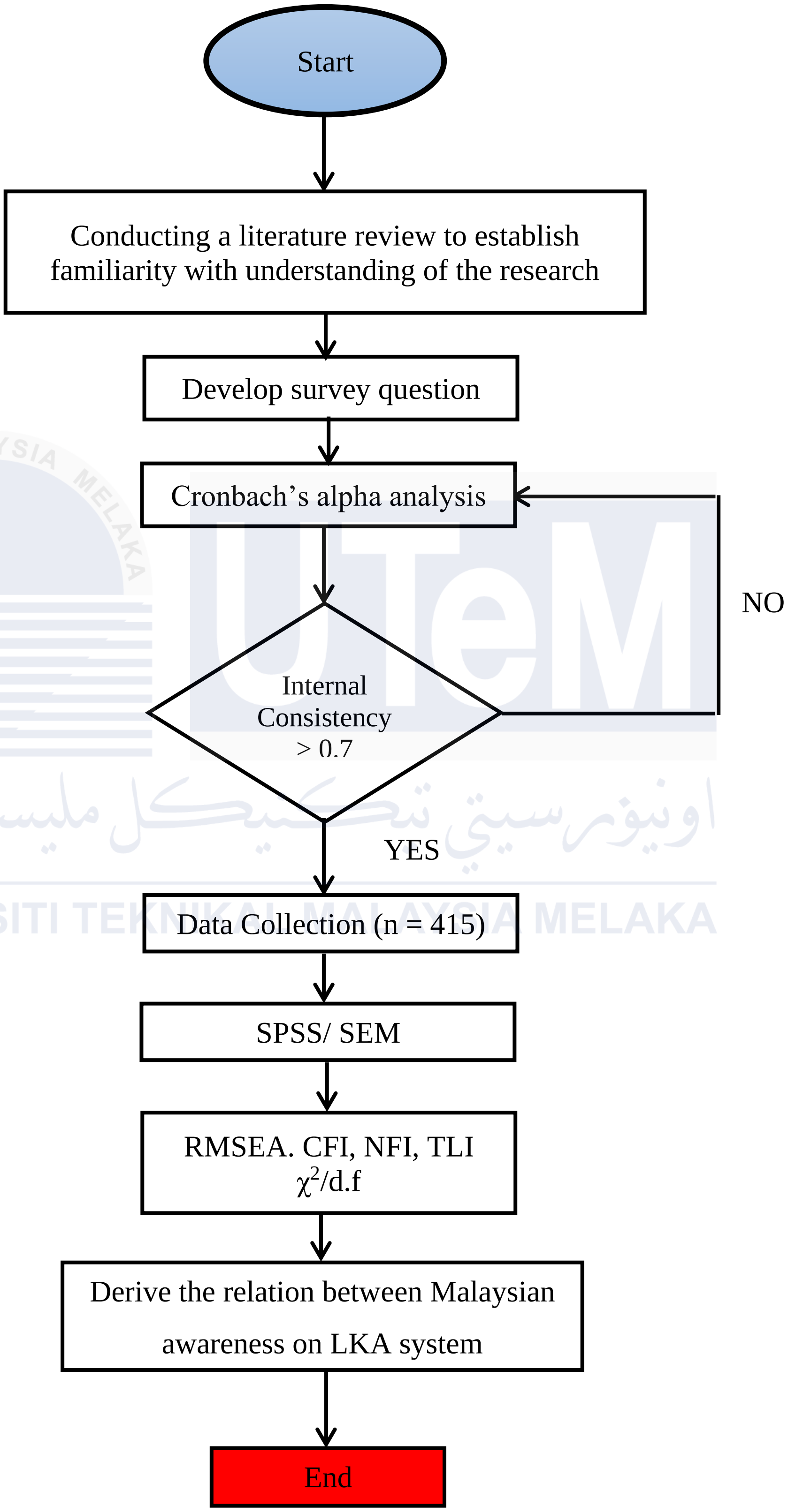


Figure 3.1 Flow chart of the methodology

CHAPTER 4

RESULT AND DISCUSSION

4.1 Introduction

This chapter will discuss the analysis of Malaysian awareness level of ADAS vehicle LKA system in relation to purchasing intention by analysing and evaluating various aspect to estimate Malaysian awareness level. Besides that, it also helps to identify weaknesses and shortcomings in this study. The expected result for this study can be described as stated in the subtopic below.

4.2 Descriptive Statistic of Respondent

The demographic features from the survey were recorded in Table 4.1. The total number of participants in this survey is 415 who completed the questionnaire and none of them were eliminated due to being not engaged (the answer somewhat agrees to every Likert scale item). The total respondent that accepted is remain N = 415 (100%), 261 (62.9%) of them were male and another 154 (37.1%) of them were female. Majority of the participants who took part were within 18-25 (38.3%). And 241 (58.07%) were single. Concerning education level, almost half respondents 177 (46.7%) had bachelor's degree, 53 (12.8%) high school and only 47 (11.3%) postgraduates. The number of respondents from different job sectors is Government servants 113 (27.2%), Private employees 111 (26.75%), Freelance or Self-employed 71 (17.1%) and student 120 (28.9%). Besides that, we ask a few other questions etc. driver's license, have you ever received formal training in the automotive industry, driving experience, type of car driven, frequency driving in the city and on highways and do you have experienced an accident.

Table 4.1 Descriptive Statistic of Respondent

Measure	**Value**	**Frequency**	**Percent (%)**
Gender	Male	261	62.89
	Female	154	37.11
Age	18 - 25	159	38.31
	26 - 35	80	19.28
	36 - 45	106	25.54
	46 and above	70	16.87
Race	Malay	313	75.42
	Cina	43	10.36
	India	44	10.60
	Others	15	3.61
Education Level	SPM	53	12.77
	Diploma	138	33.25
	Bachelor's Degree	177	42.65
	Master's Degree	41	9.88
	PhD	6	1.45
Marital Status	Single	241	58.07
	Married	174	41.93
Job sector	Government servant	113	27.23
	Private employee	111	26.75
	Freelance / Self-employed	71	17.11
	Student	120	28.92
Have you ever received formal training in the automotive industry?	Yes	204	49.16
	No	211	50.84
Driver License	Yes	404	97.35
	No	11	2.65
Driving Experience	2 years and below	89	21.45
	3 to 5 years	113	27.23
	6 to 10 years	68	16.39
	More than 10 years	145	34.94
Type of Car	Owned	368	88.67
	Rent/ Borrow	47	11.33
Frequency of driving in the city	Everyday	199	47.95
	Only on weekdays	25	6.02

	Only on weekends	80	19.28
	Drive if necessary	111	26.75
Frequency of driving highways	Everyday	123	29.64
	Only on weekdays	17	4.10
	Only on weekends	98	23.61
	Drive if necessary	177	42.65
Have you ever been involved in a car accident while driving?	Yes	199	47.95
	No	216	52.05

4.3 Reliability and Validity of Construct

Questionnaires are commonly used by researchers to examine several aspects of the human factor that cannot be measured indirectly. The analysing model was developed to assessed for indicator reliability, convergent validity and discriminant validity. In the beginning, we calculated Cronbach's alpha and composite (CR) for each construct to assess construct reliability and the values above 0.8, as suggests as shown in table 3.1. Cronbach's alpha typically used to measure the level of observational consistency of different item in the same dimension (especially when using Likert scale). Then, convergent validity was tested based on two criteria factors loading and Average Variance Extracted (AVE) need to be assessed. The standardized factor loading for every item should be 0.6 or higher and for the AVE were higher than 0.5 to be accepted. The results of the reliability and validity study are shown in Table 4.2, the result show that the variables fulfil all the requirements. Cronbach's alpha and CR values were both greater than 0.70, and the AVE of each structure was greater than 0.50, indicating the measurement interpretation structure's ideal validity and a better level composite reliability. The Cronbach's analysis findings showed that the variables had a high level of internal consistency, and the other results indicated that the internal consistency was reliable and valid.

Table 4.2 Reliability and validity of constructs

Construct	Scale Item	Cronbach's Alpha	CR	AVE	Factor Loading
Performance Expectancy	PE1	0.945	0.94	0.746	0.873
	PE2				0.875
	PE3				0.852
	PE4				0.878
	PE5				0.84
Effort Expectancy	EE1	0.981	0.93	0.738	0.84
	EE2				0.866
	EE3				0.876
	EE4				0.843
	EE5				0.87
Social Influence	SI1	0.963	0.93	0.713	0.853
	SI2				0.852
	SI3				0.844
	SI4				0.807
	SI5				0.864
Facilitating Conditions	FC1	0.951	0.91	0.665	0.794
	FC2				0.792
	FC3				0.849
	FC4				0.818
	FC5				0.823
Behavioural Intention	BI1	0.959	0.93	0.732	0.877
	BI2				0.86
	BI3				0.856
	BI4				0.845
	BI5				0.839
Use behaviour	UB1	0.968	0.92	0.688	0.878
	UB2				0.876
	UB3				0.895
	UB4				0.861
	UB5				0.598

4.4 Discriminant validity

Aside from that, Table 4.3 summarises discriminant validity using Fornell and demonstrates that the square root of the average variance shared by items in one structure must be inferior to the connection between variables in any two structures. As shown in Table 4.3, all diagonal values are greater than their horizontal and vertical values. Our measurement instrument showed strong construct validity based on the diagonal values exceeding the constructive correlation. Since the value was near to 1.0, all variables obtained dependable and accurate result (Kloft & Heck, 2024).

Table 4.3 Discriminant validity

	PE	EE	SI	FC	BI	UB
PE	**0.864**					
EE	0.872	**0.859**				
SI	0.855	0.889	**0.844**			
FC	0.768	0.853	0.832	**0.81547**		
BI	0.877	0.831	0.831	0.811	**0.856**	
UB	0.772	0.731	0.784	0.833	0.847	**0.829**

Notes: PE, Performance Expectancy; EE, Effort Expectancy; SI, Social Influence; FC, Facilitating Conditions; BI, Behavioural Intention; UB, Use Behaviour.

4.5 Summary Hypothesis

Besides, the moderating effects of the hypothesis (H1-H5) has been studied empirically in Table 4.4. H1, H2 and H3 predicted performance expectancy will positively affects use behaviour, finding positively affect between effort expectancy and use behaviour (0.772, Moderate). In H4 and H5, we tested for the positive link on performance expectancy on use behaviour, which confirmed (0.772, Moderate). H6 and H7 was predicted that social influence positively affects Public Awareness, the finding shows that these hypotheses have empirical support hence they are accepted (0.784, Moderate), H8 and H9 state Facilitating Conditions positively affect Public Awareness of Lane Keeping Assist system, and the result are fully supported in this hypothesis (0.833, High). H10 and H11 state that Behavioural

Intention show significant affects Public Awareness of Lane Keeping Assist system (0.847, High).

Table 4.4 Summary of hypothesis

Hypothesis			Estimate	Significant level	Support
Use Behaviour	←	Performance Expectancy	0.772	Moderate	Accepted
Use Behaviour	←	Effort Expectancy	0.731	Moderate	Accepted
Use Behaviour	←	Social Influence	0.784	Moderate	Accepted
Use Behaviour	←	Facilitating Conditions	0.833	High	Accepted
Use Behaviour	←	Behavioural Intention	0.847	High	Accepted

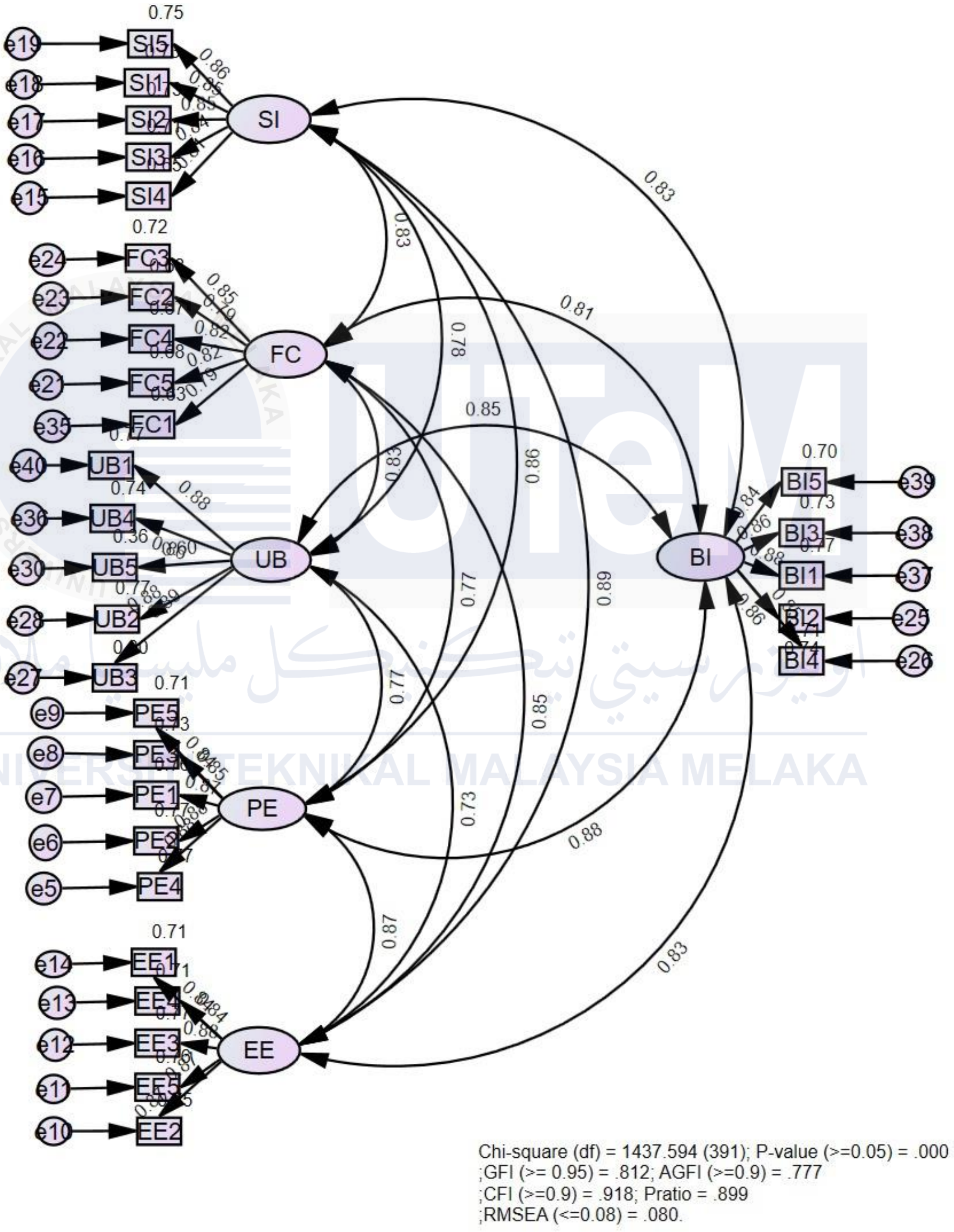
4.6 Goodness of fits indicators

To analyse the model fit, fit indices were examined, including the Goodness of Fit Index (GFI), Normed Fit Index (NFI), Comparative Fit Index (CFI), Tucker-Lewis Index (TLI), Root Mean Square Error of Approximation (RMSEA), chi-square divided by degrees of freedom (Chisq/df), and the chi-square statistic. The primary conclusion reveals that the model demonstrates a satisfactory fit, despite most of the indices getting minimal of the 0.9 threshold value. They still meet the criteria of SEM analysis (Cheng, 2011).

Table 4.5 Goodness of fits indicators

Name of Category	Fit Index	Level of acceptance	Full Measurement
Absolute fit	chi-square	P-value > 0.05	1437.594
	RMSEA	RMSEA < 0.08	0.08
Incremental fit	CFI	CFI > 0.90	0.918
	NFI	NFI > 0.90	0.89
	TLI	TLI > 0.90	0.90
Parsimonious fit	$\chi^{2/d.f}$	Chi-square/df < 3.0	3.677

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



Notes: PE, Performance Expectancy; EE, Effort Expectancy; SI, Social Influence; FC, Facilitating Conditions; BI, Behavioural Intention; UB, Use Behaviour.

Figure 4.1 Structure model

4.7 Correlation Between Variables

The Pearson coefficient represents a statistical measure of correlation, indicating the relationship between two variables that have been evaluated on the same interval or ratio scale. The Pearson coefficient is a metric used to determine the strength of the relationship between two continuous variables as shows in Table 4.5. A significantly positive high correlation between BI and UB (r (412) = 0.847, p < 0.001) and FC and UB (r (415) = 0.833, p < 0.001). For SI and UB (r (415) = 0.784, p < 0.001), PE and UB (r (283) = 0.772, p < 0.001) and EE and UB (r (415) = 0.731, p < 0.001) they have moderate correlation was observed.

Table 4.6 Correlation between variables

		PE	**EE**	**SI**	**FC**	**BI**	**UB**
PE	Pearson Correlation	1	0.872	0.855	0.768	0.877	0.772
	Sig. (2-tailed)		0.001	0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
EE	Pearson Correlation	0.872	1	0.889	0.853	0.831	0.731
	Sig. (2-tailed)	0.001		0.001	0.001	0.001	0.001
	N	415	415	415	415	415	415
SI	Pearson Correlation	0.855	0.889	1	0.832	0.831	0.784
	Sig. (2-tailed)	0.001	0.001		0.001	0.001	0.001
	N	415	415	415	415	415	415
FC	Pearson Correlation	0.768	0.853	0.832	1	0.811	0.833
	Sig. (2-tailed)	0.001	0.001	0.001		0.001	0.001
	N	415	415	415	415	415	415
BI	Pearson Correlation	0.877	0.831	0.831	0.811	1	0.847
	Sig. (2-tailed)	0.001	0.001	0.001	0.001		0.001
	N	415	415	415	415	415	415
UB	Pearson Correlation	0.772	0.731	0.784	0.833	0.847	1
	Sig. (2-tailed)	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, Behavioural Intention; UB, Use Behaviour.

4.7 Significant Levels of Factors Affecting LKAS

In statistical modelling, regression analysis is a set of statistical technique for estimating the relationship between a dependent variable and independent variable. The relationship proved by the correlation between variable in Table 4.6. The dependent variable in this study is Use Behaviour determine as public awareness, whereas the independent is Behavioural Intention, Facilitating Conditions, Social Influence, Performance Expectancy and Effect Expectancy. This analysis is made to estimate the association between the variable as shown in Figure 4.2.

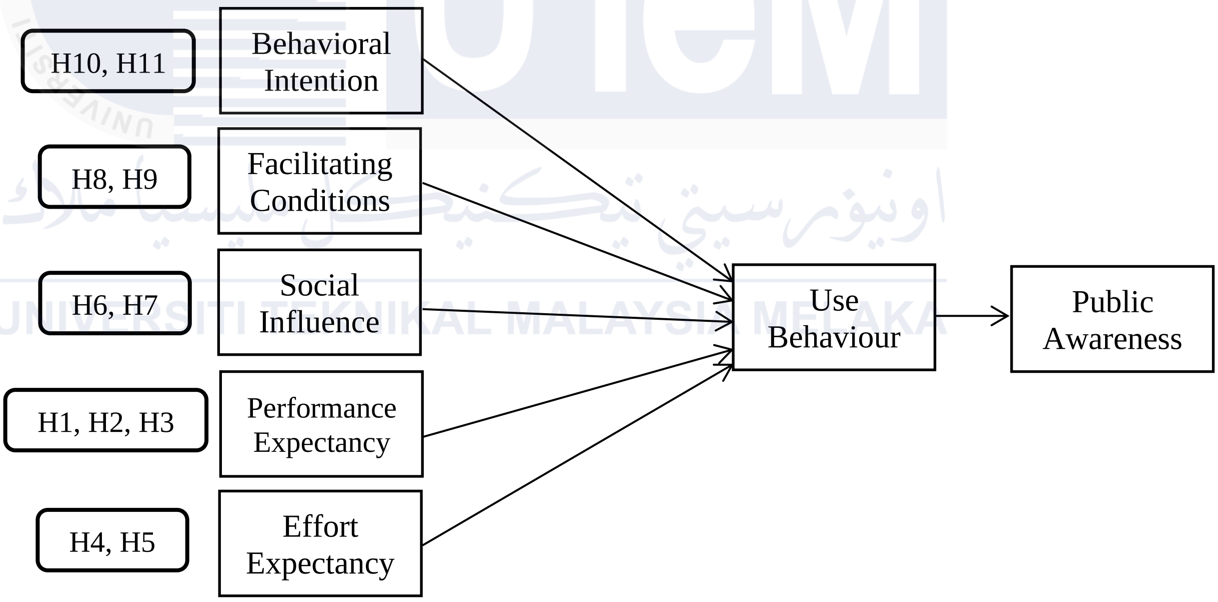


Figure 4.2 Factors affecting LKAS

The structural model in Figure 4.2 highlights the relationship between several factors that influenced the awareness of public towards LKAS. Performance Expectancy (PE) hypotheses examine how drivers' LKAS use affects their perception of its efficacy. H1, H2, and H3 argue that increased reliance on the LKAS for lane keeping assist will strengthen beliefs that the system prevents unintentional lane changes, enhances highway driving confidence, and alerts drivers of potential lane changes. Drivers' perceptions of LKAS competence and efficacy rise as they actively rely on its alerts and capabilities. H4 and H5 of the Effort Expectancy (EE) hypotheses emphasize accessibility and usability. More frequent LKAS engagement is thought to raise views of its high accessibility (H4), while growing dependence on its alerts contributes to beliefs that reacting to the system involves little effort (H5). Driver experience and how interaction affects LKAS perception are the main themes.

SI hypotheses examine how social factors affect drivers' LKAS perception and use. H6 and H7 focus on the driver's social environment, arguing that frequent LKAS use leads to more discussions about its benefits with other drivers (H6) and that consistent use strengthens the belief that peer opinions positively affect their own perception of the system (H7). These theories reveal that peer and community attitudes strongly influence drivers' views of LKAS, linking personal experience to social dynamics. H8 and H9 address Facilitating Conditions (FC) by focusing on the driver's car and technology perceptions. Increased LKAS use may lead to the impression that the vehicle is well-equipped to support the system (H8) and that the system performs consistently throughout driving circumstances (H9). These hypotheses demonstrate that technology reliance depends on vehicle infrastructure and technology trust.

Finally, Behavioural Intention (BI) hypotheses emphasize repetitive actions and use intention. H10 suggests that frequent LKAS use increases drivers' desire to use it every time they drive, and H11 suggests that increased usage increases their ability to depend on it for lane-keeping assistance. These theories show that positive LKAS encounters increase intent and readiness to depend on the technology. Drivers build habits and rely on technology by using it. These themes link LKAS use to intentions and emphasize positive reinforcement for habituation.

4.8 Summary of results

The study explored how much people in Malaysia know about Lane Keeping Assist systems (LKAS) in cars and if that knowledge makes them more likely to want to buy a car with the technology. To make the research successful, 415 people responded, the majority of them were single young men in their early twenties. Interestingly, many of them had a bachelor's degree and were either employed by the government, a private corporation, self-employed, or enrolled in school, making for an incredibly varied group. In order to determine whether that had an impact, the study also inquired about their automobile type and driving habits. Crucially, it turns out that their survey questions were valid and provided useful information about how people's perceptions of LKAS's usefulness, ease of use, and other people's opinions may influence whether or not they actually utilize the system.

According to the study, people are far more likely to utilize LKAS if they plan to use it and believe they have the resources to do so. In addition, social influence, the belief that the system is effective, and its ease of use were significant factors in their decision to utilize it, although not as strongly as the others. In particular, factors that supported their goal to utilize the system and made it easier for them to do so had the biggest influence. Despite the imperfect statistics, the model as a whole performed well and effectively represented the data. The study also discusses drivers' perceptions of the system, including whether they believe it to be reliable, helpful, or influenced by others. Ultimately, the more people have positive experiences with LKAS, the more they want to use it, and start to rely on it which also increases general awareness.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

The primary objective of this paper is to assess the factors influencing Malaysian awareness of LKAS in ADAS vehicles. An adapted version of the UTAUT model was introduced to analyse public awareness of ADAS vehicles. This study identified five direct components that contribute to public awareness, and all these factors—behaviour intention, facilitating conditions, social impact, performance expectancy, and effort expectancy—were statistically confirmed. This study employs theoretical perspectives that explain the critical aspects relevant to the adoption of LKAS, as indicated by statistical results that demonstrate a significant interrelationship between variables. According to Table 4.4, the variable that most significantly influences public awareness for the adoption of LKAS is behavioural intention, followed by facilitating conditions, social influence, performance expectancy, and effort expectancy.

Consequently, the results of our study offer valuable insights for government entities, researchers, and practitioners aiming to enhance user awareness of LKAS moving forward. Additionally, governments or vehicle manufacturers aiming to enhance the adoption and acceptance of LKAS should prioritize public promotion efforts.

5.2 Limitation and Future Research

The current finding must be considered from several perspectives due to several limitations. The sample size was modest and did not fully represent the Malaysian population. Therefore, we are not prepared to extend our findings to the public. To confirm the observation, we recommend conducting it with a larger and more diverse sample.

Furthermore, ADAS vehicles have not been established as indicated in previous LKAS awareness studies. We requested participants to respond to a question that required them to visualize the appearance of a future safety system in vehicles. Consequently, respondents likely possess an ambiguous comprehension of the technology and may be undervaluing the possible interactions a LKAS could have with passengers and other road users. Furthermore, media and OEM marketing may have predominantly influenced their impression. In conclusion, the study's validity may have been compromised since consumers would have tended to underestimate or overvalue new technology with which they had not yet had concrete and authentic experiences. While it is essential to investigate acceptability prior to the technology's readiness, further research should assess awareness once individuals have firsthand experiences with ADAS driving. Fortunately, studies on the knowledge of ADAS technology are starting to emerge (Perrier et al., 2021). For instance, an assessment of LKAS technology following personal experience. Wei et al. (2023) emphasize that, although current research primarily examines public attitudes and opinions regarding ADAS vehicles, it is essential for future studies to assess the perspectives of key stakeholders, including national government officials, legislators, and OEMs, who significantly influence the design, operation, and decision-making processes related to ADAS vehicle implementation.

5.3 Recommendations

In addition to increased acceptance and public awareness, future enhancements that can be applied in subsequent research The inclusion of the public in the testing phases of ADAS in Malaysia is a tactic aimed at eliminating scepticism in certain countries arising from its unavailability. Many Malaysians are doubtful regarding the future of ADAS technology. This includes offering ride-sharing services and soliciting their participation in testing the technology, which encourages trust in the system. According to research conducted in India, public engagement in LKAS testing sessions in ADAS vehicle helps to build trust in the technology and system. Then, expand the sample size because the results of a study with a small number of participants cannot be extrapolated to the entire population because the sample size is insufficient to reach the 56-target population size.

Additionally, this study may simulate highway and urban driving to analyse LKAS utilisation in different settings. The research uses actual road designs and environmental circumstances to examine LKAS's practical use and consequences in various driving situations. Ultimately, local authorities are pivotal in facilitating the safe deployment of autonomous vehicles and promoting its life-saving attributes. Governments should continue to enforce their conventional duties regarding vehicle licensing and registration, traffic regulations and enforcement, as well as motor vehicle insurance and liability procedures for automated automobiles to facilitate the ongoing enhancement of automated technologies. To encourage the advancement of ADAS technologies, additional testing sites and facilities must be established and enhanced.

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APPENDICES

APPENDIX A GANTT CHART OF PSM 2

Gantt chart for PSM																
No	Task Project	Plan/Actual	Week													
			1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	Correction Report	Plan	■	■	■											
		Actual	■	■												
2	Data Collecting	Plan	■	■	■	■										
		Actual	■	■	■											
3	Data Analysing	Plan			■	■	■									
		Actual			■	■										
4	Improvement Data Analysis	Plan				■	■	■								
		Actual				■	■	■	■							
5	Writing Chapter 4, 5	Plan						■	■	■	■	■	■			
		Actual							■	■	■	■	■			
6	Prepare, full Thesis. Technical Report and slide	Plan									■	■	■	■	■	■
		Actual									■	■	■	■	■	■

APPENDIX B GOOGLE FORM QUESTIONNAIRE

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

* Indicates required question

SURVEY INFORMATION

Greetings,

We are a group of researchers from Universiti Teknikal Malaysia Melaka (UTeM). We would like to request your assistance in answering this survey.

The objective of this research is to determine the level of awareness and acceptance among car drivers in Malaysia towards the Advanced Driver Assistance System (ADAS). This study will be focused on the two primary ADAS systems which are Lane Keeping Assist (LKA) and Lane Departure Warning (LDW).

Lane Keeping Assist (LKA) is a vehicle safety system that assists drivers in maintaining their position in the assigned traffic lane.

Lane Departure Warning (LDW) is a safety warning system for vehicles that produces auditory or visual alerts when the vehicle unexpectedly departs from its assigned lane without the awareness of the driver.

We are extremely grateful for the time you have dedicated in completing this survey.

This study is divided into three main sections :

1. **SECTION A :** Demographics, education level and driving experience etc.
2. **SECTION B :** Level of acceptance of the Lane Keeping Assist (LKA) system using UTAUT analysis.
3. **SECTION C :** Level of acceptance of the Lane Departure Warning (LDW) system using UTAUT analysis.

SURVEY OBJECTIVES :

1. To determine the level of understanding of the driver towards LKA and LDW systems.
2. To evaluate the driver's awareness of the existence and functions of the LKA and LDW systems.
3. To assess the driver's trust in the effectiveness of the LKA and LDW systems.
4. To analyse the extent to which the LKA and LDW systems contribute to the reduction in accident risk.

Please answer as many questions as possible, as incomplete surveys may complicate the data analysis. The survey should take 5 to 10 minutes to complete.

ALL INFORMATION COLLECTED THROUGH THIS SURVEY WILL BE KEPT STRICTLY CONFIDENTIAL AND USED SOLELY FOR THE PURPOSES OF THIS RESEARCH STUDY. DATA WILL BE ANALYSED IN AGGREGATE TO ENSURE THE CONFIDENTIALITY OF ALL PARTICIPATING AGENCIES.

SECTION A : Demographics

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

1. **A1 : Gender.** *

Mark only one oval.

- ◯ Male
- ◯ Female

SECTION B : Level of acceptance of the *Lane Keeping Assist (LKA)* system 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).

14. *PERFORMANCE EXPECTANCY (PE)* *

B1 : The LKA system is useful in enhancing my driving safety.

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

15. *PERFORMANCE EXPECTANCY (PE)* *

B2 : The LKA system improves my driving performance.

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly Agree

16. *PERFORMANCE EXPECTANCY (PE)* *

B3 : The LKA system is effective in preventing unintentional lane departures.

Mark only one oval.

	1	2	3	4	5	6	7	
Stro	◯	◯	◯	◯	◯	◯	◯	Strongly Agree