KARYA ILHAM PUBLISHING
CONNECTING MINDS, BRIDGING IDEAS, INSPIRING READERS

Journal of Advanced Research in Business and Management Studies

Journal homepage: https://karyailham.com.my/index.php/arbms/index
ISSN: 2462-1935

Purchase Behaviour of Electric Cars in Malaysia: Evidence-Based Insights

Nur Fazzillah Mohamed Noordin[1,*], Suhaiza Hanim Zailani[1]

[1] Faculty of Business and Economics, University Malaya, 50603 Kuala Lumpur, Malaysia

ARTICLE INFO

Article history:
Received 15 July 2025
Received in revised form 7 August 2025
Accepted 9 August 2025
Available online 14 August 2025

Keywords:
Electric car; purchase behaviour; business insight; Stimuli-Organism-Response

ABSTRACT

Electric car purchases in Malaysia have not increased despite government support and the apparent environmental benefits touted. The drivers' response to purchasing an electric car is crucial for decarbonizing the transportation sector and mitigating the effects of greenhouse gas (GHG). This mainly aims to determine the drivers' responses towards electric car purchases. A cross-sectional survey through a questionnaire was used to collect data from the public. The survey was developed based on the adapted and self-developed items. Based on the analysis, there were three hypotheses with significant indirect effect (vehicle infrastructure and services, vehicle investment, and government support), and one hypothesis with significant direct effect (driver's travel experience). Thus, the response of Malaysian drivers towards the purchase of electric are sensitive to infrastructure, costs, and institutional support, and driver's travel experience has a significant direct effect on electric car purchase response.

1. Introduction

Major barriers for car manufacturers to push electric car uptake in Kuala Lumpur are manifold. Electric car purchase behaviour is still evolving in Malaysia [1-3] as government support, energy saving culture, and vehicle as an investment have thus far not increased electric car uptake [4,5] on a large scale. According to Malaysia's Department of Transport data, the total number of battery electric cars in Malaysia as of 2024 is 38,742 [6]. While this is perplexing given the encouragement from the government such as tax incentives [7], it also comes as little surprise when the price of electric cars in the country is approximately upwards of MYR100,000; which has affordability issues for car drivers in the country [8,9]. However, it is found that affordability and cost is not the only factors explaining the reluctance to shift [10] in spite of government encouragement through Malaysia's Low Carbon Mobility Blueprint 2021-2030 (LCMB) [24]. Other issues such as the widespread availability of charging stations as well as long charging time also present a hindrance to electric car purchase.

[*] *Corresponding author.*
E-mail address: nurfazzillah.dmgt@gmail.com

https://doi.org/10.37934/arbms.39.1.147172

The Malaysian infrastructure that is purpose-built for electric cars such as charging stations are increasingly available in urban areas. For example, according to PLANMalaysia [11], the number of charging stations as of November 2024 is 3,171, a sizeable jump from the number two years prior in 2021 which is 316 only. It is projected to increase by 100-200% in the next five years. However, these numbers are not an indicator of accessibility for electric car drivers to recharge, despite a target of 10,000 stations (see Figure 1) that far exceeds the number of 3,652 petrol stations [12], that can stimulate electric car purchase positively. Additionally, convenience parity occurs when electric car charging carries the same time penalty as petrol car fuelling [13], and this is before taking into account the accessibility, reach, or convenience of the charging stations. Likewise, in a technical report by Wishart [14] it stated that the time taken to refuel a petrol car is approximately 3 minutes while the time taken to charge an electric car is between 30 to 300 minutes. Thus, in spite of the ratio of number of cars to charging or refuelling is 1:12 for electric cars in comparison to 1:1,538 for petrol (internal combustion engine, or ICE) cars (see Table 1), the infrastructure and its attributes present a large gap in stimuli that need to be narrowed before a mass uptake in electric cars can occur.

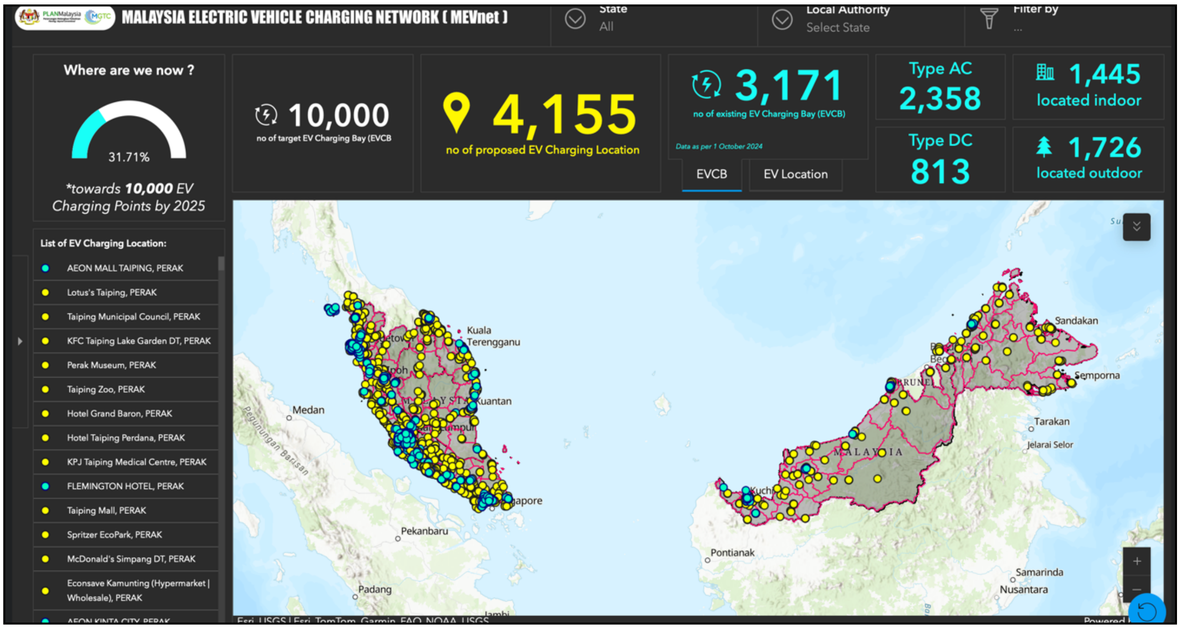

Fig. 1. Number of charging stations in 2024 [11]

Table 1
Ratio of charging or refuelling of electric and petrol cars

	Electric (Based on 2010-2024 data)	Petrol (ICE) (Based on 2010-2019 data)
Number of cars	38,742*	5,617,202*
Number of stations	3,171**	3,652***
Ratio of Cars to Stations	1:12	1:1,538

In viewing the problem, Kuala Lumpur is selected for an evidence-based study. It include identifying the car purchase behaviour of people in Kuala Lumpur, the response of people in terms of energy saving culture and concern for the natural environment, as well as the public policies that help push the electric car agenda towards a larger uptake. This city was chosen as it represents Malaysia best in terms of latest technological and infrastructure availability within the highest concentration of population in the country as shown in Table 2.

Table 2
New registration full (battery) electric and petrol cars in Malaysia 2010-2024 [6]

Year	Electric	Petrol
2010	0	557,270
2011	6	550,176
2012	26	555,847
2013	14	581,074
2014	27	602,157
2015	55	605,993
2016	32	529,963
2017	25	522,731
2018	4	548,240
2019	5	563,751
2020	71	512,652
2021	258	483,558
2022	3,129	662,335
2023	13,301	730,632
2024	21,789	754,558
TOTAL	38,742	8,760,937

Electric car is crucial for decarbonising the transportation sector and mitigating greenhouse gas (GHG) effects. Compared to "conventional" (i.e. internal combustion-engine vehicles, or ICEV), electric cars have a high potential for carbon reduction by using rechargeable batteries that were charged on the power grid [15-19]. If the power grid uses renewable energy (such as wind, solar, and hydro energies) to generate electricity, then the transport sector is another step closer to decarbonisation. Covert *et al.,* [20] noted that we should not expect the unfettered market to lead to rapid reductions in the supply of fossil fuels, as technical progress in extracting new sources of fossil fuels has advanced steadily over time. If this continues, there is a nearly limitless amount of fossil fuel deposits that, while they are not yet economical to extract at current prices, could become economical in the future [20). Thus, primary economic demand and supply factors for fossil fuel energy use in private transportation will likely remain high despite the increasing popularity of electric cars.

Judging by the number of new electric cars released by several car makers, the age of electric cars seems to be at the cusp of a beginning. The Edge Markets [21] on December 1, 2022 highlighted that Fitch Solutions Country Risk and Industry Research expects passenger electric vehicle sales in Malaysia to expand rapidly in 2023, albeit from a low base, due to the introduction of incentives to boost adoption. In a report released on November 30th 2022, the firm forecasted passenger EV sales to increase by 45.6% in 2023 to reach an annual sales volume of around 4,449 units [21].

While the outlook for Malaysia seems positive, an American study on electric car purchase by Brase [22] did not find significant correlations between electric vehicle purchase decisions and a number of other individual difference traits often thought to be factors in such decisions (i.e., social value orientation, political attitudes, environmental attitudes, preference for novel products, or an array of core social values). Regression models in Brase' [22] study also indicate that factors which did predict vehicle choices concerns were the performance and range of electric vehicles, electric vehicle prevalence in general, and beliefs about what statements different vehicle types made about their owners and the owners' values.

Based on the OEC 2022 database by Simoes and Hidalgo [23], Malaysia is a net energy exporter in terms of fossil fuel production and electricity. However, the country does not export renewable energy, which contributes to 18% of its energy mix [21]. This is a clear indication that not only is Malaysia an energy-rich country, but it also has the potential to increase its renewable energy production, especially from non-hydropower sources such as solar. Replacing petroleum products with renewable energy can reduce our reliance on fossil fuels to power our cars. This increases the potential for clean, renewable energy that the country can develop and subsequently protect the environment without reducing the need for mobility by the people.

1.1 Electric Car Policy in Malaysia

In 2021, the Malaysian government published its first Low Carbon Mobility Blueprint 2021-2030 [24] with the objective of assessing the best options in energy and greenhouse gas (GHG) mitigation planning in the transport sector. In the blueprint, it stated that Malaysia's Final Energy Consumption (FEC) in 2017 was 62,848 ktoe (kilo tonnes of oil equivalent), a 9.8 percent increase from the previous year [24]. The transportation sector has consistently been the second largest emitter of greenhouse gases (GHG), accounting for 20% of Malaysia's total GHG emissions in 2014, of which 18% originated from road transportation [24]. GHG emission and energy reduction via vehicle fuel economy and emission improvement, mobility adoption in strategic applications, alternative fuel adoption, and via mode shift are the four areas of concentration for the LCMB [24]. In each focus area, the tactics include promoting low-emission automobiles, bolstering eco-driving initiatives, and embracing electric cars [24]. In determining the future stages for electric cars, LCMB [24] considers the spirit of NAP (National Automotive Policy), GTMP (Green Technology Master Plan), and NPP (National Physical Plan) on new energy vehicles and the supporting infrastructure [24]. All the national policies are thus concluded to be moving in the same direction toward energy efficiency, low-carbon alternatives, and sustainable mobility.

However, despite the policies to encourage Malaysians to embrace the electric mobility, the proportion of electric vehicles on Malaysian roads has remained relatively low. Subsequent to the LCMB [24], the Malaysian government announced the 2022 National Budget in November 2021 with one of the incentives designed to stimulate demand for electric vehicles for personal use [25]. It is the most persuasive budget where electric cars are concerned, with a complete exemption of import duties, excise duties, and sales tax beginning January 1, 2022. The exemptions were extended by an additional year in the National Budget for 2023 [25], which continued in this vein. However, the initial uptake of electric car sales in Malaysia were relatively low. Following the introduction of supportive government policies, EV sales have seen an increase although not in proportion to the sales of ICE cars. For example, low petrol fuel prices in Malaysia were stated by Alganad [26] as one of the reasons that indicated the potential price savings and opportunity cost was not enough to stimulate consumer attitudes towards green cars. This agrees with Department of Transport [6] data that show increasing number of electric cars, but not a decreasing trend in ICE cars; thus, pointing to electric cars being second or third vehicle purchased instead of the primary car of a driver that replaces the ICE.

The Malaysian government has set ambitious targets, aiming for electric vehicles (EVs) to account for 15% of the total industry volume (TIV) by 2030, with a further goal of reaching 80% by 2050 [24]. To achieve these targets, it is crucial to understand the key factors influencing electric car purchasing decisions in Malaysia. In terms of electrical safety of electric car charging infrastructure, the availability of Malaysian Standards (MS) by Department of Standards [27] for electric cars is an extension of electric appliance safety standards that are available for consumers in Malaysia. The Malaysian standards and regulations for electric vehicle conductive charging system and electric vehicle charging system (EVCS) was established and designated as an MS or MS IEC since 2021. Where MS IEC is not available, the Standard IEC is used by default [28]. Within this MS/MS IEC/Standard IEC is the inclusion of standards for various components in electric cars, such as connectors and inlets, charging systems, sockets, etc.

As of December 2022, the electric cars available for sale in Malaysia with 9 major car makers, the on-the-road price of electric cars are separated by tiers. Tier I represent electric cars that are above RM300,000 by three brands, namely BMW, Porsche, and Tesla. Tier II represents electric cars between RM200,000 to RM300,000 by Hyundai, Mercedes-Benz, and Volvo. Tier III represents electric cars that are priced below RM200,000 by Mini, Hyundai, and Nissan. All fifteen models have exempted road taxes and have a driving range between 200 to 700km. However, in recent months as of March 2023, China's BYD electric cars have begun making inroads into the Malaysian markets with prices lower than RM200,000 but still above the RM100,000 threshold. In spite of the availability of electric cars in the Malaysian market, its uptake has yet to catch on as expected. The environmental concerns also make for a strong case to purchase electric cars instead of combustion engine cars, however, this has yet to fully convince the car drivers. All these challenges are yet to be explored and understood empirically and academically to allow government intervention as well as consumer marketing to be better prepared to market electric cars and increase the number of electric cars in Malaysia.

As exposited in the Low Carbon Mobility Blueprint 2021-2030 [24], the transportation sector is the largest contributor to greenhouse gas (GHG) emissions, an estimated 87.9% of total GHG emission in Malaysia. To overcome several of the challenges identified by the Blueprint, is an action plan that includes the government to lead by example by adopting electric car (EC) for its taxi fleet, provide EC incentives for the market, ensure EC charging infrastructure is sufficient for private EC penetration, provide research and development (R&D) grants and support to local EC manufacturers, and build a holistic EC ecosystem [24]. According to the Blueprint, the cost of this technology is very much related to the global electric vehicle (EV) battery prices. The Blueprint explains that the cost of cars is not reducing but rather battery capacity is increasing. When optimum capacity of the battery is achieved, it is expected that vehicle cost to be reduced and price parity will eventually occur [24]. Specifically, for full electric car commonly known as battery electric vehicle (BEV), the incentives include provide tax reduction to bridge price gap, build market trust, and catalyse local manufacturing.

For BEV Completely Built Units (CBU) Excise Duty and Import, there is tax exemption for maximum 10,000 volume total in 2021-2020 at 50% import duty and excise duty exemption from 2023 to 2025. For Plug-In Hybrid Electric Vehicle (PHEV)-specific incentives, first is the government provide tax exemption for qualified Completely Knocked Down (CKD) PHEV at 100% exemption from 2021 to 2022, 75% exemption from 2023 to 2025, and 50% exemption from 2026 to 2030. Second, the government incentive for PHEV is to establish qualifications based on electric range per charge and no engine charging. Thirdly, the government will provide PHEV support for EV charging infrastructure development fund at RM5,000 per PHEV (2021-2025) and RM3,000 per PHEV (2026-2030). An electric car not only encourages drivers to lower their GHG emissions, but also implies energy-saving culture, trip attributes that fit in with the range of an EC, the pull of aesthetically pleasing car design, positive concerns about the state of the environment, as well as availability of supporting infrastructure and services. However, in spite of these encouragements the purchase of electric cars in Malaysia has yet to make a large jump in numbers [29]. In the context of this study, it is on how the car market environment and various stimulating factors affect the drivers' response towards the purchase of an electric car.

2. Literature Review

As exposited in the Low Carbon Mobility Blueprint 2021-2030 [24], the transportation sector is the largest contributor to greenhouse gas (GHG) emissions, an estimated 87.9% of total GHG emission in Malaysia. One of the strategy outlined to reduce this is through the adoption of electric cars (EC). To overcome several of the challenges identified by the Blueprint, is an action plan that includes the government to lead by example by adopting EC for its taxi fleet, provide EC incentives for the market, ensure EC charging infrastructure is sufficient for private EC penetration, provide R&D grants and support to local EC manufacturers, and build a holistic EC ecosystem [24].

2.1 Previous Research on Electric Car Uptake

Previous research has addressed several aspects of electric car uptake: (1) electric car adoption [30-32], (2) electric car behaviour [32-34], and (3) electric car intention [32,35-36]. However, the previous research has yet to address several contradictions in the findings concerning the prior research. The researcher has identified there is an evidence gap in the prior studies that are contradictory in the findings [37-41]. Some of these sub-populations have been unexplored and under-researched, especially with regards to Malaysia [29,42-43].

2.2 Response Towards Purchase of Electric Car

External factors such as government support and price could influence drivers to purchase an electric car [44,48], however, the number of electric cars in Malaysia has not increased exponentially [29]. While there have been a lot of studies on adoption of an electric car [31-34] as well as the intention to purchase an electric car [9,29,35,36,45], there needs to be more evidence of studies that focus on the actual purchase of an electric car. In order to increase electric car purchase, the stimulating factors that would create a response on individuals to purchase an electric car need to be investigated. Therefore, understanding the variables influencing electric car purchase by car drivers must be supported by the methodology framework that is supported by similar previous studies.

2.2.1 Response towards Purchase of Electric Car

In the context of this study, "determinants of response" refers to the influence of particular factors on response behaviour. External (environmental) and internal (human) factors determine a response [46], in this case, the driver's. Likewise, Xu [45] noted that purchasers are usually stimulated not only by environmental stimuli, such as economic, technological, political, and cultural factors, but also by a range of marketing stimulus, such as advertising, discounts, and other promotional methods. Thus, the organism variables in the study by Xu [45] include cognitive variables (perceived risk, perceived value, perceived usefulness, and perceived ease of use of the product) and emotional variables (personal satisfaction and trust with the product).

2.3 Stimuli Factors

As stimuli, the following describe in detail the energy-saving culture, trip characteristics, vehicle infrastructure and services, environmental concerns, vehicle investment, marketing, and government support.

i. Energy Saving Culture

Stephenson [47] presented the Energy Cultures framework, which proposes that consumer energy behaviour can be comprehended at its most fundamental level by examining the interactions between cognitive norms (e.g., beliefs, understandings), material culture (e.g., technologies, building form), and energy practises (e.g. activities, processes). Each of these three main notions can be regarded as a system that interacts to form the Energy Cultures framework's core.

ii. Trip Characteristics

A journey is divided into stages or tours, which are defined as travel between two destinations [49]. A trip is distinguished by its mode of transportation, duration, length, and stops [50]. The duration of a trip may be distinct from other trip features. A trip chain depicts the full decision-making, activity, and travel process [51]. Each journey in a trip chain has features that are handled as travel attributes and are the topic of descriptive and predictive models that influence persons' activity behaviour [52,53]. The measurement of trip characteristics must therefore comprise the trip's basic factors.

iii. Vehicle Infrastructure and Services

This subtopic of electric vehicle infrastructure and services focuses mostly on charging stations and other battery-recharge facilities, such as battery swapping. Understanding the charging habits of EV drivers in terms of when they charge, how much energy they consume, how long they charge, and the sort of charging infrastructure they prefer is essential to the implementation of a successful charging infrastructure effort [54].

iv. Environmental Concerns

The increasing number of automobiles and total emissions from hydrocarbon-based vehicles might cause major diseases and a reduction in life expectancy [55]. As emissions from the transportation sector comprise the largest portion of greenhouse gas emissions, environmental concerns regarding their harmful consequences have developed in tandem due to deteriorating air quality and possible health risks.

v. Vehicle Investment

According to Moon [30], one of the most significant barriers to electric car adoption is that consumers typically only consider the initial purchase price, as exact information about operational cost savings is not easily available. When energy-saving devices have a high initial purchase price and deferred financial rewards, they have trouble gaining widespread market acceptance [56].

vi. Marketing

In determining the response of drivers towards electric car purchase, the marketing aspect is crucial in evaluating the external stimulus. According to Kotler [57], marketing is a social and managerial process whereby individuals and groups obtain what they need and want by creating and exchanging products and value with others. Compared to the conventional car, the unique selling proposition for an electric car is that it has less negative impacts on the welfare of other people and nature [58]. Social marketing is defined as (a) influencing behaviour change, (b) utilising a systematic planning process that applies marketing principles and techniques, (c) focusing on priority audience segments, and (d) delivering a positive benefit for individuals and society [59]. Social marketing is one that need not be exclusively applied by automotive companies, but also the government may draw up an effective social marketing plan to increase electric car purchase.

vii. Government Support

The transition from internal combustion engine automobiles (hydrocarbon fuel-based) to electric engine cars is challenging because to the high initial purchase price, restricted driving range, the necessity for a charging infrastructure, and the perceived unreliability of this new technology [60]. However, the transformation presents businesses and governments with a significant market potential; as a result, governments provide assistance in the form of various subsidies, tax rebates, subsidised electricity for charging, and parking privileges in order to remain competitive. Government intervention is necessary for the development of the electric vehicle industry [61].

2.4 Organism Factor

In this study, organism factors are defined as the internal human variables that interpret incoming inputs in order to produce a response. In the context of this study, the organism factors consist of human emotions associated with the driver's reaction to purchasing an electric vehicle. This human emotion consists of experience of the car drivers as well as the drivers' attitude.

2.5 Response Factor

The response factor in S-O-R paradigm is the final resulting action or reaction as a result of the direct and indirect effect of the stimuli and organism factor. Thus, to summarise the stimuli and organism factors that determine the response based on the literature, stimuli factor in this study consists of seven sub-factors, namely energy, trip, infrastructure, environment, investment and costs, marketing, government support.

2.6 Theoretical Framework

This study identifies the primary constructs of external (environmental) stimuli and the response to the purchase of an electric car, which is mediated by the organism. The organism consists of the experience and attitude of drivers. This provides clarification on the structure. The conceptual framework depicted in Figure 2 depicts the study's variables and their relationships. The study is based on the Stimuli-Organism-Response (S-O-R) paradigm that Mehrabian and Russell [62] introduced.

It is widely recognised that a number of sophisticated theoretical analysis frameworks have gradually developed in the field of electric car uptake from a behavioural and sociological perspective, which has been a significant area of mainstream social science and electric energy research over the past decade. In the excitement of a new area of study, many researchers rely on the Theory of Planned Behavior (TPB) [63] and the Diffusion of Innovation (DOI) Theory [64] to understand sociological and behavioural aspects of electric car ownership. However, to present a different dimension towards understanding electric car uptake or purchase, this study examines a lesser-used theory, the Stimuli-Organism-Response (S-O-R) Theory by Mehrabian and Russel [62].

Technology Acceptance Model (TAM) [65] and the Unified Theory of Acceptance and Use of Technology (UTAUT) are frameworks used in many studies on electric car uptake. TAM was derived from the psychological Theory of Reasoned Action (TRA) [66] and TPB [67]; therefore, while it can understand the predictors of human behaviour toward potential acceptance or rejection of the technology, it cannot answer the primary research question of this study, which is to determine the drivers' response in purchasing an EC in Malaysia. UTAUT is also inappropriate for this research because its constructs focus on the organisational level for example in the studies of Manutworakit [68] and Akinnuwesi [69], whereas this research focuses on the individual level. In light of the limitations of mathematical models, TAM, and UTAUT, as well as the commonness of TPB and DOI, the S-O-R as the theoretical framework of this study is deemed more appropriate and is employed in this investigation as was applied by several studies [35,36,45,70].

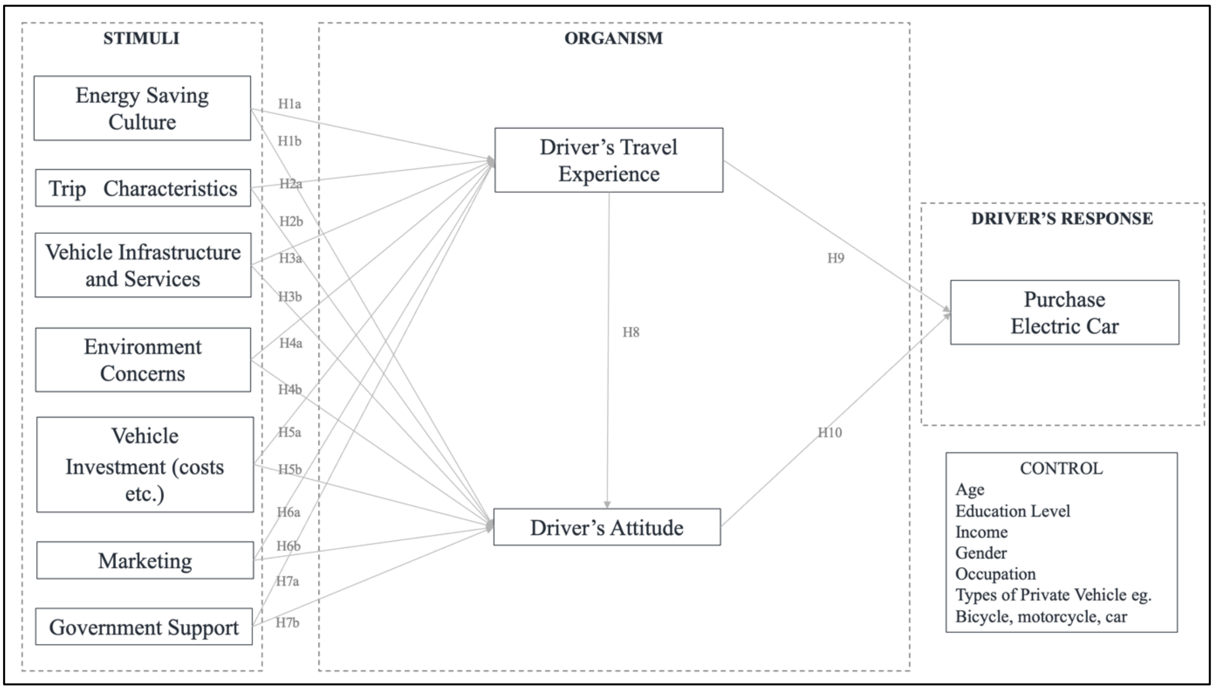

Fig. 2. Conceptual framework of the study

2.7 Hypothesis Testing

There are 7 hypotheses that contribute towards reflecting relationships in the theoretical framework, as follows:

H1: Energy Saving Culture has a significant indirect effect on purchasing an electric car.
H2: Trip Characteristics has a significant indirect effect on purchasing an electric car.
H3: Vehicle Infrastructure and Services has a significant indirect effect on purchasing an electric car.
H4: Environmental Concerns has a significant indirect effect on purchasing an electric car.
H5: Vehicle Investment has a significant indirect effect on purchasing an electric car.
H6: Marketing has a significant indirect effect on purchasing an electric car.

H7: Government support stimulus has a significant indirect effect on purchasing an electric car.
H8: Driver’s Travel Experience has a significant direct effect on driver’s attitude.
H9: Driver’s travel experience has a significant direct effect on purchasing an electric car.
H10: Driver’s attitude has a significant direct effect on purchasing an electric car.

3. Methodology

This study focuses on the external factors that influence Malaysian drivers' decision to purchase an electric vehicle, which constitutes the stimuli portion of the study and is mediated by organism (internal) factors. The location of data collection is in Kuala Lumpur, the capital city of Malaysia. This study employed Purposive Random Sampling, also known as purposive or judgmental sampling.

Data collection for the present study spanned four months (120 days) from 22 May 2023 to 19 September 2023. In the context of this study, a meticulous and rigorous methodology was adopted to ensure the highest data reliability and representativeness. Respondents were selected through a carefully devised sampling procedure, targeting diverse public areas known as hubs of transportation-related activities, such as petrol stations, public parking facilities, and car workshops.

This study's population consists of people licensed to drive cars (‘D’ licensed) in Malaysia. The sample of this study are individuals from the licensed drivers group who own at least one Proton brand car, and who have some knowledge about electric cars. Proton is chosen as the brand that is thought to represent the Malaysian context best in terms of car purchase in the country because it is the first Malaysian car brand, and based on a study on Proton advertisements [71], Proton’s marketing and positioning encode the Malaysian national identity and cultural values. Additionally, at the time of research design and data collection, Proton had yet to announce the launch of any electric car model. The sample of individuals are those within Greater Kuala Lumpur area. Table 3 displays the targeted sample and targeted respondents.

Table 3
Research design of the study

No.	Research Design of the Study	Description
1.	Population (1% of registered Proton cars)	1,028
2.	Sampling Method	Purposive Random Sampling
3.	Targeted Sample	514
4.	Targeted Respondents	Drivers who own at least one Proton car

The questionnaire survey is the primary source of quantitative data to validate the hypotheses developed for this study as shown in Table 4.

Table 4
Response rate of the questionnaire survey

Response	Response Rate
Total questionnaires sent to respondents	514
Questionnaires received from respondents	172
Unusable questionnaires	11
Overall response rate	33.4%
Usable response rate	31.3%

The study consists of seven primary constructs, which are classified as stimuli. These variables are stimuli factors or factors that occur independently, externally, and separately from the subject's body (car drivers). In contrast, the response is drivers' purchase of an electric vehicle. The organism, which consists of a construct (experience), moderates the stimuli. This study employs a five-point Likert scale to evaluate all responses to the questions except the demographic profile.

SPSS (Statistical Package for the Social Sciences) version 29 and SmartPLS version 4 are used to analyze the collected data. Using partial least squares structural equation modeling (PLS-SEM), correlations between latent variables assessed by observed data sets are examined. SmartPLS software is utilized to test the model in this study. In contrast, SPSS is utilized for data screening, reliability analysis, normality testing, descriptive analysis, identification of missing values, multiple regression, and correlation analysis.

4. Results

This chapter describes the results of statistical data analysis and the findings for the face-to-face (recorded in an online questionnaire) data obtained from Klang Valley drivers who own at least one Proton brand car registered in 2021-2022.

4.1 Demographic Profile of Respondents

The frequency distribution method was presented to understand the respondents' characteristics better. Most respondents in this study were almost evenly split between 26 and 35 years (26.7%) and between 36 and 45 years (27.3%). Combined, these two age groups make up 54% of the respondents. The age groups 46 and 55 (25.5%) and above 55 (13.0%) were also a sizeable representation. Only 7.5 percent of respondents were between 18 and 25 years old. Male respondents represented 58.4 percent, while females made up a total of 41.6 percent. Meanwhile, for ethnicity, most of the respondents were Malays, representing 80.1 percent, followed by Chinese, representing 15.5 percent. In comparison, Indians and Indigenous Sabah/Sarawak represented 0.6 percent, respectively, and the rest were others with 3.1 percent. As for the highest education level, the majority (54.7%) of the respondents have a Bachelor's degree, while 19.9 percent have a Master's degree as the highest education attained. 36.6 percent of respondents earn between RM2,001 and RM5,000 per month, and 29.8 percent earn between RM5,001 and RM10,000 per month. Most respondents live in terraced or linked houses (49.7%), and 20.5 percent live in high-rise buildings, including apartments and condominiums. Regarding employment, 46.6 percent work in the private sector, while 31.1 percent are in the government workforce. In the distributed questionnaire, two additional columns, “Own a Proton brand car” and “Know electric car,” were added to ensure that responses in the ‘No’ category were rejected as they fall outside the scope of the study.

Subsequently, all the respondents who participated owned at least one Proton brand car and knew electric cars. The demographic profile of respondents in frequency distribution is summarised in Table 5.

Table 5
Demographic profile of respondents

Profile	Frequency (N=161)	Percentage
Gender		
Male	94	58.40
Female	67	41.60
Age		
18 – 25 years	12	7.50
26 – 35 years	43	26.7
36 – 45 years	44	27.30
46 – 55	23	25.50
More than 55 years	21	13.0
Ethnicity		
Malay	129	80.1
Chinese	25	15.5
Indian	1	0.6
Indigenous Sabah/Sarawak	1	0.6
Other	5	3.1
Education		
Doctorate or higher	10	6.2
Master degree or equivalent	32	19.9
Bachelor degree or equivalent	88	54.7
Diploma or equivalent	15	9.3
Vocational certificate or equivalent	4	2.5
Professional certificate or equivalent	5	3.1
SPM or equivalent	7	4.3
Income		
Less than RM2,000	16	9.9
RM2,001 – RM5,000	59	36.6
RM5,001 – RM10,000	49	29.8
More than RM10,000	38	23.6
Housing Type		
Bungalow/Detached	23	14.3
Linked/Terraced/Townhouse	80	49.7
Semi-detached	25	15.5
Condominium/Apartment/High-rise	33	20.5
Employment Type		
Government	50	31.1
Private sector	75	46.6
NGO/Non-profit	2	1.2
Unemployed	11	6.8
Self-employed	23	14.3

4.2 Descriptive Analysis of Stimuli

For Stimuli, a total of 7 variables represented Stimuli as a whole. Table 6 shows each stimuli variable's skewness, kurtosis, and mean.

Table 6
Skewness, Kurtosis, and Mean of stimuli

Variables	Skewness	Kurtosis	Mean
Energy Saving Culture	-0.682	1.952	3.861
Trip Characteristics	-0.636	1.508	3.559
Vehicle Infrastructure and Services	-0.742	2.167	3.471
Environmental Concerns	-0.370	0.043	3.612
Vehicle Investment	-0.019	1.409	3.216
Marketing	-0.389	0.079	3.313
Government Support	-0.475	3.330	2.972

Table 7
Descriptive analysis of stimuli measurement items

Items	Item Code	Mean of Dimension	Mean of Item	s.d.	Skewness	Kurtosis
Stimuli – Energy Saving Culture As a driver, I…		3.861				
believe an electric car saves fossil fuel energy.	ES1		3.850	0.988	-0.913	0.662
always plan my journey.	ES2		4.074	0.779	-0.854	1.273
believe that the electric car is energy efficient.	ES3		3.962	0.797	-1.055	2.404
believe that using an electric car saves energy.	ES4		3.888	0.894	-0.998	1.424
believe my energy saving culture affects my travel experience.	ES5		3.745	0.903	-0.967	1.492
believe my energy saving culture affects my driving attitude.	ES6		3.646	0.931	-0.833	0.644
Stimuli – Trip Characteristics		3.559				
As a driver, I…						
travel during peak hours daily.	TC1		3.205	1.162	-0.287	-0.76
travel for a short time daily.	TC2		3.316	1.045	-0.367	-0.514
travel short distances daily.	TC3		3.372	1.023	-0.447	-0.266
travel alone daily.	TC4		3.807	1.015	-0.801	0.285
believe that my trip characteristics affects my travel experience.	TC5		3.882	0.861	-1.016	1.496
believe that my trip characteristics affects my driving attitude.	TC6		3.770	0.943	-0.925	0.907
Stimuli – Vehicle Infrastructure & Services		3.471				
As a driver, I…						
believe that infrastructure is adequate.	IS1		2.795	1.162	0.07	-0.959
believe that the electric car services is adequate.	IS2		2.670	1.082	0	-0.917
plan my purchase based on the electric car infrastructure available.	IS3		3.732	1.004	-0.677	-0.006

plan my purchase based on the electric car services available.	IS4		3.844	0.984	-0.796	0.352
believe that electric car infrastructure and services affect my travel experience.	IS5		4.012	0.851	-1.07	1.847
believe that electric car infrastructure and services affect my driving attitude.	IS6		3.770	0.976	-0.788	0.498
Stimuli – Environmental Concerns		3.612				
As a driver, I…						
understand that I am purchasing a car that is environmentally friendly.	EC1		3.857	0.954	-1.238	1.808
ensure that I have good knowledge about carbon emission.	EC2		3.944	0.815	-0.456	-0.241
believe that non-petroleum-based car is cleaner for the environment.	EC3		3.950	0.850	-1.018	1.699
am influenced by environmentalists.	EC4		3.260	0.971	-0.463	-0.075
believe that environmental concerns affect my travel experience.	EC5		3.347	0.982	-0.507	-0.071
believe that environmental concerns affect my driving attitude.	EC6		3.316	1.033	-0.53	-0.145
Stimuli – Vehicle Investment		3.216				
As a driver, I…						
agree that the initial investment of an electric car is affordable.	VI1		2.670	1.029	0.21	-0.408
agree that the maintenance costs of an electric car is affordable.	VI2		2.813	1.067	0.192	-0.494
agree that the energy cost of an electric car is not affordable.	VI3		3.149	1.019	-0.053	-0.34
believe that the initial investment of an electric car affects my travel experience.	VI4		3.360	0.984	-0.26	-0.233
believe that the maintenance costs of an electric car affect my travel experience.	VI5		3.602	0.976	-0.435	-0.148
believe that the energy cost of an electric car affects my travel experience.	VI6		3.565	0.953	-0.43	0.131
believe that the initial investment of an electric car affects my driving attitude.	VI7		3.428	1.010	-0.428	-0.177
believe that the maintenance costs of an electric car affect my driving attitude.	VI8		3.360	1.009	-0.331	-0.286

believe that the energy cost of an electric car affects my driving attitude.	VI9		2.993	1.191	-0.078	-0.934
Stimuli – Marketing		3.313				
As a driver, I…						
am influenced by the attractiveness of the electric car promotion.	MK1		3.273	1.012	-0.242	-0.456
am attracted to the price of an electric car.	MK2		2.993	1.191	-0.078	-0.934
am attracted to the electric car promotional activities.	MK3		3.105	1.058	-0.181	-0.681
am influenced by the marketing activities of electric cars near me.	MK4		2.975	1.060	-0.046	-0.724
am influenced by the attractiveness of the clean emission promotion.	MK5		3.403	1.008	-0.436	-0.224
am attracted to the idea of cheaper environmental clean-up.	MK6		3.639	0.990	-0.707	0.283
am attracted to the clean emission promotional activities.	MK7		3.478	0.949	-0.47	-0.179
am influenced by the electric car's contribution to clean air in my city.	MK8		3.639	0.978	-0.602	-0.025
Stimuli – Government Support		2.972				
As a driver, I…						
believe electricity tariff is affordable.	GS1		2.770	0.982	0.036	-0.311
believe the exemption of import and excise duties on certain cars benefit me.	GS2		3.372	1.077	-0.455	-0.376
believe the exemption of approved permit (AP) on certain cars benefit me.	GS3		3.223	1.106	-0.342	-0.382
believe the government's legislation on cars is adequate.	GS4		2.788	1.051	-0.057	-0.531
believe the government support on cars does not benefit me.	GS5		2.944	1.001	0.037	-0.172
believe the government does not support secondhand car purchase.	GS6		3.099	1.038	-0.133	-0.346
believe car loans are difficult to obtain.	GS7		3.000	0.961	-0.043	-0.024
believe the government does not favour car purchases.	GS8		2.583	1.009	0.137	-0.399

4.3 Hypothesis Testing

In this section, procedures established by Ringle [72] and Hair [73,74] were applied in SmartPLS v4.0.9.2. Estimating the measurement model is only conducted after classifying the individual constructs. The indicator and construct relationship is classified as reflective or formative. If the assigned indicators caused the construct, it is called a reflective construct [74,75] and vice versa. The two-step model consists of a measurement and structural models. Next, the study evaluates the quality of the measurement model. The measurement model for formative construct was evaluated to determine the validity and reliability of the indicators. Reliability assesses the internal consistency of a set of indicators in measuring the construct or concept. In contrast, validity assesses how well an indicator measures a particular concept it is intended to measure [76]. The formative assessment will be discussed in the following subsection below.

4.3.1 Assessment of the measurement model

An assessment was conducted on the formative construct measurement methodology to ascertain the indicators' validity and reliability. The internal consistency of a collection of indicators in assessing the construct or notion is evaluated in terms of reliability. On the contrary, validity pertains to the evaluation of an indicator's ability to accurately measure the specific construct it is designed to examine [76].

4.3.1.1 Construct and convergent validity for formative indicator

This present study evaluated convergent validity based on the item loadings, composite reliability, and average variance extracted (AVE). The item loading ranged from 0.535 to 0.901; this showed that the items measuring each construct are highly loaded on the particular construct. Following the suggestion of Hair [75], loading values lower than 0.5 should be discarded. The items that were discarded from this study due to low loadings is listed in Table 8. Convergent validity refers to the degree to which two different indicators measuring the same construct are highly correlated [78]. Hair [74,77] suggested a rule of thumb that composite reliability should be higher than 0.6 in exploratory research, and values higher than 0.7 for research in a more advanced stage are regarded as satisfactory, while if the value is below 0.6, it indicates that it lacks reliability. If an AVE value is 0.5 and higher, this represents a sufficient degree of convergent validity, while if the value is below 0.5, it represents otherwise Hair [74,77]. For an AVE of 0.5 and above, the latent variable explains more than half of the indicators’ variance, according to the rule of thumb by Hair [74,77]. Composite reliability ranged from 0.814 to 0.955, exceeding the recommended value of 0.7 [78], while AVE for all constructs ranged from 0.515 to 0.878, exceeding the recommended value of 0.5 [74,77].

Table 8
Items discarded due to low loadings (less than 0.5)

Framework		Construct	Item Discarded	
Stimuli		Energy Saving Culture	ES5	ES6
		Trip Characteristics	TC1	TC4
		Vehicle Infrastructure & Services	IS3	IS4
			IS5	IS6
		Environmental Concern	EC3	
		Vehicle Investment	VI1	VI9
		Government Support	GS1	GS2
			GS3	GS4
Organism	Driver's Travel Experience	Travel Routine	TP1	
	Driver's Attitude	Perceived Benefit	PB1	PB2
			PB5	PB7
		Personal Innovativeness	PI5	
		Perceived Convenience	PC4	PC7
Response		Driver's Response	DR1	DR2
			DR3	DR4
			DR5	DR6
			DR7	DR8
			DR9	DR11
			DR14	DR20

4.3.1.2 Discriminant validity

Subsequently, the discriminant validity of the measurement model was assessed. In determining discriminant validity, Fornell- Larcker [79] criterion and Heterotrait-monotrait (HTMT) ratio were estimated [73,74,80,81]. The Fornell-Larcker [79] criterion was assessed first. Fornell and Larcker [79] suggest that discriminant validity is established if a latent variable account for more variance in its associated indicator variables than it shares with other constructs in the same model. Each construct's average variance extracted (AVE) must be compared with its squared correlations with other constructs in the model. Fornell-Larcker criterion states that the AVE of each construct should be higher than the highest squared correlation with any other construct [73,74]. Table 8 compiled the computed Fornell-Larcker [79] criterion by SmartPLS.

4.3.1.3 Reliability analysis

Composite reliability assesses the reliability of the construct. Composite reliability estimates the internal consistencies of the measurement items. Hair [75; 74] suggested a minimum cut-off value of 0.7. The output is compiled in Table 9

Table 9
Factor loadings, average variance expected, and composite reliability of constructs

First-Order Construct	Item	Loadings / Weights	AVE	Composite Reliability
Energy Saving Culture	ES1	0.742	0.649	0.879
	ES2	0.635		
	ES3	0.915		
	ES4	0.899		
Trip Characteristics	TC2	0.636	0.529	0.815
	TC3	0.620		
	TC5	0.808		
	TC6	0.820		
Vehicle Infrastructure and Services	IS1	0.935	0.878	0.935
	IS2	0.939		
Environmental Concerns	EC1	0.615	0.555	0.858
	EC2	0.541		
	EC4	0.746		
	EC5	0.881		
	EC6	0.878		
Vehicle Investment	VI3	0.580	0.557	0.891
	VI4	0.719		
	VI5	0.850		
	VI6	0.852		
	VI7	0.860		
	VI8	0.877		
Marketing	MK1	0.778	0.637	0.933
	MK2	0.637		
	MK3	0.82		
	MK4	0.816		
	MK5	0.86		
	MK6	0.821		
	MK7	0.831		
	MK8	0.801		
Governmental Support	GS5	0.752	0.586	0.849
	GS6	0.673		
	GS7	0.784		
	GS8	0.841		

4.3.2 Results of hypotheses testing

Table 10 shows the results of hypotheses testing. Four (4) hypotheses are supported, namely vehicle infrastructure and services, vehicle investment, government support, and driver's travel experience.

Table 10
Results of hypotheses testing

Hyp.	Relationship	t-value	Decision
H1a	Energy saving culture have a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	0.882	Not Supported
H1b	Energy saving culture have a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	0.396	Not Supported
H2a	Trip characteristics have a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	1.643	Not Supported
H2b	Trip characteristics have a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	1.222	Not Supported
H3a	Vehicle infrastructure and services have a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	0.522	Not Supported
H3b	Vehicle infrastructure and services have a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	3.825**	Supported
H4a	Environmental concern has a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	1.758	Not Supported
H4b	Environmental concern has a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	1.358	Not Supported
H5a	Vehicle investment have a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	3.755**	Supported
H5b	Vehicle investment have a significant indirect effect on purchasing an EC for private usage through driver’s attitude	0.199	Not Supported
H6a	Marketing has a significant indirect effect on purchasing an EC for private usage through driver’s travel experience	0.134	Not Supported
H6b	Marketing has a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	1.674	Not Supported
H7a	Government support have a significant indirect effect on purchasing an EC for private usage through driver’s travel experience.	0.101	Not Supported
H7b	Government support have a significant indirect effect on purchasing an EC for private usage through driver’s attitude.	2.528**	Supported
H8	Driver’s travel experience has a direct effect on driver’s attitude.	1.799	Not Supported
H9	Driver’s travel experience has a significant direct effect on purchasing an EC	2.532*	Supported
H10	Driver’s attitude has a significant direct effect on purchasing an EC	0.859	Not Supported

5. Discussions

5.1 Findings and Discussions

There are four components within the research framework that provide the structure from which research findings are derived. The first element is the relationship between Stimuli and Response. In this study, the research found that the most impactful determinant of electric car purchase is Vehicle Infrastructure and Services, and Vehicle Investment. In endeavoring to explain this relationship (i.e. how or why Vehicle Infrastructure and Services, and Vehicle Investment are the two major stimuli that determines the response), the discussion of findings section of this study juxtaposes Stimuli unto the Five M’s of Management (Man, Money, Machine, Material, and Method). This offers a distinct oversight of the research problem with regards to Stimuli, that is managing a new product in the market (electric car), using new technology (non-internal combustion engine), in a new ecosystem (charging stations, battery life-cycle, autonomy, etc). This research’s findings agree with Muzir [29] that the current electric car business environment in Malaysia is yet to convince drivers that the infrastructure is available, accessible, and reliable, and worth an investment.

The second element is the mediating role of Organism (Driver’s Travel Experience) and Stimuli. The findings reveal that only one stimulus (Vehicle Investment) has a significant direct effect on

Driver's Travel Experience. The possibility of such results in this study is due to costs involved in purchasing an electric car has a direct correlation to the experience obtained. The willingness to pay a higher price (WTPHP) reflects the excess resulting from perceived value, influenced by perceived quality and actual price paid [82]. When the perceived quality exceeds the actual price paid, a surplus (perceived value) is created in the consumer's mind, leading to willingness to pay higher prices as long as the surplus remains. Additionally, the cost of ownership can be perceived as an investment as it is seemingly positively correlated to the constituents of experience [83], such as range anxiety, safety, technical assistance, etc.

The third element is the mediating role of Organism (Driver's Attitude) and Stimuli. The findings reveal that there are two variables that have significant direct effect on the Driver's Attitude. The variables are Vehicle Infrastructure and Services, and Government Support. These variables also have indirect effect on driver's response towards electric car purchase. The availability of electric car infrastructure and support by the government allows the driver's attitude to be more positive towards electric car purchase [5]. In addition to this, Driver's Travel Experience also has a direct effect on Driver's Attitude.

The fourth element is the Driver's Response in purchasing an electric car. Three stimuli variables have indirect effect on Driver's Response. The variables are Vehicle Infrastructure and Services, Vehicle Investment, and Government Support. Furthermore, Driver's Travel Experience has a direct effect on Driver's Response. Thus, the driving experience of electric vehicles has a positive effect on their feelings and awareness of range dynamics [84].

Overall, the findings of the stimuli reveal that the most impactful determinant of electric car purchase is Vehicle Infrastructure and Services, followed by Vehicle Investment, Government Support, and Trip Characteristics. While it may seem inexplicable that a little more than half (four of the seven stimuli hypotheses) are supported, this can be rationalised based on two explanations. First, that the questionnaire formulated were derived and adapted from studies originating in countries that may be vastly different from the Malaysian context. Hence, the results illustrate that the stimulus that may be important in other parts of the world (such as Energy Saving Culture) have less of an impact here. Second, that the sample of this study are Malaysians, thus the particular consumer culture here possibly differs in comparison with other countries not in Asia [85], with a moderate commitment towards circular economy [86] thus presenting a differing context. Third, the concept of 7R's of waste management, essentially part of circular economy structure [87], in particular Repair (or Reactive Maintenance as it is known in the car industry) is possibly seen by Malaysians as more environmentally-friendly than the purchase of a brand-new item especially during warranty period [88] such as an electric car, which then shows up in the results of this study as being somewhat averse to electric car purchase.

Based on the results of this study, the S-O-R model is concluded to be a good framework, albeit having an imperfect fit on the issue. This hints to the fact that the issue of electric car purchase may be far-reaching than the scope of this study is able to examine

5.2 Practical Limitations

Two practical limitations limit the expanse of this study in terms of response and opinion of the respondents. The driver's travel experience and attitudes in Malaysia varies greatly across different states due to rate of urbanization and demographic characteristics. The present study only considers Selangor and Kuala Lumpur individuals as part of its respondents. Due to the different demographic profiles in the respective states, driver's behaviours could be vastly different thus producing different responses. As an example, the response of drivers located at regions where there is a high density of electric car charging facilities would be more positive towards electric car purchase in comparison to other locations where support for electric cars are low or non-existent. Given the non-homogenous quantity as well as quality of local infrastructure in Malaysia, it is possible that responses can be irregular even within a small distance of one another.

Additionally, there is also a limitation in capturing opinions related to electric car purchase in this study. As this study is quantitative in nature, it is beyond the scope of the study to capture opinions in the form of unstructured interviews. Although there are merits in acquiring this type of data, the framework of current study is meticulous, thus rendering the data collection of public opinions to be a laborious exercise and impractical. As opinions can be not only in agreement or disagreement (black-or-white), but also personal, impersonal, neutral, biased, hidden interests, disinterested, etc., (in short, various shades and tones of greys), not only would the data collection be long and arduous but also the analysis pedantic and time-consuming. Granted, the data of opinions could be rich and nuanced as derived from intangibilities, however in this case the quantitative dataset can achieve the same objectives. The obtained data may not completely represent Malaysian individuals due to the differences in individual situations and context, and some generalizations are inevitable.

6. Conclusions

In concluding this research subject matter, the electric car, within the car manufacturing industry seems outwardly positive as a business expansion project. As cars are trending towards autonomous (self-driving) vehicles, electric cars can be a rational step towards it as technology advancements develop towards self-charging cars which the ICE cars are not able. However, the electric car trend is not growing by leaps and bounds the way it has thus been touted as car drivers remain hesitant, especially in the Global South countries where petroleum and gas are in abundance. If previously car manufacturers rely on internal market research team that may be biased in monitoring the electric car trend, this research provides an impartial valuable insight into the current electric car ecosystem.

As there are significant implications for firms, industry experts, marketers, and policymakers, this study underlines the importance of selecting a particular stimulus to concentrate on for highest return. This, particularly to gain purchasers of electric cars, is imperative if the car manufacturing industry is looking to expand their business share of the market and gain early mover advantage. Likewise, for car manufacturers that are not convinced on the viability of opening a new line of innovative cars, this research is pertinent in convincing the car brands to strategize their next course of action.

Car manufacturers should focus on compelling stimulus that would push the electric car into mass market purchase, such as electric car infrastructure. The industry should not depend solely on the government to provide the facilities, but to work in a public-private-partnership (PPP) that serves to create an all-round win. With more visible car charging facilities open to the public and at practical intervals especially along expressways in Malaysia, the electric car uptake in the country is more likely to be encouraging.

Acknowledging the interconnected nature of the electric car industry and its supply chains is a crucial component for achieving competitive advantage for car manufacturers in Malaysia. In particular, Proton, one of two Malaysian car brands, must understand that a driver's response to purchasing an electric car is an issue that is far larger than can be solved at an organizational or even national level. Given that the issue is rooted in major global resources, the economic future of countries, as well as the national securities that are tightly associated with it, it is unlikely that the car industry can single-handedly push towards electric car uptake *en masse* without a concentrated government support multiple times the strength that has been applied in Malaysia. Thus, Proton with its international parent company must work closely with not only the Malaysian government but also with its international supply chain in order to expand the electric car market in the country.

With a strong stimulus in the form of government support, other stimuli such as vehicle investment, vehicle infrastructure and services, environmental concerns, and marketing would follow suit in increasing its strength of influence towards the response of drivers in purchasing an electric car. The organism aspect would then re-calibrate to be more positive towards responding for an electric car purchase in both the driver's experience and driver's attitude aspects especially within the urban demography. How the rural demography in Malaysia would respond is as yet unknown, given the gap in electric car infrastructure that is available in these particular areas, however it can be predicted that the same trend that occurred in urban areas would apply there as well at a slower pace.

The response of drivers towards the purchase of electric car can be more complex in Malaysia where the people are sensitive to the stimuli received externally. For car brands to increase their sales in electric cars in Malaysia, it would be fruitful to approach their aims by letting their potential customer base know how they are closing the environmental loop (i.e. disposal of batteries, recycling of minerals, etc) and how they intend to minimise the environmental degradation and possible slavery that arises with cobalt mining, as well as working with the government to ensure that the public concerns regarding the entire environmental impact of the electric car cycle (from resource mining and manufacturing to vehicle end-of-life policy) are assuaged. Thus, the long-term challenge of moving the mass market from ICE to electric cars through clean energy in the entire supply chain is crucial if the electric car industry is serious about thriving.

Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the author(s) used QuillBot in order to paraphrase. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

Declaration of Funding

This research did not receive any grant or funding.

Declaration of Competing Interests

The author(s) do not have any competing interests in the subject matter(s), methods, data, and any other part of the research.

References

[1] Asadi, Shahla, Mehrbakhsh Nilashi, Sarminah Samad, Rusli Abdullah, Marwan Mahmoud, Monagi H. Alkinani, and Elaheh Yadegaridehkordi. "Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia." *Journal of Cleaner Production* 282 (2021): 124474. https://doi.org/10.1016/j.jclepro.2020.124474

[2] Adnan, Nadia, Shahrina Md Nordin, M. Hadi Amini, and Naseebullah Langove. "What make consumer sign up to PHEVs? Predicting Malaysian consumer behavior in adoption of PHEVs." *Transportation Research Part A: Policy and Practice* 113 (2018): 259-278. https://doi.org/10.1016/j.tra.2018.04.007

[3] Sang, Yew-Ngin, and Hussain Ali Bekhet. "Modelling electric vehicle usage intentions: an empirical study in Malaysia." *Journal of Cleaner Production* 92 (2015): 75-83. https://doi.org/10.1016/j.jclepro.2014.12.045

[4] Tan, Yang, Xiaoyu Ying, Weijun Gao, Shuai Wang, and Zhonghui Liu. "Applying an extended theory of planned behavior to predict willingness to pay for green and low-carbon energy transition." *Journal of Cleaner Production* 387 (2023): 135893. https://doi.org/10.1016/j.jclepro.2023.135893

[5] Khazaei, Hamed, and Mohammad Ali Tareq. "Moderating effects of personal innovativeness and driving experience on factors influencing adoption of BEVs in Malaysia: An integrated SEM–BSEM approach." *Heliyon* 7, no. 9 (2021). https://doi.org/10.1016/j.heliyon.2021.e08072

[6] Department of Transport (DOT). "Total registered full electric and hybrid electric cars in Malaysia 2010-2024." *Internal data request*. Unpublished (2025).
[7] The Star. "Budget 2024: Major incentives for EV users", *The Star*, 13 October. Available at: https://www.thestar.com.my/news/nation/2023/10/13/budget-2024-major-incentives-for-ev-users (Accessed 18 April 2024) (2023).
[8] Asadi, S., Nilashi, M., Iranmanesh, M., Ghobakhloo, M., Samad, S., Alghamdi, A., ... & Mohd, S. "Drivers and barriers of electric vehicle usage in Malaysia: A DEMATEL approach." *Resources, conservation and recycling*, 177, 105965 (2022). https://doi.org/10.1016/j.resconrec.2021.105965
[9] Adnan, N., Nordin, S. M., & Rahman, I. "Adoption of PHEV/EV in Malaysia: a critical review on predicting consumer behaviour." *Renewable and Sustainable Energy Reviews*, *72*, 849-862 (2017). https://doi.org/10.1016/j.rser.2017.01.121
[10] Krishna, G. "Understanding and identifying barriers to electric vehicle adoption through thematic analysis." Transportation Research Interdisciplinary Perspectives, 10, 100364 (2021). https://doi.org/10.1016/j.trip.2021.100364
[11] PLANMalaysia. "Malaysia Electric Vehicle Charging Network. Online Dashboard" https://www.planmalaysia.gov.my/mevnet/ Accessed November 2024. *PLANMalaysia, Ministry of Housing and Local Government Malaysia* (2024).
[12] Kementerian Perdagangan Dalam Negeri dan Kos Sara Hidup, KPDN. "Bilangan Stesen Minyak Mengikut Syarikat Minyak Dan Negeri 2019." Uploaded by Norhanim Mazlan of Bahagian Pengurusan Subsidi Petroleum Kenderaan on August 26, 2021. Accessed on February 11th 2025 from https://archive.data.gov.my/data/dataset/bilangan-stesen-minyak-mengikut-syarikat-minyak-dan-negeri (2021).
[13] Dixon, J., Andersen, P. B., Bell, K., & Træholt, C. "On the ease of being green: An investigation of the inconvenience of electric vehicle charging." *Applied Energy*, *258*, 114090 (2020). https://doi.org/10.1016/j.apenergy.2019.114090
[14] Wishart, J. "Fuel Cells vs Batteries In the Automotive Sector." Technical Report. *Intertek Transportation Technologies* (2014).
[15] Casals, L. C., Martinez-Laserna, E., García, B. A., & Nieto, N. "Sustainability analysis of the electric vehicle use in Europe for CO2 emissions reduction." *Journal of cleaner production*, *127*, 425-437 (2016). https://doi.org/10.1016/j.jclepro.2016.03.120
[16] Qiao, Q., Zhao, F., Liu, Z., & Hao, H. "Electric vehicle recycling in China: Economic and environmental benefits." *Resources, Conservation and Recycling*, *140*, 45-53 (2019). https://doi.org/10.1016/j.resconrec.2018.09.003
[17] Wu, J., Liao, H., Wang, J. W., & Chen, T. "The role of environmental concern in the public acceptance of autonomous electric vehicles: A survey from China." *Transportation Research Part F: Traffic Psychology and Behaviour*, *60*, 37-46 (2019). https://doi.org/10.1016/j.trf.2018.09.029
[18] Märtz, A., Plötz, P., & Jochem, P. "Global perspective on CO2 emissions of electric vehicles." *Environmental Research Letters*, *16*(5), 054043 (2021).
[19] Broadbent, G., Allen, C., Wiedmann, T., & Metternicht, G. "The role of electric vehicles in decarbonising Australia's road transport sector: modelling ambitious scenarios." *Energy Policy*, *168*, 113144 (2022). https://doi.org/10.1016/j.enpol.2022.113144
[20] Covert, T., Greenstone, M., & Knittel, C. R. "Will we ever stop using fossil fuels?." *Journal of Economic Perspectives*, *30*(1), 117-38 (2016). https://doi.org/10.1257/jep.30.1.117
[21] The Edge Markets. "Passenger EV sales in Malaysia to expand rapidly in 2023, says Fitch Solutions." *Theedgemarkets.com.* Accessed 1 December 2022 (2022).
[22] Brase, G. L. "What would it take to get you into an electric car? Consumer perceptions and decision making about electric vehicles." *The Journal of psychology*, *153*(2), 214-236 (2019). https://doi.org/10.1080/00223980.2018.1511515
[23] Simoes, A. J. G., & Hidalgo, C. A. "The economic complexity observatory: An analytical tool for understanding the dynamics of economic development." In *Workshops at the twenty-fifth AAAI conference on artificial intelligence* (2011, August).
[24] LCMB. "Low Carbon Mobility Blueprint 2021-2030: Decarbonizing Land Transportation." *Ministry of Environment and Water.* Government of Malaysia (2021).
[25] Ministry of Finance, M.O.F. "Malaysia Budget Speech/Annual Budget." Available at https://belanjawan.mof.gov.my/pdf/2022/ucapan/bs22.pdf (Accessed 15 January 2024) (2022).
[26] Alganad, A. M. N., Isa, N. M., & Fauzi, W. I. M. "Why people do not purchase green cars in Malaysia: The influence of consumption values on consumers' attitude towards green cars." *Case Studies on Transport Policy*, 12, 101007 (2023). https://doi.org/10.1016/j.cstp.2023.101007

[27] Department of Standards Malaysia. "Electric vehicle conductive charging system – Part 23: DC electric vehicle charging station (IEC 61851-23:2014, IDT). MS IEC 61851-23/2021." Government of Malaysia (2021).
[28] Energy Commission. "Malaysia Energy Statistics Handbook." Available at https://www.st.gov.my/en/contents/files/download/116/Malaysia_Energy_Statistics_Handbook_20201.pdf. (Accessed 17 January 2024) (2020).
[29] Muzir, N. A. Q., Mojumder, M. R. H., Hasanuzzaman, M., & Selvaraj, J. "Challenges of Electric Vehicles and Their Prospects in Malaysia: A Comprehensive Review." *Sustainability*, *14*(14), 8320 (2022). https://doi.org/10.3390/su14148320
[30] Moon, S., & Lee, D. J. "An optimal electric vehicle investment model for consumers using total cost of ownership: A real option approach." *Applied Energy*, *253*, 113494 (2019). https://doi.org/10.1016/j.apenergy.2019.113494
[31] Bansal, P., Kumar, R. R., Raj, A., Dubey, S., & Graham, D. J. "Willingness to pay and attitudinal preferences of Indian consumers for electric vehicles." *Energy Economics*, *100*, 105340 (2021). https://doi.org/10.1016/j.eneco.2021.105340
[32] Munshi, T., Dhar, S., & Painuly, J. "Understanding barriers to electric vehicle adoption for personal mobility: A case study of middle income in-service residents in Hyderabad city, India." *Energy Policy*, *167*, 112956 (2022). https://doi.org/10.1016/j.enpol.2022.112956
[33] Wang, N., Tang, L., & Pan, H. "Analysis of public acceptance of electric vehicles: An empirical study in Shanghai." *Technological Forecasting and Social Change*, *126*, 284-291 (2018). https://doi.org/10.1016/j.techfore.2017.09.011
[34] van Heuveln, K., Ghotge, R., Annema, J. A., van Bergen, E., van Wee, B., & Pesch, U. "Factors influencing consumer acceptance of vehicle-to-grid by electric vehicle drivers in the Netherlands." *Travel Behaviour and Society*, *24*, 34-45 (2021). https://doi.org/10.1016/j.tbs.2020.12.008
[35] Xu, G., Wang, S., Li, J., & Zhao, D. "Moving towards sustainable purchase behavior: examining the determinants of consumers' intentions to adopt electric vehicles." *Environmental Science and Pollution Research*, *27*(18), 22535-22546 (2020). https://doi.org/10.1007/s11356-020-08835-9
[36] Han, M. S., Hampson, D. P., Wang, Y., & Wang, H. "Consumer confidence and green purchase intention: an application of the stimulus-organism-response model." *Journal of Retailing and Consumer Services*, *68*, 103061 (2022). https://doi.org/10.1016/j.jretconser.2022.103061
[37] Adhikari, M., Ghimire, L. P., Kim, Y., Aryal, P., & Khadka, S. B. "Identification and analysis of barriers against electric vehicle use." *Sustainability*, *12*(12), 4850 (2020). https://doi.org/10.3390/su12124850
[38] Beak, Y., Kim, K., Maeng, K., & Cho, Y. "Is the environment-friendly factor attractive to customers when purchasing electric vehicles? Evidence from South Korea." *Business Strategy and the Environment*, *29*(3), 996-1006 (2020). https://doi.org/10.1002/bse.2412
[39] Hardman, S., Chandan, A., Tal, G., & Turrentine, T. "The effectiveness of financial purchase incentives for battery electric vehicles–A review of the evidence." *Renewable and Sustainable Energy Reviews*, *80*, 1100-1111 (2017). https://doi.org/10.1016/j.rser.2017.05.255
[40] Thananusak, T., Rakthin, S., Tavewatanaphan, T., & Punnakitikashem, P. "Factors affecting the intention to buy electric vehicles: Empirical evidence from Thailand." *International Journal of Electric and Hybrid Vehicles*, *9*(4), 361-381 (2017). https://doi.org/10.1504/ijehv.2017.10011120
[41] Miles, D. A. "A taxonomy of research gaps: Identifying and defining the seven research gaps." In *Doctoral Student Workshop: Finding Research Gaps-Research Methods and Strategies, Dallas, Texas* (pp. 1-15) (2017, August).
[42] Khazaei, H. "The influence of personal innovativeness and price value on intention to use of electric vehicles in Malaysia." *European Online Journal of Natural and Social Sciences*, *8*(3), pp-483 (2019).
[43] Vafaei-Zadeh, A., Wong, T. K., Hanifah, H., Teoh, A. P., & Nawaser, K. "Modelling electric vehicle purchase intention among generation Y consumers in Malaysia." *Research in Transportation Business & Management*, 100784 (2022). https://doi.org/10.1016/j.rtbm.2022.100784
[44] Gomez Vilchez, J. J., Smyth, A., Kelleher, L., Lu, H., Rohr, C., Harrison, G., & Thiel, C. "Electric car purchase price as a factor determining consumers' choice and their views on incentives in Europe." *Sustainability*, *11*(22), 6357 (2019). https://doi.org/10.3390/su11226357
[45] Xu, G., Wang, S., & Zhao, D. "Transition to sustainable transport: understanding the antecedents of consumer's intention to adopt electric vehicles from the emotional research perspective." *Environmental Science and Pollution Research*, *28*(16), 20362-20374 (2021). https://doi.org/10.1007/s11356-020-12006-1
[46] Clifford, K. R., Cravens, A. E., & Knapp, C. N. "Responding to ecological transformation: mental models, external constraints, and manager decision-making." *BioScience*, *72*(1), 57-70 (2022). https://doi.org/10.1093/biosci/biab086

[47] Stephenson, J., Barton, B., Carrington, G., Gnoth, D., Lawson, R., & Thorsnes, P. "Energy cultures: A framework for understanding energy behaviours." *Energy policy*, *38*(10), 6120-6129 (2010). https://doi.org/10.1016/j.enpol.2010.05.069
[48] Tu, J. C., & Yang, C. "Key factors influencing consumers' purchase of electric vehicles." *Sustainability*, *11*(14), 3863 (2019). https://doi.org/10.3390/su11143863
[49] Anderson, M. K. "Characteristics of trips and travellers in private and public transportation in the Danish travel survey data." In *Proceedings from the Annual Transport Conference at Aalborg University* (Vol. 17, No. 1) (2010, December).
[50] Joewono, T. B., San Santoso, D., Adinegoro, L., & Kharisma, A. H. "Characteristics of travel, activities, and action space of young workers riding motorcycles in developing city." *Transportation research procedia*, *25*, 5023-5039 (2017). https://doi.org/10.1016/j.trpro.2017.05.202
[51] McGuckin, N., & Nakamoto, Y. "Trips, Chains and tours-using an operational definition." In National Household Travel Survey Conference (p. 55) (2004, November).
[52] Buliung, R. N., & Kanaroglou, P. S. "Urban form and household activity-travel behavior." *Growth and Change*, 37(2), 172-199 (2006). https://doi.org/10.1111/j.1468-2257.2006.00314.x
[53] McNally, M. G., & Rindt, C. R. "The activity-based approach." In Handbook of transport modelling (Vol. 1, pp. 55-73). Emerald Group Publishing Limited (2007). https://doi.org/10.1108/9780857245670-004
[54] Morrissey, P., Weldon, P., & O'Mahony, M. "Future standard and fast charging infrastructure planning: An analysis of electric vehicle charging behaviour." *Energy Policy*, *89*, 25 (2016). https://doi.org/10.1016/j.enpol.2015.12.001
[55] Sajjad, A., Asmi, F., Chu, J., & Anwar, M. A. "Environmental concerns and switching toward electric vehicles: geographic and institutional perspectives." Environmental Science and Pollution Research, 27(32), 39774-39785 (2020). https://doi.org/10.1007/s11356-020-08311-4
[56] Dumortier, J., Siddiki, S., Carley, S., Cisney, J., Krause, R. M., Lane, B. W., ... & Graham, J. D. "Effects of providing total cost of ownership information on consumers' intent to purchase a hybrid or plug-in electric vehicle." *Transportation Research Part A: Policy and Practice*, *72*, 71-86 (2015). https://doi.org/10.1016/j.tra.2014.12.005
[57] Kotler, P., Armstrong, G., & Opresnik, M. O. "Principles of Marketing" (Eighteenth Ed.) (2021).
[58] Gärling, A., & Thøgersen, J. "Marketing of electric vehicles." *Business Strategy and the Environment*, *10*(1), 53-65 (2001).
[59] Lee, N. R., & Kotler, P. "Social marketing: Behavior change for social good." Sage Publications (2019).
[60] Shanju Li, S., Zhu, X., Ma, Y., Zhang, F., & Zhou, H. "The Role of Government in the Market for Electric Vehicles." (2020). https://doi.org/10.1596/1813-9450-9359
[61] Fluchs, S., & Kasperk, G. "The influence of government incentives on electric vehicle adoption: Cross-national comparison (No. 57-2017)." *MAGKS Joint Discussion Paper Series in Economics* (2017).
[62] Mehrabian, A., & Russell, J. A. "An approach to environmental psychology." The MIT Press (2017). (1974).
[63] Ajzen, I. "The theory of planned behavior." *Organizational behavior and human decision processes*, *50*(2), 179-211 (1991).
[64] Rogers, E. M. "Diffusion of innovations." The Free Press of Glencoe. *NY*, *32*, 891-937 (1962).
[65] Davis, F. D., Bagozzi, R. P., Warshaw, P. R. "User acceptance of computer technology: A comparison of two theoretical models." *Management Science*, 35(8), 982–1003 (1989).
[66] Fishbein, M., & Ajzen, I. "Belief, attitude, intention, and behavior: An introduction to theory and research." *Philosophy and Rhetoric*, *10*(2) (1975).
[67] Marangunić, N., Granić, A. "Technology acceptance model: a literature review from 1986 to 2013." *Univ Access Inf Soc* 14, 81–95 (2015).
[68] Manutworakit, P., & Choocharukul, K. "Factors Influencing Battery Electric Vehicle Adoption in Thailand—Expanding the Unified Theory of Acceptance and Use of Technology's Variables." *Sustainability*, *14*(14), 8482 (2022). https://doi.org/10.3390/su14148482
[69] Akinnuwesi, B. A., Uzoka, F. M. E., Fashoto, S. G., Mbunge, E., Odumabo, A., Amusa, O. O., ... & Owolabi, O. "A modified UTAUT model for the acceptance and use of digital technology for tackling COVID-19." *Sustainable Operations and Computers*, *3*, 118-135 (2022). https://doi.org/10.1016/j.susoc.2021.12.001
[70] Gil, M. T., & Jacob, J. "The relationship between green perceived quality and green purchase intention: a three-path mediation approach using green satisfaction and green trust." *International Journal of Business Innovation and Research*, *15*(3), 301-319 (2018). https://doi.org/10.1504/ijbir.2018.10010406
[71] Chou, E. I., bin Mohd Arus, B., & Ahmad, S. "A semiotic analysis and cultural values of Malaysian automotive TV advertisements." *Jurnal Gendang Alam (GA)*, *7* (2017). https://doi.org/10.51200/ga.v7i.1049
[72] Ringle, Christian M., Wende, Sven, and Becker, Jan-Michael. "*SmartPLS 3*." Bönningstedt: SmartPLS. Retrieved from http://www.smartpls.com (2015, November).

[73] Hair, J. F., Hult, G. T. M., Ringle, C. M., Sarstedt, M., "A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)." Sage, Thousand Oaks (2014).

[74] Hair, J. F., Hult, G. T. M., Ringle, C. M., and Sarstedt, M. "A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM)." 2nd Edition. Thousand Oaks: Sage (2016).

[75] Hair, J. F., Black, W. C., Babin, B. J., Anderson, R. E. "Multivariate Data Analysis" 7th edn. Prentice Hall, Upper Saddle River (2010)

[76] Sekaran, U. and Bougie, R. "Research methods for business: A skill building approach." 5th Edition. Chichester: John Wiley and Sons Limited (2010).

[77] Hair, J. F., Ringle, C. M., and Sarstedt, M. "PLS-SEM: Indeed a Silver Bullet." *The Journal of Marketing Theory and Practice*, 19(2), 139–152 (2011). https://doi.org/10.2753/mtp1069-6679190202

[78] Henseler, J., and Fassott, G. "Testing Moderating Effects in PLS Path Models: An Illustration of Available Procedures." *Handbook of Partial Least Squares* (2009). https://doi.org/10.1007/978-3-540-32827-8_31

[79] Fornell, C., and Larcker, D. F. "Evaluating structural equation models with unobservable variables and measurement error." *Journal of Marketing Research*, 18(1), 39–50 (1981). https://doi.org/10.2307/3151312

[80] Henseler, J., Ringle, C. M., and Sarstedt, M. "A new criterion for assessing discriminant validity in variance-based structural equation modeling." Journal of the Academy of Marketing Science, 43(1), 115–135 (2015). https://doi.org/10.1007/s11747-014-0403-8

[81] Henseler, J., Hubona, G., and Ray, P. A. "Using PLS Path Modeling in new technology research: updated guidelines." *Industrial Management and Data Systems*, *116*(1), 2–20 (2016). https://doi.org/10.1108/imds-09-2015-0382

[82] Ligas, M., & Chaudhuri, A. "The moderating roles of shopper experience and store type on the relationship between perceived merchandise value and willingness to pay a higher price." Journal of Retailing and Consumer Services, 19(2), 249-258 (2012). https://doi.org/10.1016/j.jretconser.2012.01.006

[83] Mattioli, G., Roberts, C., Steinberger, J. K., & Brown, A. "The political economy of car dependence: A systems of provision approach." Energy research & social science, 66, 101486 (2020). https://doi.org/10.1016/j.erss.2020.101486

[84] Rauh, N., Franke, T., & Krems, J. F. "Understanding the impact of electric vehicle driving experience on range anxiety." Human factors, 57(1), 177-187 (2015). https://doi.org/10.1177/0018720814546372

[85] Schütte, H., & Ciarlante, D. "Consumer behaviour in Asia." Springer (2016).

[86] Herrador, M., & Van, M. L. "Circular economy strategies in the ASEAN region: A comparative study." Science of The Total Environment, 908, 168280 (2024). https://doi.org/10.1016/j.scitotenv.2023.168280

[87] Borah, S. J., & Kumar, V. "Fundamental Principles of Waste Management for a Sustainable Circular Economy." In Integrated Waste Management: A Sustainable Approach from Waste to Wealth (pp. 1-11). Singapore: Springer Nature Singapore (2024). https://doi.org/10.1007/978-981-97-0823-9_1

[88] Jawi, Z. M., Solah, M. S., Ariffin, A. H., Shabadin, A., Ali, A., Osman, M. R., & Wong, S. V. "Automotive consumerism: A study of car user's practices & behaviour in Klang Valley, Malaysia." *MRR, MIROS* (2017).