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The Relationship of Drivers' Understanding on CO2 Emission Effects on the Environment that Reflect their Behavior

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Abstract

This study examines the relationship between drivers' awareness and perception of the adverse effects of Carbon Dioxide (CO2) emissions on the environment, their attitudes, and driving behavior. It is also examining the potential mediating effect of drivers' attitudes on the relationship between awareness and perception of CO2 emissions and driving behavior. The study focused on automobile drivers aged 18-year-old and older in Klang Valley, which has almost three million drivers, and purposive sampling yielded 425 replies for the study. The study employed the Partial Least Squares Structural Equation Modeling (PLS-SEM) approach, a widely recognized methodology in carbon footprint analysis. The data was meticulously examined using the advanced SmartPLS4 software. Results will provide valuable insights into factors that influence drivers' attitudes and behaviors toward carbon dioxide emissions. The motivation and contribution of this study lie in helping drivers understand the environmental impacts of their actions, leading to behavior change, alternative transportation, technology adoption, and policy advocacy. Promoting eco-friendly vehicles such as electric and hybrid cars enable drivers to reduce CO2 emissions, combat climate change, and preserve the ecosystem for future generations. By educating drivers about their behavior and CO2 emissions, they can make informed choices and contribute to a sustainable future.

Keywords: Drivers', Behaviors, Awareness , Attitudes, CO2, Emission, Environment

Introduction

The examination of drivers' comprehension and behaviors on the environmental impacts of carbon dioxide (CO2) emissions is of paramount importance in advancing the cause of sustainable transportation. Understanding how drivers perceive and react to these effects is crucial for mitigating their carbon emissions within the transportation sector (Alessandrini, 2012; Ayça et al., 2018). Drivers' awareness of climate change, air pollution, and the consequences of CO2 emissions is influenced by various factors, including education, media exposure, public awareness, and personal curiosity. This heightened level of consciousness significantly impacts individuals' decision-making processes and actions. According to Girod (2013), drivers are more likely to make sustainable decisions when they fully understand the environmental consequences of carbon dioxide (CO2) emissions. It involves choosing vehicles with low carbon dioxide (CO2) emissions, such as fuel-efficient, hybrid, or electric.

Additionally, it involves embracing eco-friendly driving habits, such as ensuring appropriate tire pressure, reducing unnecessary idling, and utilizing smooth acceleration and deceleration methods. Comprehending the consequences of carbon dioxide (CO2) emissions prompts individuals operating vehicles to contemplate alternative modes such as public transit, carpooling, or biking. These alternatives have been found to contribute to reducing emissions (Huang, 2018). According to Allison (2019), drivers may be motivated to endorse sustainable transportation policies and advocate for local infrastructure modifications based on their comprehension of the subject matter.

The behavior exhibited by drivers reinforces their degree of awareness and comprehension. According to Barkenbus (2010), drivers can enhance their understanding and adoption of environmentally friendly habits by using sustainable driving techniques and observing the subsequent positive environmental outcomes. Raising awareness, taking action, and providing reinforcement are instrumental in promoting sustainable transportation and mitigating carbon emissions (Outay, 2019). The primary focus should be prioritizing driver education and awareness campaigns to improve comprehension and influence behavior. According to Li (2019), disseminating environmental awareness and information among drivers can be effectively achieved through collaborative initiatives involving government agencies, non-profit organizations, educational institutions, and the commercial sector.

In summary, the level of drivers' consciousness regarding the environmental consequences associated with CO2 emissions exerts a substantial influence on their actions and the advancement of environmentally-friendly transportation. According to Jylhä and Harraou (2019), individuals' awareness of environmental issues affects their decisions regarding vehicle selection, driving behavior, and preference for alternative modes of transportation. Establishing a robust correlation between knowledge and behavior is imperative in developing a sustainable and ecologically conscious transportation infrastructure, aiming to mitigate carbon dioxide emissions and facilitate the progression toward a sustainable future (Fu, 2020).

Objectives

This study aims to investigate the relationship between drivers' awareness and perception of the damaging effects of CO2 emissions on the environment. It seeks to understand how drivers perceive the impact of their actions on CO2 emissions and the subsequent implications for the environment. The study also examines how drivers' perception of their role in CO2 emissions affects their attitudes and whether drivers are more aware of the damaging effects of CO2 emissions and hold more responsible attitudes towards their driving behavior.

Additionally, the research aims to determine whether drivers' knowledge and perception of CO2 emissions significantly influence their driving behavior and whether drivers' attitudes mediate the relationship between their awareness and perception of CO2 emissions and their driving behavior. The findings from this study can inform the development of interventions and policies aimed at promoting eco-friendly driving practices and mitigating the environmental impact of transportation.

Literature Review

Carbon Dioxide (CO2) emission

Emitting carbon dioxide (CO2) involves discharging carbon dioxide gas into the Earth's atmosphere (Mardani, 2019). Carbon dioxide (CO2) is widely acknowledged as a prominent greenhouse gas pivotal in climate change and global warming (Terrenoire, 2019). It is accepted that the release of carbon dioxide (CO2) by burning fossil fuels like coal, oil, and natural gas contributes to carbon footprints (Liu et al., 2015). Some examples of fossil fuels are coal, oil, and natural gas. The increase in carbon dioxide (CO2) emissions observed in the past century has exhibited a robust correlation with human activities, particularly the combustion of fossil fuels (Ameyaw, 2019). The exponential rise in carbon dioxide (CO2) emissions has been observed in tandem with industrialization and growing reliance on fossil fuel-based energy sources within societies (Paraschiv, 2020).

The rise in atmospheric carbon dioxide (CO2) levels has given rise to the greenhouse effect, wherein CO2 functions as a heat-trapping agent, hindering the dissipation of thermal energy into outer space and consequently causing an increase in the Earth's temperature (Anderson, 2016) (Mikhaylov, 2020). The implications of carbon dioxide (CO2) emissions are substantial and far-reaching. Climate change has been recognized as a significant and far-reaching issue in academic research (Aprea, 2012; Yamori, 2022). The principal reason for the rise in average temperatures around the planet is the growing levels of atmospheric carbon dioxide (CO2) as well as other greenhouse gases in the Earth's atmosphere of the Earth. The phenomenon is something that scientists are now investigating. The factors mentioned earlier play a significant role in ice cap melting, leading to an elevation in global sea levels.

The increase in sea levels leads to heightened weather phenomena and induces changes in ecological systems. Furthermore, it has been observed that this phenomenon has the potential to cause disturbances in agricultural practices and exert adverse effects on the availability of water resources (Baker, 2018; McGowan, 2020). Carbon dioxide (CO2) emissions also substantially impact the exacerbation of air pollution and the degradation of air quality. When fossil fuels are burned, toxic chemicals and particles are released into the atmosphere, as stated by (Liu, 2020). Carbon dioxide (CO2), sulfur dioxide (SO2), nitrogen oxides (NOx), and particulate matter are all examples of such gases and particles. The presence of these pollutants has been observed to have adverse effects on human health, specifically leading to respiratory diseases, cardiovascular conditions, and increased susceptibility to infections. The coexistence of carbon dioxide (CO2) emissions and other air pollutants poses significant hazards to both human health and the environment (López a, 2023).

As stated by Benamara (2019), the imperative to mitigate climate change and advance sustainability requires the reduction of carbon dioxide emissions. This objective can be attained by adopting alternative energy sources, including solar, wind, and hydroelectric power. In order to mitigate carbon dioxide (CO2) emissions, it is imperative to employ a range of strategies, including but not limited to improving energy efficiency, advocating for

conservation practices, adopting sustainable transportation methods, implementing sustainable practices in industries, and incorporating sustainable agricultural techniques (Yang, 2023; Azam, 2023). The Paris Agreement, in conjunction with a range of international policies, seeks to mitigate the emission of greenhouse gases. Many nations have committed to reducing emissions, shifting towards economies with lower carbon footprints, and adopting targeted strategies for mitigating CO2 emissions. It has been determined that implementing carbon pricing systems, providing subsidies for renewable energy sources, and developing novel technology are all necessary steps (Falkner, 2016; Delbeke, 2019).
Andong (2017) asserts that individuals can effectively mitigate CO2 emissions by adopting intentional lifestyle choices, such as selecting public transportation or participating in carpooling, adopting energy-efficient equipment and practices, and supporting sustainable businesses and initiatives. As people worldwide learn more about the effects of CO2 emissions on things like climate change, air quality, and human health, they become more alarmed by the situation. Therefore, the imperative to mitigate CO2 emissions is paramount in effectively tackling the issue of climate change and advancing the principles of sustainability (Azarkamand, 2020). In order to ensure the preservation of the ecosystem and facilitate a more resilient global environment for future generations, individuals must mitigate carbon dioxide emissions by adopting cleaner energy sources and promoting sustainable behaviors (Mossler, 2017).

Impact of CO2 Emission on the Environment

CO2 emissions harm the environment, accelerating climate change and fueling global warming (Waheed, 2018). Increasing CO2 levels harm ecosystems, biodiversity, and the environment because CO2, a greenhouse gas, absorbs heat (Yoqutxon, 2022). Excessive carbon dioxide (CO2) emissions from human activities, most notably the combustion of fossil fuels, cause global warming. Rising sea levels, altered weather patterns, storms, and the prevalence of severe weather, including droughts and heat waves, are all consequences of global warming, contributing to melting ice caps and glaciers (Peters, 2013).
Ecosystems and biodiversity are also affected by rising CO2 because many species are sensitive to temperature fluctuations, and habitat changes may interrupt their life cycles and migratory patterns. Furthermore, rising CO2 levels raise ocean temperatures, bleaching coral reefs and destroying vital marine ecosystems (Ziska, 2022). Temperature and precipitation changes may affect plant and animal distribution and abundance, causing ecosystem alterations and biodiversity loss (Hisano, 2018).
CO2 emissions acidify oceans because seawater absorbs excess CO2 and forms carbonic acid, which lowers ocean pH (Mossler, 2017). Acidic waters may harm marine life, especially shell-building species. Increased acidity makes it harder for these animals to create and maintain their structures, threatening coral reefs, shellfish populations, and other marine species at the bottom of the food chain (Nagelkerken, 2015). CO2 emissions may degrade ecosystems, animal habitats, and agriculture production, causing respiratory and cardiovascular ailments (Six, 2013). Reduce greenhouse gas emissions and switch to sustainable energy to mitigate the environmental effects of CO2 emissions (Khezri, 2022; Vo, 2020).
Renewable energy, energy efficiency, sustainable transportation and industry, and preserving forests and other carbon sinks are all essential. International accords like the Paris Agreement establish emission reduction objectives and promote worldwide collaboration to reduce global warming and CO2 emissions (Falkner, 2016). CO2 emissions must be understood and addressed to mitigate global warming, conserve ecosystems and biodiversity, and ensure our

planet's long-term health and sustainability. Everyone must work together to cut CO2 emissions and move to a low-carbon, sustainable future (Schneider, 2019; Michaelowa, 2019).

Drivers' Awareness of CO2 Effect on the Environment

The importance of drivers' understanding of the environmental impact of CO2 emissions cannot be overstated in fostering sustainable driving behaviors and reducing the environmental consequences associated with vehicular activities (Abdul Aziz, 2015). According to Luís (2018), drivers can enhance their decision-making abilities, adopt environmentally conscious driving practices, and contemplate alternative transportation options by comprehending the ramifications associated with carbon dioxide emissions originating from vehicles.

This knowledge enables drivers to acknowledge their role in addressing climate change and motivates them to act. Drivers who know the Impact of CO2 emissions on the environment are more inclined to embrace environmentally conscious driving practices, including but not limited to minimizing idling time, ensuring appropriate tire pressure, refraining from aggressive driving behaviors, and maximizing fuel efficiency. In addition, Khan (2020) emphasizes the significance of prioritizing vehicle maintenance to achieve optimal engine performance and fuel economy.

The level of awareness regarding the Impact of CO2 emissions can influence the decision-making process of drivers when it comes to the purchase or lease of vehicles. This influence can be observed in the preference for fuel-efficient hybrid or electric cars emitting lower CO2 emissions (Sottile, 2015). In addition, individuals may contemplate alternative modes of transportation, such as utilizing public transportation, engaging in carpooling arrangements, or opting for biking, when appropriate. This acknowledgment is rooted in understanding the potential decrease in emissions linked to these alternatives (Buwana, 2016)

According to Alkhateeb (2020), implementing educational campaigns, public awareness initiatives, and government regulations plays a crucial role in enhancing drivers' understanding of the Impact of CO2 emissions on the environment. The primary objective of these endeavors is to widely distribute precise and easily comprehensible information regarding the ecological consequences associated with carbon dioxide (CO2) emissions from automobiles.

This initiative seeks to foster informed decision-making that actively supports the reduction of individuals' carbon footprint and ameliorates the environmental ramifications stemming from their transportation preferences (Vasilev, 2021). Furthermore, the consciousness of drivers regarding the Impact of CO2 emissions on the environment can create a ripple effect throughout society, serving as a source of inspiration and influence for others to embrace sustainable driving behaviors. Cultivating collective awareness and subsequent action can foster a societal ethos centered on environmental consciousness, facilitating a transition towards more sustainable transportation alternatives (Wals, 2017).

Drivers' Perception of CO2 Effect on the Environment

Drivers' perceptions of the Environmental Impact of CO2 emissions from automobiles significantly impact their attitudes, beliefs, and actions toward carbon emissions and sustainability (Ali, 2018). Some drivers may be well-versed in the scientific facts about CO2 emissions and see them as a serious environmental concern, leading to eco-friendly driving behaviors and vehicle selection (Cologna, 2022). However, others may need to understand the link between CO_2 emissions and environmental repercussions, leading to less incentive to improve driving habits or make environmentally responsible decisions (Meseguer, 2017).

According to Schäfer (2014) external variables, such as media influence, societal standards, and cultural values, also affect drivers' perceptions of CO_2's environmental Impact (Stamm, 2000). Positive media depictions of sustainable driving behaviors and environmental efforts can improve drivers' perceptions and inspire them to adopt a more environmentally aware mentality (Marisa Dispensa, 2003). Societal norms that value sustainability and responsible environmental stewardship may also impact drivers' perceptions and lead to a higher feeling of personal responsibility in lowering CO_2 emissions (Wilson, 2013). Effective communication and education initiatives are crucial in altering drivers' perceptions of the Environmental Impact of CO_2 (Irfan, 2022).

Dispelling misunderstandings and filling knowledge gaps concerning the environmental impacts of CO_2 emissions requires information that is both clear and intelligible. As a result, they may develop a stronger sense of individual accountability and be more motivated to reduce their environmental impact (Kolenat, 2022). Personal experiences and observations can also alter drivers' perceptions of the CO_2 effect on the environment. Experiences with climate change, such as severe weather occurrences or the loss of natural landscapes, can cause drivers to reconsider their viewpoint and become more conscious of the need to reduce CO_2 emissions (Arroyo-López, 2021).

In conclusion, drivers' perceptions of the Environmental Impact of CO_2 emissions affect their attitudes and actions toward carbon emissions. Understanding drivers' perceptions is crucial for successful communication and education methods to encourage environmentally friendly driving habits (Khazaei, 2021). By molding a positive view and cultivating a feeling of personal responsibility, drivers can make environmentally conscious decisions and reduce CO_2 emissions by fostering a sense of personal responsibility and minimizing the environmental impact of their driving behavior (Ayyildiz, 2017).

Drivers' attitude towards CO_2's effect on the environment

Drivers' attitudes towards CO_2 emissions and their environmental impact are influenced by their views, values, and emotional disposition. Positive attitude's view CO_2 emissions as a significant environmental problem and worry about their Impact (Keyvanfar, 2018). These drivers are more likely to proactively reduce their carbon footprint through sustainable driving behaviors and vehicle selection. Conversely, neutral or apathetic views may result in drivers lacking the incentive to improve their driving habits or make environmentally responsible decisions (Bigerna, 2017).

External variables, such as societal standards, peer influence, and cultural values, also influence drivers' views on the Environmental Impact of CO_2 (Zacharof, 2016). Positive societal norms that promote sustainability and environmental responsibility influence drivers' attitudes toward lowering CO_2 emissions. Peer pressure and societal pressure to adopt sustainable behaviors also impact drivers' attitudes and promote a feeling of collective responsibility (Lois, 2019).

Effective communication and education initiatives are crucial in altering drivers' views on the Environmental Impact of CO_2 (Waygood, 2016). Informative and persuasive communications emphasizing the environmental repercussions of CO_2 emissions can raise awareness and instill worry and a feeling of personal responsibility (Lu, 2018). Concrete examples of the beneficial influence of sustainable driving behaviors can also shift drivers' views toward more favorable and proactive positions (Zhang, 2022).

Personal values, beliefs, and emotional reactions also impact drivers' views regarding the CO2 effect on the environment (Adnan, 2017). Those with strong environmental values and a sense of responsibility for the Earth are more likely to have positive attitudes and be more inclined to act. Empathy for the effects of climate change or a personal connection to the environment may also alter drivers' attitudes and push them to adopt environmentally responsible decisions (Gatersleben, 2014).

In conclusion, drivers' attitudes regarding the environmental impact of CO2 are necessary for affecting their intentions and actions toward carbon emissions is crucial for developing successful communication and education methods to encourage environmentally friendly driving habits. By fostering positive attitudes, increasing awareness, and appealing to personal values and emotions, drivers can be motivated to adopt more environmentally conscious behaviors and contribute to reducing CO2 emissions (Liu et al., 2017).

Drivers driving behavior and Impact on the Environment.

Driver behavior significantly impacts the environment, particularly CO2 emissions and transportation sustainability (Fafoutellis, 2020). Speed, acceleration, braking, idling, vehicle maintenance, and fuel economy are essential factors in determining CO2 emissions and driving sustainability (Sanguinetti, 2017). Speed is crucial, as high speeds necessitate more fuel usage, resulting in higher CO2 emissions. Maintaining a constant speed and smooth acceleration and deceleration can significantly increase fuel economy and CO2 emissions (Mane, 2021). Idling is another environmentally damaging activity, consuming too much gasoline and emitting too many pollutants. Regular car service, correct tire pressure, and engine maintenance can increase fuel efficiency and minimize CO2 emissions (Miotti, 2021). Fuel economy is another crucial factor in driving behavior and environmental effect (Zhang et al., 2020). Choosing fuel-efficient automobiles, such as hybrid or electric vehicles, can significantly reduce CO2 emissions (Peters et al., 2011). Additionally, avoiding overloading, reducing extraneous weight, and using air conditioning sparingly can help reduce emissions.

Driving habits may also impact environmental factors, such as CO2 and particulate matter, which harm air quality and human health (Érika et al., 2020). Promoting sustainable driving behaviors is critical for reducing the environmental effect of driving. Education and awareness programs highlighting eco-driving strategies, such as keeping a constant speed, avoiding excessive idling, and adopting fuel-efficient driving habits, can encourage drivers to adopt more environmentally friendly behaviors (Huang, Eco-driving technology for sustainable road transport: A review, 2018). Technological improvements and the availability of environmentally friendly automobiles, such as electric or hybrid vehicles, can also help reduce CO2 emissions and air pollution. The advancement of charging infrastructure and renewable energy sources contributes to the long-term viability of electric vehicles. Driver conduct plays a significant role in determining CO2 emissions and driving sustainability.

Theoretical Framework

A research model (see Figure 1) has been developed to elucidate the interrelationships among several factors, drawing upon insights gleaned from prior investigations. The model facilitates the identification of interrelationships among various phenomena under investigation. This model focuses on examining driver behavior within society as its primary area of investigation. It is posited that individuals' behavior is contingent upon their affective response to the environmental consequences associated with carbon dioxide emissions. This can be called their "stance" or "perception" regarding CO2 emissions. Now, what factors influence their

attitude? Two crucial factors that exert influence are awareness and perception. Awareness pertains to individuals' level of knowledge and comprehension regarding the detrimental impacts of carbon dioxide (CO2) emissions on the environment.
Perception, conversely, pertains to an individual's subjective observation and interpretation of these phenomena. Hence, the objective is to examine the impact of individuals' cognitive and affective states on their driving behavior in relation to carbon dioxide (CO2) emissions. Individuals' cognitive and affective aspects, including their knowledge and comprehension of the detrimental consequences associated with emissions and their subjective perception and interpretation of these impacts, contribute to forming their thoughts, feelings, and attitudes.

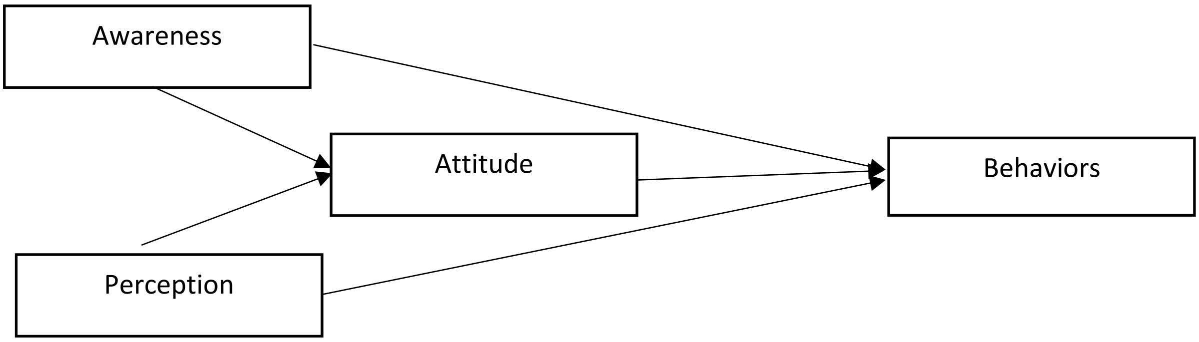

Figure 1: Theoritical Framework

Methodology
Convenience sampling was used in this research to gather information from a broad population quickly. This sampling technique was chosen because it is quick, cost-effective, and allows accessible data collection. In order to minimize sampling bias, the study made efforts to include various types of respondents, such as college students, teachers, professionals, and non-professionals within the study area. Before conducting the main survey, a pilot test was conducted with 30 respondents to ensure that the questions were clear and understandable.
The questionnaires were divided into five sections: A, B, C, D, and E. Section A captured demographic information about the respondents. Section B included general questions about a specific topic. Section C comprised inquiries specifically formulated to assess individuals' level of awareness, perception, and attitudes on the detrimental consequences of carbon dioxide (CO2) emissions on the environment and their impact on drivers' behavior. The constructs were assessed utilizing a 5-point Likert scale, which spanned from strongly disagree to agree strongly.

Demographics
A total of 600 questionnaires were distributed in the Klang Valley, which has an approximate population of 3 million. After removing outliers and erroneous responses, 425 valid responses were obtained. The demographic profiles of the participants are provided in Table 1.

Table 1
Demographic Factor of Respondent (N=425)

Demographic Factors	Categories	Frequency	Percentage
Age	Under 18	1	0.2
	18-24	104	24.5
	25-34	82	19.3
	35-44	87	20.4
	45 and above	151	35.5
Gender	Women	135	31.8
	Man	290	68.2
Traveling Activities	To college	85	20.0
	To work	279	65.7
	To do house chore	61	14.4
Distance of Daily Traveling	less than 50km	314	73.8
	50 - 100 km	83	19.5
	100-150 km	16	3.8
	150 - 200km	4	0.9
	more than 200km	8	1.9
Employment Status	Employed full time	290	68.2
	Employed part-time	50	11.7
	Own business	39	9.2
	Retired	46	10.8

Normality Test

The normality test (see Table 2) presents statistical results for all the indicators used in the research. It provides insights into the distribution and characteristics of the scores. The indicator with code db2_4 shows a minimum mean value of 2.27, indicating the lowest average score observed among the indicators. Conversely, the indicator with code db1_1 shows a maximum mean value of 4.18, representing the highest average score obtained among the indicators. The standard deviation values reflect the spread or variability of the scores. Indicator db1_3 shows the lowest standard deviation value of 0.993, suggesting a relatively low dispersion of scores, indicating that the data points are closely clustered around the mean.

Conversely, the indicator aw2_2 shows the highest standard deviation value of 2 signifies more significant variability in the scores, implying a wider distribution. Skewness measures the asymmetry of the score distribution. The range of skewness values between -1.228 and 0.638 suggests that the scores deviate from a perfectly symmetrical distribution. Negative skewness (-1.228) indicates a longer tail on the left side of the distribution, while positive skewness (0.638) signifies a longer tail on the right side of the distribution. Kurtosis, on the other hand, assesses the shape of the distribution, specifically the presence of extreme values.

The range of kurtosis values between -1.088 and 0.936 suggests that the scores deviate to some extent from the shape of a normal distribution. Negative kurtosis (-1.088) implies the distribution has fewer extreme values than a normal distribution, while positive kurtosis (0.936) indicates a distribution with more extreme values. Therefore, based on the range of skewness and kurtosis values observed, most of the indicators in the research exhibit relatively normal distributions, with acceptable skewness values indicating approximate symmetry.

Table 2
Normality Test

Code	Indicator(s)	Mean	Std. Deviation	Skewness	Kurtosis
aw2_1	Have you heard that it is important to protect the environment?	4.11	1.973	-0.143	-0.967
aw2_2	Have you heard of the term "eco-friendly" before?	4.08	2	-0.127	-1.04
aw2_3	Have you known what it means to be eco-friendly?	3.84	1.912	-0.019	-0.995
aw2_4	Have you ever taken any actions to be more eco-friendly?	3.59	1.855	0.213	-0.928
db2_4	Have you ever engaged in aggressive driving behaviors, such as overtaking other vehicles or tailgating?	2.27	1.345	0.638	-0.891
db2_6	Have you ever typically accelerated while exiting a toll booth?	2.53	1.328	0.307	-1.088
db1_1	Keep your car well-maintained: Regular maintenance and service of your vehicle will help it run more efficiently and have fewer emissions.	4.18	1.005	-1.228	0.936
db1_2	Drive smoothly: Rapid acceleration and sudden braking can cause your vehicle to consume more fuel and produce more CO2 emissions. To reduce the amount of CO2 released, try to drive smoothly and av...	3.95	1.049	-0.932	0.317
db1_3	Check your tire pressure: Underinflated tires can increase fuel consumption and CO2 emissions. Regularly check your tire pressure and make sure they are inflated to the recommended level.	4.02	0.993	-0.925	0.413
em_11	How often do you feel in a hurry while driving?	3	1.022	-0.018	-0.394
em_12	How does feeling in a hurry affect your driving style?	2.99	1.077	0.008	-0.548

Tests for confirmatory factor analysis (CFA)
Before using the Partial Least Square Structural Equation Modelling (PLS-SEM) to test our framework, we conducted a Confirmatory Factor Analysis (CFA) on all the measurement indicators together. This analysis helped us evaluate the measurement model and identify any terms that did not strongly contribute to the constructs we were studying. We removed those terms with factor loadings less than 0.50. After conducting the CFA tests, we found that four factors explained over 80% of the variance. The sample size was considered adequate, indicated by the Kaiser-Meyer-Olkin Measure of Sampling Adequacy measure, which was 0.712.
Additionally, Bartlett's Test of Sphericity gave a p-value of less than 0.001, indicating a significant relationship among the variables. These tests helped us evaluate the reliability and validity of our questionnaire. We used a measure called Cronbach's Alpha, and all four

dimensions of our questionnaire showed reliability values above 0.70, which is considered good. This means that the questionnaire is reliable and consistent in measuring what it intends to measure. To establish construct validity, we examined the standardized factor loadings. A factor loading of 0.40 or higher is acceptable, but ideally, it should be 0.70 or higher. In the present investigation, it was observed that all the factor loadings satisfied or surpassed the established criteria, thereby suggesting that the questionnaire effectively assesses the specific factors under investigation.

Table 2
Confirmatory Factor Analysis (CFA)

Indicator(s)	Perception	Attitude	Awareness	Behaviors	α
aw2_1			0.913		
aw2_2			0.937		0.94
aw2_3			0.914		
aw2_4			0.909		
db2_4				0.789	0.78
db2_6				0.798	
db1_1		0.807			
db1_2		0.802			0.86
db1_3		0.85			
em_11	0.737				0.93
em_12	0.759				
Eigenvalues	3.562	2.141	1.772	1.145	
X^2 Chi-Square	2906 (45)				
P-value	<0.001				
%of variance	86.2				

Note: α = Cronbach’s Alpha; *p <.05.

Measurement Model Assessment

Table 3 summarizes the results for assessing the convergent validity of the measurement model. The indicators used to measure the different constructs in the model met the minimum requirements, with loading values above 0.70 (Hair et al., 2012). This means that the indicators effectively measure the intended constructs. Furthermore, it is worth noting that the Average Variance Explained (AVE) for each construct exceeded the threshold of 0.50, as reported by (Hair et al., 2017).

This finding suggests that the indicators employed in the study effectively capture a substantial proportion of the construct's variability. This demonstrates that the indicators are reliable in capturing the essence of each construct. Furthermore, the reliability tests for each construct, including the Composite Reliability and Cronbach's Alpha, were above 0.70 (Hair et al., 2017). This suggests that the measurement model is reliable and consistent in measuring the constructs.

Table 3
Measurement Model

Constructs	Indicator(s)	Loading	AVE	γ
Awareness	aw2_1	0.912*	0.868	0.963
	aw2_2	0.934*		
	aw2_3	0.945*		
	aw2_3	0.935*		
Behaviors	db2_4	0.817*	0.755	0.86
	db2_6	0.918*		
Attitude	db1_1	0.883*	0.756	0.903
	db1_2	0.905*		
	db1_3	0.819*		
Perceptions	em_11	0.967*	0.939	0.969
	em_12	0.971*		

Note: AVE = Average Variance Explained; γ = Composite Reliability, *p <.05.

Table 4 presents the results of the Fornell-Larcker analysis, which was used to assess the discriminant validity of the model. This analysis confirms that each construct in the model is distinct from the others because the values on the table's diagonal are greater than those off the diagonal (Fornell, 1981) (Hair, 2017). Therefore, the results in Table 4 show that each construct in the model differs from the others. This means that the indicators used to measure each construct effectively capture the unique aspects of that construct and do not overlap with indicators of another construct.

Table 4
Fornell-Larcker Discriminant Analysis for Measurement Model.

	Attitude	Awareness	Behaviors	Perception
Attitude	0.870			
Awareness	0.299	0.931		
Behaviors	0.733	0.308	0.869	
Perception	0.552	0.154	0.652	0.969

Structured Model Assessment

The structural analysis results (see Table 5) show that approximately 35.2% of the variation in Attitude can be explained by the two independent variables. This means that these variables significantly influence shaping people's attitudes, accounting for a good portion of the variability observed in Attitude. Similarly, the independent variables explain about 63.5% of the variation in Behavior. This indicates that Awareness, Perception, and Attitude significantly influence people's behaviors, explaining a substantial portion of the observed variability in Behavior. Furthermore, the independent variables demonstrate small to medium effect sizes, ranging from 0.026 to 0.452 (Hair et al., 2012).

This suggests that the independent variables have a noticeable impact on Attitude and Behavior, although the effect sizes are relatively small. The predictive validity of the independent variables is also noteworthy, with a value of 0.342 for predicting Attitude and 0.462 for predicting Behavior. This indicates that the independent variables can predict or forecast individuals' attitudes and behaviors to a moderate extent.

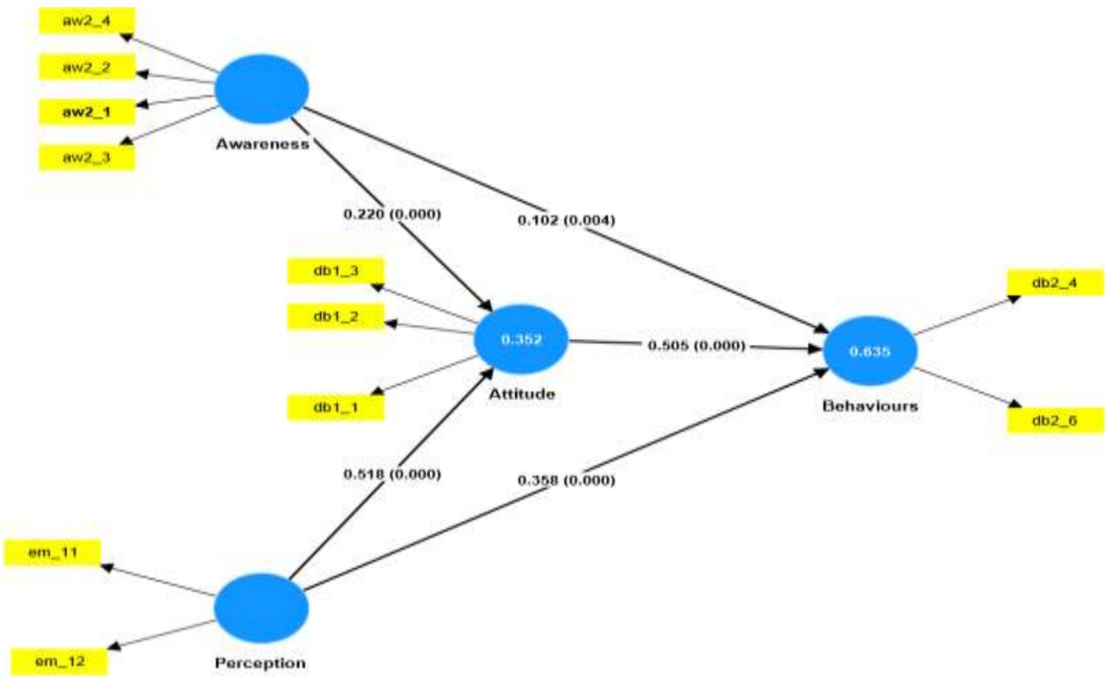

Figure 2 : Path Coefficient and P-Value for Structured Model

Figure 2 and Table 5 shows the results of structural analysis. Results in table 5 indicates that Awareness (β = 0.220, t = 5.383, p <.05; 95% Bootstrap-t: (0.14, 0.298)) and Perception (β = 0.518, t = 12.592, p <.05; 95% Bootstrap-t: (0.434, 0.597)), have a positively significant effect towards Attitude. Thus, Awareness and Perception have a significant positive effect on Attitude. Meanwhile Awareness (β = 0.102, t = 2.902, p <.05; 95% Bootstrap-t: (0.033, 0.173)), Perception (β = 0.358, t = 7.478, p <.05; 95% Bootstrap-t: (0.263, 0.451)), and Attitude (β = 0.505, t = 11.113, p <.05; 95% Bootstrap-t: (0.417, 0.592)) simultaneously have a positive significant effect towards Behavior. Furthermore, the results also show that Awareness, Perception, and Attitude all have a positive influence on Behavior.
This means that individuals who are more aware of the damaging effects of CO2 emissions, perceive their own contribution to these emissions, and have a positive Attitude towards environmental issues are more likely to engage in behaviors that align with protecting the environment.

Table 5
Structural Model Assessment

Path	Outcomes	Beta	SE	*t-statistics*	*p-value*	95%Bootstrap-t LLCI	ULCI	f^2	q^2
Awareness -> Attitude	Attitude	0.220	0.041	5.383	0	0.14	0.298	0.073	0.342
Perception -> Attitude		0.518	0.041	12.592	0	0.434	0.597	0.405	
Attitude -> Behaviors	Behaviors	0.505	0.045	11.113	0	0.417	0.592	0.452	0.462
Awareness -> Behaviors		0.102	0.035	2.902	0.004	0.033	0.173	0.026	
Perception -> Behaviors		0.358	0.048	7.478	0	0.263	0.451	0.243	

Note: SE = Standard Error ,*f2* = Effect Size; *q2* = Predictive Relevance; The bootstrap samples were 5000 samples; *p <.05.

Motivation And Contribution of This Study

Responsible driving is essential for reducing emissions and promoting a sustainable future. By understanding the relationship between driving, CO2 emissions, and the environment, drivers can make intelligent choices and reduce their carbon footprint. This research can help drivers comprehend the environmental impacts of their actions, leading to behavior change, alternative transport, technology adoption, and policy and advocacy. By promoting eco-friendly driving practices, promoting alternative transportation, and adopting eco-friendly technology, drivers can reduce emissions, combat climate change, and preserve the ecosystem for future generations. By educating drivers on their behavior and CO2 emissions, they can promote sustainable mobility, build successful regulations, engage lawmakers, and advocate for low-emission car incentives, renewable energy investment, and sustainable urban design. By doing so, responsible driving can help reduce emissions, mitigate climate change, and preserve the ecosystem for future generations.

Conclusion and Recommendations

This research demonstrates the significant influence of Awareness, Perception, and Attitude on both Attitude and Behavior concerning CO2 emissions and environmental issues. The structural analysis revealed that these variables explain a considerable portion of the variability in Attitude (35.2%) and Behavior (63.5%). The findings emphasize the importance of raising awareness and improving perception among individuals about the detrimental effects of CO2 emissions on the environment. Practical strategies, such as educational campaigns and targeted interventions, can enhance public knowledge and understanding (de Lange, 2019). By doing so, individuals are more likely to develop positive attitudes toward environmental issues, leading to sustainable and eco-friendly behaviors.

Additionally, recognizing the impact of individual contributions to CO2 emissions and promoting environmentally conscious actions through community engagement and social media campaigns are recommended (Mavrodieva, 2019). This research highlights the need for comprehensive approaches to address drivers' awareness, perception, attitudes, and behaviors regarding CO2 emissions, aiming to mitigate environmental impact and foster a greener future. Based on these findings, it is recommended to focus on raising awareness and improving perception among individuals regarding the damaging effects of CO2 emissions on the environment.

Educational campaigns, information dissemination, and targeted interventions can enhance public knowledge and understanding. Increasing awareness and perception makes individuals more likely to develop positive attitudes toward environmental issues, which can drive sustainable and environmentally friendly behaviors. Furthermore, efforts should be made to promote the importance of individual contributions to CO2 emissions and the potential for positive change through individual actions. This can be achieved through community engagement, social media campaigns, and collaborative initiatives that encourage and reward environmentally conscious behavior.

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