

Factors of Old Vehicles Contributing to Air Pollution in The Urban Environment

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Abstract

Air pollution poses a significant threat to climate change and the deterioration of air quality, particularly in metropolitan cities. The use of private vehicles in the transportation sector significantly contributes to poor air quality. However, old vehicle usage in the city has increased, hence the increase in harmful emissions. This study explores various factors contributing to the impact of old vehicles on air pollution in urban areas. This research also investigates the interaction and relationship of multiple factors, such as fuel consumption, driving patterns, mobility behavior, maintenance and repair and vehicle age with carbon emissions. This study uses a quantitative research approach using a questionnaire survey in Kuala Lumpur. The targeted respondents were vehicle users who use vehicles 10 years old and older. Simple random sampling was used in this study, and 384 questionnaires were disseminated to the targeted respondents. The data were analyzed through Descriptive Analyses and Pearson Correlation. Pearson Correlation was conducted to determine the relationships between fuel consumption, driving patterns, mobility behavior, maintenance and repair and vehicle age with carbon emissions. The findings indicate a significant positive relationship between fuel consumption, driving patterns, mobility behavior, maintenance and repair and vehicle age with carbon emissions in urban areas.

Keywords: Air Pollution, Transportation, Old Vehicles, Carbon Emission, Urban Environment

Introduction

Transportation is known as one of the most developing sectors worldwide as it provides services for people. The surge of private vehicles in urban areas can be attributed to the growth of population and the advancement of economic development (Sharma et al., 2011). Urban employment opportunities have led to more private vehicle use due to the migration

of rural residents to cities (Yasin et al., 2022). In Malaysia, many people still use old vehicles for their daily transportation needs. The rise in aging vehicles in the cities has increased due to rapid urbanization and increased demand for cars (Fourn & Fayomi, 2006). Besides, low-income individuals tend to keep their old vehicles as they cannot afford to buy new vehicles.

According to the President of the Automotive Accessories Traders Association of Malaysia, 19 million out of 33 million registered vehicles were 10 years old and older (Ahmad, 2022). The use of older vehicles causes air pollution and worsens climate change. The primary pollutants released by road transportation include carbon dioxide (CO₂), nitrogen oxides (NO_x), carbon monoxide (CO), and particulate matter. Vehicles also emit significant amounts of greenhouse gases, primarily CO₂. For instance, high CO₂ emissions are released by aging vehicles (Marino et al., 2023). The transportation sector in Malaysia contributes a total of 85.2% of CO₂ emissions (Mustapa & Bekhet, 2016).

The use of old vehicles contributes to high levels of air pollutants. Old vehicles are defined as vehicles that are more than 10 years old (Knight, 2021). According to Das et al. (2022), vehicles lose fuel efficiency due to aging and poor maintenance, causing engine components to malfunction and release pollution when left unused for extended periods. This is because old vehicles with old engine technology tend to release more pollution (Bikam, 2021). Besides, the age of vehicles is directly connected to the mileage, which contributes to increasing greenhouse gas emissions. Wadud et al (2022) asserted that even though the mileage is lower for aging vehicles, they tend to release high levels of CO₂. Despite the harmful emissions they release, many old vehicles remain on the roads, exacerbating environmental pollution. It is crucial to identify the factors that contribute to the impact of aging vehicles on carbon emissions, especially in urban areas.

The following hypotheses are developed to determine the relationship between fuel consumption, driving pattern, mobility behavior, maintenance and repair, age of vehicles, and carbon emissions.

H1: Fuel consumption and carbon emissions have a positive relationship.

H2: Driving patterns and carbon emissions have a positive relationship.

H3: Mobility behavior and carbon emissions have a positive relationship.

H4: Maintenance and repair and carbon emissions have a positive relationship.

H5: Vehicle age and carbon emissions have a positive relationship.

Literature Review

Carbon Emissions

Carbon emissions can be defined in terms of types, sources, and characteristics. Generally, carbon emission causes pollution problems and environmental degradation. However, greenhouse gas emissions are often referred to as CO₂ emissions. Carbon dioxide emissions are a type of greenhouse gas, according to the United States Environmental Protection Agency (EPA). While numerous studies examined the effect of environment of the transportation sector, only a few have specifically focused on carbon emissions. According to Su et al. (2022), the transportation sector is one of the primary contributor to global carbon emissions, and human activities account for 80% of global CO₂ emissions (Heede, 2014). However, CO₂ emission from the motor vehicles particularly private vehicle emissions are still dominated in Malaysia (Ghadimzadeh et al., 2015). According to the International Energy Agency (2019), Malaysia's transportation industry produce 28.8% of CO₂ emission from fuel combustion which accounted 24.5% more than the world average. As a result, there must be a clear understanding on the factors that contributes to the emissions of CO₂ particularly from

old vehicles. In this study, the emissions of CO₂ reflect the perception of public regarding old vehicles emissions.

Fuel Consumption

According to the National Research Council (2011), fuel consumption can be defined as the inverse of a fuel economy. Moreover, according to Mathew (2014), fuel consumption is defined as the amount of fuel consumed per unit distance and it is usually expressed in liters/100 km. For instance, the lower the value of fuel consumed by vehicles, the higher savings occur. Additionally, fuel consumption is the amount of vehicle fuel that is used to travel to a particular distance. The efficiency of the fuel depends on a conversion of energy. Furthermore, there is a strong correlation between fuel consumption and carbon emissions. An old engine with inadequate emissions reduction technology results in higher fuel consumption and carbon emissions (Assamoi & Lioussé, 2010). Fuel quality is also one of the major contributors to vehicle emissions. The use of cleaner fuels is essential to reduce air pollution from vehicles, particularly from aging vehicles. Das et al (2022) argued that diesel-powered vehicles contribute to higher emissions due to being old and poorly maintained. Additionally, Saboori et al. (2014) claimed that the transportation sector consumes high fuel consumption, which significantly contributes to carbon emissions.

Driving Patterns

Driving patterns play an important role in understanding drivers' behaviors when operating their vehicles because they may have a huge impact on vehicle performance (Barothi et al., 2018). Each driver can have a distinct pattern of driving; it can be a good or bad habit. Generally, irregular driving patterns may lead to vehicle malfunction and failure that lead to high carbon emissions (Bikam, 2021). The concept of driving pattern does not include route choice, travelling mode and trips generation. Identifying driver patterns plays an important role in modelling and understanding the driver's behavior. In urban areas, changes in vehicle operation, particularly in traffic conditions, may affect vehicle emissions (Rodríguez et al., 2016). On a similar note, Szumska and Jurecki (2020) argued that aggressive driving patterns may contribute to high levels of vehicle pollutants.

Mobility Behavior

The changes in mobility behaviors such as vehicle travelled distance, number of trips, heavy loads, the length of the route, purpose of the trips and vehicle ownership pattern may have a positive environmental impact. Mobility can also be defined as the complex of interconnected practices and intersection of other daily practices. Furthermore, it is also imperative to determine the changes in the mobility behavior of vehicle users. According to Snyder et al (2014), vehicle mileage and vehicle trips determined the vehicle emissions. For instance, the Ministry of Road Transport and Highways India (2012) claimed that aging vehicles with lower mileage emit higher carbon emissions. Meanwhile, Amatuni et al (2020) suggested that car sharing could reduce the level of greenhouse gas emissions. Besides, vehicles that spend more time on the road tend to emit more pollution. Therefore, mobility behavior has a significant impact on the energy level in urban transportation, particularly with the use of older vehicles.

Maintenance and Repair

Maintenance and repair in the motor vehicle industry is important and one of the components of customer service. This is to ensure the quality of the product is well maintained. Vehicle maintenance refers to regular maintenance activities that ensure a vehicle is in a good working condition, runs smoothly and prevent breakdown (Gomathy, 2022). Motor vehicles need to be regularly maintained and repaired to ensure vehicle safety. For instance, regular inspections, oil changes, tire rotations, brake checks, filter replacement and other preventative measure is important to ensure the vehicles is function efficiently and safely (Grimaldi, 2022; Theissler et al., 2021). Maintenance and repair are one of the critical factors in reducing vehicle emissions. Poor vehicle maintenance can reduce its lifespan; for example, an engine that fails due to old technology can lead to high emissions (Peter, 2022). This could be due to a faulty catalytic converter or engine failure, resulting in high vehicle emissions. This is supported by Odunlami et al. (2018), who found higher pollutant concentrations in poorly maintained vehicles.

Vehicle Age

Vehicle age is another crucial factor in determining transport emissions (Caserini et al., 2013). Besides, it can also computed by totaling the number of years in between and including the model year and calendar year. Vehicle age can be categorized into a few parameters, such as model year, body type, and registration class (Varanasi, 2003). Pandey et al (2022) claimed that aging vehicles with high mileage tend to emit more exhaust particles compared to newer vehicles. This is corroborated by Namukasa et al (2020) who found a positive relationship between vehicle age and carbon emissions. As vehicle age increases, the effect of pollution released by the vehicles is higher compared to a new vehicle, which means an older vehicle is more harmful to the environment than a new one.

Methodology

Research methodology is vital as it aids the researcher in providing evidence for an idea and convincing others to support the idea. This study utilized descriptive analysis to achieve its objectives and aimed to determine the relationships between the independent and dependent variables. As part of a quantitative study, this research examines the relationship between fuel consumption, driving patterns, mobility behavior, maintenance and repair, vehicle age, and carbon emissions, utilizing Pearson Correlation to analyze these variables. Data was collected through questionnaires in order to achieve the study's objectives. Future researchers could collect data using qualitative methods like interviews and observations, which provide valuable insights and deeper understanding. This research was carried out in Kuala Lumpur City by distributing 384 questionnaires to the targeted respondents.

Data Collection

Kuala Lumpur is known as the most industrialized and economically fastest-growing region in Malaysia (Yasin et al., 2022). The metropolitan city attracts people from rural areas with a plethora of job opportunities, ultimately resulting in an influx of low-income migrants who tend to utilize old vehicles.

A survey using structured questionnaires based on the Likert Scale method was conducted among vehicle users to collect data. This questionnaire uses a 5-point Likert-type scale. The Likert Scale was arranged in a numerical scale from '1' to '5' ranging from 'strongly disagree' to 'disagree', 'not sure' and 'agree' to 'strongly agree'. The researcher uses a 5-point

Likert Scale as it would increase the response quality (Sachdev & Verma, 2004). The questionnaires were designed in Malay and English for better respondent comprehension. By providing questions in dual languages, every respondent can easily comprehend the questions and cater to diverse needs and preferences, making the survey experience more pleasant and effective.

The study exclusively targets old vehicle users, and the respondents were chosen using the simple random sampling method. Using the decision table by Krejci and Morgan (1970), 384 sets of questionnaires were disseminated among the targeted samples. Roscoe (1970) suggests that a sample size of at least 30 is required, as a rule of thumb. The study adopts a two-pronged approach, through WhatsApp and face-to-face methods, ensuring maximum participation from all segments of the study population.

Utilizing descriptive analysis, valuable insights shared by participants in the study were thoroughly scrutinized. Meanwhile, Pearson correlation analysis was conducted to examine the relationships between fuel consumption, driving patterns, mobility behavior, maintenance and repair, vehicle age, and carbon emissions. Pearson Correlation tests the variables' positive or negative correlation as per research hypotheses (Sekaran, 2003).

Findings and Discussion

Demographic Profile of Respondents

The analyses show that most of the respondents in this study were male (53.1%) followed by female (46.9%). The results were similar to those of the Department of Statistics Malaysia (2023), where the more considerable portion of the population in Kuala Lumpur was male (51.3%) while females made up 48.7% of its inhabitants. The findings also indicate that the majority of people in the age group of 41 to 50 years old (34.6%) used old vehicles compared to other age groups; below 20 years old (4.2%), 21 to 30 years old (17.7%), 31 to 40 years old (26.6%), 51 to 60 years (15.4%) and above 60 years old (1.6%). Moreover, most of the respondents are working (89.3%) followed by students (6.0%), unemployed (3.6 %) and retired (1.0%). Kuala Lumpur has been a commercial and economic administration since colonial times. Thus, more job opportunities were created in large cities such as Kuala Lumpur (Zahari et al., 2022).

Additionally, according to the Department of Statistics (2023), the percentage of employed people in Kuala Lumpur was 96%. Most of the vehicle ownership was more than 20 years (33.1%) whereas the lowest percentage of vehicle ownership was less than five years (18.2%). The outcomes suggest that most respondents belong to the B40 category (79.4%). Zahari et al (2022) argued that people who migrated from the rural areas to Kuala Lumpur city for job opportunities are primarily from a low-income group, or the B40 category. Due to financial constraints, individuals with low incomes often cannot afford to purchase new vehicles or obtain loans to do so. As a result, they continue to use their old vehicles (Pan, 2022).

Most of the survey participants (84.4%) reported using cars, while only a small minority (15.6%) used motorcycles. The survey results showed that over half of the respondents (52.9%) drove vehicles that were 22 years old or older. About 24.5% of the respondents were using vehicles in the range of 19 to 22 years old, 13.8% drove cars in the range of 15 to 18 years old, and only 13.8% were using vehicles in the range of 10 to 14 years old. Many of the respondents use their vehicles in the morning (80.7%), while 98.2% of the respondents use petrol for their vehicles. Table 1 shows the respondents' demographic profile of this study.

Table 1

Respondent demographic profile

Respondents	Profile	Frequency	Percentage
Gender	Female	180	46.9
	Male	204	53.1
	Total	384	100.00
Age	Less than 20 years	16	4.2
	21-30 years	68	17.7
	31-40 years	102	26.6
	41-50 years	133	34.6
	51-60 years	59	15.4
	60 above	6	1.6
	Total	384	100.00
Employment status	Student	23	6.0
	Working	343	89.3
	Unemployed	14	3.6
	Retired	4	1.0
	Total	384	100.00
Vehicle ownership	Less than 5 years	70	18.2
	5-10 years	97	25.3
	11-19 years	90	23.4
	More than 20 years	127	33.1
	Total	384	100.0
Household income group	B40 (Less than RM9150)	305	79.4
	M40 (RM9150-RM16,639)	75	19.5
	T20 (More than RM 16,640)	4	1.0
	Total	384	100.0
Type of vehicle frequently used	Motorcycle	60	15.6
	Car	324	84.4
	Total	384	100.0
Vehicle age (years old)	10-14	53	13.8
	15-18	34	8.9
	19-22	94	24.5
	>22	203	52.9
	Total	384	100.0
Time of the day often using Vehicle	Morning	310	80.7
	Afternoon	39	10.2
	Night	35	9.1
	Total	384	100.0
Type of fuel	Petrol	377	98.2
	Diesel	3	0.8
	Gasoline	0	0
	Hybrid	4	1.0
	Electric	0	0
	Total	384	100.0

Relationship between fuel consumption and carbon emissions

The results indicate a significant positive correlation between fuel consumption and carbon emissions. The findings are supported by other researcher where they indicate there are a positive correlation between fuel consumption and carbon emissions (Rongshuo et al., 2023). According to Song et al (2013), the major contributor to greenhouse gas emissions is road transportation because they are the major fuel consumers. The findings of this study also show that older vehicles tend to consume more fuel and therefore release high carbon emissions. Furthermore, Schwela (2012) argued diesel powered vehicles particularly use of low fuel quality in old vehicles contributes to high emissions. Old vehicles tend to lose its fuel efficiency as vehicle engine start to deteriorate. Therefore, use of fuel-efficient vehicles could reduce carbon emissions, especially in urban areas.

Relationship between driving patterns and carbon emissions

The findings show that there is a significant positive correlation between driving patterns and carbon emissions. Driving patterns are one of the major factors in the environmental impact caused by vehicles. Eva (2001) supported the findings where the results show that driving pattern and carbon emissions have significant relationship. The findings show aggressive driving in old vehicles contributes to higher carbon emissions. This is because a vehicle's engine may continue to wear out faster because high pressure will be applied on the pedals and hence released high pollution. Additionally, smooth gear changing in old vehicles is important as it will reduce the friction on the gearstick.

Relationship between mobility behavior and carbon emission

The study's finding demonstrates a significant positive correlation between carbon emissions and mobility behavior. Therefore, to minimize carbon emissions, limiting the use of old vehicles and reducing their mobility is necessary. This is because old vehicles that travel more miles tend to emits more carbon emissions compared to new vehicles (Wadud et al., 2022). Old vehicles that tend to travel longer distance usually encounter vehicle broke down and therefore released high pollution (Leroutier & Quirion, 2022).

Relationship between maintenance and repair and carbon emission

The finding revealed a substantial correlation between maintenance and repair and carbon emissions, and the results indicate that the relationship between maintenance and repair and carbon emission is very strong. Generally, old vehicles with poor maintenance and practices contribute to degradation in the environment, particularly in developing countries (Wright, 2004). Therefore, a proper service is important for old vehicles to replace their failure components in order to function smoothly (Danilecki et al., 2023). Next, old vehicles often required to change its engine oil as it will decrease emissions (Gligorijevic et al., 2006).

Relationship between vehicle age and carbon emission

The results show that the relationship between vehicle age and carbon emission shows a significant positive relationship. Harrington (1997) argued old vehicles released high emission as vehicle age increases. Based on this findings, the results show that vehicle age is the most significant factor that contributes to carbon emissions. Therefore, this can be concluded that vehicle age plays a major role in reducing carbon emissions from old vehicles, especially in urban areas.

Table 2

Results of Pearson Correlation

Carbon emission		
	Coefficient, r	Strength of relationship
Fuel consumption	0.727*	Very strong
Driving pattern	0.797*	Very strong
Mobility behavior	0.695*	Strong
Maintenance and repair	0.749*	Very strong
Vehicle age	0.831*	Very strong

Note: * Correlation is significant at the 0.01 level (2-tailed)

Conclusion

This study sheds light on the factors contributing to air pollution from old vehicles in the city. The findings of this study show that fuel consumption, driving pattern, mobility behavior, maintenance and repair and vehicle age have significant relationship with carbon emission. Notably, this study raises awareness of the environmental impact of old vehicles, helping the public choose cleaner options. Furthermore, the insight and understanding from the findings of this study could assist the government in developing effective regulations and policies. Governments can effectively reduce the usage of old vehicles, particularly in cities, by implementing appropriate measures. It is crucial to assess the impact of older vehicles on carbon emissions, which is influenced by various factors, despite their continued use by citizens. Poor maintenance and use of old engine technology significantly contribute to higher emissions into the atmosphere. The rise in fuel consumption in old vehicles also increases the emissions of harmful substances. Therefore, the transportation sector needs to shift towards more eco-friendly alternatives, which is essential as it would reduce pollution in urban areas, especially in Kuala Lumpur. Thus, eliminating old vehicles' usage in the city would significantly reduce air pollution.

These findings of this study make significant theoretical and contextual contributions by providing a deeper understanding of the factors of old vehicles towards air pollution in the urban environment. Theoretically, this research highlights the importance of existing frameworks which explains the complex relationship between vehicle age and emissions. By determining the specific aspects of old vehicles such as inefficient fuel consumption, driving patterns, mobility behavior, maintenance and repair and vehicle age, the researcher contribute to the refining of the theoretical models which describe the dynamic of vehicle emissions. Contextually, this study also emphasizes the challenges faced by old vehicles in urban environments. This research gives insights for the government to analyze the impact of old vehicles on air pollution and provides support for research and development initiatives aimed at improving technologies and eliminating old vehicles. Old vehicles often release greenhouse gas emissions due to outdated engine technologies. By investing in Research and Development (R&D) for cleaner and more efficient vehicle technologies, governments can mitigate environmental damage and work towards achieving climate change goals. Therefore, this allows fostering innovation and driving transition towards sustainable transportation system.

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