

BIODIESEL FUEL UTILISATION FOR EVALUATING ROADWORTHINESS: A STUDY CENTRED ON HONG KONG.

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ABSTRACT

In heavily crowded and congested metropolitan areas like Hong Kong, biodiesel has emerged as a practical substitute for traditional petroleum-based diesel due to the rising need for environmentally friendly transportation options. With a focus on the function of fleet composition, this research examines the effects of biodiesel energy consumption on automobile roadworthiness. Distribution of organised survey forms to automobile drivers, fleet managers and transportation experts around Hong Kong allowed for the collection of data employing a quantitative study design. To investigate how people see biodiesel and what it means for roadworthiness, the study used statistical methods such as variance assessment, correlation assessment, and descriptive statistics. Decreased exhaust, decreased resonance, and enhanced combustion efficiency are just a few of the functional and ecological advantages that biodiesel delivers, according to the results. But there are still questions about how it will affect engines over time, how much care they'll need, and how efficient they'll be, especially in vintage cars. Older diesel-fuelled cars in Hong Kong are more dangerous and noncompliant than current biodiesel-capable ones, hence the make-up of the city's vehicle fleet is an important component in roadworthiness evaluations. Biodiesel has the potential to improve durability and help Hong Kong achieve its ecological goals, according to the study. However, strong regulatory policies, public education, and assistance with technology are necessary for its widespread acceptance. Extending fuel infrastructure, engaging in additional research on higher biodiesel mixes, transitioning out emissions-intensive automobiles, and stimulating biodiesel usage are all suggestions. A safer, healthier, and more environmentally friendly communication system that doesn't sacrifice roadworthiness can be achieved in Hong Kong by coordinating biodiesel use with fleet control policies and legal structures.

Keywords: Biodiesel; Biodiesel fuel utilisation; Roadworthiness; Hong Kong; Vehicle fleet composition.

INTRODUCTION

One potential answer to the transportation problems is biofuel. One way to switch transportation oils off petroleum is via biofuel, which is made from biomass. Biofuels help reduce transportation-related CO₂ outputs since their entire life process CO₂ outputs are often less than those of fuels made from petroleum. Several consider biodiesel a healthier, “greener”

substitute to petroleum diesel. Current investigations on biodiesel particulate matter (PM) features as well as health impacts use laboratory-generated PM from consumer automobile combustion and are contradictory. In "real-life" settings with heavy duty diesel (HDD) vehicles and industrial petrol, diesel and biodiesel PM must be examined (Feizi et al., 2025). There is a wide range of opinions on how biodiesel affects roadworthiness. On one hand, it might lower output levels of gases and PM, however, on the other hand, it might raise the usage, of fuel, cause filtering obstruction from plaque development. Instead of depending only on research in laboratories, actual-life operating usage testing are necessary to evaluate a motor vehicle's biodiesel roadworthiness by assessing its fuel efficiency, reliability, and impurities under realistic functioning of operation (Reksowardojo et al., 2023). The automobile sector is making a concerted effort to create increased motor controls and pollutant for reducing pollution in preparation for the imminent implementation of fresh emission regulations. This is why the limits are going to be put into effect, which is the reason for this scenario. The administration of the "Hong Kong Special Administrative Region (HKSAR)" has initiated several programmes with the goal of lowering the number of hazardous compounds that are released into the atmosphere by automobiles (Maolin et al., 2024). The implementation of financial rewards for the placement of emissions post-treatment devices, stricter pollution limitations for automobiles, and tax advantages for the utilisation of renewable energy sources were several of the regulations that were among those that were implemented. These regulations have received widespread support, and preliminary initiatives that have utilised environmentally friendly techniques have demonstrated good results up to this point. Despite this, most of them have not been successful in increasing their efficiency or decreasing their fuel use. Most of the time, they do anything to either enhance the standard of the atmosphere in Hong Kong or to lower the expenses of fuel.

BACKGROUND OF THE STUDY

Power usage and carbon dioxide (CO₂) output are significantly higher in the transportation sector. According to the International Energy Agency (IEA), over fifty per cent of the world's petroleum use was attributed to the transportation industry. In the year 2013, transportation was the culprit behind 23 per cent of the world's CO₂ output caused by fuels. As an example of a developing marketplace, China's car marketplace has grown rapidly in the past few decades. The yearly rise of expansion for residential car purchases in China was 19 per cent between 2000 and 2014, going from a total of 2.1 million to 23.5 million units. There were 154 million of automobiles in China's inventory by the end of the year 2014 (Zhu & Fan, 2023). Airborne pollutants, power instability, and CO₂ production in China's cities have all been heightened as a result. As a case study, foggy conditions have become more common in China's main large cities in subsequent decades, and this is partly due to exhaust from cars and trucks. In the year 2014, approximately 5 per cent of China's overall greenhouse gas output came from cars and trucks, and about 8 percentage points came from the goods transportation industry. Intense preventive strategies are currently put in place in China and around the world to deal with these problems. An evaluation of biodiesel's impact on automobile roadworthiness was conducted in Hong Kong. The results showed that biodiesel greatly decreases the release of

smoke and motor vibration, but it could moderately lower engine performance and have different impacts on the use of gasoline. This information was reported by the "Environmental Protection Department (EPD)" in Hong Kong (Maolin et al., 2024). There are some reservations regarding the efficacy and permanent reliability of engine elements with greater quantities of biodiesel, according to the study. Despite this, the federal government presently prescribes B5 (5 per cent biodiesel) as the mixture for both automobiles and outdoors motor vehicles, primarily because recyclable oil from cooking is used as a raw material in the area. The piano, as a popular and all-ages musical instrument, is particularly important in the future development of art teaching in colleges and universities. The introduction of multimedia technology into piano teaching in colleges and universities is important means to meet the needs of art teaching in the current era. The piano, as a popular and all-ages musical instrument, is particularly important in the future development of art teaching in colleges and universities. The introduction of multimedia technology into piano teaching in colleges and universities is important means to meet the needs of art teaching in the current era.

PURPOSE OF THE RESEARCH

This study aims to investigate the feasibility of using biodiesel fuel for roadworthiness evaluations in the specific setting of Hong Kong. Biodiesel has appeared as a viable ecological option that might lessen pollutants and encourage healthier modes of transportation in response to rising worldwide concerns about ecological deterioration, contamination in cities, and reliance on petroleum-based fuels. In highly populous metropolitan locations like Hong Kong, yet there has been a lack of appropriate research into its real-world ramifications for automobile efficiency, servicing, and fulfilment of roadworthiness regulations. This research aims to determine the effects of biodiesel use on combustion of engines, pollution regulation, and reliability over an extended period, all of which are important measures of a motor vehicle's roadworthiness. Additionally, from a legislative and technological standpoint, it seeks to investigate whether biodiesel is compatible with the current roadworthiness assessment procedures and licensing standards in Hong Kong. The research's final objective is to provide legislators, transportation officials, and automobile owners with reliable suggestions regarding the viability, safety, and sustainability of biodiesel as a fuel alternative. This will help achieve Hong Kong's power and ecological objectives without compromising roadworthiness.

LITERATURE REVIEW

Biodiesel has proven to be a green and environmentally friendly alternative to conventional petroleum-based fuel. It is a regenerative biofuel made from substances that are organic and breaks down naturally. The impact of biodiesel on internal combustion engines (ICEs) has been the subject of a great deal of research, with studies focussing on diesel engine reliability measures, combust characteristics, and output characteristics. The PM outputs from diesel-powered vehicles are significantly reduced when using biodiesel. From the point of viewpoint of sustainability, there have been notable advances in the worldwide use of biodiesel, as

summarised in an earlier article (Suhara et al., 2024). By summarising palms biodiesel's present status and analysing worldwide developments in biodiesel deployment, this assessment has offered insightful perspectives on the obstacles and possibilities linked with the development of environmentally responsible biofuel techniques. Resolving issues with resource accessibility, pricing predictability, and approval from regulators can help biodiesel be more widely used. Substantial ecological advantages could be realised, and a more renewable biofuel could be made because of this. More specifically, another article has laid out the regulatory and legislation that have encouraged the BRICS countries to increase their biofuel development and manufacturing (Saravanan et al., 2020). The report has detailed the biofuel strategies of the BRICS countries, including their combination objectives, existing regulations, national activity plans, government assistance methods (such as subsidies), productivity goals, and the main obstacles and opportunities for biofuel's effective integration into the electrical energy marketplace. Another published research has developed an approach called the "Comprehensive Biofuel Policy Analysis Framework" to conduct composite examination of policies. The results of the evaluation are reflected in a score called "Total Policy Measure Support". According to the results, the biofuel industry in different nations with greater marks are more successful than those within nations with a lower score (Usmani et al., 2023). An unbalanced framework for policies is associated with this, as is the lack of or inadequate attention to certain policy components. The significance of a well-rounded policy system is emphasised by this.

RESEARCH QUESTIONS

What is the impact of vehicle fleet composition on roadworthiness in Hong Kong?

RESEARCH METHODOLOGY

Research Design: This inquiry into biodiesel gasoline consumption and the consequences for automobile roadworthiness in Hong Kong was conducted using a quantitative research design. Information was examined employing SPSS version 25, which incorporates odds ratios and 95% confidence intervals, to determine the strength and alignment of quantitative correlations. A p-value of 0.05 or lower was considered a statistically meaningful outcome. Descriptive studies validated the credibility and accuracy of results from structured questionnaire techniques, while descriptive statistics summarised the data collection's essential features.

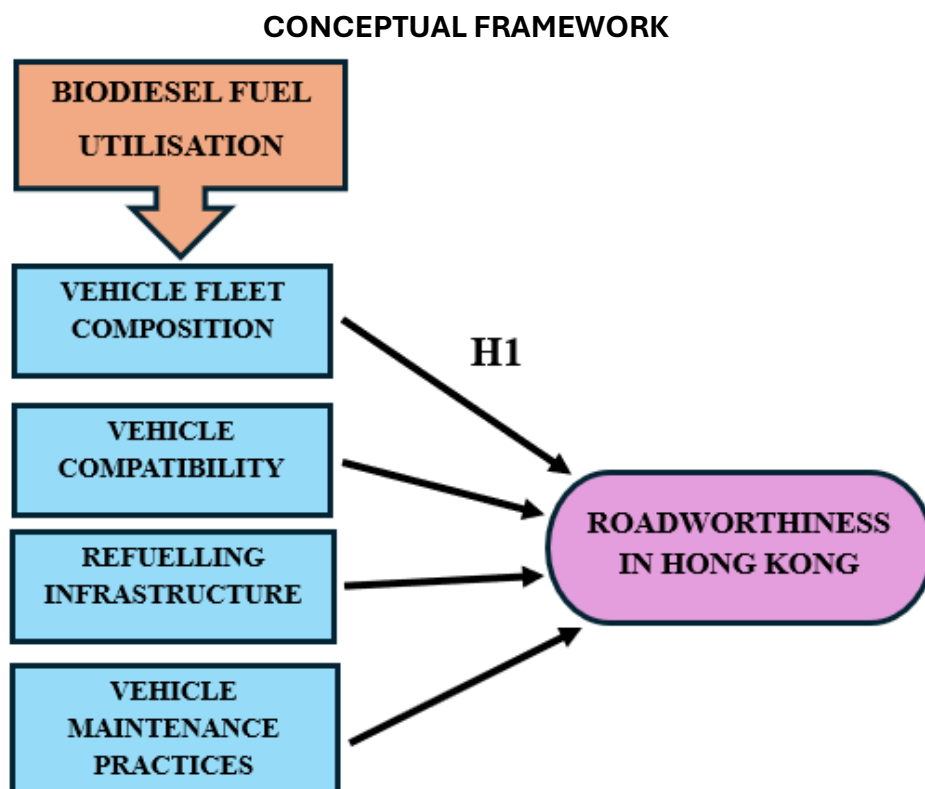
Sampling: A stratified sample process was used to guarantee that Hong Kong's varied transportation network was fairly represented. A sample size threshold of 472 was established by applying the Rao-soft sampling number generator. Researchers circulated 600 questionnaires proportionally throughout the strata to account for any inability to respond. Participants sent back approximately 560 answers. The final sample size was 535 after 25 submissions with contradicting or inaccurate details were removed from the study. Partners'

views on biodiesel use and automotive roadworthiness were fairly and accurately reflected by this approach.

Data and Measurement: A standardised questionnaire was sent out to transportation experts, automobile drivers, and automobile proprietors as the main means of gathering data. The device was divided into two parts: Section A collected basic socioeconomic facts and details about the vehicles. Section B utilised a 5-point Likert scale, with options that varied from "completely disapprove" to "completely concur," to assess how people felt about biodiesel in terms of its accessibility, reliability, affordability, and effect on automobile functionality and adherence to roadworthiness regulations. Secondary data was gathered from academic research on biodiesel use in Hong Kong, papers from the public transportation department, and official documents from the government to strengthen the conclusions.

Statistical Software: Statistical calculations, evaluation, as well as interpretation were carried out using SPSS version 25, whereas MS Excel was used for initial information arrangement.

Statistical Tools: Population trends and features of the vehicles were presented using descriptive statistics, and the accuracy and dependability of the survey components were tested using factor analysis (FA). Researchers used analysis of variance (ANOVA) to look for differences in car kinds, consumption of use, and owning kinds. Additionally, to investigate notable correlations and developing trends regarding the use of biodiesel fuel and its part in preserving Hong Kong's roadworthiness requirements, predictive analytics and correlation tests were executed.



RESULT

Factor Analysis (FA): The goal of Factor Analysis (FA) is to reveal latent features in otherwise accessible data. When straightforward visual or physiological indicators are lacking, regression coefficients are frequently employed in assessments. The goal of simulation is to find vulnerabilities, violations, and potential interconnections that are evident to the naked eye. Several regression experiments collect data, which are then evaluated using the Kaiser-Meyer-Olkin (KMO) test. Estimates based on the mathematical model and its sample factors have proven to be accurate. The data may show that there are copies. Data is made clearer by lowering the percentages. The investigator receives a number between zero and one from KMO. A KMO value between 0.8 and 1 indicates a sufficient sample population. The values that follow, according to Kaiser, are the appropriate intervals: Listed below are the credentials criteria that Kaiser has established:

An appalling 0.050 to 0.059; well below the usual range of 0.60 to 0.69; The typical range for middle grades is between 0.70 and 0.79.

A quality point score between 0.80 and 0.89. The interval from 0.90 to 1.00 astounds them. According to the Kaiser-Meyer-Olkin scale: 0.836. The results of Bartlett's test of Sphericity are as follows: 4533.638; 190 is degrees of freedom (df); sig =.000 is the approximate chi-square value.

Table 1. Examination of KMO and Bartlett's Sampling Adequacy.

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.836
Bartlett's Test of Sphericity	Approx. Chi-Square	4533.638
	df	190
	Sig.	0.000

This makes it easy to apply decision for choice usually. If the correlation matrices showed statistical value, the researchers determined it using Bartlett's Assessment of Sphericity. A sufficiently broad sample is defined as one with a Kaiser-Meyer-Olkin value of 0.836. Based on Bartlett's Sphericity examination, the p-value is 0.00. The fact that Bartlett's Sphericity test came back positive means that the correlation array is not unique.

INDEPENDENT VARIABLE

Biodiesel fuel utilisation: The decreasing availability of fossil fuel supplies, in addition to increasing worries about the planet, has led to a rise in the amount of study that is being

conducted on biodiesel as a more environmentally friendly fuel option that is generated from resources that are renewable. The substance is a substitute petroleum that is more environmentally friendly and can be used in diesel-powered machines despite the need for any alterations to be made to the vehicle (Goh et al., 2020). The generation of biodiesel from vegetable oils constitutes approximately 95% of the total worldwide manufacturing. Because of a disagreement on food, it has been subjected to severe criticism from non-profit groups all over the world. The retail value of the basic ingredients is the key factor that determines the overall expense of biodiesel, which comprises between 75 and 88 per cent of the whole. With the utilisation of non-edible petroleum as an initial ingredient in the manufacturing of biodiesel, it is possible to drastically minimise the overall budget for generating biodiesel output (Chuah et al., 2022). This has served to demonstrate the growing attention in biodiesel as well as its importance for the health of the planet. Some of the drawbacks of using biodiesel fuel include its substandard preservation and freezing circulation features, its inferior aerosol qualities, and its decreased temperature concentration.

FACTOR

Vehicle fleet composition: The arrangement of numbers and kinds of cars in use inside a specific area, community, or organisation are referred to as the vehicle fleet composition. Travel effectiveness, usage of fuel, pollutants, and circulation trends can all be better understood with its help. Cabs, privately owned automobiles, buses, lorries, motorbikes and speciality automobiles are all part of a collection of vehicles, and they all affect connectivity and the natural environment in their own unique ways. According to legislation, economics, and geography, the composition can change (Tian et al., 2022). Examples of fleet composition can include private automobiles, public transportation buses, and taxis in densely populated urban areas and trucks and big-rig cars in more industrialised areas. Vehicle technology, age, and fuel type all play a role in how efficient and long-lasting a fleet can be. Compared to newer fleets, older vehicles are less fuel efficient and produce more pollution. On the other hand, hydrogen-, electric-, and biodiesel-fuelled vehicles are becoming more common. Transportation planning, assessing highway security, and preserving the environment all rely on knowing fleet composition (Redmer, 2022). This information is useful for legislators as they work to reduce emissions, set fuel guidelines, and encourage environmentally friendly transportation options. It is now essential to optimise the physical makeup of vehicle fleets towards healthier more environmentally friendly solutions to achieve responsible public transit systems, as worries about environmental degradation and reliability of electricity continue to rise.

DEPENDENT VARIABLE

Roadworthiness in Hong Kong: Roadworthiness is a characteristic or capacity for a motor vehicle, bus, tractor, or any other sort of automotive to be in a satisfactory operational state or to satisfy approved requirements for secure operation and transportation of passengers, luggage, or goods on highways or paths, and to be legally operable as a result. Roadworthiness

is also referred to as a vehicle's street-worthiness. The purpose of a roadway-worthy examination is to examine the automobile to ensure that its essential components are in a satisfactory state, which is not the same as being in a perfect state, and that they are adequate for proper operation on roads (Mikulić et al., 2020). The evaluation of the main components and the quantitative ranking procedure are utilised in the computation of the roadworthiness value. Automobiles that are used for business purposes and transport of goods in Hong Kong must also pass yearly vehicle inspections. Additionally, all privately owned cars that were produced at least six years prior to the issuance of their licenses, as well as lightweight transportation vehicles with an overall weight that is not more than 1.9 metric tonnes, are supposed to endure periodic checks at Designated Car Testing Centres prior to can be issued new licenses (Li et al., 2023). This is done to guarantee that the vehicles comply the safety standards.

Relationship between Vehicle fleet composition and Roadworthiness in Hong Kong:

Providing secure, effective, and environmentally friendly transport in Hong Kong relies heavily on the connection among vehicle fleet composition and roadworthiness. Personal automobiles, public transportation buses, taxis, large pickup trucks and hefty rigs make up Hong Kong's varied fleet of vehicles. Highway security, ecological effect, and adherence to regulations are all affected in unique ways by each of these categories. For example, due to their extensive employment and corrosion, business automobiles like buses and pickups must undergo frequent inspections and servicing to remain roadworthy (Li et al., 2023). The year of manufacture and energy kind of the vehicle fleet are strongly associated with roadworthiness in Hong Kong. There still have a lot of vintage automobiles powered by diesel on the road, and they pose more of a threat to air pollution and mechanical breakdowns despite lowering security requirements. Strict yearly maintenance standards, the elimination of older, high-emission vehicles, and the promotion of electricity-powered and hybrid automobiles are all responses to this problem that the administration of Hong Kong has instituted (Wang et al., 2022). Government of Hong Kong may more effectively customise regulations to promote roadworthiness by studying the composition of the fleet. Reducing technical issues, improving security, and minimising harmful emissions are all goals to encourage greener, higher-tech automobiles. Overall roadworthiness regulations and the sustainable viability of Hong Kong's transportation infrastructure are, therefore, strongly impacted by the vehicle fleet composition. Considering what has been discussed so far, the researchers in this study set out to test the following hypothesis regarding the relationship between Vehicle Fleet Composition and Roadworthiness in Hong Kong:

“H₀₁: There is no significant relationship between Vehicle fleet composition and Roadworthiness in Hong Kong.”

“H₁: There is a significant relationship between Vehicle fleet composition and Roadworthiness in Hong Kong.”

Table 2. H1 ANOVA Test.

ANOVA					
Sum					
	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	94,539.992	202	5,464.506	874.321	0.000
Within Groups	270.552	332	6.250		
Total	94,810.544	534			

Significant results have been drawn from this investigation. The F-value is 874.321 and the p-value is 0.000, indicating that there is statistically relevance significance below the 0.05 alpha criterion. The findings indicates that the “***H₁: There is a significant relationship between Vehicle fleet composition and Roadworthiness in Hong Kong***” has been accepted, and the null hypothesis has been rejected.

DISCUSSION

Considered across the prism of vehicle fleet composition, the results of this research emphasise the substantial impact of biodiesel usage on roadworthiness in Hong Kong. The findings show that biodiesel may assist in eliminating pollutants, enhance its ecological impact, and meet changing objectives for sustainability when used in transports. This is in line with the findings of studies conducted all over the world, which show that biodiesel can effectively replace gasoline-based energies, particularly in heavily crowded and polluted cities including Hong Kong, thanks to its regenerative nature. Conversely, contemporary fleets that use technology that is suitable with biodiesel are more environmentally friendly and safer. The governmental goal of progressively banning automobiles with excessive emissions and encouraging greener options strengthens this connection. Still, there are obstacles that the report points out. Although biodiesel lessens vibrations from engines and emissions, its effect on engine productivity and longevity is still up for discussion, especially when using greater mixing percentages. Many car drivers were worried about the high expense of repairs, the unpredictability of gas mileage, and the incompatibility with their current certification mechanisms. To address these problems and foster trust concerning biodiesel application, stronger rules and regulations, improved assistance with technology, and broad sector learning are necessary. When paired with diligent fleet administration, continuous regulatory requirements, and investments in greener automotive innovations, the research shows that biodiesel can effectively improve roadworthiness. To achieve its mobility and ecological objectives, Hong Kong needs to switch to fleets that can run on biodiesel, implement stronger servicing regulations, and offer encouragement for acceptance. Henceforth, there is a scope for future researchers in conducting further research work on the chosen topic.

CONCLUSION

The study concluded that biodiesel consumption significantly affects the roadworthiness of vehicles in Hong Kong, especially when considering the various fleet makeup of the city. According to the results, biodiesel is a better option than regular diesel in congested metropolitan areas since it improves the quality of the environment, reduces exhaust production, and lessens dangerous toxins. For outdated automobiles that weren't built to be compatible with biofuels, the impact on powerplant longevity, operating needs, and fuel effectiveness over a lengthy period is a major worry. There are advantages and disadvantages to the make-up of Hong Kong's fleet, which contains a lot of old diesel cars. For transportation to be genuinely environmentally friendly, regulations must be put in place to promote environmentally friendly biodiesel innovations and push for the decommissioning of highly polluting automobiles. Various suggestions for the future arise after completion of the research. To begin, federal agencies should provide credits or tax breaks to fleet managers who switch to cleaner fuels, and it should make it easier for businesses to use biodiesel. To further clarify biodiesel efficiency and dispel myths, public education initiatives and technological guidelines are required. Thirdly, future rules can be informed by investments to conduct studies on the long-lasting effects of increasing biodiesel compositions. At last, a more seamless transformation can be supported by increasing the support systems for unconventional energy sources, which will guarantee the availability of them. These steps will help Hong Kong achieve its environmentally friendly targets in transportation while also protecting the city's roads.

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