Research Article

Study on Impact of Motorcycle Ride Hailing Service on Energy Consumption and GHG Emission in Land Transport in Malaysia

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Abstract: Transportation segment is one of the significant parts of globalization and makes a fundamental commitment to the economy. The number of motorcars in Malaysia is growing, from around 15 million in 2005 to around 26 million in 2015. In this paper, we study the impact of motorcycle ride hailing on energy consumption and GHG emission in land transport. The highest contribution to the energy consumption and GHG emission is private car because it has high fuel consumption. Public transport likes bus and rail have low GHG emission for each passenger kilometer travelled which very good to reduce the GHG emission. On Motorcycle ride hailing can reduce the energy consumption and GHG emission in land transport sector. Based on the online survey, the percentage of shifted people to motorcycle ride hailing met the requirement to reduce the GHG emission which is more people from private car shifted to motorcycle ride hailing.

Keywords: Transport Studies, Motorcycle Ride Hailing, Energy Consumption, GHG Emission.

1. INTRODUCTION

Transportation segment is one of the significant parts of globalization and makes a fundamental commitment to the economy. Plus, it assumes a curial job in day-by-day exercises far and wide. Shockingly, this movement is significant vitality utilization and utilize a large portion of the constrained non-sustainable power source that makes a negative effect to living condition. In addition, transportation segment is answerable for an enormous and developing portion of emanations that influences worldwide environmental change. The purpose of this study is to identify the current status of energy consumption and greenhouse gas (GHG) emission from vehicles in land transport. The primary purpose of this study is to determine the impact of motorcycle ride hailing service on energy consumption and GHG emission in land transport.

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Teter et al. (2019) stated that due to improved efficiency, electrification and increased use of biofuels, global transportation emissions only increased by 0.6% in 2018 (compared to 1.6% per year over the last ten years). Transport is calculated to account for 24% of direct CO_2 emissions from fuel combustion. Road vehicles are in three quarters of CO_2 emissions in traffic.

The online ojek or known as Gojek is a type of ride hailing service that use motorcycle as the main vehicle to transport the customers. The Gojek system is basically very famous in Indonesia but there are several issues that rose when the company want to expand their business in Malaysia. The proposal to bring e-hailing motorcycle taxi service Gojek to Malaysia brings mixed feelings among locals here.

In this research Wu et al. (2018), the purpose of the study is the impacts of China's car hailing services on energy use and CO_2 emissions. He uses China's online car hailing services on energy use and CO_2 emissions (CEM-OCHS) model that provides a technology roadmap of different future scenario analysis and a quantitative study framework of energy use and CO_2 emissions.

Sukarno et al. (2016) developed a transportation model could be a simplified representation of the real-world phenomenon to form it easier to grasp. within the urban context, system dynamic modelling can help the influential person to satisfy challenges of deciding to support the urban development process to estimate the fuel consumption and emission in a city of Indonesia.

Suatmadi et al. (2019) performed an online travel survey designed to grasp individual travel behavior before and after the introduction of online ojek. the information was collected throughout a web survey. So, basically this research is based on the data that they get from the survey.

2. STATUS OF ROAD VEHICLES AND PUBLIC TRANSPORT

Here a brief glance of an overview of some relevant information about the land transport which include private and public transport scenario in Malaysia as a developing country.

2.1 Number of registered vehicles

The number of vehicles in the country is growing at a significant rate, from around 15 million in 2005 to around 26 million in 2015. The most majority of the registered road vehicles are cars and motorcycles, with a volume share of 45.25 percent and 46.10 percent, respectively. According to Economic Research Institute for Asean and East Asia (2018), in Malaysia, most of the vehicles that run on the road are mostly using petroleum fuels which more than 90% and caused the fuel demand and CO_2 emissions increased. Transport sectors consume 45% total final energy consumption that most of them are land transportation modes.

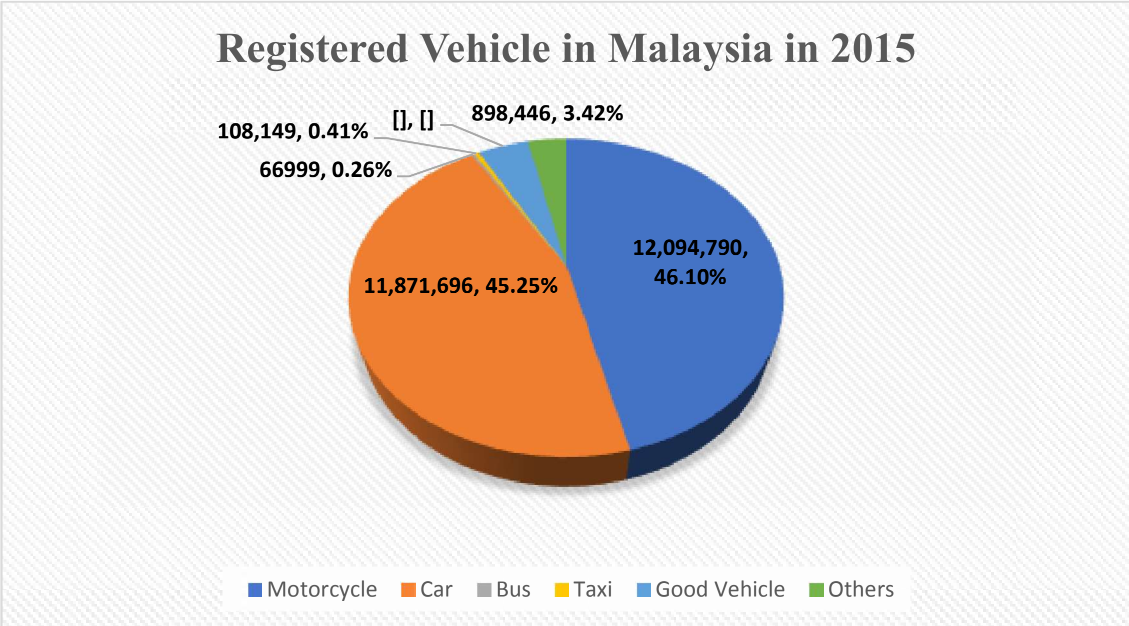

Figure 1: Number of registered vehicles in Malaysia. Source data from Final Report on Demand Side Management (2017)

2.2 Public transportation

Rail transit ridership for the two LRT systems has been gradually growing since it started plateauing in 2008, until 2015. The introduction of the MRT in 2017 has a moderate impact on other forms of public transport modes; in the same year, only KTM Komuter and KLIA transit reported a decreasing trend. There are many reasons for the decline in the KTM ridership which started in 2015. Increase in cost and regular interruption of train services owing to expansion of railway network operations. It is not possible to assess how many formerly private car drivers are among the MRT new customers, but since 2017 the total public transit ridership has grown.

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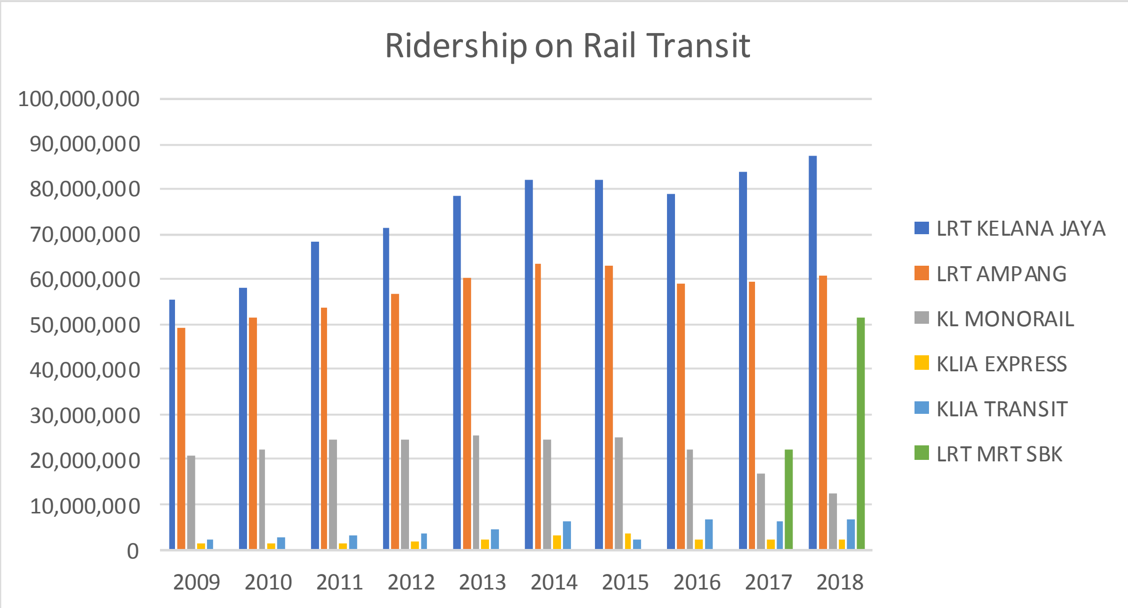

Figure 2:Ridership on rail transit. Source data from Prasarana Malaysia Berhad, Express Rail Link Sdn. Bhd.

3. ENERGY CONSUMPTION GHG EMISSION

This section will present the collection data for the analysis, the estimation of vehicle kilometer travelled, and the resulting energy consumption and GHG emission produced by each vehicle type.

3.1 Collection of Data

The energy consumption and GHG emission are quantified supported available data toward land transport. Vehicle fuel efficiency, the gap travelled, and the fuel used will affect the GHG emission. The vehicle fuel efficiency and kilometer travelled are listed in Table 1 and Table 2. The emission factor for various fuel is shown Table 3.

Table 1: The fuel efficiency of land transport vehicles. Source of data from Final Report on Demand Side Management (2017) and US EPA website.

Vehicle Type	Fuel type	Fuel Efficiency (L/100km)	Net Calorific Value (kJ/kg)
Car	Petrol	8.17	44300
Motorcycle	Petrol	2.15	44300
Bus	Diesel	28.10	43000
Taxi	Petrol	9.79	44300
Rail	Electricity	322.58	

Table 2: Annual vehicle kilometer travelled for various vehicle type.

Vehicle Type	Annual Vehicle Kilometer Travelled (km)	Data Source
Car	28184	MIROS (2007)
Motorcycle	21500	MIROS (2007)
Bus	100000	Economic Planning Unit (2017)
	86000	Economic Planning Unit (2017)

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Table 3: Emission factor for various vehicle fuel

Vehicle Fuel	Emission Factor (t CO_{2eq}/TJ)	Data Source
Petrol	72.309	IPCC (2006)
Diesel	70.085	IPCC (2006)
Electricity	192.7	Greentech Malaysia 2016

3.2 Vehicle kilometer travelled estimation

In calculating GHG emissions it is found that for several reasons the registered number of the car cannot be used directly. First, the number of registered vehicles of nearly 25 million is far greater than that of 18.6 million active licenses issued. Secondly, it will cause higher estimated energy usage and GHG emission values compared to the National Energy Balance (NEB) report Malaysia 's Third National Communication and therefore the Second UNFCC (BUR) Biennial Survey. In Figure 3, the measurement therefore uses a mean vehicle kilometer travelled (VKT), which is modified proportionately to fulfill these conditions; the quantity of vehicles on the road cannot exceed the quantity of licenses and therefore the energy usage and GHG emission values correspond to those recorded within the NEB and BUR reports.

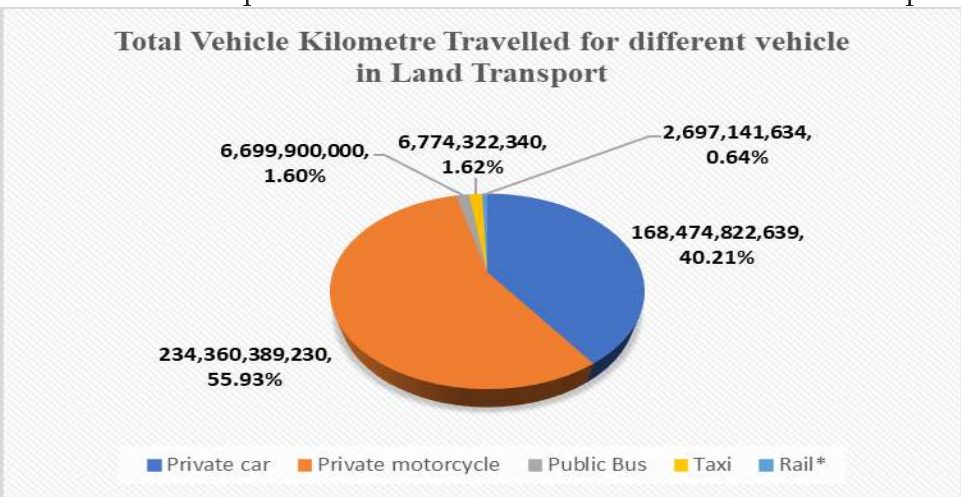

Figure 3: Total Vehicle Kilometer Travelled for different vehicle in Land Transport.

3.3 Theory of energy consumption and GHG emission

Based on the model framework in Figure 4, a case analysis is done by combined with real data to show the working mechanism, the research method and different scenario analysis results the impact of the energy consumption and GHG emission in land transport.

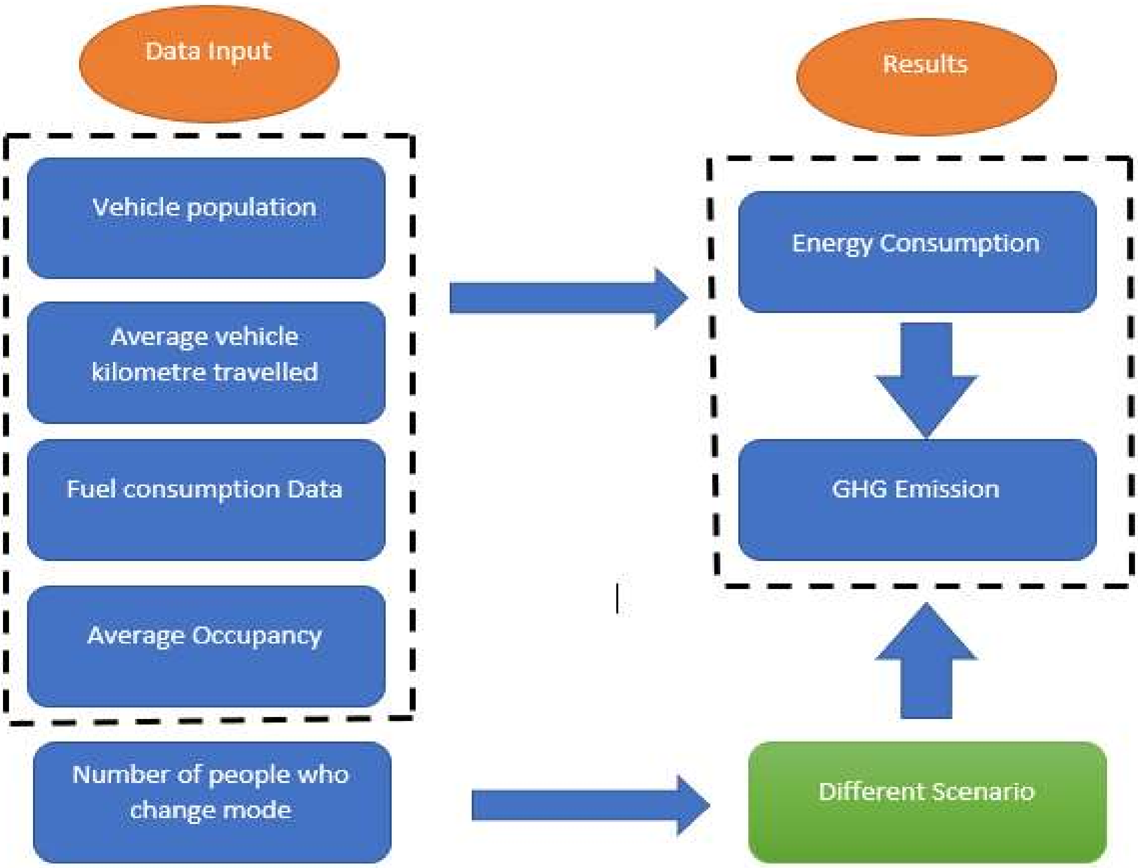

Figure 4: Model Framework and calculation method of energy consumption and GHG emission

3.4 Energy consumption and GHG emission formula

The calculation model for vehicle energy consumption is a bottom-up method, and functions based on establishing an emission list according to vehicle ownership, vehicle kilometers travelled (VKT), and emission factors per unit of distance. All formula that had been used for this research is taken from Sustainable Land Transport Indicators on Energy Effieciency And Greenhouse Gas Emission In ASEAN Guidelines. Within a certain area, energy consumption and CO_2 emissions are calculated with the following formula:

$$EC_Z = \sum((\mathrm{Vehicle}_{i,a} * \mathrm{VKM}_{i,a} * \mathrm{FE}_{i,a}) * \mathrm{Calorific\ Value}_a) \quad (1)$$

where EC_Z = represent respectively road transport energy consumption (kJ)
$\mathrm{Vehicle}_{i,a}$ = number of vehicle type i using fuel a
$\mathrm{VKM}_{i,a}$ = average vehicle kilometres performed by vechile type i using fuel a
$\mathrm{FE}_{i,a}$ = average fuel economy (expressed as L/km) of vehicle type i using fuel a
$\mathrm{Calorific\ Value}_a$ = calorific value for fuel a $\left(\frac{kJ}{kg}\right)$
i = types of vehicles (e.g. private car, private motorcycle, buses, rail)
a = types of fuels (e.g. gasoline, diesel, electricity)
z = transport modes (e.g. road, rail)

$$TGHG_z = \sum (EC_a * EF_{a,x} * GWP_e) \tag{2}$$

where $TGHG_z$ = total GHG emission (tCO_2e) for mode z
EC_a = energy consumption of fuel a
$EF_{a,x}$ = emission factor ($\frac{kg}{TJ}$) for greenhouse gas x for fuel a
GWP_e = global warming potential (in terms of CO_2 equivalent)

The GHG 'x' for fuel 'a' for CO_2 this is based on the fuel Carbon Content and global warming potential (in terms of CO_2 equivalent for greenhouse gas e). While a and e represent fuel and different type of gas which are carbon dioxide, methane, and nitrous oxide. For this research, I only focused on carbon dioxide emission so the value for other gases like methane and nitrous oxide will not be evaluated.

3.5 Scenarios

For this investigation, an online travel survey is conducted to comprehend individual travel behaviour when the motorcycle ride hailing service was introduced. The information was gathered all through an online review. Information with respect to individual data, financial condition, and travel conduct of the examples were incorporated. In any case, this cannot ensure that the respondents are illustrative of all clients utilizing on motorcycle ride haling service. Consequently, the outcomes must be interpreted regarding this limitation.

This study aims to evaluate the impact of motorcycle ride hailing services on energy consumption and GHG emission in land transport. In order to achieve it, there are two type of scenario which are the situation where before motorcycle ride hailing service was introduce and another one is after the service introduced to the community. For both scenarios, the destination for using transportation was set up as workplace or desired place. In Scenario A, it divided into five categories which are using different kinds of transport modes. For Scenario B, after the motorcycle ride hailing introduced, all the categories are changed into motorcycle ride hailing mode to arrive the destination.

A. Before motorcycle ride hailing introduced.

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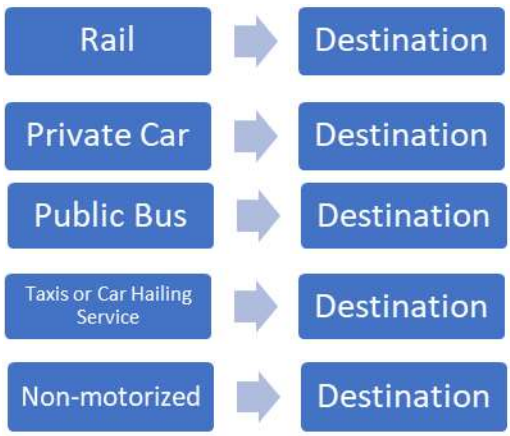

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B. After motorcycle ride hailing service was introduced.

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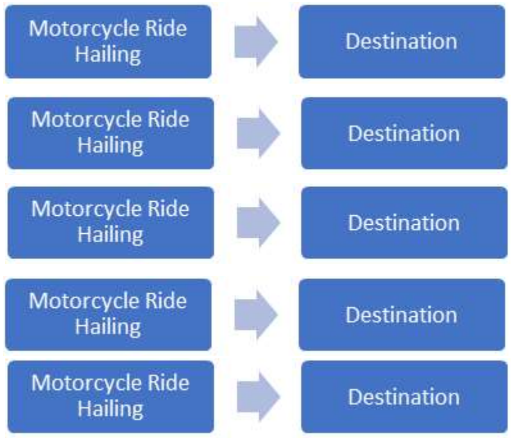

4. RESULTING ENERGY CONSUMPTION AND GHG EMISSION FOR LAND TRANSPORT

Based on the methodology that had been proposed in the previous section, it has two scenario which are A and B. In Scenario A, all the input data according to the parameters in the model framework in Figure 4, which is vehicle population, average vehicle kilometer travelled, fuel consumption data and average occupancy while these values will be based on the previous research. For Scenario A, there is no shifting mode to motorcycle ride hailing. While in Scenario B, there will be shifting mode to motorcycle ride hailing and the data is obtained from the online survey through the Google form.

4.1 Energy consumption and GHG emission for scenario A

Private car has the highest contribution on energy consumption in land transport, referring to the VKT presented in Figure 3, the VKT for private cannot be compared with other type of vehicle because it to high. On the opposite hand, motorcycle has also a serious contribution of the overall VKT, have significantly low energy consumption and low GHG emission contributions. This happen because the fuel economy for private motorcycle is very low compared to private car. Buses has small energy consumption and GHG emission due to the low value of VKT even though it has high fuel consumption.

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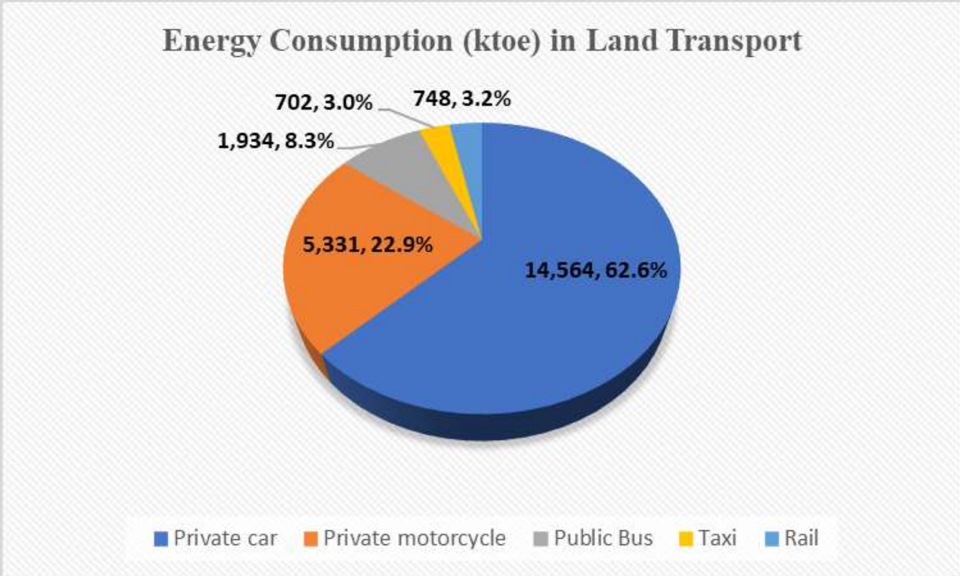

Figure 5: Energy consumption by various type of vehicles in land transport for 2015

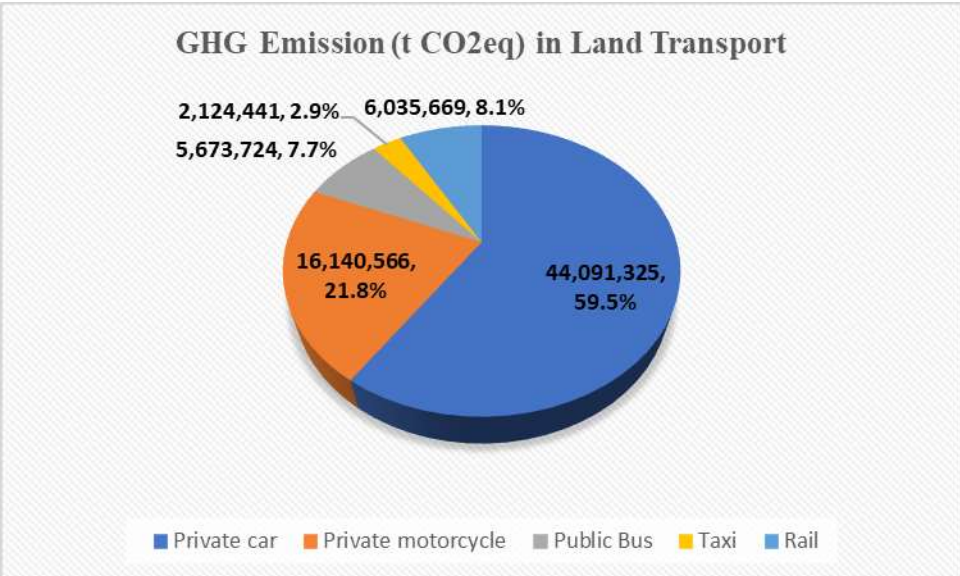

Figure 6: GHG emission by various type of vehicles in land transport for 2015

Table 4: Comparison GHG emission for different land transport vehicles in Malaysia

Vehicle Type	Fuel type	GHG Emission per vehicle km (g CO_{2eq})	Occupancy Rate (passenger/vehicle)	GHG Emission per passenger km g CO_{2eq}
Private Car	Petrol	261.71	1.40	187
Private Motorcycle	Petrol	68.87	1.20	57
Bus	Diesel	846.84	18.40	46
Taxi	Petrol	313.60	1.55	202
Rail	Electricity	2,237.80	36.75	61

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4.2 Energy consumption and GHG emission

The energy consumption and GHG emission from the various vehicle types of inland transport which based on the online survey data are illustrated in Figure 7 and Figure 8, respectively. The private become the major contributor to energy consumption and GHG emission.

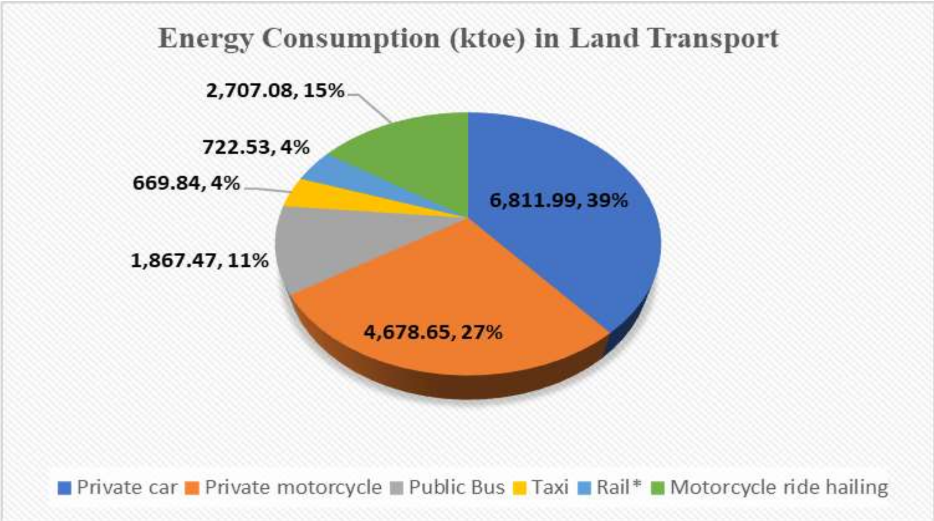

Figure 7: Energy consumption by various type of vehicles in land transport after shifting for 2015

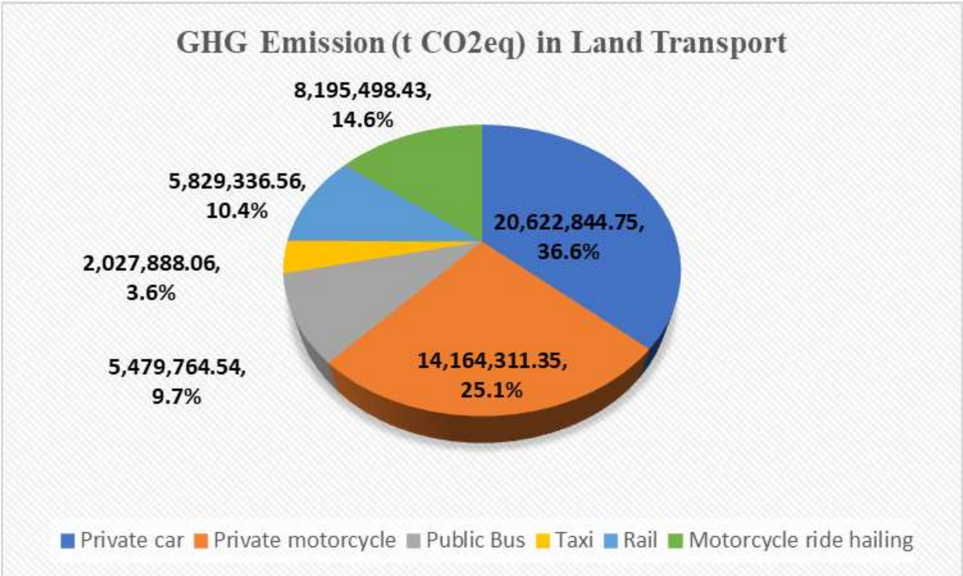

Figure 8: GHG emission by various type of vehicles in land transport after shifting for 2015

4.3 Parameters for scenario 'B'

The surveys were comprised of three sections, which are information, household demographics and travel behaviour. The main objective of the survey design was to gather extensive data on urban populations' current, potential future travel, residential, and vehicle ownership choices. This survey is an internet-based platform that enabled complex survey logic and branching.

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Questions	Remarks
Information: Did you know about motorcycle ride hailing service? What your opinion on this matter if the service launches later?	User are expected to choose one of the given answers and write their opinion
Personal detail: Age Gender Type of Job Monthly income	Users are expected to choose one of the given answers
Travel behaviour: Current transportation mode If the motorcycle ride hailing service available on the, will you change?	Users are expected to choose one of the given answers

Table 5: Details of Questionnaire Utilized in this Research.

There were 174 responses analysed and 61.2% of them were female. Almost half of the respondents 45.5% were 50-64 years old, 29.7% were 30-49 years old, 23.4% were between 18-29 years old, 1.0% were above 65 years old, and 0.5% aged less than 18 years old. From an occupation perspective, 53.6% of respondents worked as government, 20.6% were non-government, 14.8% were students and 11.5% were self-employed, unemployed, and retired. 20.1% of respondents lived in urban area while 42.9% lived in rural area. 84.7% of respondents had access to private cars while 40.7% has private motorcycle and the rest did not own any vehicles. Among the respondents, 56.9% had income more than Rm 4000, 17.7% had income between Rm 2001 – Rm 4000, 16.3% with zero income and 9.1% had income of less than Rm 2000.

Firstly, most common transport that had been used by the respondents to go to their desired place. Based on the survey, 77% of the respondents commonly use the private car, 15.8% were using private motorcycle, 4.3% were using rail transport, 0.5% used public bus, 1.4% used taxi and 1% were using non-motorized transport. Another factor that showed the respondent travel behaviour is how much they spend for using the transport in a month. There were 38.8% of the respondent that spend more than Rm 200, 21.1% were between Rm 150-Rm 199,16.3% spend around Rm 100 to Rm 149, 9.1% were between Rm 50-Rm 99, and about 14.8% spend less than Rm 50 monthly.

Furthermore, based on the survey, 66% of the respondents know about the motorcycle ride hailing while 34% did not. Then, there are about 42.1% of the respondents that agree to shift their current transportation to motorcycle ride hailing while 57.9% did not want. In addition, the number of people who want to shift their current transportation to motorcycle ride hailing or not. In Table 6, it showed the percentage of shifted and unshifted that will be used to calculate the energy consumption and GHG emission.

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	Number of people shift	Number of people did not shift	Percent of shifted (%)	Percentage of unshift (%)
Private car to motorcycle ride hailing	55	79	26.32	37.80
Private motorcycle to motorcycle ride hailing	11	9	5.26	4.31
Public Bus to motorcycle ride hailing	3	3	1.44	1.44
Taxi to motorcycle ride hailing	4	13	1.91	6.22
Rail to motorcycle ride hailing	3	16	1.44	7.66
NMT to motorcycle ride hailing	12	1	5.74	0.48
Total number of respondents	88	121	42.11	57.89

Table 6:: Number of people shifted and did not shift for land transport

4.4 Comparison between scenario 'A' and 'B'

The comparison of energy consumption and GHG emission between scenario A and B are illustrated in Table 7 and Table 8, respectively. Based on the result, there are very high reduction energy consumption and GHG emission for private car which is 45.7%. This happens due to the high percentage of shifting from private car to the motorcycle ride hailing that obtained from online survey. The shifting able to produce high reduction of energy consumption and GHG emission because of the motorcycle itself has low fuel consumption. Furthermore, private motorcycle has 10.2% of reduction because the VKT for private motorcycle decreased after shifting to motorcycle ride hailing. Next, public bus and rail mode also have reduction of energy consumption and GHG emission up to 2.8%. But public mode has higher energy consumption compared to rail mode.

Table 7: Reduction of Energy Consumption 2015

Mode Transport	Scenario		Reduction of Energy Consumption (ktoe)
	A	B	
Private car	14,564.00	7,907.29	6,656.71
Private motorcycle	5,331.00	4,785.00	546.00
Public Bus	1,934.00	1,878.46	55.54
Taxi	702.00	675.13	26.87
Rail	748.00	726.78	21.22
Motorcycle ride hailing	0.00	2,310.12	-2,310.12
Total	23,279.00	17,457.56	5,821.44

Table 8: Reduction of GHG Emission 2015

Mode Transport	Scenario	Reduction of GHG Emission

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	A	B	(t CO_{2eq})
Private car	44,091,325.00	23,938,780.00	20,152,545.00
Private motorcycle	16,140,566.00	14,486,270.00	1,654,296.00
Public Bus	5,673,724.00	5,512,011.00	161,713.00
Taxi	2,124,441.00	2,043,901.00	80,540.00
Rail	6,035,669.00	5,863,640.00	172,029.00
Motorcycle ride hailing	0.00	6,993,731.00	-6,993,731.00
Total	74,065,725.00	58,838,331.00	15,227,394.00

4.5 Modal shift estimation

After the evaluation of energy consumption and GHG emission based on the online survey data, the potential changes that can be made by modal change need to be evaluated, we need to calculate the actual output of each future mode of transport.

Table 9: Energy consumption for different land transport vehicles. Source data for occupancy rate Briggs and Leong (2016)

Mode	Energy Consumption per vehicle km (MJ)	Occupancy Rate	Energy Consumption per passenger km (MJ)
Private car	3.61931	1.4	2.58522
Private motorcycle	0.95245	1.2	0.79371
Public Bus	12.08300	18.4	0.65668
Taxi	4.33697	1.5	2.79805
Rail	11.61288	36.7	0.31600

Based on Table 7, we able to predict the actual value of CO_2 reduction by modal shift per passenger as shown in Table 8.

Table 10: CO_2 reduction by modal shift, by percentage

	Reduction of energy moving to				
From:	Car	Taxi	Motorcycle	Bus	Rail
Rail	88%	89%	60%	52%	0%
Bus	75%	77%	17%	0%	
Motorcycle	69%	72%	0%		
Taxi	-8%	0%			
Car	0%				

Table 11: Mt CO_2 reduction by modal shift from a baseline of 74 Mt total from the transport sector

	Reduction of energy moving to				
From:	Car	Taxi	Motorcycle	Bus	Rail
Rail	38.70196	1.88452	9.71457	2.94353	0
Bus	32.89147	1.62585	2.78646	0	
Motorcycle	30.55452	1.52181	0		
Taxi	-3.62974	0			
Car	0				

It implies that 100% of the passenger kilometer transported are moved from the less

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effective to the more productive form of transport, which is obviously an unrealistic scenario. Regardless of the possible pace of growth, this makes it very apparent that moving from passenger car to practically every other method would have the largest influence, with rail being the chosen form. Motorcycle pollution can only be greatly decreased by switching riders to train.

5. CONCLUSION AND RECOMMENDATION

In conclusion, the objectives of this research which are to determine this status of energy consumption and GHG emission in land transport and to ascertain a model framework for energy consumption and GHG emission computation are fully achieved. The transport sector is one of the foremost important sectors for the country to chop back GHG emission. Collection of data gathered from published data are presented, and energy consumption and GHG emission computation has been performed. Private car may well be a major road transport vehicle category because it contributes towards the biggest portion of total energy consumption and GHG emission.

There are a few conclusions can be made by comparing the energy consumption and GHG emission. In Scenario A, the highest contribution to the energy consumption and GHG emission is private car because it has high fuel consumption. Public transport such as bus and rail have low GHG emission for each passenger kilometer travelled which very good to reduce the GHG emission. On the other hand, private motorcycle also has low GHG emission for each passenger kilometer travelled but due to high motorcycle population it produced a lot of GHG emission.

In Scenario B, motorcycle ride hailing can reduce the energy consumption and GHG emission in land transport sector. Based on the online survey, the percentage of shifted people to motorcycle ride hailing met the requirement to reduce the GHG emission which is more people from private car shifted to motorcycle ride hailing. It became the major contribution in reduction of energy consumption and GHG emission. The energy consumption and GHG emission will increased if the percentage of shifted people from rail and public are high because both transport mode lower GHG emission due to electricity as power supply and high occupancy rate.

There is one recommendation to overcome the limitation in term of lack of data resources which is establish centralized authority that related to non-motorized transport (NMT) for energy consumption and vehicle kilometer travelled assessment. As we overcome the limitation, we able to achieve the objectives perfectly.

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