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

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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.

KEY WORDS: 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.

Teter, Feuvre,Gorner,Scheffer [1] 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.

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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. [2], 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, Matsumoto, and Susanti [3] 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, Creutzig, and Otto [4] performed an online travel survey designed to grasp individual travel behaviour 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.

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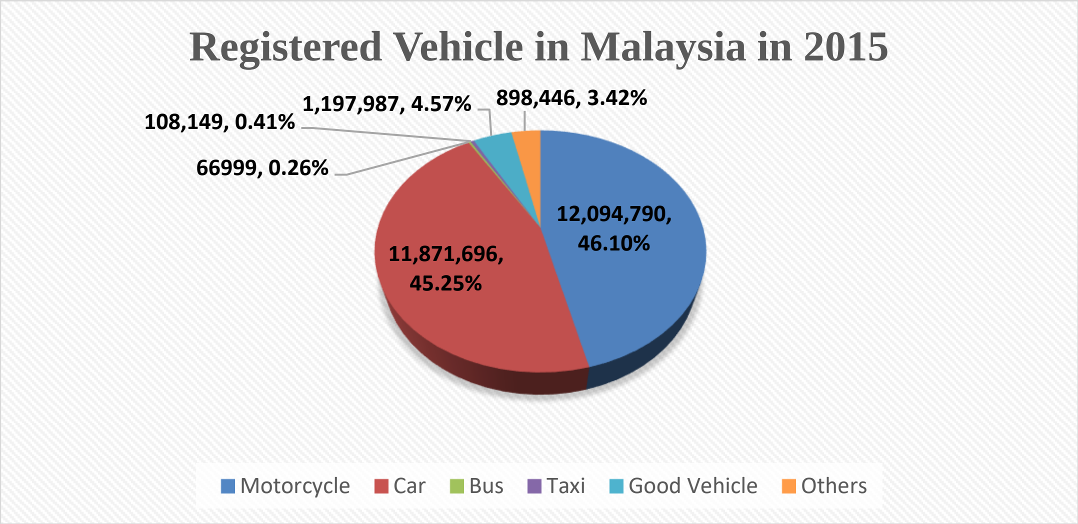

Figure 1: A number of registered vehicles in Malaysia. Source Data [5]

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.

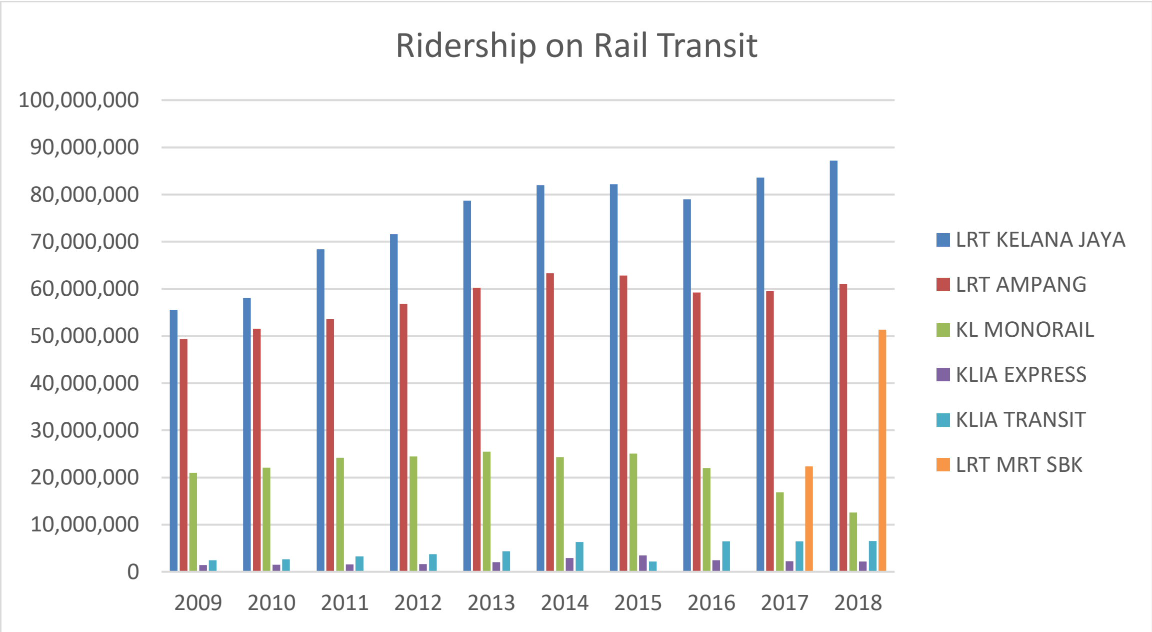

Figure 2: Ridership on rail transit. Source data from Prasarana Malaysia Berhad, Express Rail Link Sdn. Bhd.

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3. ENERGY CONSUMPTION AND GHG EMISSION

This section will present the collection data for the analysis, the estimation of vehicle kilometre 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 kilometre 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: [5,6]

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 kilometre travelled for various vehicle type

Vehicle Type	Annual Vehicle Kilometer Travelled (km)	Data Source
Car	28184	MIROS (2007) [7]
Motorcycle	21500	MIROS (2007) [7]
Bus	100000	Economic Planning Unit (2017) [6]
Taxi	86000	Economic Planning Unit (2017) [6]

Table 3: Emission factor for various vehicle fuel

Vehicle Fuel	Emission Factor (t CO_{2eq}/TJ)	Data Source
Petrol	72.309	IPCC (2006) [8]
Diesel	70.085	IPCC (2006) [8]
Electricity	192.7	Greentech Malaysia 2016 [9]

3.2 Vehicle kilometre travelled estimation

In calculating GHG emissions it's 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 kilometre 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.

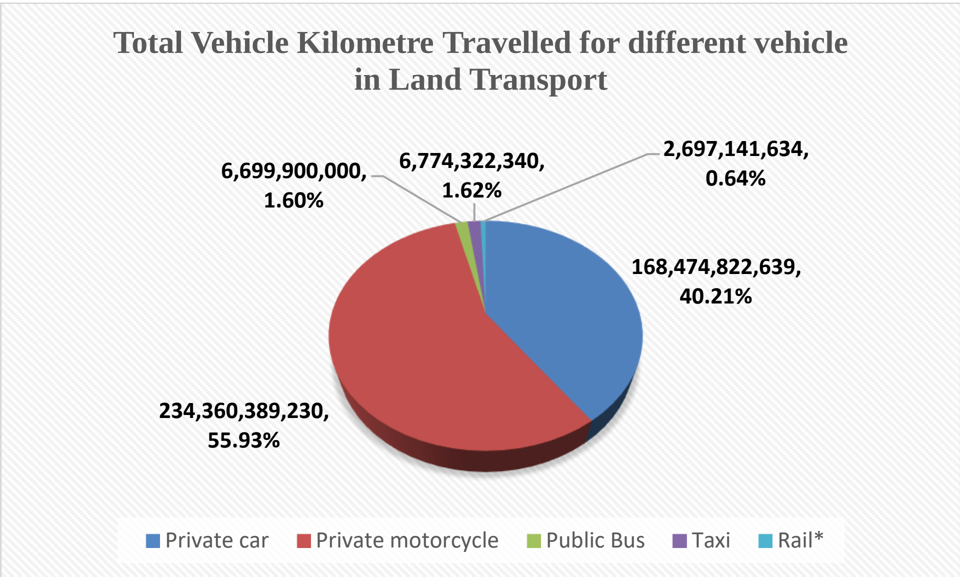

Figure 3: Total Vehicle Kilometre Travelled for different vehicle in Land Transport [5].

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.

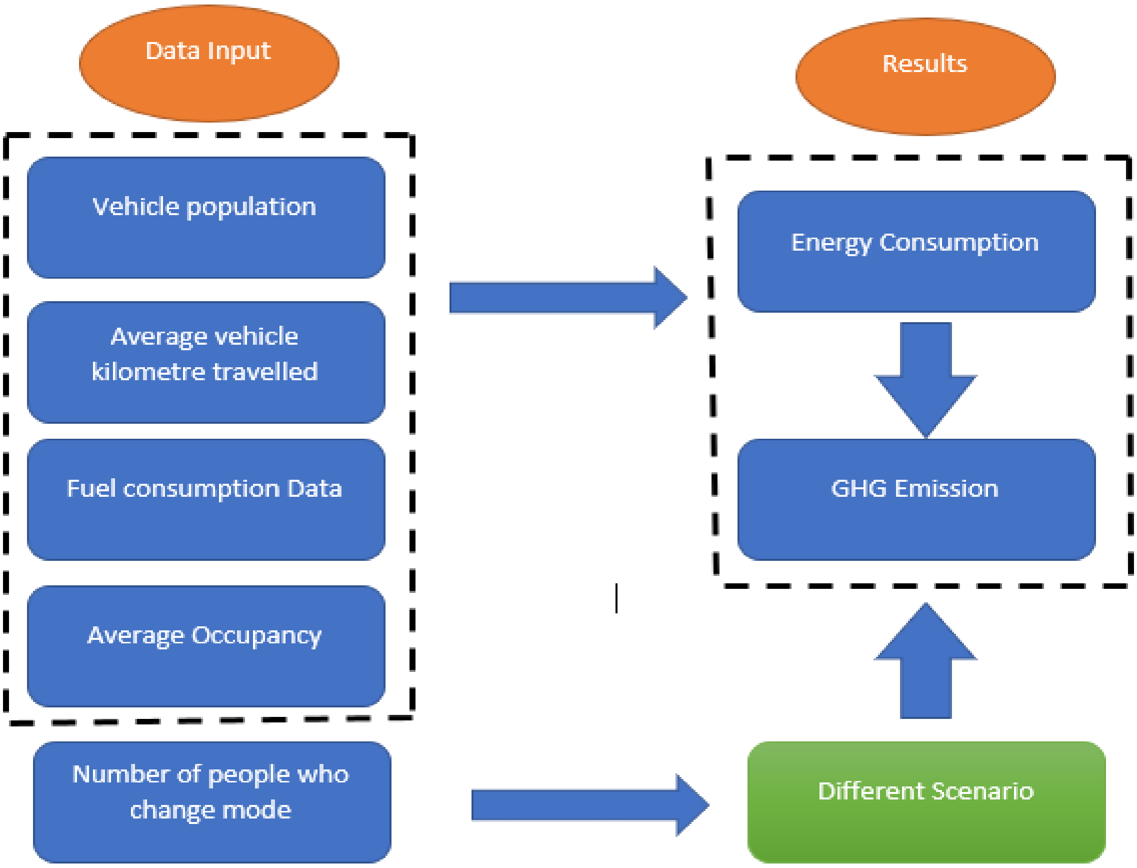

Figure 4: Model Framework and calculation method of energy consumption and GHG emission

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 kilometres travelled (VKT), and emission factors per unit of distance. Within a certain area, energy consumption and CO2 emissions are calculated with the following formula:

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

Source Data: [10]

where i and a represent the types of vehicles and types of fuels. In this study, vehicles are categorized into private cars, private motorcycles, buses, railway and non-motorized mode. Types of fuels include gasoline, diesel and electricity. EC_Z represent respectively road transport energy consumption (kJ) while $Vehicle_{i,a}$, $VKM_{i,a}$ and $FE_{i,a}$ represent respectively population of vehicle type i that consumes fuel a in the year t, its VKT (km) and fuel economy (L/km). $Calorific\ Value_a$ represents the density of fuel a (kJ/kg).

$$TGHG_z = \sum (EC_a * EF_{a,x} * GWP_e) \quad (1)$$

Source Data: [10]

where $TGHG_z$ is the transport GHG emission (tCO_2e) for mode z that represent the same mode to calculate the energy consumption. EC_a, $EF_{a,x}$, and GWP_e represent respectively transport energy consumption of fuel consumed (TJ), emission factor (kg/TJ) for 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.

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, the value 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.

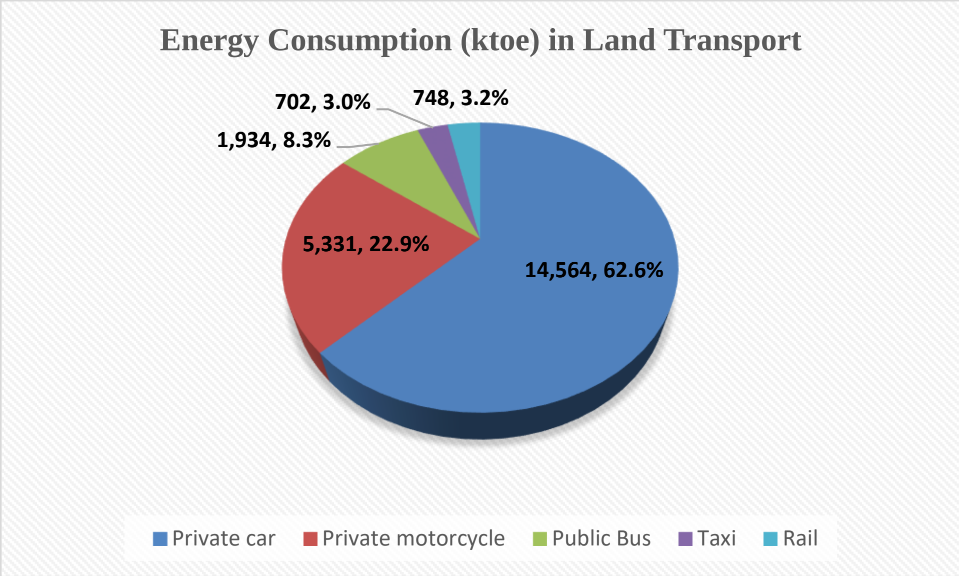

Figure 5: Energy consumption by various type of vehicles in land transport for 2015

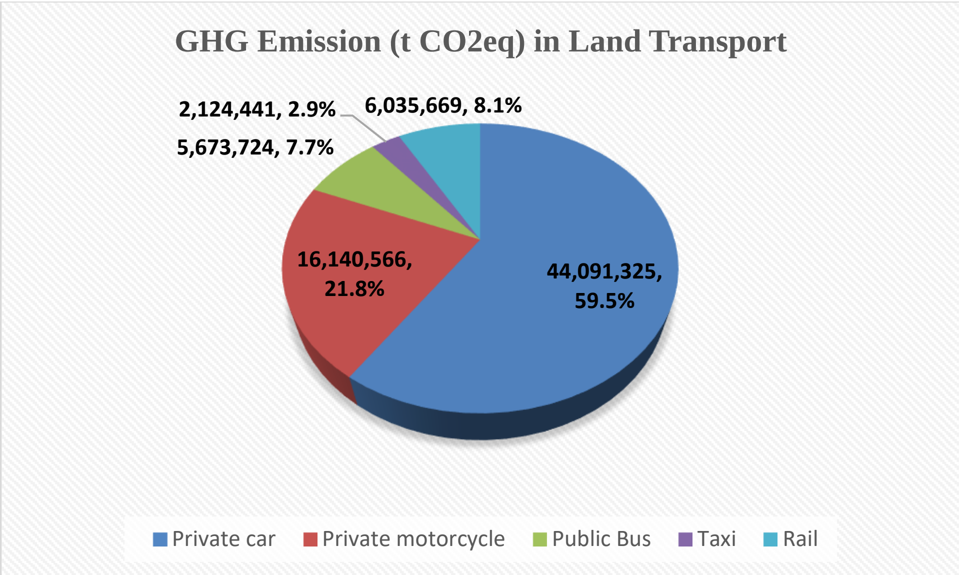

Figure 6: GHG emission by various type of vehicles in land transport for 2015 [5]

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Table 4: Comparison GHG emission for different land transport vehicles in Malaysia.[11]

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

4.2 Energy consumption and GHG emission for scenario B

The energy consumption and GHG emission from the various vehicle types 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.

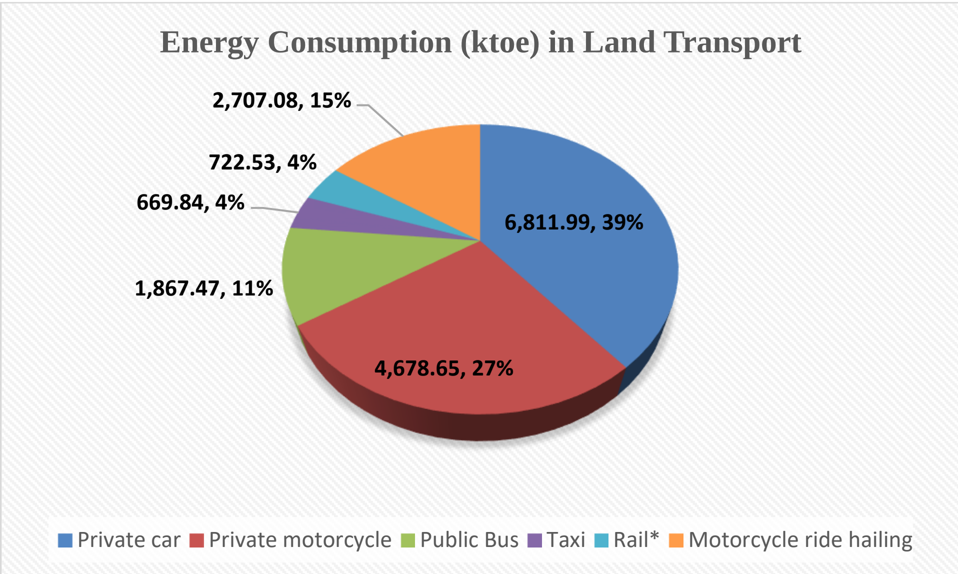

Figure 7: Energy consumption by various type of vehicles in land transport after shifting for 2015 [5]

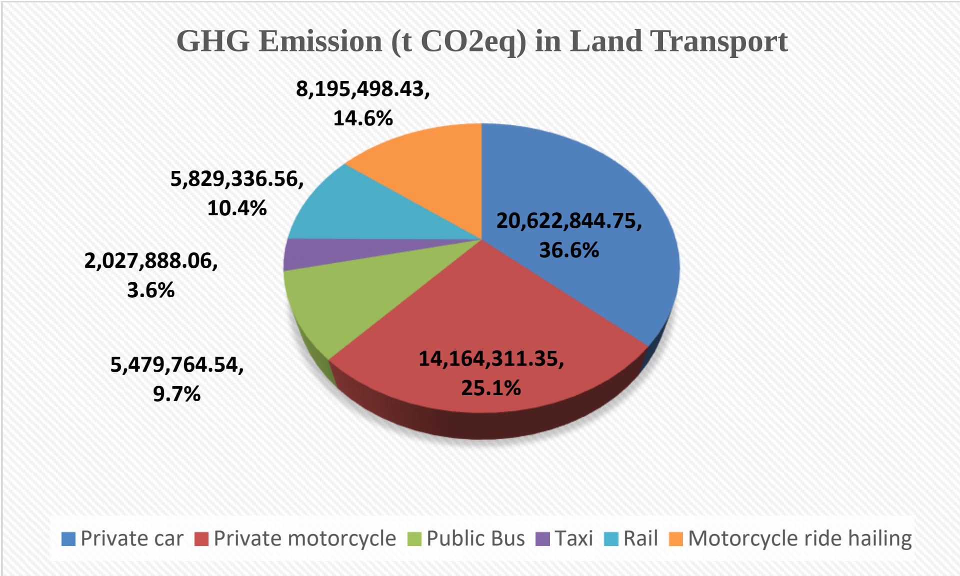

Figure 8: GHG emission by various type of vehicles in land transport after shifting for 2015 [5]

4.3 Comparison between scenario 'A' and 'B'

The comparison of energy consumption and GHG emission between scenario A and B are illustrated in Table and Table, respectively. Based on the result, there are very high reduction energy consumption and GHG emission for private car which is 53.2%. This happen 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 12.2% 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 3.4%. But public mode has higher energy consumption compared to rail mode.

Table 5: Reduction of Energy Consumption 2015

Mode Transport	Scenario		Reduction of Energy Consumption (ktoe)
	A	B	
Private car	14,564	6,811.99	7,752.01
Private motorcycle	5,331	4,678.65	652.35
Public Bus	1,934	1,867.47	66.53
Taxi	702	669.84	32.16
Rail	748	722.53	25.47
Motorcycle ride hailing	0	2,707.08	-2,707.08

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Total	23,279	17,457.56	5,821.44

Table 6: Reduction of GHG Emission 2015

Mode Transport	Scenario		Reduction of GHG Emission ($t\ CO_{2eq}$)
	A	B	
Private car	44,091,325	20,622,845	23,468,480
Private motorcycle	16,140,566	14,164,311	1,976,255
Public Bus	5,673,724	5,479,765	193,959
Taxi	2,124,441	2,027,888	96,553
Rail	6,035,669	5,829,337	206,332
Motorcycle ride hailing	0	8,195,498	-8,195,498
Total	74,065,725	56,319,644	17,746,081

4.4 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 7: Energy consumption for different land transport vehicles.[11]

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	1.55	2.79805
Rail	11.61288	36.75	0.31600

Table 8: 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 9: 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				

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 kilometre travelled which very good to reduce the GHG emission. On the other hand, private motorcycle also has low GHG emission for each passenger kilometre 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 centralised authority that related to non-motorized transport (NMT) for energy consumption and vehicle kilometre travelled assessment. As we overcome the limitation, we able to achieve the objectives perfectly.

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