DIGITALES ARCHIV

Yuaningsih, Lilis; Febrianti, R. Adjeng Mariana; Ahmad, Munawar Javed

Article

Examining the factors affecting CO2 emissions from road transportation in Malaysia

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

This Version is available at:
http://hdl.handle.net/11159/7875

Mitglied der

Examining the Factors Affecting CO$_2$ Emissions from Road Transportation in Malaysia

Lilis Yuaningsih[1], R. Adjeng Mariana Febrianti[1], Munawar Javed Ahmad[2]*

[1]Widyatama University Indonesia, Indonesia, [2]IQRA University, Karachi, Pakistan. *Email: munawar.javed@iqra.edu.pk

ABSTRACT

Increased economic growth and transportation have led to a great increase in carbon emission in Malaysia. This paper investigates the factors such as distance travel (DT), fuel efficiency (FE), fuel price (FP) and fuel consumption as determinants of carbon emission from road transportation in Malaysia for the period 1990 to 2019. The results indicate that DT, FP, and FE are the main determinants of carbon emission. The study concludes that to reduce carbon emission in Malaysia, policies causing structural adjustments in the road transport sector of Malaysia must be implemented.

Keywords: Carbon Dioxide Gas Emissions, Energy Consumption, Road Transportation, Economic Growth
JEL Classification: Q19

1. INTRODUCTION

In prior decades emission of carbon dioxide gas increase appeared as a challenging problem in environment caused by negative climate influence. Globally, rapid economic growth causes an increase in demand of energy consumption and increase emission of carbon dioxide gas as well. Annual emission of carbon dioxide gas raised to 1.9% from 20.9 billion tons to 32.3 billion tons of carbon dioxide emission in 1990 and 2013 respectively (Timilsina and Shrestha 2009). Transportation sector covers a specific percentage of emission out of worldwide emission that is reported as 23% and equivalent to 7.2 billion tons and in future the carbon emission aimed for considerable growth in economy. Higher the number of vehicles on road higher the concentration of emission of carbon dioxide gas will be. Globally the numbers of vehicles are about one billion rising the consumption of petroleum and fuels equivalent to 13.1 billion barrels on annual base and polluting annually for about 5.4 billion tons of carbon dioxide gas emission (Xu and Lin 2015). Carbon emission will produced by transportation sector of about 50% and more than 80% in 2030 and 2050 respectively with increasing demand of energy and number

of vehicles causes for more emission of carbon dioxide gas in country (Morán and del Rio Gonzalez 2007; Sheereen, 2019).

Globally carbon dioxide gas emission has become a worldwide challenging problem that has to be confronted by country (Mustapa and Bekhet, 2015). That is why the nations all over the world, decrease in emission of carbon dioxide gas particularly in the transportation sector became a crucial memo. This Malaysian comparative study has shown emission of carbon dioxide gas with other developing and few developed nations. The pure and compulsion countries rapid emitters like France, Sweden and Switzerland are included in developed nations whereas it must be taken in observation of emitters like China and Malaysia which go beyond the developed countries in emission of carbon dioxide gas (Timilsina and Shrestha, 2009). Through adopting environment policies which aimed for development clean energy brings out with downward trending emission in carbon dioxide gas per capita in developed nations and demonstrate gross domestic product (GDP) as decouple growth by emission in carbon dioxide (Shepherd et al., 2012).To be a developed nation, the Malaysian nation crucially goes beyond in emission of carbon dioxide gas. In

2007 it was declared by climate scientist Bali which highlighted to implement efficient and essential measuring policies in terms of climate influence with acceptance of all facts (Chang and Lin 1999). Moreover, the Malaysian nation and other few nations have set a committee for reduction in carbon dioxide gas emission. At 15th 2009 Conference of Parties set for the reduction of carbon dioxide gas emission intensiveness, up to 40% in 2020 constitute on 2005 level which was unpaid target by Malaysia (Xu and Lin 2015).

In 2020, rapid growth having a higher concentration of income and standard of nations' development was a crucial target to be achieved for Malaysia (Li et al., 2017).There will be a rise in the emission of carbon dioxide gas if the nations go ahead with progression it will bring out a rise in the utilization of energy and hence the demand for energy. The growth rate was 5.2% and 6% within the period of 1990 to 2013 respectively. Higher the GDP growth rate higher will be the emission of carbon dioxide gas suggested by Malaysia. The policy implemented for declining carbon dioxide gas intensiveness is suggested because of the measurement of carbon dioxide gas intensity based on per GDP emission with maintenance and compelling rise in the total rate of emissions. To accomplish the aspirations for the sake of reduction in emission of carbon dioxide gas the Malaysian government should take some environmental friendly imperative measures.

The essential role has been played by the transport sector in the economy which partakes in economic development. In among all other sectors, the utilization of energy was used by the transportation sector in the nation. Reported consumption of energy in 2013 was 43.3% equivalent to about 22.4 million tons of energy of which 85% equivalent to about 19 million tons means that greater contribution came from vehicles as transport on the roads (Lin and Xie, 2014).

In 2013 energy consumption reached up to 21 million tons of energy enhanced by 7.4% on annual base while 92% of energy was consumed collectively by motorcycles and cars (MOT, 2013). Insufficient amount of public transport appeared as greater numbers of motor vehicles. There is a total contribution of numbers of registered vehicles as public transportation infrastructure is 8%in the country. After electricity generation, it led to a higher concentration of carbon dioxide gas emission among all remaining larger emitters.   From several prior years, the emission rate of carbon dioxide gas has been increased in Malaysia. Energy sector became a cause to emit carbon dioxide gas of total 208 million tons of energy in 2013 (Liimatainen et al., 2014). Specific sectors contribute in the specified rate of emission and increase in growth like 46%, 22%,19% and 13% of emission rate is contributed by electricity generation sector, transport sector, manufacturing and remaining sectors with a specified increase in growth rate with 6.4%, 4.4%, 3.6% and 13.9% respectively. In recent years it has been noticed that even the transport sector has a higher capacity of using energy and emit a greater amount of carbon dioxide emission rather than the manufacturing sector.

Higher demand of several passengers in terms of transport services is caused by increasing income, rapid economic development and growth in urbanization (Zhang and Nian 2013). With proper decisive evidence of having more concentration of income could bring out more use of modernized transport resulting in detrimental impacts on the environment (Papagiannaki and Diakoulaki, 2009). In terms of share of the total emission of carbon dioxide gas throughout others sectors largest share has been accounted by transport sector including marine, aviation and rail with 85.2% of carbon dioxide gas emission in Malaysia. Total road transport share in terms of private vehicles like motorcycles and motor cars accounted for 70% out of the total emission of carbon dioxide gas (Gambhir et al., 2015). Recently transport sector heavily constituted on diesel and petroleum with a specified amount of share equivalent to 66% and 32% respectively while gas has 2% marginal fuel share out of total emission of carbon dioxide gas (McKinnon, 2007). It has been harder in future for safety, emission of carbon dioxide inclusion and security terms if using a higher concentration of petroleum products (Lu et al., 2007).

Indisputably, for the sake of decline in the emission of carbon dioxide gas, the transportation sector is pivotal with illumination of exceptional development in the pervasiveness of private vehicles that scheduled to increase transportation services for passengers (He et al., 2005). Transportation sector would get adversely influenced if efforts are made for declining carbon dioxide gas emission and consequently it gives negative shadow in efficiency and growth of the economy and it is emphasized by some concerns. Possibly, there is concern relying on modernized technology used in vehicles could lead to a decline in carbon dioxide gas emission as well as intensiveness of emission with increase in fuel efficiency (FE) with no adverse impact on economic growth (Wang et al., 2011).The occurrence of such condition considered as a tandem of Environmental Kuznets Curve (EKC) and made the hypothesis that there is inversed U structured relationship between carbon dioxide gas emission and policy trails for a nation with technological measures (Streets et al., 2001). Hence the paper is intended to enquire the features which have impact on the emission of carbon dioxide gas in terms of road transportation and suggest the policy measures meant to be effective and efficient to be implemented for its country and accomplish the aspiration of decline in the emission of carbon dioxide. Partition of this paper is trended as following like part 2 is discussing the findings through given prior empirical studies. Part 3 is depicting the data source and discussion of methodology. Results given by data analysis have given in part 4. Part 5 is a discussion of conclusion and policy implementation suggested from this study.

2. LITERATURE REVIEW

Some efforts were made for various countries for the sake of reliable energy and planning to be in favor of the environment policy. This purpose brings out a study in different energy sectors for modulation, methodology and considered techniques to enquire the influencing features, factors and alleviation policies affecting the emission of carbon dioxide gas. Optimization models, time series analysis and regression analysis generally used in prior studies.

The first paragraph has taken start-up of research by time series analysis. The environment has concern with increased

energy consumption because of emission of carbon dioxide gas (Ambroziak et al., 2014). Linton et al. (2015) examined co-integration for transport fuel consumption of fuel price and per capita income while according to Fuglestvedt et al. (2008) analyzed long term relationship between emission of carbon dioxide gas and energy consumption. Bin and Dowlatabadi (2005) found effects on emission of carbon dioxide gas of factors like population growth, GDP and FC. According to Sobrino and Monzon (2014) suggested in its study for the possibility of a reduction in emission growth by fuel consumption and emission in carbon dioxide acquiring technology with low carbon. Consistent with Aggarwal and Jain (2016) studied of having inelastic supply property in terms of transport demand which depicted inefficient fuel price as subsidy economically and moderate emission of carbon dioxide in transportation sector concerns with investment in production.

According to Mazzarino (2000)conducted a study to investigate the relationship among urbanization, GDP, energy intensity and income resulting from that decline in the emission of carbon dioxide gas can be determined through the rise in fuel efficiency and fuel knobbing of renewable energy instead of fossil fuels. Timilsina and Shrestha (2009) examined the GDP, cargo return, energy intensity, urbanization and private vehicles account for emission of carbon dioxide gas. Resulting from higher economic growth the low carbon vehicles like hybrid and high-speed rail will become strong hold for passengers and cargo vehicles. Sobrino and Monzon (2014) analyzed that there is a high concentration of carbon dioxide gas emission with higher population density on intense road set up of urban regions. Xu and Lin (2015) analyzed the energy intensity, GDP, energy structure and impact of the populace on the emission of carbon dioxide gas. The determination of emission of carbon dioxide gas constituted on GDP adopted by energy structure and population scales. Higher the growth of technology advancement higher will be fuel consumption efficiency, suggested by the paper. In order words, technology advancement was an effective idea for efficiency in fuel consumption.

Higher the requirement of mobility and distance travel (DT) that increased through road transportation in people resulted by urbanization and higher economic growth. For sustainable structure, this process increases the concerns raising the demand for fuels. According to Yan and Crookes (2010) by employing decomposition analysis postulated influence in transportation sector concerning carbon dioxide gas emission for GDP, DT and population growth. Xu and Lin (2015) questioned the influence in transport distance travel, the total number of vehicles and energy intensity impact on the emission of carbon dioxide gas concerning energy. Linton et al. (2015) investigated such components relate to model shift influence, coefficient of emission, fuel mix, transport energy intensity and growth of GDP that decomposed the carbon dioxide gas emission.

For sustainable energy plan and decline in carbon dioxide gas emission several numbers of best optimized models were established. Model of linear programs examined alleviations decisions of cost-effectiveness in the emission of carbon dioxide gas with related to energy industries. Using the model of multiple linear programs investigated the impacts in case of fuel balance and fuel switch alternative for energy generation. Best sorted ways were offered by fuel efficiency and fuel switching to reduce the emission of carbon dioxide gas emission. Mazzarino (2000) applied multiple integer linear programs for the possibly best plan of making waste to energy leading to minimization cost in electricity generation for Malaysia. Mustapa and Bekhet (2015) for the sake of cost minimization and hydrogen supply in optimum set up in Peninsular Malaysia, a model was established.

The table is a depiction of main factors with the inclusion of literature, applied methodology and other main features enquired in this study. Through an evident data given in Table 1, it is clear from prior studies of Malaysia examined fuel consumption, GDP and population as a key factor in related to the emission of carbon dioxide gas. Remaining factors like fuel efficiency, fuel price and distance travel have an impact on the emission of carbon dioxide gas relevance with road transport emission Mazzarino (2000). These variables were considered and study questioned for FC, FP, FE and DT impact and relationship with transportation sector emission of carbon dioxide gas in Malaysia with the supposition of simultaneous use of multiple regression analysis.

3. THEORETICAL FRAMEWORK AND CARBON DIOXIDE EMISSION REDUCTION MODEL

The relevant literature comes up with emphasize of the relationship among FC, FP, FE and DT on the emission of carbon dioxide gas. Keeping because of present study considerable schedule was designed to investigate the features influencing emission of carbon dioxide gas in terms of road transport. Here the study considers carbon dioxide gas emission as a dependent variable with intend to have the primary interest of study. Four sorts of explanatory variables constituting FP, FC, FE and DT correlated with each other can describe the variance independent variables. Variable FC is representing the volume of fuel consumed by the vehicles in terms of road transport sector. Lower the fuel consumption the lower can be the emission of carbon dioxide gas in the road transport sector. In other words, it can be said that FC is directly proportional to the emission of carbon dioxide gas. One way to reduce the emission of carbon dioxide gas without lowering the fuel consumption consumed in the transport sector is to utilize low carbon item in terms of use of non-fossil fuels. It is depicting somehow a direct relationship between emission reduction amount and no fossil fuel use like greater the use of non-fossil fuels more declined would exist in the emission of carbon dioxide gas (Wang et al., 2011).

FE represents the efficiency of fuel and measured by ratio of amount per unit consumed by a vehicle while travelling distance. There is a direct relationship between FE with DT and an inverse relationship with FC. In other words, greater the alleviation in FC will bring out larger DT and cause to decline in FC needed for the specific distance that has to travel and it will decrease the emission of carbon dioxide gas.

Table 1: Depiction of energy and environmental planning related prior studies

Sector/Country	Methodology/Approach	Factors
Energy/Malaysia	Johansen, Co-integration, VECM	GDP, CO$_2$ emissions, FC
Transport/Ghana	Time series	Income, FC, price, human capital, efficiency
Electricity/Taiwan	Linear programming	Optimization on CO$_2$ emissions, electricity production
Energy/Malaysia	Time series, ARDL approach	GDP, FC, populace, CO$_2$ emissions
Energy/Malaysia	Time series, ARDL approach	CO$_2$ emissions, GDP, export, import, FC
Energy/Malaysia	VECM	Oil cost, GDP, employment, FC
Transport/Sweden	Linear programming	Optimization on CO$_2$ emissions and economic cost
Energy/Turkey	ARIMA	FC
Electricity/Ontario	Mixed integer programming	Optimization on CO$_2$ emissions and economic cost
Residential/Malaysia	Time series, ARDL approach	Electricity use, GDP, FP, population
Residential/Malaysia	Time series, ARDL approach	Electricity use, GDP, FP, populace, FDI
Transport/Malaysia	Mixed integer programming	Optimization on economic cost
Transport/USA	Decomposition	CO$_2$ emission, FC, DT, populace and GDP
76 developing countries	Panel regression	Energy concentration, income, urbanization and GDP
16 emerging countries	Panel regression	Energy concentration, income, urbanization and GDP
Transport/Louisiana	Panel regression	CO$_2$ emission, populace, urban regions, income and road mass
Transport/Mauritus	Time series, ARDL approach	FC, FP, Income per capital
Waste/Malaysia	Mixed integer programming	Optimization on CO$_2$ emissions and economic cost
Transport/Asian countries	Decomposition	CO$_2$, fuel mix, model's switch, GDP, populace, emission coefficients and energy concentration
Iron and Steel	Objectives optimization	Optimization on CO$_2$ emissions and output cost
Transport/China	Decomposition	CO$_2$ emissions, FC, model share, transport concentration
Transport/China	Non-parametric regression	CO$_2$ emission, GDP, population, FC
China	Decomposition	CO$_2$ emission, FC, GDP, energy intensity

Some keywords are used in this table so their full name is as "VECM" stands for "Vector error correction model," "GDP" for "Gross domestic product," "FC" for "Fuel consumption," "FP" for "Fuel price," "DT" for "Distance travel," "FDI" for "Foreign direct investment," "ARDL" for "Autoregressive Distributed lag," "ARIMA" for "Autoregressive integrated moving average"

FP is depicting the price or cost of fuel as a ratio of cost per unit used by a vehicle. It shows a negative relationship between FP and F like increase in FP will decrease FC and resulting demand downwards (Lu et al., 2007). However, the rise in FP increases the probability of a decline in the emission of carbon dioxide gas.

DT is denoting distance travel in the road transport sector referred to the unit in the quantity of DT with passengers and cargo. Larger the DT higher will be FC and also increase in emission of carbon dioxide gas. Efficient cars increase DT and decline FC and also emission of carbon dioxide gas. Demand in public transport rises if FP does not meet with people's affordability. Orderly these relationships as assumption are shown.

Consistently, the hypothesis can be made like

H$_1$: Relationship among emission of carbon dioxide gas and its factors is significant.

H$_2$: Effects of factors (FP, FC, Fe and DT) on the emission of carbon dioxide gas are significant.

4. DATA SOURCE AND METHODOLOGY

4.1. Data Source

The data for fuel efficiency, fuel price, fuel consumption and distance travel has been gathered from several sources from 1990 to 2013 shown in Table 2. Collected data was relying onthe on-road transport sector. Here the considered type of vehicles are motorcycles, motor cars, hire, driving cars, taxis, buses and goods vehicles. The data is summed up in this study with a series of vehicle technology depending on different sort of fuels like natural gas, petroleum and diesel.

Table 2: Denotation of variables, description and units

Variables	Description	Unit
FC	FC sort of fuel	ktoe
FE	FE average vehicle technology	Km/L
	Average market price of fuel in sort of fuel category	RM/L
DT	Average DT vehicle technology	BpKm
CO$_2$ emission (E)	CO$_2$ emission in transportation sector	Million tons

The largest contribution of vehicles in the road transport sector is petroleum consumption made up a percentage equivalent to 93% mostly used by motorcycles and motor cars whereas diesel consumption is made up of 6% consumed by buses, taxis and other vehicles on another hand natural gas share consumed by taxis and buses is marginal 1%. It has stated that there is the smallest share of natural gas vehicle share in all of total vehicles, hence not including in this analysis. Although two sorts of data would be taken the data for vehicles consumed petroleum and vehicles consumed diesel.

From statistical reports of Energy Commission (EC, 2012 and 2014), Ministry of Domestic Trade and International Energy Agency annual data for FP, FC and emission of carbon dioxide gas was collected respectively which is an official data source. Readymade data for DT and FE was not available. But there was a record of average mileage annually, annual vehicle numbers, occupancy and average FE of vehicles through published literature and sources. Collected data from such sources was employed to estimate the FE and DT of different vehicle technologies. Gathered data is shown in Table 2 with summarization into set and data analysis for this purpose was performed by SPSS version 21 for this study.

4.2. Methodology

This study aimed to investigate the inter-link and effects among determinants of carbon dioxide gas emission in the road transport sector in Malaysia. Two testing applications have been done for this study named as descriptive statistics and multiple regression analysis with the links with each other.

The initial part was examined to undertake the conditions and distribution normality in data. Data quality was observed the values of mean and standard deviation whereas normality distribution of data was observed by skewness, kurtosis and Shapiro–Wilk tests. Determination of direction and strength has shown by linear inter-connection between determinants and emission of carbon dioxide gas.

The second part examined multiple regression models which undertake the effects between determinants composing with FC, FE, FP and DT and emission of carbon dioxide gas. Term wise linear relationship approach was employed to investigate the impact of these features on the emission of carbon dioxide gas. Regression analysis was carried out by using SPSS software stands for Statistics Software Package.

It can be postulated with rising in FC and DT carbon dioxide gas emissions also rise and its decline with rising in FP and FE (Streets et al., 2001). The model has a dependent variable as the emission of carbon dioxide gas. Four independent variables are used for the determination of effect on the emission of carbon dioxide gas. Equation of this model for regression analysis is composed as shown.

$$E = \alpha_0 + \alpha_1 FC_1 + \alpha_2 FE_2 + \alpha_3 DT_3 + \alpha_4 FP_4 + \varepsilon \qquad (1)$$

In the above equation alphas's are denoting regression coefficients required to be estimated for this model depending on reported observations whereas e is the last term and referred to as residual. Residual is used to test the significance of the equation by F test and t-test is used for the significance of regression coefficients.

In the Malaysian road transport sector, vehicles based on petroleum and diesel derives vehicle technologies. Regression approach was applied for two models separately. Model 1 depicts a set of data related to vehicle technology using petroleum. Model 2 depicts a set of data related to vehicle technology using diesel. A stepwise approach is used for both models. Parameters include or exclude with every step as this approach is reiterating the analysis through each step. However in equation 1 considered to have an impact on the emission of carbon dioxide gas of all features. In every vehicle technology, not each factor is significant. The model coefficients that have to be estimated are depicted and explained in part 5.

5. RESULTS AND INTERPRETATION

5.1. Descriptive Statistics, Normality Distribution Analysis and Inter-Relationships

Statistical description for each determinant has shown in Table 3. Data quality has shown in the first left side column of the table based on mean, standard deviation, maximum and minimum values. It was observed to have small standard deviation compare to mean value for all factors which suggested for good quality of data. Normality of distribution is reported on the right side of the column based on data skewness, kurtosis and Shapiro–Wilk. Kurtosis shown within the range between −3 to +3 and skewness has shown within the range between −1 to +1 representing good normal distribution for the factors has to be investigated for. As data set base on small observation hence through a statistical technique known as the Shapiro–Wilk test, normal distribution was further surveyed. Table 3 is showing data of good fit for all factors with probability value equivalent to P > 0.001 and significant value (Ambroziak et al., 2014).

For determination of direction and strength of factors for interlinks of linear relationships between explanatory variables of FC, FE, FP and DT and the dependent variable of emission of carbon dioxide gas denoted as E. different range of value of correlation shows different kinds like there are slight correlation, low correlation, moderate correlation, high correlation and very high correlation with a value range of <0.20, 0.20-0.40,0.4-0.7, 0.7-0.9 and >0.9 respectively (Ambroziak et al., 2014). Correlation coefficients have shown in Table 4 where all the factors are showing the value of >0.8 resulting in high correlation with the emission of carbon dioxide gas. A direct relationship has been shown by FC (FEP, FED) and DT (DTP, DTD) with the emission of carbon dioxide gas depicting DT and higher consumption compel to rise emission of carbon dioxide gas both kinds of vehicle technology petrol and diesel have shown an inverse relationship with the emission of carbon dioxide gas illustrating more increase in FE and FP will bring out more reduction in carbon dioxide gas emission.

Table 3: Descriptive statistics

Variables	Min	Max	Mean	SD	Skewness	KSW	P-value
CO₂ emission	15.37	45.50	31.02	8.91	−0.26	−0.95	0.40
FC Petrol	2889.0	12288	6680.75	2338	0.15	−0.02	0.45
FC Diesel	1351.24	4820	2934.86	1136.77	−0.138	−1.50	0.01
FE Petrol	7.47	9.58	8.49	0.68	0.161	−1.27	0.19
FE Diesel	5.80	8.12	6.97	0.76	0.07	−1.25	0.19
FP Petrol	0.29	0.80	0.5750	0.19	−0.35	−1.55	0.00
FP Diesel	0.34	1.03	0.7258	0.25	−0.43	−1.43	0.01
DT Petrol	106.40	591.25	309.24	156.22	0.47	−1.09	0.10
DT Diesel	74.50	272.60	169.38	58.81	−0.04	−1.03	0.55

KSW is representing Kurtosis Shapiro–Wilk, SD is denoting standard deviation, FC is fuel consumption, FP is showing fuel price here DT is distance travel and FE is denoting fuel efficiency

5.2. Impact Analysis between Carbon Dioxide Gas Emissions and Factors Determination

For better understanding of carbon dioxide, gas emission and its influencing factors impact multiple regression analysis was employed step by step lead to compelling analysis to include or exclude the variables at every single step independently. For the addition of variable include probability of F to enter ≤0.05 and for the elimination of variable include the probability of F to remove ≥0.1.Outliers of the residual term would be eliminated due to regression analysis relying upon normal distribution of error terms that were estimated statistically.

The cumulative impact of FE (FEP) and FP (FPP) with the emission of carbon dioxide gas is significantly revealed by Table 5 depiction of results of model 1. The procedure has done by t-test at a level of significance equivalent to <0.05 and multicollinearity value equivalent to 5.658. Accomplishing with FE and FP results suggested the significant impact of carbon dioxide gas emission in terms of the road transport sector.

Factors FEP and FPP are explaining the variance of 98.1% of carbon dioxide gas emission with adjustment value of R^2 equivalent to 0.98 shown in Table 5 of model 1. In ANOVA table value of F test statistic is equivalent to 595.7 and statistically large to accept where the level of significance is 0.00. Durbin-Waston test statistic was used to identify the correlation presence and show a value of 1.98 suggested no autocorrelation of error terms with each other (Montgomery et al., 2006). When variance explained all factors and show dominancy the largest value of the Beta coefficient for FEP equivalent to −15.72 showing the largest contribution in explaining the emission of carbon dioxide gas. The higher increase in FEP will bring out a reduction in the emission of carbon dioxide gas (McKinnon 2007). The largest and dominant contributions in all other factors were FEP and FPP shown in ranking order. It has been determined that FP and FE are

the prominent key factors manipulating the emission of carbon dioxide gas for petrol vehicles technology in Malaysia.

In comparison, the estimated coefficient of model 2 in Table 5 is depicting DT (DTD) impact on the emission of carbon dioxide gas. Factor DT (DTD) is explaining the variance of 97.8% of carbon dioxide gas emission with adjustment value of R^2 equivalent to 0.98 shown in Table 5 of model 2. In ANOVA table value of F test statistic is equivalent to 1018.076 and statistically able to be accepted where the level of significance is 0.00.the t-test is significant at the value of <0.05. Durbin-Waston test statistic was used to identify the correlation presence and show a value of 1.82 suggested no autocorrelation of error terms with each other. It has been suggested in model 2 that the largest contribution of emission of carbon dioxide gas are diesel consuming vehicles technology indicating a higher increase in DTP will bring out more emission in carbon dioxide gas. Consequently, DT is a key factor to increase the emission of carbon dioxide gas in term of the road transport sector (Li et al., 2017). Differentiation of consumed petrol by personal or public transport and diesel by cargo and passenger transport vehicle can better state the results. Passenger transport like buses and taxis and goods transport mostly consume diesel and fuel to travel a long distance in Malaysia.

Tables 5 and 6 respectively showing results for inter-connection and impact on variables based on statistical analysis. In Table 7 results have shown for the sake of inter-connection all the factors supporting the null hypothesis. Results in terms of the effect on variables with statistical analysis in Table 6 appeared in favor of alternate hypothesis by factors of FE, FP and DT and revealing largest contribution of FE, DT and FP in rank respectively. However, it could be said that in Malaysia FE, DT and FP bring out as significant factors and efficient in declining emission of carbon dioxide gas. As FE advancement would impact FC but FC has no good support in both of the models ultimately which

Table 4: Dataset of correlation coefficient of road transport

Factors	CO₂	FCP	DTP	FEP	FPP	FCD	DTD	FED	FPD
E	1.000								
FCP	0.963	1.000							
DTP	0.959	0.929	1.000						
FEP	−0.986	−0.957	−0.978	1.000					
FPP	−0.851	−0.845	−0.933	0.907	1.000				
FCD	0.936	0.923	0.907	−0.945	−0.863	1.000			
DTD	0.989	0.964	0.984	−0.995	−0.901	0.939	1.000		
FED	−0.984	−0.950	−0.985	0.999	0.911	−0.944	−0.996	1.000	
FPD	−0.836	−0.805	−0.912	0.869	0.899	−0.845	−0.863	0.876	1.000

Correlation is significant at the level of significance equal to 0.0 implying two‑tailed test. FC is denoting fuel consumption, FP is fuel price, DT is distance travel, FE is fuel efficiency

Table 5: Measurement results of Model 1 (petrol vehicles) and Model 2 (diesel vehicles)

Construct	Non-homogeneous coefficients/α	Standard/Error	Standardized coefficients/Alpha	t-value	P-value	VIF
Model-1 (Petrol vehicles)						
Constant	157.81	5.91	-	−26.69	0.00	-
FEP	−15.73	0.89	−1.21	−17.69	0.000	5.66
FPP	11.63	3.25	0.25	3.59	0.002	5.66
Model-2 (Diesel vehicles)						
Constant	5.65	0.84	-	6.72	0.00	-
DTD	0.15	0.005	0.99	31.91	0.000	1.00

Model 1 is representing R-value equal to 0.99 where Adjusted R^2 is equal to 0.98, F has the value of 595.68, the significance level is 0.000 and Durbin–Watson value is 1.98. The Model 2 is representing R equal to 0.99 where Adjusted R^2 is 0.98, F has a value equal to 1018.08 and significance level is 0.000

Table 6: Results of impact analysis with the implication of hypothesis testing (H₂)

Hypothesis	Petrol vehicles			Diesel vehicles		
	Standardized coefficients	P-value	Results	Standardized coefficients	P-value	Results
FC→CO₂	-	-	Rejected	-	-	Rejected
FE→CO₂	−1.22	0.00	Accepted	-	-	Rejected
DT→CO₂	-	-	Rejected	0.99	0.00	Accepted
FP→CO₂	0.25	0.00	Accepted	-	-	Rejected

Level of significance is 5% with P<0.05 whereas FC is fuel consumption, FP is fuel price, DT representing distance travel and FE denoting fuel efficiency

respond to an increase in emission level of carbon dioxide gas (Loo and Li 2012).

6. CONCLUSIONS AND POLICY IMPLEMENTATIONS

The paper determined the driving forces of the road transport sector by employing regression analysis and data has taken from 1990 to 2019. It has been investigated in Malaysia the relationships and effect came out from the assumption of predictors of FC, FE, FP and DT on the emission of carbon dioxide gas of the road transport sector. Significant impact has shown by results between carbon dioxide gas emission and factors. Moreover, the study concluded FE, FC, FP and DT as key influencing factors of carbon dioxide gas emission in terms of the road transport sector. According to empirical results reported in prior studies that FE, FP and DT are significantly influencing factors for the emission of carbon dioxide gas. It has also suggested in previous studies that reduction in emission is possible by clean and efficient energy policymaking and its better implementation without hurting the growth and mobility of an economy in-country (Davis et al., 2010).

Higher the demand of energy higher will be the emission of carbon dioxide gas in the opinion of energy planning and assumptions in the road transport sector. To address the problem of emission of carbon dioxide gas DT better management, FE advancement and FP mechanism can provide an efficient policy implementation direction in the road transport sector. It is suggested that use of more efficient and advance vehicle technology like hybrid and electric vehicle technology by substituting with conventional vehicles is helpful to reduce the emission of carbon dioxide gas whereas passenger vehicle normally consumes petrol of 93% and rise emission (Ehsani et al., 2016). By government provision of fiscal incentives and more intensification of such vehicles must be promoted to accelerate the use of advance vehicles. Through fiscal instrument, energy-saving technology like car manufacturing by a preferable policy like fuel policy must be improved by the government (Loo and Li 2012). It will bring out in favor of advance and efficient vehicle substitution with conventional vehicles.

According to the experience of implying fuel economy policy in other countries like Japan, the United States, Europe and Singapore reported less use of fuel and emission of carbon dioxide gas. An authority was required to institutionalize for the implication of fuel economy policy on standard vehicles in Malaysia. An initiative taken by Association of South Asian Nations (ASEAN) states aimed to have vehicle efficiency and to decline in the emission of carbon dioxide gas providing a better platform to promote the use

of efficient vehicles and accelerating competitiveness with market transformation inclusion among car manufacturers in Malaysia.

FC has a direct relationship with carbon dioxide gas emission higher the fuel consumption higher will be the emission of carbon dioxide gas and to lower the fuel consumption brings out lower emission of carbon dioxide gas in terms of road transport. For mobility need using fuel-switching options implied to decline the emission of carbon dioxide gas whereas DT is considered as a key factor for the vehicle technology using diesel. To achieve aimed target alternative fuels consumption intensity having less carbon content like biofuels and can be used for the purpose to have less carbon dioxide gas emission achieved (He et al., 2005). For less carbon dioxide emission in-country B5 and B7 mixture of 5% palm biodiesel and 95% of petroleum diesel and 7% of palm biodiesel and 93% of petroleum diesel respectively are currently consuming by vehicles. In 2020 efficient biodiesel B17 mixture of 17% of palm biodiesel introduced for the decrease in carbon dioxide gas emission. If the adoption of consumption of bioethanol for road transport there will be a much higher decrease in carbon dioxide emission as much as the passenger vehicles will move to consume petrol Mazzarino (2000)**.** Use of efficient fuel vehicles like electric, eco and hybrid cars go in favor of reduction in fuel demand and emission of carbon dioxide gas in the road transportation sector. For less carbon dioxide gas emission green logistic policy can be implied as diesel vehicles mostly use by industries.

FP has a significant impact on declining emission of carbon dioxide gas. In 2014 FP subsidy elimination for petrol and diesel both on government decision is praiseworthy. The decline in prices globally accelerates the marginal effect of FP with the rise in reasonability of both petrol and diesel with more private use of transport. To reduce the FC and emission of carbon dioxide demand rising measures like vehicle tax, congestion fee, carbon tax implementation would be beneficial.

Results have shown the potential to reduce the emission of carbon dioxide gas and provided favorable alleviation measures decisions made in local perspective for the road transport sector. Study on considered for road transport perspective excluding other modes of sectors related to transportation. Out of several policies transferring private vehicle technology to public transport technology like mass rapid transit, light rail transit noticed to be efficient and effective alleviation policies for sake of reduction in emission of carbon dioxide gas (He et al., 2005).This study suggests other researchers with the inclusion of other modes of transportation like maritime, rail and air for offering effective and efficient transportation and measures taken by local and governmental bodies for a reduction in emission of carbon dioxide gas. Research work can be extended

finding out the optimal level of reduction in carbon dioxide gas emission to investigate for the capability of a country to reduce emission. To examine more energy reduction effective ways favored by governmental bodies, further investigation needed to imply optimizing mode of method.

REFERENCES

Aggarwal, P., Jain, S. (2016), Energy demand and CO_2 emissions from urban on-road transport in Delhi: Current and future projections under various policy measures. Journal of Cleaner Production, 128, 48-61.

Ambroziak, T., Jachimowski, R., Pyza, D., Szczepański, E. (2014), Analysis of the traffic stream distribution in terms of identification of areas with the highest exhaust pollution. Archives of Transport, 32, 7-16.

Bin, S., Dowlatabadi, H. (2005), Consumer lifestyle approach to US energy use and the related CO_2 emissions. Energy Policy, 33(2), 197-208.

Chang, T., Lin, S.J. (1999), Grey relation analysis of carbon dioxide emissions from industrial production and energy uses in Taiwan. Journal of Environmental Management, 56(4), 247-257.

Davis, S.J., Caldeira, K., Matthews, H.D. (2010), Future CO_2 emissions and climate change from existing energy infrastructure. Science, 329(5997), 1330-1333.

Ehsani, M., Ahmadi, A., Fadai, D. (2016), Modeling of vehicle fuel consumption and carbon dioxide emission in road transport. Renewable and Sustainable Energy Reviews, 53, 1638-1648.

Fuglestvedt, J., Berntsen, T., Myhre, G., Rypdal, K., Skeie, R.B. (2008), Climate forcing from the transport sectors. Proceedings of the National Academy of Sciences, 105(2), 454-458.

Gambhir, A., Lawrence, K., Tong, D., Martinez-Botas, R. (2015), Reducing China's road transport sector CO_2 emissions to 2050: Technologies, costs and decomposition analysis. Applied Energy, 157, 905-917.

He, K., Huo, H., Zhang, Q., He, D., An, F., Wang, M., Walsh, M.P. (2005), Oil consumption and CO_2 emissions in China's road transport: Current status, future trends, and policy implications. Energy Policy, 33(12), 1499-1507.

Li, A., Zhang, A., Zhou, Y., Yao, X. (2017), Decomposition analysis of factors affecting carbon dioxide emissions across provinces in China. Journal of Cleaner Production, 141, 1428-1444.

Liimatainen, H., Kallionpää, E., Pöllänen, M., Stenholm, P., Tapio, P., McKinnon, A. (2014), Decarbonizing road freight in the future-detailed scenarios of the carbon emissions of Finnish road freight transport in 2030 using a Delphi method approach. Technological Forecasting and Social Change, 81, 177-191.

Lin, B., Xie, C. (2014), Reduction potential of CO_2 emissions in China's transport industry. Renewable and Sustainable Energy Reviews, 33, 689-700.

Linton, C., Grant-Muller, S., Gale, W.F. (2015), Approaches and techniques for modelling CO_2 emissions from road transport. Transport Reviews, 35(4), 533-553.

Loo, B.P., Li, L. (2012), Carbon dioxide emissions from passenger transport in China since 1949: Implications for developing sustainable transport. Energy Policy, 50, 464-476.

Lu, I., Lin, S.J., Lewis, C. (2007), Decomposition and decoupling effects of carbon dioxide emission from highway transportation in Taiwan, Germany, Japan and South Korea. Energy Policy, 35(6), 3226-3235.

Mazzarino, M. (2000), The economics of the greenhouse effect: Evaluating the climate change impact due to the transport sector in Italy. Energy Policy, 28(13), 957-966.

McKinnon, A. (2007), CO_2 Emissions from Freight Transport in the UK. London: Commission for Integrated Transport.

Morán, M.Á.T., del Rio Gonzalez, P. (2007), Structural factors affecting land-transport CO_2 emissions: A European comparison. Transportation Research Part D: Transport and Environment, 12(4), 239-253.

Mustapa, S.I., Bekhet, H.A. (2015), Investigating factors affecting CO_2 emissions in Malaysian road transport sector. International Journal of Energy Economics and Policy, 5(4), 1073-1083.

Papagiannaki, K., Diakoulaki, D. (2009), Decomposition analysis of CO_2 emissions from passenger cars: The cases of Greece and Denmark. Energy Policy, 37(8), 3259-3267.

Sheereen, F. (2019), Energy consumption and economic growth for small Island developing states: A panel ARDL approach. Energy Economics Letters, 6(1), 23-29.

Shepherd, S., Bonsall, P., Harrison, G. (2012), Factors affecting future demand for electric vehicles: A model based study. Transport Policy, 20, 62-74.

Sobrino, N., Monzon, A. (2014), The impact of the economic crisis and policy actions on GHG emissions from road transport in Spain. Energy Policy, 74, 486-498.

Streets, D.G., Gupta, S., Waldhoff, S.T., Wang, M.Q., Bond, T.C., Yiyun, B. (2001), Black carbon emissions in China. Atmospheric Environment, 35(25), 4281-4296.

Timilsina, G.R., Shrestha, A. (2009), Factors affecting transport sector CO_2 emissions growth in Latin American and Caribbean countries: An LMDI decomposition analysis. International Journal of Energy Research, 33(4), 396-414.

Timilsina, G.R., Shrestha, A. (2009), Transport sector CO_2 emissions growth in Asia: Underlying factors and policy options. Energy Policy, 37(11), 4523-4539.

Wang, W., Zhang, M., Zhou, M. (2011), Using LMDI method to analyze transport sector CO_2 emissions in China. Energy, 36(10), 5909-5915.

Xu, B., Lin, B. (2015), Factors affecting carbon dioxide (CO_2) emissions in China's transport sector: A dynamic nonparametric additive regression model. Journal of Cleaner Production, 101, 311-322.

Yan, X., Crookes, R.J. (2010), Energy demand and emissions from road transportation vehicles in China. Progress in Energy and Combustion Science, 36(6), 651-676.

Zhang, C., Nian, J. (2013), Panel estimation for transport sector CO_2 emissions and its affecting factors: A regional analysis in China. Energy Policy, 63, 918-926.