Comparative Study of the Effects of Fuel Sources (Diesel, Gasoline and Autogas) in Public Transportation in Metro Manila on Price, Emission and Health Issues

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Abstract: One of the sources of energy in vehicles is fuel. There are different kinds of fuels, gasoline, and diesel are the common types, but lately is being used as an alternative fuel for road transport. The study wants to see the impact of pollution from vehicular exhaust on human health and the environment. There is no available study that analyses/compares the different aspects (cost, emissions and health) that dictates the flow of the fuel industry in Metro Manila. The data on the cost, environment and health effects was called from primary and secondary sources. Primary data was given and conducted by the following government department. Based on the data represented that we analyzed, gasoline shows a significant result in cost and emission following autogas that take the health at critical, while diesel stays normal among the three fuels. Gasoline is expensive, yet it is less harmful to environment and health.

Keywords: Fuel, Diesel, Public Transportation, Emission

1. INTRODUCTION

One of the sources of energy in vehicles is fuel. There are different kinds of fuels, gasoline, and diesel are the common types, but lately is being used as an alternative fuel for road transport.

Diesel is a heavy mineral oil used as fuel in engines. This fuel is derived from petroleum and heavier than gasoline/petrol. It is used to power diesel engines which burn this fuel using the heat produced when air is compressed.
(http://www.allwords.com/word-diesel.htm)

Gasoline is a volatile mixture of flammable liquid hydrocarbons derived chiefly from crude petroleum and used principally as a fuel for internal-combustion engines. Gasoline is used as a fuel for internal-combustion engines in automobiles, motorcycles, and small trucks.
(www.answers.com /topic/gasoline)

Source of gasoline is the petroleum or crude oil. Crude oil is extracted from earth crust and is further processed in order to separate those different fractions from crude oil that are of significant important and are helpful in meeting the demands of the world. Gasoline is extracted from crude petroleum via fractional distillation. Heavy fractions remains at the bottom and light fractions like gasoline are collected at the top.

Autogas is the common name for liquefied petroleum gas (LPG) when it is used as a fuel in internal combustion engines in vehicles as well as in stationary applications such as generators. It is a mixture of propane and butane. Autogas is the third most popular

automotive fuel in the world, with approximately 16 million of 600 million passenger cars powered using the fuel, representing less than 3% of the total market share. Autogas is used as a "green" fuel as it decreases exhaust emissions. (http://en.wikipedia.org/wiki/Autogas)

LPG is synthesized by refining petroleum or "wet" natural gas, and is usually derived from fossil fuel sources, being manufactured during the refining of crude oil, or extracted from oil or gas streams as they emerge from the ground. It was first produced in 1910 by Dr. Walter Snelling, and the first commercial products appeared in 1912. It currently provides about 3% of the energy consumed, and burns cleanly with no soot and very few sulfur emissions, posing no ground or water pollution hazards.

Significance of the Study

- The study wants to see the impact of pollution from vehicular exhaust on human health and the environment.
- There is no available study that analyses/compares the different aspects (cost, emissions and health) that dictates the flow of the fuel industry in Metro Manila.

Objectives of the study

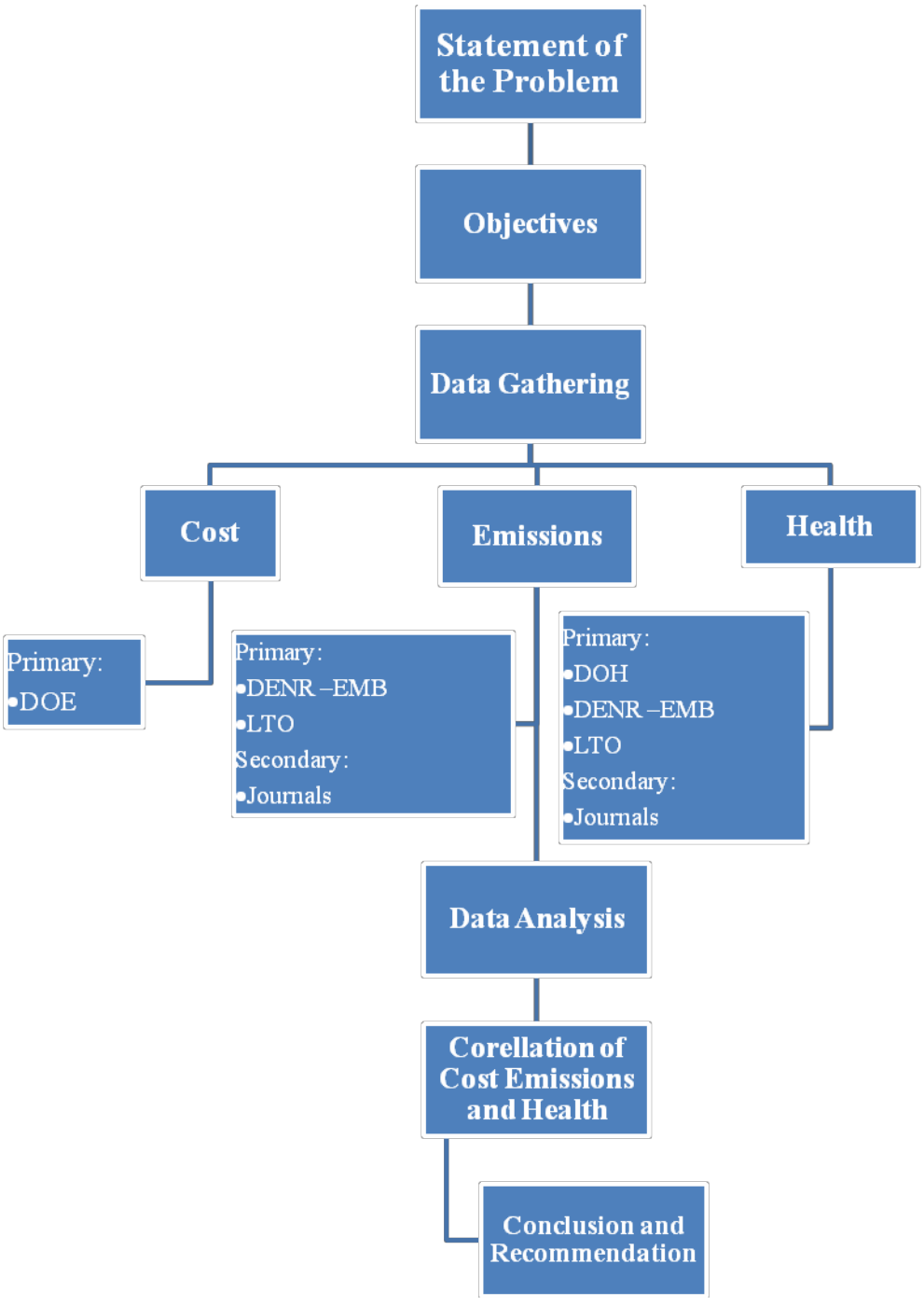
The study wants to compare the advantage and disadvantage of diesel, gas, and auto gas, based on cost, emissions, and health aspects. To achieve this goal the following sub-objectives has to be performed. We are going to compare the different prices of fuel from 2008 – 2009, 2012 – 2013 and to correlate the cost to the environmental effects and to compare the effects emission to the environment also to assess and evaluate the effects of those different fuel concerning health issues on drivers effect.

Scope and Limitations of the Study

- The sampling site is limited to Metro Manila to determine prices, attitude and health of the drivers from year 2012 to 2013.
- Impacts on environment and human health are not specific to the type of fuel used.

3. METHODOLOGY

3.1 Research Framework



This research study aims to compare the advantages and disadvantages of diesel, gasoline, and Autogas based on cost, effects on environment and health. It views the harmful impact on human health of exposure to vehicle pollutants. The occurrence of health problems during the use of fuel were reviewed and analyzed.

The data on the cost, environment and health effects was called from primary and secondary sources. Primary data was given and conducted by the following government department: Department of Energy, Department of Environmental and Natural Resources, Land Transportation Organization and Department of Health. Department of Environmental and Natural Resources is one who is calculating the emissions in the Philippines while Land Transportation Organization is the one testing the emissions of the diesel, gasoline and Autogas. The Department of Health is the one conducting studies about health effects of the fuels. Secondary data will get through from the related studies in the journals, pamphlets and articles.

After all the necessary data was gathered, data analysis was done to relate and compare the types of fuels on environment and health aspects. Following the conclusions and recommendations needed based on the data gathered that is collected to the study and for the future studies.

4. RESULTS AND DISCUSSION

Through the different agencies mentioned, data were collected to support the comparative analysis of different fuels (diesel, gas and LPG) in terms of cost, emissions and the effect of it to the environment and health.

4.1 Cost

Data from the Department of Energy (DOE) showed the prices of the different types of fuels (gas, diesel and Autogas). The Figure below shows the variation of each type of gasoline prices for every month from Year 2008, 2009 and June of 2012 to May 2013. It shows that Autogas has a remarkable result in terms of pricing. One of the reason may be observed is that Autogas is cheaper since it is newly introduce yet available in the market.

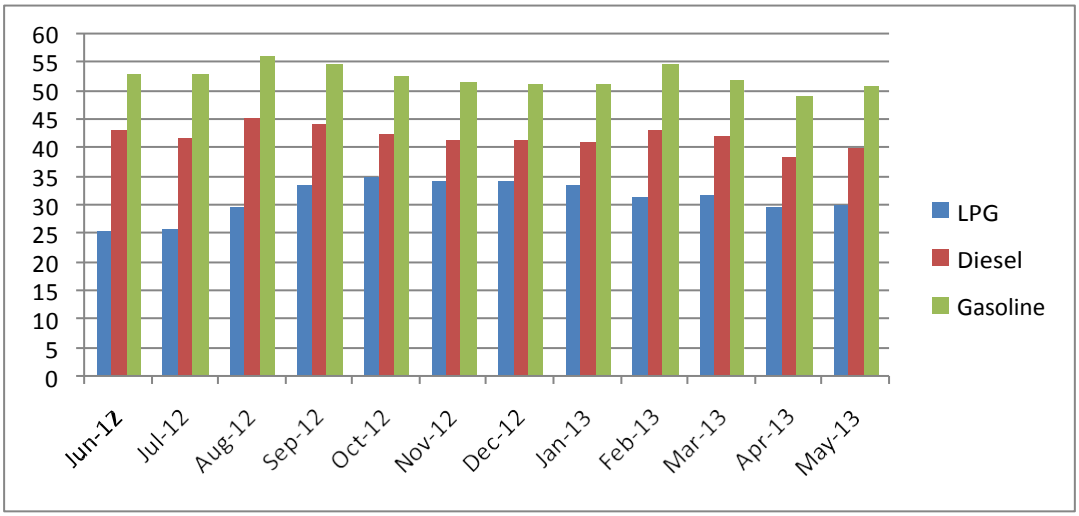


Figure 4.1 2012 – 2013 Prices of fuel

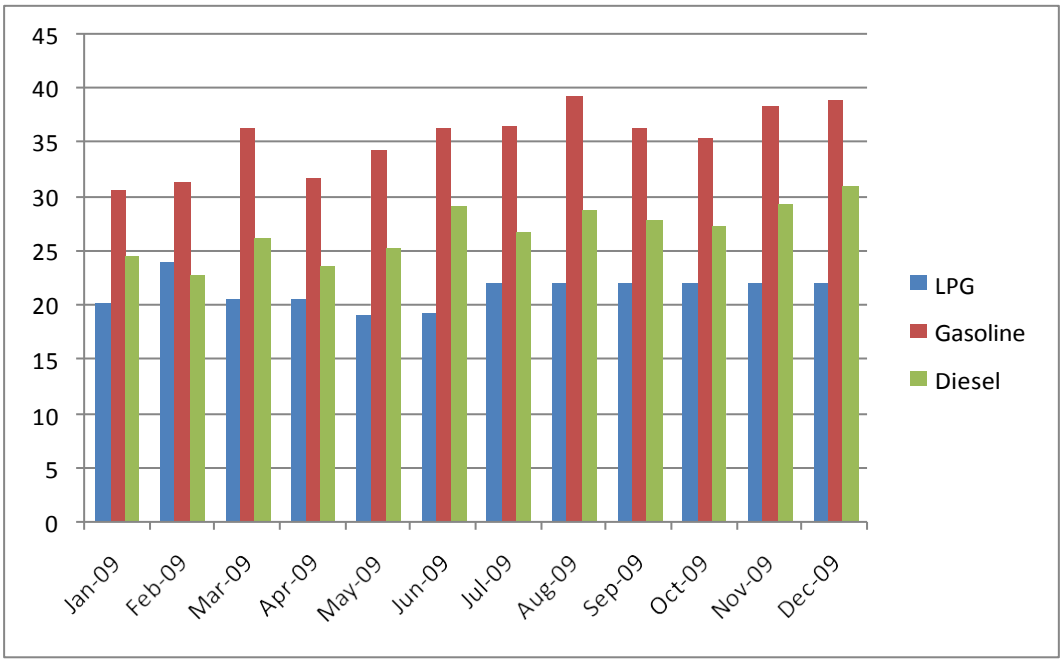


Figure 4.2 2009 Prices of fuel

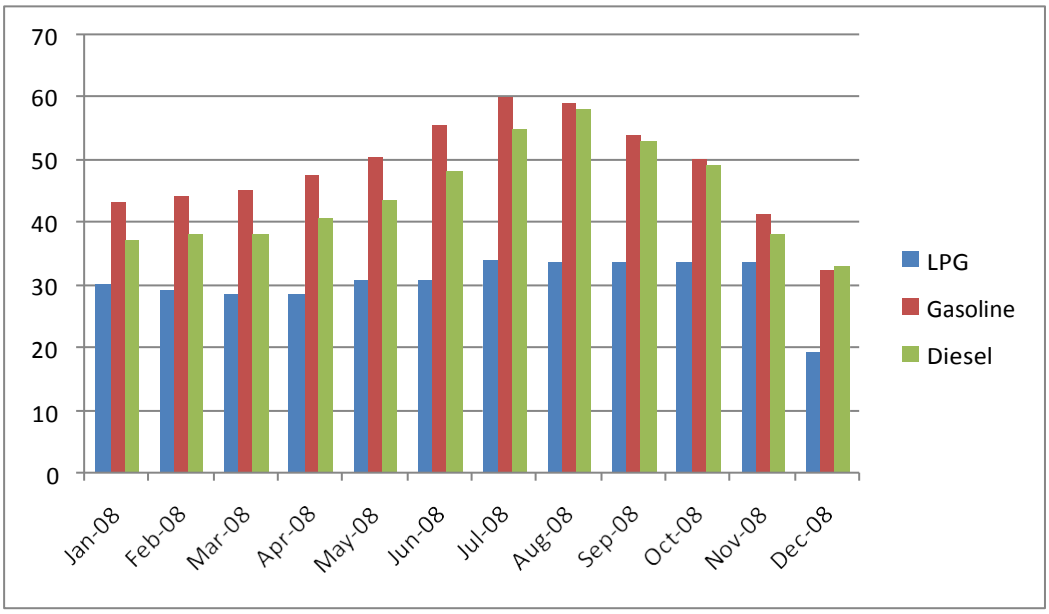


Figure 4.3: 2008 Prices of fuel

Based on the Tables presented, gasoline has the highest price while diesel and Autogas have lower prices. On the other hand some of the gases increase in price dramatically due to economic problems. But these tables clearly stated that Autogas is the cheapest in fuel sources. We also get the average amount for 2008 for gasoline diesel and autogas are (48.49, 44.43, 27.87) for 2009 these are the values (35.36, 26.86, 21.55) and lastly for 2012-2013 (52.16, 41.33, 30.99).

4.2 Emission

Data were collected to support the comparative analysis of different fuels (diesel, gas and LPG) in terms of emissions and the effect of it to the health from the different agencies involved.

The given by the DENR – EMB have a remarkable impact on our study given some ideas on how polluted is the surroundings. Apparently, it explains to us that not all the pollutants came from transport vehicles, it only has 75 – 80% of the totality of the results. In such we decided to take it to have visual representation on how the surrounding in an area is con critical or not.

Table 4.1: Mobile Source Emission by Population 2012

	348,337	1,110,997	127,182	10,296	282,276	
NCR	**PM**	**CO**	**NOx**	**SOx**	**TOG**	**TOTAL**
Las Pinas	16,235	51,780	5,928	480	13,156	**87,579**
Makati	15,544	49,575	5,675	459	12,596	**83,849**
Malabon	10,381	33,110	3,790	307	8,413	**56,001**
Mandaluyong	9,657	30,802	3,526	285	7,826	**52,096**
Manila	48,542	154,821	17,723	1,435	39,336	**261,857**
Marikina	12,462	39,746	4,550	368	10,098	**67,225**
Muntinlupa	13,513	43,100	4,934	399	10,951	**72,897**
Navotas	7,320	23,346	2,672	216	5,931	**39,485**
Paranaque	17,280	55,112	6,309	511	14,003	**93,214**
Pasig	19,678	62,763	7,185	582	15,946	**106,154**
San Juan	3,568	11,379	1,303	105	2,891	**19,246**
Valenzuela	16,904	53,915	6,172	500	13,699	**91,190**
Caloocan	43,749	139,535	15,973	1,293	35,452	**236,002**
Pasay	11,543	36,815	4,214	341	9,354	**62,267**
Pateros	1,885	6,011	688	56	1,527	**10,167**
Quezon City	81,141	258,795	29,626	2,398	65,753	**437,713**
Taguig City	18,935	60,392	6,913	560	15,344	**102,144**
	348,337	**1,110,997**	**127,182**	**10,296**	**282,276**	

Source: DENR – EMB

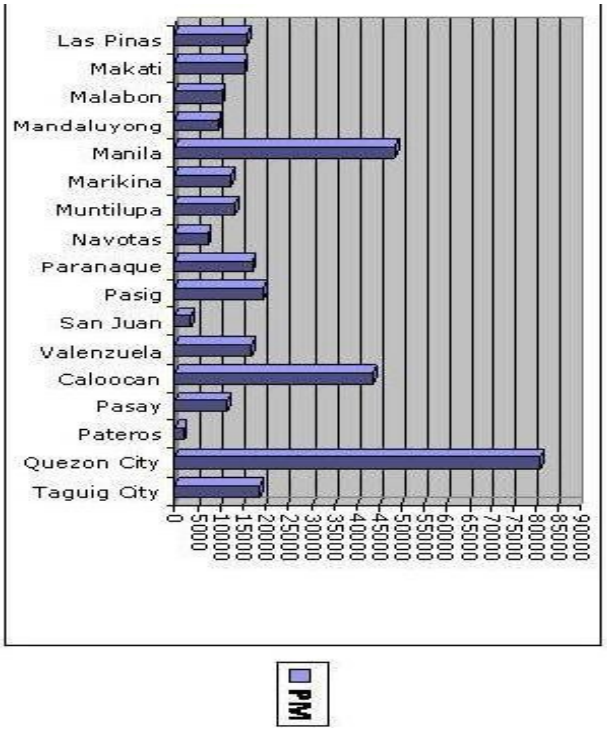
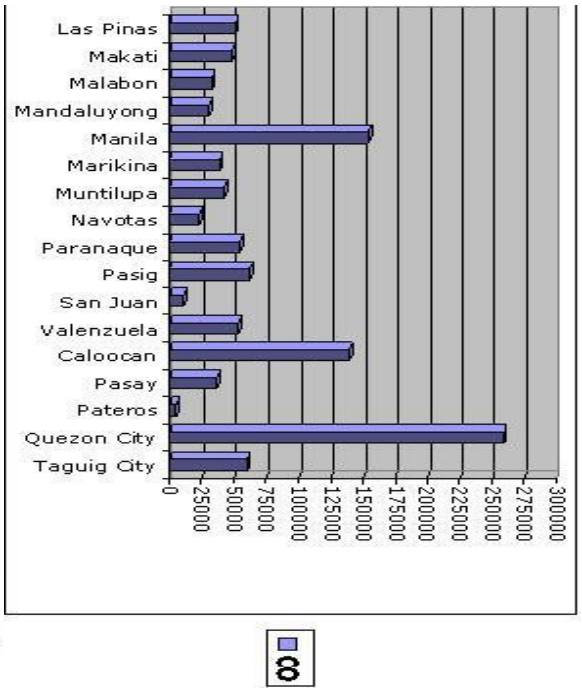


Figure 4.4



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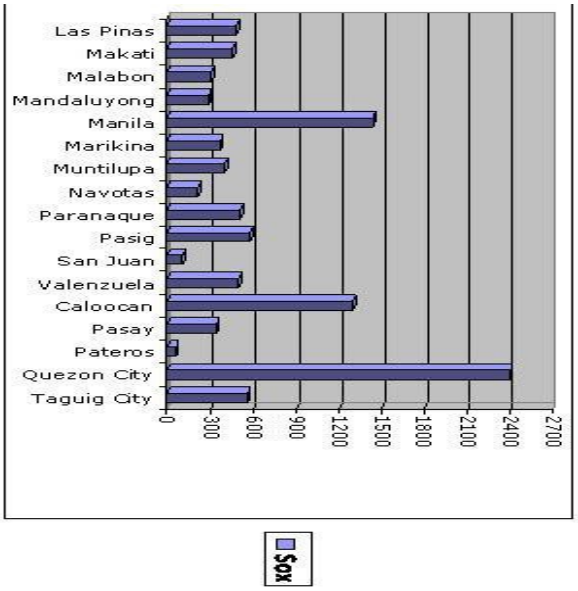

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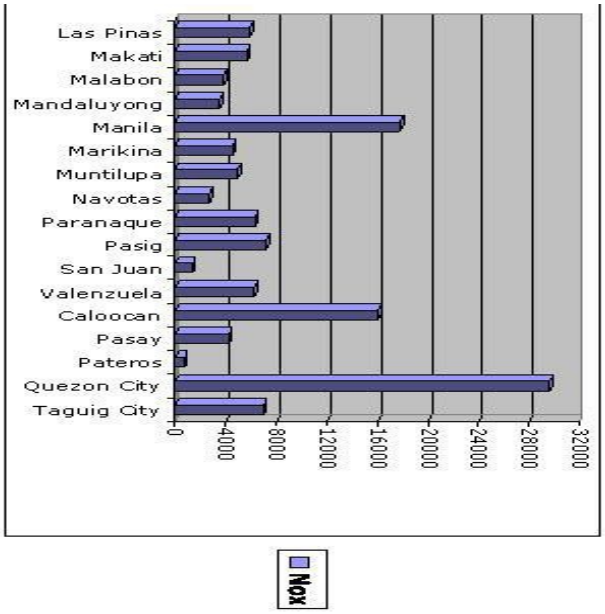

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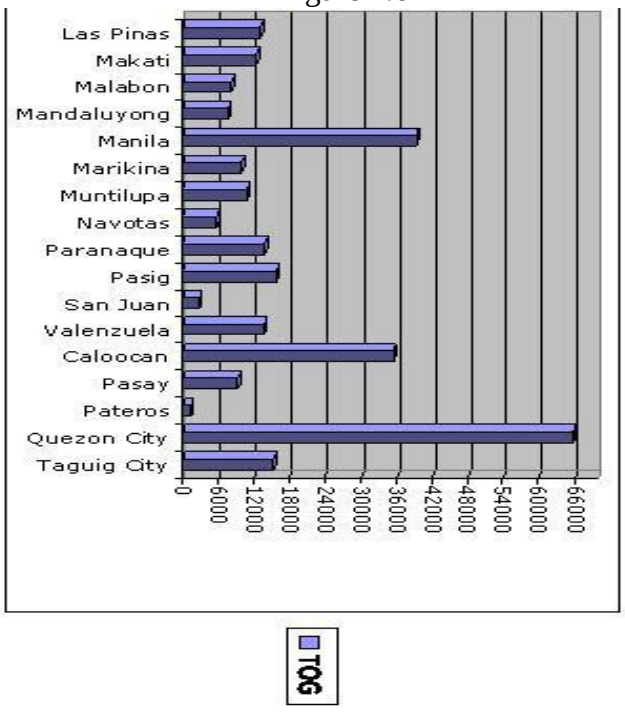

Figure 4.8

Figure 4.4 4.5 4.6 4.7 and 4.8 Mobile Source Emission by Population 2012

The data was taken from different places in Metro Manila where traffic has been identified, putting an instrument to measure pollutants and it was monitor every month. Every month results are collected. According to the tables above, Quezon City has the highest results in terms of all the pollutants causing it to be top of the list, but we see that Manila is on the second rank in terms of all the pollutants results and the totality.

To visualize more how these results can be very critical to us without noticing it, the representation of the totality listed in the Table 4.1: Mobile Source Emission by

Population 2012 was shown.

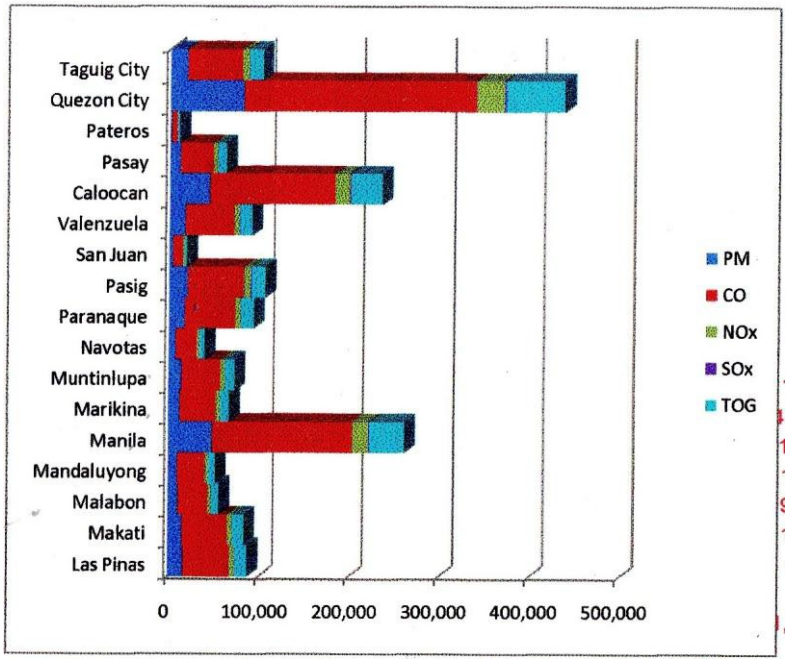

Figure: 4.9: Mobile Source Emission by Population 2012

Source: DENR – EMB

As mentioned earlier Quezon City, Manila and Caloocan has the major pollutants totality as shown in Figure: 4.9: Mobile Source Emission by Population 2012. The next representation is the critical value on how every pollutant can be dangerous to our environment also in health as well.

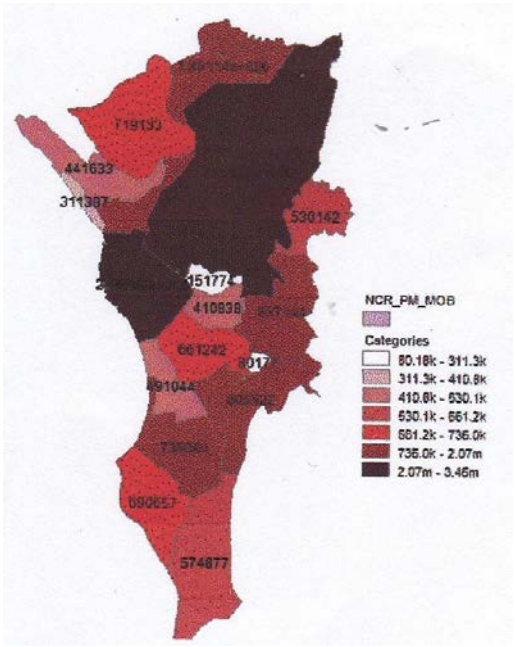

Figure 4.10: Mobile Source Emission on PM

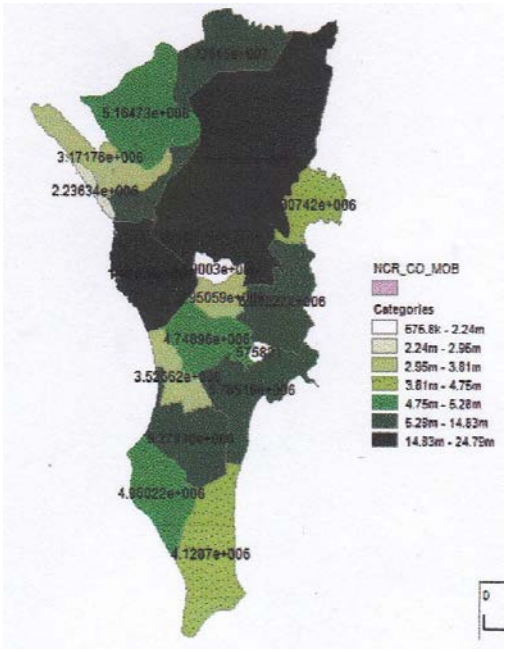

Figure 4.11: Mobile Source Emission on CO

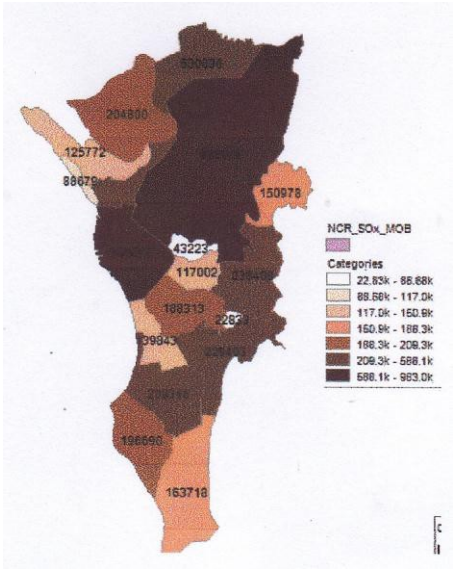

Figure 4.12: Mobile Source Emission on SO

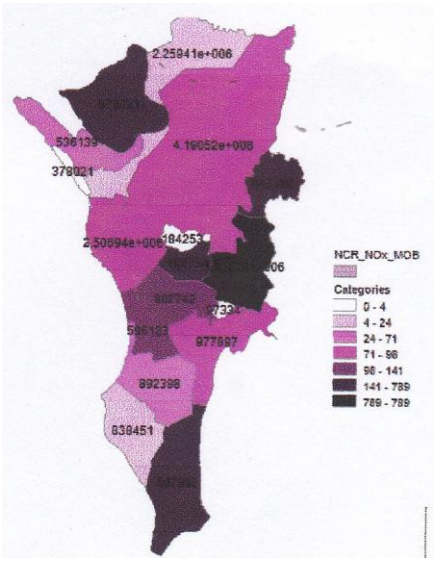

Figure 4.13: Mobile Source Emission on Nox

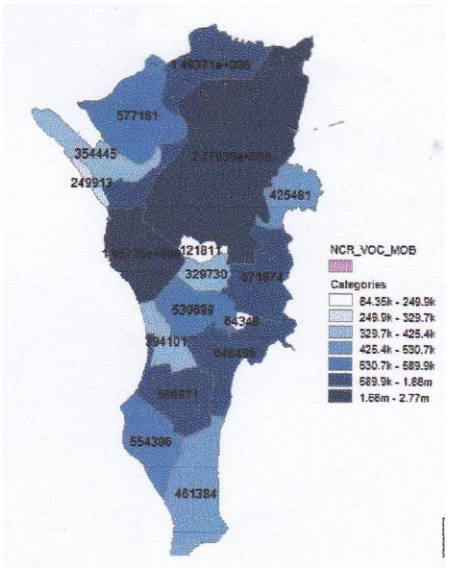

Figure 4.14: Mobile Source Emission on VOC

Source: DENR – EMB

Figure 4.10 - 4.14 shows the location in NCR which has the critical area in terms of pollution. The darkest part is the Quezon City followed by Manila and Caloocan, they are the top three cities that are polluted and the lightest of the cities the Pateros. Thus showing the values doesn't mean that this entire reading belongs to public transportation and some of it is from urban areas, factories and other establishments and also we cannot determine the source of fuels that contributes to the pollutants in the environment.

Table 4.2: Philippine Guidelines Values, WHO Guidelines and US Standards

Pollutant	Averaging Time	Philippine NAAQGV[a]	WHO (2005)[b]	USEPA[d]
TSP	24 hours	230	—	—
	1 year	90	—	—
PM10	1 hour	200	—	—
	24 hours	150	50	150
	1 year	60	20	revoked
PM2.5	24 hours	—	25	15
	1 year	—	10	35
SO_2	10 minutes	—	500	—
	1 hour	340	—	—
	24 hours	180	20	365 (0.14 ppm)
	1 year	80	—	78 (0.03 ppm)
NO_2	1 hour	260	200	—
	24 hours	150	—	—
	1 year		40	100
O_3	8 hours	60	100	157 (0.08ppm)
	1 hour	140	—	235 (0.12ppm)
CO	1 hour	35,000	30,000[c]	40,000
	8 hours	10,000	10,000[c]	10,000
Pb	1 year	1	0.5[c]	—
	3 months	1.5	—	1.5

Source: Environment Monetary Bureau

Table 4.2 compares the Philippine guideline values with the World Health Organization guideline and standards implemented in the US. The Philippine guideline values for short and long term PM10, SO2 are more lenient compared to WHO values and relatively similar to USEPA values. These standards were established in 1999. There are no information of government plans to change the standards in response to updates released by WHO in 2005.

A result in Land Transportation Office (LTO) through the Emission Test Center makes a good data on how the vehicle may pass or fail for the renewal registration. The testing is needed to see whether it complies with the provision and emission standard. If it fail, therefore it may be harmful to the environment as well as health, although if the vehicle pass still there is emission produce which it explained and detected by the EMB on the previous results.

A study by the Department of Health (DOH) – UPM National Poison Management and Control Center in monitoring the diesel and lpg of taxi conduct a test in the emission in the vehicle measuring different pollutants helps us analyzing the hazard of using autogas. It revealed on the study that, results of the hydrogen sulfide (H_2S) and carbon monoxide (CO) monitoring showed levels in the auto-LPG retrofitted vehicles were much higher than those measured in conventional vehicles. Comparing the means showed that H_2S levels were 68 times higher and CO levels were 8 times higher for auto-LPG vehicles than conventional vehicles. Decreased O_2 levels may increase the potential toxic effects of the gaseous substances within the vehicle because of the limited concentration and mixing of air to dilute contaminants.

4.3 Health

Vehicles were sampled while waiting resealing of calibrated taxi meters at the open-space LTFRB compound in Quezon City. Direct reading instruments were used, i.e. photoionization device (PID) for volatile organic chemicals (VOCs), butane and aromatics while multi-gas monitors were used for carbon monoxide, hydrogen sulfide and oxygen levels. The following gases were monitored: regulated components carbon monoxide (CO) and unregulated components hydrocarbons, aromatics, butane, hydrogen sulfide (H_2S) and oxygen (O_2) levels.

Table 4.3: Environmental Monitoring of ALPGT and DGT Vehicles

No. of vehicles Total = 53	**LPG (N=28)**				**Conventional Gasoline/Diesel (DGT) (N=25)**			
Area	**Butane ppm**	**Carbon monoxide (CO),**	**O_2 level (%)**	**H_2S, ppm**	**Total BTEX/ HC**	**Carbon monoxide (CO),**	**O_2 level (%)**	**H_2S, ppm**
NIOSH/OSHA standard	**800 ppm**	**35/50 ppm**		**10/20 ppm**	**1&5 ppm (as C6H6)**	**35/50 ppm**		**10/20 ppm**
Drivers Side	0-71.87	0-50	19.2-19.6	0-21.78	0-3.4	0-10	19.2-19.7	0–11.22
No.with sig.rdgs	**0**	**1**	**8**	**5**	**4**	**0**	**16**	**1**
Passenger Side	0-79.50	0-46	19.3-19.6	0-24.09	0 – 2.3	0 -76	19.3-19.6	0-7.59
No.with sig. rdgs	**0**	**1**	**18**	**2**	**3**	**1**	**17**	**0**

Front (nr the engine)	0-1524.6	0-99	19.3-19.6	0-435.6	0 – 1	0-22		0-3.3
No.with sig. rdgs.	**2**	**2**	**12**	**5**	**1**	**0**	**14**	**0**
Back (compartment)	0-123.6	0-128	19.3-19.6	0-37.29	0-3.5	0-41	19.3-19.6	0-11.55
No.with sig. rdgs	**0**	**4**	**11**	**4**	**5**	**1**	**14**	**2**

Source: DOH

Findings of the DOH through the research show that, Diseases that were common among the drivers in both groups were hypertension, asthma and pulmonary tuberculosis. There were more Autogas taxi (N=23) drivers who were presented with medical complaints at the time of consultation compared to gas/diesel taxi (N=13) drivers. Most common complaints among the Autogas taxi drivers were dry throat (N=19: 90.5%), odor (N=17:81%), headache/dizziness (N=13:61.9%), chest pain and cough/difficulty of breathing (N=10:47.6%). Gas/diesel taxi drivers complained of cough (N=5:83.3%), dry throat/dizziness (N=6:75%), headache, odor/chest pain/difficulty of breathing (N=5:62.5%) and nausea (N=3:42.9%). (N= number of drivers)

Also, 68.8% of Autogas taxi drivers had abnormal PFT and 58.8% had abnormal CXR findings. Among the gas/diesel taxi drivers, 54.5% had abnormal PFT and 62.5% had abnormal CXR readings. Those with findings of lung infiltrates in their CXRs had restrictive findings in their PFTs. Of the non-smokers, three had elevated methemoglobin levels indicating exposure to oxidizing agents and two of the ALPGT drivers had sulfhemoglobinemia indicating exposure to sulfur compounds.

Based on this the risk, factors and conditions that may result in the release of emission of the chemicals within the vehicle and potential exposure among drivers were the inaccurate and improper conversion of vehicle to auto-LPG, the lack of regular environmental monitoring of vehicles, poor maintenance of vehicle and the long work hours spent by drivers. Drivers in this study were exposed to either auto-LPG or diesel/gasoline. Frequency and duration of exposure were the same in both groups. However, past exposures by either group cannot be discounted because of previous jobs as drivers.

Based on the graphical representation that we analyzed, gasoline shows a significant result in cost and emission following autogas that take the health at critical, while diesel stays normal among the three fuels. Gasoline is expensive, yet it is less harmful to environment and health.

Diseases common among the drivers in both groups were hypertension, asthma and pulmonary tuberculosis. Most common complaints among the autogas taxi drivers were dry throat (90.5%), odor (81%), headache/dizziness (61.9%), chest pain and cough/difficulty in breathing (47.6%). gas/diesel taxi drivers complained of cough (83.3%), dry throat/dizziness (75%), headache, odor/chest pain/difficulty of breathing (62.5%) and nausea (42.9%).

5. CONCLUSION AND RECCOMENDATION

Conclusion

Based on the results that we presented, we have this conclusion from the documents we have gathered and collected. Gasoline is the most expensive followed by diesel and autogas. We also get the average of gasoline diesel and autogas from year 2008, 2009 and 2012-2013. Gasoline also has the highest value in terms of failure from the emission test but that doesn't mean that gasoline is the most dangerous of all the fuel types in the environment. We also get the mobile source emission from NCR but due to the capability of the device, we cannot determined whether those gases from that area have come from vehicles and also we cannot evaluate whether it is gasoline, diesel or Autogas. In health, autogas has the highest hydrogen sulfide that is critical for our health it can result to eye irritation, sore throat and cough, shortness of breath and fluid in the lungs. Among the three, we could say that Autogas is dangerous to our health.

Using this result we try to compare them to their advantage and disadvantage. The cost of Autogas is cheaper than diesel and gasoline. But because of the components of the system of Autogas, using this fuel cause their health in much dangerous than the other fuels. While diesel is good for heavy duty especially in calamity, but because of its combustion it is harmful for the environment and Autogas is the cleanliness fuel in the environment. While gasoline is the most expensive of all fuel types, it is also the most used fuel type.

We believe that all of these fuels have their benefits but it's up to us on how we can be smart in using and maximizing their advantages over the others. Are we willing to sacrifice the cost in order to save the health of the driver's and contribute to the environment or vice versa? A proper maintenance of a vehicle plus a well discipline and educated driver can avoid this problem and can help in preserving our environment.

Recommendation

Based on the results, we recommend having an instrument that can be measuring on the following pollutants emitted by the vehicles by doing it, a precise and clear data can be attained. Also a program by each department concerning on the environment as well as health must be develop to have an idea about the effects of the fuels on the passenger and drivers.

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