Environmental Monitoring and Assessment by Applying IoT for Reducing Pollution Caused by Vehicles

M Srinivasan, S Koteeswaran

Abstract: The variables for the design of the vehicles are correlated and collectively affect the vehicle emissions. The conventional design of the vehicle includes the following variables: 1) a fuel pump 2) fuel storage tank 3) vapours of the fuel could be absorbed by the activated carbon canister 4) internal combustion engine for the gasoline-fuelled vehicles that has the spark-ignited engine and the diesel fuelled vehicle that has the compression ignited engine 5) Power transmission system that transfer the power to the wheels from the engine 6) an exhaust to minimize the emissions from the vehicle. The emissions from the vehicle could be influenced by the operating conditions of the engine. Maximum HC and NOX emission could happen in both the strong and lean conditions. The objective of this paper is to design a framework to analyze the pollution in the environment.

Keywords: Internet of Things; Smart city; Pollution monitoring.

I. INTRODUCTION

Vehicle pollutants are likely classified as two types: primary and secondary pollutants. Primary pollutants such as NOX, HC and CO emitted have a direct contact with the atmosphere. On the other hand, Physio-chemical gives rise to the secondary pollutants that could be ozone (O_3) and PAN (peroxyl acetyl nitrate). There is a complex relationship between the primary and the secondary pollutants. The primary pollutant concentration could be reduced by the secondary pollutants formed in the atmosphere. Primary pollutants are found in large quantities and that does not have any effect in reducing the formation of secondary pollutants. Moreover, there is not an exact relation among the NOX and NO_2 as the urban atmosphere has a limited capacity to convert NO into NO_2. The major concentration of nitrogen pollution (Subhadeep Sarkar et.al, 2018) is due to the gasoline fuelled vehicle that could be in the form of Nitrogen oxides, carbon monoxide and hydrocarbons. It could lead to 90-98% of nitrogen oxide emission. The pollution from the vehicle mainly arises from the engine as well as the exhaust. There are 3 sources from the vehicles that mainly emit the pollutants: 1) Hydrocarbons that are produced from the crank vents 2) Hydrocarbons emitted from the carburettor and the fuel tank 3) CO, NOX and HC emitted from the exhaust (Lingzhi Yi et al 2017). The operating condition of the vehicle could be obtained from the speed, load as well as the thermal condition of the engine followed by its driving condition and catalytic behaviour that could also affect the emission of the vehicle. Various numbers of sectors affect the emission. However, the major contribution of emission arises due to the transport (Lina Xu et.al, 2018) and thus causing air pollution. Conventional engines that are fuelled with the petrol are commonly used among the passenger vehicle that leads to the major portion of transport. The emission of the vehicle could be influenced with several interacting vehicles with their operating condition and various other chemical and physical in-engine factors working simultaneously. The prediction of the vehicle emission complexity has influenced many researchers to work with the model in order to control the air pollution. But the degradation of air quality and the mechanism effect over the environment has not yet wholly detected. Accordingly, new regulations should be imposed with the defined one to protect the urban areas from pollution due to the vehicle emission and changes that could happen due to the climate (Yu Liu et.al, 2018) should also be considered. It is very important to enlarge the facility of policy makers to attain sound and logical decisions about vehicle emissions and air quality in order to hold up research explanation and termination.

II. TRANSPORT AIR-POLLUTION

As mentioned earlier, transport contributes their major part in the air pollution. The pollution is due to the usage of fossil fuel that is used as the source of energy. The compounds emitted from the vehicles include the following:

- Volatile organic compounds (VOC) such as hydrocarbon
- Carbon monoxide
- Nitrogen oxides (NOX)
- Reactive organic compound (ROC)
- Carbon dioxides (CO2)
- Sulphur dioxide (SO2),
- Lead (Pb)
- Solid carbon particulate matter (PM)

These compounds contribute to the major part of global warming, declination of forest, ozone depletion as well as smog. Moreover, they could also have an impact in reducing the visual sight that could bring several health and respiratory problems. In the year of 1940, the issue of air pollution was determined in Los Angeles basin in the US. It is not only that transport is the major reason for the air pollution but also the other contribution goes to the industrial waste. The transport sector in New South Wales accounts for 40 percent of total HC emitted and 35 percent of the total NOX. Moreover, transport sector in KK accounts for 16 percentage of HC with 45 percentage of NOX. Similarly, United States transport accounts for 35 percent of total HC with 47 percent of total NOX emission (Lin Yang, 2018).

III. ENERGY USAGE WHICH INFLUENCES ENVIRONMENT

The quantity of the energy that we use in our daily lives depends on the types of devices that utilize the amount of energy as well as depending on the climate and the weather condition. The devices that we use for transport vehicles have been increased rapidly. In United States, the use of air conditioner has been increasing from the year of 1980. The household plugs in numerous electronic and other appliances that have been comparatively increased than before. Before the usage of refrigerators and other equipment used for cooking has been in common. At the present scenario, usage of dishwasher, washing machine, dryers, and ovens has been used commonly with the use of televisions and computers (Naser Hossein Motlagh 2016). Moreover, this technique tends to increase their mode of innovation that motivates the usage of the gaming system and other rechargeable electronic devices that becomes a part of integration for our modern lifestyle. This result in the increase in the energy usage and the top three primary types of energy that powers the transport vehicles in a community are as follows:

Natural Gas

This is commonly found deep under the earth, which is colorless, tasteless and odorless in nature. The main substance of the natural gas is methane that could be denoted as CH_4. Natural gas also consists of hydrocarbon gas liquids and non-hydrocarbon gas. The natural gases could be used as a fuel. Coal-bed methane is said to be a natural gas substance that could be found in the coal. U.S. and other few countries produce the natural gas from the shale and various types of rocks that consists of natural gases within the pores of the rock. This formation of rocks gets fractured by the water forces or either chemical down a well and releases the natural gases. The amount of natural gas utilized by the U.S. was found to be 27.49 trillion cubic feet (Tcf) by the year 2016. This account 29% of usage is done by the natural gases. The total consumption done by various sectors with the natural gas in the year 2016 is listed as follows:

- Electric power—9.987 Tcf—36%
- Industrial—9.31 Tcf—34%
- Residential—4.35 Tcf—16%
- Commercial—3.11 Tcf—11%
- Transportation—0.74 Tcf—3%

Natural gas has been ultimately used to produce electricity, but some commercial sectors use the resource for heating the building and for other purposes. The utmost resource to produce electricity is mainly done by natural gas. Over 27% of electricity has been produced mainly by burning natural gas in the United Stated in the year 2016. From this point, the need of internet of things (Yuan Chen et.al, 2018 and Ajmal Khan et.al, 2018) arises for pollution monitoring.

Nuclear energy

Commercially nuclear power production has been in use from the year 1950. At present, there are about 99 nuclear reactors with 61 plants over 30 states of U.S. Although some of the reactor core has been shut down, the power produced in the year of 2017 seems to be same as in the year of 2013. The commercially operating nuclear reactor of U.S is located at the east of Mississippi river. The largest reactor core that operates in the United States produces an electricity of about 1400 MW. Each nuclear power plant (above 32) has at least two nuclear reactors. The main source of the nuclear particle is Uranium. They utilize more capacity than other plants that have been shown in the figure given below.
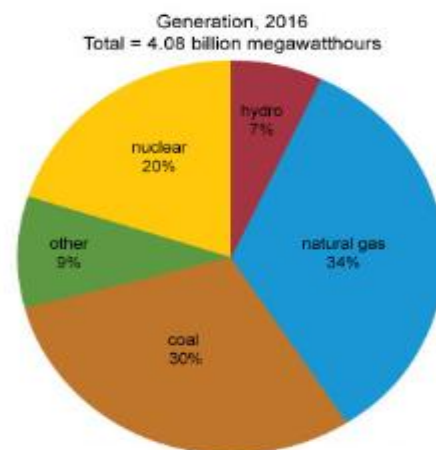

Fig. 1. Electricity generation at the year of 2016 using nuclear energy

IV. Environmental Impact

Several impacts could be caused due to the non-renewable sources of energy that we commercially use, which are as follows:

- Over the past, tiny animals and sea plants died on the sea or land is found to be buried under the earth that decays for several years. They were buried deeper and deeper which could be forced by the reaction of temperature and pressure that could change them into oil and gas. At present, we dig the layers of sand, silt, and rock for determining the natural gases.

- The cost of the heating oil price seems to be very large. Crude oil accounts for 55% average price of gallons during the winter and 29% per gallon accounts for the cost of refining the oil and the remaining percent fall under the category for the distribution, marketing and profits. This increases the rate of the heating oil. Households who use heating oil should buy them before winter and store it for the future purposes.

• Like the other natural gases and fossils, the nuclear reactor does not show any impact to produce carbon dioxide. Moreover, the equipment that are used for the mining of the uranium seems to pollute since this equipment could be operated by the means of burning the fossil fuels that seems to associate with the electricity the nuclear plant produces.

Disposal of Nuclear waste

A major threat to the environment occurs due to the emission from the radioactive waste from the uranium mill tailings, reactor fuel and the remaining nuclear waste. This could remain radioactive and can cause several threats. Hence the handling of these nuclear wastes is ultimately very important. Handling necessarily deals with the proper transportation, disposal and storage of nuclear materials. In the United States, the U.S. Nuclear Regulatory Commission (NRC) handles the operation of Nuclear power plants.

The waste from the nuclear plant is been classified under 2 categories namely: 1) low-level waste and high-level waste. The radioactivity from these wastes could be in the range of low background level that could be in the uranium mill tailings to the higher background, which could be seen in the reactor fuels. The term radioactive decay means that the nuclear waste decreases with the increase in time. As the year passes, the radioactivity of the substance could reduce. Radioactive half-life means, the time requires for the radioactive substance to reduce half of its original level. In order to reduce the potential of the radiation, the nuclear waste should be properly stored at the temporary period. Uranium mill tailing releases a radioactive element called radon which is in a gaseous state at the time of their decay. They are often placed near their processing facility, from the place they occur. They are enclosed properly with the seal bearings that could be in the form of clay so that this could avoid radiation from entering the atmosphere. These barriers are covered by large rocks or other materials and buried deep into the soil that could prevent erosion. Low radiating waste could be the protective clothes, tools and other small disposal that could contain only a minimum amount of radiation. These are subjected to special regulations that could prevent them from contacting the atmosphere (Rana et.al, 2015).

Local Air and water quality

The United States promotes a greater impact in their safety and the risk of the contamination of water, land, and air is considered very low due to their diverse, superfluous barriers and their various safety requirements. The contamination due to the nuclear waste and burning of natural gases could raise an abundant pollution into the air and water. But the government fixes certain norms for running the power production plant. They enhance their local quality of air and water by

• Maintaining the operation of the reactor plant
• Effectively utilizing the available resources
• Maintaining and testing the regular activity
• Proper disposal of the waste

Moreover, the reactor plant utilizes the containment vessels for the disposal of waste so that the vessel could promote enough strength to withstand the extreme weather conditions and earthquakes or other natural calamities.

Renewable energy resources and their impacts

According to U.S. Energy Information Agency, 16.9% of energy resources occur from the hydro-electric power, solar, biomass, wind and geothermal resources. The most important thing to be noted is that these resources are said to be renewable resources. Among these, the solar and the wind energy is the popularly used one. The emission of carbon dioxide is greatly reduced using these resources. The benefits and their impacts are many that are as follows:

• Reduction in global warming
• Enhancement of public health
• Lowers the energy price
• Inexhaustible energy
• Promotes better employment and other economic benefits.

Figure 2 clearly shows the petrol produced from the renewable resources.
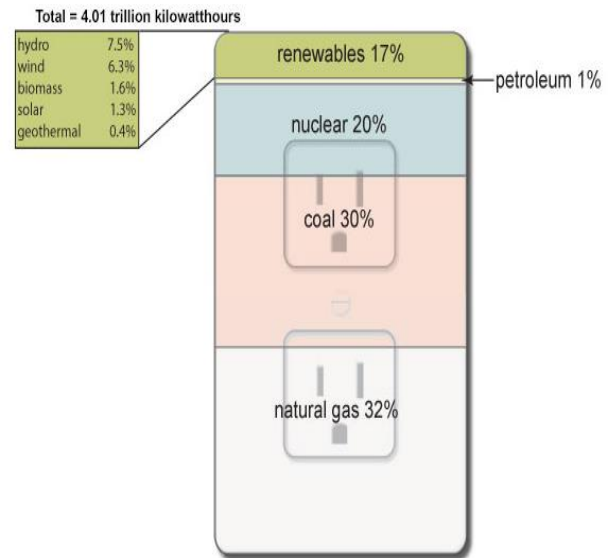
Fig. 2. Power generated by the various resources

It could be difficult for the whole community to adapt to the new methods. This could lay on the expenditure, location and various other factors.

Cost Expenses of the alternative resources

It is known that the renewable energy is said to be costly when compared to the fossils and nuclear power. Moreover, there are some additional conventional improvements that must be done for the renewable energy technologies. Levelized energy costs (LEC) is the more common term used by the economist that says regarding the ratio of the total cost of the construction of the equipment to the expected annual electricity generated.

The LEC cost of the U.S. has been compared with the alternative fuels at the year 2017 and it has been mentioned in the figure given below.

Power Plant Type	Cost $/kW-hr
Coal	$0.11-0.12
Natural Gas	$0.053-0.11
Nuclear	$0.096
Wind	$0.044-0.20
Solar PV	$0.058
Solar Thermal	$0.184
Geothermal	$0.05
Biomass	$0.098
Hydro	$0.064

Fig. 3. U.S. cost comparison of various sources of energy

The purpose of vehicle selection is important to lessen noise pollution and other pollution emitted from the vehicles. The main target of this section aims in defining the heavy and the light vehicles best optimized for controlling noise pollution (Xianjun Deng et.al, 2018). This mainly focuses on the reducing the efforts of the managers by increasing the efficiency of the fuel and reducing the pollution of the vehicle. By achieving this, the company should also target the safety of the environment. For instance, the impacts of the government in any country plays a vital role by proposing certain policies that could reduce the carbon deposition and efficient steps were taken in the freight sector.

V. CASE STUDY

This case study is regarding the Highlanders Company that had made an investigation with the management team, in order to replace the Toyota vehicles from the courier services and replace with the best-selling automobile that could increase the efficiency and decrease the cost.

How Ford ventured into New Zealand automobile as an alternative for Toyota

This was started by setting a goal that drive more qualified customers to Ford NZ in order to maximize visitors of this website, which could convert into inquiries. Ford New Zealand (Ford NZ) and J. Walter Thompson (JWT NZ) analysed the significance of intensifying their online viewers by transferring them into customers. They constructed brand preference and drive deliberation that converts more site viewers as customers. In order to make this idea possible they banged the Google Display Network. For the suitable customers they started to deliver the appealing digital impact. About seventy five percent of the clients were involved in their web search, sites, videos and other sources to view their new model car. Though this method they started to guess the information regarding their brand which the customers got attracted and the reports were framed that gather the positive and negative impact of the upcoming model. Although this method banged the eyes of the customer view, they again started to get the clients attention by establishing the idea of

JWT NZ. The agency made collaboration that demonstrated banners and attached them with customized content that targeted in engaging the consumers across various websites during their acquisition journey. At past they followed the plan of "set-and-forget" where it came to be called later as "test-and-refine" approach.

Next Ford started a method of "in-market" audiences that targeted the customers who were to purchase the new vehicles. Through the In-market strategy they reached the customers by the data they have, who were enthusiastically glancing to formulate an acquisition. With these approaches they started to reach many customers and, they bought the viewers of Google audience as clients. At last, they used GDN's marketing tool that bought the previously viewed customer of the site again to view their site newly. They used a customized message setting that made numerous visitors of that site to visit again.

Chris Masterson the head of the Ford group says that, "It's critical to use the right data to drive your marketing strategy. We learned that there is a unique data insight about our audience at each stage of the purchase journey. Acting on those right insights opened the door for us to truly deliver the right message at the right moment to the right potential customer". This is how Ford strengthens their business strategy. The top vehicle that makes a best service includes Ford Ranger, Holden Colorado, Mitsubishi Triton, Kia Sportage, Mazda CX-5, Nissan Navara.

Commercial vehicle movements in New Zealand

In our study we have taken the light weight commercial vehicles (LMCV) that could travel well in the urban areas. These are designed under certain criteria that are as follows:

- Cars that contains traditional insignia (this indicates the person who is the owner/ operator of the vehicle)

- Vans, less weight trucks and utility that takes about 3.5 times larger gross laden weight (typically we consider the light commercial vehicles to have only a sole rear tyre but here we can include dual rear tyre also).

- Two-axle large trucks more than 3.5 tones gross laden weight that is independent of a trailer.

Though the study has more significance in the LMCV vehicles, certain consideration was made in the vehicle that makes the commercial purpose by entering the corridor. These vehicles were analysed based on the goods and service related and analysed whether the vehicle is coming into the city or going out of the city. Certain consideration regarding the vehicle that is made in our report includes:

- The vehicle should carry the good or provide services or it should do both. The purpose of the vehicle should satisfy the business meets, picking up of goods from certain organizations, attend the expectation of the employer and finally deals with the confidential actions.

- This involves LMCV, HCV (high commercial vehicles) and other type of vehicles such as personal cars, taxi, in fact it also deals with the non-motorized vehicles such as bicycle or walk

- The term "incoming" means that somebody arrives from different site to the organization or business beneath surveillance and "outgoing" means that somebody from the pragmatic business or organization is moving to various site.

The New Zealand Qualifications Authority (NZQA) is the New Zealand government top body that plays a major role in offering their control during the assessments and qualification. This educational act came in the year of 1989. The National Certificate in Motor Industry (Automotive Electrical and Mechanical Engineering) Level 6 with filaments in Electrical as well as Electronics, Light Vehicle, Motorcycle, Outdoor Power Equipment, and Trailer Boat Systems identifies the skills and acquaintance necessary for people in responsibilities within the automotive electrical and mechanical division of the motor industry, which engage common vehicle or tool repair and service work at an initial level to transitional level.

The execution of fleet management is very important that could create efficiency in the utilization of the fuel. According to the New Zealand, the term heavy vehicle means the trucks or lorry or busses that weight more than 3.5 tons. This is defined as a heavy weight group of vehicles. This could be managed by an individual company although it has a single owner operator within the circle. These vehicles are created for the specific purposes and the driver who drives these vehicles should be well equipped with specified skills. The vehicles are extremely costly. For operating the fleet, the company must come forward to show their interest. For example, the company can increase the amount of production by increasing the profit by efficiently utilizing the vehicle.

New Zealand has also defined the light fleet vehicles evidently. They provide vehicles to companies like taxi, courier, provide vehicles to employees, government and public sectors. The fleet ensure in following the "safety driving policy" among the employees. They could also vary at certain circumstances. The country tends to reduce the circumstances by reducing the consumption of fuel using certain factors like slow driving, using the vehicles for a long distance, regularly monitoring the fuel tank etc. Due to this the country not only provide a safe and secure environment but also it raises the profit and the business economy of the industry by increasing it' productivity. In this chapter we have presented certain specification of the commonly used vehicles in New Zealand and made a study based on their cost, which is presented in a spreadsheet.

IoT based Fleet management

Fleet management (Jiandong Zhang et.al, 2018) is very necessary that falls under the hands of a transport operator who select a vehicle by considering the fuel management, safety for the transportation and select a driver who could manage the task efficiently. The operator is responsible for managing other factors too that could enhance the fuel-efficiency, safety and cost. The factor of saving fuel is very important since this could have impacts on the following factors:

- This could increase the fleet profit by lowering its operating cost and increasing its demand and productivity
- Enhances the economy of the country by reducing the imports, which does not affect the employment

- The energy security of the country could increase since the country need not depend on the fuel from other countries
- Highly saves the environment by decreasing the emission of carbon dioxide. This could have an impact in the reduction of toxic gases that could save the people health.

This factor forms a strong bond between the safety and the efficiency. Certain steps are required to bring these factors into activity: 1) managing speed 2) predicting the situation at a prior stage 3) reduction in rash driving 4) regularly monitoring the type pressures 5) maintaining the vehicle and avoiding the vehicle usage for a minimum distance. The increase in the vehicle driving could contaminate the road and affect the brake system of the vehicle.

IoT smart way of transport (Fleet Logistics Energy and Environmental Tracking)
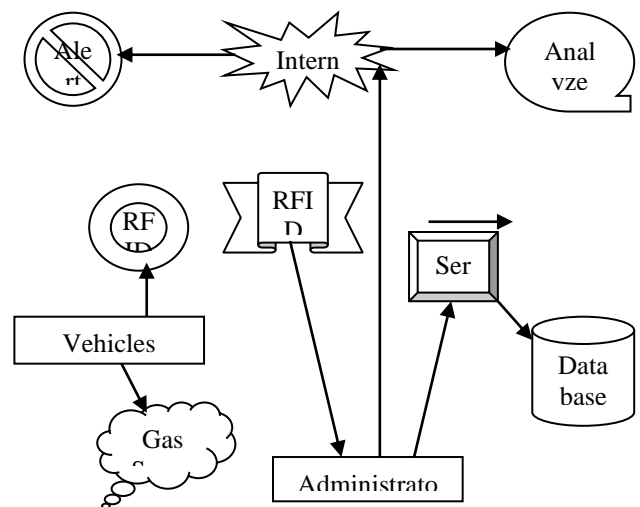
Fig. 4. Proposed Pollution Monitoring System
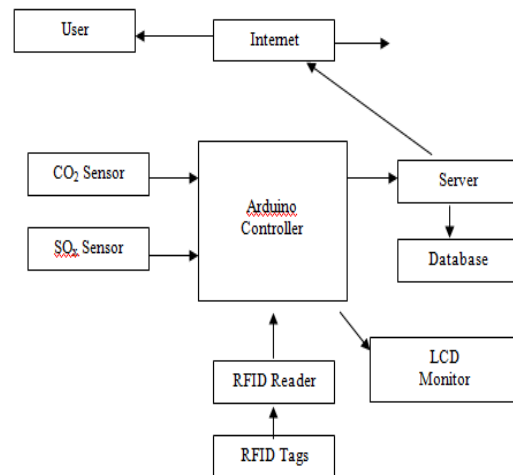
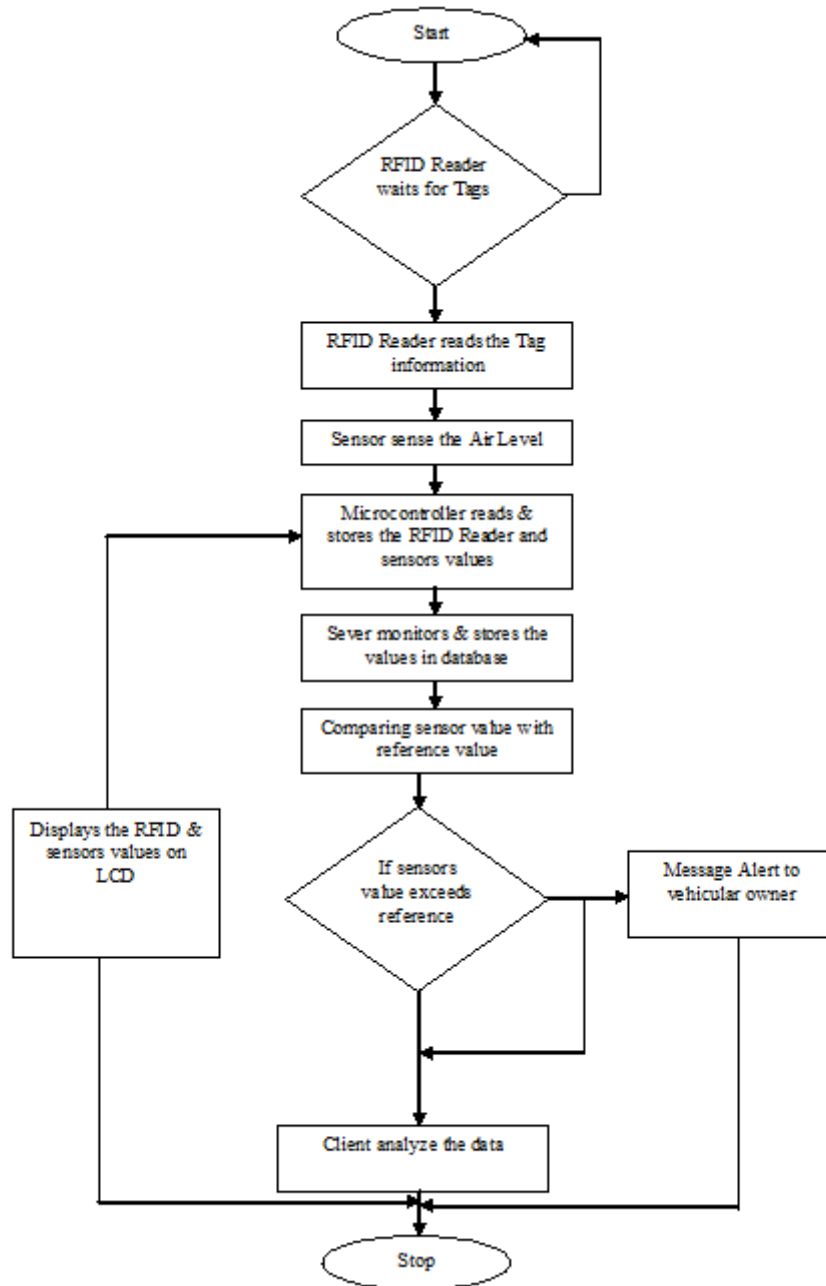**Fig. 6. Block diagram of Vehicle Pollution Monitoring system**

Fig. 7. Flowchart for Experimental step of proposed system

Smart way (Akyildiz, 2015) of transport is also the similar way of achieving the sustainability of vehicle like fuel efficiency. Smart Way Transport recognizes the operators of the transport system and shippers who help them in improving their environmental facilities by certain measures. Those

Operators should involve in cost savings and fuel efficiency to improve the business strategy once in three years. They are required to measure their performance using the Smart Way Fleet Logistics Energy and Environmental Tracking (FLEET) system and sign the Smart Way partnership agreement. Once they receive this recognition, they can receive their logo and display it in their systems. Shippers are the major user of the transport facility and they must spend 50% of their goods with the smart way transport operators. This quantity is monitored by the FLEET. By their own facility they must agree in the reduction of the emission. The most significant concept of this system is to increase the

popularity of Smart way transport to the public by helping them in reducing the environmental factors. Fig. 5 and Fig. 6 show the proposed methodology for pollution monitoring in smart city. Fig. 7 shows the flowchart for pollution monitoring in smart city.

Transport supply within a corridor

Transportation is a major part of function in the courier deliver. There are numerous factors that involves in providing the transport facility within the corridor based on the time, logistics etc., that are as follows:

• Organizations mixture and its density within the corridor

- Service prospect based on the customer's point of view
- The standards followed by the operators of the transport service
- Volume of the traffic
- Competitors among the suppliers. This could create a sustainable solution by providing the best services with lowering the cost of the transport.

## VI. SPARE PARTS FOR TRANSPORT VEHICLES INTEGRATED WITH IOT

Chassis design

The chassis design is the main objective that is to be considered while designing a vehicle. This design requires the use of certain software such as CAD and other simulation software such as CATIA V5 R19 and ANSYS 15.0. The chassis design must be considered based on the level 7 consideration of NZQA. During this measure it is necessary to consider base of the wheel, width of the track and other vehicle measurements that are listed below:

- Track Width (Front)
- Track width (Back)
- Overall Weight (without tyres)
- Overall length (with tyres)
- Overall width
- Distance from back to back wheel axle
- Distance from front to front wheel axle
- Tube thickness

The wire frame of the chassis model of a car is shown in the figure given below
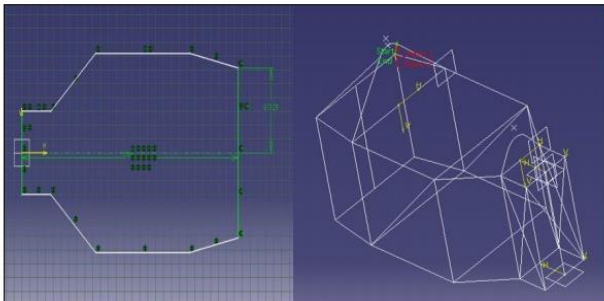
Fig. 8. Wire frame of a chassis model
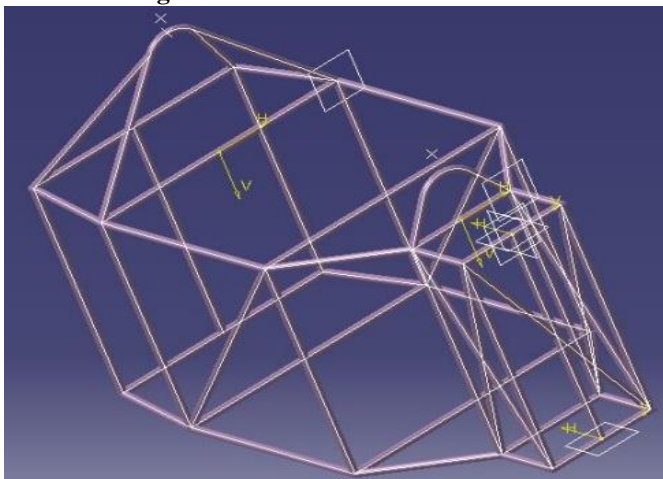
Fig. 9. Final design of the chassis model

BACKUP

Again, coming back, the environmental issue is the major role that is to be considered while making chassis. Carbon fibre composite material that is used while manufacturing the chassis utilizes Petroleum based resin material. This material may not be a biodegradable and it could also be hazardous to the environment. Due to this material, it can affect the human health of the employers who work there during the time of manufacturing. Hence maximum steps should be taken to avoid the petroleum-based resin and replace it by sustainable and secure resin materials like bio based green (Faisal Karim Shaikh et.al, 2017) resins that serves best to the environment.

VII. TYPES OF SMART VEHICLE WITH ITS RANKING
LIGHT VEHICLE FLEET

The term 'light vehicle fleet' comprises of five types of companies that includes certain safe driving policies for the employees that are as follows:

- Taxi companies
- Car or light vehicle rental companies
- Courier companies
- Companies, which supply vehicle for the employees
- Government and public agency vehicles

Certain light weight vehicle with their fuel types is listed in the table given below. There are about 20 vehicles in the below table and these values are taken from the registration database. Other than these fuel certain light vehicles use compressed gas, electricity and liquid petroleum that are not considered in our chapter. It is to be notes that the amount of diesel as well as petrol fleets in the category of fleet size does not match the number of fleets of that size of vehicle. This is because large fleet vehicles could use both type of fuels. This states that the fleet of 400 vehicles could contains 250 petrol-based vehicles and the remaining 150 diesel-based vehicles.

TRANSIT VANS

In the business era the model of Mark 7 or 6 is most adapted that offers both the front and the rear wheel drive. The transit vehicles are the most versatile one since this comes in a most flexible style and range that gives more comfort. Certain points to remember while choosing a transit van that requires a test driving and inspection, which are as follows:

1) Careful inspection should be done on the tyres by checking whether there are any cracks, bulges and any patchy wear on the treads. When these are found then it means that the tyres are not properly aligned.

2) Load area should be checked properly. During the time of loading and unloading, ply lined vans could suffer denting and scraping that is to be considered

3) There should not be any rust found on the wheel arches, sills and door slide. Make sure that the door handles work in a proper condition and radio work is also checked.

4)   A test drive is carried out that ensure the smooth drive of the van and no noise should be produced while catching the break. A solid feel should be produced while driving.

5)   It is necessary to check the seat belts that should properly fit with the passenger. Ensure their presence and check whether they work well.

6)   The electronic parts should be checked such as lights, sensors, which forms a major problem. Check the brake light, front and back light and make sure whether the indicator works well during their indication.

Table 1. Light vehicles with the petrol and diesel fuel type with varying fleet size

Vehicle fleet size	Light vehicles	Petrol vehicles	Diesel vehicles
21-50	1540	1077	476
51-100	527	330	164
101-200	242	159	54
201-400	89	53	18
400+	45	28	7

Table2 Results from the Sensors

| Sensor	Sensitivity	Response time	Measurement range
CO_2	44 ~ 72mV	1.5 minutes	350 ~ 10000ppm
Air pollutant I $C_6H_5CH_3$, H_2S, CH_3CH_2OH, NH_3, H_2	0.15 ~ 0.5	30 seconds	1 ~ 30ppm
Air pollutant II C_4H_{10}, CH_3CH_2OH, H_2, CO, CH_4	0.3 ~ 0.6	30 seconds	1 ~ 100ppm
Temperature	10mV/Co	1.65 seconds	-45 degree to +125 degree
Pressure	46mV/kPa	20ms	15 ~ 115kPa

VIII.   RESULTS

Table 3 Smart Sensors results by using the Proposed Algorithm

| Experiment		Number of entries	Number of vehicles	Average degree
3 monitors	Located by proposed algorithm	150945	59542	0.394
	Located by experience	163498	62693	0.383
	Located randomly	92567	32985	0.356
10 monitors	Located by proposed algorithm	443287	152794	0.344
	Located by experience	435769	95387	0.218
	Located randomly	293596	52592	0.179
20 monitors	Located by proposed algorithm	754392	246494	0.327
	Located by experience	813595	175936	0.216
	Located randomly	680372	174596	0.256
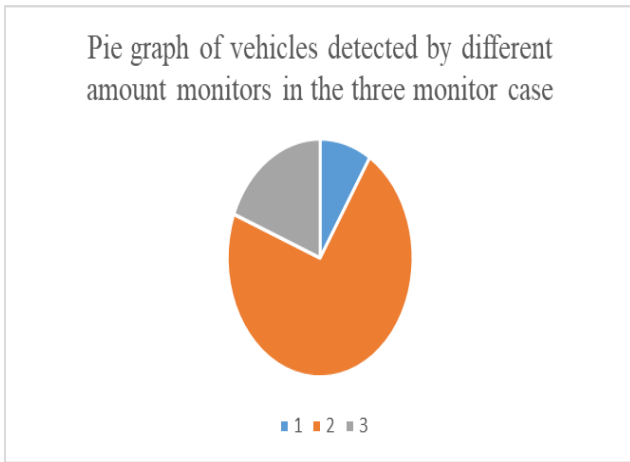
(a)
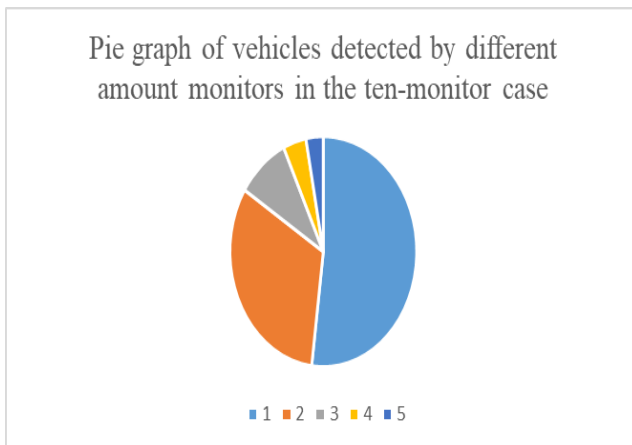
(b)
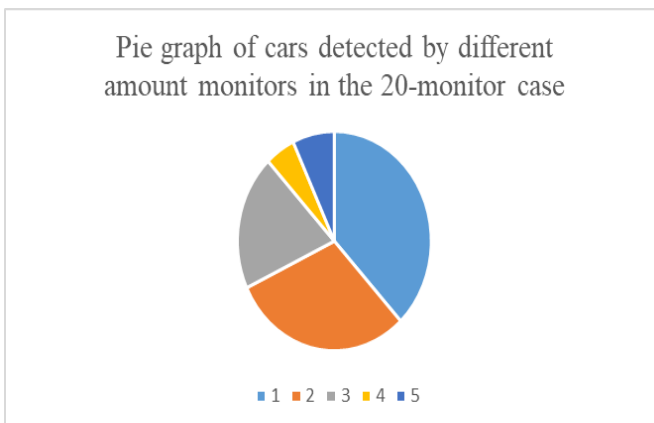
(c)

Fig. 10. Results of different Sensors

IX. CONCLUSION

Throughout the chapter, we have achieved in knowing the techniques in reducing pollution such as noise pollution emitting from vehicles. A case study is also made regarding the Highlanders Company that had made an investigation with the management team, in order to replace the Toyota vehicles from the courier services and replace with the best-selling auto mobile that could increase the efficiency and decrease the cost. The classification of smart vehicles which is produces less pollution to environment is also studied in this chapter.

REFERENCES

1. Lin Yang ; Wenfeng Li ; Masoud Ghandehari ; Giancarlo Fortino., "People-Centric Cognitive Internet of Things for the Quantitative Analysis of Environmental Exposure", IEEE Internet of Things Journal, Vol. 5, No. 4, pp. 2353-2366, 2018
2. Lingzhi Yi ; Xianjun Deng ; Minghua Wang ; Dexin Ding ; Yan Wang., "Localized Confident Information Coverage Hole Detection in Internet of Things for Radioactive Pollution Monitoring", IEEE Access, Vol. 5, pp. 18665-18674, 2017
3. Naser Hossein Motlagh ; Tarik Taleb ; Osama Arouk., "Low-Altitude Unmanned Aerial Vehicles-Based Internet of Things Services: Comprehensive Survey and Future Perspectives", IEEE Internet of Things Journal, Vol. 3, No. 6, pp. 899-922, 2016.
4. M.M. Rana ; L. Li., "Microgrid state estimation and control for smart grid and Internet of Things communication network", Electronics Letters, Vol. 51, No. 2, pp. 149-151, 2015.
5. I. F. Akyildiz ; M. Pierobon ; S. Balasubramaniam ; Y. Koucheryavy., "The internet of Bio-Nano things", IEEE Communications Magazine, Vol. 53, No. 3, pp. 32-40, 2015.
6. Xianjun Deng ; Laurence T. Yang ; Lingzhi Yi ; Minghua Wang ; Zhiliang Zhu., "Detecting Confident Information Coverage Holes in Industrial Internet of Things: An Energy-Efficient Perspective", IEEE Communications Magazine, Vol. 56, No. 9, pp. 68-73, 2018
7. Jiandong Zhang ; Xiaoyu Qu ; Arun Kumar Sangaiah., "A Study of Green Development Mode and Total Factor Productivity of the Food Industry Based on the Industrial Internet of Things", IEEE Communications Magazine, Vol. 56, No. 5, pp. 72-78, 2018.
8. Subhadeep Sarkar ; Subarna Chatterjee ; Sudip Misra., "Assessment of the Suitability of Fog Computing in the Context of Internet of Things", IEEE Transactions on Cloud Computing, Vol. 6, No. 1, 2018.
9. Faisal Karim Shaikh ; Sherali Zeadally ; Ernesto Exposito., "Enabling Technologies for Green Internet of Things", IEEE Systems Journal, Vol. 11, No. 2, pp. 983-994, 2017.
10. Yu Liu ; Kahin Akram Hassan ; Magnus Karlsson ; Ola Weister ; Shaofang Gong., "Active Plant Wall for Green Indoor Climate Based on Cloud and Internet of Things", IEEE Access, Vol. 6, pp. 33631-33644, 2018.
11. Lina Xu ; Gavin Mcardle., "Internet of Too Many Things in Smart Transport: The Problem, The Side Effects and The Solution", IEEE Access, Vol. 6, pp. 62840-62848, 2018.
12. Yuan Chen ; Soummya Kar ; Jose M.F. Moura., "The Internet of Things: Secure Distributed Inference", IEEE Signal Processing Magazine, Vol. 35, No. 5, pp. 64-75, 2018.
13. Ajmal Khan ; Farman Ullah ; Zeeshan Kaleem ; Shams Ur Rahman ; Hafeez Anwar ; You-Ze Cho., "EVP-STC: Emergency Vehicle Priority and Self-Organising Traffic Control at Intersections Using Internet-of-Things Platform", IEEE Access, Vol. 6, pp. 68242-68254, 2018.

AUTHORS PROFILE

Mr. M. Srinivasan, currently working as an Associate Professor in the Department of Information Technology at P.S.V Engineering College, Krishnagiri, Tamilnadu, India. He is pursuing Ph.D in the Department of Computer Science and Engineering at Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Avadi, Chennai. He has total 12 years of teaching Experience. He did his Under Graduate B.Tech Information Technology at Vel Tech Engineering College, Avadi, Chennai He did his Post Graduate M.E Computer Science and Engineering at SKP Engineering College, Thiruvannamalai. His research area is Cloud commuting and IoT. He has applied many project proposals to various funding agencies like SERB, MODROPS, etc. He is a Member of ISTE, IAENG, IACSIT, UACEE, CSTA, IEEE, and IAOE.

Retrieval Number C5819028319/19©BEIESP
Journal Website: www.ijeat.org

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Blue Eyes Intelligence Engineering
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Dr. Koteeswaran Seerangan, currently working as an Associate Professor in the Department of Computer Science and Engineering at Vel Tech Rangarajan Dr. Sagunthala R&D Institute of Science and Technology, Chennai-62, Tamilnadu, India. He has authored and co-authored several papers in various reputed journals and conference proceedings. He is a reviewer for more than a dozens of journals. His research interests include Theory of Computation, Software Engineering, Internet of Things, Data Science and Analytics. He is a Member of ACM, Member of IET, Senior Member of IEEE and Life Member of ISTE.