

Scenario of Vehicular Emissions and its Effect on Human Health in Kolkata City

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Abstract: Vehicular Pollution level in the city of Kolkata and its outskirts is alarming. West Bengal Pollution Control Board has indicated that the automobiles contribute significantly to particulate of the size of 1.1 micron and account for nearly 50 percent of the air pollution load in Kolkata. WBPCB has identified some of the reasons which are responsible for automobile pollution in the city which includes mainly high emission from two and three wheelers using of adulterer fuel, lacking in maintenance of vehicles, erratic traffic behavior and congestion at selected traffic intersection points, road encroachment by pavement dwellers, street hawkers and illegal car parking, improper traffic diversion, by Kolkata Traffic Police and inadequate traffic management emit huge amount of automobile pollutants in the city of Kolkata.

In Kolkata nearly 65 percent of the vehicles are diesel run. Diesel emissions are very toxic and it is carcinogenic in nature. Even Bharat Stage – IV compliant vehicles have higher toxicity than the petrol counterpart. Though petrol fuel emit high percentage of carbon monoxide and hydro –carbon and it is approximately 24 to 30 $\mu\text{g}/\text{m}^3$ per day (WBPCB, Annual Report 2012 – 2013) compared to diesel fuel where the rate is nearly 18 to 21 $\mu\text{g}/\text{m}^3$ per day in the city. To assess the status of automobile pollution load, twenty traffic intersection points has been selected both from North, South, East, West and Central Kolkata in order to estimate the automobile pollution status. It has been noted that large and small buses are also the principle sources of NO_x, CO, HC, Pb, CO₂, SPM and RPM in the city. The average age of the passenger cars within the city is about 10 years but over one quarter of the large diesel trucks are over 30 years. Therefore a large quantity of automobile exhaust not only effect the existing environment in the city of Kolkata but also results into heat island in all the traffic intersection points in comparison to other peripheral location in and around Kolkata. Further it has also been marked out that high rate of automobile emission may enhance the rate of temperature as well as relative humidity and in turn may reduce the amount of rainfall, thus unsaturated environmental condition has been noted in these selected traffic points. As an after math various respiratory diseases has cropped up like Bronchial Asthma, Chronic Bronchitis, Breathing problem, on the one hand and other diseases like Eye irritation, High pressure on the other found among the respondents in the city of Kolkata because of high rate of exhaust from the in-road running vehicles. Therefore an attempt has been made to justify the issue of vehicular pollution in Kolkata which has made residents at risk and to point out the traffic related air pollution in the city of Kolkata and its effect on environ along with comparison among the megacities of India followed by some critical appraisal and recommendations.

Key words: Automobiles, Traffic Intersection Points, Carcinogenic, Bronchial Asthma, Chronic Bronchitis, Breathing Problem,

I. INTRODUCTION

Vehicular air pollution is a growing problem in Kolkata due to high growth rates of motorized transport. The rising level of air pollution can be attributed mainly to increasing vehicular population, which has been observed in an average decadal growth rate of almost more than 70 percent for two wheelers, 15 to 20 percent for four wheelers especially personalized cars and taxis, 8 to 13 percent for buses and 10 to 14 percent for three wheelers during 2001 to 2011. The West Bengal Pollution Control Board has pointed out that the main reasons behind the maximum vehicular emission are high average age of the vehicles very low road surface area, road surface condition such as speed breakers, high density of population using the same road space, mixed vehicular mode along with the slow moving vehicles which are responsible for congested traffic condition in the city of Kolkata. From the Asian Development Bank Report, it has been noted that the citizens of Kolkata breathe roughly 857 tonnes of air pollutants every day (ADB REPORT 2005). The pollution levels in Kolkata are not only increasing over the period but are critical at some traffic intersection point.

Area of Study :

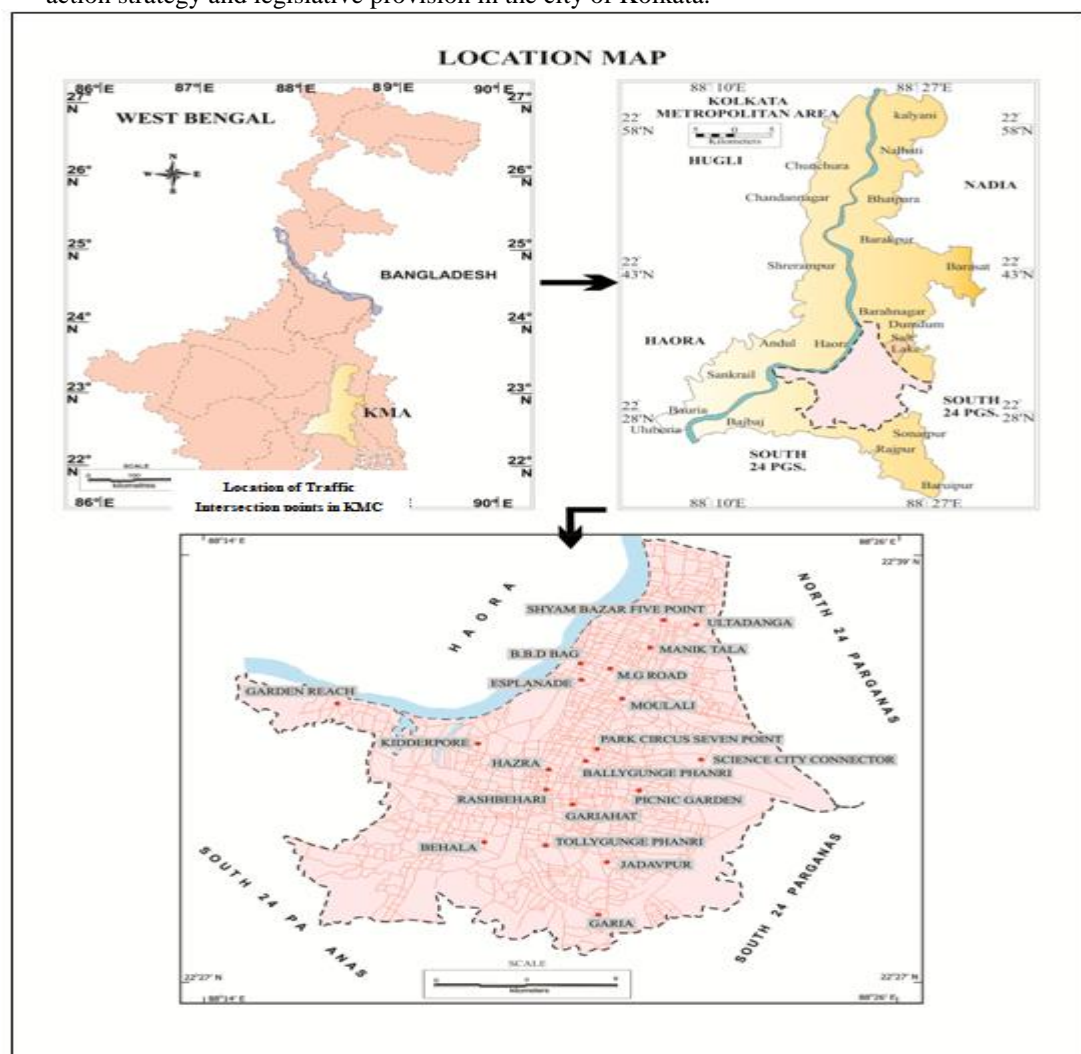
The study area is the city of Kolkata under the jurisdiction of Kolkata Municipal Corporation (KMC). The district of Kolkata lies between 22°30' N to 22°37' N latitudes and 88°18' E to 88°23' E longitudes. The city

comprises of an area of 187.33 sq. km. which is divided into 141 wards under 15 boroughs. According to the census of India (2011), the total population of Kolkata is 4,486,679 persons with a density of population of 24,718 persons per sq.km. It has shown a declining trend since 1991. But the vehicular population is on rise which shown an increase of 8 times from 1951 to 2011.

Objectives:

The study has been conducted with a view to fulfill the following objectives:

- (i) To identify growth of different modes of urban transport and its importance and to mark out different sources of vehicular emission in the city of Kolkata.
- (ii) To measure the degree of different automobile pollutants at different traffic intersection points in North, South, East West and Central Kolkata.
- (iii) To make a co-relation between concentration of automobile pollutants and climatic characteristics such as temperature, rainfall and relative humidity at different traffic points within the KMC boundary of Kolkata
- (iv) To make a comparative analysis regarding pollution level and vehicular growth among ten metropolitan cities in India including Kolkata city.
- (v) To examine the status of present scenario of fuel quality standard norms in the city of Kolkata.
- (vi) To evaluate the status of environmental pollution and health hazard related to vehicular air pollution in the city of Kolkata.
- (viii) To suggest how to minimize and reduce automobile pollution load by implementing various transport action strategy and legislative provision in the city of Kolkata.



Data Source: KMC and NATMO

Methodology:

All work of this academic tasks have been done in phases :

The first Phase: The first phase of the study was a preliminary attempt to gather various information and secondary data in registered vehicular population, like various sources of automobile pollution, diurnal variation of vehicular pollutants and seasonal variation of air pollution at different stations in the city of Kolkata. The information have been collected from the Transport Department, Government of West Bengal, various websites of CSTC, CTC and Kolkata Auto and Taxi Union, West Bengal Bus Syndicate Association, West Bengal Surface Transport Corporation ,JNNURM, South Bengal State Transport Corporation and KMC offices of the 15 borough in the city.

Simultaneously, study on the existing literature available on the subject from libraries of West Bengal Pollution Control Board, and Kolkata Metropolitan Development Authority. Secondary data have been collected from various Government Reports and Manual in automobile air pollution and news paper cuttings.

The intermediate phase :

Collection of primary data has been made with the help of structured questionnaire. The primary survey has been conducted on the basis of various perception from the traffic policemen, bus, auto and taxi driver and the people of Kolkata at different traffic junction points with the help of questionnaire survey. Relevant photographs have been taken during the field survey to illustrate the scenario more specifically.

The Final Phase:

After the collection of primary and secondary data, computation, tabulation and analysis of the same have been done. In this phase data have been processed to prepare relevant maps and cartographic diagrams.

The interpretation of the prepared maps and diagrams has been done with necessary modifications of the previous works and with critiques of the prevailing systems and other government policies.

Vehicular growth in Kolkata:

Kolkata city is connected with surrounding suburban areas by long and short distances bus services. These bus route services are mainly operated by public or Government sector (South Bengal State Transport Corporation, Calcutta Tramways Company, West Bengal surface Transport Corporation and Calcutta State Transport Corporation) and private sector (Bengal Bus Syndicate association, Calcutta Bus Syndicate Association, Calcutta Mini Bus Association and privately own Chartered Bus services). During the observation from 2008 to 2012, growth of two wheelers have been increased more than 3,00,000 followed by four wheeler (personalized car) which is more than 1,00,000 Three wheelers (more than 30,000) (Taxis (more than 40,000) and Buses (more than 10,000) have been observed in the city of Kolkata. According to 2011 census, vehicular population of Kolkata is near about 12.04 lakhs and total road space within the KMC area 7.0%. From this observation it has been marked that there is a negative co-relation between number of vehicle growth and limited road space, as a result there is traffic congestion together with automobile emission in the city of Kolkata.

Concept of vehicular emission:

The fuel loss of vehicles may be due to emissions of refueling. The emissions may be evaporative or exhaust emission. The emission may be of different types as follows :

(a) Exhaust Emission :

Exhaust emission are those which are emitted through the exhaust pipe when the vehicle is running or is started. The exhaust emissions may be of two types :

(1) Start up Emission :

Emissions when the vehicle is started initially. Board on how long the vehicles had been turned off after use, they may be cold start and hot start. Cold Start refers to when the vehicle is started suddenly after a long gap of use, whereas, hot start refers to when the vehicle is started without the vehicle getting enough time to cool off after its previous use.

(2) Running Emissions:

Emissions during normal running of the vehicle, for example when the vehicle is in a hot stabilized mode.

- (b) **Evaporative Emission :**
 These include running losses and hot soak emissions produced from fuel evaporation when an engine is still hot at the end of a trip, and diurnal emissions (daily temperature variation).
- (c) **Exhaust Pollutants :**
 The pollutants which are emitted from the exhaust pipe of the automobiles; they are formed as a result of combustion of the fuel in the engine. These pollutants are harmful to the atmosphere and living things in particular in the city of Kolkata.

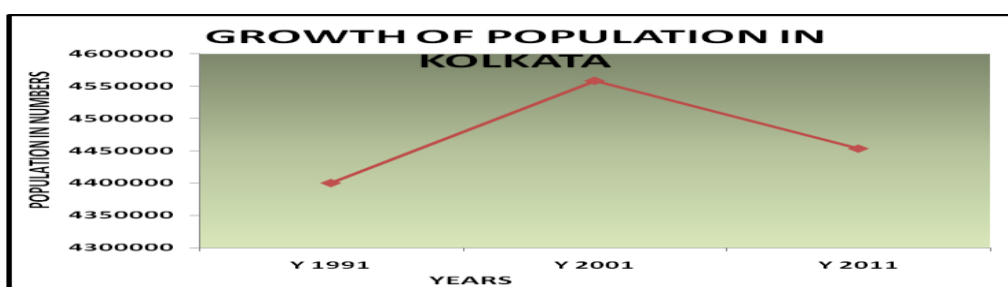
Major Automobile Pollutants in Kolkata

Table : 1

Pollutants	Description
Nitrogen Oxides (NO)	Road transport contributes to 49 percent of total NO emission in the city of Kolkata. NOx is a precursor of ozone formed in the troposphere.
Sulphur Dioxide (SO₂)	Sulphur in diesel contributes to the exhaust particulate matter while in petrol it effects the performance of catalytic converters in engines.
Carbon Monoxide (CO)	Road transport is the principle source of CO in the city of Kolkata.
Volatile Organic Compounds (VOCs)	It includes wide range of hydrocarbon, oxygenates and halogen-containing species. Petrol vehicles emit more benzene in exhaust than diesel vehicles even when catalytic converters are used. The main source of 1.3 butadiene in the atmosphere is the combustion of petrol and diesel fuels.
Hydro Carbons (HC)	About 10 percent is emitted from automobile exhaust in the city of Kolkata.
Ozone (O₃)	Ozone has a strong diurnal variation with concentration in peak in daytime hours Road traffic is a major contributor to its formation.
Lead (Pb)	The primary source of atmospheric lead in the city of Kolkata is leaded gasoline.
Particulate Matter (PM₁₀)	Transport sectors in Kolkata again emit huge amount of particulate matter in the atmosphere.

Source: Health Effect of Air Pollution: A Study on Kolkata by WBPCB
Growth of population in Kolkata

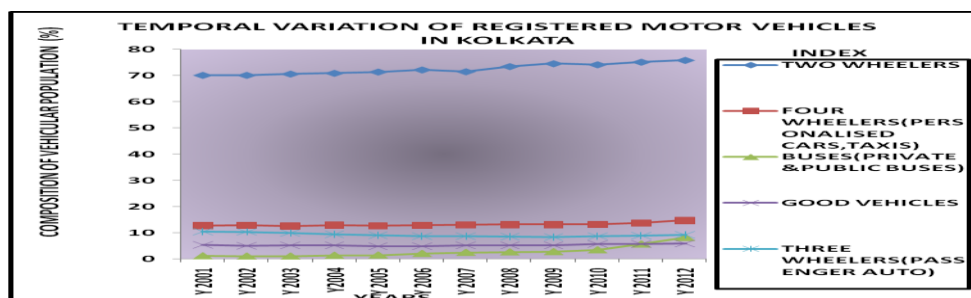
Figure: 1



Data source: Census of India 2011

Growth of Vehicular Population in Kolkata

Figure: 2



Data source: Transport Department, Government of West Bengal, 2014

Since Kolkata is a big city, growth of population have been increasing in Geometric Progression upto 2001 but then it has declined (fig: 1) whereas vehicular growth (fig : 2) has shown a steady rise from 2001 to 2011. To maintain the status of the urban mind, most of the people depend on personalized vehicles especially two wheeler and four wheelers. From the recent observation, it has been focused that percentage growth of two wheelers are maximum in numbers followed by four wheelers, three wheeler and private and public buses. As a result these two wheeler and three wheeler emit huge proportion of automobile pollutants in the city of Kolkata due to ill maintained engine, using of adulterated oil and even aged and weight of the cars. From the statistical information provided by Transport Department, Government of West Bengal, it has been found that most of the old engine vehicles do not have catalytic converter which results in to exhausts of automobile emission in the environ of the city.

Major causes of air pollution from automobiles in the city of Kolkata:

There are several causes which are responsible for automobile pollution in the city of Kolkata. It includes mainly:

- (a) High emission from two and three wheelers petrol driven vehicles.
- (b) Using of poor quality fuel which include high sulphur, benzene and olefin.
- (c) Adulteration of fuel especially using of Katatel (Kerosene and exhaust mobile) in the engine of three wheelers that is the autos in Kolkata.
- (d) Lacking in maintenance of vehicles.
- (e) Large number of heavy weight old engine petrol driven vehicles inuse causes high emission.
- (f) Erratic traffic behavior leading to congestion and emit huge proportion of automobile pollutants.
- (g) Most of the busy traffic intersecting points in Kolkata have been encroached by pavement dwellers, street hawkers and illegal car-parking, as a result widening space of the road has reduced and thereby results to huge traffic congestion in the city of Kolkata.
- (h) Improper construction of road divider in between two lane of the road make inadequate road space which prevent better mobility of traffic and even unscientific construction of speed breaker reducing traffic speed in the city of Kolkata.
- (i) Even improper management of traffic diversion by Kolkata traffic police and problem of traffic signaling system can create congestion which results into emission.
- (j) Unscientific construction of flyover, size and weight of the car, inadequate traffic management emit huge amount of automobile pollutants in the city of Kolkata.

Concentration of Pollutants at Various Traffic Intersection Points in Kolkata:

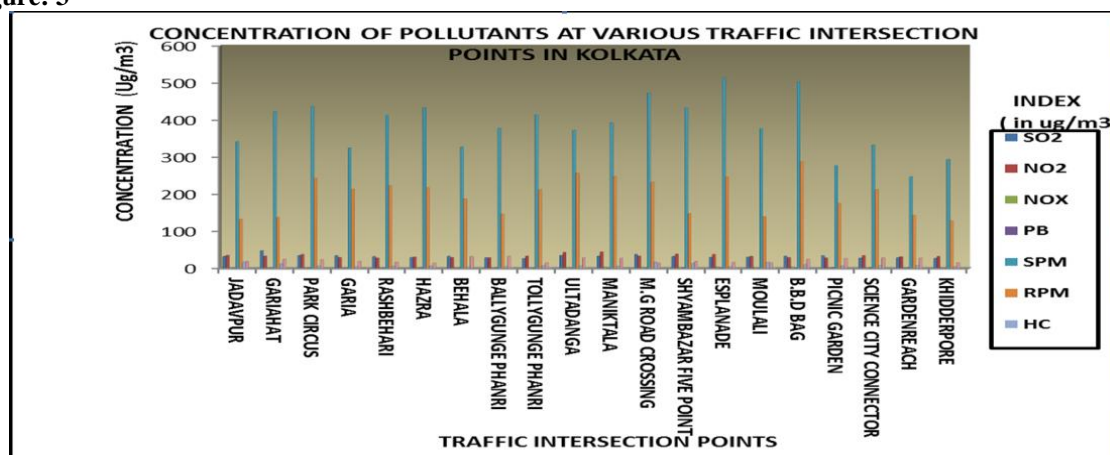
During primary survey, 20 traffic intersection points has been selected to measure different degree/paratre of the different automobile pollutants to make an appropriate observation relevant to the study.

Table: 2 WARD WISE DISTRIBUTION OF MAJOR TRAFFIC INTERSECTION POINTS IN KOLKATA.

Borough	Wards	Selected Wards	Traffic Intersection points	Zone	Description
I	1, 2, 3, 4, 5, 6, 7, 8, 9				
II	10, 11, 12, 15, 16, 17, 18, 19, 20	11	Shyambazar Five Points Crossing	I	North
III	13, 14, 29, 30, 31, 32, 33, 34, 35	13	Ultadanga	I	North
IV	21, 22, 23, 24, 25, 26, 27, 28, 38, 39	44, 50, 45,27	M.G.Road Crossing,Moulali,B.B.D. Bag,Maniktala	I& V	North & Central
VI	46, 47, 51, 52, 53, 54, 55, 60, 61, 62	46	Esplanade	V	Central
VII	56,57, 58, 59, 63, 64, 65, 66, 67	64, 67, 66	Park Circus Seven Points Crossing, Picnic Garden, Science City Connector	V & III	Central & East
VIII	68, 69, 70, 72, 83, 84, 85, 86, 87, 88, 90	86, 84, 72, 69	Gariahat,Rashbehari,Hazra,Ballygunge Phanri	II	South
IX	71, 73, 74, 75, 76, 77, 78, 79, 80, 82	77	Khidderpore	IV	West
X	81, 89, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100	100, 94	Garia ,Tollygunge Phanri	II	South
XI	103, 104, 110, 111, 112, 113, 114	102	Jadavpur	II	South
XIII & XIV	115,116,117,118,119,120, 121,122,123,124,125,126, 127,128,129,130,131,132	116	Behala	IV	West
XV	133,134,135,136,137,138,139,140,141	137	Garden Reach	IV	West

Data Source: Computed by the Author,2014

Figure: 3



Date Source: Primary Survey and Computed by the Author, 2014

From the above observation (figure: 3), it can be pointed out that, Park Circus Seven Point Crossing, Gariahat, Rashbehari and Hazra in South, Ballygunge and Tollygunge Phanri also in South, and M.G. Road, Shyambazar Five Points Crossing in the North and Esplanade and B.B.D. Bag in the Central Kolkata recorded maximum concentration of SPM, RPM, SO₂ and NO₂ concentration in comparison to other selected traffic intersection points in the city of Kolkata. As a result these traffic points considered to be the site of heat islands in the city of Kolkata due to enhancing level of pollutants and temperature and relative humidity.

Comparative analysis of Kolkata among other several metropolitan cities in India :

Central Pollution Control Board (CPCB) has published a recent empirical report, on which it has examined that, Kolkata is ranking fourth in term of level of pollution after Delhi, Bangalore and Luck now. From the observation it has been identified that SO₂ has shown a decreasing trend of pollution level due to various interventions that have been taken place in recent years such as reduction of sulphur in diesel, and even use of cleaner fuel such as CNG in Delhi and Mumbai etc. Other measures include implementation of Bharat Stage – III emission norms for new vehicles and commensurate fuel quality, There has been a change in domestic fuel used from LPG which may have contributed to reduction of SO₂ in ambient air levels.

Recently a declining trend in NO₂ has been observed in Ahmedabad, Faridabad, Kolkata, Mumbai and Pun. The reason for low level of NO₂ may be because of various measures taken, such as banning of old vehicles, better traffic management etc. Even introduction of improved vehicular technology in the form of Bharat stage- III vehicles, banning of old vehicles in some cities, improved traffic management etc.

In regard to RSPM, a downward trend has been observed in the cities namely Ahmedabad, Hyderabad, Sholapur, Bangalore and Faridabad in comparison to Kolkata. implementation of stricter vehicle emission norms and commensurate fuel quality, cleaner fuels, banning of diesel driven cars in same cities etc. are also the reasons.

Trend of SPM is fluctuating in many cities like Patna and Varanasi, in comparison to Kolkata. The reason for high SPM levels may be natural dust, suspension of dust from vehicles etc.

Effect of vehicular air pollution on human health in the city of Kolkata :

There are several type of diseases that have been observed due to maximum emission of vehicular pollution.

(a) **Chronic Bronchitis :**

A chronic inflammatory disease of the bronchus resulting in persistant production of cough and breathlessness due to maximum concentration of dust and SPM from exhaust emission of automobiles.

(b) **Chronic Obstructive Pulmonary Disease (COPD) :**

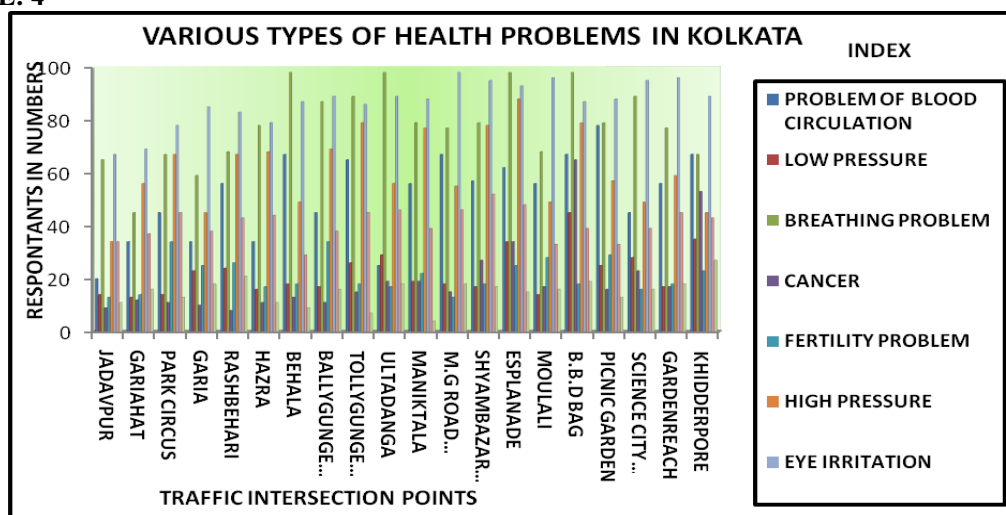
COPD has been observed due to maximum inhale of SO₂ and RPM through the respiration system or process by the human being, this type of obstruction may occur.

(c) **Lung Cancer :**

Automobile pollution is another responsible factor for lung cancer in the city of Kolkata. It is the fact that age-adjusted rate of lung Cancer per 1,00,000 population is highest in Kolkata compared to other cities due to huge amount of vehicular emission (Cancer Registry, CNCI, 2009).

- (d) **Bronchial Asthma :**
Epidemiologic evidence supports that exposure to high level of vehicular air pollutants is associated with increase in morbidity and mortality from Asthma results due to Ozone, SO₂, Nox and Respirable Particulate Matter from automobile sources.
- (e) **Allergic Alveolitis :**
This may be due to exposition of SO₂, NO₂ and particulates matters from petrol driven engine vehicles and burning adultered fuel.
- (f) **Pulmonary Edema :**
High exposure to NO₂ and O₃ is known to cause structural changes in the lung resembling ageing and emphysema in the city of Kolkata.

FIGURE: 4



Data Source: Primary Survey and Computed by the Author, 2014

During primary survey (fig : 5), it has been observed that, people of Kolkata are suffering from various type of health problems such as problem of blood circulation, low pressure, problem of breathing, cancer or leukemia, reduction of fertility among the couples, enhancing high pressure, problem of eye irritation, lung diseases and infections in the stomach etc. From the primary data source, it has also been examined that most of the people of Kolkata are suffering from breathing problem, high pressure, eye irritation and even lung diseases as a chronic diseases in comparison to other acute diseases in the city of Kolkata.

Table : 3
Pollutants effect on human health

Carbon Monoxide	Affects the cardio vascular system, exacerbating cardio-vascular diseases symptoms, particularly angina, affects nervous system impairing physical co-ordination, vision and judgment, creating nausea and headaches, reducing productivity and increasing personal discomfort.
Nitrogen Oxides	Increased susceptibility to inflections, pulmonary diseases, impairment of lung function and eye, nose and throat irritations.
Sulphur di-oxide	Affect lung function adversely
SPM & RPM	Fine particulate matter may be toxic in itself or may carry toxic trace substance, and can alter the immune system. Fine particulates penetrate deep into the respiratory system, irritating lung tissue and causing long term disorders.
Lead	Impairs liver and kidney causes brain damage in children resulting in lower I.Q., hyperactivity and reduce ability to concentrate.
Benzene	Both toxic and carcinogenic excessive incidence of leukemia (blood cancer) in high exposes area.

Source : Health Report, Department of Health, Govt. of West Bengal, 2014

Policy & guidelines to reduce vehicular emission in the city of Kolkata:

In terms of implementation of Act U/S 20 of the air (prevention and Control of Pollution) Act 1981, the following direction are issued to maintain the emission level within the jurisdiction of Kolkata Municipal Corporation.

- (vii) Transport vehicles of 15 years old and more should not be allowed to operate in the city of Kolkata.
- (ii) All registered auto-rickshaws (three wheelers) plying within Kolkata Municipal area need to be converted into LPG or CNG mode by 31st March 2009. In this concern motor vehicles department should regulate their registration on auto-rickshaw in Kolkata.
- (iii) Reduction of Sulphur content diesel and Benzene content petrol should be implemented as per the auto-fuel policy of Govt. of India to reduce the use of adulterated fuel.
- (iv) Registration of Auto-rickshaw having 2-stroke engines should be stopped immediately by the motor vehicles department and all the four wheelers should be converted into Euro-III and IV emission norms.
- (v) Automobile air quality should be monitored by WBPCB in a regular way at same selected nodal points within Kolkata to measure the parameters of automobile pollutants.
- (vi) Pollution under control certificate (PUC) should be issued after checking the engine scientifically by the issuing authority at different pumping station and selected model station.
- (vi) Motor vehicle act 1988, 1989, must be followed within the KMC area to reduce the emission and monitor the pollution scale of all the engines of the vehicles.

Findings and Conclusion:

During the observation following points have been notified:

- (vii) It is better to limit the number of personalized vehicles especially two wheelers and four wheeler because it emits more pollutants in the environ of Kolkata.
- (ii) Frequency of buses should be increased to cover the regular distance, otherwise increasing number of vehicles are not adequate in proportion to road space within the city of Kolkata.
- (iii) Poor quality of fuel must be banned where as LPG and CNG must be encouraged to reduce automobile emission.
- (iv) Strict order and regulations should be maintained to ban the encroachment on the side of road and as it has been notified that catalytic converter engine reduce the emission, so motor vehicles department in collaboration with WBPCB must implement catalytic converter engines in all the newly launched vehicles under WBSTC, CSTC, CTC and JNNURM.
- (v) Phasing out of 15 years of old or more engine vehicles from the city of Kolkata should be looked upon as it emits more and create traffic congestions.
- (vi) Optimization of traffic and improvement in traffic management must be followed to increase the speed of the vehicles which would reduce vehicular emission at end. Traffic management programme includes GPS navigation and traffic signaling system, green corridors, removal of encroachment of roads, regulation of digging roads etc.
- (vii) Improvement of vehicle technology is another systematic approach to reduce emission followed by restriction on manufacturing of two stroke engines, emission warranty and on board diagnostic system.

It can be summarized that if above noted points are taken into consideration for reduction programme, pollution specially vehicular emission may eliminate from Kolkata city in near future and will make the city clean and pollution free.

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