

COMPARATIVE STUDY ON THE EFFECT OF NEXT GENERATION METRO ON ENVIRONMENT AND TRANSPORTATION

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Abstract: Metro has changed the way Delhiites travel. But with a massive rise in passenger count, Delhi Metro Rail Corporation (DMRC) is taking its reinvention seriously. Delhi Metro have faced many challenges mainly in its third phase for creating an interactive route map. The aim of accepting challenges is to reduce pollution. This paper seeks to quantify the causal effect of operation of the DM on environment using secondary data from several sources, including hourly levels of 'criteria' pollutants and interviews from the commuters. This paper presents that Delhi Metro is growing with ageing. The Delhi Metro is the biggest and busiest metro in India and the world's ninth longest metro system in length and sixteenth biggest in ridership. The Delhi Metro has additionally contributed hugely on the earth front by turning into the main ever railroad venture on the planet to guarantee carbon credits for regenerative braking has likewise been confirmed by the United Nations (UN) as the principal Metro Rail and Rail based framework on the planet to get Carbon Credits for decreasing Green House gas emanations as it has diminished contamination levels in the city by 6.3lakh tons consistently consequently helping in lessening an Earth-wide temperature boost. The new age metro is providing services which have increased the ridership as ridership is increased the vehicles of these riders are off road apart from providing comfortable travel facility for people. This paper presents air-quality trends for Delhi to examine whether air quality has in fact improved in the city in recent times with the Metro. Levels of five conventional pollutants—CO, NOx, HC, CO₂ and PM are considered in the study.

Key Words: Delhi Metro Rail Corporation (DMRC), Carbon credits, Green House gas emissions

I. INTRODUCTION

The Delhi Metro is playing an important role in the daily life of the new generation. The use of Metro shows tremendous reduction in various pollutants, by the reduction of vehicles on the road. The study conducted by the Central Road Research Institute on behalf of Delhi Metro, is part of the Environment Impact Assessment. The Delhi Metro is being built in phases I, II, III and IV. Phase I and II are fully completed. Report for phase III conducted in 2017-2018, the study says that lakh plus vehicles will go off the city roads once the third and fourth phase becomes operational. Phase-III has 28 underground stations, 2 new lines and 11 route extensions, totaling 167.27 km (103.94 mi), with a cost of ₹350 billion (US\$5.1 billion) and having a planned completion date of December 2018. Phase IV (113.2 km or 70.3 mi) is planned to be completed by 2022.

The Delhi Metro has likewise contributed tremendously on the environment front by turning into the main ever railroad project on the world to guarantee carbon credits for regenerative braking. DMRC has additionally been affirmed by the United Nations (UN) as the first Metro Rail and Rail based system on the planet to get carbon Credits for reducing Green House gas emissions as it has diminished contamination levels in the city by 6.3lakh tons every year thus helping in decreasing a worldwide temperature alteration.

The economic benefits from the reduced number of vehicles on Delhi roads because of the Metro could be recognized as the accompanying:

- Savings in Foreign Exchange because of reduced Fuel Consumption
- Reduction in Pollution
- Savings in Time for all travelers utilizing Metro and Roads
- Savings in Accidents
- Savings in Vehicle Operating Cost (VOC) because of decongestion for lingering activity
- Savings in Capital and operating cost of redirected vehicles
- Savings in the cost of Road Infrastructure

II. METHODOLOGY ADOPTED

The principal objective of present research is to carry out a comparison of vehicle pollution before and after Metro in Delhi. The intent is to suggest strategies for reduce of vehicle pollution due to metro. The following methodology has been adopted for conducting the present study.

- The details of number & vehicle reduced has been collected
- The average daily running kilometer of various cars and two wheelers were collected from two wheelers and car users.
- The emission levels of different vehicles have been collected from Central Pollution Central Board, New Delhi and from other vehicle sources.
- Available data has been analyzed to meet the objective that how vehicle pollution is minimized due to Delhi Metro.

III. INTERACTIVE ROUTE MAP TO REDUCE POLLUTION

Phases I and II of Delhi Metro had laid the foundation of a robust mass rapid transit system in the capital, connecting all four corners of the city and the larger NCR. Phase III, which is nearing completion, has connected the linear corridors of the earlier phases and made the metro accessible to most major localities of the city. it's the third phase that was the toughest so far in terms of the engineering challenges.

At 160km, the entire Phase III is equal to phases I and II combined. It saw work on 11 different corridors with 30 mammoth tunnel boring machines and a workforce of 30,000. The civil engineering challenges encountered on the way have been compiled in a book, 'Delhi Metro—Phase 3 Challenges', which was unveiled ,it focuses on the three main corridors—Majlis Park-Shiv Vihar Pink Line, Janakpuri West-Botanical Garden Magenta Line and Central Secretariat-Kashmere Gate Violet Line. DMRC operates over 2,700 trips daily, with first trains starting at around 05:00 and last at 23:30.¹In the financial year 2016–17, the Delhi Metro had an average daily ridership of 2.76 million passengers and served 100crore (1.0 billion) riders in total during the year.

IV. WORLD'S FIRST GREEN METRO

By adhering to the green building standards for its residential colonies, the Delhi metro Railway Corporation (DMRC) has turned into the world's first totally green metro. The Indian Green Building Council (IGBC) granted the Delhi metro the platinum rating for adhering to the green building standards for its 10 residential colonies. It has likewise set up rooftop top sunlight based power plants at a significant number of its stations. All stations of the by and by under development halls are being built as green structures. The study revealed that there have been colossal decreases in the two noteworthy transportation toxins to be specific carbon monoxide and nitrogen dioxide.

V. FACTORS AFFECTED THE REDUCTION IN AIR POLLTION

The Delhi Metro Project has played a very important rule in public urban transportation in India. The modern Metro System provides comfortable, eco-friendly and air-conditioned service for the very first time in India and has resulted in revolution in the mass transportation not only in the NCR region but also in the entire nation. As the facilities provided by DMRC are laudable. A study was carried out in 2015, (Deepti Goel et al, 2015) to study the impact of Delhi Metro on Air Pollution. The study revealed that there has been huge reductions in the two major transportation pollutants namely carbon monoxide and nitrogen dioxide.

Ridership

The cumulative ridership of the Delhi Metro within a financial year crossed the one billion(100crores) building up DMRC as the mass transportation backbone of the National Capital Region (NCR). According to the data, almost 80% are daily commuters and 70% are male and 30% are female. The majority of commuters are office-goers. The age of the 47.5% riders is 20-30 years. The 16% commuters are student . For a considerable length of time, U Specials, for university bound buses, were the main method of transport for students travelling to Delhi University's north campus. All that changed when the Kashmere Gate to Vishwavidyalaya area of Delhi Metro opened.

VI. FACILITIES PROVIDE BY DMRS

50% of the respondents highly agree with the Delhi Metro has provided escalator and lifts in the stations so that senior citizens, physically disables, can use metro. 8% of the respondents neutral with the same. Janakpuri-Kalkaji section of Delhi Metro Magenta Line will have the country's tallest escalator. This will help senior citizens to use Metros.

50% of the respondents highly agree with the Wi-Fi facilities provided by the Delhi metro are enjoyable and helpful for commuters, 10% of the respondents neutral with the same. Delhi Metro commuters travelling in the Blue Line will now be able to enjoy free Wi-Fi at stations. Delhi Metro Rail Corporation (DMRC) has also promised to give the facility at stations on Yellow Line and inside the trains on Airport Express Line by early next year. The facility -Oui DMRC Free Wi-Fi -will be available on all 50 stations of the line. Commuters will have the facility to sign in after a one-time enlistment through their cell phones. They will have the capacity to utilize all standard web applications at the station.

Long Routes

For long routes commuters prefer to travel by metro. 57% of the respondents highly agree with the Travelling on long distance Delhi-NCR have reduced travel time and cost. 33% of the respondents agree, 6% of the respondents neutral with the same and 3% of the respondents highly disagree with the above statement.

On going deep down, the Metro which was initially built for 3 million passengers per day finally carries only 1 million despite cancelling more than 100 bus routes on the journey. It has obviously led to the displacement of more than 200,000 people but only 50,000 have been rehabilitated. Travelling from Sector 77 in Noida to Cyber City, Gurgaon, takes two-hour but commuters can sit in the air-conditioned comfort of Delhi Metro's Magenta Line and can reach in half an hour .Earlier, the commuters rode up to Rajiv Chowk and then take the train to Gurgaon. Now they can change trains at Hauz Khas and save at least half an hour of commuting time.

Happy Flyers

In August 2016, Airport Express Line crossed the 50,000 ridership figure, a huge jump from the 12,000 in March 2014. The figure was at 19,466 in 2015. According to Delhi Metro, the daily average ridership has now settled between 44,000 and 45,000. To ensure that more people use this line, DMRC

revised the fare twice and made several passenger-friendly changes. The maximum fare has been reduced to Rs 60 while the minimum is now Rs 10. Various other steps like extension of timings to suit passengers of Shatabdi Express trains, improvement of frequency from 15 minutes to 10 minutes 30 seconds, improvement of speed from 70kmph to 80kmph, seamless interchange between the Indian Railways station at New Delhi and Metro stations have been taken.

Shoppers in clog areas

50% of the respondents highly agree with it becomes easy to move in crowded area like Chandni Chowk and CP for shopping. 35% of the respondents agree, 8% of the respondents neutral with the same and 5% of the respondents highly disagree, 2% of the respondents disagree with the above statement.

The Walled City or Shahjahanabad, popular for its lip-smacking delicacies and bargain shopping, was forbidding for many citizens due to lack of parking, the narrow lanes and the mindboggling congestion. Delhi Metro opened up this quarter of Old Delhi to the rest of the capital when the Chandni Chowk station opened. The huge ridership not only surprised Old Delhi shop owners, but DMRC too, which had to create additional infrastructure to deal with the unexpected crowds.

Once the prime shopping hub of New Delhi, Connaught Place lost its sheen after swank malls began opening up in other parts of the city and in Gurgaon. Shoppers began deserting CP, so much so that the once beautiful central park even became a den for drug addicts. The advent of Delhi Metro, however, turned the tide for the heritage commercial centre. The train service brought the shoppers back, and CP is now a happening place, particularly with the youth.

VII. AIR QUALITY TREND

The source of the data is from Automotive Research Association of India. Table-1 shows the emission factors in g/km of different vehicles like Cars and Jeep, Two-wheelers and Buses. Table 2 shows the number of vehicles off road due to metro.

TABLE 1: EMISSION FACTORS FOR ROAD VEHICLES (G KM-1)

Vehicle Type	CO	NOx	HC	CO2	PM
Car & Jeep	0.84	0.09	0.12	172.95	0.006
Two wheelers	1.65	0.27	0.61	24.97	0.035
Buses	3.97	6.77	0.26	73.51	1.075

TABLE 2: NUMBER OF VEHICLES OFF ROAD FROM DELHI CITY

Year	Cars& Jeeps	Two wheelers	Buses	Total
2005-06	50586	284433	3398	338418
2010-11	80731	479286	4767	564784
2015-16	238737	1496497	12388	1747622

TABLE 3: SHOWS THE EMISSION FACTOR FOR DIFFERENT VEHICLES CALCULATED FOR DIFFERENT POLLUTANTS IN 2005-2006

Vehicle Type	No. of Vehicles	CO	NOx	HC	CO2	PM
Car & Jeep	50586	42492.24	4552.74	6070.32	8748849	303.516
Two	284433	469314.45	76796.9	173504	7102292	9955.155

wheelers						
Buses	3398	13490.06	23004.5	883.48	249787	3652.85
Total	338417	525296.75	104354.1	180457.9	16100928	13911.521

Table 3: Pollutants reduced in 2005-2006

TABLE 4: SHOWS, THE EMISSION FACTOR FOR DIFFERENT VEHICLES CALCULATED FOR DIFFERENT POLLUTANTS IN 2010-2011

Vehicle Type	No. of Vehicles	CO	NOx	HC	CO2	PM
Car & Jeep	80731	67814	7265.79	9687.72	13962426.5	484.386
Two wheelers	479286	790822	129407	292364	11967771.4	16775
Buses	4767	18925	32272.6	1239.42	350422.17	5124.53
Total	564784	877560.9	168945.6	303291.6	26280620.04	22383.92

Table 4: Pollutants reduced in 2010-2011

TABLE 5: SHOWS THE EMISSION FACTOR FOR DIFFERENT VEHICLES CALCULATED FOR DIFFERENT POLLUTANTS IN 2015-2016

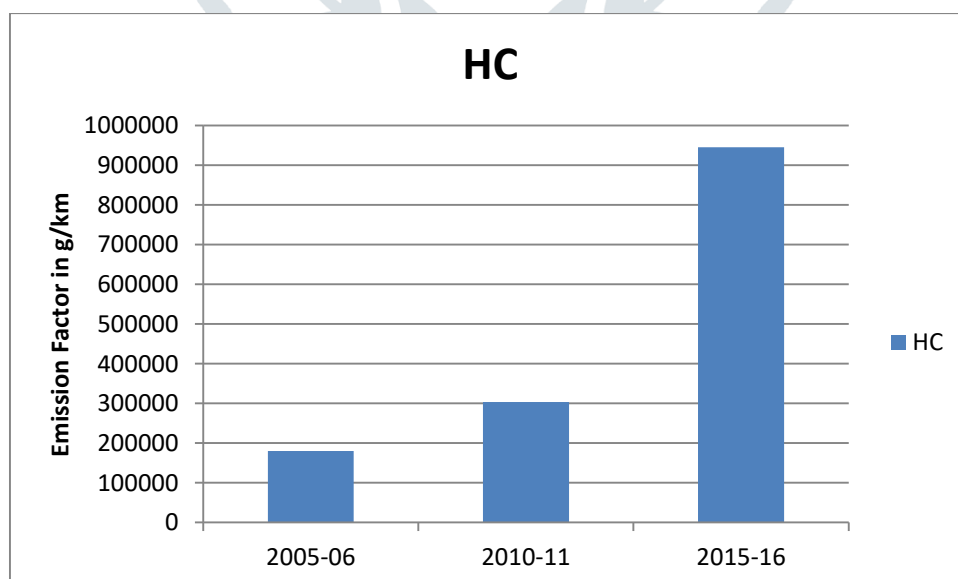
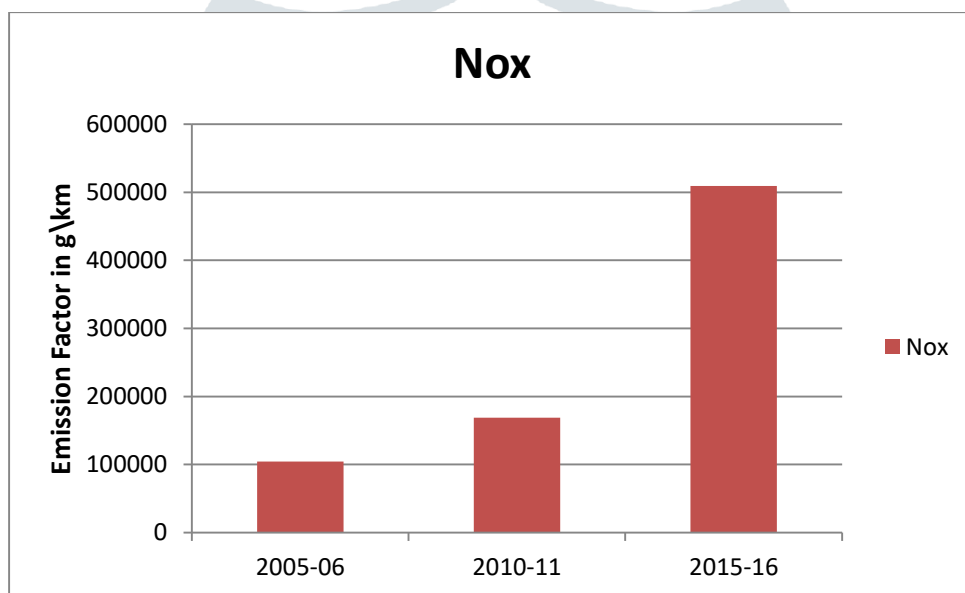
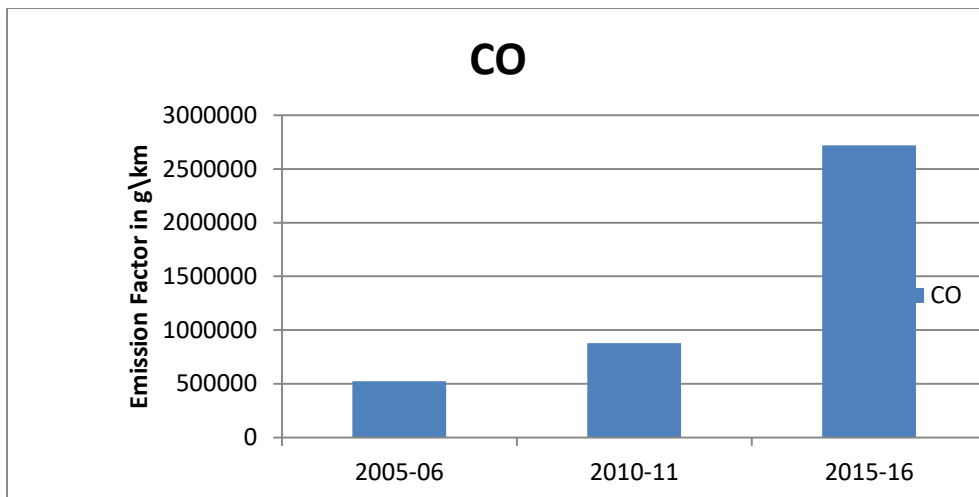
Vehicle Type	No. of Vehicles	CO	NOx	HC	CO2	PM
Car & Jeep	238737	200539	21486.3	28648.4	41289564.15	1432.42
Two wheelers	1496497	2469220	404054	912863	37367530.09	52377.4
Buses	12388	49180.4	83866.8	3220.88	910641.88	13317.1
Total	1747622	2718939	509407.3	944732.5	79567736.12	67126.92

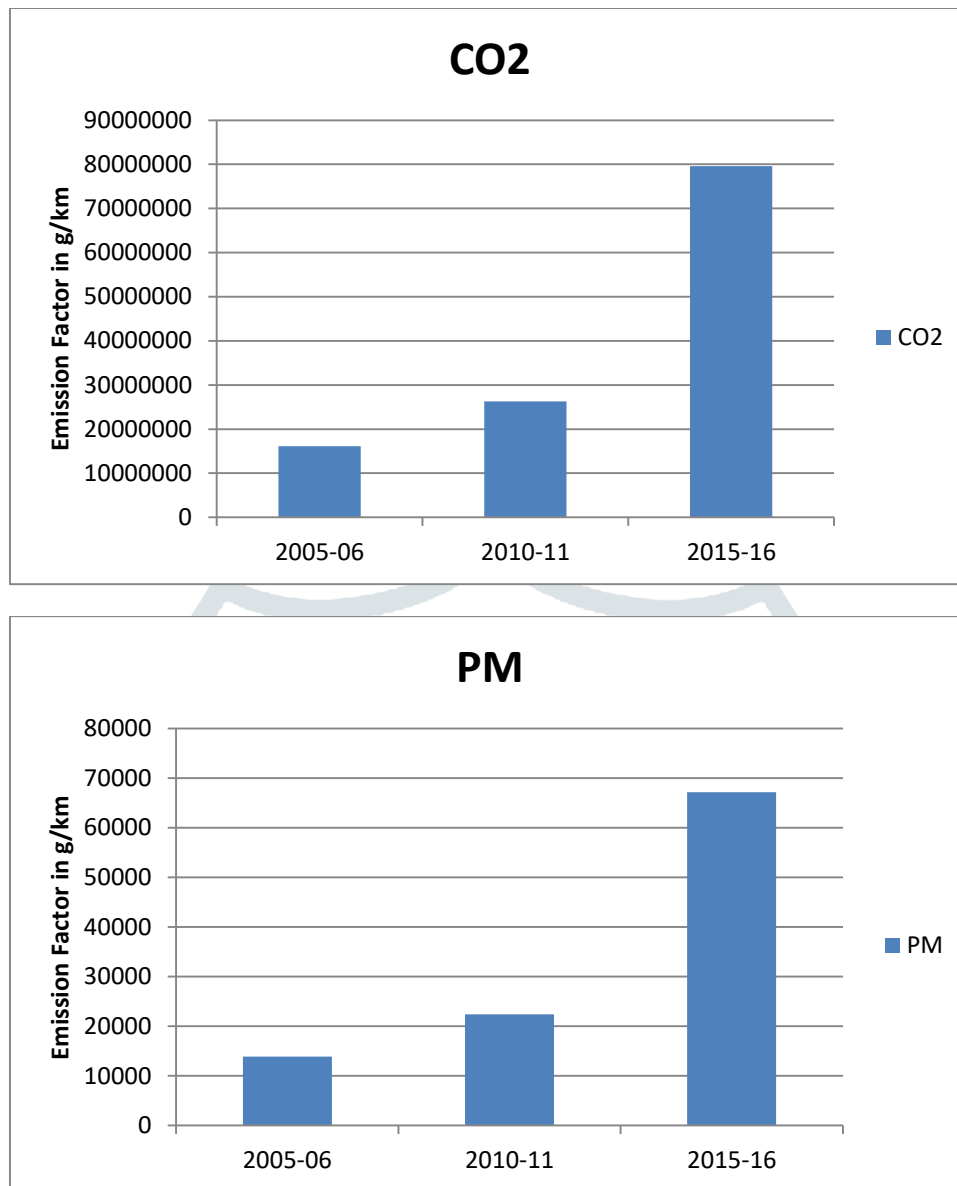
Table 5: Pollutants reduced in 2015-2016

TABLE 6 :SHOWS THE INCREASE IN REDUCTION IN CO, NOX, HC, CO2AND PM FROM 2005 TO 2016 IN TEN YEARS WITH THE INCREASE IN VEHICLES OFFLOAD DUE TO METRO.

	CO	NOx	HC	CO2	PM
2005-06	525296.75	104354.1	180457.93	16100927.69	13911.521
2010-11	877560.93	168945.6	303291.6	26280620.04	22383.921
2015-16	2718939.49	509407.3	944732.49	79567736.12	67126.917

Table 6 : Increase in reduction of different pollutants





All the above graphics representation shows that CO, NO_x, HC, CO₂ and PM are reduced to 5 times due to reduction of vehicles on the road as commuters have adopted the Delhi Metro as the mode of transportation.

VIII. RECOMMENDATIONS:

Delhi Metro is doing a good job in reducing pollution but with some more recommendations in area of transportation we can increase metro ridership.

- Banning of registration of luxury SUVs and diesel cars above 2000cc
- Odd-Even Rule to reduce traffic by allowing odd numbered vehicles on odd days respectively.
- Banning of the old diesel vehicles.
- Recently Noida Metro has planned to power up all of its new metro stations with solar energy. Similar measures can be adopted by the DMRC in all of its existing as well as new metro stations. Solar power can be used to run offices, stations and footbridges. Traditional power connection can be used as a supplement in case of any glitch.
- The rooftops of Metro stations can be used as rainwater harvesting pits which can provide water to the nearby localities.

- Most of the stations should be underground to avoid the problems of land acquisition.

In addition to above recommendations, there is a need for implementation of various other managements in order to save environment on a sustainable bases. In fact the containment of vehicular pollution because all integrated approached with following:

- i) Improvement of public transport system.
- ii) Optimization of traffic and improvement sensor automated (e.g. time rate inter session) in traffic control system, no traffic zone, green corridors, removal of encroachments on roads. Regulation for digging of road.
- iii) Phasing out of grossly polluting vehicles.
- iv) Tightening of emission norms (e.g., EURO-IV);
- v) Chilling evaporation emissions from storage flubs and fuel distribution system.

IX. CONCLUSION:

Delhi Metro runs on Electricity supplied by Hydro-Electric Projects and Thermal Power Plants (mostly). The pollution is therefore offset by polluting some other region than Delhi. The effect can be seen on the rainy day, when it is difficult for the commuters to move to the metro station. They prefer their own vehicles; this increases the pollution and traffic on the roads. But with some recommendations we can reduce more pollution.

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