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RESEARCH ARTICLE

EFFECT OF ODD EVEN SCHEME TO COMBAT AIR POLLUTION IN NCT OF DELHI.

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Abstract

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Introduction:-

Air pollution is a major environmental issue affecting people across the world. According to the World Health Organization (WHO), more than 2 million people worldwide die every year from air pollution. Of all the air pollutants, fine particulate matter (PM) is one of the most hazardous pollution for the human health. The particulate matter causes about 9% of lung cancer deaths worldwide, 5% of cardiopulmonary deaths and about 1% of respiratory infection deaths. There have been several studies done on assessment of ambient air quality and concentration of different pollutants of air (i.e. heavy metals, polycyclic aromatic hydrocarbons etc) in various regions of India. (Kaushik & Haritash, 2006; Haritash & Kaushik, 2007, Haritash & Kaushik, 2011). But the policy related interventions to improve air quality are still lacking in Indian context.

Air quality or ambient (outdoor) air pollution is represented by the annual mean concentration of particulate matter PM₁₀ (particles smaller than 10 microns) and PM_{2.5} (particles smaller than 2.5 microns, about 25 to 100 times thinner than a human hair). The environmental and health concerns related to PM₁ is more since the penetration of fine particles into the respiratory system is deeper and associated health effects are also severe (Haritash & Kaushik, 2012). Considering health effects of PM₁, SAFAR initiated monitoring of this pollutant in the air during second phase of Odd Even Scheme.

The Government of NCT of Delhi had implemented odd-even scheme aiming to reduce the pollution level in the city. The idea of this scheme came from the system that was implemented in Beijing in 2008 just before the summer Olympics. While the rule was initially said to be temporary, it turned out to be so effective the government made it

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permanent. Similar road-rationing rules are imposed in many places around the world like Paris, Mexico and Bogota to curb road jams and pollution.

The scheme has been performed in two phases. One from 1st to 15th January, 2016 and the second phase of the scheme was implemented between 15th to 30th April 2016 with the objective of reducing air pollution in Delhi. The odd-even scheme applied to four wheeler Passenger/Private Cars. The AAP cabinet announced private vehicles to run across the city based on their registration numbers. If a vehicle's registration number ends with an odd digit, it will be allowed on the road on January 1 that is on odd numbered days, while that ending with an even number can be driven on the second, and so on. This step has been taken as a measure to bring down and control air pollution.

Air-pollution levels in Delhi rose 15% during the 15-day period (January 1 to 15, 2016) of the state government's odd-even measure over the previous 15 days (December 17 to 31, 2015), according to an analysis of PM_{2.5} (particulate matter) data, generated by various studies.

Odd Even Scheme:-

The odd even scheme is one of the road rationing system also called as alternate-day travel is a travel demand management strategy aimed at reducing the negative obverse generated by urban air pollution or peak urban travel demand through artificially restricting demand (vehicle travel), especially during the peak periods or during peak pollution events. This objective is achieved by restricting traffic access into an urban area, city or district based upon the last digits of the license number on pre-established days and during certain periods, usually, the peak hours.

Delhi Government had imposed this scheme in two phases. Initially the scheme was implemented from 1st January 2016 to 15th January 2016 and the second phase had been in operation from 15th April to 30th April 2016. According to the notification issued by the government, from 8 am to 8 pm private vehicles with odd registration numbers will be allowed on the road on Mondays, Wednesdays and Fridays. Vehicles with even numbers will run on Tuesday, Thursday and Saturday. But on Sundays there was no as such restrictions.

This rule will not be applicable on emergency vehicles like PCR vans, fire tenders and ambulances, and on public transports like CNG-driven buses, taxis and auto-rickshaws.

The government also decided to exempt two-wheelers from this rule. This system, therefore, was applicable only on private-owned four wheelers running across Delhi, and on those coming in from other states. And that includes vehicles used by ministers and bureaucrats of all ranks.

To make the scheme work effectively the government has added the public transport will be strengthened from the first of January. This will include increasing the frequency of metro trains across the city.

Analysis of data:-

The air quality in Delhi is monitored through a set of Continuous Ambient Air Quality Monitoring System (CAAQMS) and manual stations (NAMP). The present analysis is based on the data collected by CPCB from 08 operational CAQMSs including 04 of its own (Shadipur, Dwarka, Dilshad Garden & Parivesh Bhawan) and 04 belonging to DPCC (Mandir Masg, R. K. Puram, Punjabi Bagh & Anand Vihar). Apart from this, data has also been collected from 07 manual stations of CPCB (Pitampura, Sirifort, Janakpuri, Nizamuddin, Shahzada Bagh, Shahdara & BSZ Marg) which operate on alternate days. The overall contribution of vehicular pollution in ambient air in Delhi during winter season is estimated to be around 20-25% in respect of PM₁₀ and PM_{2.5}. However, in terms of emission load, it contributes about 9% and 20% respectively for PM₁₀ and PM_{2.5}, as per IIT Kanpur study, of which the 4-wheeler passenger cars contribute about 10%. The odd-even scheme could have theoretically contributed to PM reductions in respect of exhaust emissions from off-road odd or even cars, marginal reduction in road dust and secondary pollutants.

The pollutants for which data have been considered for the above said assessment include PM₁₀, PM_{2.5}, SO₂, Benzene, O₃, NO₂ and CO. It may be seen that during January 1-15, 2016, the pollutants viz., PM₁₀ ranged between (161-629 µg/m³); PM_{2.5} (79 – 507 µg/m³); SO₂ (4-42 µg/m³); Benzene (1-11 µg/m³); O₃ (2-66 µg/m³); NO₂ (9-159 µg/m³) and CO (280 – 1990 µg/m³).

The data analyses for days preceding (period from 25th to 31st December, 2015) and post (period from 16th to 21st January, 2016) to the odd-even scheme, shows that during pre-odd-even scheme December 25-31, 2015; the

pollutants viz., PM₁₀ ranged between (142-454 µg/m³); PM_{2.5} (52-298 µg/m³);SO₂ (4-31 µg/m³); Benzene (1-7 µg/m³); O₃ (18-48 µg/m³); NO₂ (5-116 µg/m³)and CO (114 – 1244 µg/m³); while during post odd-even scheme, January 16-21, 2016; the pollutants viz., PM_{2.5} ranged between (76-342 µg/m³); SO₂ (4-13µg/m³); Benzene (1-7 µg/m³) O₃(13-34 µg/m³); NO₂ (17-47 µg/m³) and CO(278 – 1316 µg/m³).With no clear trend and wide fluctuations observed in the concentrations, it is evident that the meteorology and emissions from other polluting sources have been major factors impacting air quality of Delhi during the period. Higher wind speeds and mixing height in general result in better dispersion and lower pollution levels. Overall, it can be stated that while some reduction in air pollution is likely to happen due to odd-even scheme, a single factor or action cannot substantially reduce air pollution levels in Delhi. Therefore, a comprehensive set of actions following an integrated approach is required to make substantial improvement in air quality.

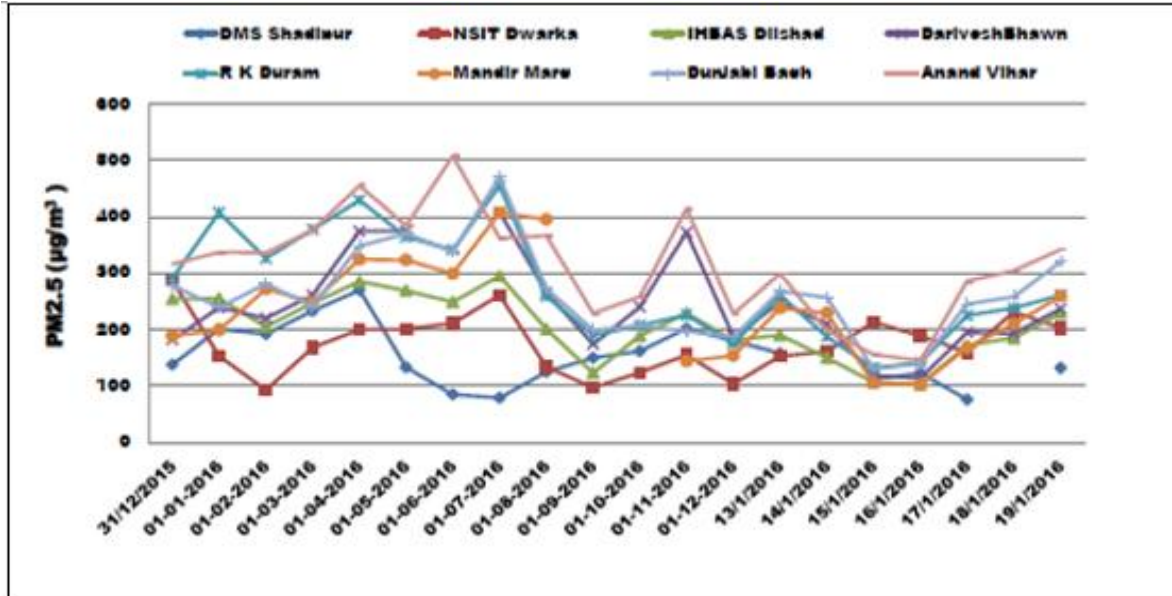


Fig 1:- Daily average PM_{2.5} values comparison at different stations Across Delhi

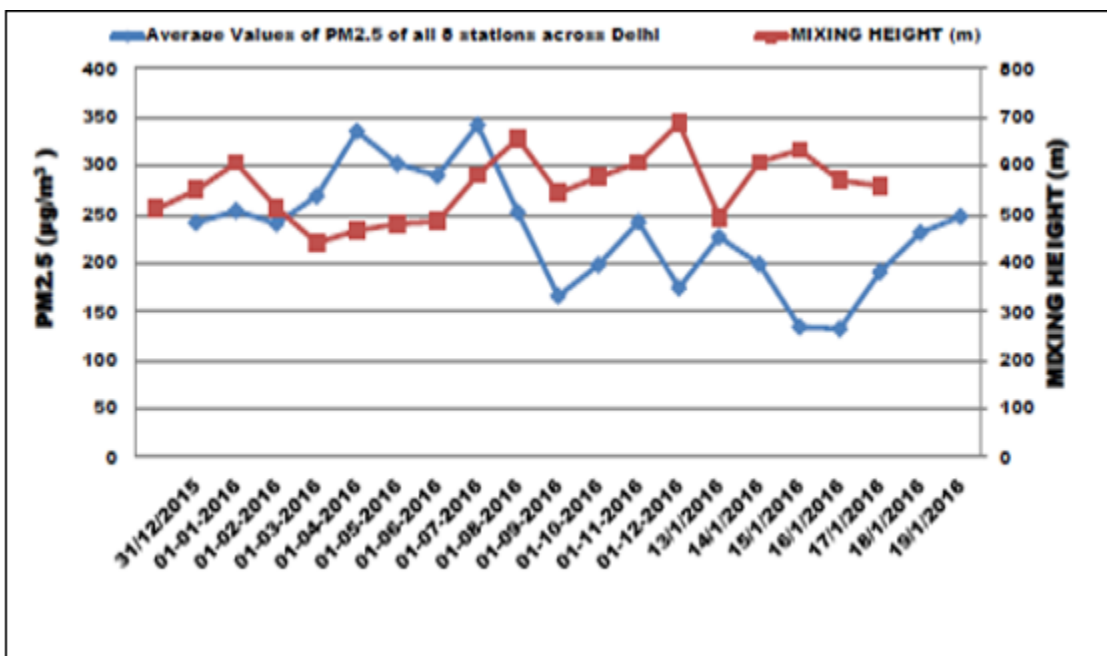


Fig 2:- Correlation of daily average PM_{2.5} values with mixing height

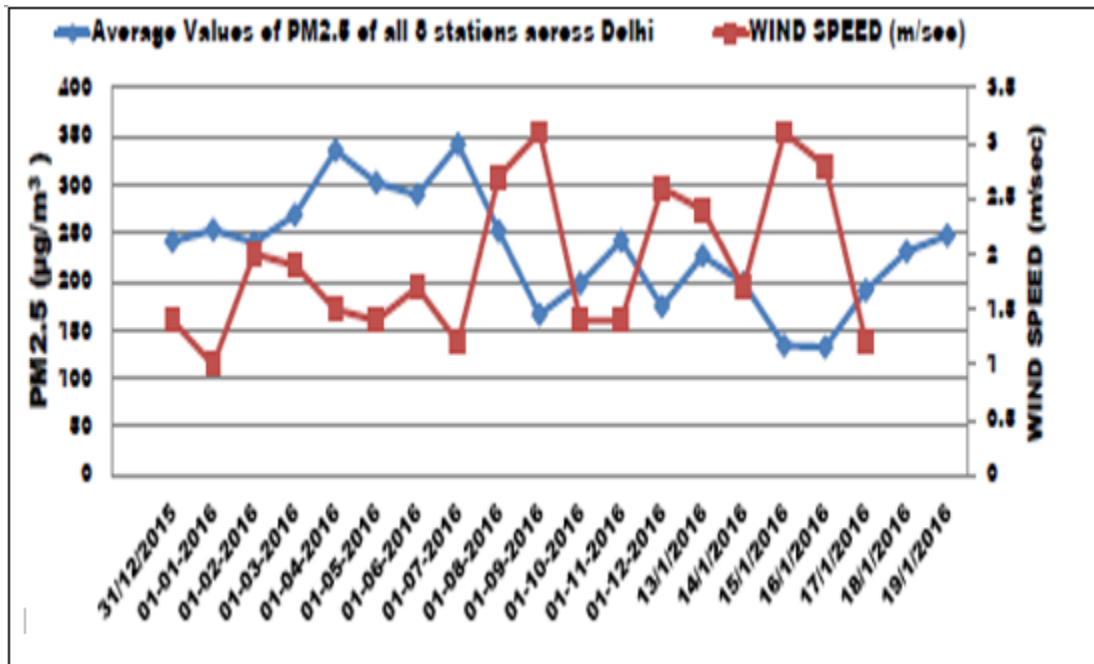


Fig 3:- Correlation of PM_{2.5} with wind speed

Table 1:- Daily average concentration (µg/m³) of air pollutants in Delhi during the study

(CAAQM Stations)

Stations (CPCB Stns.)	Parameters	Pre Odd Even Scheme (25-31 December 2015)						During Odd Even Scheme (01-15 January 2016)						Post Odd Even Scheme (01-15 January 2016)					
		PM 2.5	CO	NO ₂	O ₃	Benzene	SO ₂	PM 2.5	CO	NO ₂	NO _x	Benzene	SO ₂	PM 2.5	CO	NO ₂	O ₃	Benzene	SO ₂
Shadiour	Max	141	1244	72	48	3	31	220	1990	126	45	8	26	165	604	47	34	4	13
	Min	65	114	35	34	1	22	73	280	14	2	1	7	76	270	20	13	1	7
Dwarka	Max	298	693	12	40	7	28	261	1061	33	66	11	8	235	675	28	32	7	7
	Min	52	484	3	18	3	8	93	438	9	4	2	3	160	502	17	13	3	4
Dilshad Garden	Max	221	1006	71	NA	NA	19	295	1610	140	NA	NA	12	229	1316	44	NA	NA	8
	Min	85	321	51	-	-	7	107	321	29	-	-	6	102	363	27	-	-	7
Parivesh Bahwan	Max	NA	NA	NA	NA	NA	NA	400	NA	NA	NA	NA	NA	237	NA	NA	NA	NA	NA
	Min	-	-	-	-	-	NA	119	-	-	-	-	-	114	-	-	-	-	-

Table 2:- Daily average concentration ($\mu\text{g}/\text{m}^3$) of air pollutants in Delhi during the study
(Manual Monitoring Stations in Delhi)

Manual Stations (CPCB Stns.)	Parameters & Data Range	Pre Odd Even Scheme (25-31 December 2015)				During Odd Even Scheme (01-15 January 2016)			
		PM 10	PM 2.5	NO ₂	SO ₂	PM 10	PM 2.5	NO ₂	SO ₂
Pitampura	Max	420	NA	44	9	541	429	98	17
	Min	142	NA	43	5	207	116	15	4
Sirifort	Max	Data Inadequate				548	286	98	39
	Min	Data Inadequate				301	168	33	4
Janakpuri	Max	Data Inadequate				614	259	97	34
	Min	Data Inadequate				367	102	24	4
Nizamuddin	Max	270	NA	71	30	294	185	81	11
	Min	253	NA	51	13	161	84	31	4
Shazada Bagh	Max	309	233	93	17	607	166	93	15
	Min	301	193	52	5	172	81	50	4
Shahdara	Max	Data Inadequate				629	231	106	42
	Min	Data Inadequate				217	82	26	4
BSZ-Marg	Max	454	-	116	4	516	-	159	17
	Min	254	-	77	4	169	-	64	4

Another analysis done by **System of Air Quality and Whether Forecasting and Research** (SAFAR) also showed a similar trend in air quality status of Delhi.

The pollutants for which data have been considered for the above said assessment include PM₁₀, PM_{2.5}, SO₂, Benzene, O₃, NO₂ and CO of which ozone, PM₁₀ and PM_{2.5} is the major one. It also monitored the finer PM₁ particles, or particles of size less than 1 micron, which are known to penetrate deep into the lung tissues and the cardiovascular tract.

Ozone:

The levels of ozone, which scientists describe as the most critical summer pollutant in Delhi, between April 15 and 30, peaked at 88 parts per billion or 176 micrograms per cubic metre ($\mu\text{g}/\text{m}^3$) on April 30, the last day of the odd-even scheme, according to SAFAR data. In comparison, during April 1-15, the levels peaked at around 60 parts per billion or 120 $\mu\text{g}/\text{m}^3$ on April 6.

On April 24, ozone levels hit 75 parts per billion or 150 $\mu\text{g}/\text{m}^3$, the first sharp rise seen during the scheme, from around 62 parts per billion or 124 $\mu\text{g}/\text{m}^3$ the preceding day. Between April 19-22 ozone levels remained around 51-52 parts per billion or 102-104 $\mu\text{g}/\text{m}^3$. According to scientists, the level of the pollutant spiked consistently between April 17 and 19, ranging between 75 and 80 $\mu\text{g}/\text{m}^3$. An initial dip was reported between April 15-17.

Comparing this with data from April last year, the trends are quite similar, according to scientists. On April 24 last year, ozone levels had peaked at 90 parts per billion or 180 $\mu\text{g}/\text{m}^3$, the highest between April 15-30. Between April 1-15 last year, a peak of around 70 parts per billion or 140 $\mu\text{g}/\text{m}^3$ was observed in ozone levels on April 5, the highest during the first fortnight of the month. This year, the peak was observed on April 6.

PM₁

Between April 15-30, the data shows, PM₁ levels peaked on April 30 at around 78 $\mu\text{g}/\text{m}^3$. After recording less than 60 $\mu\text{g}/\text{m}^3$, till April 23 which is the safe limit for the larger PM_{2.5} particles, the PM₁ levels escalated between April 25-28 at around 75 $\mu\text{g}/\text{m}^3$. After dropping to 60 $\mu\text{g}/\text{m}^3$ again on April 29, the levels shot up on the last day of the scheme. "The safe limits for PM₁ are not defined as yet in India. But considering that these are finer than PM_{2.5} and they can penetrate deeper into the respiratory and cardiac organs, the safe limits should be far lower," a studied. In comparison, between April 1-15, PM₁ levels peaked at around 70 $\mu\text{g}/\text{m}^3$ on April 3. Three peaks of around 60 $\mu\text{g}/\text{m}^3$ each were observed on April 4, 7 and 9, before the levels dropped to between 30 and 40 $\mu\text{g}/\text{m}^3$ till April 14. On April 15, levels again hit 60 $\mu\text{g}/\text{m}^3$. PM₁ levels were not being monitored last year.

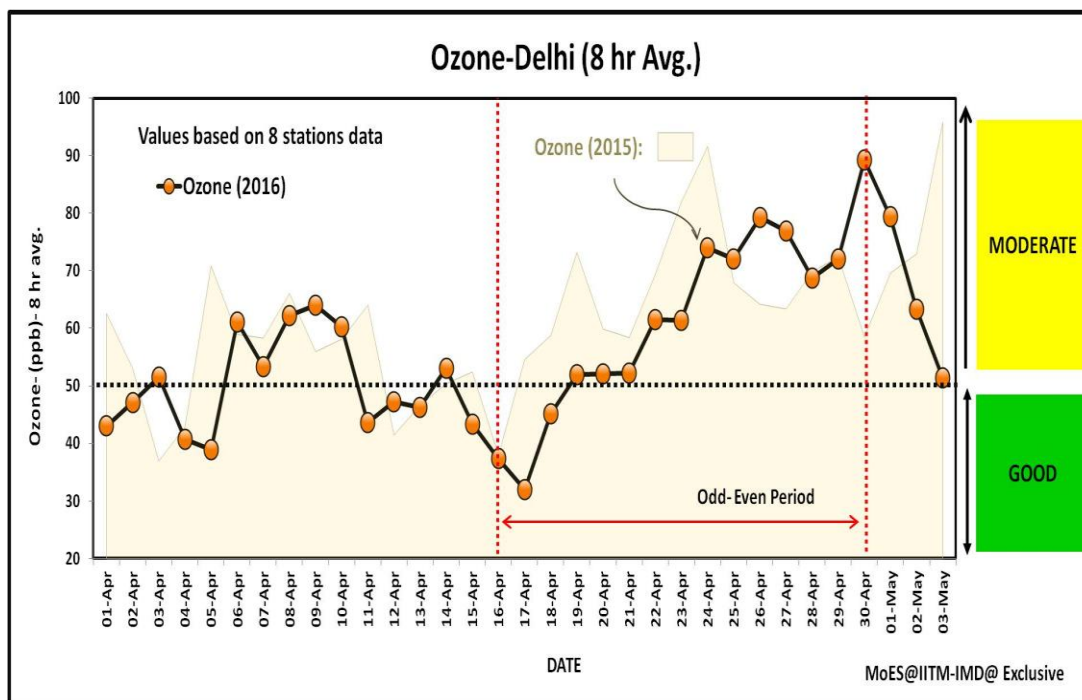


Fig 4:- Average Ozone levels in Delhi (8hr)

Conclusions:-

The Government of NCT of Delhi has implemented Odd Even Scheme with aim to reduce air pollution level in the city. Data from either the DPCC or the CPCB has not shown any improvement in air quality. Similar trends can be observed from data from the Indian Institute of Tropical Meteorology's SAFAR, which showed that the quality of air continuously deteriorated from December 25, with pollution levels being "severe" on four out of the first eight days of January, worse than the previous week. It is concluded that the scheme did not worsen air quality; meteorological conditions did, but the scheme was not able to mitigate this impact. For one, wind, which disperses pollutants, has fallen consistently in speed since December. On the other hand, higher temperatures in this year as compared to the same time last year, usually improve air quality by dispersing pollutants in the atmosphere, but the concentration level of particulate matter in January 2016 is twice as much as it was during January 2015. It is quite clear from data about sources of air pollution in Delhi that cars are not the major polluters. The draft report of the Indian Institute of Technology, Kanpur, which was commissioned by the Delhi Government in 2013, on the sources of particulate matter found that vehicles contribute to 20 percent of $PM_{2.5}$ concentration. Among them, trucks and two-wheelers together contribute to 80% of pollution and cars contribute 10% only. This means that the contribution of four-wheelers to air pollution in Delhi is just 2%. On a given day, when half the cars are taken off the road during the odd-even trail, with additional exemptions, only a 0.5-1% reduction in pollution can be expected. This could be marginally higher depending on the impact of the wind.

In Delhi, the transport, industrial and the domestic sectors were also considered as the major contributors towards the rising ambient air pollution levels, in addition to the presence of natural dust due to meteorological conditions. Besides anthropogenic sources, some other factors that contribute in the buildup of pollution levels are climate and natural sources. Delhi has a semi-arid climate, with an extremely hot summer, average rainfall and very cold winters. Mean monthly temperatures range from 14.3 °C in January (minimum 3 °C) to 34.5 °C in June (maximum 47 °C). Dust storms occur frequently during summer months leading to build-up of particulate matter in the atmosphere. It is concluded that two-wheelers along with many other environmental factors are responsible for more PM_{10} and $PM_{2.5}$ than cars when it comes to polluting the air.

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