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Research Article

THE ODD EVEN EXPERIMENT IN DELHI

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A R T I C L E I N F O

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A B S T R A C T

Delhi, the capital of India is always in the limelight, be it anything food, history, monuments, politics, crime, etc. Since last few years the capital is always in the headlines because of its poor air quality. Delhi is among the world's most polluted cities. Nowadays people are talking more about the air pollution in the city as compared to its culture and heritage. As a result of this the Delhi government took an initiative to clean up the cities air by bringing out the Odd-Even Rule.

According to this rule, all the private vehicles (including all two-wheelers and four-wheelers) were only allowed to run on the roads of Delhi according to their enrollment numbers. The odd- even rule was implemented twice in Delhi once during winter's (1st - 15th January, 2016) and once in summer's (15th -30th April, 2016).

In this study the two phases of the odd-even rule are studied, compared and evaluated thoroughly. Results show that odd-even is not a long run strategy to be used for pollution control. It can be helpful for a shorter duration by reducing congestion, traffic jams, diverting people to use public transport but cannot clean the capital's air.

INTRODUCTION

Air pollution can be defined as the presence of any kind of substance in the air that deteriorates its quality and changes its chemical composition (Boubel *et al*. 2013). There are various pollutants such as oxides of sulfur and nitrogen, particulate matters, ozone, hydrocarbons, etc. that are present in the air of Delhi. Among these the one that cause major problem are oxides of sulfur and nitrogen (SO2 and NO2) and particulate matter (PM 10 and PM 2.5). The sources of nitrogen oxide include kindling of fossil fuels from immovable sources such as heating, power station, etc. and motor vehicles. Particulate matter are produced from gases (majorly released from vehicles), smallest of which are formed by nucleation resulting from chemical reactions that form new particles (Brunekreef *et al*. 2002).

Overpopulation, different economic activities and increase in no. of vehicles are reasons behind the rising level of air pollution in large cities of developing countries (Atash *et al*. 2001). It had been identified long ago that vehicular emissions were the major cause in polluting the air of Delhi and strategies such as use of CNG as an alternative fuel in vehicles has been implemented long back. But the major role of vehicular emission in air pollution came into limelight when the Delhi government announced the odd-even scheme for controlling air pollution in Delhi on December 4, 2015. Some important aspects of this new measure to combat Delhi's pollution are summarized in table 1.

Table 1 Summarizes various aspects of the Odd-Even rule

Sr. No.	Feature	Description
1.	Phases	2 (winter and summer)
2.	Dates	Phase 1 : January 1-15, 2016 and Phase 2: April 15-30,2016
3.	Timings (rule applicability)	8:00am-8:00pm every day of the week except for Sunday
4.	Limitations	The rule was applicable only on Private vehicles and also not on the vehicles registered outside Delhi.
5.	Exemptions	Vehicles carrying women and children, CNG vehicles, Emergency Vehicles (Ambulance, Fire brigade, etc.), Vehicles of President, Vice-President, Chief Justice of India, Prime Minister, Lokayukta, LokSabha Speaker, Leaders of opposition parties in LokSabha and RajyaSabha, Deputy chairman of RajyaSabha and Deputy Speaker of LokSabha, Chief Ministers of all the states and union territories,Judges of Supreme Court and Delhi Courts. Vehicles driven or occupied by handicapped person, Enforcement Vehicles (Police, Paramilitary forces, etc.). Vehicles bearing ministry of Defense no. plates, Embassy vehicles bearing CD numbers, Vehicles carrying pilots/escorts, Vehicles of SPG protectees. Vehicles of Chairperson, Union Public Service Commission, vehicles of Election Commissioners and vehicles of Controller Auditor General of India. Vehicles of State Election Commission, Delhi & Chandigarh and vehicles deployed by the commission with Election Observers/ Returning Officers/ Assistant Returning Officers and security vehicles.
6.	Fine	Rs. 2000/- for breaking the rule.
7.	Effect on Public Transport	3,000 extra buses ran on the roads, 198 more metro trains were run to make an additional 365 trips a day, the cabs Ola, Uber introduced carpooling services, share ride services, etc.

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MATERIALS AND METHODS

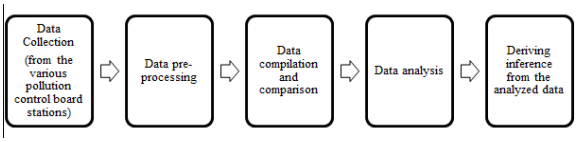

Figure 1 Illustrates the flowchart of the work

The data collection involves measurement of notified parameters in ambient air which includes sulphur dioxide (SO2), nitrogen dioxide (NO2), and particulate matter (PM 10 and PM 2.5) in ambient air. All these pollutants are measured using different methods and procedures.

Sulfur dioxide (SO2) amount in the surrounding air is determined using the changed West and Gaeke strategy. SO2 in the air is caught up in combination of 0.04M sodium tetrachloromercurate at a normal stream rate of 1 liter for every moment (LPM), leading to the formation of dischlorosulphitomercurate complex. Fundamental obstruction is due to the oxides of nitrogen, ozone and trace metals. Impedance from NO2 can be avoided using sulphamic acid, which goes about as a diminishing specialist and changes over a portion of the oxygenated nitrogen species to nitrogen gas. Intervention from ozone can be wiped out by conditioning the specimen before investigation. Intrusion from trace metals can be counteracted through EDTA (disodium salt) to the unexposed absorbing solution (Salem *et al*. 2009).

Nitrogen dioxide in the air is caught up in a mixture of sodium hydroxide and sodium arsenite. SO2 is the main impinging compound. The impedance of SO2 is removed of by transforming it to sulphuric acid via expansion of hydrogen peroxide (Merryman *et al*. 1973).

Respirable Suspended Particulate Matter [PM 10] is quantified gravimetrically using GFA/EPM 2000 filter paper via respirable clean sampler. In gravimetric strategy, air is drawn at a stream rate that is commonly 1.1 m3/min by a size-specific channel in which the particulate issue is fractionated in two streamlined breadth measure ranges, 0-10 smaller scale meter called RSPM of PM10 or more 10 miniaturized scale meter called coarse division. PM10 is gathered on a 20.3 X 25.4 cm (8 X 10 in) channel. The weight of these particles is controlled through the distinction in channel weights before and in the wake of inspecting. The amount of PM10 is figured by isolating the weight pick up ofchannel through the volume of air tested (Shin *et al*. 2011).

The Particulate Matter in surrounding air (streamlined size <2.5 or in atmosphere, is estimated by an electrically fueled air sampler draws encompassing air at a consistent volumetric stream rate of 16.7 LMP (1 m3/h) kept up by a mass stream controller coupled to a chip into exceptionally outlined inertial molecule estimate separator (typhoons or impactors) where PM2.5 is isolated and gathered on a 47 mm poly-tetrafluoroethylene (PTFE) channel over a fixed sampling duration.

RESULT

This section contains three parts in the first section pre, post and during odd-even phase 1 result is discussed. Section two comprises of the result of phase 2 and further a comparison between the two phases is done in the third section.The concentration of pollutants (NO2, SO2, PM10 and PM2.5) pre, post and during Odd-Even Phases (both 1 and 2) is calculated and determined from the available data for eight different stations (Punjabi Bagh, AnandVihar, East Arjun Nagar, MandirMarg, IHBAS, NSIT Dwarka, R.K. Puram and Shadipur) of the pollution control boards.

Section I

Comprises odd-even phase I result. The figure 2[A], [B], [C] illustrate the pre, during and post odd-even phase I concentration of different pollutants present in the air. According to these results nothing can be concluded in terms of decrease in the levels of pollutants because it was observed that in some stations the level of a certain pollutant went down while on the other station the level of some other pollutant elevated as in case of AnandVihar and Mandir Marg. When comparing with the pre data the level of PM 10 went down during the odd-even in AnandVihar whereas its level elevated in Mandir Marg. Similarly SO2 levels increased in AnandVihar during the phase I whereas they decreased significantly in Mandir Marg. Hence, no clear demarcation or conclusion can be made about the level of pollution in Delhi during the odd-even phase I.

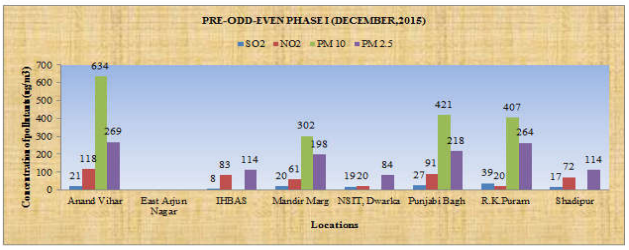

Figure 2[A]: Depicts Pre-Odd-Even Phase I concentration of pollutants

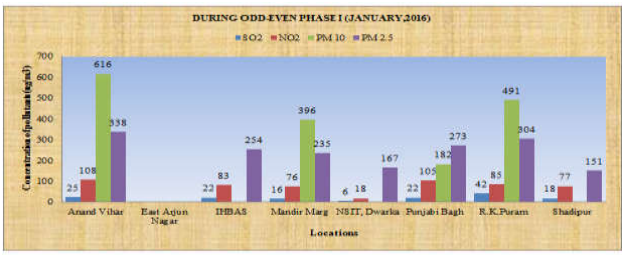

Figure 2[B]: Depicts During Odd-Even Phase I concentration of pollutants

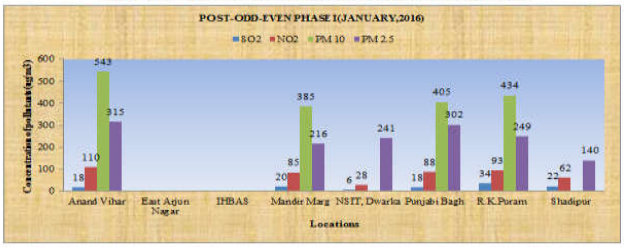

Figure 2[C]: Depicts Post- Odd-Even Phase I concentration of pollutants

Figure 2 [A], [B], [C]: Illustrates the pre, during and postoddeven phase I concentration of different pollutants

Section II

After the phase I of odd-even scheme the government could not come to a conclusion that is the technique good or not whether it was successful in reducing air pollution or not because based on data for 15 days nothing could be concluded so the government decided to bring the rule in Delhi again for the second time in the month of April. It was commonly known as *"**ODD-EVEN DUBARA**"*.Similar kind of results were obtained wherein nothing can be concluded because the level of one pollutant decreased at a particular station and at the same time there was an elevation in the levels of another

pollutant. Clearly this is depicted at the IHBAS station where the levels of SO2 increased during the odd-even phase and on the other hand the levels of PM 2.5 decreased by certain levels. Hence there is a lot of ambiguity regarding this scheme.

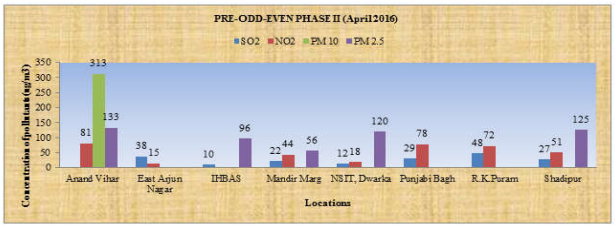

Figure 3[A]: Depicts Pre- Odd-Even Phase II concentration of pollutants

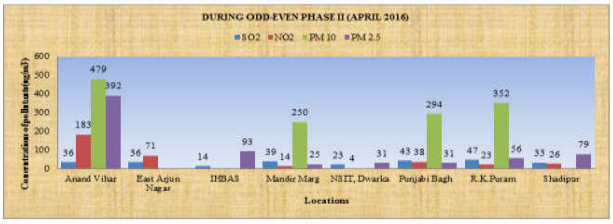

Figure 3[B]: Depicts during Odd-Even Phase II concentration of pollutants

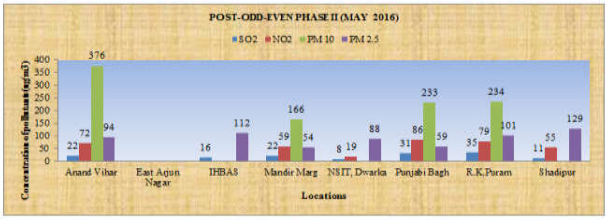

Figure 3[C]: Depicts Post- Odd-Even Phase II concentration of pollutants

Figure 3 [A], [B], [C]: Illustrates the pre, during and post odd-even phase II concentration of different pollutants

Section III

In the following section we have compared both phases of the odd-even rule implemented in Delhi. This comparison is made on the basis of the concentration of the levels four pollutants SO2, NO2, PM10 and PM 2.5. According to the figure 4[A] it is clear that the levels of SO2 increased during the phase II of the scheme. The figure 4[B] shows that the levels of NO2 decreased significantly during the phase II of the scheme at all the stations except for AnandVihar. This again gives rise to ambiguity and lack of inference that which phase of the scheme is better. Again figure 4[C] and [D] illustrate the levels of the Particulate Matter that went down during the second phase of the scheme.

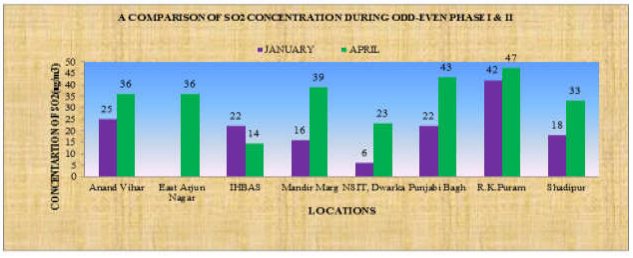

Figure 4[A]: Compares the concentration of SO2 in air during both the phases

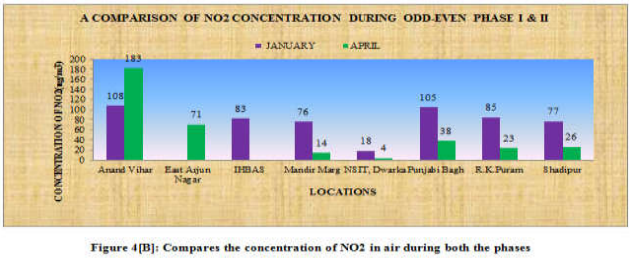

Figure 4[B]: Compares the concentration of NO2 in air during both the phases

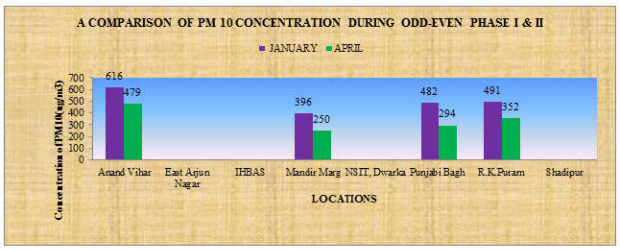

Figure 4[C]: Compares the concentration of PM 10 in air during both the phases

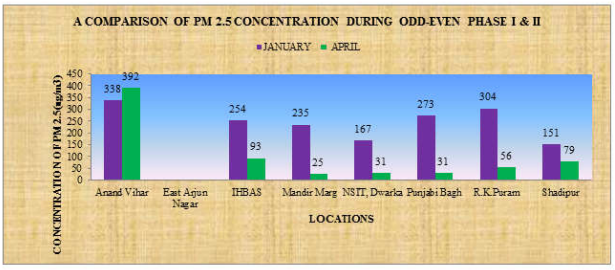

Figure 4[D]: Compares the concentration of PM 2.5 in air during both the phases

Figure 4 [A], [B], [C], [D]: Compare the levels of different pollutants during phase I & II of the odd-even scheme

DISCUSSION

There is lot of confusion when it comes to odd-even. Few people say the scheme was successful but the others say it's not and actually it's not because there is no clarity when it comes to evaluation of the results after data analysis. With slight variations in the pollutant levels we cannot determine the success of the scheme. When it comes to air pollution slight variations do not create any difference there should be significantly identifiable change.

The climatic conditions during the phase I supported it and made it appear to be successful in front of the eyes of few but actually it was not due to this scheme. It was the climatic conditions that were favorable at that time. It was during the winters when due to thermal inversion the pollutants remain close to the surface of Earth because the air does not rises up so there is no air mixing at that time. This was the main reason not the odd-even rule because of which the pollutants levels were less during the scheme. Secondly the schools were not functional at that time, vacations were going on. Due to this there were no schools buses or vehicles carrying the school children on the roads of Delhi. Hence the illusion that the reduction was due to odd-even is completely wrong.

When it comes to the second phase the climatic conditions were different during it. Even the schools were functional at that time. April also observed external factors such as crop burning and forest fires in Uttrakhand and Haryana which indirectly affected the air quality. Even the number of vehicles running on the roads of Delhi increased during the phase II which included private vehicles, carpool, CNG vehicles, increased no. of cabs and other public transports. Also a lot of ongoing construction activities were observed in Delhi.

As a whole when we look at the scheme it was a complete failure. There are numerous reasons for this including the number of exemptions that were given, the timing of the scheme what about the pollution levels before 8 in the morning and after 8 at night and the most important reason for the failure was lack of awareness, understanding and responsibility among the people. Irrespective of the rule going on they

brought their vehicles on the roads [***On the very first day of odd-even 1300 people were fined***]. Some people even brought new vehicles so that they can go on the roads on both odd and even day. Some people got new number plates also one for odd day and other for even. One more major reason was that it was implemented only in Delhi not in the surrounding National Capital Regions such as Gurgaon, Noida, Ghaziabad, Faridabad and Muzzafarnagar surrounding Delhi. Vehicles were still running there and pollution was still there and no one can stop the polluted air from these areas to come to Delhi.

CONCLUSION

The odd-even investigation in January was the trying of a fleeting administrative arrangement. Like any other test, it also gave incomplete experiences into the air contamination be wilder. It was also a test of the people of Delhi resolve to do something about it. The second analysis in April had little effect on clog amid peak hours. Evidently, people acquired more autos, utilized more cabs and some even changed over to CNG. Lessening in clog, despite the fact that air contamination stays at a similar level, decreases individuals' introduction.

It is difficult to evaluate the effect of odd-even on contamination levels as one also needs to factor in changes in wind speed, wind bearing, outflows by neighboring territories, fires, and so on. Starting there of view, one can't survey the second odd-even investigation. It may at present be viewed as beneficial as it demonstrated that individuals will make protective move and this may not be the answer for Delhi's contamination issue.

Tidying up the Capital's air requires both short and long term solutions. Regularly, the control of various here and now arrangements lies with the Delhi government, while long term arrangements require the Central government to act.

Odd-even can't be a long term solution for the NCR as the quantity of vehicles in Delhi alone, not including the NCR area, is expanding at about 6 lakhs for every year in Delhi alone, of which somewhere in the range of 35 for every penny are autos. Odd-even may have taken out at most 30 for every penny of the autos of Delhi's 28 lakh autos as autos out and about continue expanding and inside two or three years, even with odd-even, the autos out and about would increment. To lessen contamination, we require cleaner autos and considerably more noteworthy utilization of open transport, strolling, cycling and change in the nature of open transport. The arrangement lies in a more far reaching transport technique and managing different wellsprings of contamination. It requires activities by Delhi government, as well as by legislatures of the encompassing states and in addition by the Central government.

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