Impact of Covid-19 on Air Quality Index in Mumbai City

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ABSTRACT

Air pollution has been a widespread and visible concern, that has increased significantly over the last decade across many parts of Mumbai with severe consequences for human health and well-being. The Indian government and many other countries responded to the COVID-19 pandemic by enforcing a variety of restrictions on normal activity. A beneficial short-term effect on the natural environment across Mumbai was a significant reduction in air pollution. The pandemic and its management, have brought home the interconnectedness between nature and human existence. This study empirically examines the impact of imposing a 21-day lockdown on air pollution in Mumbai by comparing pollutant concentration data from 7 Air Quality Index stations in Mumbai. Over Pre Lockdown, during lockdown & post lockdown period. The study indicates that there was substantial variation in pollutant concentration, PM10 [Min(-17.17%)-Max-49.44%] ,PM2.5[Min (-307.8%)-Max-(43.76)%], NOx[Min (-93.37)%-Max-(83.63)%] and CO[Min(-4.76%)-Max-100%]. This provides an opportunity to understand the maximum extent to which air pollution could potentially be reduced in those areas in Mumbai City.

***Key Words**: Covid-19, Corona Virus, Impact,Air quality index, Mumbai city.*

INTRODUCTION

In December 2019, a Novel infectious coronavirus disease (COVID-19) was identified in Wuhan, China which was later confirmed to be transmitted human to human through respiratory droplets (WHO, 2020).[1] On 30th January, the first confirmed case of COVID-19 in India was found. As well as in Mumbai the 1st case found on the 11th March 2020, [2] As of 23rd March 2020, the number of COVID-19 cases increased to 499 in India [3], which was still very less than many other countries like the US, Italy, and China. Mumbai is Rank 1 populated country in India which has a population of around 12,442,373. So, the chances of the spread of Covid 19 in Mumbai are very high.

To prevent the spread of the COVID-19, the government of India imposed a nationwide lockdown from 24th March to 31st May. As a result, all non-essential services including schools, colleges, religious worship places, government offices, modes of transport (all types of trains, flights, and cabs), public utilities, and industrial activities were closed. Citizens were advised to remain at home and to maintain social distancing. The Lockdown is also strictly followed and implemented in Mumbai.

As Mumbai is one of the most populated city, Mumbai, Maharashtra is the entertainment, fashion, and commercial center of India. Mumbai is the second-largest economy in India [4].

It is the wealthiest Indian city with a net wealth of $1.950 trillion with 46000 millionaires and 56 billionaires [5]. Mumbai accounts for slightly more than 6.16% of India's economy contributing 10% of factory employment, 30% of income tax collections, 60% of customs duty collections, 20% of central excise tax collections, 40% of foreign trade, and rupees 80,000 crores (US$20 billion) in corporate taxes to the Indian economy [6].

Mumbai is the world's 37th largest city by GDP [7]. Mumbai was ranked among the fastest cities in India for business startup in 2009 [8]. Mumbai has a GDP per capita of $5,328 [9]. Due to a large amount of industrialization, the emission of toxic gases and waste also increased. Therefore In 2018, Greenpeace India ranked Mumbai as the 37th most polluted city in India. Having analyzed data from 2013 to 2018 the Airpocalypse-IV report showed that for more than 52 days, the level of air pollution in Mumbai exceeded the safety standards of 60 micrograms per cubic meter (µg/m3) for the presence of PM10 particulate matter.

This number of 162 µg/m3 for 2018, is three times the suggested national ambient air quality safety standard and eight times the international standard (20 µg/m3) recommended by the World Health Organization (WHO). It seems that, like other major cities throughout the world, most of the pollution is caused by traffic and construction. 29 percent of the airborne particulate matter comes from road and construction dust. This is followed by power plants which add 20 percent to the PM levels. The main source of traffic contamination comes from heavy-duty vehicles which run on diesel.

Traffic congestion builds up due to delays caused by the construction and demolition of buildings within the city. As a direct result of these delays, the traffic often stands idle whilst waiting for the line to start moving again. All the while though, its engines are still running and pumping exhaust gases into the atmosphere. As a result of roads that are in bad condition, traffic moves at a slower speed and therefore stays within the city limits for longer than necessary.

It has been noticed that the areas within Mumbai which recorded the poorest AQI index have the largest number of registered vehicles. In 2019 the number of registered vehicles rose by 9.9 percent bring the total to approximately 3.5 million [10]. During the complete lockdown in India, roads were deserted without any vehicle except the emergency vehicles. The Government of India has further extended lockdown in some parts.

This paper aims to study the impact of a complete lockdown in Mumbai on air quality (PM10, PM2.5, NOx, and CO) during COVID-19 by comparing air quality parameters from Feb-March 2020 (Pre Lockdown Period) to March-April 2020 (Lockdown Period) and the Feb-March 2020 (Pre Lockdown Period) to Feb-March 2021 (Post Lockdown Period). Our results show a pronounced variation in PM10, PM2.5, NOx, and CO over seven different stations of AQI of Maharashtra Pollution Control Board (MPCB) located in Mumbai city, during the complete lockdown period (25 March –14 April 2020) and the Post Lockdown Period (Feb-March 2021).

DATA AND METHODS

Approach

We have considered seven major Air Quality Index stations of Maharashtra Pollution Control Board (MPCB) in Mumbai city for our study. The details of Air Quality Index stations of Maharashtra Pollution Control Board (MPCB) are given in Table 1.[11]

Table 1: Location of the Air Quality Index selected Stations of Maharashtra Pollution Control Board (MPCB) in Mumbai city.

Station Name	Latitude	Longitude
Bandra, Mumbai - MPCB	19.0627° N	72.8461° E
Chhatrapati Shivaji Intl. Airport (T2), Mumbai - MPCB	19.1008° N	72.8746° E
Colaba, Mumbai - MPCB	18.9100° N	72.8200° E
Kurla, Mumbai - MPCB	19.0863° N	72.8888° E
Powai, Mumbai - MPCB	19.1375° N	72.9151° E
Sion, Mumbai - MPCB	19.0418° N	72.8652° E
Worli, Mumbai - MPCB	18.9936° N	72.8128° E

The Maharashtra Pollution Control Board (MPCB)'s Air Quality Index monitoring stations are located in twenty-one different parts of Mumbai city, out of which seven stations data of AQI is selected by us. Bandra, Mumbai - MPCB(3.37 Million) [12], Chhatrapati Shivaji Intl. Airport (T2), Mumbai - MPCB (1.46 Million) [13], Colaba, Mumbai - MPCB (0.8 Million) [14], Kurla, Mumbai - MPCB (1.91 Million) [15], Powai, Mumbai - MPCB(2.06 Million) [16], Sion, Mumbai - MPCB(1.56 Million) [17] and Worli, Mumbai - MPCB(1.32 Million) [18]; in the bracket, the populations are given as per the latest census. The selected stations are located in the most populated areas of Mumbai. It covers around 61.65 percentage of the total population of Mumbai. We have studied variation in level of four primary air pollutants PM10, PM2.5 particulate matter with a particle size of 10-micron diameter and 2.5-micron diameter respectively, and NOx and CO Air Quality Index AQI. which are monitored by each respective Maharashtra Pollution Control Board (MPCB)'s Air Quality Index stations at five locations. Data are taken from the Central Pollution Control Board (MPCB) through the CPCB portal [19].

PM 10

Airborne particulate matter (PM) is a mixture of many chemical species. It is a complex mixture of solids and aerosols composed of small droplets of liquid, dry solid fragments, and solid cores with liquid coatings. His Particles very small in size, shape, and chemical composition, and may contain inorganic ions, metallic compounds, elemental carbon, organic compounds, and compounds from the earth's crust. Particles are defined by their diameter for air quality regulatory purposes. Particles with a diameter of 10 microns or less (PM10) are inhalable into the lungs and can induce adverse health effects. Fine particulate matter is defined as particles that are 2.5 microns or less in diameter (PM2.5). Therefore, PM2.5 comprises a portion of PM10 [20].

PM 2.5

PM2.5 is fine inhalable particles, with diameters that are generally 2.5 micrometers and smaller. These particles come in many sizes and shapes and can be made up of hundreds of different chemicals. Some are emitted directly from a source, such as construction sites, unpaved roads, fields, smokestacks, or fires. Most particles form in the atmosphere as a result of complex reactions of chemicals such as sulfur dioxide and nitrogen oxides, which are pollutants emitted from power plants, industries, and automobiles. Particulate matter contains

microscopic solids or liquid droplets that are so small that they can be inhaled and cause serious health problems. Particles less than 2.5 micrometers in diameter, also known as fine particles or PM2.5, pose the greatest health risk [21].

NOx

NOx is produced from the reaction of nitrogen and oxygen gases in the air during combustion, especially at high temperatures. In areas of high motor vehicle traffic, such as in large cities, the amount of nitrogen oxides emitted into the atmosphere as air pollution can be significant. NOx gases are formed whenever combustion occurs in the presence of nitrogen – e.g. in car engines; they are also produced naturally by lightning [22].

CO

A colorless, odorless, tasteless, and toxic air pollutant that is produced in the incomplete combustion of carbon-containing fuels, such as gasoline, natural gas, oil, coal, and wood. Around the 707,700 total Estimated Emissions by Sector for 2018 (units – tons/year). Out of which the largest amount around 527,250 tons are emitted by the transport emissions from the road, rail, aviation, and shipping [23]. Breathing the high concentrations of CO typical of a polluted environment leads to reduced oxygen (O2) transport by hemoglobin and has health effects that include headaches, increased risk of chest pain for persons with heart disease, and impaired reaction timing [24].

RESULTS AND DISCUSSION

Pre Lockdown Period to Lockdown Period

Bandra and Kurla, which generally witness high traffic congestion.Because the major industries and their headquarters located in this area. During the lockdown period, a supreme decline in transport pollution was noticed [25]. As the big hub of transportation, Mumbai Bandra Terminus also known as Vandre Terminus is a railway terminus in Bandra from where trains bound for Northern India and Western India are scheduled regularly are located in the Bandra area. Also, the Lokmanya Tilak Terminus is a railhead; and the biggest railway terminus in the Kurla suburb of Mumbai, India is located. The sudden reduction in the use of transportation, as well as the majority of a construction project like the underground metro project and the other construction work in the Bandra area, are the major source of the dust flow, which suddenly stops so the dust flow is also reduced. The concentration level of the NOx has reduced by 76.09% for the Bandra area, 79.90% for the Kurla area. The main source of the CO is vehicles. All most three million vehicles are in Mumbai city [26]. The 76.19% reduction in the concentration level of the pollutant CO; was observed in Chhatrapati Shivaji International Airport (T2), which is the highest. Colaba, Kurla, Sion, Bandra, and the Worli area have a reduction in concentration level is around 21.43%,38.10%,57.14%,50.88% respectively. Powai area, the increase in the concentration level of CO pollutant by 4.76%.

The concentration level of the pollutant PM10; is dropped by 53.71% in the Chhatrapati Shivaji International Airport (T2) area, which is the highest among all areas. All international and domestic flights are also closed from Chhatrapati Shivaji International Airport (T2), which is the only international airport in Mumbai this has a major contribution to the reduction in the concentration level of NOx and the PM2.5. Reduction in the concentration level of the PM10 level observed in the Worli, Sion, Colaba, and Kurla area are 32.48%, 44.63%, 46.58%, and 48.76%, respectively. Kurla area includes lots of new construction projects and small industries, factories, and big wholesale markets. The reduction in the concentration level is in the range of; 32-49% in these Four areas. As the lowest percentage

of reduction in the concentration level of the PM10 is almost 17-19%, noticed in the Bandra and Powai areas.

The highest reduction in the concentration level of PM2.5 is 43.76%, which is at Chhatrapati Shivaji International Airport (T2) area. In the Kurla, Colaba area, the reduction in the concentration level of the PM2.5 is observed around 38-40%, and in the Sion, Bandra area 29-31%. The concentration level of pollutant PM2.5; was noticed in the Powai, which is around 8.20%only, which is the lowest one. The reduction in the concentration level of PM2.5 was observed, as 5.80% in the Worli area, which is the lowest one.

The reduction in the concentration level of NOx is 76.09% in Bandra,78.26% in Colaba area, 77.13% in Sion,79.90% in Kurla, and highest at 83.63% in the Worli area, except the Powai and the Chhatrapati Shivaji International Airport (T2) where it is noticed, as 68.17% and 51.50%. The NOx pollutant emitted by the burning of the fule by the vehicles; as the Powai-Vikhroli, Senapati Bapat Marg, Saki Naka, Goregaon Bridge are the areas; where the most traffic in Mumbai City is spotted [27]. So the reduction range is between 80-86.5%.

The reading of pollutants in Figure 1 reflects the impact of complete lockdown in Mumbai, PM10, PM2.5, NOx, and CO concentrations during the Non-Lockdown Period (Feb-March 2020) and the Lockdown Period(March-April 2020) in 2020. It concludes that the concentration level of PM 10, PM2.5, NOx, CO before the lockdown was high. In comparison to the lockdown period at all the areas in Mumbai City.

Pre Lockdown Period to Post Lockdown Period

The 100% reduction in the concentration level of the CO is observed at the Bandra, Powai, and the Chhatrapati Shivaji International Airport (T2) area. At the Sion, Kurla, and Worli area, a reduction in the concentration level of the CO was observe;55%,38.10%,33.33% respectively. The lowest reduction; in the concentration level of the CO was 19.05% in the Colaba area. The concentration level of PM2.5 was increased in all the areas. The increase at the highest level among all the areas are observed at Kurla, is around 307.80%. The lowest was in the Colaba area, which is around 70.84%. As well as; 242.45%,221.62%,167.57%, 154.85% and 99.59% in the Worli,Powai,Sion,Bandra and at the Chhatrapati Shivaji International Airport (T2) area respectively. Reduction in the concentration level of NOx was observed, only at the only Worli area, around 14.05% only, and the highest increase at the Powai area,92.37%. Other parts increase in the concentration level of NOx was observed is 75.89%, 72.06%, and 15.61%; at the Colaba, Kurla, and the Chhatrapati Shivaji International Airport (T2) area respectively.

The concentration level of the PM10 was increased at Bandra and Powai area only; by 17.17% and 6.21%. The highest reduction in the concentration level of PM10 is at the Colaba area by 49.44%. It is 5.99%,2.56%, and 1.77% at the Worli, Chhatrapati Shivaji International Airport (T2), and the Kurla area respectively. The lowest reduction at the concentration level of the PM10 is at the Sion area, 096% only.

The reading of pollutants in Figure 1 reflects the impact of complete lockdown in Mumbai, PM10, PM2.5, NOx, and CO concentrations during the Pre Lockdown Period (Feb-March 2020) and the Post Lockdown Period(Feb-March 2021) in 2020-2021. It concludes that the

concentration level of PM 10, PM2.5, NOx, CO before the lockdown was high and low in some areas of Mumbai city.

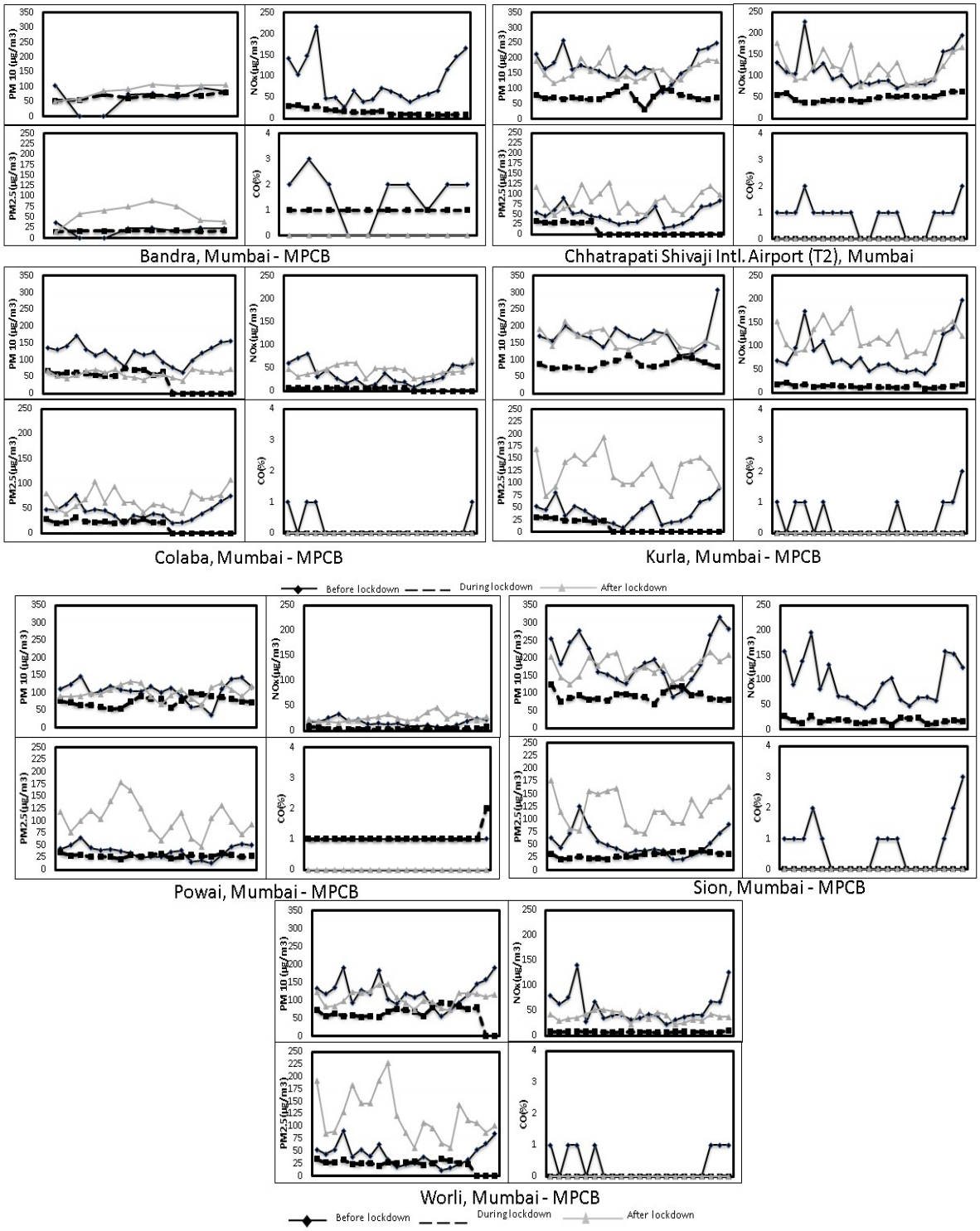

Fig. 1. Daily pollutant concentration levels and standards for Mumbai's Areas. Source: Authors' calculations based on data from CPCB, Feb-March 2020 [26] ;CPCB, March-April 2020 [27] and Feb-March 2021.[28]

***Note**: Information for some lockdown periods was not available for some stations; therefore they are not considering; Time-weighted average standards for PM10, PM2.5, and NOx are for 24-hour and annual durations; CO standards are for 8-hour durations.*

CONCLUSION

The results showed that the COVID-19 lockdown was highly beneficial in reducing in all the areas of Mumbai City, one of the most polluted cities in India, in a relatively short period. The AQI has markedly improved the Pre Lockdown Period compared with that Lockdown Period in the corresponding month in 2020 and the Pre Lockdown Period to the Post Lockdown Period in 2020-2021. In addition to ambient air quality, positive outcomes in the PM10, PM2.5, NOx, and CO values were observed. Our results provide strong evidence for a correlation between the COVID-19 lockdown and improvement in AQI parameters in Mumbai City. It is also concluded from our results that after ending the complete lockdown, as well as the life become come to somehow normal, again the pollution level is increased significantly. In many areas it increases very highly, We acknowledge that this analysis requires further investigation owing to the lack of data available for all metropolitan cities in India. If this lockdown continues for a longer period, the beneficial impact in India may be overshadowed by other emerging factors such as household pollution, increasing incidences of domestic violence, suicides, mental health concerns in adults and children, and rising food insecurity among the unemployed.

Conflict of Interest: There is no conflict of interest

REFERENCES

1) Sonal Kumari, Anita Lakhani, K. Maharaj Kumari*
2) https://www.mumbailive.com/en/health/one-year-of-first-covid-19-case-reported-in-mumbai-62542
3) https://www.worldometers.info/coronavirus/ country/india/
4) "Global city GDP 2014". Brookings Institution. Archived from the original on 25 May 2017. Retrieved 8 May 2015.
5) https://economictimes.indiatimes.com/news/economy/indicators/mumbai-12th-richest-city-globally-total-wealth-at-usd-950-billion/articleshow/62870741.cms
6) "Mumbai, Mumbai city, Mumbai tourism, Mumbai tour, Maharashtra Capital Mumbai, Commercial Capital Mumbai, Bollywood Mumbai, Mumbai Transport". *Archived from* the original *on 11 October 2007*. Retrieved 12 October 2007.
7) The 150 richest cities in the world by GDP in 2005, dated 11 March 2007. The list fails to include Taipei. Accessed 3 July 2007.
8) "Doing Business in India 2009". World Bank. Retrieved 8 June 2010.
9) Suzuki, Yusuke (March 2020). "Mitsui & Co. Global Strategic Studies Institute Monthly Report" (PDF).
10) https://www.iqair.com/us/india/maharashtra/mumbai
11) Ramesh P. Singh1 & Akshansha Chauhan2
12) https://indiamapia.com/Mumbai
13) https://en.wikipedia.org/wiki/Bandra
14) https://geoiq.io/places/Vile-Parle-East/iXxdyXmVx2
15) https://geoiq.io/places/Colaba/fbDBXEFVru
16) https://postal-codes.cybo.com/search/?q=400070&tok=qrn6vc-02f741f037e4782a1a69&pl=&i=&t=

17) https://postal-codes.cybo.com/india/400076_powai/
18) https://geoiq.io/places/Sion/UTGvBQ8sq9.
19) https://geoiq.io/places/Worli/7uYHdrVc2l
20) https://ww2.arb.ca.gov/resources/inhalable-particulate-matter-and-health#:~:text=Airborne%20particulate%20matter%20(PM)%20is,mixture%20of%20many%20chemical%20species.&text=Those%20with%20a%20diameter%20of,can%20induce%20adverse%20health%20effects.
21) https://www.epa.gov/pm-pollution/particulate-matter-pm-basics
22) http://www.icopal-noxite.co.uk/nox-problem/nox-pollution.aspx#:~:text=NOx%20is%20produced%20from%20the,air%20pollution%20can%20be%20significant.
23) https://urbanemissions.info/india-apna/mumbai-india/
24) https://www.nap.edu/read/10378/chapter/3
25) https://www.hindustantimes.com/mumbai-news/bandra-kurla-saw-highest-dip-in-transport-caused-pollution/story-iDNEO2yN4lxcoBfFSRhjmK.html#:~:text=Vehicles%20and%20thermal%20power%20plants,oil%20contribute%20to%20NO2%20pollution.
26) https://www.statista.com/statistics/666663/total-number-of-vehicles-in-mumbai-india/#:~:text=The%20number%20of%20registered%20vehicles,18%20percent%20in%20the%20city.
27) https://blog.driveu.in/5-deadliest-traffic-junctions-in-mumbai-85e66c4b0b3b
28) https://www.statista.com/statistics/666663/total-number-of-vehicles-in-mumbai-india/#:~:text=The%20number%20of%20registered%20vehicles,18%20percent%20in%20the%20city.

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