

A STUDY OF COVID-19 IN MAHARASHTRA (PART-1): Fitting An Arima Model For Its Forecast And Assessing Maharashtra Government Response For Pre-Vaccine Period.

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Abstract:

COVID-19 is an infectious disease with a catastrophic amount of unfortunate deaths and infected individuals worldwide. The World Health Organization (WHO) on March 11, 2020, declared the novel COVID-19 outbreak as a global pandemic affecting more than 200 countries. India is one of the most affected countries by COVID-19 with Maharashtra being the most affected state by with Mumbai, Pune, Thane, Nashik, etc districts being the key contributors to the epidemic in the state. This paper series focuses on the response of the Maharashtra State Government to the ongoing pandemic. Part-1 is a study for the pre-vaccine (before the vaccines were introduced to the population) situation of Covid-19 in the State whereas the upcoming Part-2 will be for the post-vaccine situation.

Objective: To examine the trends and situation of the pre-vaccine time of COVID-19 in Maharashtra. To forecast the confirmed cases and death cases of COVID-19 until December 2020; using the time series ARIMA model. Conduct SWOT analysis to assess the State's response to tackling the pandemic.

Method: We projected the cases up to 22nd December 2020 using the ARIMA Forecasting model and the ARIMA model fitted correlogram for the Death and confirmed cases based on data from 3 March 2020 to 23 October 2020. We have also conducted the SWOT analysis by creating a SWOT matrix using S/O, S/T, W/O, and W/T.

Results: The analysis result shows the total confirmed and Death cases for Maharashtra. According to our forecasts, Maharashtra will be having 1781193 confirmed cases on November 15 (95% CI: 1674032,1888355), 1878628 confirmed cases on November 30 (95% CI: 1635368,2121888), 1876058 confirmed cases on December 15 (95% CI: 1563135,2388980), and

at the end of December confirmed cases are 2021525 (95% CI: 1519695,2523355) and 477632 Death cases on November 15 (95% CI: 44759, 50506), 50701 Death cases on November 30 (95% CI: 44918,56484), 53770 Death cases on December 15 (95% CI: 44451, 63089) and at the end of December Death cases is 55202 (95% CI: 44049, 66355).

Discussion and Conclusion: It has been observed that with time, confirmed cases will increase at a faster rate since the vaccine for Covid-19 has still not been administered to the population. Also, all the results forecasted are quite close to the corresponding actual values that were observed by the end of December 2020.

Introduction

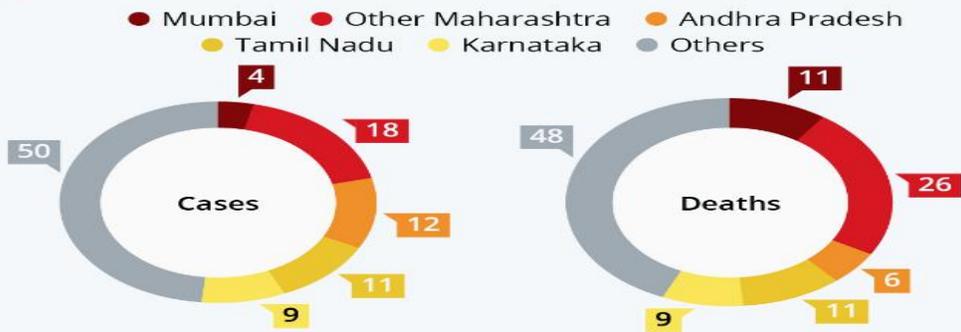
The **COVID-19 pandemic in India** is part of the worldwide pandemic of coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The Government of India confirmed India's first case of Coronavirus disease 2019 on 30 January 2020 in the state of Kerala, when a university student from Wuhan traveled back to the state.

Maharashtra is a state in the western peninsular region of India occupying a substantial portion of the Deccan Plateau. Maharashtra is the second-most populous state in India with a mid-year population of 123 Million (projected by Unique Identification Aadhar India, updated 31, May 2020). It is spread over an area of 307,713 km².

The state of **Maharashtra** emerged as the biggest contributor to the nation with the highest amount of total confirmed cases and deaths. The first confirmed case of a novel coronavirus in Maharashtra was reported on 9 March 2020 in Pune, where a couple returning from Dubai tested positive. As of 8th September 2020, Maharashtra by itself accounted for 22% of total cases and 37% of total deaths in India. Thus it is of utmost importance to learn about the situation of Covid-19 in Maharashtra^[1]. Here in this paper, we are going to discuss the trends of various parameters of the Covid-19 in Maharashtra, make projections for the later part of the pre-vaccine time, and further extend our discussion to the SWOT analysis of the handling of covid-19 in the state.

Maharashtra Counts 37 Percent of COVID-19 Deaths in India

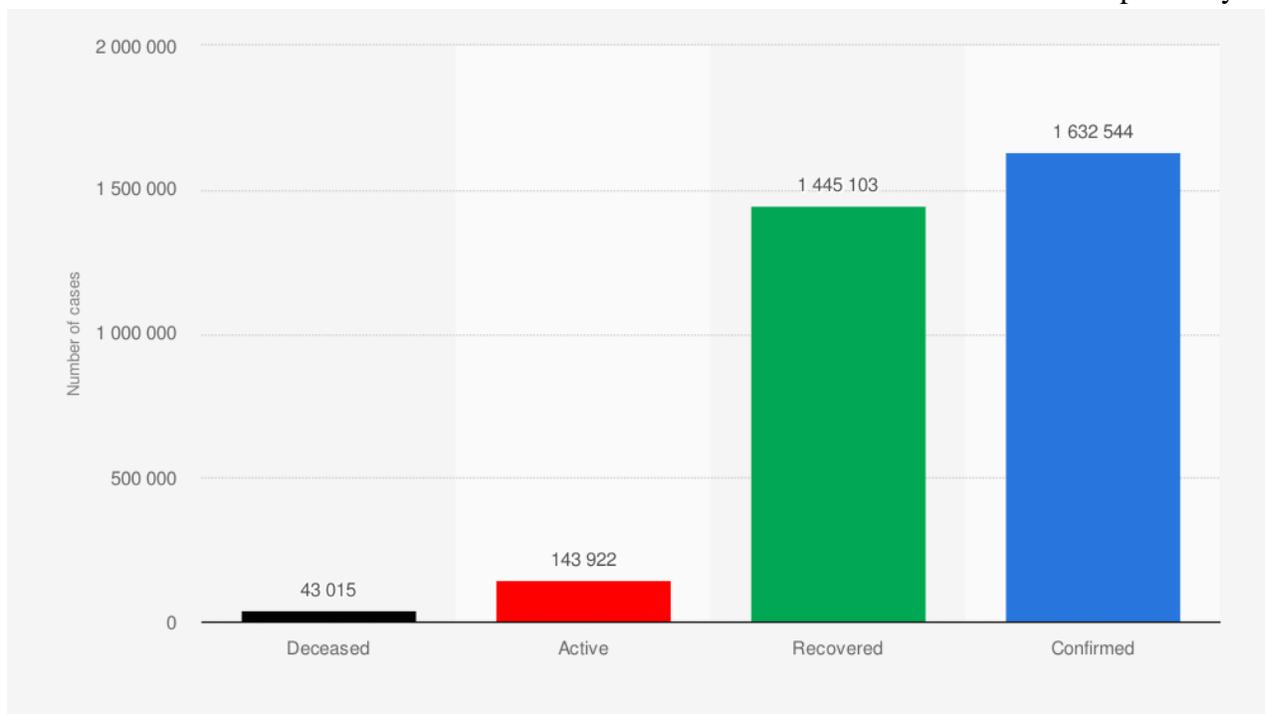
Confirmed COVID-19 cases and deaths in India, by state/city (in percent)



As of September 8, 2020
Source: Ministry of Health and Family Welfare India

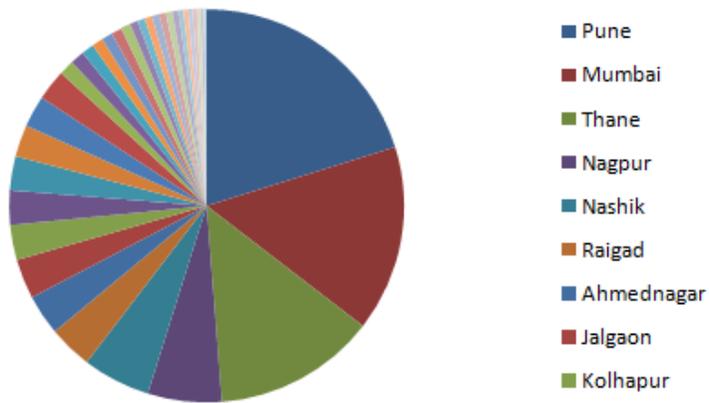


Up till 28th October 2020, Maharashtra had reported a whopping total of over 16.32 lakhs Confirmed cases, over 14.45 lakhs Recovered cases, and over 1.43 lakhs and 43,000 Active and Deceased cases respectively.



The top 3 worst performing districts are Pune, Mumbai, and Thane in the decreasing order with their share of 20%, 15%, and 13% respectively in the total cases up till 22nd October 2020.

Top Worst Performing Districts



Trends

Before doing the projections and understanding the SWOT analysis of the Covid-19 in the state of Maharashtra, we first need to understand certain trends of various parameters of the epidemic in the state to get a much comprehensive and bigger picture.

Figure 1: Cumulative Values

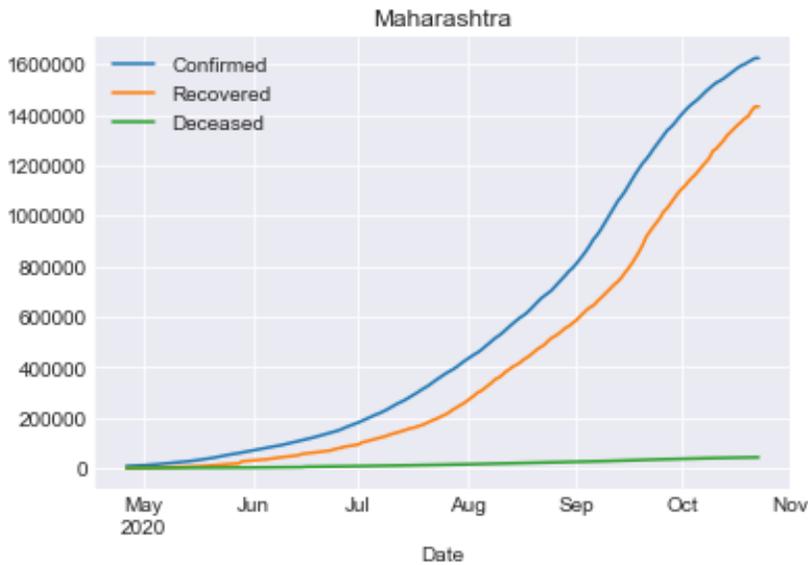
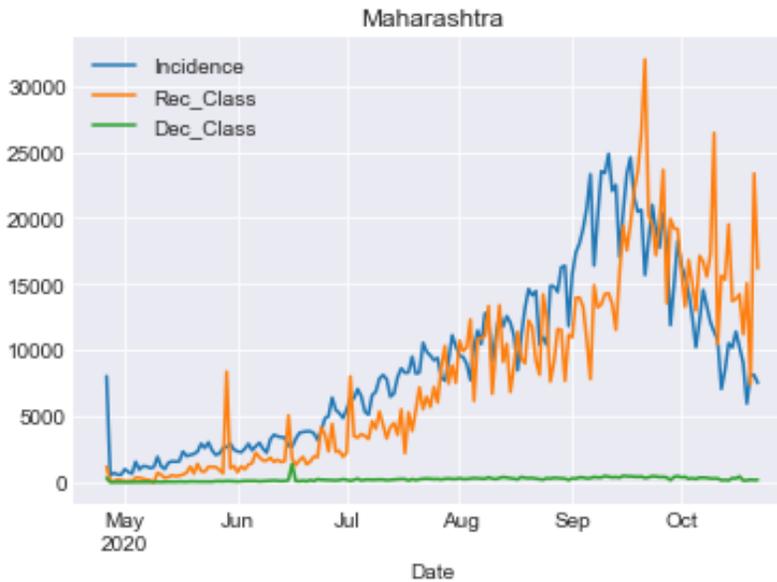


Figure 2: Spikes

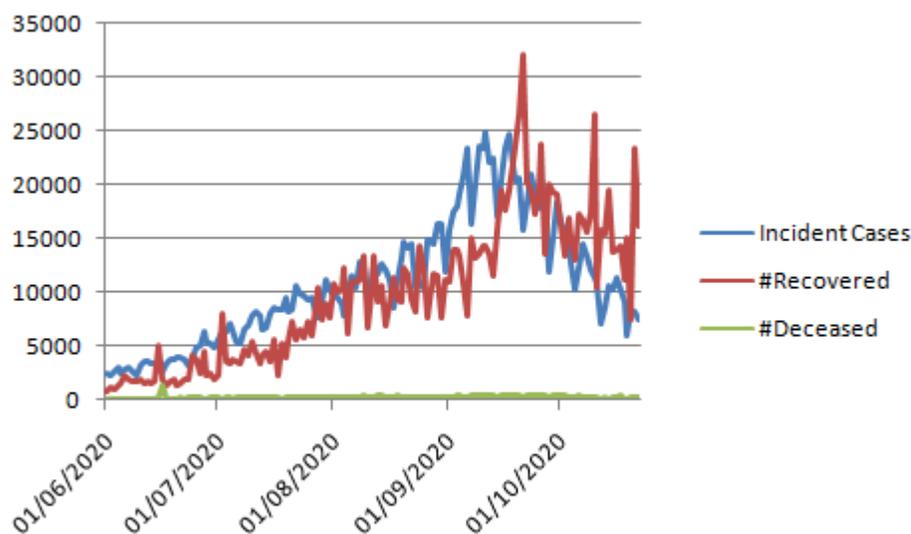


The above two plots tell us a lot about how covid-19 had its trend in Maharashtra. **Figure-1** shows the total confirmed cases increased very rapidly, almost exponentially till the first week of

September 2020. It then started decreasing and if the state authorities and governance can control the epidemic in near future, the line of confirmed cases(Blue) will be asymptotic and the line may follow a logistic curve. Thus if it happens so, it can be an indicator that the state has been successful in controlling the epidemic. The plot for the recovered cases (Orange) also follows a similar trend to the total cases line. The line for deceased cases is somewhat linearly increasing with a very small slope.

As Figure-1 has helped us in understanding the overall trend up till 22nd October 2020, **Figure-2** gives us a much greater insight into the day-day action of covid-19. The highest number of incident cases (new cases) had reached up to around 25,000 in a day in about 7 months. We are considering it as the peak of covid-19 in the state of Maharashtra. Though the discussion about the peak should be done only after considering other parameters like the Basic Reproductive Rate (R_0). Thus, we will take this discussion in the next segment. The number of recovered cases per day overtook the number of incident cases somewhere after the mid-September.

Figure 3: Situation after Unlock-1



The MHA had issued fresh guidelines for June, stating that the phases of reopening would "**have an economic focus**". Lockdown restrictions were only to be imposed in containment zones, while activities were permitted in other zones in a phased manner. This first phase of reopening was termed "Unlock 1.0" and permitted shopping malls, religious places, hotels, and restaurants to reopen from 8 June 2020. Large gatherings were still banned, but there were no restrictions on interstate travel. Night curfews were in effect from 9 p.m. to 5 a.m. in all areas and state governments were allowed to impose suitable restrictions on all activities. According to the Maharashtra government, 60,000 industries were reopened in the state which employed about 1.5

million directly^[2]. But in this effort to revive the economy, the spread of covid-19 escalated. We can see a very rampant increase in the number of incident cases for each day in **Figure-3**.

Important Parameters and Indicators of the Epidemic (Up until 22nd October 2020)

I. Basic Reproductive Number:

The basic reproduction number R_0 is the average number of people that an infected person could spread the virus to in their infected period. It is the ratio of the number of new infections by the number of existing infections.

- If R_0 is greater than 1, then the outbreak will lead to an epidemic
- If R_0 is less than 1, then the outbreak will become extinct.
- If R_0 is equal to 1, one infected person will infect exactly one other person, and so the number of infected persons in the population will remain constant over time and the epidemic will become endemic.

The exponential model ^[3] used to find the value of R_0 for each day t is,

$$I(t) = (R_0)^{(t/SI)}$$

where,

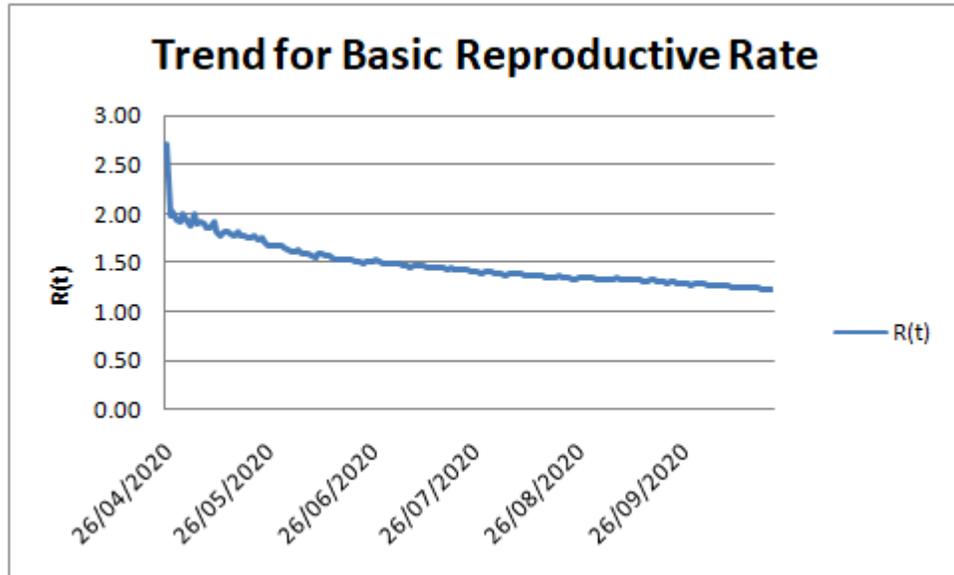
$I(t)$: number of incident cases at time t

R_0 : Basic Reproductive Number

SI : Serial Interval

t : Prediction Time

Figure 4: Trend for Basic Reproductive Number in Maharashtra



In the **Figure-4**, we can see that the value of the R_0 is decreasing and is tending to 1.00 which is a great sign as the outbreak is **trying to achieve the endemic status**.

Now coming to the discussion of whether the Covid-19 had achieved its peak in September or not, that we would like to draw the reader's attention to June in **Figure-2**. It had a similar situation to September where the number of recovered people overtook the number of (new) incident cases for a particular day. It was being speculated at that time in June that whether Maharashtra had achieved its peak or not just like we are doing for September. Now if we compare the values of the R_0 in June and September, which are somewhere around 1.6 and 1.2 respectively, We think that it is a much safer assumption of achieving the peak of covid-19 in September considering the value and trend of the R_0 and assuming that no extreme event occurs.

II. Herd Immunity:

Herd Immunity(HI) is defined as resistance to the spread of an infectious disease within a population that is based on pre-existing immunity of a high proportion of individuals as a result of previous infection or vaccination. It is given by:

$$\text{HI} = 1 - (1/R_0)$$

III. Case Fatality Rate:

The **case fatality rate** also called **case fatality risk** or **case fatality ratio**, in epidemiology, is defined as the proportion of people who die from a specified disease among all individuals diagnosed with the disease over a certain period. It is used to measure the severity of the disease in terms of the deaths caused by it. It is given by

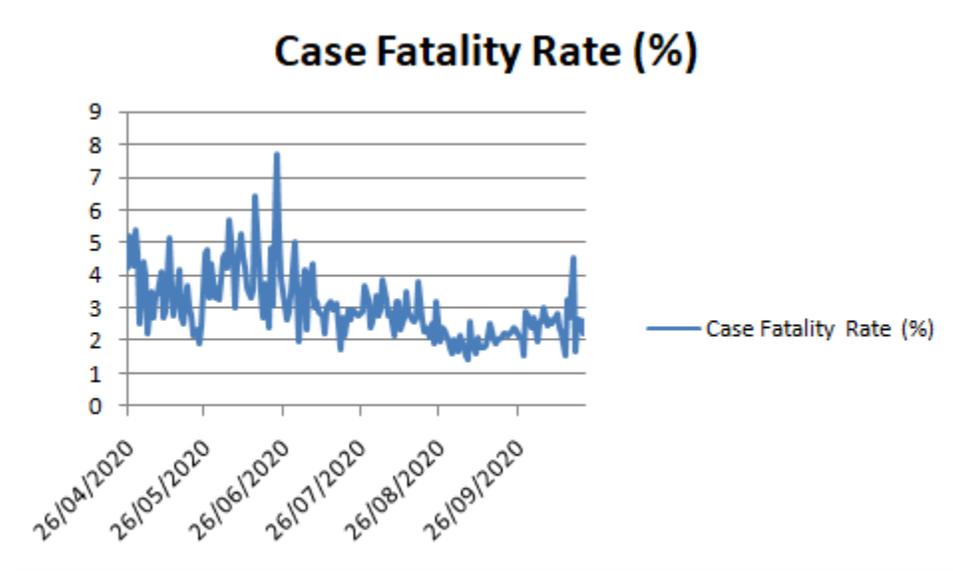
$$\text{CFR}(\%) = (D(t)/C(t)) * 100$$

where,

D(t): Number of people Deceased at time t

C(t): Number of cases Confirmed at time t

Figure 5: Trend for Case Fatality Rate



The case fatality rate of Maharashtra on average has stayed below the global average but has been one of the highest for a state in the nation.

IV. Number of Tests done and Test Positivity Rate:

It is very important to test a person for covid-19 for two reasons:

- 1) Confirm the diagnosis of the disease
- 2) Find asymptomatic cases to help stop the transmission of the disease

Thus it is very important to do maximum testing and screening of the diagnosed as well as the general population and the test positivity rates tell us whether the government or the authorities are doing enough testing or not.

Test Positivity Rate is defined as the fraction of tests having a positive result out of the total number of tests done. The lesser the TPR, the better it is. It is given by

$$\text{TPR}(\%) = (\text{NP}(t) / \text{TT}(t)) * 100$$

where,

NP(t): Number of Positive Tests at time t

TT(t): Total Tests done at time t

Figure 6: Trend of Tests done per day

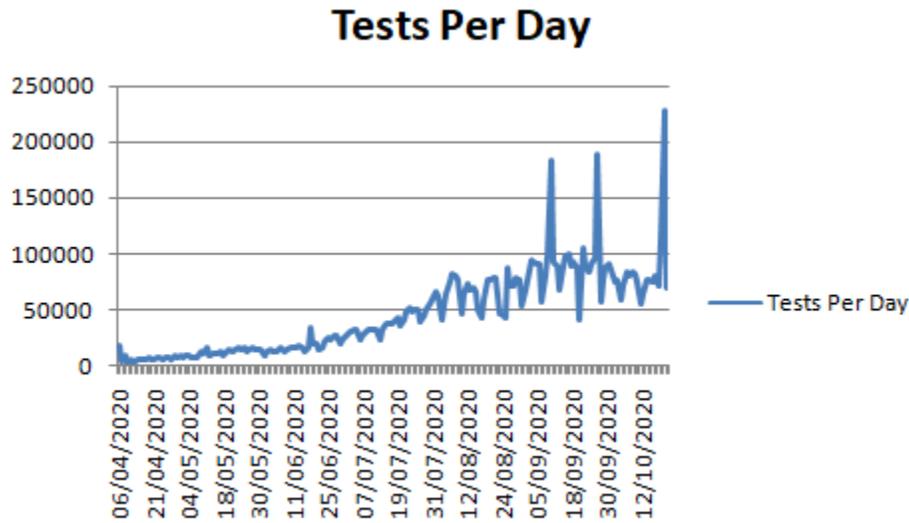


Figure 7: Trend of TPR

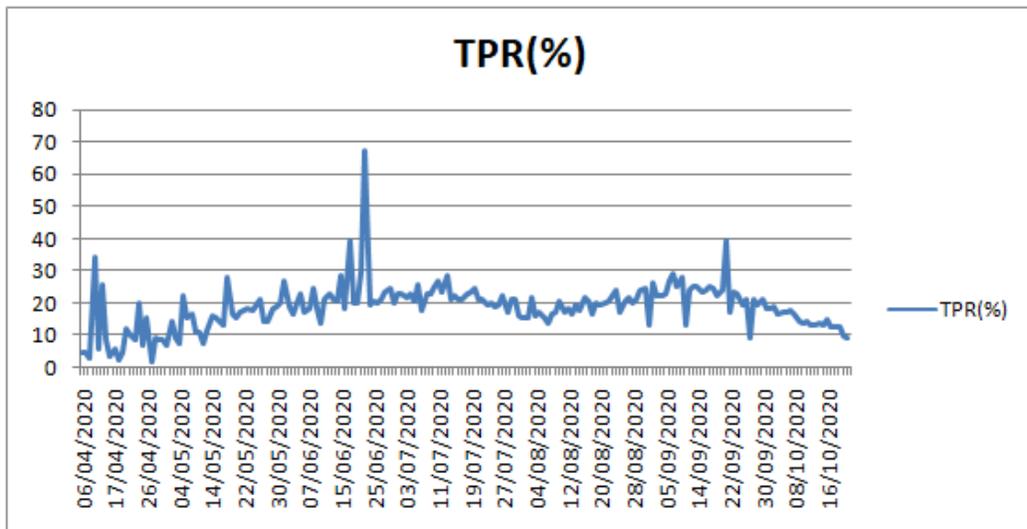


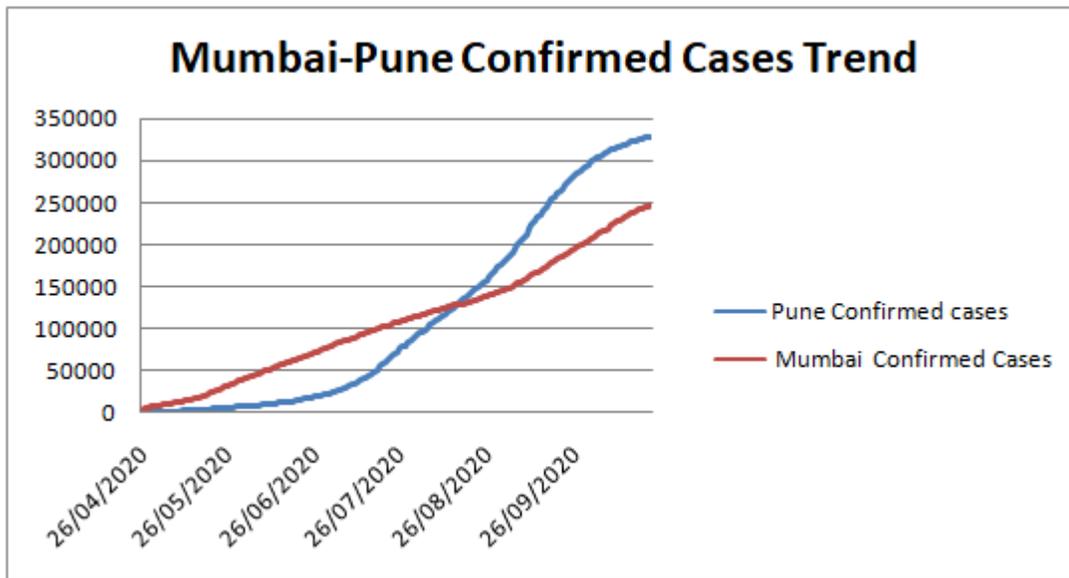
Figure-6 shows the number of tests done per day. We can see a clear rise in the tests done in June. This might be because of the government guidelines of testing for covid-19 when they permitted the private labs as well. There is also a huge spike in the amount of testing in the second week of September. This can be associated with the cause of the launching of the policy “**My Family, My Responsibility**” by the Chief Minister of Maharashtra which aimed at surveying, screening, and if needed then testing a total of 22.5 million families twice a month ^[4].

Situation and Trends in Mumbai and Pune(Up till 22nd October 2020)

Mumbai and Pune are the two major business districts as well as the Urban centers of the state of Maharashtra. Mumbai is the biggest Urban center in India with a population total of 20.4 million people (estimated for 2020) and Pune with a population of 7.4 million (estimated for 2020). They are the largest contributors to the burden of covid-19 in Maharashtra. Thus looking at the trends of the epidemic and its parameters and indicators for these two districts with special consideration is very important.

The following are the few graphical representations for the aforementioned districts of Maharashtra:-

Figure 8: Pune vs Mumbai



Pune being the leading contributor to the total confirmed cases in Maharashtra has a total of over 3.27 lakhs cases whereas Mumbai has a total of over 2.47 lakhs. From **Figure-8**, we can see that Mumbai was quite ahead in the race of confirmed cases till mid-August. Pune overtook Mumbai later in August. The reason for this cannot be pinpointed as numerous things were happening

altogether. Along with relaxations offered in the “Unlock 3.0”, the state was also celebrating Ganpati, its biggest festival of the year.

Figure 9: Trend of CFR in Mumbai

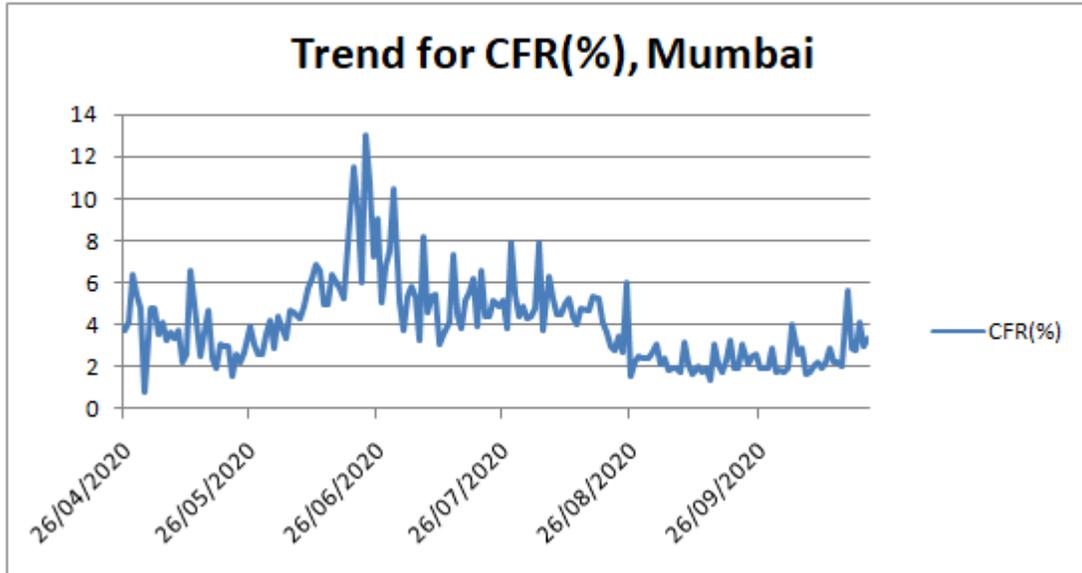


Figure 10: Trend of CFR in Pune

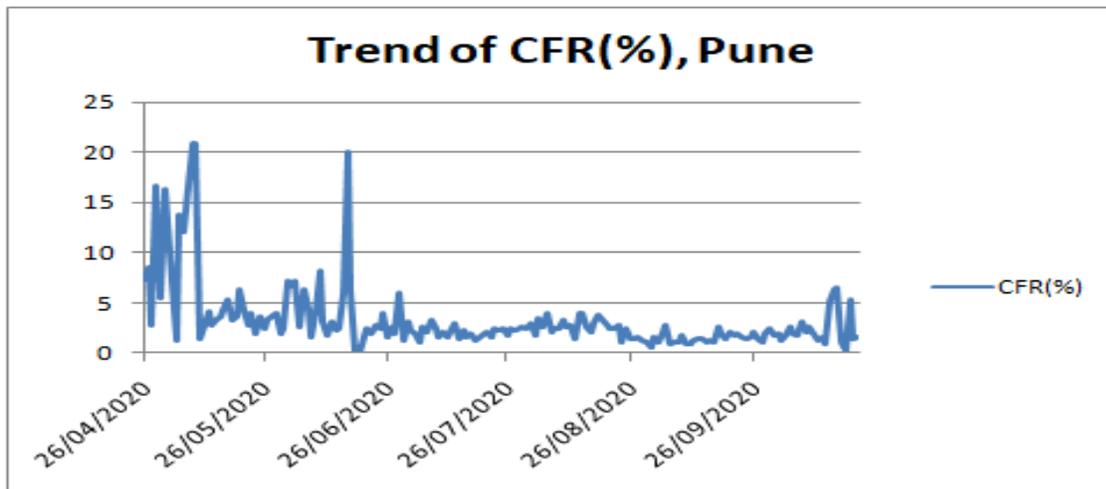


Figure 11: Trend of Basic Reproductive Number in Mumbai

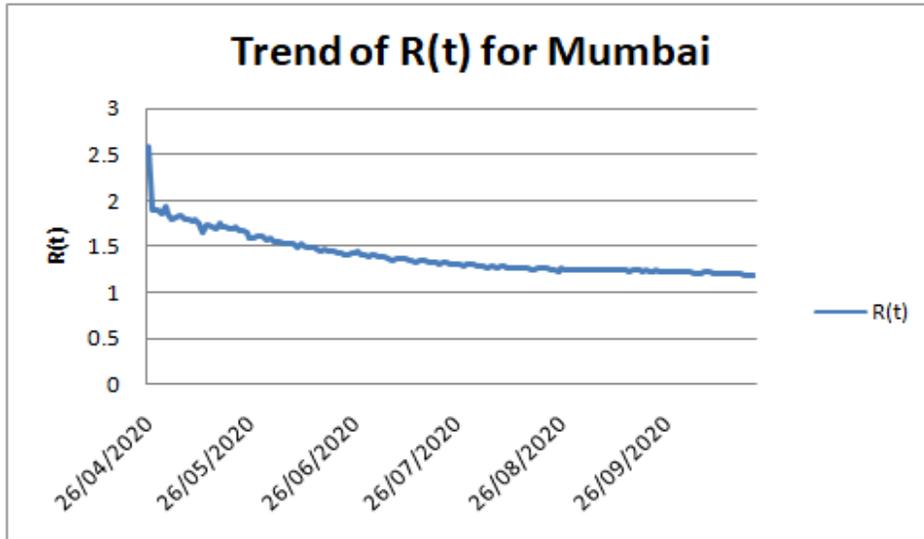
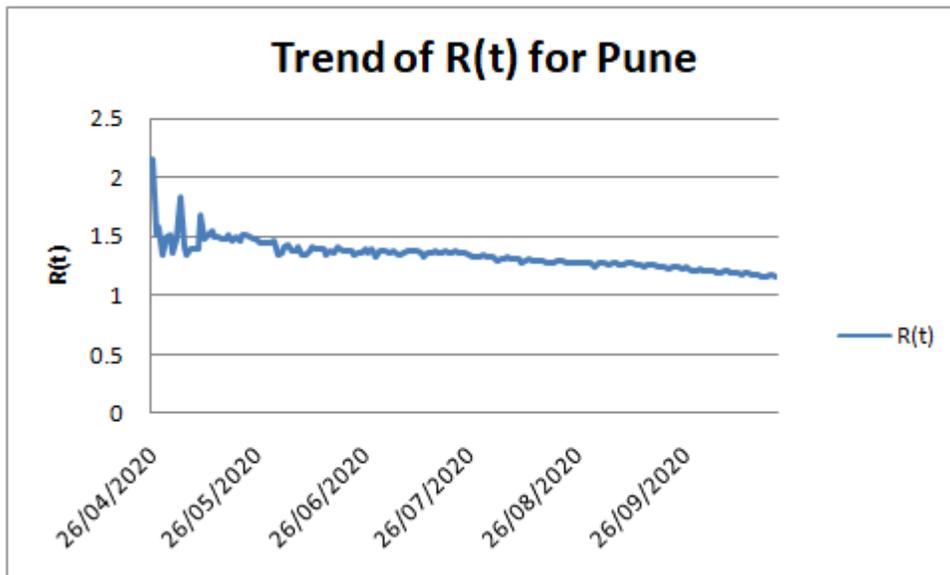


Figure 12: Trend for Basic Reproductive Number in Pune



Forecasting trends:

The Indian public health care system is already overstretched, and this pandemic is making things even worse. That is why forecasting cases is necessary to meet the future demands of the health infrastructure.

Considering the pre-vaccine time for Covid-19, the prevalence of the disease is increasing day by day and all the scientists in the world are still doing a lot of research to stop this huge crisis that has hit the world. It is very important to have a projection for the epidemic in the state of Maharashtra, considering its contribution to the burden of the Covid-19 in India. The projection helps the government in its future endeavors.

Many researchers around the world have used different mathematical models such as the exponential method, time-series model, etc. We have used the ARIMA time series model using R studio in this study. The ARIMA (Auto Regressive Integrated Moving Average)model is a simple stochastic time series model and is used to understand data and predict the future. ARIMA model is a very good model for COVID19 projection. Using this model, we have tried to estimate the number of confirmed cases and death cases of COVID19 in the future. ARIMA model prediction is based on different parameters. Parameters are p, d, q which evaluate Auto Regressive, integrated and moving average respectively. ARIMA MODEL deals with stationary data, to check stationarity A D Fuller test is used. If data is not stationary make it stationary by differencing method, differencing is done till data become stationary that is the value of d (no of time differencing is done), and Parameters p and q are determined based on partial Auto-correlation function or partial Correlogram function (PACF) and Complete Auto-Correlation Function or Complete correlogram (ACF) respectively. For different data, we get different values of P, d and q. These parameters help to predict the future. This model not only shows the overall trend but also shows 95% and 80% confidence intervals for point estimation.

Data and Methods

The data source^[5] provides the data in cumulative form. We projected cases up to 22 December 2020 using the ARIMA Forecasting model based on data from 3 March 2020 to 23 October 2020.

The model for forecasting future confirmed and death cases of COVID-19 cases is represented as:

$$\text{ARIMA (p,d,q): } X_t = \alpha_1 X_{t-1} + \alpha_2 X_{t-2} + \beta_1 Z_{t-1} + \beta_2 Z_{t-2} + Z_t$$

$$Z_t = X_t - X_{t-1}$$

from fig X_t is the predicted number of cumulative confirmed and death COVID-19 cases at t^{th} day; α_1 , α_2 , β_1 , and β_2 are parameters whereas Z_t is the residual term for t^{th} day.

Forecasted Confirmed cases of COVID-19 for Maharashtra: Table 2, shows the forecast of confirmed cases of Maharashtra on November 15, November 30, December 15, and December 22. The analysis result for India in Table 1 and Fig. 2 shows the total confirmed and Death cases for

Maharashtra. It has been observed that with time, confirmed cases will increase at a faster rate. According to our forecasts, Maharashtra will be having 1781193 confirmed cases on November 15 (95% CI: 1674032,1888355), 1878628 confirmed cases on November 30 (95% CI: 1635368,2121888), 1876058 confirmed cases on December 15 (95% CI: 1563135,2388980), and at the end of December confirmed cases are 2021525 (95% CI: 1519695,2523355) and at mid of the December cases will start to stabilize because herd immunity among people of Maharashtra is increasing day by day so emerging new no of cases will slow down at it become stable at the end of December.

Similarly, According to our forecasts, Maharashtra will be having 477632 Death cases on November 15 (95% CI: 44759, 50506), 50701 Death cases on November 30 (95% CI: 44918,56484), 53770 Death cases on December 15 (95% CI: 44451, 63089) and at the end of December Death cases is 55202 (95% CI: 44049, 66355)

Results:

Fig. 1(a) Correlogram and ARIMA Forecast for the Confirmed COVID-19 Cases in Maharashtra

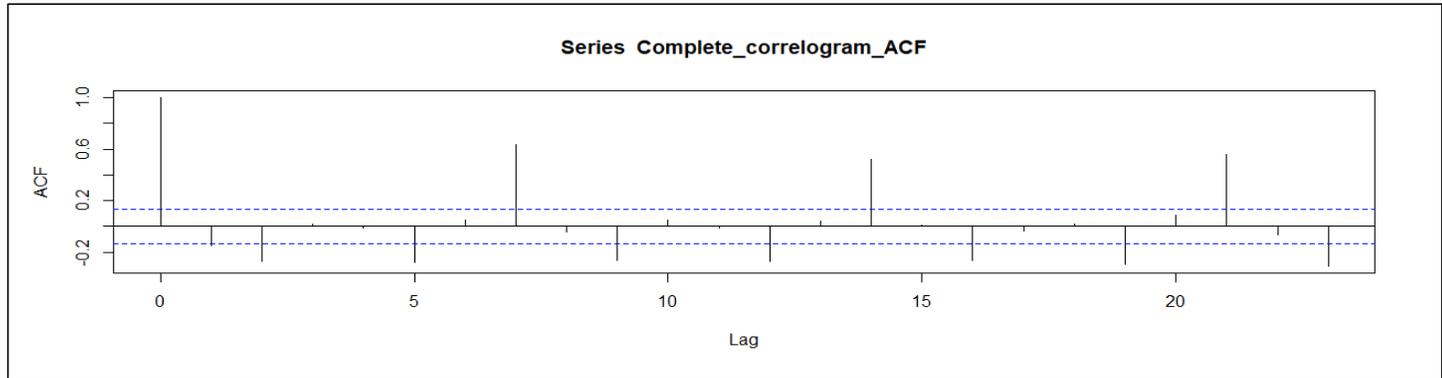
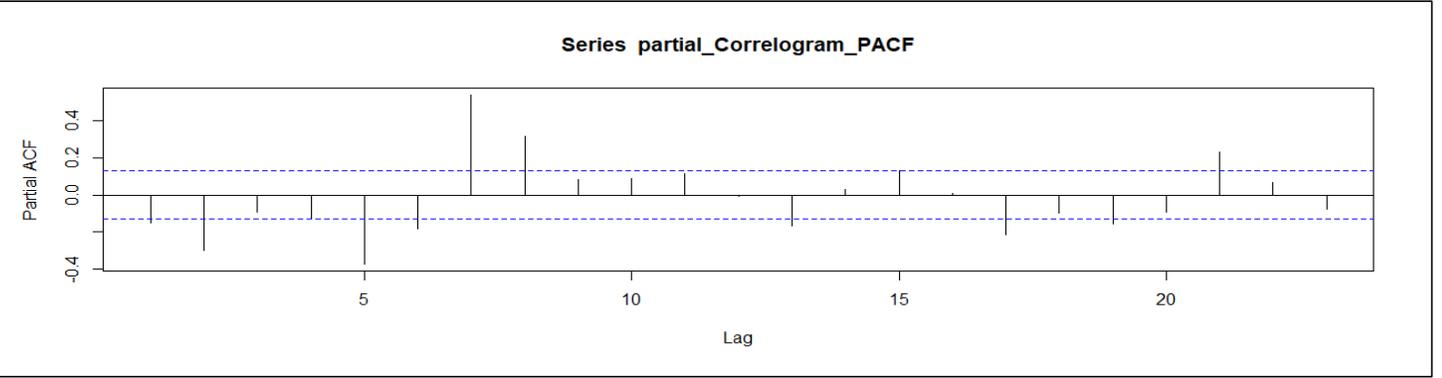
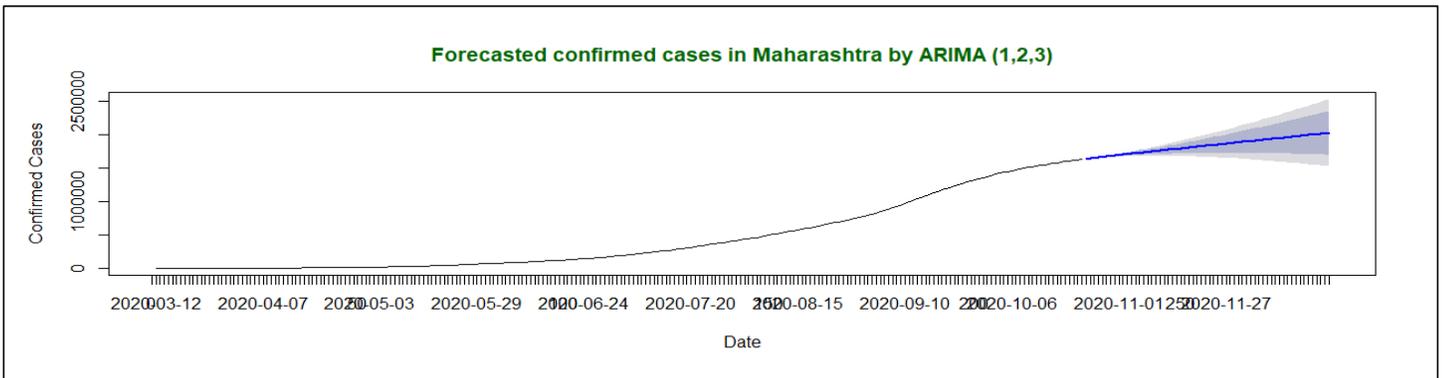
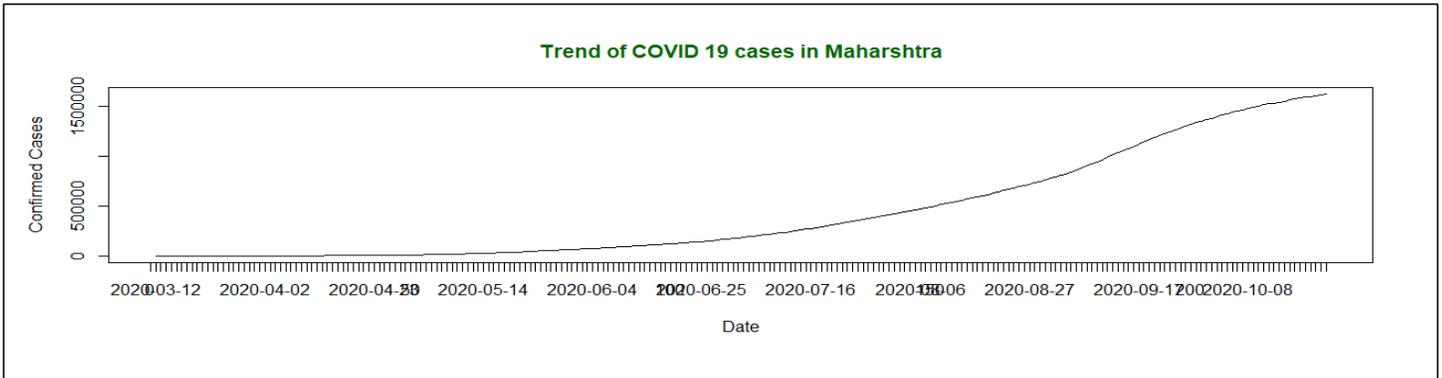
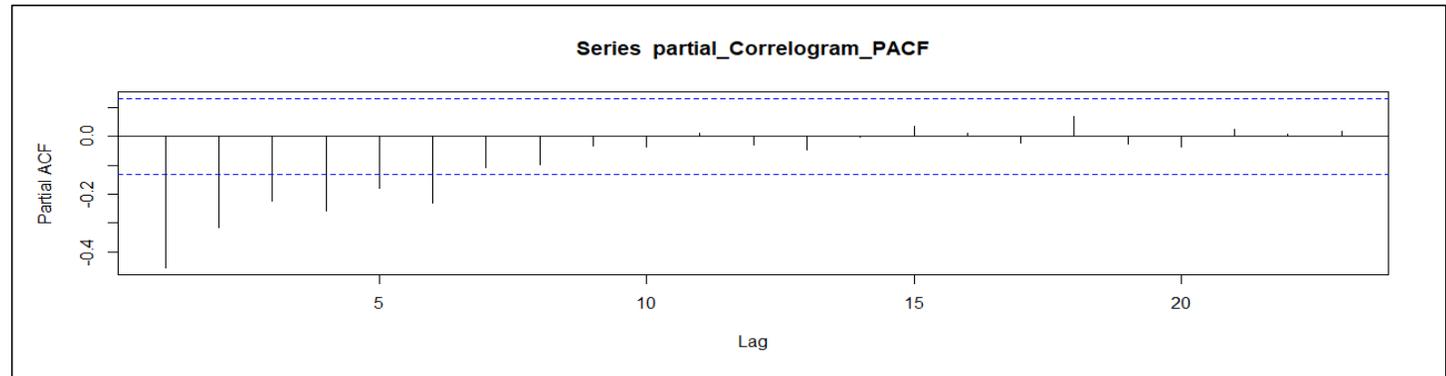
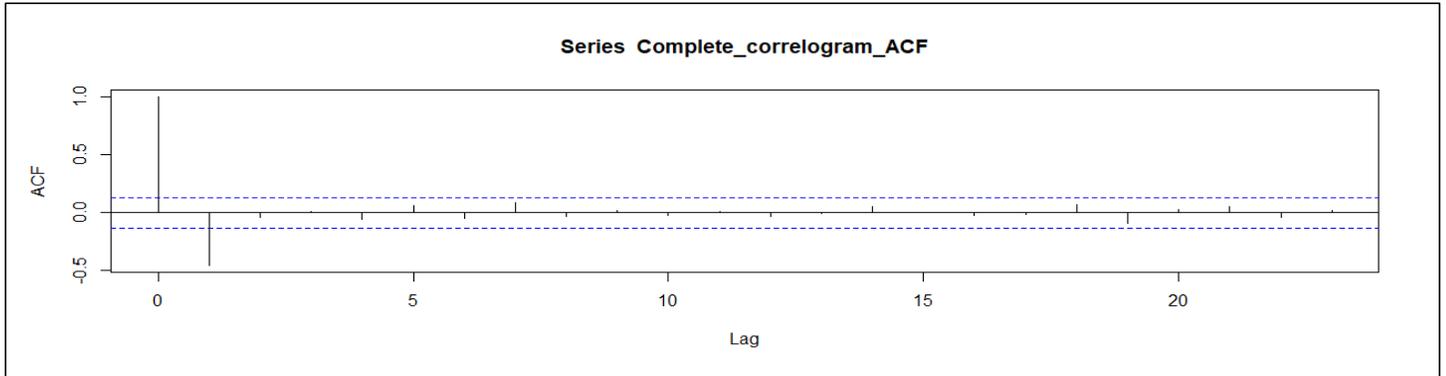
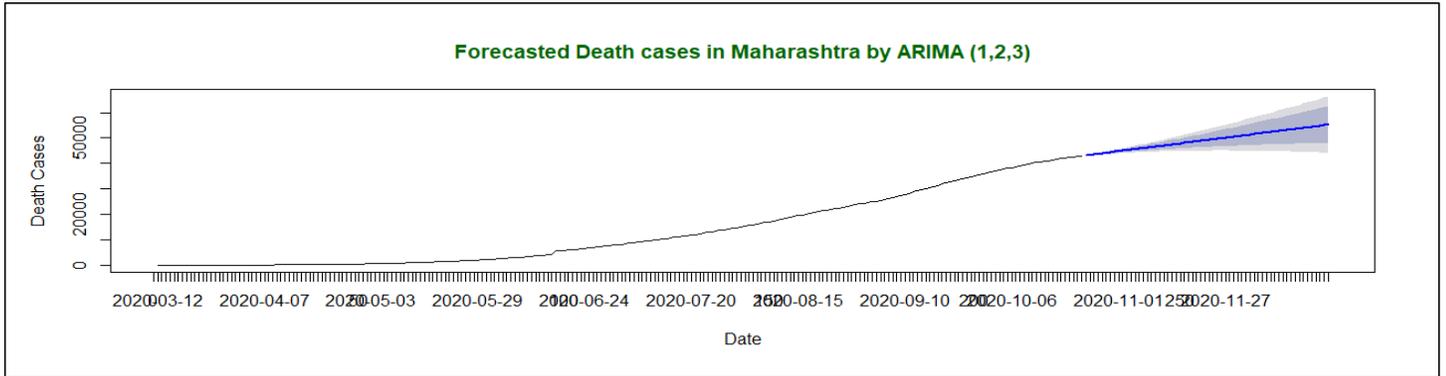
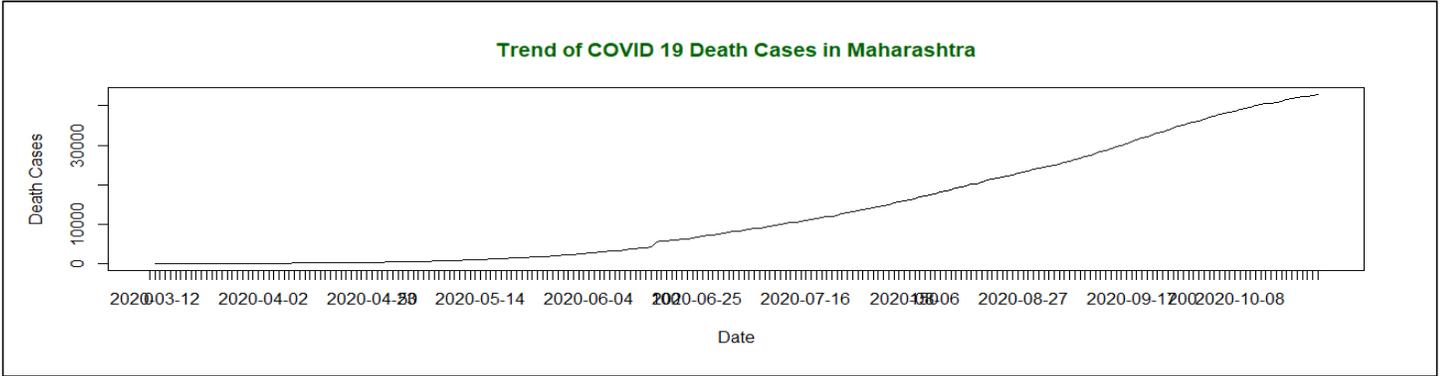


Fig. 1(b) Correlogram and ARIMA Forecast for the Active COVID-19 Cases in India



ARIMA model fit for confirmed and Death cases of COVID-19 in Maharashtra Fig 1(a) & 1(b), shows the ARIMA model fitted correlogram for the Death and confirmed cases. In these figures, we see four subfigures that reveal the trend for the earlier and forecasted values for both confirmed and Death cases. Forecasting based on PACF and ACF graphs helps to determine parameters p and q. Moreover, the best ARIMA model fit is considered to have the lowest Akaike Information Criterion (AIC) value. Fig 1(a) also shows the fitted model for total confirmed cases with ARIMA (1,2,3) having the lowest AIC. With the help of this model, we have predicted confirmed cases with 95% CI till December 22, 2020. Similarly, for total Death cases in Fig 1(b), we have a suitable model with ARIMA (1,2,3), which helps to predict active cases with 95% CI till December 22, 2020. The results forecasted are quite close to the corresponding actual values that were observed by the end of December 2020.

SWOT Analysis

The Maharashtra government undertook many initiatives to fight against the COVID-19 and also launch many programs and policies. However, to plan an effective strategy for fighting covid-19 while minimizing risk and maximizing results, it is crucial to identify the internal and external factors correctly.

A SWOT analysis can be done to assess the state's current position in tackle the pandemic. The analysis examines Maharashtra's Strengths, Weaknesses, opportunities, and Threats on the COVID-19 front.

Strength:

- Existing infrastructure like private hospitals, NGOs, railway coaches, schools was converted into isolation wards.
- Strict lockdown, trains, buses, and international flights are closed.
- Restriction of people movement from inter-district, intra-district, and state except for an emergency.
- War Against Virus: For monsoon challenges ahead which cover :
 - Bed strength to around 2.90 lakh.
 - over 8,500 ICU beds in major hospitals
 - more than 3,000 ventilators

- more than 3,000 ventilators, around half a million PPE kits, and one million N95 masks are ready for the medical and para-medical staff in various hospitals
- Jyotiba Phule Jan Arogya Yojana (MJPJAY) will provide free and cashless insurance protection to all citizens under the state government's health scheme and cover 85% of the population.
- Mission Begin Again: strictly follow the lockdown
- Chase The Virus: a COVID-19 patient will compulsorily be kept in institutional quarantine
- My family my responsibility: a door-to-door survey which covers 2.25 crore families.
- Maharashtra launches Project Platina, 'world's largest' plasma therapy trial for covid-19 patients
- Maharashtra govt launches 'COVID-Madat' for tele-screening

- The state government has decided to unveil a new policy on the registration of migrant workers.
- While the return of migrants workers who left the state during lockdown is certain, the objective of the registration is to collect data on the number of migrant laborers, their home states, and where they were working before they left Maharashtra. When they return, they will be registered so that they can resume their duties or get new jobs.
- Three-time meals every day are being given to seven lakh migrants labor and the homeless along with medical assistance.
- There are no restrictions for the farmer on farming activities and commodities.
- As far as day-to-day activities are concerned, meals are being served at Rs 5, and wheat and rice are provided to orange ration cardholders.
- According to data of the labor department, nearly 12 lakh and 5.5 lakh migrant laborers left for their hometown in Shramik Special trains and Maharashtra State Road Transport Corporation (MSRTC) buses, respectively.
- Of the Rs 54.75 crore sanctioned from the CM's Relief Fund for the travel of migrant workers to their respective states by special trains, Rs 12.96 crore are earmarked for Mumbai city and Rs 10 crore for Mumbai suburbans.
- since 1 May, at least 822 Shramik special trains from Maharashtra have taken 11.86 lakh migrant workers back to their home states.

Weakness:

- Lack of testing kits, PPE, mask, and ventilators
- Lack of oxygen, lack of dialysis machines
- Lack of isolation and quarantine ward
- As many times locals are reluctant to share their details.
- Movement of people from cities to villages
- Poor surveillance and active case search, cases are detected late
- Lack of health workers staff for the survey.
- Lack of health workers staff for the survey.

- Unplanned lockdown most affected migrant workers.
- Shortage of trains for migrants workers.
- Movement of people from cities to villages
- Poor surveillance and active case search, cases are detected late.
- Poor quality of resources.
- As many times locals are reluctant to share their details.
- Shortage of emergency healthcare infrastructure and professionals
- Lack of health workers staff for the survey.

Opportunity:

- Enhance measures for institutional quarantine
- Contain disease in urban areas and prevent infection spilling over to rural
- Beef up medical resources and infrastructure
- Development of a vaccine/antidote for covid-19
- Numerous web resources.
- To move our classes to a different platform, introduce e-learning & develop learners' autonomy.
- Contact tracing becomes easier and this will become a better control of spreading the coronavirus.
- Lockdown and isolation important techniques on the spread of covid-19.
- Health survey is to collect health details for future planning and reference & this will help to construct a health map of Maharashtra.

Threats:

- Failure in contact tracing may lead to worsening of the present situation and an increase in the probability of being hit by the second wave of covid-19.
- Higher chances of frontline workers contracting the disease.
- most of the housing societies people are not allowing the campaign employees to come inside to conduct the survey.
- The elderly population getting affected.
- Spread of disease from urban to rural areas.
- Drastic measures like complete stoppage of the local suburban train and bus services in key cities like Mumbai.

SWOT Matrix	Opportunities	Threats
Strengths	<p><u>Using strengths to Maximized Opportunities</u></p> <ul style="list-style-type: none"> • Health survey is to collect health details for future planning and reference & this will help to construct a health map of Maharashtra. • Development of a third-tier governance system for educating and monitoring people. • Making use of the R&D ecosystem for rapid development of COVID-19 vaccine/antidote. 	<p><u>Using strengths to Minimized Threats</u></p> <ul style="list-style-type: none"> • Implementation of strong policies for present and future outbreaks. • Extending health assurance benefits to the larger masses. • Now, in inter-state migration people go through the process of registration, so we can easily tracing and if people infected by Covid we can keep it in quarantine or isolation ward.
Weaknesses	<p><u>Using Opportunities to Minimized weakness</u></p> <ul style="list-style-type: none"> • Make a strong team of paramedical staff for the future. • More available of ventilators, dialysis machines, etc. • Start-ups, MSMEs for the production of PPEs, testing kits, masks, etc. • Develop technical infrastructures to ensure smooth and flexible employee working arrangements to minimize job losses. 	<p><u>Prevent weaknesses from turning into threats</u></p> <ul style="list-style-type: none"> • In public places, like Mumbai locals make sure that people maintaining social distancing. • High-density population in Mumbai, people's mobility is also high so elderly people do not go out in public places. • Specific action to be taken for the people below the poverty line. • Ensure adequate infrastructure and protect our frontline workers and healthcare staff.

Discussions and Conclusions

The world is going through a pandemic, and almost every country is affected by it. In India, proactive measures like nation-wide lockdown and social distancing had been taken at an early stage of infection. India's R_0 had hit its peak on the 26th of April, 2020 during a lockdown with

$R_0 = 2.58$ but on 26 th May, it goes down to $R_t = 1.50$ which shows that the nation-wide lockdown has slowed the reproduction rate of COVID-19. The daily confirmed cases were increasing day by day during a lockdown in a slow manner and during unlocking 1,2,3 and 4 the no of confirmed cases and death cases started increasing in a fast manner.

This rapid increase in cases has stressed most healthcare systems worldwide and has further made outbreak response and resource planning a challenge. In response, health authorities have attempted to forecast the trend of this pandemic, however, this has proven to be difficult as COVID-19 is a novel disease with limited data and knowledge on the disease trends and dynamics. This is especially observed when using compartmental and time series models to predict disease trends, where compartmental models.

Our results are compatible with findings obtained from ARIMA models to estimate the number of confirmed and Death cases related to the COVID-19 pandemic in Maharashtra. However, since the results of our study are obtained from more recent data, we think that we have obtained a more consistent forecast for the future. ARIMA models are not only effective but it's a simple and easy method by which COVID-19 trends can be predicted based on open access data. Also, the use of smoothened data and independent covariates improved model accuracy.

In conclusion, ARIMA models have been created by considering the most appropriate AIC and BIC values for Confirmed cases and death numbers for Maharashtra. According to the results, while the number of cases in Maharashtra is expected to decrease after the vaccines are administered, i.e., as of January end of 2021. The number of deaths in Maharashtra is expected to be the lowest in December end of 2020. Also, it is thought that studies in which the sensitivity and validity of these methods are tested with more cases will contribute to researchers working in this field.

The actual numbers are close to what we had forecasted. As Maharashtra state and the central government started focusing on these issues as deep as the individual level taking all proper precautions and properly followed the WHO guidelines, it has most certainly helped in decreasing the impact of the crisis to some extent before the vaccines are introduced. By the end of January, the graph becomes stable, where we are expecting not much rise in the Cases due to the administration of the vaccines to the population by the government in a phase-wise manner as planned by the Central Government.

Table 1

Indicator	State Average	Mumbai	Pune
Test Positivity Rate(TPR)	19%	-	-
Basic Reproductive Number(R_0)	1.3	1.38	1.34
Herd Immunity(HI)	28.13%	28.05%	25.53%
Case Fatality Rate(CFR)	3.2%	4.51%	3.24%

Table 2 Forecast of Confirmed and Death Cases of COVID-19 for Maharashtra from June 24 October to December 22, 2020, Maharashtra

Date	Confirmed Cases	95% Confidence Interval		Death Cases	95% Confidence Interval	
	Point Estimates	Lower	Upper	Point Estimate	Lower	Upper
24th October 2020	1633244	1630684	1635804	43061.86	42864.14	43259.58
25th October 2020	1641109	1636406	1645811	43288.63	42987.82	43589.44
26th October 2020	1648603	1642257	1654948	43508.39	43125.23	43891.54
27th October 2020	1655826	1647728	1663925	43723.35	43261.93	44184.76
28th October 2020	1662853	1652692	1673013	43935.03	43393.65	44476.4
29th October 2020	1669735	1657116	1682354	44144.46	43518.86	44770.06
30th October 2020	1676513	1661010	1692016	44352.36	43637.07	45067.66
31st October 2020	1683214	1664400	1702028	44559.22	43748.26	45370.17
1st November 2020	1689860	1667323	1712396	44765.35	43852.66	45678.05
2nd November 2020	1696464	1669816	1723112	44971	43950.56	45991.44
3rd November 2020	1703039	1671913	1734166	45176.31	44042.31	46310.3
4th November 2020	1709593	1673642	1745543	45381.39	44128.24	46634.53
5th November 2020	1716131	1675032	1757229	45586.31	44208.67	46963.96
6th November 2020	1722657	1676105	1769209	45791.13	44283.87	47298.39
7th November 2020	1729175	1676880	1781470	45995.87	44354.1	47637.64
8th November 2020	1735687	1677375	1793998	46200.56	44419.58	47981.54
9th November 2020	1742194	1677604	1806784	46405.22	44480.53	48329.91
10th November 2020	1748698	1677581	1819815	46609.85	44537.11	48682.6

11th November 2020	1755200	1677317	183308 2	46814.47	44589.49	49039.4 6
12th November 2020	1761700	1676822	184657 8	47019.08	44637.81	49400.3 5
13th November 2020	1768198	1676104	186029 3	47223.68	44682.19	49765.1 6
14th November 2020	1774696	1675171	187422 1	47428.27	44722.77	50133.7 8
15th November 2020	1781193	1674032	188835 5	47632.86	44759.63	50506.1
16th November 2020	1787690	1672691	190268 9	47837.45	44792.88	50882.0 3
17th November 2020	1794186	1671155	191721 7	48042.04	44822.6	51261.4 8
18th November 2020	1800682	1669429	193193 5	48246.63	44848.89	51644.3 7
19th November 2020	1807178	1667519	194683 8	48451.21	44871.8	52030.6 2
20th November 2020	1813674	1665427	196192 0	48655.8	44891.41	52420.1 8
21st November 2020	1820169	1663159	197717 9	48860.38	44907.8	52812.9 6
22nd November 2020	1826665	1660719	199261 1	49064.96	44921.01	53208.9 2
23rd November 2020	1833160	1658110	200821 1	49269.55	44931.11	53607.9 9
24th November 2020	1839656	1655334	202397 7	49474.13	44938.15	54010.1 1
25th November 2020	1846151	1652397	203990 6	49678.71	44942.18	54415.2 5
26th November 2020	1852646	1649299	205599 4	49883.3	44943.25	54823.3 5
27th November 2020	1859142	1646045	207223 8	50087.88	44941.4	55234.3 6
28th November 2020	1865637	1642637	208863 7	50292.46	44936.69	55648.2 4
29th November 2020	1872133	1639077	210518 8	50497.05	44929.14	56064.9 5
30th November 2020	1878628	1635368	212188 8	50701.63	44918.81	56484.4 6
1st December 2020	1885123	1631511	213873 5	50906.22	44905.72	56906.7 1
2nd December 2020	1891619	1627510	215572 7	51110.8	44889.92	57331.6 8
3rd December 2020	1898114	1623366	217286 2	51315.38	44871.44	57759.3 3

4th December 2020	1904609	1619081	219013 7	51519.97	44850.31	58189.6 2
5th December 2020	1911104	1614657	220755 2	51724.55	44826.56	58622.5 3
6th December 2020	1917600	1610096	222510 4	51929.13	44800.24	59058.0 3
7th December 2020	1924095	1605399	224279 1	52133.72	44771.35	59496.0 8
8th December 2020	1930590	1600568	226061 3	52338.3	44739.94	59936.6 6
9th December 2020	1937086	1595605	227856 6	52542.88	44706.03	60379.7 3
10th December 2020	1943581	1590512	229665 0	52747.47	44669.66	60825.2 8
11th December 2020	1950076	1585289	231486 3	52952.05	44630.83	61273.2 7
12th December 2020	1956572	1579939	233320 4	53156.63	44589.59	61723.6 8
13th December 2020	1963067	1574462	235167 2	53361.22	44545.94	62176.4 9
14th December 2020	1969562	1568861	237026 4	53565.8	44499.93	62631.6 7
15th December 2020	1976058	1563135	238898 0	53770.38	44451.57	63089.2
16th December 2020	1982553	1557287	240781 9	53974.97	44400.87	63549.0 6
17th December 2020	1989048	1551318	242677 8	54179.55	44347.87	64011.2 3
18th December 2020	1995544	1545229	244585 8	54384.13	44292.59	64475.6 8
19th December 2020	2002039	1539021	246505 7	54588.72	44235.04	64942.3 9
20th December 2020	2008534	1532695	248437 3	54793.3	44175.25	65411.3 5
21st December 2020	2015030	1526253	250380 6	54997.88	44113.23	65882.5 4
22nd December 2020	2021525	1519695	252335 5	55202.47	44049	66355.9 3

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Appendix:

Fig. Trend of Forecasted Confirm COVID-19 Cases over the Period in Maharashtra

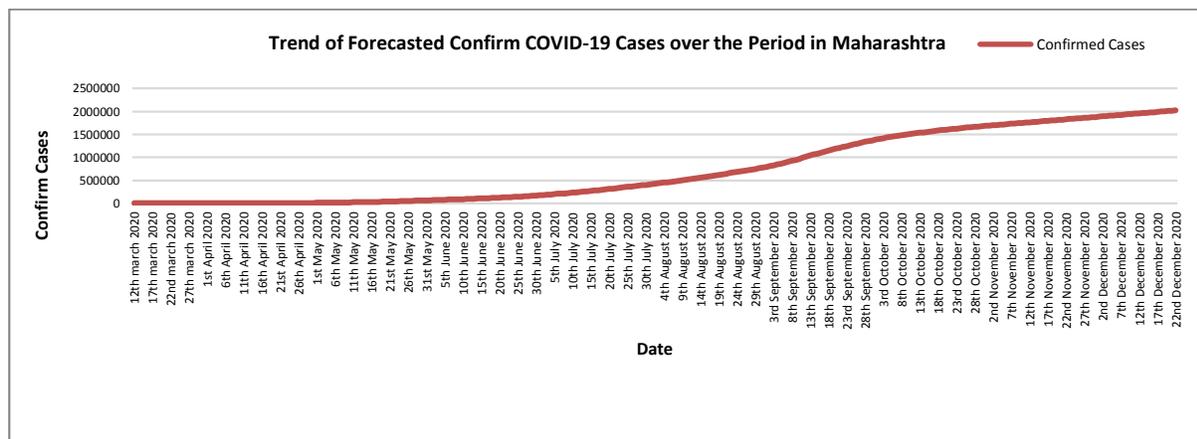


Fig. Trend of Forecasted Confirm and Active COVID-19 Cases over the Period in Maharashtra

Trend of Forecasted Confirm and Active COVID-19 Cases over the Period in Maharashtra

