Actionable Insights to Contain the Spread of Coronavirus

By

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Summary

Coronavirus is spreading fast. While the country is attempting to unlock the economy, the number of new cases per day has almost touched 10,000. Actionable insights to contain the spread is the need of the hour.

Keeping this goal in mind, we have developed two dashboards[1][2] to enable policymakers to extract a variety of information from publicly available data on COVID 19. These dashboards will also be accessible from the website of the Indian Statistical Institute. While these dashboards provide risk summaries and enable users to look at data from different perspectives, arriving at actionable insights may be difficult. This report is a supplement to the dashboards, and it describes three 'easy to implement' insights. We propose to continue to analyse available data and bring out new insights regularly. We believe our effort would be beneficial to the policymakers and other users. We are willing to provide analytical support and are open to criticism. A brief description of the insights is given below. More important details are in the subsequent pages.

1. **Action 1 – Improve Recovery:** The daily recovery varies widely and is low in many States and cities. Daily recovery is even zero on several occasions and frequently varies by over five times or more on subsequent days. The process of recovery comprises interdependent activities like sample collection, testing, retesting, and approval of final release. Built-in delays in such processes are often over 50% of the total time, and standard techniques exist to reduce the cycle time drastically.

   Improving recovery by about 40% in West Bengal could have reduced active cases from 4025 to 2929 as on 5 June 2020. In Mumbai, a threefold increase of recovery could have reduced active cases from 22795 to 11263 as on 1 June 2020. Both these targets are likely to be achievable through the usage of six sigma techniques of cycle time reduction. Reduction of active cases would free up resources and provide much-needed confidence on the ability of the healthcare system to ensure a quick recovery.

2. **Action 2 – Develop Early Indicator to Assess Risk of Spread of Virus:** Currently, cumulative cases are being reported separately at State and district levels. Presenting the daily occurrence (new cases) curves of the entire State and districts together is likely to bring out impending dangers.

   Time series plot of daily cases of West Bengal along with Kolkata, Howrah, and North 24 Parganas clearly shows a faster rate of increase for the entire State compared to these 'most important' districts from the middle of May 2020. The differential rate of increase provides an early warning about emerging risk areas other than the districts currently being targeted. Time series plot of daily cases in Maharashtra and Mumbai appears to show a slowdown in Mumbai compared to the entire State from the end of May 2020.

3. **Action 3 - Analyse Test Results to Understand and Eliminate Risks:** Percentage of positive test results observed weekly in Delhi, Maharashtra, and Tamil Nadu varied between 5 – 16%, 7 – 19%, and 1 – 8% respectively. Percentage of positive test results in Mumbai on 21, 22 and 23 May 2020 were less than 30%, over 50%, and about 35% respectively. The percentage of positive test results observed daily in West Bengal steadily decreased from over 4% to less than 1.5% during 5 – 16 May 2020 and then increased to about 4.5% during 17 May – 5 June 2020. Such significant and systematic variations in the same State suggests the existence of fundamental issues in the testing system that need to be addressed.

   A detailed study of testing with a specific focus on points of generation (district/ward/type of patient) and laboratories may provide crucial insights. For example, do specific channels like healthcare workers, routine test of patients before a medical procedure, migrant labourers, persons having contact history, and quarantined persons have different rates of positivity? Does the rate of positivity differ across districts/wards? Are test results from specific laboratories positive with a higher frequency compared to other laboratories? Accurate answers to these questions would lead to effective policymaking and control.

The goal is to turn data into information and information into insight.
– Carly Fiorina, Former CEO, HP

Detailed Report

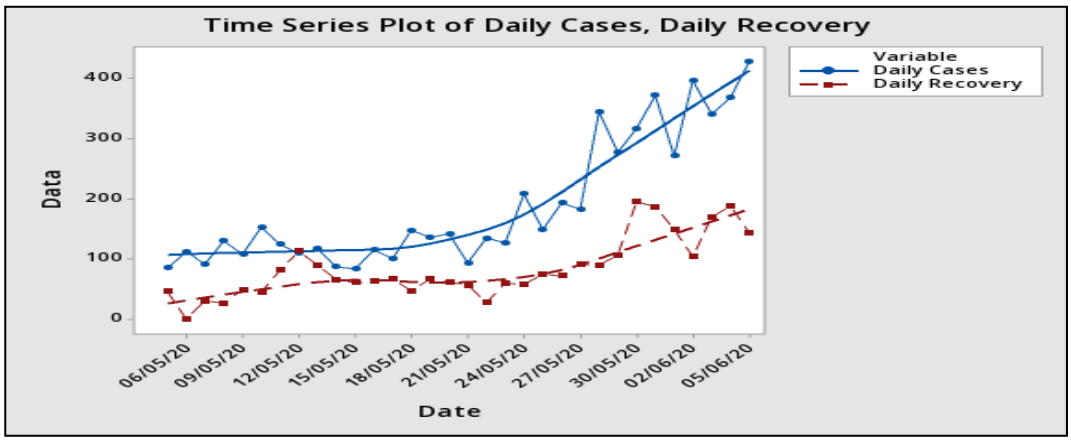
1. Action – 1: Improving Recovery and Reduction of Active Cases

The number of active cases depends on the rate of arrival of new cases and the rate of recovery. The ratio of arrival rate and recovery rate is called *Traffic Intensity*. Traffic Intensity greater than one implies a higher rate of arrival of new cases compared to recovery. Naturally, higher values of traffic intensity tend to inundate the healthcare system. We present the observed daily arrival, recovery, and traffic intensity for West Bengal, Kolkata and Mumbai. We subsequently present the cumulative cases, active cases, and hypothetical active cases for West Bengal and Mumbai to give an idea about the reduction in the number of active cases that could perhaps be achieved. The hypothetical active cases were computed assuming a certain level of improvement of recovery rate.

a. Daily Cases, Recovery, and Traffic Intensity for WB, Kolkata, and Mumbai

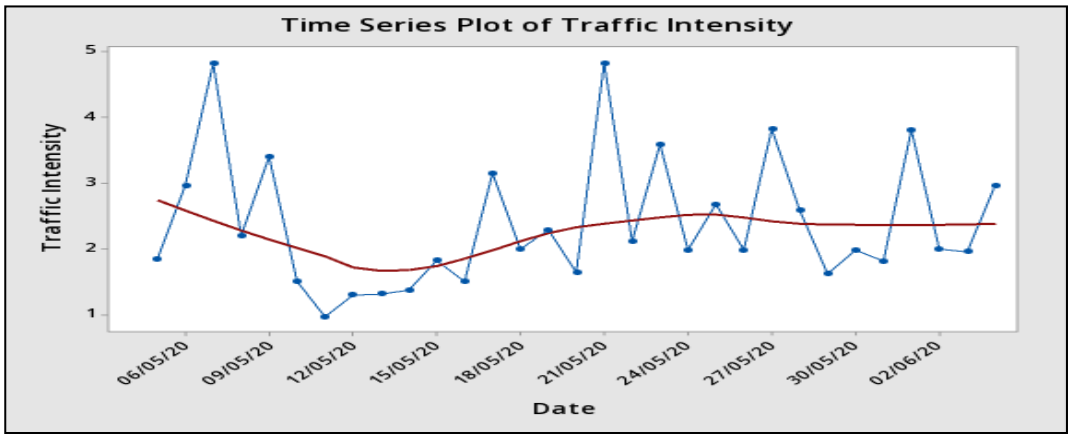
West Bengal: The daily cases and recovery for the State of West Bengal during 5 May – 5 June 2020 is given below. It is readily observed that the rate of recovery is often low and sometimes close to zero. Further, the increase of recovery is much slower compared to the arrival of new cases leading to a large gap between arrival and recovery, as shown below. The large gap between arrival and recovery increases the number of active cases and results in higher stress on healthcare resources.

Figure – I: Time Series Plot of Daily Cases and Recovery in WB



The traffic intensity for the State of West Bengal is presented below.

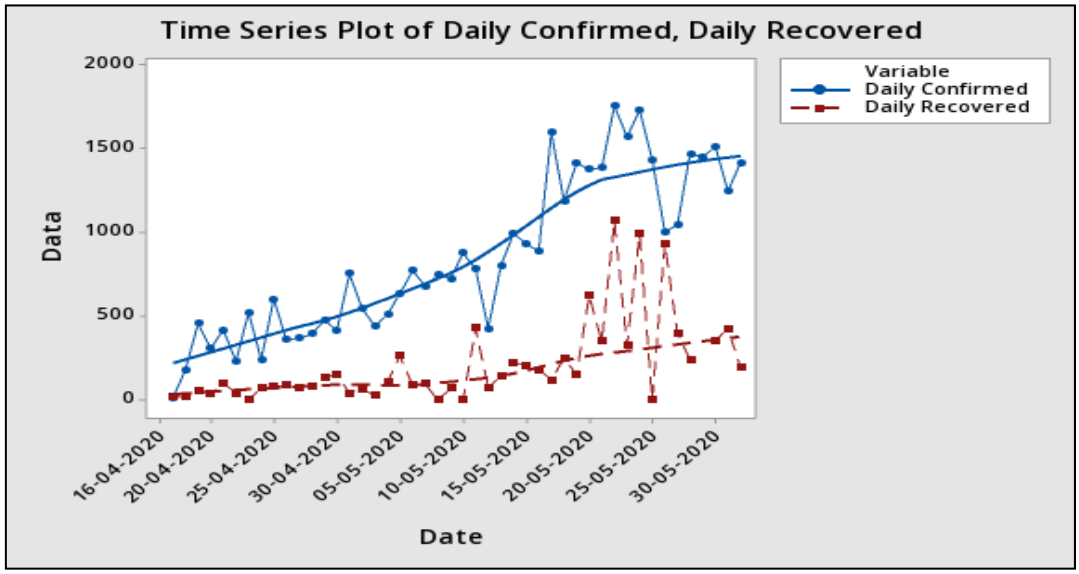
Figure – II: Traffic Intensity – West Bengal



The overall traffic intensity for West Bengal during 5 May – 5 June 2020 was observed to be 2.24 (total arrival / total recovery). The traffic intensity, observed daily, was often substantially less than 2. Thus setting a 40% improvement (i.e. a traffic intensity of 2.24 / 1.4 or 1.6) target does not appear to be unjustified.

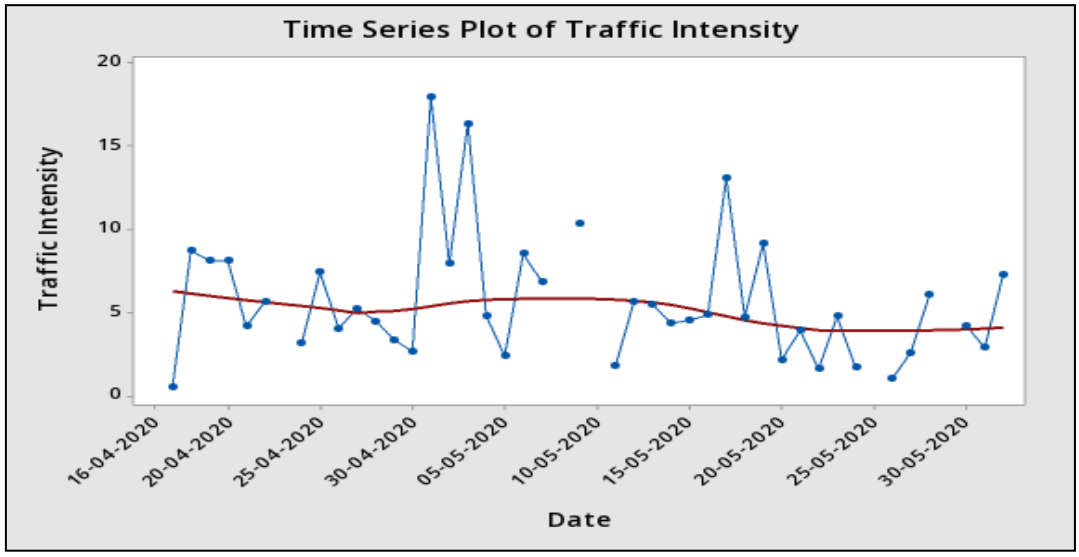
Mumbai: Time series plot of daily cases and recovery for Mumbai during 16 April – 1 June 2020 is given below.

Figure – III: Daily Confirmed and Daily Recovery in Mumbai



The increasing gap between daily confirmed cases and daily recovered cases is easily visible. The daily recovery was close to zero for about a month (from 16 April to middle of May 2020), followed by wide fluctuation, strongly indicating the presence of systemic issues. An examination of the time series plot of traffic intensity leads to similar conclusions.

Figure – IV: Traffic Intensity in Mumbai

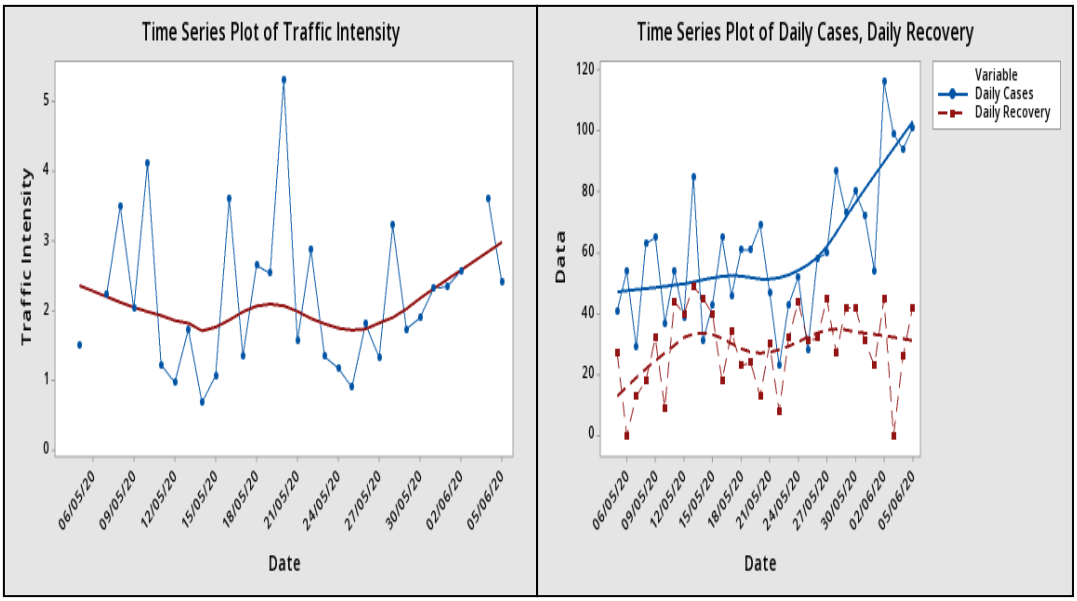


The time series plot of traffic intensity in Mumbai had several gaps as the number recovered was zero on several days. Further, the number recovered was fairly low on several other days, leading to traffic intensity close to or over 10.

Overall, the process of recovery appears to be unstable and bringing out substantial improvement should be feasible. The overall traffic intensity in Mumbai during 16 April – 1 June 2020 was 4.14. As substantial improvement appeared feasible, a target of threefold improvement may be set to bring the traffic intensity close to 1.

Kolkata: The time series plots of daily cases / recovery and traffic intensity during 5 May – 5 June 2020 for the city of Kolkata are given below.

Figure – V: Time Series Plot of Traffic Intensity and Daily Cases and Recovery in Kolkata

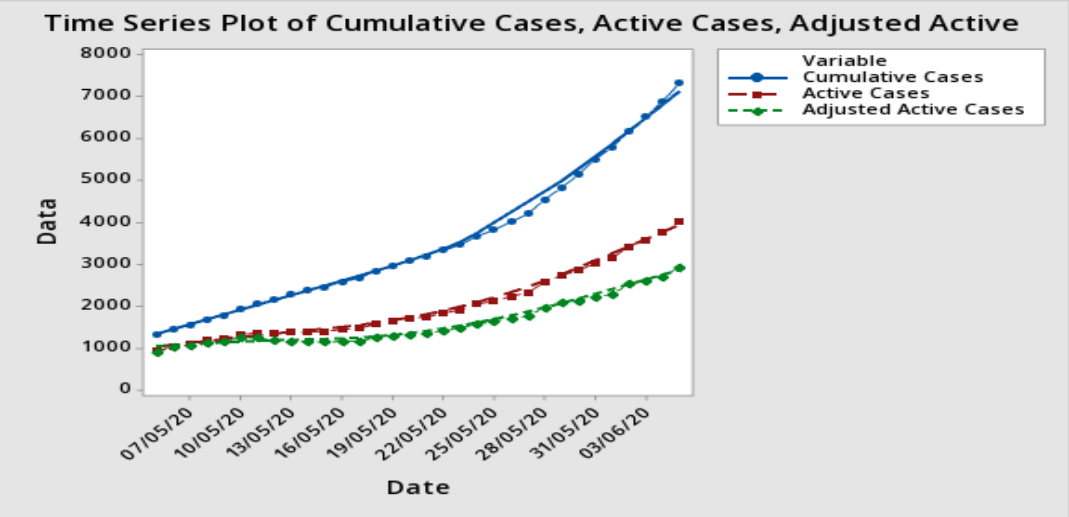


It is easily observed that daily recovery dipped towards the third week of May 2020. Traffic intensity shows a considerable variation with a couple of gaps as the recovery was zero in a couple of days. Clearly, the process of recovery needs attention.

b. Possible Reduction of Active Cases for West Bengal and Mumbai

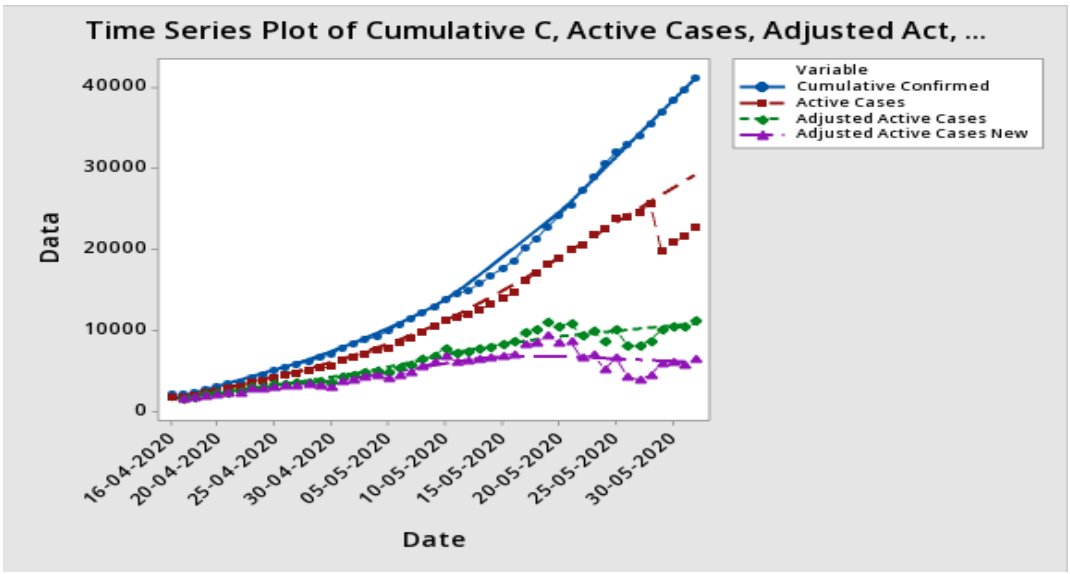
Having concluded that the processes of recovery in Mumbai, Kolkata and West Bengal have enough scope of improvement, we proceed to examine possible reductions of active cases by improving recovery. The possible reduction of active cases in West Bengal is given in figure VI. The green line shows the hypothetical active cases. It is easily observed that even with a modest (40%) improvement of number recovered, the number of active cases could possibly be brought down to less than 3000 from over 4000.

Figure – VI: Time Series Plot for Cumulative, Active, and Hypothetical Active Cases in WB



The time series plot for cumulative cases, active cases, and hypothetical active cases for Mumbai is given in figure VII.

Figure – VII: Time Series Plot for Cumulative, Active, and Hypothetical Active Cases for Mumbai



The process of recovery was found to be fairly unstable in Mumbai with an average traffic intensity of 4.14. A 2.5- to a 3-fold improvement of daily recovery is, therefore, required to ensure that the system does not get congested. Fortunately, the daily cases appear to be decreasing. Further, considerable variability in daily recovery suggests that significant improvement may not be infeasible. The above graph shows that a threefold improvement of recovery could have brought down the number of active cases from 22795 to 11763.

c. Conclusions

At present, the process of recovery is not being talked about much and does not seem to be the main focus area. However, recovery appears to have a significant potential for improvement. The process of recovery consists of several interdependent steps like sample collection, test, retest, and final approval before release. Such processes are known to have built-in delays, often in excess of 50% of the elapsed time. Study of recovery in West Bengal, Kolkata, and Mumbai revealed considerable variation and systematic pattern across days. This lends credence to the hypothesis that substantial improvement is possible. Construction of hypothetical plots for active cases, assuming certain improvement, shows that 30 – 50% reduction in the number of active cases over a medium-term (about six weeks) could have been achieved. Six Sigma methodology using a detailed process map of the recovery process may be used to understand and improve the process of recovery.

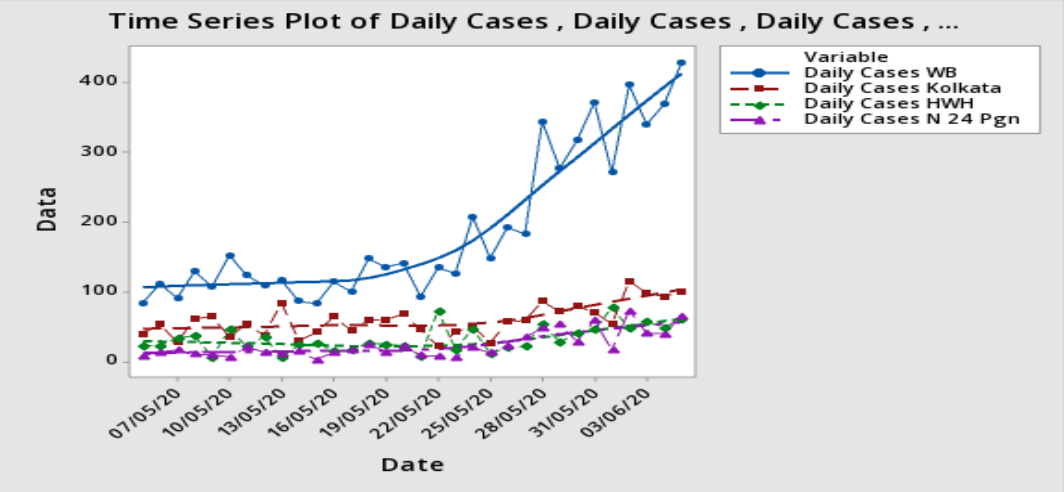
2. Action 2 – Developing Early Indicators to Assess Risk of Spread of Virus

At present, we often attempt to assess the risk of spread of the virus by looking at the cumulative number of cases in States or districts individually. This method of examination often fails to detect subtle changes in the pattern of occurrence. Time series plots of daily cases for the entire State along with important districts are more likely to bring out significant issues not easily detected by cumulative cases. We present the cases of West Bengal with its three most critical districts, namely Kolkata, Howrah, and North 24 Parganas as well as the case of Maharashtra and Mumbai, to clarify this point.

a. Study of Daily Cases in States and Districts

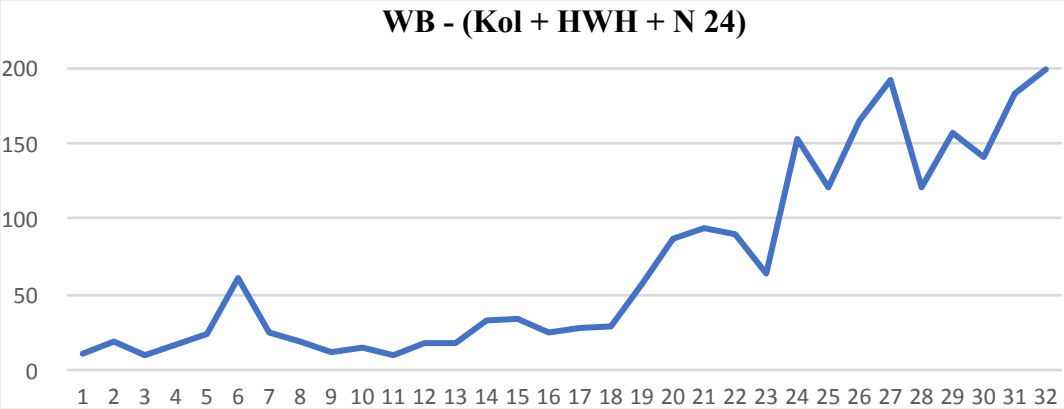
The time series plot of daily cases in West Bengal along with Kolkata, Howrah, and North 24 Parganas during 5 May – 5 June 2020 is given below.

Figure – VIII: Time Series Plot of Daily Cases in WB, Kolkata, Howrah, and North 24 Parganas



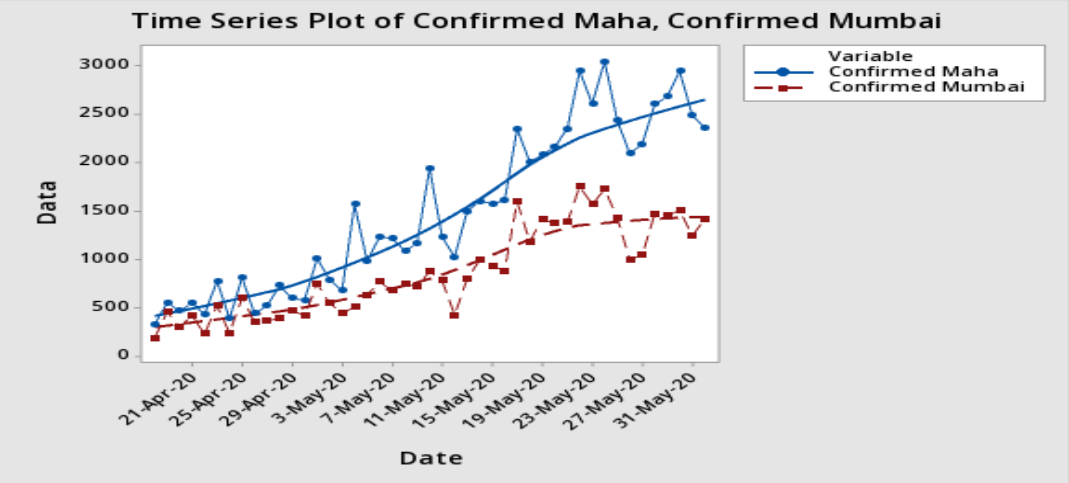
The daily cases in the State have taken an upward turn from the middle of May 2020 even though occurrences at Kolkata, Howrah, and North 24 Parganas remained about the same. The chart, therefore, works as a useful leading indicator. It is pertinent to mention that regular plotting could have identified the trend by 3rd week of May 2020 itself giving enough time to the State to initiate action. The following graph of the number of daily cases in West Bengal minus the three districts clarifies this point.

Figure – IX: Daily Cases of WB – (Kolkata + Howrah + North 24 Parganas)



The time series plot of daily cases for Maharashtra and Mumbai during 16 April – 1 June 2020 is given below.

Figure – X: Time Series Plot of Daily Cases in Maharashtra and Mumbai



It is important to note that there is a dip in the rate of daily new cases in Maharashtra in general, and Mumbai in particular, towards the end of May 2020. However, the dip appears to be more prominent for Mumbai compared to the entire State. It is necessary to examine whether the downward trend is real and whether it signifies a reduction of risk.

b. Conclusions

The practice of looking at cumulative cases only may miss out important points. Regular plotting of daily cases for the entire State along with important districts is likely to bring out actionable insights. The graph showing the difference between the daily cases in West Bengal and the three highest occurrence districts, namely Kolkata, Howrah, and North 24 Parganas brings out this point loud and clear. A downward trend in Mumbai might be occurring. However, this requires further examination. States are, therefore, well advised to plot daily cases along with districts for quick identification of change of trends.

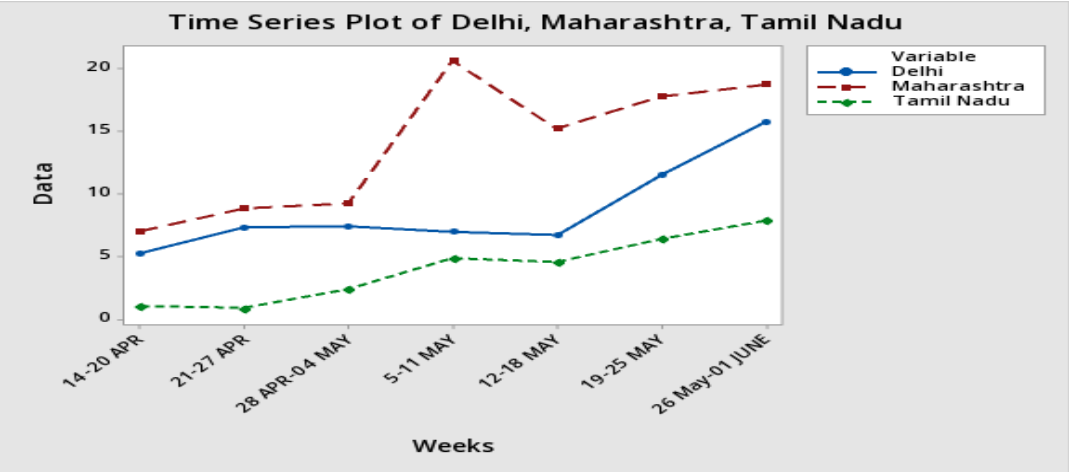
3. Action 3 – Analysing Test Results to Understand and Eliminate Risks

Testing is currently a focus area. Most States are in the process of carrying out more and more tests. The test results are generally reported on a cumulative basis. Even when daily tests are reported, the graphs/charts do not permit easy visualisation of patterns. In this report, we show the weekly and daily trends of different States, discuss the insights that could probably be extracted from these plots, and further data collection.

a. Weekly Trends of Delhi, Maharashtra, and Tamil Nadu

Time series plot of the percentage of positive test results for Delhi, Maharashtra, and Tamil Nadu for 7 consecutive weeks starting from 14 – 20 April is given below.

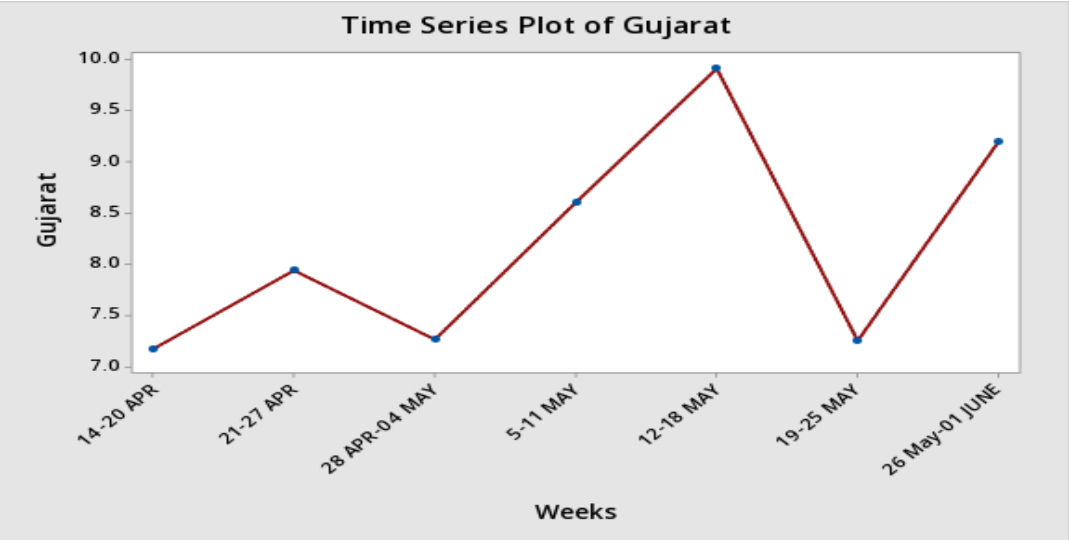
Figure – XI: Time Series Plot of Percentage Positive Cases in Delhi, Maharashtra, and Tamil Nadu



The percentage of positive results in Tamil Nadu, Delhi, and Maharashtra increased from 1 to 7.8%, 5.2 to 17.7%, and 7 to 18.7%, respectively. Such large variations, with increasing trend, suggest either a fundamental change in the characteristic of underlying population being tested or in the accuracy of the test or both.

b. Weekly Trend at Gujarat

Figure – XII: Weekly Trend of Percentage Positive Cases in Gujarat

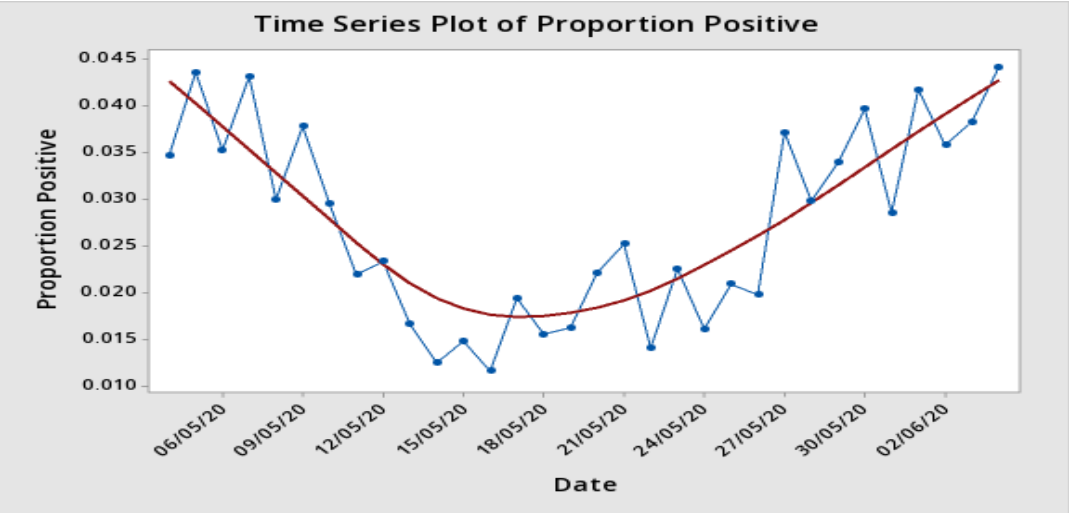


The above graph shows a substantial variation in the weekly percentage of positive test results in the State of Gujarat. Change of percentage positive by two percentage points or more in consecutive weeks indicates fundamental changes in the characteristics of the underlying population being tested or the accuracy of the test or both.

c. Daily Trend at West Bengal

The proportion of positive test results observed daily during 5 May – 5 June 2020 was plotted as a time series and the same is given below.

Figure – XIII: Daily Trend of Percentage Positive Cases in West Bengal



The percentage of positive test results reduced from over 4% to less than 1.5% from 5 – 16 May 2020. Subsequently, the proportion increased to over 4% during 17 May – 5 June 2020. As noted in earlier cases, this pattern indicates fundamental changes in the testing scenario over time.

d. Conclusions

Percentage of positive test results have wide variation and unexpected trend across consecutive days and weeks within the same State. Such large variability and trend require detailed investigation. Percentage of positive results may vary across:

- Types of persons tested (healthcare workers / other frontline workers like police/patients tested before medical procedure/migrant labourers/persons having contact history / quarantined persons and others)
- Geographic regions (districts / wards)
- Laboratories

Collection of test data, keeping identification of the factors mentioned above, and analysis of the same could lead to actionable insights and effective policy decisions.

4. Conclusions and Possible Actions

We have identified three significant threads of action:

a. **Focus on Recovery:** This appears to be a neglected but lucrative area. Recovery being primarily systemic, meaningful improvements may be possible by improving the supply chain. As demonstrated, an increase in daily recovery results in a significant reduction of active cases. This will free up resources and help to restore confidence regarding the capability of the healthcare system to ensure a quick recovery.

b. **Develop Early Indicators of Risk:** As demonstrated, studying daily arrival of new cases of the State along with important districts, often provides an early warning regarding the change of pattern of arrival of new cases. States should focus on plotting daily cases regularly and study the same to get an idea about the impending risks of the spread of the virus. Reacting to early indications is likely to reduce risk.

c. **Generate Actionable Insights from Test Results:** Rate of positive test results show wide variation and unexpected patterns when studied across consecutive days/weeks. Assessment of the variation of test results across different types of persons tested (healthcare workers / other frontline workers like police/patients tested before medical procedure/migrant labourers/persons having contact history / quarantined person), geographic regions (districts/wards) and laboratories can identify risky areas as well as opportunities for improvement.

Glossary of Terms

1. **Active cases on day** i = Cumulative cases till day i - Recovered cases till day i - Deceased cases till day i

2. **Cumulative cases till day** i = Total positive cases detected till the i^{th} day

3. **Cases on a day** i = Positive cases detected on the i^{th} day

4. **Percentage Positive on a day** $i = \frac{\text{Positive test results on } i^{th}\text{day}}{\text{Total tests on } i^{th}\ day}$

5. **Percentage Positive in week** $i = \frac{\text{Positive test results in } i^{th}\text{week}}{\text{Total tests in } i^{th}\ week}$

6. **Traffic Intensity** $= \frac{\text{Cases on } i^{th} day}{\text{Recoveries on } i^{th}\text{day}}$

Links

Dashboard 1 Dashboard 2