# ANALYSIS AND PREDICTION OF COVID-19 IN TAMIL NADU

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**Abstract**

This study investigates the efficacy of lockdowns and curfews using national Covid-19 data from India. The primary goals include anticipating active cases in Tamil Nadu and understanding the consequences of lockdowns and relaxations. Reliable secondary data was pre-processed, and EDA offered insightful information. Regression models were created for the lockdown and unlock phases in Tamil Nadu, determining the best-fit model for making future forecasts and investigating various procedures and techniques for precision.

**Keywords** Coronavirus, Covid-19, Tamil Nadu, Lockdown phases, Unlock Phases, Regression Models, EDA and WHO

## 1 Introduction

The first case of a novel virus was discovered in Wuhan, China, in December 2019, which was a significant development. The SARS-CoV-2 virus was found to be the infection's primary cause. The scientific world rapidly identified this virus as a "coronavirus," later known as "Covid-19". The development of Covid-19 has serious consequences, affecting a large population and resulting in multiple fatalities. Notably, because of migration from China to other parts of the world, the virus spread across international borders and into other countries. This global mobility was a major factor in the virus's rapid spread around the world. The World Health Organisation (WHO) promptly issued a stern warning, encouraging all governments to take quick action to protect the lives of their citizens, realising the seriousness of the situation [2]. The WHO's appeal to action emphasised the virus's potentially catastrophic implications and urged group efforts to stop its spread and lessen its effects on global public health.

COVID-19 initially appeared in India on January 30, 2020, with the first case ever recorded coming from China. A crisis developed as a result of the virus' quick spread, forcing the Indian government to respond quickly. A historic decision was made on March 24, 2020, and a 21-day nationwide lockdown was put into effect until April 14, 2020. Due to the virus's exceedingly contagious nature, which was mostly communicated through airborne droplets produced by coughing or sneezing, strict measures were necessary. Guidelines for social segregation were published, recommending individuals to maintain a safe distance from one another and telling those who were afflicted to quarantine. Thorough testing revealed many confirmed cases, which flooded hospitals and made it challenging to deliver adequate care. With 1.39 million reported deaths and 58 million confirmed cases worldwide, the figures depicted a bleak picture. With a population of 120 crore, India had enormous difficulties in keeping the virus under control. 9.14 million confirmed cases and 134,000 fatalities were reported nationwide, with Maharashtra being the worst-affected state. The Indian government extended the lockdown over several periods in order to protect lives and stop the virus' spread. However, as time went on, several easings were gradually added during the "unlocks." These policies intended to strike a compromise between concerns about public health and the restart of social and economic activity. The country persisted in fighting the pandemic as the situation changed, demonstrating resiliency and resolve in the face of unimaginable difficulties.

Regression is a statistical method for simulating the relationship between a dependent variable (also known as the outcome or target variable) and one or more independent variables (also known as predictor variables or characteristics) [9]. Regression analysis' main objective is to determine the relationship between changes in the independent variables and changes in the dependent variable. Regression's fundamental goal is to find a mathematical equation that best fits the data and captures the relationship between the dependent and independent variables [16]. Depending on the type of data, this equation is frequently a straight line (linear regression), but it can also be a curve or higher-order polynomial (non-linear regression) [17, 20]. A regression model, which is the end result of a regression analysis, can be used to forecast the values of the dependent variable based on the values of the independent variables. The model offers details on the direction and strength of the correlations between the variables as well as how much the independent variables contribute to the variance in the dependent variable [18]. Regression is frequently used to make predictions, explain the relationships between variables, and find significant elements that influence an outcome in a variety of disciplines, including economics, social sciences, engineering, finance, and machine learning [19].

Regression analysis has allowed researchers to better understand the impact of many factors on the course and outcomes of the COVID-19 pandemic. Researchers studying the relationships between COVID-19 cases, death rates, and other pertinent variables have employed regression analysis, as have public health experts and others. Regression models have been developed to identify the parameters that influence the severity and spread of the infection. In addition to independent variables including demographics, healthcare infrastructure, and policy-related variables, these models make use of historical data on COVID-19 cases and deaths [21]. These models have shed important light on how elements including population density, age distribution, healthcare capacity, and the use of social isolation measures affect COVID-19 death rates and its dissemination. Regression analysis has also made it possible to identify high-risk demographics and geographic areas, which will help policymakers better target their initiatives to lessen the effects of the virus. Regression has also been used to estimate the course of COVID-19 outbreaks, which helps with resource allocation and emergency preparation. These models can be regularly updated as new data becomes available to increase their accuracy and dependability. Regression analysis, which offers evidence-based insights into the variables driving a disease's transmission and severity, has, in summary, been vital in helping to understand the complexity of the COVID-19 pandemic. These discoveries have helped society and healthcare institutions around the world gain a better understanding of the virus and its effects. They have also informed public health decision-making.

## 2 Literature Survey

Establishing a statistical model for forecasting the course of COVID-19 fatality cases in Pakistan is the primary goal of this work. The study also used a descriptive methodology to illustrate the distribution of COVID-19 victims by gender and age [6]. In this work, a brand-new Support Vector Regression (SVR) technique is presented for examining five different tasks connected to the unique coronavirus. Our method, in contrast to conventional regression lines, uses support vectors to improve classification accuracy. Our method demonstrates promising results by being tested against established regression models on common datasets and showing superiority in terms of both efficiency and accuracy [7]. With R2 ratings of 0.99 and 1.0, respectively, the study's comparison of linear regression and multiple linear regression models demonstrated high predictive ability for predicting COVID-19 instances for the days ahead. The study estimated 52,290 active cases in India and 9,358 in Odisha for August 15th using Multiple Linear Regression, assuming the existing trend holds. These precise models demonstrate a significant relationship between independent variables (positive, deceased, and recovered cases) and active cases [8]. Covid-19 has developed a number of forms that have been categorised and examined as it continues to spread. The significance of various Covid-19 variations in terms of therapeutic strategies is discussed below, along with examples of each variety. For instance, substantial CT scan research on Covid-19 pneumonia has allowed radiologists to recognise patterns in atypical pneumonias that resemble Covid-19, assisting in correct diagnosis and treatment [10]. Using the Fuzzy Inference System (FIS) and Deep Neural Network, the Hybrid Diagnose Strategy successfully and accurately identified Covid-19 patients. This method fared better in terms of accuracy, error, precision, and macro-average than more current methodologies, proving its efficacy in diagnosing Covid-19 patients [11]. Using a deep transfer learning network, instances of Covid-19, pneumonia, and tuberculosis were automatically identified from X-rays [12]. Using a Fuzzy integral-based CNN ensemble, Covid-19 was found in the lungs [13]. It was decided to examine the Covid-19 epidemic using fuzzy graphs [14]. Regular Covid-19 Pneumonia Severity Biomarkers in Kidney Transplant Recipients May Display Disparate Results [15].

## 3 Methods and Process

This section focuses on data preparation, going into the process of refining and organising collected data. Additionally, it offers a thorough analysis of regression models and a thorough description of data visualisation using charts.

### 3.1 Data Pre-Processing

A supplementary dataset obtained from Kaggle initially collects thorough data on coronavirus cases in India from January 30, 2020, to September 29, 2020. This dataset includes 6806 observations that fall under the following 8 categories: Time, Date, State/Union Territory, Confirmed Domestic Cases, Confirmed Foreign Cases, Confirmed, Cure, and Deaths. Repetitive data is deleted to improve the dataset's quality and relevance to the study. In particular, columns that do not advance the data analysis or provide insightful information are found and removed. As a result, the variables "Confirmed Indian national," "Time," and "Confirmed Foreign national" are disregarded because they frequently have missing values (more than 90% of the time). The dataset is refined after these redundant variables are eliminated, and this refined dataset forms the basis for the succeeding regression models. This condensed dataset guarantees a more precise and illuminating analysis, facilitating the examination of significant correlations between the remaining variables.

### 3.2 Visualisation of Data Using Plot

In comparison to verbal explanations, data visualisation through plots gives a highly effective way to understand the dataset. As a result, different plots are used to visualise the obtained data. The dataset is divided into several "lockdown phases," with each phase having its own data. The top 5 states most affected by each lockdown phase are determined in order to get insightful information. Graphs showing the correlation between confirmed cases and cured patients, as well as between confirmed cases and death cases, are presented during each lockdown period. With a total of 9,07,212 confirmed cases, 6,44,400 cured cases, and 26,604 death cases, Maharashtra stands out among the states as being the most severely afflicted throughout the lockdown periods. An important finding is made about Tamil Nadu, which continuously ranks among the top 5 afflicted states and has varied rates of active case increase across distinct lockdown phases. This analysis helps to comprehend the fundamental causes of the variations in the virus's impact and fatality rates in Tamil Nadu during each lockdown. The same methodology is also applied to the "unlock phases," allowing for a thorough knowledge of the dataset during these different phases of lifting limitations. These visual representations are useful aids for understanding the dynamics of the COVID-19 virus's transmission and its effects on various states throughout lockdown and unlock periods.

### 3.3 Prediction Model

Building a regression model becomes vital in the pursuit of our objective. A regression model is specifically created to forecast the quantity of confirmed cases. By fitting a linear equation to the observed data, we use linear regression to attempt to model the connection between two variables. One variable is used in this situation as the explanatory variable, and the other one is used as the dependent variable. By making it easier to comprehend how variations in the explanatory variable affect variations in the number of confirmed cases, this regression model will ultimately offer insightful information on the dynamics of the COVID-19 outbreak.

Regression: $Y = a + bX$, Where X is the explanatory variable and Y is the dependent variable. The slope of the line is b, and a is the intercept

The dataset for Tamil Nadu was used to extract pertinent information, with a particular emphasis on the correlation between the number of confirmed COVID-19 instances and the related dates. The number of confirmed cases (Confirm cases) was used as the dependent variable (Y) in a regression model, while the dates were used as the explanatory variable (X). This regression model proved crucial in predicting upcoming active cases and offering insightful information for predicting the pandemic's course. Two assessment techniques—the Mean Absolute Percentage Error (MAPE) and the min-max accuracy—were used to thoroughly test the developed model's accuracy in order to guarantee its dependability. These evaluation techniques evaluated the model's ability to predict outcomes, allowing for a thorough understanding of its effectiveness in identifying patterns and promoting well-informed decision-making for managing and regulating COVID-19 in Tamil Nadu.

The correlation between Date and Confirmed instances in this instance for the state of Tamil Nadu is 0.9087, which is a very high correlation. The number of active cases will increase during the days.

## 4 LOCKDOWN AND UNLOCK PHASES

A significant burden on the healthcare system and a number of fatalities were caused by the COVID-19 outbreak that India experienced in March 2020 [1]. The Indian government acted decisively and enacted a Nation-Wide lockdown with different measures, including a curfew from March 25 to April 14, 2020, in reaction to the worsening crisis and to protect the populace from new diseases. Despite these measures, the rate of infections remained high, prompting the continuation of the lockdown in four phases in order to slow the virus's spread and cut down on the number of affected individuals. Table 1 shows the dates of the lockdown.

**Table 1: Lockdown phase**

| *LOCKDOWN PHASES* | *DATES* |
|---|---|
| *Phase 1* | 25-Mar-2020 –14-Apr-2020 ,21 days |
| *Phase 2* | 15-Apr-2020 – 03-May-2020,19 days |
| *Phase 3* | 04-May-2020- 17-May-2020,14 days |
| *Phase 4* | 18-May-2020 -31-May-2020,14 days |

The Indian government implemented a series of steps known as the "Unlock phases" after the lockdown phases were finished in an effort to loosen the stringent limitations that had been put in place. Six stages of the Unlock phases' implementation, which lasted until November, were completed. The administration aimed to return different parts of everyday life to normalcy through these incremental easings while still taking the essential safety measures to protect the public's health. Table 2 contains the unlock phase's dates.

**Table 2: Unlock Phase**

| *Unlock phases* | *Dates* |
|---|---|
| *Phases 1* | 1 Jun 2020 – 30 Jun 2020 (30 days) |
| *Phase 2* | 1 Jul 2020 – 31 Jul 2020 (31 days) |
| *Phase3* | 1 Aug 2020 – 31 Aug 2020 (31 days) |
| *Phase4* | 1 Sep 2020 - 30 Sep 2020 (30 days) |
| *Phase5* | 1 Oct 2020 - 31 Oct 2020 (31 days) |

| | |
|---|---|
| *Phase6* | 1 Nov 2020 - 30 Nov 2020 (24 days) |

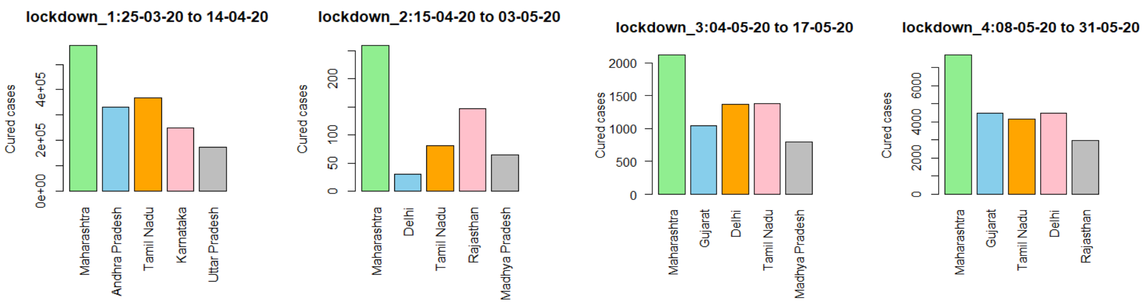
**Note:** Here the study deals with data up to September only.

## 5 EXPLORATORY DATA ANALYSIS

Exploratory Data Analysis (EDA) is used to generate important insights for forecasting. The maximum affected condition for each shutdown phase is determined throughout the EDA process by choosing a certain date and retrieving pertinent data points. The data for the most afflicted states in terms of cured patients and death cases is then plotted using visualisation tools. This enables a comparison of Tamil Nadu's performance in terms of deaths and cases that were healed throughout each lockdown period. It is clear from the research in Figure 1 that MAHARASHTRA is the state that is most adversely affected, although Tamil Nadu shows changes in healed cases during various lockdown phases. This finding suggests that the government may have been successful in containing death instances by implementing specific circumstances throughout the lockdown stages.

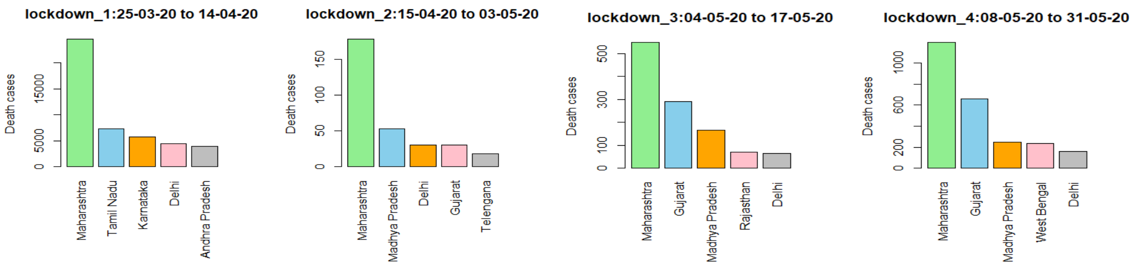
From Fig. 1 and Fig. 2. Tamil Nadu was the third-most afflicted state at first. The affected patients, however, received good care and were cured. The situation worsened on March 31 when 100 confirmed cases were reported. Due to people moving around to acquire groceries and moving to safer neighbourhoods to protect their family, Chennai, the state's capital, is experiencing an increase in active cases every day. 8000 confirmed cases were reported on May 11; this scenario of a rise in the number of active cases is thought to have occurred as a result of the order to open TASMAC on May 7.[3] However, treatment led to 100 cured patients in phase 3 and 500 in lockdown phase 2 as a result of treatment.

Fig 1. Maximum affected state with cured cases for 4 lockdown phases




According to the study shown in Figure 2, it is clear that MAHARASHTRA is the state that is most affected, as there are a greater number of mortality cases there. Contrarily, Tamil Nadu (TN) experienced a greater number of fatalities only during the first part of the lockdown, indicating that the safeguards put in place during the lockdown were successful in lowering the number of fatalities. Notably, on March 7, Tamil Nadu announced its first COVID-19 case. On April 12, as the situation continued to develop, the state recorded 1000 active cases and 10 fatalities. On April 28, there were 2000 active cases, along with 28 death cases. These facts highlight how crucial prompt actions are in halting the virus's spread and reducing the pandemic's effects in Tamil Nadu.

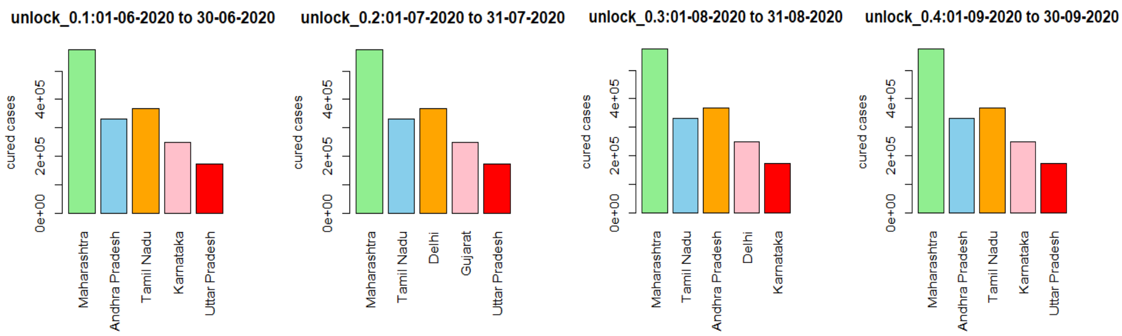
Fig 2. Maximum Affected State with maximum death cases for 4 phases




To check the same for unlock phases, a specific date for each unlock phase is selected and checked. From the analysis, Fig 3 clearly shows that MAHARASTRA is the maximum affected state during unlock.

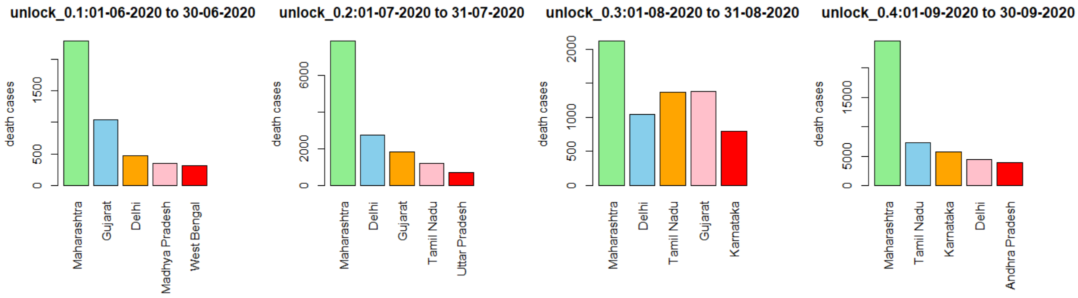
According to the data analysis, Tamil Nadu showed changes in the number of cases that were successfully treated during each lockdown phase, demonstrating the state's attempts to manage and control death instances even during the unlock periods. The number of confirmed cases did, however, clearly grow throughout this time. On May 29, the lockdown was extended into Phase 4, and as of that day, the state reported 20,000 active cases. After 50,000 active cases were recorded on June 17, inter-transport movements were restricted on June 25 in response to a large increase in active cases. Despite these difficulties, Phase 4 saw a favourable trend as the number of healed cases topped the number of daily active cases, indicating some success in slowing the virus's spread in Tamil Nadu.

Fig. 3 Maximum Affected State with Cured cases for Unlock phases




The study, which is clearly shown in Figure 4, demonstrates that MAHARASHTRA emerges as the state that is most impacted during the unlock phases. In contrast, during unlock stages 2, 3, and 4, there were more fatalities in Tamil Nadu (TN). Phase 3 distinguishes out among these phases since there were a lot of deaths during the unlock time. Notably, there was a worrying uptick of 100 fatalities reported on a single day in the month of August, with a significant concentration of cases documented in Chennai. These results highlight the difficulties Tamil Nadu encountered during the unlock phases, particularly in managing and containing fatality cases, with particular attention on the significant increase during phase 3 and the strain this put on Chennai's hospital system.

Fig 4 Maximum Affected State with Death cases for Unlock phases




Due to rigorous lockdown regulations and their relaxation with certain mitigations, TN has reduced its mortality instances compared to other states while increasing the number of cure cases.

## 6 RESULTS

The primary goal of this study is to develop the most accurate predictive model for forecasting Tamil Nadu's confirmed case data. To achieve this objective, Regression analysis is employed as the chosen predictive modelling technique.

The data pertaining to Tamil Nadu was extracted from the dataset, and subsequently, Lockdown phase 1 data was utilized as the training dataset, while Lockdown phase 2 data served as the test dataset to forecast the active cases for that particular phase. The primary objective of this task was to predict the active cases for the upcoming lockdown phases and then compare these predicted values to evaluate the accuracy of the regression model. The overarching aim was to construct and compare regression models that could effectively forecast future active cases. This predictive analysis provides valuable insights into the potential level of virus spread, enabling the government and citizens to devise appropriate plans and measures to tackle the situation. By implementing various mitigation strategies and necessary actions, they can work towards minimizing the spread of the virus and managing the COVID-19 situation effectively [4].

The date is used as an independent variable and the quantity of confirmed cases as a dependent variable in this study's training data. The dataset is trained using linear regression. The formula is used to create a regression line that allows the model to predict the number of daily active instances in the test data. In the Tamil Nadu statistics, this procedure is repeated for each lockdown stage. The key advantage of this method is the ability to evaluate the model's performance meaningfully by comparing the anticipated results with the actual values. A bar plot used to visualise the results of this comparison makes it easier to grasp how accurate and successful the forecasts were.

Illustration for the Regression of lockdown phase1

**Regression: lm (formula = Confirmed ~ Date, data = lockdown_1)**

A linear regression analysis application is shown by the formula that was previously presented. The dataset in this context contains information about the first lockdown in Tamil Nadu, designated as "Lockdown_1." The date is used as the independent variable in the analysis, while the confirmed cases are used as the explanatory variable. The model uses Linear Regression to predict the number of confirmed cases for each distinct date in the dataset, enabling a thorough understanding of the relationships between variables and their potential influence on the COVID-19 outbreak during the initial lockdown period.

MinMaxAccuracy and MAPE are two methodologies that have been used to evaluate the model's accuracy. A number near 1 denotes a perfect fit, and the MinMaxAccuracy indicates how closely the model's predictions match the actual data. The relative accuracy of the model's predictions is measured instead by MAPE (Mean Absolute Percentage Error), and a number close to 0 denotes a perfect fit. For easy reference and comparison, the results of each of these strategies are shown in the table below along with the R2 values for each model.

**Table 3: MinMaxAccuracy**

| | R-squared | MAPE | MinMaxAccuracy |
|---|---|---|---|
| Phase 1 & 2 | 0.9613 | 0.0395 | 0.9604 |
| Phase 2 & 3 | 0.9406 | 0.5115 | 0.4884 |
| Phase 3 & 4 | 0.9968 | 0.0384 | 0.9616 |
| Phase 4 & 1 | 0.9986 | 0.2641 | 0.7358 |
| Phase 1 & 2 | 0.9751 | 0.2600 | 0.7399 |
| Phase 2 & 3 | 0.9877 | 0.0723 | 0.9276 |
| Phase 3 & 4 | 0.9998 | 0.0035 | 0.9965 |

The table shows R-squared values above 90%, demonstrating the robustness of the model in capturing the underlying patterns by fully accounting for changes in the response variable around its mean. Additionally, the min-max accuracy lies between 0.4 and 0.99, indicating a well-fitted prediction model with the capacity to precisely anticipate the active instances for the following days. This information, which is backed up by reference [5], highlights how trustworthy and successful the model is at delivering accurate predictions.

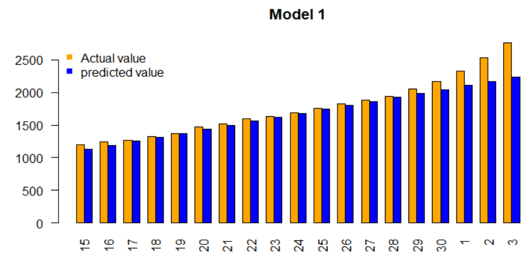



Fig 5. Actual vs Predicted for lockdown 1as training and lockdown 3 as the test dataset

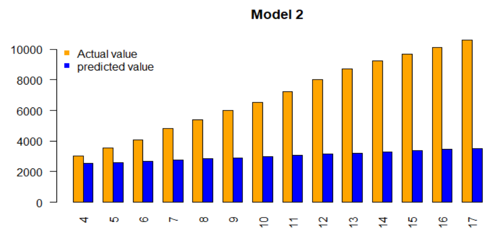



Fig 6. Actual vs Predicted for lockdown 2 as training and lockdown 2 as the test dataset

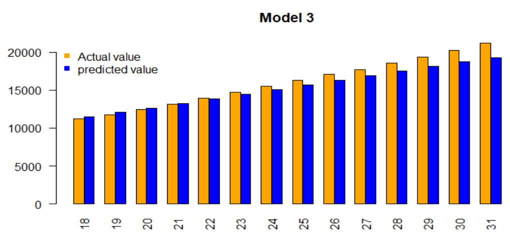



Fig 7. Actual vs Predicted for lockdown 3 as

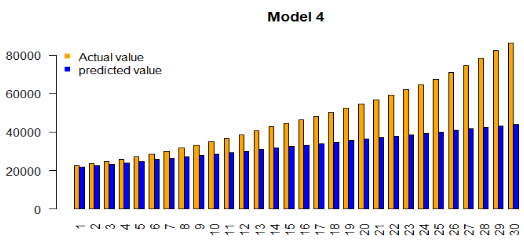



Fig 8. Actual vs Predicted for lockdown 4 as

training and unlock 1 as the test dataset

training and lockdown 4 as the test dataset

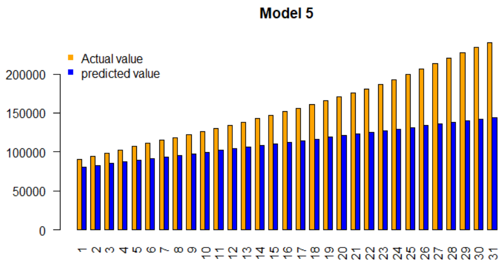



Fig 9. Actual vs Predicted for lockdown 4 as training and unlock 3 as test dataset

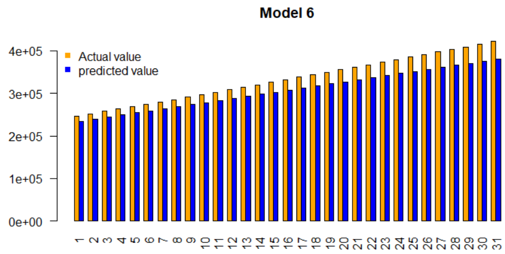



Fig 10. Actual vs Predicted for unlock 2 as training and unlock 1 as the test dataset

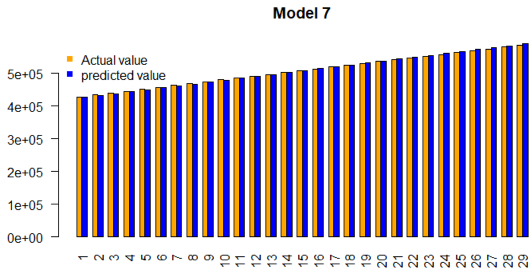



Fig 11. Actual vs Predicted for unlock 3 as training and unlock 4 as test dataset

## CONCLUSION

The objective of this study was to create a regression analysis that would serve as the best possible prediction model for upcoming COVID-19 cases. The model showed how well it predicted cases by looking at lockdown phases. Because lockdown measures were successful in reducing deaths up until September, the model shows promise for continued use in forecasting further cases. Regression analysis was used, and it met the goals of the research by offering useful insights into data investigation. By examining time series forecasting methods and other mathematical prediction models, future studies could build on these findings. The regression model's accuracy, as measured by MAPE and Min-Max Accuracy, varied from 0.0035 to 0.5115 and 0.4884 to 0.9965, respectively, demonstrating its dependability in forecasting real values. The development of efficient programmes to manage COVID-19 patients would be assisted by these predictive capabilities for healthcare providers and government officials. In Tamil Nadu, managing active cases and reducing mortality required tight adherence to lockdown procedures as well as appropriate medical therapies, according to a study.

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