Journal of New Frontiers in Healthcare and Biological Sciences

ISSN 2719-2385 (Online)

Volume 1, Issue 1, 2020, 26 -42

Home page: www.imathm.edu.lk/publications

IMM

Estimate and Forecast COVID -19 Pandemic in Victoria, South Australia, and Capital Territory of Australia

K.M.U.B. Konarasinghe
Institute of Mathematics and Management, Sri Lanka

udaya@imathm.edu.lk

ABSTRACT

Australia is one among the countries which neutralized the spread of COVID 19. Now they are waiting to reopen the state after locked down for several months. Objectives of the study are to estimate and forecast the amount of infected cases of COVID -19 in Victoria (Vic), South Australia (SA) and Australian Capital Territory (ACT), as they might be guideline for reopening the states. The daily confirmed cases of COVID-19 of the Vic, SA and ACT for the period of 22nd January 2020 to 15th June 2020 were obtained from the World Health Organization (WHO) database. Both descriptive and inferential statistics were used for data analysis. Time series plots, Auto Correlation Functions (ACF), and Partial Auto Correlation Functions (PACF) were used to examine the pattern of the series. The Auto-Regressive Integrated Moving Average (ARIMA) and Linear Trend Models were tested to forecast the pandemic. The Anderson Darling test, ACF, and Ljung-Box Q (LBQ)-test were used to test the validation criterion and fit the model. The forecasting ability of the models was assessed by two measurements of errors; Route Mean Square Error (RMSE), and Mean Absolute Deviation (MAD) in both model fitting and verification process. It is concluded that there is a 99% possibility that population means of daily infected cases in Vic, SA and ACT are 9, 2 and 1 consecutively. The patterns of daily infected cases in SA and ACT have reached the zero level. Number of infected cases in Vic would tend to zero by 2nd October 2020.

Keywords: Infected Cases, Linear Trend, COVID-19

1. INTRODUCTION

1.1 Background of the Study

The COVID -19 became the worldwide crisis in the middle of the year 2020. Some countries still locked down and their authorities dedicated to combating the epidemic with their resources. The spread of pandemic among each continent was unbelievable and doubtful. As per the World Health Organization (WHO) reports, over 3 million active cases and over 400,000 deaths reported worldwide. Europe and the USA grappled with the worst outbreak and paralyzed their health system. USA and Brazil suffered from the highest number of infected cases at the current. UK has reported the second-highest death total after the USA. At present, the outbreaks in several countries were satisfactorily controlled. Australia is one of them that seem to be controlled infected cases tremendously compared with their middle of the outbreak. According to the WHO reports, 6703 recovered among 7260 total confirmed cases and 102 deaths. The recovery rate indicated more than 90%. The epidemic infected rate in Australia is 0.02%. Still, the country is locked down and waiting to reopen as they need to make sure the sleek run as was usual. WHO reports show the fast decline of infected cases in Australia and zero community spread, but the governing authorities need a transparent future for their decisions. Australia consists of six states and three internal territories. The study was focused on two adjoining states and the main administrative territory at this stage.

1.2 Research Problem

Estimating and forecasting infected cases play a crucial role choose to combat the pandemic and convey back a country to a sleek run. An outsized number of researchers dedicated to model COVID -19 for various countries round the globe. Their findings would be highly valued, and it may be a lighthouse to beat the pandemic and turned their countries to normal. The eye paid by global researches in Australia is extremely less. The Australian authorities have to understand the future behavior of the pandemic spread state wise for their future decisions and policy making. Hence, this study was focused to fill the knowledge gap.

1.3 Objective of the Study

The objectives of the study were to estimate and forecast the amount of infected cases of COVID -19 in Vic, SA, and ACT of Australia.

1.4 Significance of the Study

The results of this study would be a lighthouse for proactive decisions to make sure sleek functions in Australia. The results provide a much better picture of the future behavior of the pandemic of each state in Australia. Authorities can decide which parts to be reopened, restrict movements, and impose mandates to combat the pandemic. Pre-plan for manufacturing volumes of personal Protective Equipment (PPE) kits and other medical equipment would be another sign of the study.

.

ISSN 2719-2385 (Online)

2. LITERATURE REVIEW

The study reviewed research papers related to the modeling pandemic in various countries. Giuliani, et al., (2020) have modeled the number of infections in several provinces in Italy. They have applied Spatio-temporal models. The study of Massonnaud, et al., (2020) based on the Susceptible-Exposed- Infectious-Removed (SEIR) model to estimate the number of cases, hospitalizations, and deaths in France. Al-qaness, et.al. (2020) have applied improve Adaptive Neuro-Fuzzy Inference System (ANFIS) to estimate and forecast the number of confirmed cases in China. Anastassopoulou, et.al., (2020) has applied the Susceptible, Infectious, Dead and Recovered (SIDR) model, to provide estimations and forecast of the basic reproduction number (R_0), and therefore the per day infection mortality and recovery rates in Hubei, China. Petropoulos & Makridakis (2020) have applied Exponential Smoothing techniques to forecast confirmed cases, deaths, and recoveries of worldwide. Modified susceptible-exposed-infected-removed (SEIR) epidemiological model was the application of Yang, et. al.,(2020). They wanted to predict trends of virus transmission in Zhejiang, Guangdong, and Hubei provinces and nationwide in China. Giordano, et. al., (2020) have applied SIDARTHE Mathematical Model (S, Susceptible, I, Infected, D, Diagnosed, A, Ailing, R, Recognized, T, Threatened, H, Healed; E, Extinct (dead)) to estimate the infected cases in Italy. Ahmadi, et.al.,(2020) have forecasted trends of epidemic in Iran by Gompertz and Von Bertalanffy models. Konarasinghe (2020-a) has applied the Autoregressive Integrated Moving Average (ARIMA), Autoregressive Distributed Lag Models (ADLM), and Double Exponential Smoothing (DES) to forecast epidemic in USA, UK, and Russia. Konarasinghe (2020-b) has applied ARIMA, ADLM, DES technique, Linear, Quadratic, Growth Curve, and Pearl- Reed Logistic trend models to forecast the epidemic in India and Brazil. The Ace Mod has applied by Chang, et.al., (2020) to forecast pandemic in Australia. SEIR model has applied by Moss, R.,(2020) to forecast pandemic in Australia.

According to the literature, mathematical models, statistical models, and soft computing techniques were applied by most of the researches to forecast pandemic. Some of the models are; SEIR, SIDR, SIDARTHE, Gompertz, Von Bertalanffy, ARIMA, ADLM, DES, Linear, Quadratic, Growth Curve, and Pearl-Reed Logistic models. Soft computing techniques like ANFIS also has applied to forecast and estimate the pandemic. Aside from Gompertz, Linear, Quadratic, and Pearl-Reed Logistic models, all the other techniques were successful for various states and countries. Researchers have forecasted the pandemic of the mainland of Australia, but the concentration was very less on forecasting pandemic in state wise.

3. METHODOLOGY

The daily confirmed cases of COVID-19 of the Vic, SA and ACT of Australia for the period of 22nd January 2020 to 15st June 2020 were obtained from the WHO database. At first the descriptive statistics and confidence intervals were obtained. Then hypotheses tests for population mean of Vic, SA and ACT were conducted. Thirdly the ANOVA technique was applied for mean comparison of them.

ISSN 2719-2385 (Online)

Pattern recognition of a data series paves the path for model selections (Konarasinghe, 2020).It gives an insight into the trends, seasonal variations, cyclical variations, and volatility within the precise period of time (Konarasinghe, 2020). Therefore, time series plots, Auto Correlation Functions (ACF), and Partial Auto Correlation Functions (PACF) were used for the aim, as done by Konarasinghe & Abeynayake (2014). Supported by the pattern recognition, the Auto Regressive Integrated Moving Average (ARIMA) and Linear Trend Models were tested to forecast the pandemic. The Anderson Darling test, ACF, and Ljung-Box Q (LBQ)-test were used to test the validation criterion and fit the model. The forecasting ability of the models was assessed by two measurements of errors; Route Mean Square Error (RMSE), and Mean Absolute Deviation (MAD) in both model fitting and verification process, as per Konarasinghe, et al. (2015).

3.1 Confidence Intervals for Population Mean

The confidence interval (CI) is an interval estimate of an unknown population parameter. It is a random interval constructed, so that it has a given probability of including the parameter. For example; consider a population with unknown parameter θ. If the confidence interval (a, b) such that; P (a < θ < b) = 0.95, we can say that (a, b) is a 95% confidence interval for θ. It implies that there is a 95% chance for θ to lies within the interval. Consider a normal population; $X \sim N(\mu, \sigma^2)$ where   and σ are the population mean and variance respectively. The population mean is an unknown parameter; hence the sample mean can be used to obtain the CI for ; CI for $\mu = \bar{X} \pm \sigma / \sqrt{n}$ where n is the sample size.

3.2 Hypothesis Test for Population Mean

Suppose a sample has drawn from a normal population with unknown mean   and known variance σ^2. Then the hypothesis test for population mean is written as;

H_0: $= {}_0$

H_1: $\neq {}_0$ or $< {}_0$ or $> {}_0$

H_0 is called the null hypothesis and H_1 is the alternative hypothesis. If statistical tests show that null hypothesis is rejected, we favor the alternative hypothesis (Amarakoon, et. al., 2020).

Let H_0: $= {}_0$

H_1: $\neq {}_0$ or $< {}_0$ or $> {}_0$

The test statistic $z = \dfrac{\bar{X} - \mu}{\sigma / \sqrt{n}}$

ISSN 2719-2385 (Online)

Significance level is denoted by α. Accordingly, Z_α can be found from the normal distribution table. If test statistic > Z_α, then H_0 is rejected. If the sample has not come from a normal population or a sample size is small, the t-test is used for the purpose. The test statistic of the t-test is, $T = \frac{\bar{X} - \mu}{S/\sqrt{n}}$; s is the sample standard deviation

3.3 Hypothesis Test for Mean Comparison

Consider two random samples, sizes n_1 and n_2, came from normal populations where,

$X_1 \sim N(\mu_1, \sigma_1^2)$; $X_2 \sim N(\mu_2, \sigma_2^2)$

Hypothesis test for mean comparison is;

$$\begin{aligned} H_0 &: \mu_1 = \mu_2 \\ H_1 &: \mu_1 \neq \mu_2 \\ &\text{or } \mu_1 > \mu_2 \\ &\text{or } \mu_1 < \mu_2 \end{aligned}$$

The test statistic for Z test can be obtained using sample means;

$$Z = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - (\mu_1 - \mu_2)}{\sqrt{\left(\sigma_1^2/n_1 + \sigma_2^2/n_2\right)}}$$

If the populations are not normally distributed or population standard deviations are unknown or samples are small, then the t-test can be used, where;

$$T = \frac{\left(\bar{X}_1 - \bar{X}_2\right) - (\mu_1 - \mu_2)}{S_p\sqrt{\left(1/n_1 + 1/n_2\right)}}$$

where S_p is the pooled standard deviation.

3.4 Auto Regressive Integrated Moving Average (ARIMA)

An ARIMA model is given by:

$$\phi(B)(1-B)^d y_t = \theta(B)\varepsilon_t$$

ISSN 2719-2385 (Online)

Where; $\phi(B) = 1 - \phi_1 B - \phi_2 B^2 ....\phi_p B^p$

$\theta(B) - 1 - \theta_1 B - \theta_2 B^2 ......\theta_P B^q$ (1)

ε_t = Error term

D = Differencing term

B = Backshift operator ($B^a Y_t = Y_{t-a}$)

3.5 Linear Trend Model

Trend analysis fits a general trend model to time series data and provides forecasts (Konarasinghe, 2015). This study has applied linear trend model and the models follows:

$$Y_t = \alpha + \beta \text{ t} + \varepsilon \quad (2)$$

4. RESULTS

The analysis contains four main parts:

4.1 Descriptive statistics.
4.2 Inferential statistics.
4.3 Pattern recognition.
4.4 Forecasting pandemic.

Initially, the descriptive statistics obtained for Vic, SA and ACT followed by inferential statistics. The pattern recognition has done before forecasting.

4.1 Descriptive Statistics

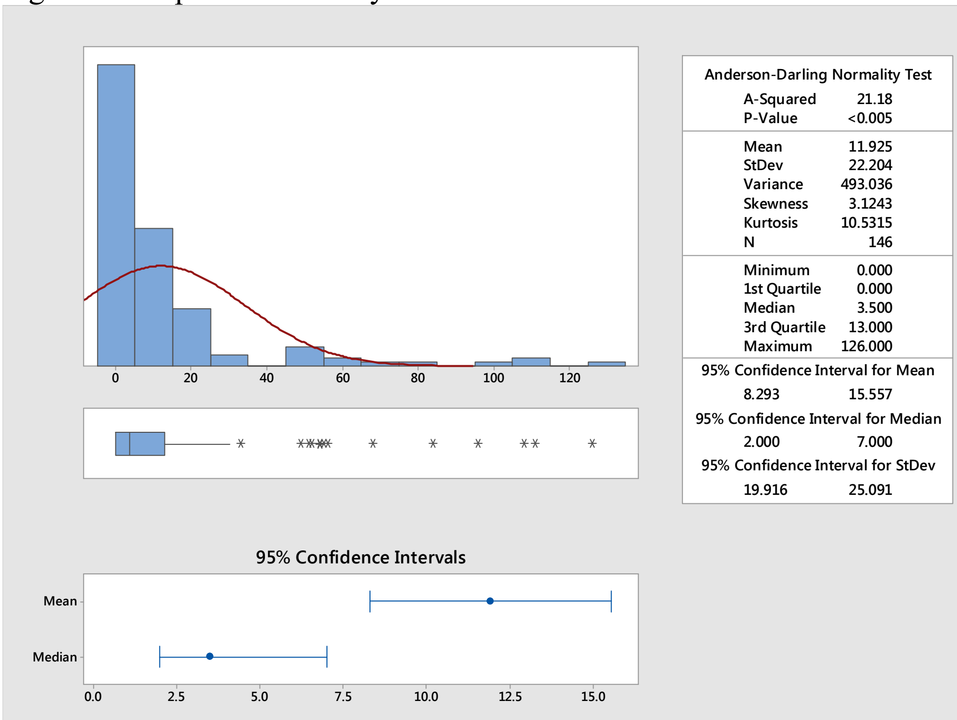
The graphical summary of sample data was obtained for two states and the territory.

4.1.1 Descriptive Statistics of Vic

Figure 1 is the Graphical Summary of Vic. It shows that the data set is not normally distributed. Therefore, the median is the appropriate measure of location. The distribution of the daily infected cases was positively skewed. The minimum cases are 0 and the maximum was 126. The first quartile was 0. It means 25% of the days between 22nd January and 15th June 2020 had no infected cases. The median was 3.5. It is clear that 50% of the days between the consecutive periods had 4 infected cases. The third quartile was 13. It means 75% of the days between the above periods had 13 cases. The 95% Confidence Interval (CI) for the median is [2, 7], hence 50% of the days had at least 2 cases and at most 7 infected case.

ISSN 2719-2385 (Online)

Figure 1: Graphical Summary of Vic

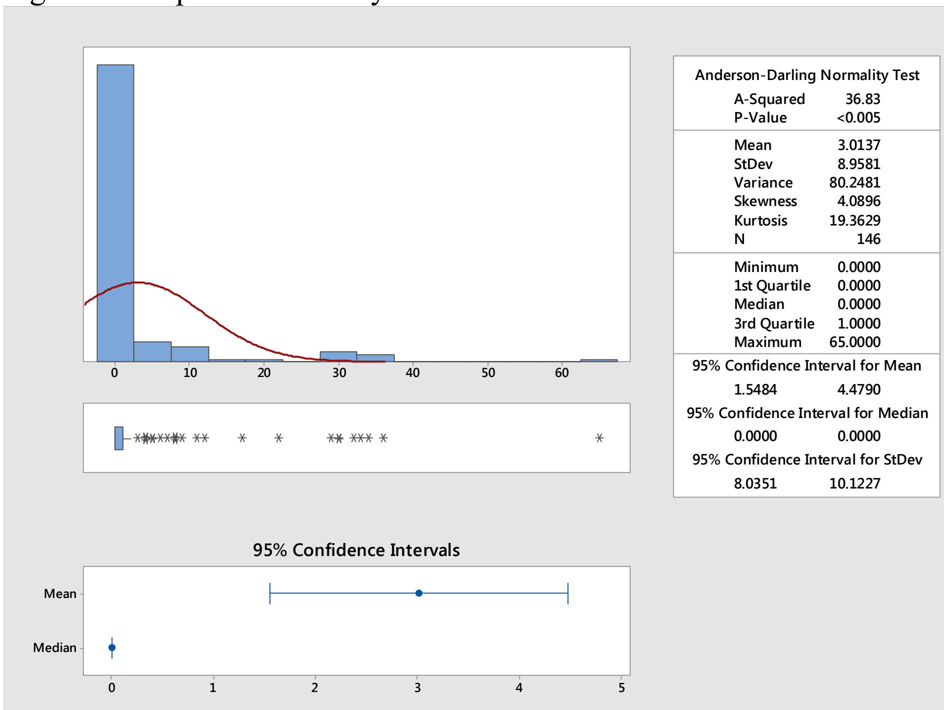


4.1.2 Descriptive Statistics of SA

The Graphical Summary of SA is presented in Figure 2. The data set is not normally distributed. Hence, the median is the appropriate measure of location. The distributions of the daily infected cases were positively skewed like Vic. The minimum cases were 0 and maximum was 65. The first quartile was 0, it means 25% of the times between 22nd January and 15th June 2020 had no infected cases. The median was 0 too. It is clear that 50% of the days between the consecutive periods also had no infected cases. The third quartile was 1. It means 75% of the times between the above periods had just one case. The 95% CI for the median is [0, 0]. It is evidence that the median number of cases for the period was 0.

ISSN 2719-2385 (Online)

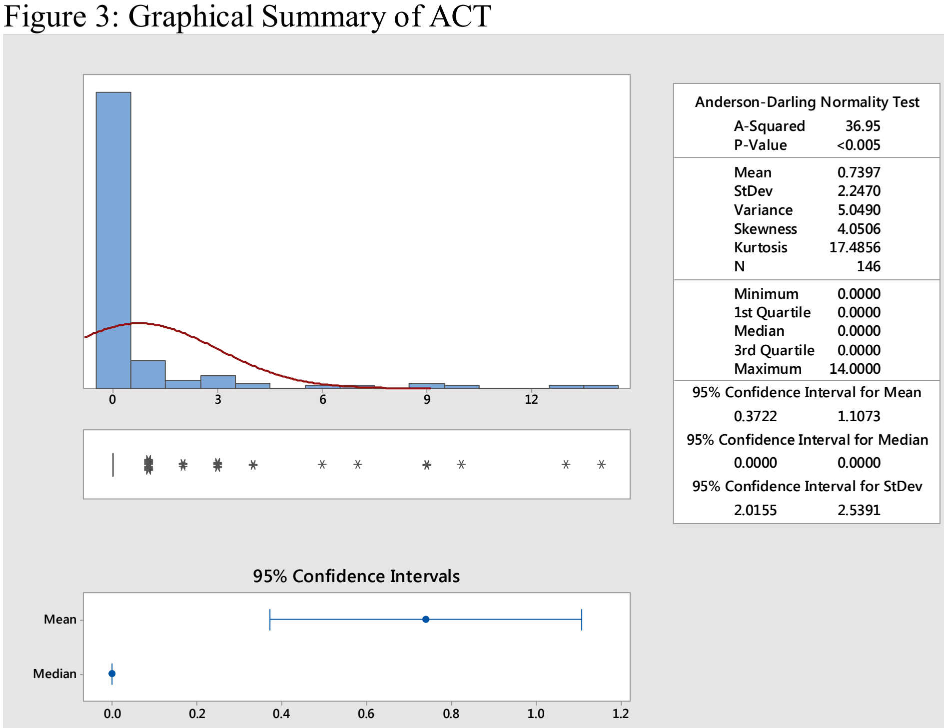
Figure 2: Graphical Summary of SA



4.1.3 Descriptive Statistics of ACT

The Graphical Summary of ACT in Figure 3,

Figure 3: Graphical Summary of ACT



ISSN 2719-2385 (Online)

The data set of ACT is not normally distributed. Hence, the median is the appropriate measure of location. The distributions of the daily infected cases in the ACT were positively skewed. The minimum cases were 0 and the maximum was 14. The first quartile, median, and third quartiles were 0. It means 75% of the days between the above periods had 0 cases. The 95% CI for the median is [0, 0]. It is evidenced that the median number of cases for the period was 0. Once again it is very clear that there was a declining of the pandemic spread in the ACT and the daily reported cases were extremely low.

4.2 Inferential Statistics

The 95% CI's for population means were obtained under the paragraphs of 4.1.1, 4.1.2, and 4.1.3. The sample mean for Victoria State is 11.92 and the CI is [8, 16]. The sample mean for South Australia is 3.01 and the CI is [2, 4]. The sample mean for ACT is 0.73 and the CI is [0, 1]. However, the data were not normally distributed; hence the population means were estimated by trial and error method.

4.2.1 Hypothesis Test for Population Mean of Vic

The population mean of the Victoria State was estimated as follows.
Hypothesis 1:

$$H_0 : \mu = 8$$
$$H_1 : \mu \neq 8$$

At a 5% significance level (α = 0.05) the P-value of the t-test (0.034) is less than the significance level. Hence, the null hypothesis is rejected. It is evidenced that the population mean is not equal to 8.
Hypothesis 2:

$$H_0 : \mu = 8$$
$$H_1 : \mu > 8$$

At the 5% significance level, the P-value of the t-test (0.017) is less than the significance level. Hence, the null hypothesis is rejected. It is evidenced that the population mean is greater than 8
Hypothesis 3:

$$H_0 : \mu = 9$$
$$H_1 : \mu \neq 9$$

At a 5% significance level, the P-value of the t-test (0.114) is greater than the significance level. Hence, the null hypothesis is not rejected. It is concluded that the population mean is equal to 9. There is enough evidence to say that the average number of infected cases in the population per day is 9 in Victoria State. For further confirmation hypothesis 3 was repeated at 2% and 1% significance levels. The corresponding P values

ISSN 2719-2385 (Online)

were 0.114 and 0.114; therefore the null hypothesis is not rejected at both significance levels. Hence, the finding is highly evidenced.

4.2.2 Hypothesis Test for Population Mean of SA

The population mean of South Australia was estimated as follows.
Hypothesis 1:

$$H_0 : \mu = 2$$
$$H_1 : \mu \neq 2$$

At a 5% significance level (α = 0.05) the P-value of the t-test (0.174) is greater than the significance level. Hence, the null hypothesis is not rejected. It is evidenced that the population mean is equal to 2. There is enough evidence to say that the average number of infected cases in the population per day is 2 in South Australia. For further confirmation hypothesis 1 was repeated at 2% and 1% significance levels. The corresponding P values were 0.174 and 0.174; therefore the null hypothesis is not rejected at both significance levels. Hence, the finding is highly evidenced.

4.2.3 Hypothesis Test for Population Mean of ACT

The population mean of the ACT was estimated as follows.
Hypothesis 1:

$$H_0 : \mu = 0$$
$$H_1 : \mu \neq 0$$

At a 5% significance level (α = 0.05) the P-value of the t-test (0.000) is less than the significance level. Hence, the null hypothesis is rejected. It is evidenced that the population mean is not equal to 0.
Hypothesis 2:

$$H_0 : \mu = 0$$
$$H_1 : \mu > 0$$

At the 5% significance level, the P-value of the t-test (0.000) is less than the significance level. Hence, the null hypothesis is rejected. It is evidenced that the population mean is greater than 0.
Hypothesis 3:

$$H_0 : \mu = 1$$
$$H_1 : \mu \neq 1$$

At the 5% significance level, the P-value of the t-test (0.164) is greater than the significance level. Hence, the null hypothesis is not rejected. It is evidenced that the

ISSN 2719-2385 (Online)

population mean is equal to 1. There is enough evidence to say that the average number of infected cases in the population per day is 1 in the ACT.

4.2.4 Hypothesis Test for Mean comparison of Vic, SA and ACT

It was intended to test whether the numbers of infected cases in three states are different or not. The one way ANOVA test was conducted;

$$H_0 : \mu_1 = \mu_2 = \mu_3$$
$$H_1 : \text{At least one mean is different from others}$$

The results of the hypothesis test in Table 1.

Table 1: Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	2	10204	5102.2	26.4	0.000
Error	435	83858	192.8		
Total	437	94063			

The P valve of ANOVA is less than the significance level. Hence, the null hypothesis is rejected. It is evidence that at least one mean is different from others. Hence, confidence intervals for population means were obtained for pair wise comparison. The results of the mean comparisons in Table 2. The CI's of SA and ACT overlaps, hence, the average number of daily infected cases of SA and ACT are not different from each other.

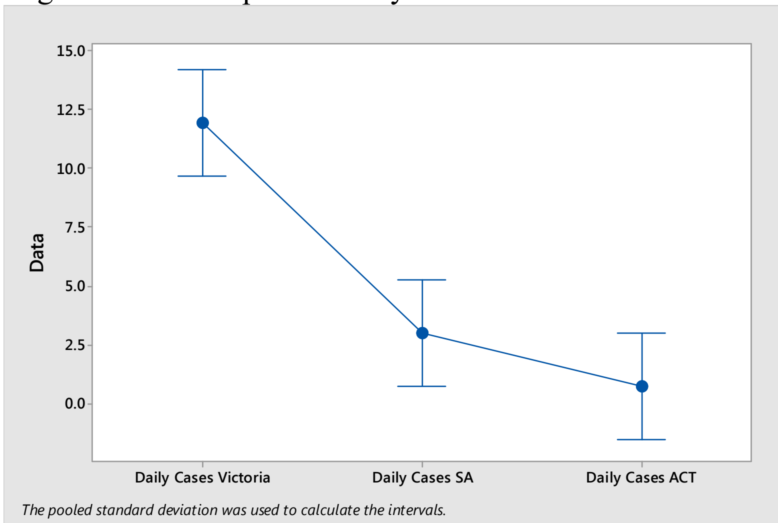
Table 2: Mean Comparisons

Factor	N	Mean	StDev	95% CI
Daily Cases Vic	146	11.92	22.20	(9.67, 14.18)
Daily Cases SA	146	3.014	8.958	(0.755, 5.272)
Daily Cases ACT	146	0.740	2.247	(-1.519, 2.998)

However, the CI of the Vic does not overlap with any of the other two. It is concluded that the number of daily infected cases of Vic is higher than that of SA and ACT or different from them. Figure 4 has confirmed the same.

ISSN 2719-2385 (Online)

Figure 4: Interval plot of Daily Infected Cases



4.3 Pattern Recognition

The pattern recognition was done to review the behavior of pandemic. It is useful to spot an appropriate model to forecast the spread.

4.3.1 Pattern Recognition of Vic

Time series plot of daily infected cases in Vic for the period of 22nd January 2020 to 15th June 2020 is Figure 5. The first confirmed case reported from Victoria on 26th January 2020. The number of daily cases was almost zero up to 20th March 2020 and shows a rapid growth with big fluctuations till 2nd April 2020. Afterward, there was a decline in daily infected cases up to 8th April. Then, the infected cases reported low without trend till 15th June 2020. The Auto Correlation Function (ACF) as in figure 6. It shows the non-stationary behavior of the daily infected cases. After 8th April an infected cases reported very low with tiny fluctuations. Hence, the pattern after 8th April 2020 in Vic was re-examined.

Figure 5: Time Series Plot of Daily Infected Cases in Victoria

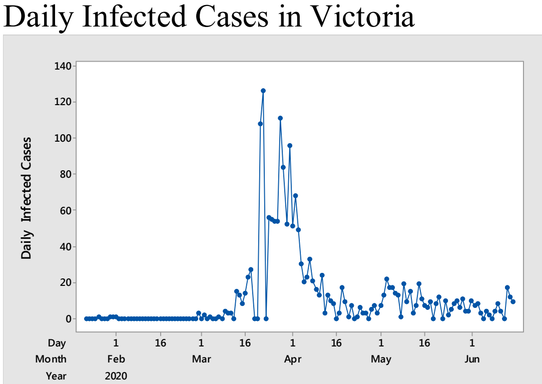
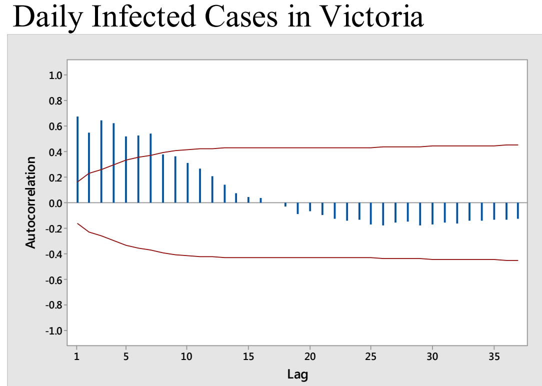


Figure 6: ACF of Daily Infected Cases in Victoria



ISSN 2719-2385 (Online)

Figures 7, time series plot shows fluctuations. The ACF (Figure 8) confirm the stationary of the infected cases after 8th April 2020

Figure 7: Time Series Plot of Daily Cases

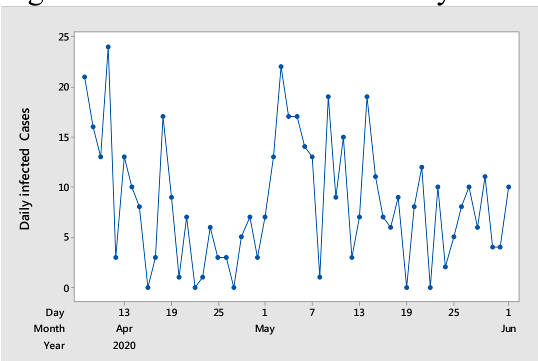
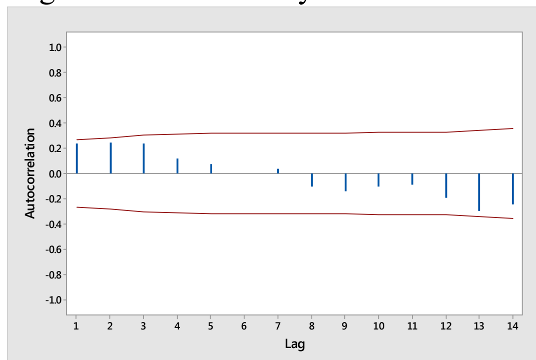


Figure 8: ACF of Daily Cases



4.3.2 Pattern Recognition of SA

Time series plot of daily infected cases in SA for the period of 22nd January 2020 to 15th June 2020 in Figure 9.

Figure 9: Time Series Plot of Daily Infected Cases in SA

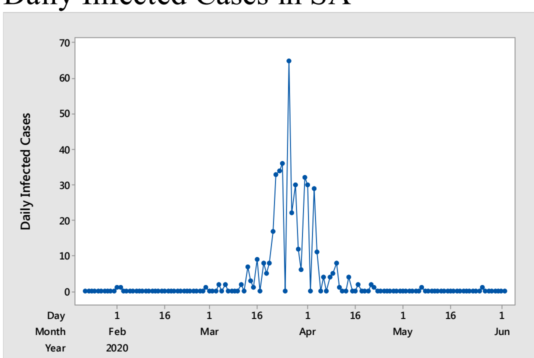
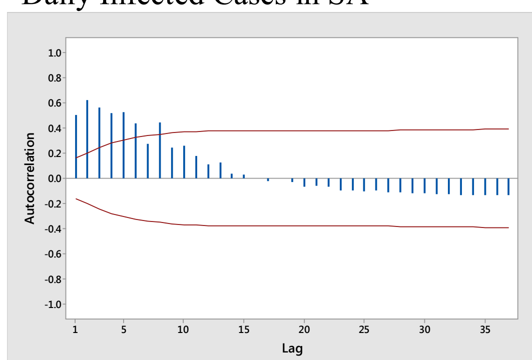


Figure 10: ACF of Daily Infected Cases in SA



The first confirmed case reported from South Australia on 1st February 2020. The number of daily cases was almost zero up to 19th March and shows a rapid climb with big fluctuations till 26th March. Afterward, there was a heavy decline of daily infected cases up to 5th April and continued almost zero levels. The ACF in Figure 10 shows the non-stationary behavior of the daily infected cases in SA.

4.3.3 Pattern Recognition of ACT

Time series plot of daily infected cases in ACT for the period of 22nd January 2020 to 15th June 2020 in Figure 11.

ISSN 2719-2385 (Online)

Figure 11: Time Series Plot of
Daily Infected Cases in ACT

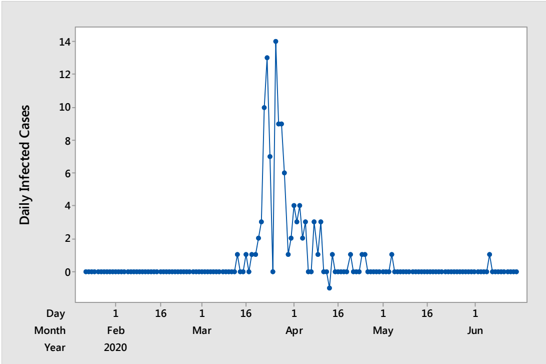
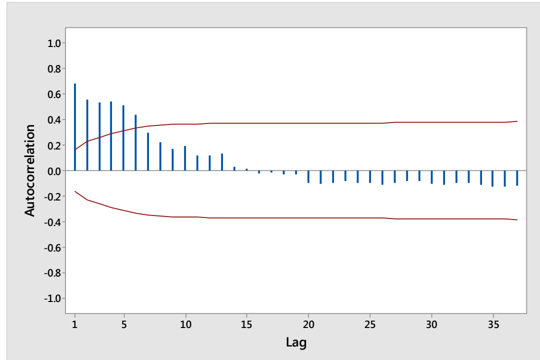


Figure 12: ACF of
Daily Infected Cases in ACT



The first confirmed case reported from ACT on 13th March 2020. The amount of daily cases was almost zero up to 19th March and shows a rapid growth with big fluctuations till 30th March. Afterward, there was a drop up to 11th April and continued almost zero levels. The ACF in Figure 12 shows the non- stationary behavior of the daily infected cases within the ACT.

4.4 Forecasting Pandemic

The patterns of daily infected cases of Vic, SA, and ACT were examined under paragraph 4.3. It is observed that patterns of SA and ACT have zero levels of daily infected cases at the present. Besides, Vic reports some daily infected cases. Hence, forecasting of daily infected cases in Vic is meaningful. Initially, the ARIMA was tested and followed by a linear trend model. The results of the two models are given in Table 3. Both the linear trend model and ARIMA were well fitted. The Anderson Darling test confirmed the normality of residuals. The ACF of the residuals and LBQ test confirmed the independence of residuals of both models. The measurements of errors were low of both models. But, measurements of errors of ARIMA (1, 1, 0) were higher than linear trend model under the fitting and verification. Hence, linear trend model is the most suitable model in forecasting daily infected cases of pandemic in Vic.

Table 3: Summary of Fittings and Verifications of ARIMA and Linear Trend Model

Model	Model Fitting		Model Verification	
$Y_t = 10.18 - 0.0571t$	MAD	5.07	MAD	4.13
	RMSE	6.13	RMSE	5.00
	Normality	P =0.295		
	Independence of Residuals	Yes		

ISSN 2719-2385 (Online)

ARIMA (1,1,0)	MAD	5.00	MAD	5.43
	RMSE	6.44	RMSE	6.26
	Normality	P =0.112		
	Independence of Residuals	Yes		

Linear trend model was used to forecast the date which would report zero infected cases in Vic as follows..

The trend model;

$$Y_t = 10.18 - 0.0571t$$

When $Y_t = 0$

$$10.18 - 0.0571t = 0$$

$$t = 10.18 / 0.0571$$

$$= 178.28$$

$$\approx 178$$

Therefore number of infected cases would be zero from 178 days from 8th April 2020. In other words, number of infected cases would be zero by 2nd October 2020 in Vic.

5. CONCLUSION AND RECOMMANDATIONS

It is concluded that the mean of daily infected cases in Vic, SA, and ACT were 9, 2 and 1 consecutively. The linear trend model is the best suited model in forecasting daily infected cases of the pandemic in Victoria State. As per the model number of infected cases would be zero by 2nd October 2020.

The study was focused on adjoining states and an important territory in Australia. But the highest populated state named New South Wales (NSW) couldn't be analyzed due to the lack of reliability of the data set. Hence, the study avoided NSW and focused on ACT within NSW.

The results of this study might be a guideline for decision making, regarding the re-open of states and territories. It had been observed that the large climb and a drop within a very short period of time in Vic, SA, and ACT. The synchronization of the health care framework of medical staff, authorities and general public would be the inspiration of this achievement. The morals of the general public and the authorities would be another factor for this achievement. Due to the absence of antiviral drugs for COVID-19, the effective

ISSN 2719-2385 (Online)

implementation and continue of immunization and non-pharmaceutical practices were very useful to achieve positive consequences during a very short period. Besides, standard operational procedures of all working places, restaurants, public and private transport should be focused on non-pharmaceutical practices. It should be monitored by the authorities. Imposing restrictions for smoking and alcohol consumption may be better for society in the long-term. The results of this study will be useful to develop National policies to combat pandemic at the present and within the future. The restrictions of the movements of domestic tourist between states and territories, control measures for international tourism, reopen airports, flight schedules of domestic and international, quarantine sites etc could be decided by considering the results of the study. It is recommended to analyze the pandemic treat for other states in Australia are very useful at present.

REFERENCES

Amarakoon A.A.N.R, Konarasinghe K.M.U.B, & Konarasinghe W.G.S.,(2018). Risky Sexual Behaviour of Adolescents in Western Province of Sri Lanka. *International Journal of Novel Research in Physics Chemistry & Mathematics*, 5(3): 1-9.

Ahmadi, A., Fadaei, Y., Shirani, M., & Rahmani,F.,(2020).Modeling and Forecasting Trend of COVID-19 Epidemic in Iran until May 13, 2020.

Anastassopoulou, C., Russo, L., Tsakris, A., Siettos, C., (2020). Data-based analysis, modeling and forecasting of the COVID-19 outbreak. *PLoS ONE,* 15(3): e0230405. https://doi.org/10.1371/ journal.pone.0230405.

Al-qaness, M.A.A., Ewees, A.A.,Fan,H. & El Aziz, M.A. (2020). Optimization Method for Forecasting Confirmed Cases of COVID-19 in China. *Journal of Clinical Medicine.*

Chang,S.L.,Harding,N., Zachreson,C., Cliff, O. M., & Prokopenko, M.,(2020). Modeling transmission and control of the COVID-19 pandemic in Australia. https://hdl.handle.net/2123/22168.

Giuliani,D.,Dickson,M.M., Espa,G., & Santi,F.,(2020). Modeling and predicting the spatio-temporal spread of Corona virus disease 2019 (COVID-19) in Italy.

Giordano,G., Blanchini,F.,Bruno, R., Colaneri, P.,Filippo, A.D.,Matteo,A.D.,Colaneri,M. & the COVID19 IRCCS San Matteo Pavia Task Force.,(2020). A SIDARTHE Model of COVID-19 Epidemic in Italy.

ISSN 2719-2385 (Online)

Konarasinghe, W .G. S., & Abeynayake, N. R.,(2014). Time series patterns of Sri Lankan stock returns. *Proceedings of the 11th International Conference on Business Management, Phd Consortium*, Faculty of management studies and commerce, University of Sri Jayewardenepura.78-95.

Konarasinghe, W.G.S., Abeynayake, N.R., & Gunaratne, L.H.P.,(2015). Forecasting Share Prices of Banks of Colombo Stock Exchange. *International Journal of Research & Review.* 2(6)*,* 372-378.

Konarasinghe, K.M.U.B.,(2015).*Trend Analysis of Direct Employment in Tourism Industry of Sri Lanka*.Conference Proceedings of the 4th International Conference of the Sri Lankan Forum of University Economists. 31. ISSN: 2279 -2406.

Konarasinghe, K.M.U.B.,(2020-a). *Modeling COVID -19 Epidemic of USA, UK and Russia*. Journal of New Frontiers in Healthcare and Biological Sciences,1(1), 1-14.

Konarasinghe,K.M.U.B.,(2020-b). *Modeling COVID -19 Epidemic of India and Brazil* Journal of New Frontiers in Healthcare and Biological Sciences,1(1),15-25.

Massonnaud,C., Roux,J.,& Crépey,P.,(2020). COVID-19: Forecasting short term hospital needs in France. https://doi.org/10.1101/2020.03.16.20036939.

Moss, R.,Wood, J.,Brown, D.,Shearer, F., Black, A.J., Cheng, A.C., McCaw, J.M. & McVernon, J., (2020).Modelling the impact of COVID-19 in Australia to inform transmission reducing measures and health system preparedness. https://doi.org/10.1101/2020.04.07.20056184.

Petropoulos, F., Makridakis, S., (2020). Forecasting the novel coronavirus COVID-19. *PLoS ONE ,* 15(3): e0231236. https://doi.org/10.1371/journal.pone.0231236.

Yang Z, Zeng Z, Wang K, Wong SS, Liang W, Zanin M, Liu P, Cao X, Gao Z, Mai Z, Liang J, Liu X, Li S, Li Y, Ye F, Guan W, Yang Y, Li F, Luo S, Xie Y, Liu B, Wang Z, Zhang S, Wang Y, Zhong N, & He J. (2020). Modified SEIR and AI prediction of the epidemics trend of COVID-19 in China under public health interventions. *J Thorac Dis*, 12(3):165-174. doi: 10.21037/jtd.2020.02.64.

ISSN 2719-2385 (Online)