International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 6, pp 169-175, June-2021

https://doi.org/10.47001/IRJIET/2021.506032

Forecasting Covid-19 Mortality in Chile

[1]Dr. Smartson. P. NYONI, [2]Mr. Thabani NYONI, [3]Mr. Tatenda. A. CHIHOHO

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]SAGIT Innovation Center, Harare, Zimbabwe
[3]Independent Health Economist, Harare, Zimbabwe

***Abstract* - In this study, the ANN approach was applied to analyze COVID-19 deaths in Chile. The employed data covers the period 1January 2020 to 20 April 2021 and the out-of-sample period ranges over the period 21 April to 31 August 2021. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is quite stable. The results of the study indicate that daily COVID-19 deaths in Chile are likely to be between 0 and 150 per day over the out-of-sample period. Therefore there is need for the government of Chile to ensure adherence to safety guidelines while continuing to create awareness about the COVID-19 pandemic and speed up COVID-19 vaccination.**

Keywords: ANN, COVID-19, Forecasting.

I. INTRODUCTION

Health systems all over the world have been shaken by the emergence of the COVID-19 pandemic (Goic et al, 2021; Li et al, 2020; Walker et al, 2020; Flaxman et al, 2020). The COVID-19 outbreak started in Wuhan city in China in December 2019 (Wang et al, 2020; Tang et al, 2020). The rapid spread of the virus is alarming and at the beginning of the pandemic some countries never imagined themselves being suffocated by the ferocious SARS-COV2 virus, the causative agent of the COVID-19 disease. In the months of January, February and March 2020, many countries had started reporting cases of COVID-19 and deaths (Spitteri et al, 2020; Holshue et al, 2020). Several countries reported that their medical supplies were dwindling at an alarming rate with many patients failing to secure hospital ICU beds (Asahi et al, 2021; Souza et al, 2020; WHO, 2020). The shortage of oxygen is a huge blow on the face as thousands of patients continue to die whilst helplessly waiting for emergency supplies (John Hopkins University, 2021). Elective procedures were cancelled at the start of the COVID-19 outbreak as special attention was being given to COVID-19 patients and emergency surgical and medical cases. Health facilities had to change their operating procedures to take into consideration recommended WHO COVID-19 prevention protocols to minimize hospital or clinic transmission of SARS-COV2 virus. Some of the health care staff had to offer their patients telemedicine services to minimize contact with patients. In this study we propose the artificial neural network approach to predict daily COVID-19 deaths in Chile. The results of the study are envisioned to reveal future trends of COVID-19 mortality thereby stimulating an evidence based COVID-19 response in order to curb the spread of the coronavirus in the country.

II. LITERATURE REVIEW

Tariq et al (2021) estimated the reproduction number throughout the epidemic in Chile and studied the effectiveness of control interventions especially the effectiveness of lockdowns by conducting short-term forecasts based on the early transmission dynamics of COVID-19. The study findings indicated that the control measures at the start of the epidemic significantly slowed down the spread of the virus. Barrı´a-Sandova et al (2021) compared different time series methodologies to predict the number of confirmed cases of and deaths from COVID-19 in Chile. The study consisted of modeling cases of both confirmed cases and deaths from COVID-19 in Chile using Autoregressive Integrated Moving Average (ARIMA) models, Exponential Smoothing techniques, and Poisson models for time-dependent count data. The study showed that ARIMA models are an alternative to modeling the behavior of the spread of COVID-19; however, depending on the characteristics of the dataset, other methodologies can better Short-term forecasting of ICU beds during the COVID-19 outbreak was executed by Goic et al (2020). The study utilized autoregressive, machine learning and epidemiological models to provide a short-term forecast of ICU utilization at the regional level. The predictions achieved average forecasting errors of 4% and 9% for one- and two-week horizons, respectively, outperforming several other competing forecasting models. Nyoni et al (2020) proposed the artificial neural network technique to predict daily COVID-19 cases in Chile based on a data set covering the period February 23, 2020 to October 31, 2020. The out-of-sample period ranged over the period November 2020 to April 2021. The results of the study indicated that daily COVID-19 cases would sharply decline, from the estimated 1096 cases on November 1, 2020; until around December 23, 2020; where an equilibrium daily case volume of approximately 153 cases could be reached and this daily equilibrium case volume was most

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

likely to be persistent throughout the rest of the out-of-sample period. Cumsille et al (2020) applied the SER model to describe diverse aspects of the pandemic in Chile. The results reproduced the general trend of the infected's curve, distinguishing the reported and real cases.

III. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modeling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in architecture inspired by the way biological nervous systems of the brain appear like. Since no explicit guidelines exist for the determination of the ANN structure, the study applies the popular ANN (12, 12, 1) model based on the hyperbolic tangent activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting COVID-19 deaths in Chile.

Data Issues

This study is based on daily COVID-19 deaths in Chile for the period 1 January 2020 – 20 April 2021. The out-of-sample forecast covers the period 21 April – 31 August 2021. All the data employed in this research paper was gathered from the Johns Hopkins University (USA).

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	C
Observations	464 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning:	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	2.107495
MSE	3319.497155
MAE	21.940881

Residual Analysis for the Applied Model

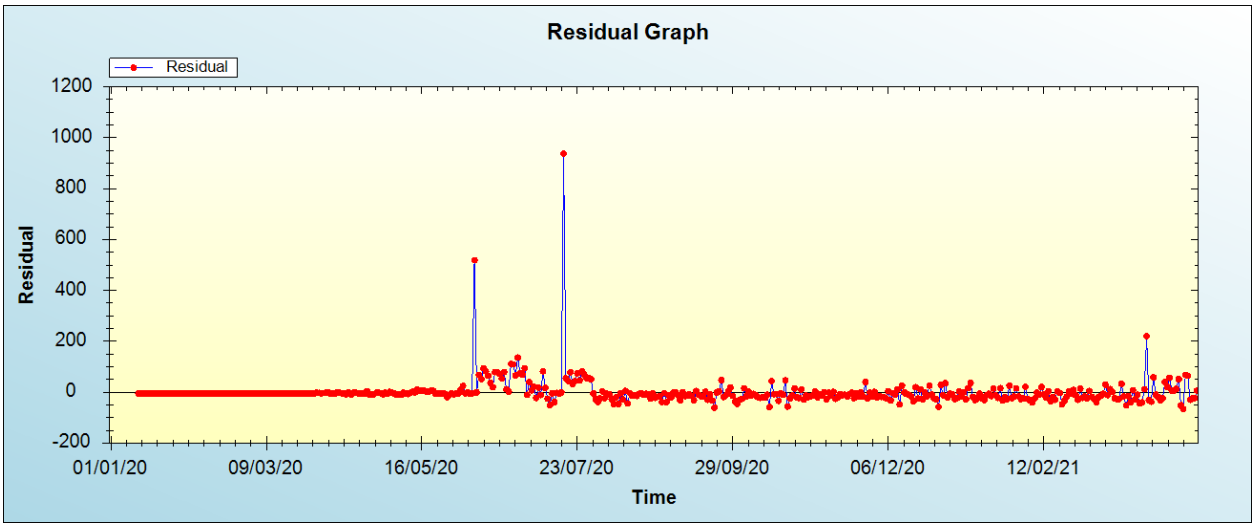

Figure 1: Residual analysis

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

In-sample Forecast for C

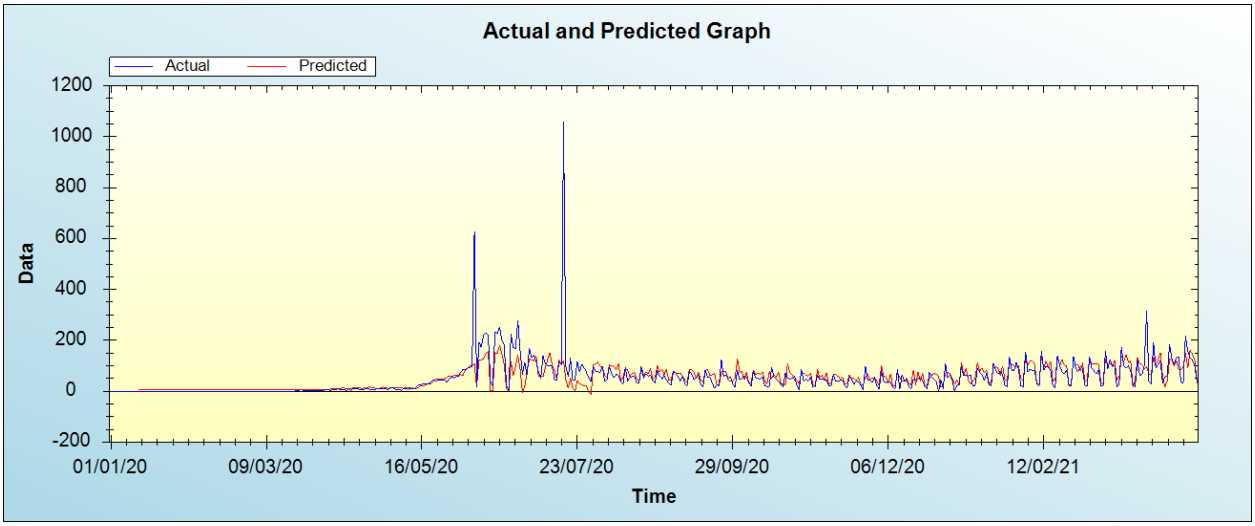

Figure 2: In-sample forecast for the C series

Out-of-Sample Forecast for C: Actual and Forecasted Graph

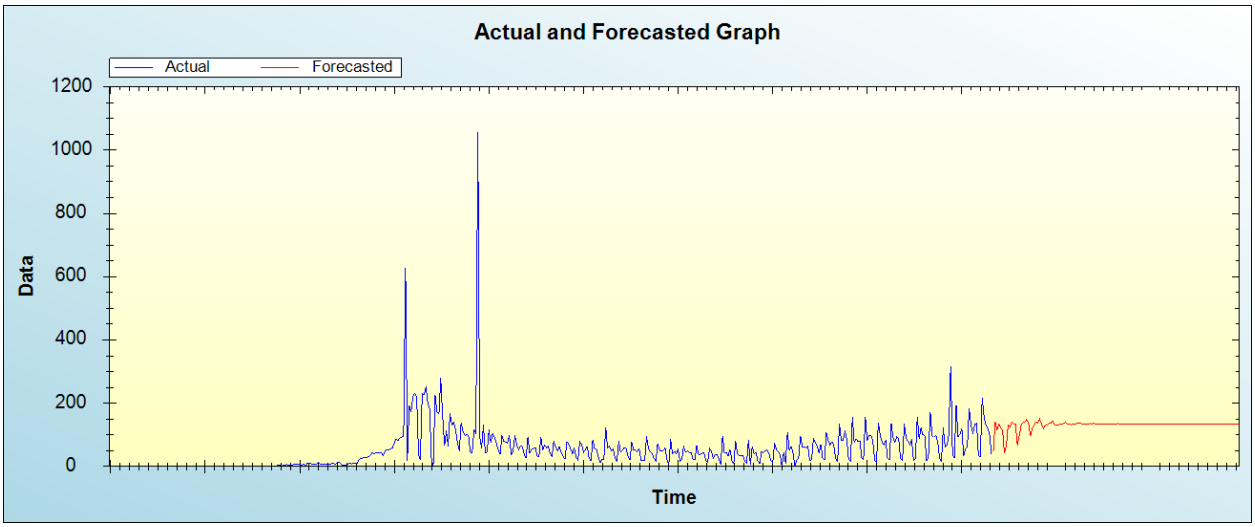

Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

Day/Month/Year	Projected COVID-19 deaths
21/04/21	48.6477
22/04/21	142.5083
23/04/21	114.4466
24/04/21	135.6172
25/04/21	120.3157
26/04/21	115.1326
27/04/21	42.7574
28/04/21	64.4056
29/04/21	130.5854
30/04/21	126.3570

ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

01/05/21	141.5837
02/05/21	135.1630
03/05/21	134.0991
04/05/21	67.9602
05/05/21	96.7708
06/05/21	129.6463
07/05/21	140.1907
08/05/21	140.4363
09/05/21	149.3985
10/05/21	137.8752
11/05/21	96.2362
12/05/21	122.7585
13/05/21	129.4857
14/05/21	142.2755
15/05/21	138.3775
16/05/21	151.1871
17/05/21	134.1192
18/05/21	120.0223
19/05/21	130.6310
20/05/21	131.5971
21/05/21	137.8655
22/05/21	137.6270
23/05/21	145.9172
24/05/21	132.6137
25/05/21	132.9765
26/05/21	130.7470
27/05/21	134.0929
28/05/21	134.0776
29/05/21	138.0466
30/05/21	139.5618
31/05/21	134.5558
01/06/21	135.6874
02/06/21	132.1232
03/06/21	135.0718
04/06/21	133.1135
05/06/21	137.9152
06/06/21	135.8228
07/06/21	136.5716
08/06/21	134.9578
09/06/21	134.4815
10/06/21	134.5918
11/06/21	134.2723
12/06/21	136.5744
13/06/21	135.1561
14/06/21	136.7400
15/06/21	134.6955
16/06/21	135.7588
17/06/21	134.2236

ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

18/06/21	135.4639
19/06/21	135.2661
20/06/21	135.6648
21/06/21	135.8425
22/06/21	135.2388
23/06/21	135.6469
24/06/21	134.6368
25/06/21	135.6580
26/06/21	134.8825
27/06/21	135.8729
28/06/21	135.2076
29/06/21	135.7070
30/06/21	135.1988
01/07/21	135.2678
02/07/21	135.3139
03/07/21	135.1666
04/07/21	135.5902
05/07/21	135.2055
06/07/21	135.6803
07/07/21	135.1139
08/07/21	135.5368
09/07/21	135.1146
10/07/21	135.4566
11/07/21	135.2810
12/07/21	135.4269
13/07/21	135.4210
14/07/21	135.3061
15/07/21	135.4470
16/07/21	135.2074
17/07/21	135.4701
18/07/21	135.2225
19/07/21	135.4994
20/07/21	135.2758
21/07/21	135.4511
22/07/21	135.3062
23/07/21	135.3682
24/07/21	135.3514
25/07/21	135.3239
26/07/21	135.4143
27/07/21	135.3054
28/07/21	135.4378
29/07/21	135.2880
30/07/21	135.4210
31/07/21	135.2929
01/08/21	135.4006
02/08/21	135.3287
03/08/21	135.3787
04/08/21	135.3631

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

05/08/21	135.3473
06/08/21	135.3814
07/08/21	135.3229
08/08/21	135.3934
09/08/21	135.3200
10/08/21	135.3977
11/08/21	135.3289
12/08/21	135.3867
13/08/21	135.3401
14/08/21	135.3677
15/08/21	135.3554
16/08/21	135.3530
17/08/21	135.3714
18/08/21	135.3439
19/08/21	135.3794
20/08/21	135.3386
21/08/21	135.3784
22/08/21	135.3401
23/08/21	135.3734
24/08/21	135.3482
25/08/21	135.3661
26/08/21	135.3574
27/08/21	135.3572
28/08/21	135.3643
29/08/21	135.3503
30/08/21	135.3687
31/08/21	135.3480

The main results of the study are shown in table 1. It is clear that the model is stable as confirmed by evaluation criterion as well as the residual plot of the model shown in figure 1. It is projected that daily COVID-19 deaths in Chile are likely to be between 0 and 150 per day over the out-of-sample period.

V. CONCLUSION AND POLICY RECOMMENDATIONS

The novel coronavirus remains a public health challenge which continues to be on top of the global health agenda. Many lives are being lost and the economic impact is unbearable to many nations. Several scientists are busy researching on the structure of the virus and its health impact especially transmissibility and virulence. In addition, various studies have been done to predict the evolution of the disease. In this study we proposed an artificial intelligence method to forecast COVID-19 mortality in Chile. The model predictions suggest that daily COVID-19 deaths in Chile are likely to be between 0 and 150 per day over the out-of-sample period.. Therefore we encourage the authorities in Chile to scale up COVID-19 vaccination amongst other measures.

REFERENCES

[1] Asahi K., Undurraga EA., Valdes R., & Wagner R (2021). The effect of COVID-19 on the economy: evidence from an early adopter of localized lockdowns. J Glob Health. 2021; in press.

[2] De Souza WM., Buss LF., CandidoDdS., Carrera J-P., Li S., Zarebski AE (2020). Epidemiological and clinical characteristics of the COVID-19 epidemic in Brazil. Nat Hum Behav, 4(8):856–65. https:// doi.org/10.1038/s41562-020-0928-4 PMID: 32737472

[3] Eric Toner (2021). Potential Solutions to the COVID-19 Oxygen Crisis in the United States , Johns Hopkins Center for Health Security, centerforhealthsecurity.org, pp 1-3

ISSN (online): 2581-3048
Volume 5, Issue 6, pp 169-175, June-2021
https://doi.org/10.47001/IRJIET/2021.506032

[4] Flaxman S., Mishra S., Gandy A., Unwin HJ T., Mellan TA., Coupland H (2020). Estimating the effects of non-pharmaceutical interventions on COVID-19 in Europe. Nature. 2020; 584(7820):257–61. https:// doi.org/10.1038/s41586-020-2405-7 PMID: 32512579

[5] Goic M., Bozanic-Leal MS., Badal M., & Basso LJ (2021) COVID-19: Short-term forecast of ICU beds in times of crisis. PLoS ONE 16(1): e0245272. https://doi.org/10.1371/journal. pone.0245272

[6] Holshue M L., DeBolt C., Lindquist S., Lofy K H., Wiesman J, Bruce (2020). First Case of 2019 Novel Coronavirus in the United States. N Engl J Med. 2020; 382(10):929–36. https://doi.org/10.1056/ NEJMoa2001191 PMID: 32004427

[7] Li Y., Campbell H., Kulkarni D., Harpur A., Nundy M., Wang X (2020). The temporal association of introducing and lifting non-pharmaceutical interventions with the time-varying reproduction number (R) of SARS-CoV-2: a modelling study across 131 countries. Lancet Infect Dis. 2020. Epub October 22. https://doi.org/10.1016/S1473-3099(20)30785-4.

[8] PGT., Whittaker C., Watson OJ., Baguelin M., Winskill P., Hamlet A, et al. The impact of COVID19 and strategies for mitigation and suppression in low- and middle-income countries. Science (New York, NY). 2020; 369(6502):413–22. https://doi.org/10.1126/science.abc0035 PMID: 32532802

[9] Spiteri G., Fielding J., Diercke M., Campese C., Enouf V., Gaymard A (2020). First cases of coronavirus disease 2019 (COVID-19) in the WHO European Region, 24 January to 21 February 2020. Euro Surveill, 25(9):2000178. Doi: 10.2807/1560-7917.ES.2020.25.9.2000178. PMID: 32156327.

[10] Tang. B et al (2020). An updated estimation of the risk of transmission of the novel coronavirus (2019-nCoV). Infectious Disease Modelling 5, 248–255.

[11] Tang. B et al (2020). Estimation of the transmission risk of the 2019-nCoV and its implication for public health interventions. J. Clinical Med. 9, 462.

[12] Wang D et al (2020). Clinical characteristics of 138 hospitalized patients with 2019 novel coronavirus–infected pneumonia in Wuhan, China. JAMA 323, 1061–1069.

[13] Wang H et al (2020). Phase-adjusted estimation of the number of coronavirus disease 2019 cases in Wuhan, China. Cell Discovery 6, 76.

[14] Wang. W et al (2020). Updated understanding of the outbreak of 2019 novel coronavirus (2019-nCoV) in Wuhan, China. J. Med. Virology 92, 441–447.

[15] WHO (2020). Situation Reports Coronavirus World Health Organization2020. Available from: https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports.

Citation of this Article:

Dr. Smartson. P. NYONI, Mr. Thabani NYONI, Mr. Tatenda. A. CHIHOHO, "Forecasting Covid-19 Mortality in Chile" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 6, pp 169-175, June 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.506032

****

