

Projection of Future Trends of Under Five Mortality Rate for Costa Rica Using Artificial Neural Networks

¹Dr. Smartson. P. NYONI, ²Thabani NYONI

¹ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

²Independent Researcher & Health Economist, Harare, Zimbabwe

Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Costa Rica from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast performance measures indicate that the ANN (12, 12, 1) applied model is stable in forecasting U5MR in Costa Rica. ANN model projections revealed that annual U5MR will remain around 9 deaths per 1000 live births throughout the out of sample period. Hence, we implore the government of Costa Rica to craft strategies that will effectively maintain under five mortality below 25 deaths per 1000 live births.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Quality, affordable and accessible maternal and child healthcare services are very important in order to achieve the set targets of sustainable development goals by 2030 (UN, 2016). The 1994 programme action recognized sexual and reproductive health and rights of women. The sexual and reproductive rights of every individual or couple must be respected. The signatories to the 1994 conference on Population and development recognized the need to uphold the SRH rights of women and adolescent girls who are suffering from gender-based or intimate violence and sexual abuse in many countries across the globe. Adolescent girls and young women have the right to information on family planning services (Darroch & Singh, 2013). Developing countries continue to report high maternal, infant mortality and under five mortality (Horvath S & Schreiber, 2017; Dastgiri *et al.* 2017; Melese *et al.* 2017; Bishwajit *et al.* 2017). Adolescent girls and young women are at high risk of having STIs, early unwanted pregnancies, unsafe abortions and obstetric complications (Chandra-Mouhi *et al.* 2015). Many adolescents lack comprehensive information on SRH and thus end up having unprotected sexual intercourse leading to unintended pregnancies and STIs (Yakubu *et al.* 2018).

The Agenda 2030 for sustainable development which was launched in September 2015 added a stronger voice to the need to recognize human rights including the rights of women and children. Women should be accorded their rights to freedom of expression, choice of sexual partners and to have equal employment opportunities. Women and children must have equal access to healthcare services in order to minimize adverse maternal and child health outcomes. Under the 3rd sustainable development goal, all countries should endeavor to reduce maternal and child mortality. It is expected that each country should reduce maternal mortality ratio to less than 70 deaths per 100 000 live births and under five mortality to levels as low as 25 deaths per 1000 live births by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). In line with the agenda 2030 for sustainable development, this research is conducted to forecast future trends of under-five mortality rate for Costa Rica using the artificial neural network technique. The findings are envisioned to inform child health policies, planning and allocation of resources to MNCH program activities in order to end all preventable under five deaths.

II. LITERATURE REVIEW

Adjei *et al.* (2021) investigated the effect of community-, household- and individual-level factors on the risk of neonatal mortality in two districts in Ghana. The longitudinal study used the Kintampo Health and Demographic Surveillance System as a platform to select 30,132 neonatal singletons with 634 deaths. Multilevel cox frailty model was used to examine the effect of community-, household- and individual-level factors on the risk of neonatal mortality. The conclusion from the study was that there is risk of neonatal mortality at the individual- and household-levels in the Kintampo Districts. Tesema & Worku (2021) examined the individual and community-level determinants of neonatal mortality in the Emerging regions of Ethiopia. Secondary analysis of the data from the 2016 Ethiopian Demographic and Health Survey (EDHS) was carried out and the findings indicated that Neonatal mortality in Emerging regions of Ethiopia was unacceptably high. Iriondo *et al.* (2020) developed and validated different mortality predictive models, using Spanish data, to be applicable to centers with similar morbidity and mortality. Infants born alive, admitted in NICU, and registered in the SEN1500 database, were included. Multivariable regression models were used for the different time periods. The study concluded that using dynamic models to predict individual mortality can improve outcome estimations. Development of models in the prenatal period, first 24 hours, and during hospital admission, cover key stages of mortality prediction in preterm infants. Mishra *et al.* (2019) gave a detailed presentation of how they used the ARIMA

model to forecast infant mortality rates (2017 – 2025). The forecast of the sample period (1971 – 2016) showed accuracy by the selected ARIMA (2, 1, 1) model. The post-sample forecast with ARIMA (2, 1, 1) model showed a decreasing trend of infant mortality (2017 – 2025). The forecast infant mortality rate for 2025 in India is 15/1000 live births. A Zimbabwean study by Nyoni & Nyoni (2020) modelled and forecasted infant deaths in Zimbabwe using ARIMA model. The study utilized annual time series data on total infant deaths in Zimbabwe from 1960 to 2018. The best model based on AIC was the ARIMA (1, 2, 5) model. The study findings indicated that the number of infant deaths per year, over the out-of-sample period, would follow a downward trend.

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 annual under five mortality rate for Costa Rica.

Data Issues

This study is based on annual under five mortality rate in Costa Rica for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 – 2030. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	R
Observations	49 (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	0.002968
MSE	0.303138
MAE	0.423317

Residual Analysis for the Applied Model

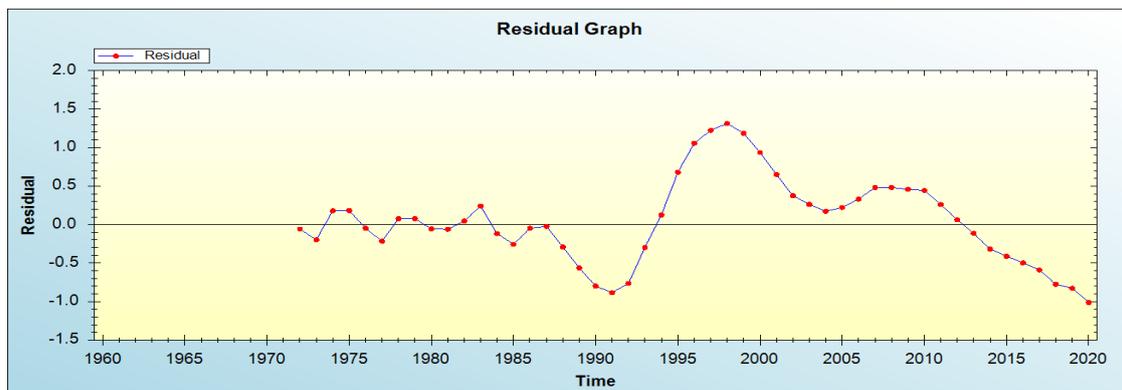


Figure 1: Residual analysis

In-sample Forecast for R

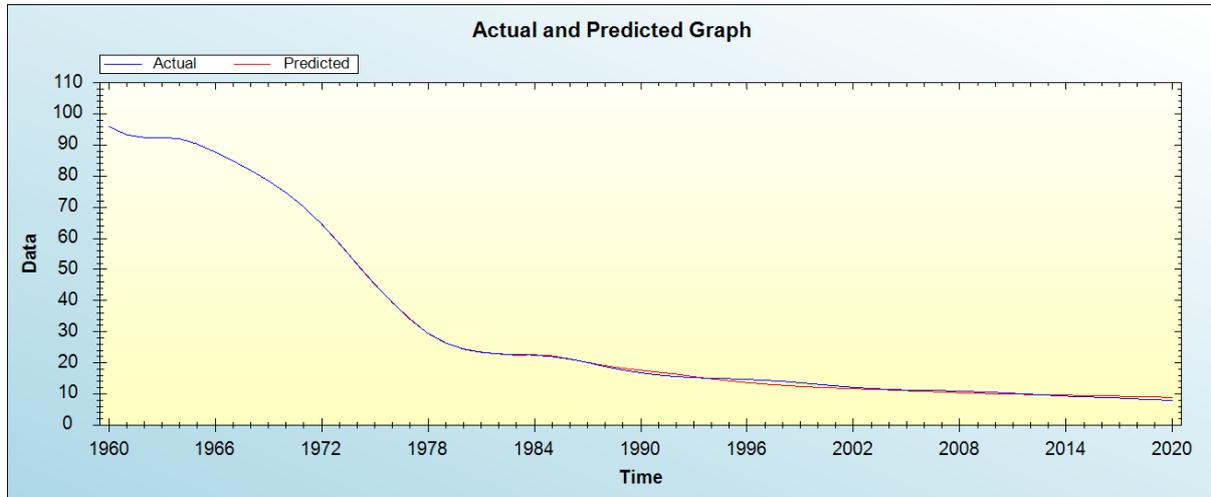


Figure 2: In-sample forecast for the R series

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

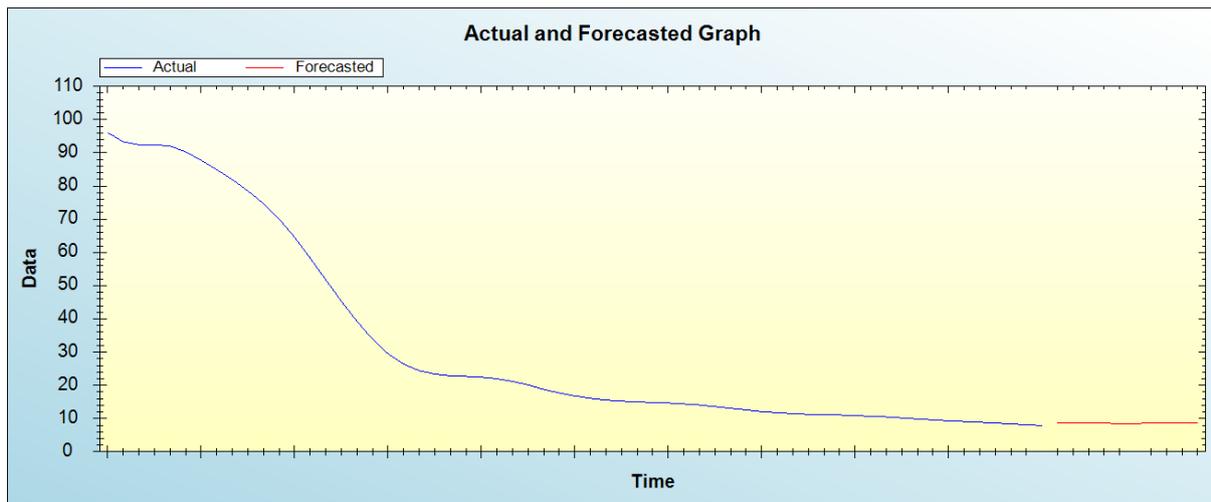


Figure 3: Out-of-sample forecast for R: actual and forecasted graph

Out-of-Sample Forecast for R: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	8.8102
2022	8.7948
2023	8.7460
2024	8.6477
2025	8.4593
2026	8.5449
2027	8.6070
2028	8.6377
2029	8.6692
2030	8.6025

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 annual U5MR will remain around 9 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The continued suffering and death of under five children requires combined effort in order to effectively control the problem. Early identification of root causes of mortality is critical in decision making to alleviate the public health challenge. Forecasting techniques have been found to be very useful early surveillance tools to detect abnormal trends of health phenomena. In this study we applied the ANN model to predict under five mortality rate in Costa Rica. The results of this paper highlighted that annual U5MR will remain around 9 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage authorities in Costa Rica to craft strategies that will ensure under five mortality remains below 25 deaths per 1000 live births.

REFERENCES

- [1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
- [2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
- [3] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [4] UNICEF (2018). Every Child alive. New York: UNICEF
- [5] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [6] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.
- [7] Horvath S., & Schreiber CA (2017). Unintended Pregnancy, Induced Abortion, and Mental Health. *Curr Psychiatry Rep.* 2017; 19:77. <https://doi.org/10.1007/s11920-017-0832-4> PMID: 28905259
- [8] Dastgiri S., Yoosefian M., Garjani M., & Kalankesh LR (2017). Induced Abortion: a Systematic Review and Metaanalysis. *Mater Socio-Medica.* 2017; 29:58–67.
- [9] Melese T., Habte D., Tsima BM., Mogobe KD., Chabaesele K., & Rankgoane G (2017). High Levels of Post-Abortion Complication in a Setting Where Abortion Service Is Not Legalized. *PLoS ONE.* 2017; 12. <https://doi.org/10.1371/journal.pone.0166287> PMID: 28060817
- [10] Bishwajit G., Tang S., Yaya S., & Feng Z (2017). Unmet need for contraception and its association with unintended pregnancy in Bangladesh. *BMC Pregnancy Childbirth.* 2017; 17:186. <https://doi.org/10.1186/s12884-017-1379-4> PMID: 28606062
- [11] Darroch JE., & Singh S (2013). Trends in contraceptive need and use in developing countries in 2003, 2008, and 2012: an analysis of national surveys. *Lancet Lond Engl,* 381:1756–62.
- [12] Chandra-Mouli V., Svanemyr J., Amin A., Fogstad H., Say L., Girard F., & Temmerman M (2015). Twenty years after international conference on population and development: where are we with adolescent sexual and reproductive health and rights? *J Adolesc Health.* 2015;56:1–6.
- [13] Yakubu I., & Salisu WJ (2018). Determinants of adolescent pregnancy in sub-Saharan Africa: a systematic review. *Reprod Health.* 2018; 15(1):15.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, “Projection of Future Trends of Under Five Mortality Rate for Costa Rica Using Artificial Neural Networks” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 192-195, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607039>
