

Forecasting Future Trends of Under Five Mortality Rate for Samoa 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 for Samoa from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation criteria indicate that the applied ANN (12, 12, 1) model is stable in forecasting under five mortality rate. ANN (12, 12, 1) model projections suggest that annual U5MR will hover around 18 deaths per 1000 live births throughout the out of sample period. Therefore, the government of Samoa should continue providing financial support to the maternal and child health program to ensure availability of adequate medical supplies and healthcare professionals.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Many countries made significant progress during the era of Millennium Development goals (MDGs), however there are several areas which still need attention (UN, 2016; UN, 2015). All UN member states and global partners decided to introduce a new global action plan; The Agenda 2030 for sustainable development which is meant to finish up the issues left by MDGs. This plan of action aims to solve all problems affecting humanity which include eradication of poverty and hunger, universal health coverage and access to quality healthcare, education for all and fostering economic growth. It has been realized that many Sub-Saharan African countries are still far away from achieving the sustainable development goal 3 targets 3.1 and 3.2 which focus on the substantial reduction of maternal, newborn and under five deaths (UN, 2020; World Bank, 2019; WHO, 2019; UNICEF, 2019; UNICEF, 2018). At the UN General assembly in September 2015, all stakeholders recognized the importance of early warning systems and risk reduction in relation to SDGs, hence in this research we apply the artificial neural network technique to forecast future trends of under-five mortality rate in Samoa. The findings will inform maternal and child health policies and allocation of resources to the health sector in order to effectively address the problem of under-five mortality.

II. LITERATURE REVIEW

Muin *et al.* (2021) conducted a population-based study on epidemiological characteristics of singleton antepartum stillbirth in Austria between January 2008 and December 2020. Data were derived from the validated Austrian Birth Registry. The study found that from January 2008 through December 2020, the antepartum stillbirth rate $\geq 20+0/40$ was 3.10, $\geq 22+0/40$ 3.14, and $\geq 24+0/40$ 2.83 per 1000 births in Austria. The highest incidence was recorded in the federal states of Vienna, Styria, and Lower and Upper Austria, contributing to 71.9% of all stillbirths in the country. Harpur *et al.* (2021) investigated trends in infant mortality rates (IMR) and stillbirth rates by socio-economic position (SEP) in Scotland, between 2000 and 2018, inclusive. Data for live births, infant deaths, and stillbirths between 2000 and 2018 were obtained from National Records of Scotland. Annual IMR and stillbirth rates were calculated and visualized for all of Scotland and when stratified by SEP. Negative binomial regression models were used to estimate the association between SEP and infant mortality and stillbirth events, and to assess for break points in trends over time. The study revealed that IMR fell from 5.7 to 3.2 deaths per 1000 live births between 2000 and 2018, with no change in trend identified. Stillbirth rates were relatively static between 2000 and 2008 but experienced accelerated reduction from 2009 onwards. When stratified by SEP, inequalities in IMR and stillbirth rates persisted throughout the study and were greatest amongst the sub-group of post-neonates. Another study by Nath *et al.* (2020) investigated the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. The study used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistics. The study findings revealed that infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life. A prospective, population-based research study was conducted by Dhaded *et al.* (2020) to examine neonatal deaths in rural Karnataka, India for the period 2014–2018. Study staff collected demographic and health care characteristics on eligible women enrolled with neonatal outcomes obtained at delivery and day 28. Cause of neonatal mortality at day 28 was assigned by algorithm using prospectively defined variables. Study results indicated that infants who were preterm and low-birth weight remained at highest risk for 28-day neonatal mortality in India.

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 Samoa.

Data Issues

This study is based on annual under five mortality rate in Samoa 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	A
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	0.009413
MSE	1.013657
MAE	0.359932

Residual Analysis for the Applied Model

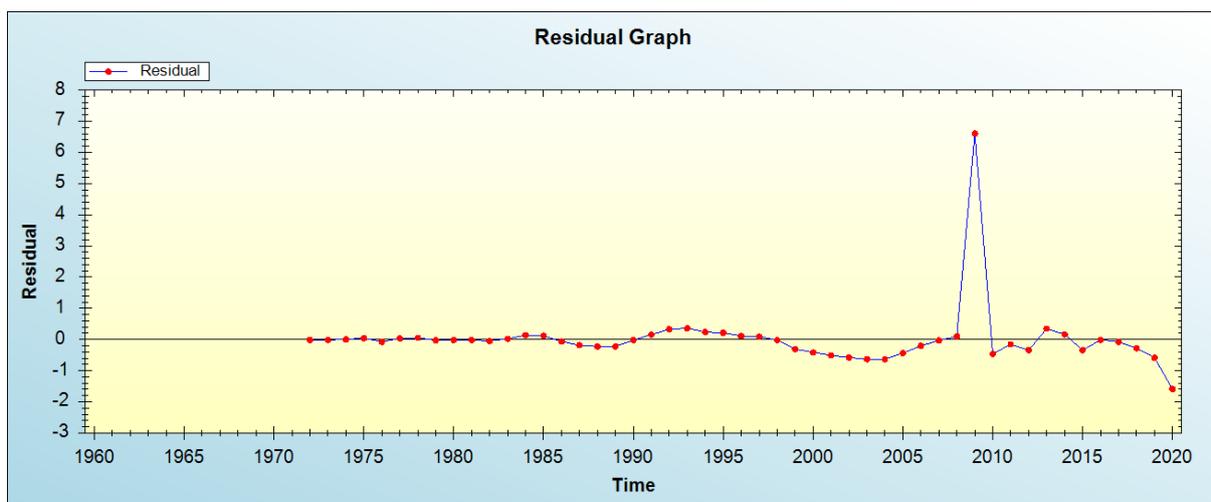


Figure 1: Residual analysis

In-sample Forecast for A

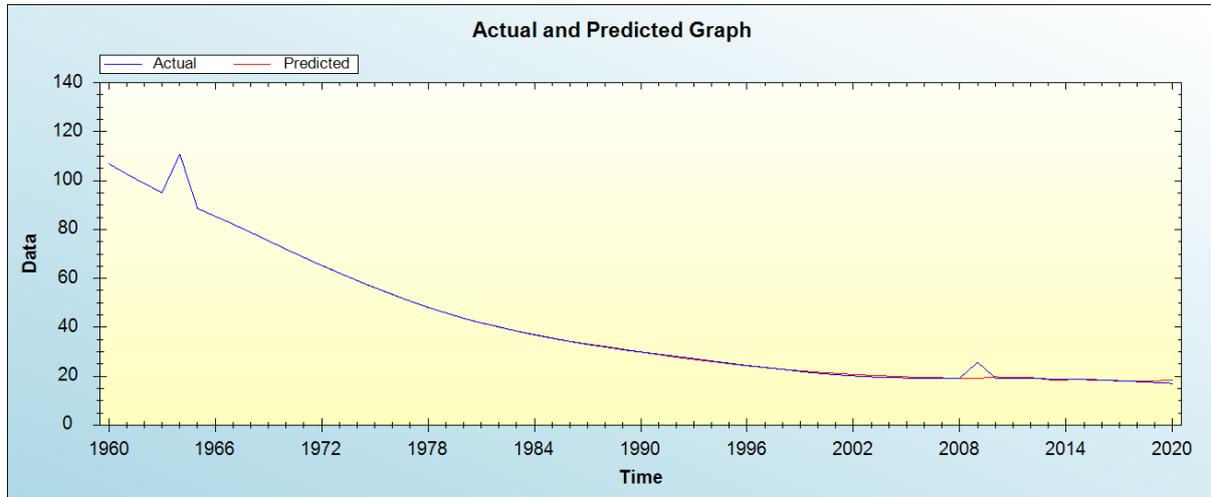


Figure 2: In-sample forecast for the A series

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

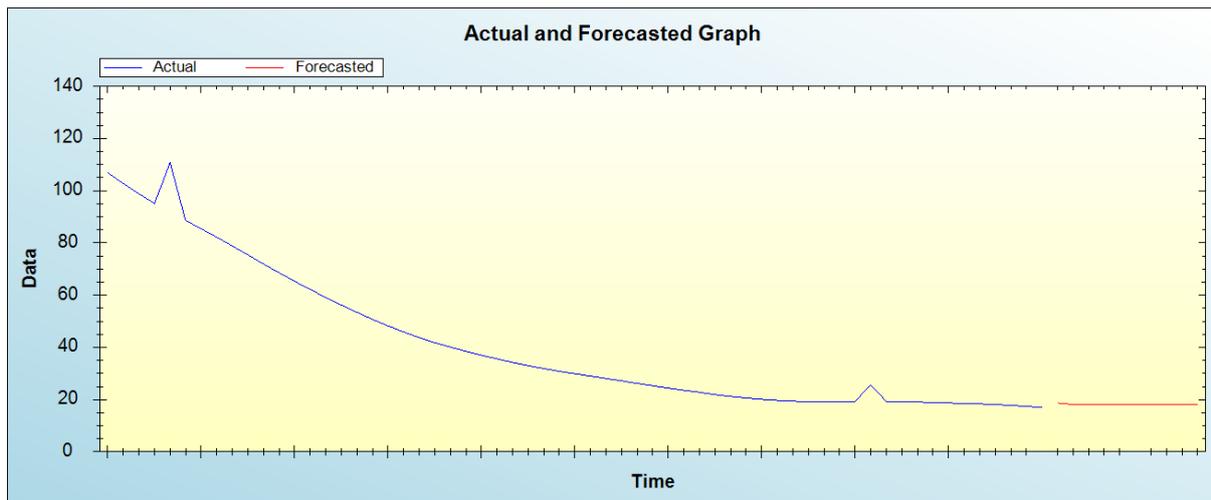


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	18.6906
2022	18.1376
2023	18.1459
2024	18.2396
2025	18.1297
2026	18.0964
2027	18.2111
2028	18.1713
2029	18.1099
2030	18.0394

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 hover around 18 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

By the end of 2030, all UN member states are expected to have managed to solve all the major problems affecting the human race such as poverty, hunger, inequalities, human rights abuses, wars, health problems and educational needs. One of the targets of SDG3 is the substantial reduction of under-five mortality to levels as low as 25 deaths per 1000 live births. This study applied the ANN model to project future trends of under-five mortality rate in Samoa. The ANN model projections suggest that annual U5MR will hover around 18 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Samoa to continue providing financial support to the maternal and child program to ensure availability of medical supplies and healthcare professionals at all levels of healthcare.

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] World Bank (2019). Mortality rate, under 5.
- [4] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [5] UNICEF (2018). Every Child alive. New York: UNICEF
- [6] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [7] United Nation. Transforming our world: The 2030 agenda for sustainable development 2016.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Forecasting Future Trends of Under Five Mortality Rate for Samoa Using Artificial Neural Networks" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 442-445, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607097>
