

Assessing the Feasibility of Achieving Substantial Reduction of Under Five Mortality in Liberia by 2030 Using Artificial Neural Networks

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Liberia 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 model is stable in forecasting under five mortality rate. ANN (12, 12, 1) model projections indicate that U5MR will remain very high throughout the out of sample period. Therefore, we encourage the Liberian government to address all the challenges that contribute to under five mortality by paying particular attention to capacitating primary healthcare facilities across the country.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

All UN member countries made a serious commitment to adopt and implement the global action plan: Agenda 2030 for sustainable development. The main focus is to alleviate human suffering as a result of various problems such as poverty, hunger, sickness, human rights abuses, lack of education and injustices (UN, 2016; UN, 2015). Several countries have made tremendous progress towards achieving set targets for SDGs (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). Remarkable progress has been observed in the reduction of under 5 mortality in Sub-Saharan Africa as it dropped from 180 per 1000 live births in 1990 to 83 deaths per 1000 live births in 2015 (World Bank, 2019; UNICEF, 2015). During the same period Liberia made commendable progress by achieving a 73% reduction in under five mortality (UN, 2015). This was attributed to the government's commitment in improving maternal and child health (Lori *et al.* 2017; Lori *et al.* 2013; Lori & Stark, 2012). In line with the agenda 2030 for sustainable development, this study applies the artificial neural network technique to predict future trends of under-five mortality rate for Liberia. The results are expected to inform policy, decisions and allocation of resources to maternal and child health programs so as to keep under five mortality under control.

II. LITERATURE REVIEW

A description of household factors associated with under-five mortality in Bankass, a remote region in central Mali was done by Boettiger *et al.* (2021). The authors analyzed baseline household survey data from a trial being conducted in Bankass. The survey was administered to households between December 2016 and January 2017. Under-five deaths in the five years prior to baseline were documented along with detailed information on household factors and women's birth histories. Factors associated with under-five mortality were analyzed using Cox regression. The study concluded that U5 mortality is very high in Bankass and is associated with living a greater distance from healthcare and several other household factors that may be amenable to intervention or facilitate program targeting Yaya *et al.* (2019) investigated the changes in maternal healthcare services utilization between 2007 and 2016 in Post war Liberia. The cross-sectional study utilized 2007 and 2013 Liberia Demographic and Health Survey (LDHS) and the 2016 Malaria Indicator Survey. The outcomes of interest were: place of delivery and antenatal care visits. Univariate analysis was conducted using percentages and means (standard deviations) and multiple binary multivariable logistic models were used to examine the factors associated with the outcome variables. The study findings indicated that key maternal healthcare utilization indicators have improved substantially, especially facility-based delivery. However, a large proportion of women remain deprived of these life-saving health services in the post-war era. A cross-sectional study in Ghana conducted by Annan & Asiedu (2018) applied the logit model to assess the maternal, neonatal, and health system related factors that influence neonatal deaths in the Ashanti Region, Ghana. The study revealed that there was a high number of neonatal deaths which were mainly caused by birth asphyxia, infections, congenital anomalies and respiratory distress syndrome. Brault *et al.* (2018) examined factors contributing to the reductions in under-five mortality in Postwar Liberia by conducting a case study mixed methods approach drawing on data from quantitative indicators, national documents and qualitative interviews were used to describe factors that enabled Liberia to rebuild their maternal, neonatal and child health (MNCH) programmes and reduce under-five mortality following the country's civil war. The findings revealed that three main factors contributed to the reduction in under-five mortality: national prioritization of MNCH after the civil war; implementation of integrated packages of services that

expanded access to key interventions and promoted inter-sectoral collaborations; and use of outreach campaigns, community health workers and trained traditional midwives to expand access to care and improve referrals.

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 Liberia.

Data Issues

This study is based on annual under five mortality rate in Liberia 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	V
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	0.000976
MSE	0.655806
MAE	0.626866

Residual Analysis for the Applied Model

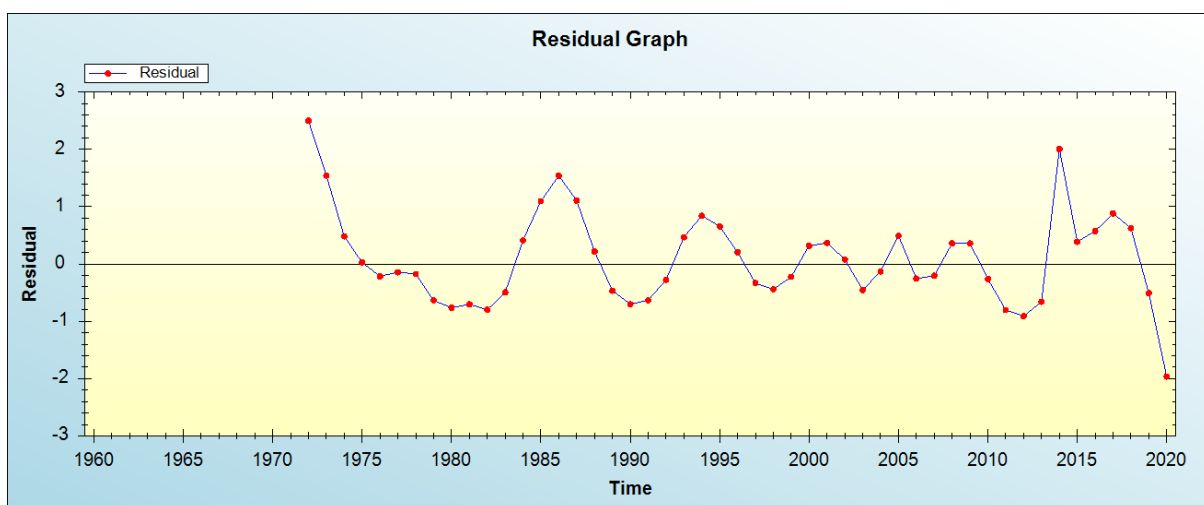


Figure 1: Residual analysis

In-sample Forecast for V

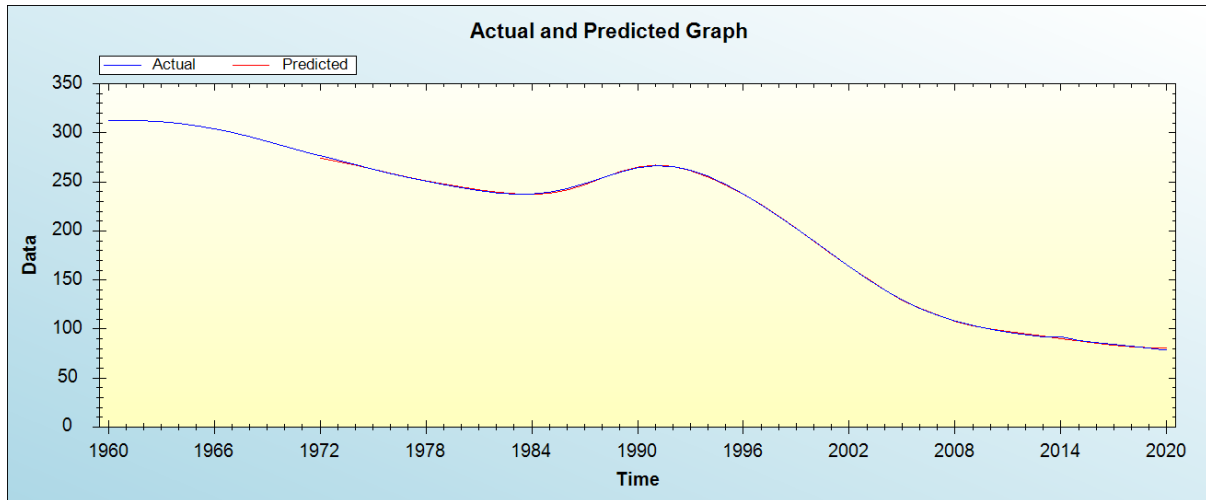


Figure 2: In-sample forecast for the V series

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

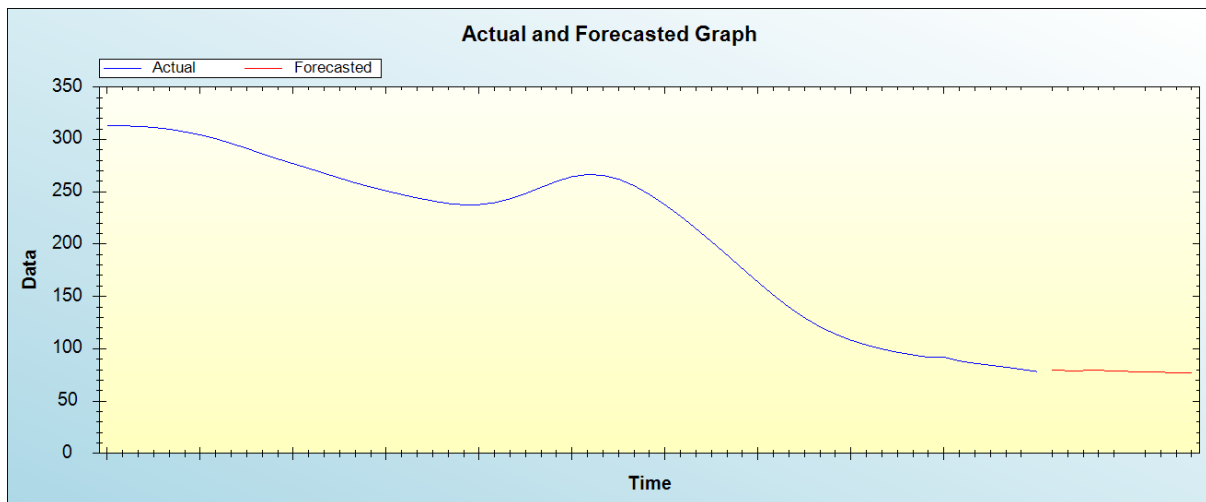


Figure 3: Out-of-sample forecast for V: actual and forecasted graph

Out-of-Sample Forecast for V: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	79.4400
2022	79.1839
2023	79.2457
2024	79.4309
2025	78.9647
2026	78.2900
2027	78.0087
2028	77.6662
2029	77.2378
2030	76.8574

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 very high throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Liberia has demonstrated commitment to the agenda 2030 for sustainable development as indicated by the reported downward trend in under five mortality rate. However, there are numerous challenges that require urgent attention in order for the country to achieve all the set targets outlined under SDG-3. This study applies the ANN model to predict future trends of U5MR and forecast results indicate that U5MR remain very high throughout the out of sample period. Therefore, we encourage the Liberian authorities to address all the existing challenges that significantly contribute to mortality among under five children and there is need to capacitate primary healthcare facilities across the country

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Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, “Assessing the Feasibility of Achieving Substantial Reduction of Under Five Mortality in Liberia by 2030 Using Artificial Neural Networks” Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 331-334, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607070>
