Tracking the Future Path of Under Five Mortality Rate for Trinidad and Tobago Using Artificial Neural Networks

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Abstract - **This study uses annual time series data on under five mortality rate (U5MR) for Trinidad and Tobago from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and model evaluation criteria indicate that the applied ANN (12, 12, 1) model is stable in forecasting under five mortality rate. ANN model projections suggest that annual U5MR will hover around 16 deaths throughout the out of sample period. Therefore, we encourage the government of Trinidad and Tobago to address all the issues that affect the successful implementation of the third sustainable development goal (SDG3) in order to all end all preventable under five deaths.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

This current era of sustainable development goals (SDGs) is expected to bring to an end all forms of human suffering by 2030 (UN, 2020). The agreement signed by all UN member states at the UN Head Quarters in New York in September 2015 outlined the 17 thematic areas and 169 targets that clearly defined a roadmap that all member countries will follow in order to arrestall suffering around the globe (UN, 2016; UN, 2015). All member countries appreciated that this was not an easy task to handle given the different dynamics which characterize various regions of the world. Persistent droughts driven by climate change are making the journey towards sustainable development even harder. The continuous deterioration of health infrastructure in low and middle income countries is a cause for concern (Schuurmans *et al*. 2021). The mass exodus of qualified and experienced health personnel who are going for greener pastures in developed regions of the world is decreasing the chances of achieving the set SDG targets by 2030 for developing countries (Baruwa *et al*. 2021). All these challenges suggest that SDG 3 targets 3.1 and 3.2 will be difficult to achieve hence it is important for developing countries to develop very aggressive approaches to at least record some commendable progress towards achieving the set SDG targets by 2030. Target 3.1 of the 3rd sustainable development goal was designed to solve the problem of maternal mortality around the globe. The expectation is that the global maternal mortality ratio should fall to levels below 70 deaths per 100 000 live births for every country by 2030. On the other hand, target 3.2 is meant to achieve a reduction of neonatal and under five mortality to levels that are as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births respectively by 2030 (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). In line with the Agenda 2030 for sustainable development, this study proposes the artificial neural network approach to forecast future trends of under-five mortality rate for Trinidad & Tobago. The study findings will assist in policy-making, planning and resource allocation with the aim of ending all preventable under five deaths in the country.

II. LITERATURE REVIEW

Juarez et al. (2020) conducted a quality improvement study to increase the detection of neonatal complications by lay midwives in rural Guatemala, thereby increasing referrals to a higher level of care. A quality improvement team in Guatemala reviewed drivers of neonatal health services provided by lay midwives. Improvement interventions included training on neonatal warning signs, optimized mobile health technology to standardize assessments and financial incentives for providers. The primary quality outcome was the rate of neonatal referral to a higher level of care. It was found that structured improvement interventions, including mobile health decision support and financial incentives, significantly increased the detection of neonatal complications and referral of neonates to higher levels of care by lay midwives operating in rural home-based settings in Guatemala. Raymondville *et al*. (2020) conducted a convergent, mixed methods study to assess barriers and facilitators to facility based childbirth at Hôpital Universitaire de Mirebalais (HUM) in Mirebalais, Haiti. A secondary analyses of a prospective cohort of pregnant women seeking antenatal care at HUM was performed and quantitatively assessed predictors of not having a facility-based childbirth at HUM. The study also prospectively enrolled 30 pregnant women and interviewed them about their experiences delivering at home or at HUM. It was found that living further from the hospital, poverty and household hunger were associated with not having a facility-based childbirth. Primigravid women were more likely to have a facility-based childbirth. A prospective, population-based research study was conducted by Dhaded *et al*. (2020) to investigate 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 defend variables. Study found that infants who were preterm and low-birth weight remained at highest risk for 28-day neonatal mortality in India. Rhoda et al, 2018 did a literature review of estimates of NMR, causes of neonatal deaths, and described how the mortality from preventable causes of death could be reduced in South Africa. The study concluded that there was need of high-impact interventions, adequate number of appropriately trained healthcare providers and a more active role played by ward-based community health workers and district clinical specialist teams.

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 Trinidad and Tobago.

Data Issues

This study is based on annual under five mortality rate 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

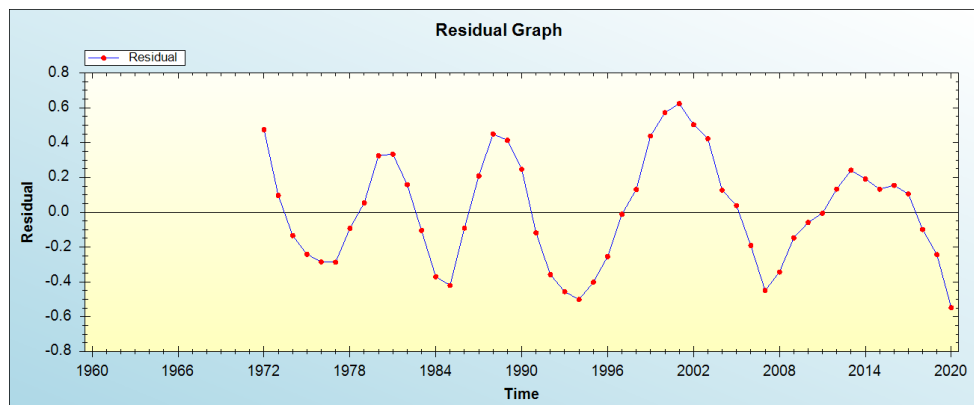| Variable	H
Observations	49 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	12
Hidden Layer Neurons	12
Output Layer Neurons	1
Activation Function	Hyperbolic Tangent Function
Back Propagation Learning	
Learning Rate	0.005
Momentum	0.05
Criteria:	
Error	0.002998
MSE	0.095076
MAE	0.261002

Residual Analysis for the Applied Model

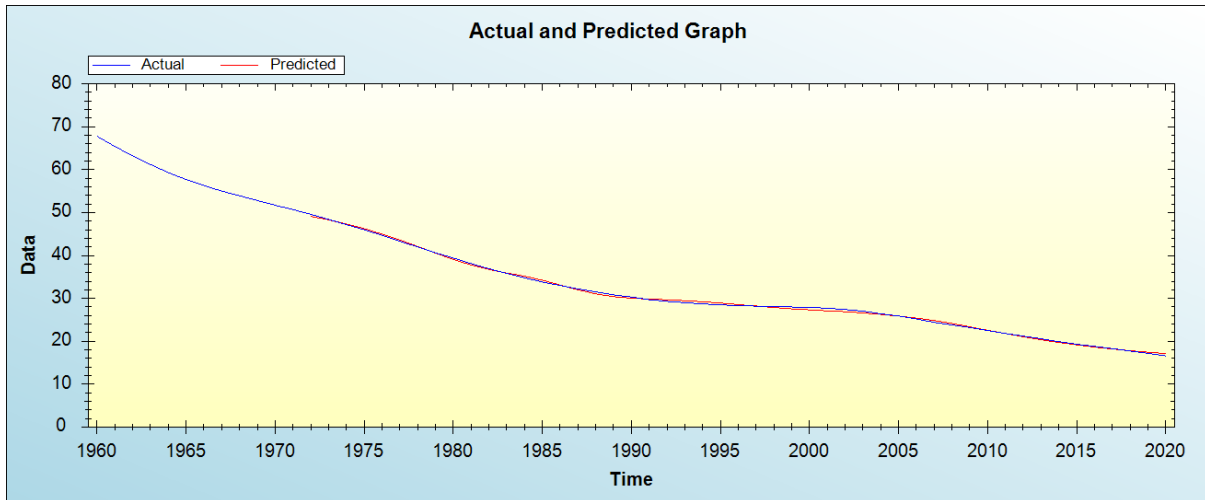Figure 1: Residual analysis

In-sample Forecast for H

Figure 2: In-sample forecast for the H series

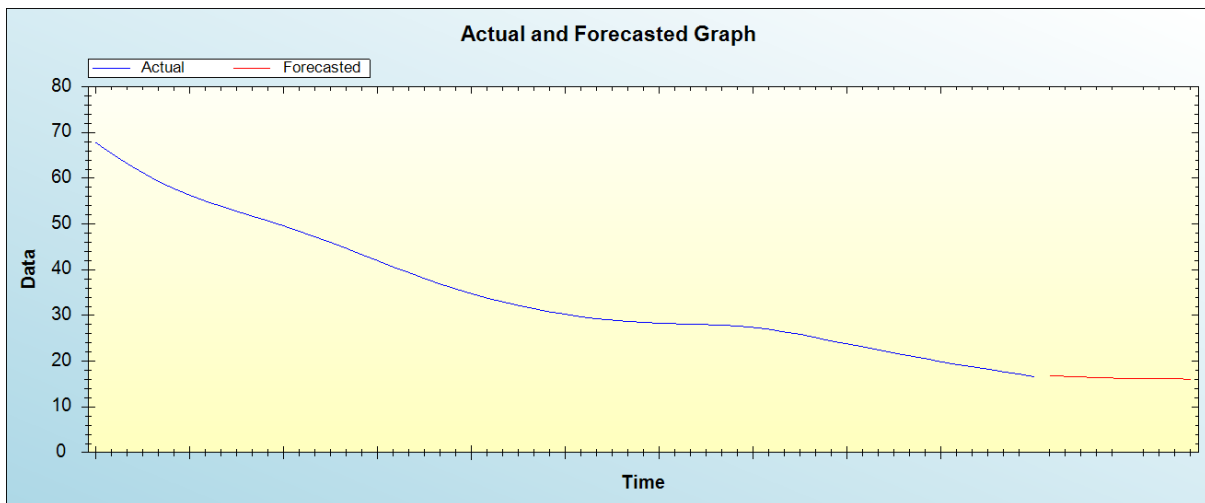Out-of-Sample Forecast for H: Actual and Forecasted Graph

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

Out-of-Sample Forecast for H: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	16.8856
2022	16.6816
2023	16.5462
2024	16.4406
2025	16.3117
2026	16.2369
2027	16.1654
2028	16.1551
2029	16.1304
2030	16.0882

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 16 deaths throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

At the beginning of the era of sustainable development goals all UN member countries agreed to solve all the major problems affecting human populations across the globe. Many UN member states have made significant progress towards achieving the set targets although there are numerous challenges that hinder the successful implementation of these SDGs. Persistence of wars, political conflicts, effects of climate change and economic downturn due to COVID-19 are among the factors that will derail the SDG progress. This study applied the ANN model to project future trends of under-five mortality rate in Trinidad and Tobago. Forecast results revealed thatannual U5MR will hover around 16 deaths throughout the out of sample period. Therefore, we encourage the government to address all the challenges that hinder successful implementation of the 3rd sustainable development goal (SDG3) in order to end all preventable under five deaths.

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