Tracking Future Trends of Under Five Mortality Rate for Seychelles Using a Machine Learning Method

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Abstract - **This study uses annual time series data on under five mortality rate for Seychelles from 1960 to 2020 to predict future trends of under-five mortality rate 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 model projections revealed thatU5MR will remain around 14 deaths per 1000 live births throughout the out of sample of period. Therefore, we encourage the government of Seychelles to address all the pertinent challenges that hinder the success of the maternal and child health program.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

The Agenda 2030 for sustainable development is a comprehensive outcome document that was intended to bring to an end all of forms of deprivation and create a conducive environment for human beings to live peacefully, in good health, with equal employment opportunities, and enjoying their rights and prosperity (WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). The implementation of the global action plan has encountered numerous challenges which include limited financial resources, climate change and wars. The health section of the outcome document outlines in detail how governments should address various health challenges affecting their people. This part of the global agenda aims to prevent avoidable deaths as a result of different causes such as communicable and non-communicable diseases. It also focuses on the significant reduction of maternal, neonatal and under five deaths by 2030 (UN, 2020). It is worthy to mention that all these efforts should be facilitated by technological advancement and research. Therefore, in this study we apply the artificial neural network approach to predict future trends of under-five mortality rate for Seychelles. The findings are anticipated to inform policy and allocation of resources to maternal and child health program activities in order to keep mortality among under five children.

II. LITERATURE REVIEW

Soleman *et al.* (2020) conducted a cross-sectional study in Indonesia to describe trends and main causes of children mortality in Indonesia from 2000 to 2017. The data was taken from World Health Organization Maternal Child Epidemiology Estimation from 2000 to 2017. The study results showed that the trend of three parameters of child mortality declined within 17 years and the main causes of mortality were premature birth in neonates, ARI in post neonates and premature birth in under five children. A quality improvement study was conducted by Juarez *et al.* (2020)to improve 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. The study concluded 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.Machio (2017)investigated the effects of antenatal and skilled delivery care services on neonatal and under-five mortality in Kenya using pooled Kenya demographic and health survey data for 1998, 2003, 2008/2009 and 2014. Two-stage residual inclusion estimation procedure and the control function approach were used to test and control for potential endogeneity of antenatal and skilled delivery care and for potential unobserved heterogeneity. Findings indicated that adequate use of antenatal care services reduced risk of neonatal and under-five mortality by 2.4 and 4.2 percentage points respectively.A cross sectional study was conducted by Nadin *et al.* (2017) to investigate the incidence of preterm delivery, maternal risk factors for having a preterm neonate, and preterm neonates' mortality in Jordan. Socio-demographic, perinatal, delivery risk factors, and survival information were gathered in pre- and post-hospital discharge interviews with 21075 women who gave birth to live neonates at ≥20 weeks of gestation in 18 hospitals in Jordan. Women were interviewed between 2012 and 2013. The study revealed that mortality rate was considerably higher among preterm neonates than among term neonates; discrepancies between Jordan and other countries existed. AZambian cross-sectional study by Lukonga & Michello (2015) revealed that low birth weight and overweight were significant predictors of neonatal mortality.

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 Seychelles.

Data Issues

This study is based on annual under five mortality rate in Seychelles 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	Y
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	0.001026
MSE	0.105401
MAE	0.254976

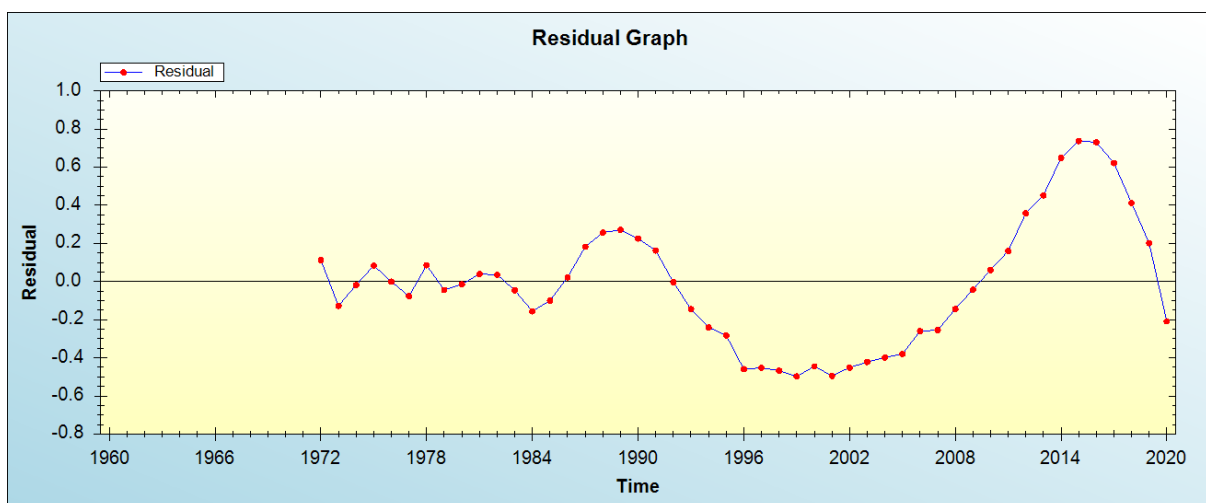Residual Analysis for the Applied Model

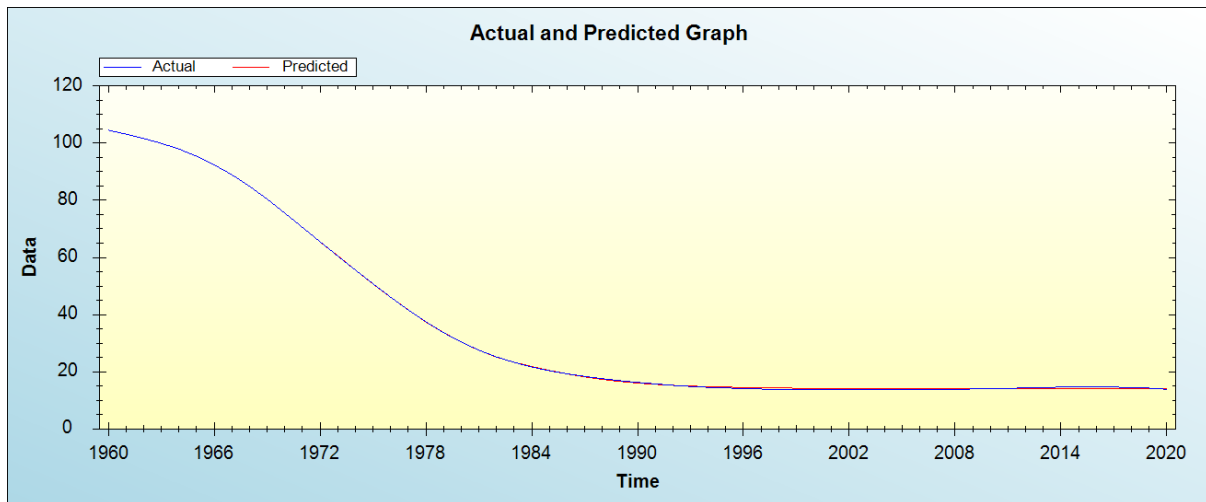Figure 1: Residual analysis

In-sample Forecast for Y

Figure 2: In-sample forecast for the Y series

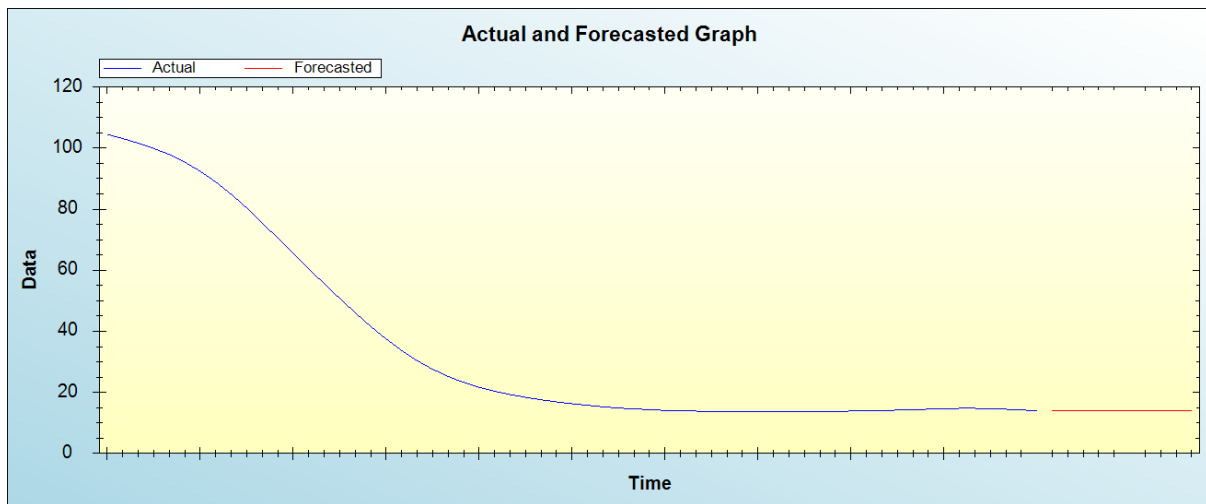Out-of-Sample Forecast for Y: Actual and Forecasted Graph

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

Out-of-Sample Forecast for Y: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	14.1133
2022	14.1278
2023	14.1267
2024	14.1283
2025	14.1089
2026	14.1121
2027	14.1138
2028	14.1089
2029	14.0894
2030	14.0765

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 14 deaths per 1000 live births throughout the out of sample of period.

V. POLICY IMPLICATION & CONCLUSION

So far there has been significant progress made towards achieving set targets for sustainable development goals by many UN member states. However the challenge is that some countries are lagging behind in some of the SDGs. It is critical for these countries to direct their efforts towards crafting new strategies that will address various issues affecting their citizens. Tracking of progress will guide policies, planning, decision and allocation of resources. This study applied the ANN model to project future trends of under-five mortality rate in Seychelles. The results of the study revealed thatU5MR will remain around 14 deaths per 1000 live births throughout the out of sample of period. Therefore, we encourage health authorities in Seychelles to address all the various challenges that affect under five children and hinder the success of the maternal and child health program.

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