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Assessing the Feasibility of Ending All Preventable Under Five Deaths in the Kingdom of Eswatini By 2030

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Eswatini 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 U5MR. The ANN (12, 12, 1) model projections suggest thatU5MR will remain high over the out of sample period. Therefore, we encourage the Kingdom of Eswatini to channel more resources to the maternal and child health (MNCH) program to ensure availability of adequate medical staff and supplies at all levels of healthcare especially primary healthcare facilities in the rural areas.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Sustainable development has three dimensions which are social, environmental and economic (UN, 2016; UN, 2015). These three aspects must be achieved by the end of 2030. The Agenda 2030 for sustainable development stimulated its 17 objectives and 169 targets with a view to solve all major global problems that are causing pain and suffering among different populations. By the end of 2030 all UN member countries anticipate to end all forms of poverty and other deprivations. Several stakeholders or global partners pledged to support 'Vision 2030' through provision of financial and technical assistance. UN member countries are expected to show commitment to this agenda through 'action' not 'words' and there should be evidence of progress. It was highlighted at the launch of the sustainable development goals in September 2015 that all activities designed to address the 17 thematic areas of the Agenda 2030 must be documented and carried out within the expected time lines. The 3rd SDG was viewed by many countries as one of the top priorities in this century. The existence of epidemics such as TB, HIV, Malaria and of late the COVID-19 pandemic demands unified effort to reduce the impact on the human race. Maternal and child health problems have been in existence for decades now and attending to the major drivers as quickly as possible will help to end all preventable maternal, newborn and under five deaths by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). The objective of this study is to model and project future trends of under-five mortality rate for Eswatini using the artificial neural network technique. We expect the study findings to inform child health policies, planning and allocation of resources to MNCH program activities in order to end all preventable under five deaths by 2030.

II. LITERATURE REVIEW

Ouedraogo *et al*. (2020) conducted a retrospective, descriptive and analytical study to investigate the risk factors for neonatal mortality in the Neonatology Department of Saint Camille Hospital of Ouagadougou (HOSCO - Hospital Saint Camille de Ouagadougou). The study included all newborns hospitalized in the neonatology department, at St Camille Hospital, in Burkina Faso from January 1 to December 31, 2017. Total of 710 records of hospitalized newborns in 2017 were analyzed and specifically focused on neonatal mortality. The study findings revealed that the leading cause of death was respiratory distress (89.8%). All the newborns had been hospitalized within 24 hours of life and the average time to death in the unit was 3 days and 54% of deaths occurred within 72 hours of hospitalization. A time series forecasting study by Nyoni & Nyoni (2020) used monthly time series data on neonatal deaths cases at Chitungwiza Central Hospital (CCH) from January 2013 to December 2018; to forecast neonatal deaths over the period January 2019 to December 2020 using the Box-Jenkins SARIMA approach. The parsimonious model was found to be the SARIMA (0, 0, 3) (2, 0, 0)12 model and its predictions indicate slow but steady decrease in neonatal deaths at CCH. Taha *et al.* (2020) investigated the prevalence of and factors associated with preterm birth and LBW among mothers of children under two years in Abu Dhabi, United Arab Emirates. Data were collected in clinical and non-clinical settings across various geographical areas in Abu Dhabi. The data were analyzed using both descriptive and inferential statistics. A total of 1610 mother–child pairs were included in the study. The study found that factors that were positively associated with preterm birth were Arab mothers, maternal education level below secondary, caesarean section, and LBW. Weddhi *et al.* (2019) examined factors associated with neonatal mortality at the Referral Hospital in Nouakchott, Mauritania. A cross-sectional study was conducted between January 2013 and December 2013 and included neonatal patients hospitalized at the National Referral Hospital (NRH). Data were collected by reviewing the medical charts and through questionnaires administered to the parents. The authors concluded that neonatal mortality remains a significant burden in Mauritania. They identified different socioeconomic and clinical

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risk factors indicating the need for more intensified prenatal care and improved transport of high risk neonates, especially in the regions outside the capital.

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 Eswatini Kingdom.

Data Issues

This study is based on annual under five mortality rate in the Kingdom of Eswatini 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	E
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	0.008019
MSE	2.256183
MAE	1.124643

Residual Analysis for the Applied Model

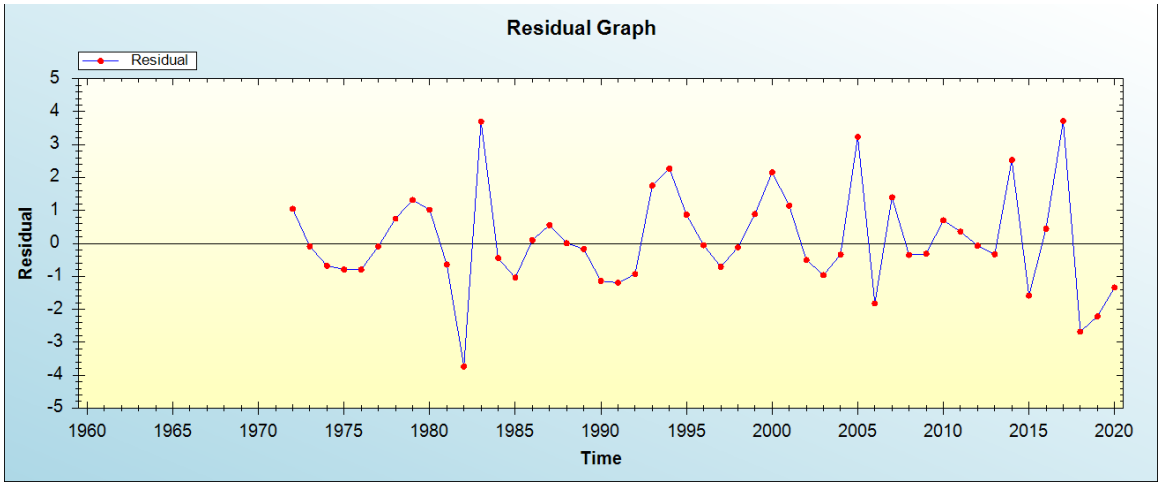

Figure 1: Residual analysis

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In-sample Forecast for E

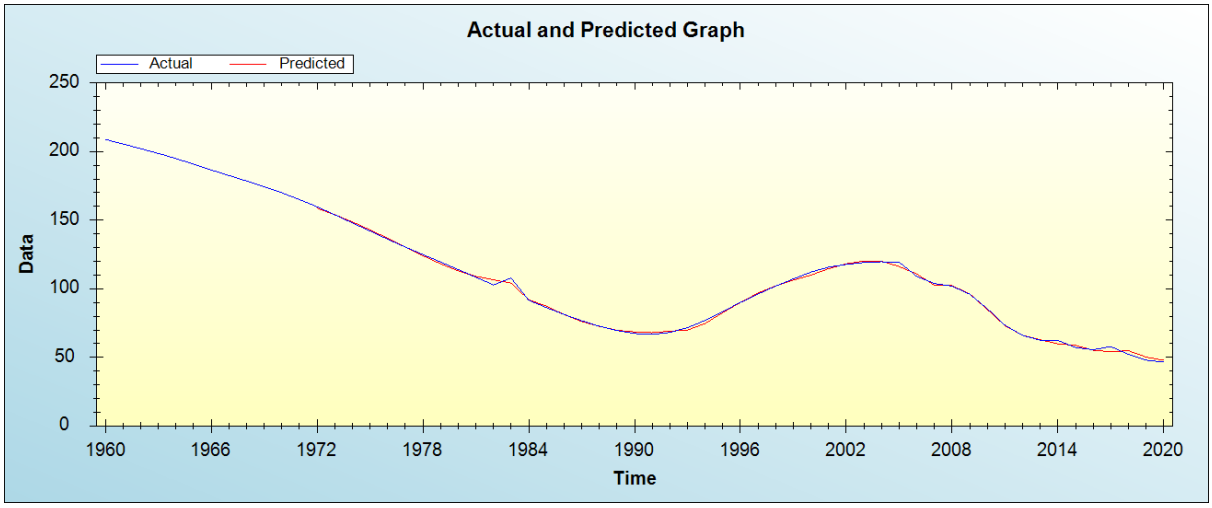

Figure 2: In-sample forecast for the E series

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

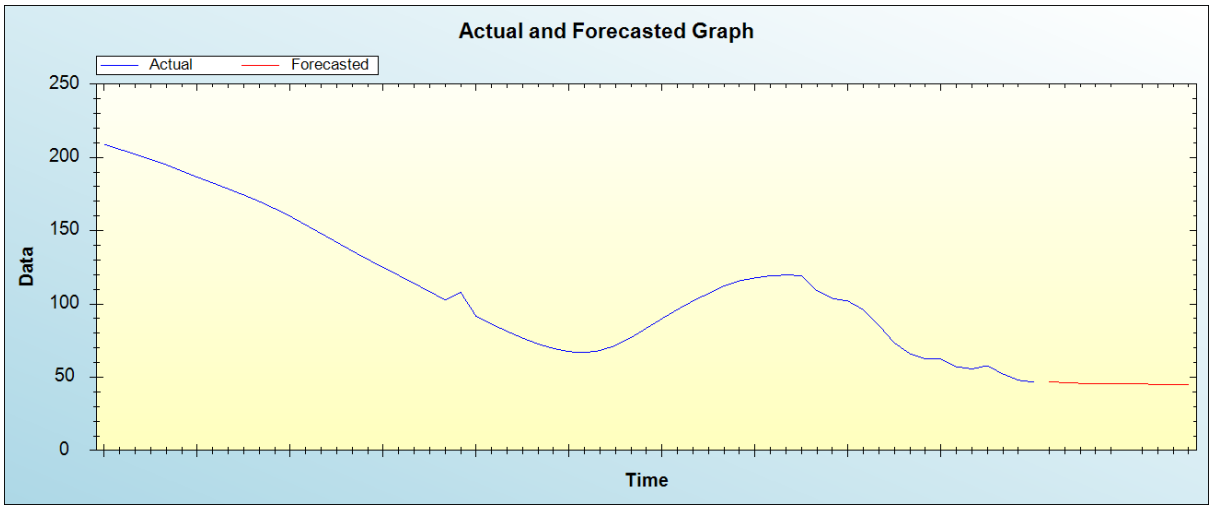

Figure 3: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	47.0435
2022	46.2144
2023	45.8944
2024	45.7055
2025	45.5444
2026	45.4596
2027	45.3835
2028	45.1842
2029	44.9387
2030	44.7400

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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 high over the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

Improving child survival should be a priority for maternal and child health (MNCH) programs in developing countries as they continue to report high absolute numbers of under five deaths. The quality and accessibility of healthcare services must be improved. Eswatini has made significant progress towards substantial reduction of under-five mortality and this is evidenced by the downward trend of under-five mortality over the past decades. This study applied the ANN (12,12, 1) model to predict U5MR in Eswatini. The findings of this paper revealed thatU5MR will remain high over the out of sample period. Therefore, we encouraged health authorities in this country to allocate more resources to MNCH program activities to ensure availability of medical staff and medical supplies at all levels of care particularly in the rural areas.

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