

# Predicting Future Trends of Under Five Mortality Rate for Ecuador Using Artificial Neural Networks

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**Abstract - This study uses annual time series data on under five mortality rate for Ecuador 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. The ANN (12, 12, 1) model projections indicated that U5MR will continue to decline over the out of sample period. Therefore, we encourage authorities in Ecuador to allocate more resources to the maternal and child health program so as to keep under five mortality below 25 deaths per 1000 live births.**

**Keywords:** ANN, Forecasting, U5MR.

## I. INTRODUCTION

Significant progress was witnessed under the era of millennium development goals (MDGs) although several global issues were partially attended (UN, 2016; UN, 2015). Many countries continue to suffer from hunger, poverty, wars, human rights abuses and global health problems among other challenges. The ushering in of the global agenda for sustainable development is expected to resolve all the remaining global concerns. However, the reality on the ground indicates that some developing countries are most likely to miss their SDG targets in various thematic areas (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Under 5 mortality is still a global public health problem requiring serious commitment from all countries and global partners so as to improve maternal and child health outcomes (UNICEF, 2019). Deaths among children is influenced by social, proximate, and intermediate factors (Adeyinka *et al.* 2019; El Ansari *et al.* 2015; Mckinnon *et al.* 2014). In line with the Agenda 2030 for sustainable development, this study aims to model and project future trends of under-five mortality rate for Ecuador using the artificial neural network technique. The findings of this piece of work are expected to facilitate planning and allocation of adequate resources to maternal and child health (MNCH) so as to effectively control mortality among under five children in Ecuador.

## II. LITERATURE REVIEW

Islam *et al.* (2020) developed a predictive analytics framework to predict the death rates with high accuracy and to find the significant determinants that cause high child mortality. The framework used an automated method of information gain to rank the information-rich mortality variables for accurate predictions. Ethiopian Demographic Health Survey and Pakistan Demographic Health Survey data sets were used for the validation of the proposed framework. These real-world data sets were tested using machine learning classifiers, such as Naïve Bayes, decision tree, rule induction, random forest, and multi-layer perceptron, for the prediction task. The study concluded that Naïve Bayes classifier predicts the child mortality rate with the highest average accuracy of 96.4% and decision tree helps in identifying key classification rules covering the factors behind children deaths. A cross-sectional study was conducted in Burundi by Moise (2018) to describe the main causes of hospitalization and mortality in children during the neonatal period and at ages 1 to 59 months, for boys and girls, and to assess the total annual (2010) burden of under-five morbidity and mortality in hospitals using hospitalization records from 21 district hospitals. The study findings revealed that human malarial infections continue to be the main cause of hospitalization and mortality among under-five children in Burundi. A comparison of Pakistan's under-five mortality, neonatal mortality, and postnatal newborn care rates with those of other countries was carried out by Ahmed & Won (2017). Neonatal mortality rates and postnatal newborn care rates from the Demographic and Health Surveys (DHSs) of nine low- and middle-income countries (LMIC) from Asia and Africa were analyzed. The study results indicated that postnatal newborn care in Pakistan was higher compared with the rest of countries, yet its neonatal mortality remained the worst. In Zimbabwe, both mortality rates have been increasing, whereas the neonatal mortality rates in Nepal and Afghanistan remained unchanged. An Indonesian study by Suparmi *et al.* (2016) applied the cox proportion hazard regression to analyze the contribution of low birth weight on neonatal mortality. The study highlighted that children born with low birth weight and born from younger mothers had higher risk 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 Ecuador.

#### Data Issues

This study is based on annual under five mortality rate in Ecuador 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	0.001091
MSE	0.345474
MAE	0.452785

#### Residual Analysis for the Applied Model

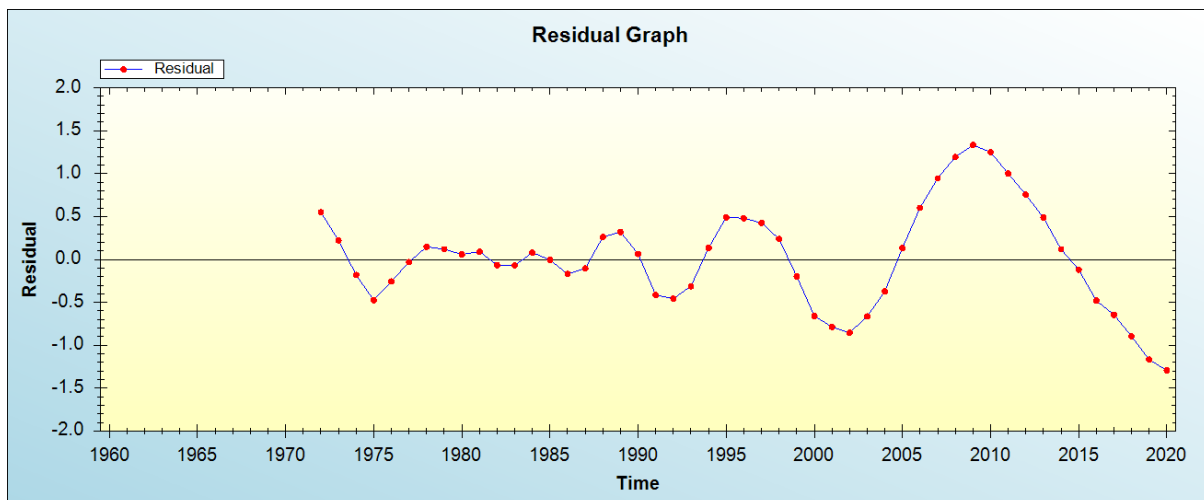


Figure 1: Residual analysis

In-sample Forecast for E

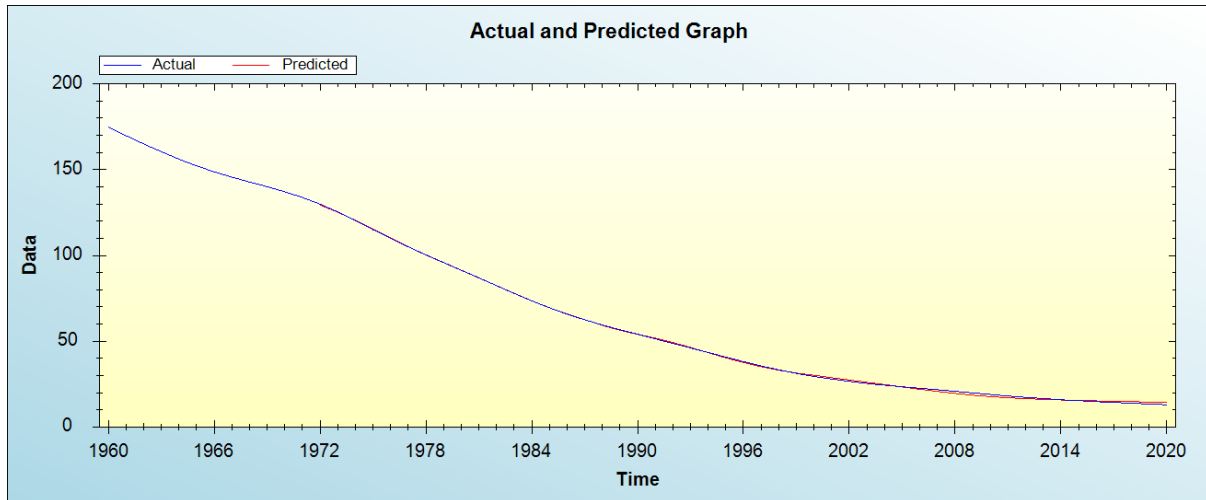


Figure 2: In-sample forecast for the E series

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

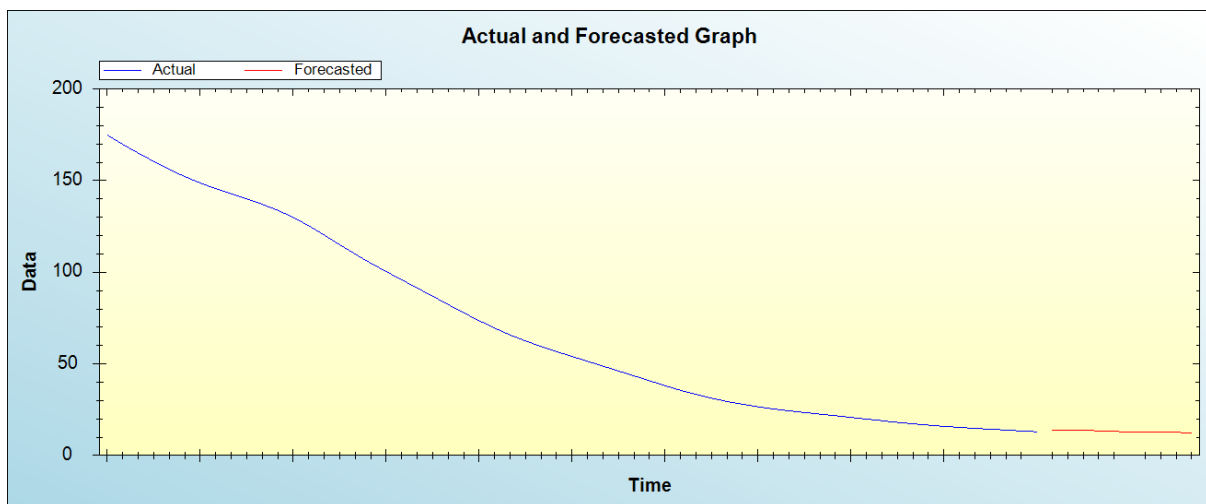


Figure 3: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	14.0516
2022	13.8580
2023	13.7757
2024	13.4886
2025	13.2021
2026	12.8437
2027	12.8789
2028	12.7594
2029	12.6158
2030	12.5012

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 continue to decline over the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

The downward trends of neonatal and under five mortality rates recorded by Ecuador over the past decade reflect the government's commitment to the agenda 2030 for sustainable development. In this study we applied the ANN (12, 12, 1) model to project future trends of under-five mortality in Ecuador. The results of the study indicate that U5MR will continue to decline over the out of sample period. Therefore, we encourage authorities in this country to allocate more resources to the maternal and child health program in order to keep under five deaths below 25 deaths per 1000 live births.

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