

# Forecasting Under Five Mortality Rate for Mexico Using an Artificial Intelligence Technique

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**Abstract** - This study uses annual time series data on under five mortality rate (U5MR) for Mexico 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 ANN (12, 12, 1) model is stable in forecasting under five mortality rate. ANN model projections revealed that U5MR will continue to decline throughout the out of sample period. Therefore, we implore the Mexican government to design local strategies that will keep under five mortality under control.

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

## I. INTRODUCTION

Empirical data is in three basic forms namely time series, cross-sectional and panel data (Gujarat & Porter, 2008). Time series data is very common in public health and it refers to the chronological record of observed values of a particular variable (Salvatore & Reagle (2001). Discrete time series data refers to data such as daily, monthly, quarterly or annual data. Time series data can be analyzed using various methods such as regression analysis, probability modelling, VAR modelling and ARDL modelling (Gujarat & Porter, 2008). A time series can display components such as trend, seasonality and irregular components (Box & Jenkins, 1970; Nyoni, 2018). A time series can be linear or nonlinear in nature. In this study we apply the artificial neural network approach to model U5MR for Mexico using annual univariate time series data. The findings are expected to stimulate an appropriate timeous response to the problem of under-five mortality in the country.

## II. LITERATURE REVIEW

Reis *et al.* (2021) evaluated the fetal and infant mortality rates due to congenital anomalies (CA) in Maranhão from 2001 to 2016 in Brazil. Data were obtained from the SINASC, and SIM databases. The study used simple linear regression, Poisson distribution, and ANOVA (Bonferroni's post hoc test) and analyzed the public data (2001–2016) of 1934858 births and determined the fetal, neonatal, perinatal, and post-neonatal mortality rates associated with CA by mesoregions. The results indicated mortality rates due to CA in Maranhão increased over the period 2001–2016 possibly as a result of improved maternal-infant health conditions eliminating other causes of death. Khasawneh & Khriesat (2020) assessed the rate of prematurity and determine the mortality rate and short-term outcomes among premature infants admitted at King Abdullah University Hospital (KAUH) in Jordan. A retrospective cross-sectional review of all premature infants admitted at KAUH between August 2016 and August 2018 was conducted. A high rate of prematurity was observed, the majority were late preterm with reassuring outcomes. Bitew *et al.* (2020) determined the incidence density rate and predictors of neonatal mortality by utilizing electronic databases. The study findings indicated that the incidence density rate of neonatal mortality in Sub-Saharan Africa is significantly high. Multiple factors (neonatal and maternal) were found to be independent predictors. In a 2019 study, Souza *et al.* examined the determinants of neonatal mortality in Foz do Iguassu in Brazil. The authors analyzed all neonatal deaths that occurred in Foz do Iguassu from 2012 to 2016. Birth and mortality data were extracted from two national governmental databases (SINASC and SIM). It was found that high rate of neonatal death in Foz do Iguassu is strongly associated with newborn characteristics and not associated with maternal socio-demographic characteristics.

## 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 Mexico.

Data Issues

This study is based on annual under five mortality rate in Mexico 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	X
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	0.000403
MSE	0.099654
MAE	0.232800

Residual Analysis for the Applied Model

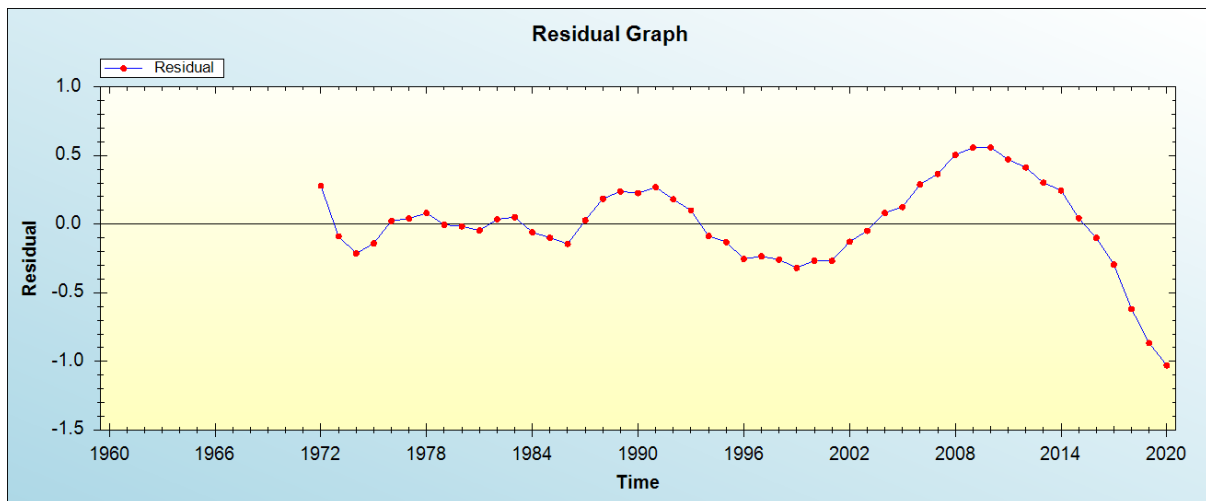


Figure 1: Residual analysis

In-sample Forecast for X

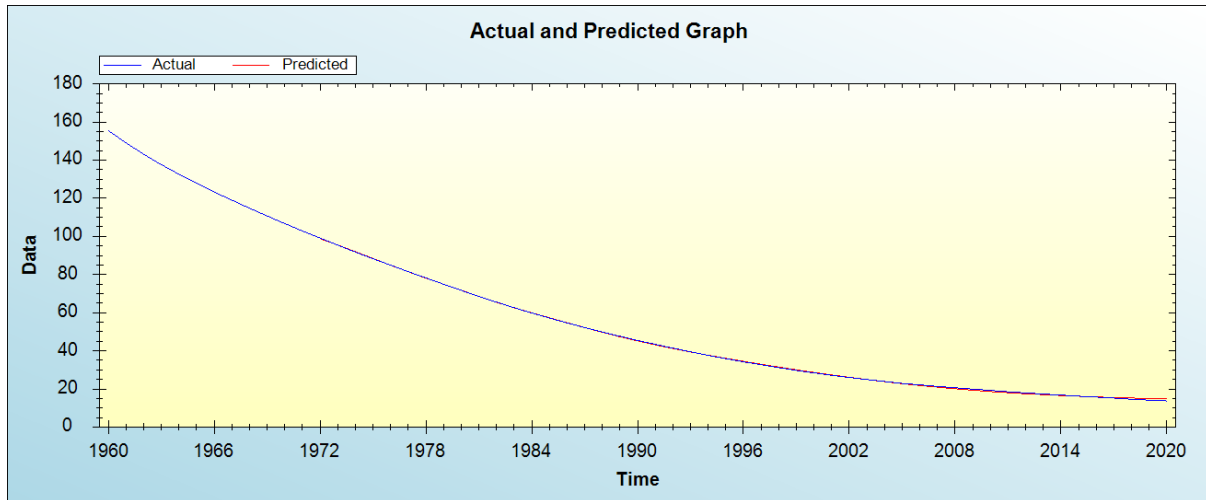


Figure 2: In-sample forecast for the X series

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

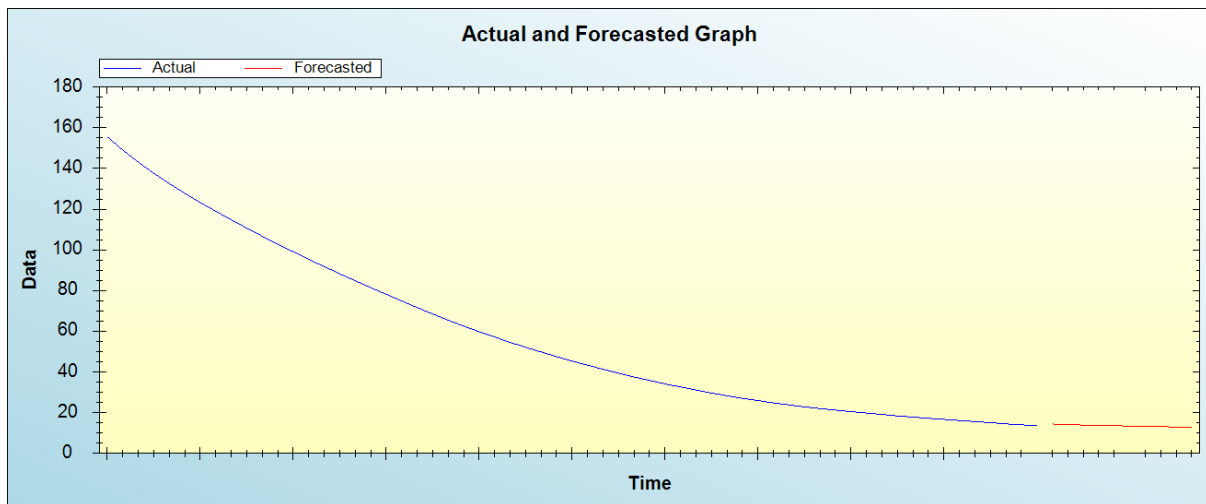


Figure 3: Out-of-sample forecast for X: actual and forecasted graph

Out-of-Sample Forecast for X: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	14.5024
2022	14.2519
2023	13.9903
2024	13.8073
2025	13.6412
2026	13.5276
2027	13.3654
2028	13.2032
2029	13.0789
2030	13.0527

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 throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

The Mexican government has witnessed a downward trend of under-five mortality over the past decades indicating the government's commitment to the agenda 2030 for sustainable development. This study applied the ANN model to predict under five mortality rate and the findings revealed that U5MR will continue to decline throughout the out of sample period. Therefore, we encourage health authorities to address all the challenges that contribute to under five mortality especially in the rural areas and other disadvantaged communities.

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