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# Forecasting Infant Mortality Rate in Cameroon Using Artificial Neural Networks

**[1]Dr. Smartson. P. NYONI, [2]Thabani NYONI**

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Department of Economics, University of Zimbabwe, Harare, Zimbabwe

***Abstract* - In this research article, the ANN approach was applied to analyze infant mortality rate in Cameroon. The employed annual data covers the period 1960-2020 and the out-of-sample period ranges over the period 2021-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting infant mortality rate in Cameroon. The applied ANN (12, 12, 1) model predicted that IMR will be around 48/1000 live births per year. Therefore the government, in line the suggested policy directions; should strengthen and capacitate primary health care, increase coverage of immunizations for infants and children, and train health workers on essential newborn care in order to reduce infant mortality in the country.**

***Keywords:*** ANN, Forecasting, infant mortality rate.

## I. INTRODUCTION

Public health surveillance is the systematic ongoing data collection, analysis, interpretation and dissemination of relevant health information for use by policy makers. Developing countries are lagging behind in terms of utilization of artificial intelligence (AI) technologies in public health surveillance yet these countries are witnessing epidemiologic transition and emergency of new diseases coupled with deteriorating health systems. AI applications are play a key role in screening, prognosis, diagnosis and time series forecasting (Zhao et al, 2020; Panch et al, 2018).Machine learning (ML) is a component of AI and enables computers to learn through experience. Computer programs enable the computer to understand the patterns in the data. Algorithms of ML are categorized into supervised, unsupervised and re-enforcement learning. In supervised learning the algorithm learns a hypothesis function from the input and output data whereas in unsupervised learning the algorithm finds the hidden patterns in the input data. Semi supervised learning is a mixture of both. Re-enforcement learning means that the algorithm maximizes on rewards (Weng et al, 2017). Artificial neural networks, support vector machine, K-nearest neighbors, tree based models, and Bayesian networks are widely used in time series forecasting problems (Zhao et al, 2020;Nyoni et al, 2020; Scavuzzo et al,2018; Gambhir et al, 2018; Laurean-Rosario et al, 2018; Yan et al, 2018; Kaushik & Sahi, 2018; Weng et al, 2017; Guo et al, 2017; Fojnica et al, 2016 ;Althouse et al, 2011; Zhang, 2003;Kishan, 1997; Patterson, 1995)

In this paper we aim to model and predict infant mortality rate in Cameroon using artificial neural networks. The findings of this study are envisioned to reveal trends in infant mortality rate and help in the evaluation of maternal and child health programs in the country.

## II. LITERATURE REVIEW

Nyoni & Nyoni (2020) modelled and forecasted infant deaths in Zimbabwe using ARIMA model. The study utilized annual time series data on total infant deaths in Zimbabwe from 1960 to 2018. The best model based on AIC was the ARIMA (1, 2, 5) model. The study findings indicated that the number of infant deaths per year, over the out-of-sample period, would follow a downward trend. In a related study, 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. Saravanou et al (2016) studied the infant mortality prediction using features extracted from birth certificates. Training of classification models to decide whether an infant will survive or not was carried out. The authors focused on exploring and understanding the importance of features in subsets of the population and compared models trained for individual races to general models. The study concluded that the applied methodology outperformed standard classification methods used by epidemiology researchers. Goncalves & Moultrie (2012) examined the risk of child mortality associated with short preceding birth intervals in Mozambique. The researchers applied a piecewise log-rate model to a pooled dataset comprising 36,305 live births from the 1997 and 2003 Mozambique

 

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Demographic and Health Surveys (DHS). The results revealed that the effects of short preceding intervals are strongest during the first month of life, particularly the first week, indicating prenatal maternal depletion as the dominant pathway. The rapid decline in mortality rates from intervals of less than six months to the category 30 to 35 months suggests an optimal waiting period of at least 30 months between one birth and the next pregnancy.

## III. METHODOLOGY

The Artificial Neural Network (ANN), which we intend to apply in this study; is a data processing system consisting of a huge number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from any data-set to describe the nonlinear and interaction effects with great accuracy. No strict rules exist for the determination of the ANN structure hence 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 infant mortality rates in Cameroon.

### Data Issues

This study is based on annual infant mortality rates in Cameroon for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 to 2030. Infact mortality rate, which is simply a proxy for infant deaths; for the purposes of this study, is defined as the number of infants dying before reaching one year of age, per 1000 live births in a given year. All the data employed in this paper was gathered from the World Bank.

## IV. FINDINGS OF THE STUDY

### ANN Model Summary

**Table 1: ANN model summary**

| | |
|---|---|
| Variable | T |
| 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 | 0.010655 |
| MSE | 0.455367 |
| MAE | 0.511161 |

 

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*Residual Analysis for the Applied Model*

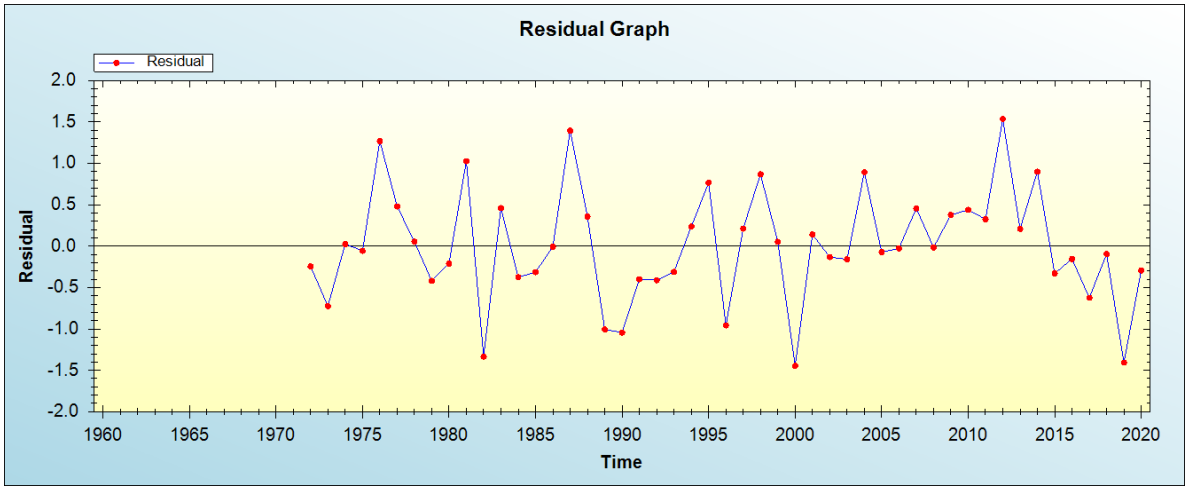


**Figure 1: Residual analysis**

*In-sample Forecast for T*

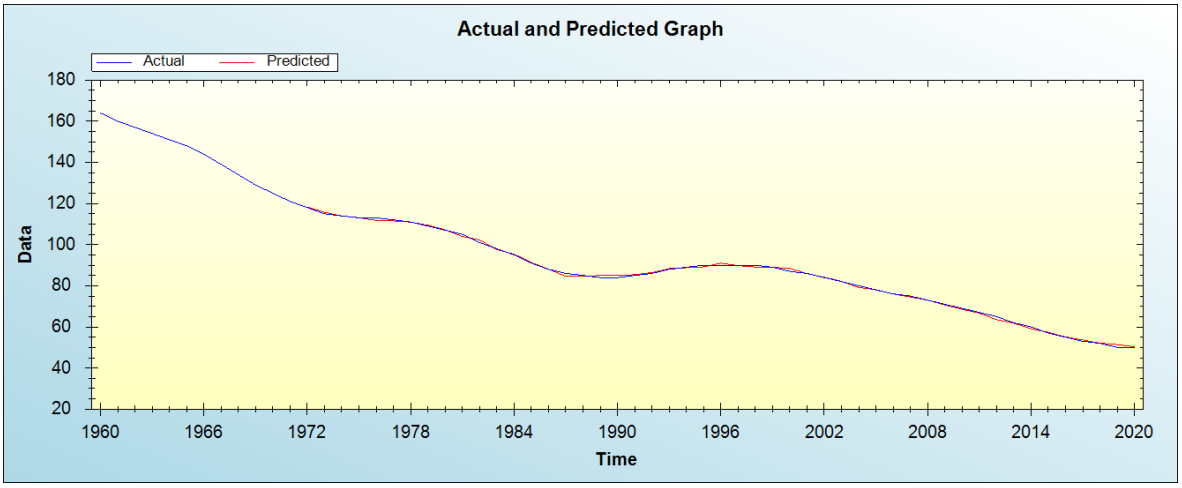


**Figure 2: In-sample forecast for the T series**

*Out-of-Sample Forecast for T: Actual and Forecasted Graph*

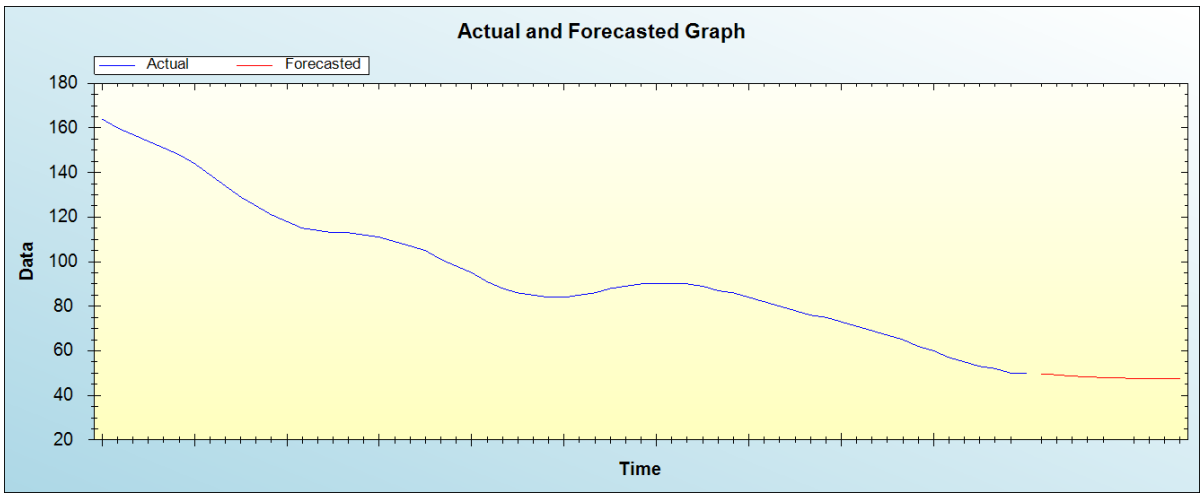


**Figure 3: Out-of-sample forecast for T: actual and forecasted graph**

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*Out-of-Sample Forecast for T: Forecasts only*

**Table 3: Tabulated out-of-sample forecasts**

| Year | Forecasts |
|---|---|
| 2021 | 49.7148 |
| 2022 | 49.2465 |
| 2023 | 48.6247 |
| 2024 | 48.3922 |
| 2025 | 47.9454 |
| 2026 | 47.8403 |
| 2027 | 47.6013 |
| 2028 | 47.5592 |
| 2029 | 47.3982 |
| 2030 | 47.4547 |

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 infant mortality in Cameroon is likely to remain around 48/1000 live births per year over the next decade.

## V. CONCLUSION AND POLICY RECOMMENDATIONS

Preventing infant mortality remains one of the main objectives of the health ministry in Cameroon. The government remains committed to ending preventable deaths infants in the country. The study used annual data to analyze the trends of infant mortality in Cameroon. The applied model is the ANN model. In order to make sure that infant mortality in the country significantly declines, the government of Cameroon ought to consider the following policy suggestions:

i. The government should continue to encourage mothers to breast-feed their babies adequately.

ii. There is need for all child-bearing women to be vaccinated against common illnesses.

iii. There is need to prevent birth defects in Cameroon.

iv. The government of Cameroon should address preterm birth, low birth-weight and their outcomes.

v. The government of Cameroon should also ensure adequate access to pre-pregnancy and prenatal care.

vi. There is need to educate, especially, mothers on the importance of creating a safe infant sleep environment in the country.

vii. Healthcare providers in the country need to use newborn screening activities in order to detect hidden conditions.

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