

Forecasting Infant Mortality Rate in Gabon Using Artificial Neural Networks

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Abstract - In this research paper, the ANN approach was applied to analyze infant mortality rate (IMR) in Gabon. The employed annual data covers the period 1978-2020 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 IMR in Gabon. The applied ANN (12, 12, 1) predictions revealed that IMR will around 31/1000 live births per year in the next 10 years. Therefore the Gabon government is encouraged to intensify maternal and child health surveillance and control programs with special priority being given to capacitating primary health care.

Keywords: ANN, Forecasting, infant mortality rate.

I. INTRODUCTION

The death of a child during the first year of life is referred to as infant death whereas the death of an infant per 1000 live births is infant mortality rate (IMR). Infant mortality is a very important indicator of the health status of the population (Weldearegawi et al, 2015). High IMR indicates the existence of poor socio-economic and environmental conditions during the first year of life (Nyoni & Nyoni (2020); Dube et al, 2013; UN, 2013; NIS, 2012; Reidpath & Allotey, 2003). Several developing countries have committed their resources to the reduction of infant mortality by increasing the coverage of immunizations, Vitamin A supplementation, promotion of institutional deliveries, integrated management of childhood illnesses and exclusive breastfeeding of babies up to 6months (Lawn et al, 2005; Claeson et al, 2000). Many researchers conducted studies on infant mortality and concluded that infant mortality is influenced by demographic, socio-economic and proximate factors (Diallo et al, 2012; Adhikari & Sawangdee, 2011; Kumar & File, 2010; Deribew et al, 2007; Katz et al, 2003; Asefa et al, 2002; Hirve & Ganatra, 1997). In this study we aim to model and forecast IMR in Gabon using the artificial neural network approach. The multilayer perceptron was utilized in this piece of work because of its popularity and accuracy in time series forecasting (Nyoni et al, 2020; Kaushik & Sahi, 2018; Yan et al, 2018; Fojnica et al, 2016; Zhang, 2003; Kishan, 1997; Patterson, 1995). The findings of this study are expected to reveal future trends of IMR and will facilitate resource allocation for maternal and child health services in the country. Furthermore the resources will assist in the assessment of the progress towards achieving the sustainable development goals by 2030.

II. LITERATURE REVIEW

Nyoni & Nyoni (2020) modelled and forecasted infant deaths in Zimbabwe using the 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 revealed that the number of infant deaths per year, over the out-of-sample period, would follow a downward trend. 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 based on AIC and its predictions indicate slow but steady decrease in neonatal deaths at CCH. Weddhi et al (2019) performed a study on 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 risk factors indicating the need for more intensified prenatal care and improved transport of high risk neonates, especially in the regions outside the capital. Goncalves & Moultrie (2012) examined the risk of child mortality associated with short preceding birth intervals in Mozambique. The authors applied a piecewise log-rate model to a pooled dataset comprising 36,305 live births from the 1997 and 2003 Mozambique Demographic and Health Surveys (DHS). The results showed 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. Basically, 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 Gabon.

Data Issues

This study is based on annual infant mortality rates in Gabon for the period 1978 – 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	N
Observations	31 (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	0.027697
MSE	0.568496
MAE	0.590241

Residual Analysis for the Applied Model

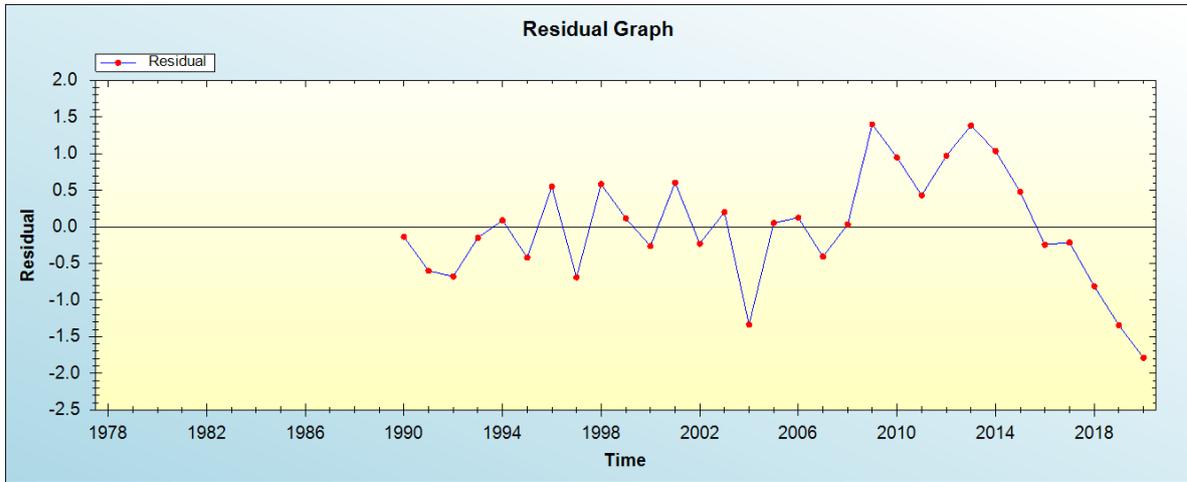


Figure 1: Residual analysis

In-sample Forecast for N

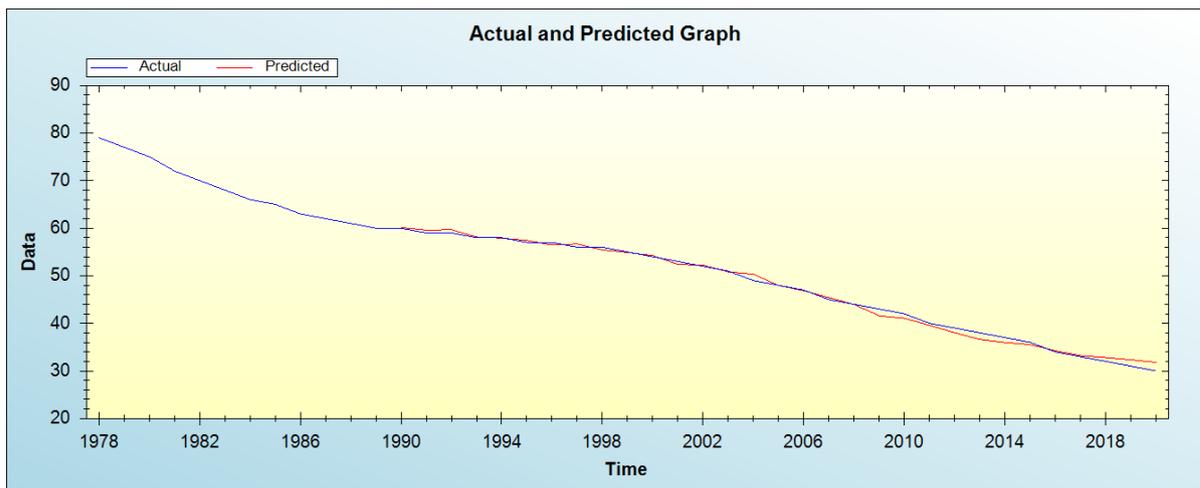


Figure 2: In-sample forecast for the N series

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

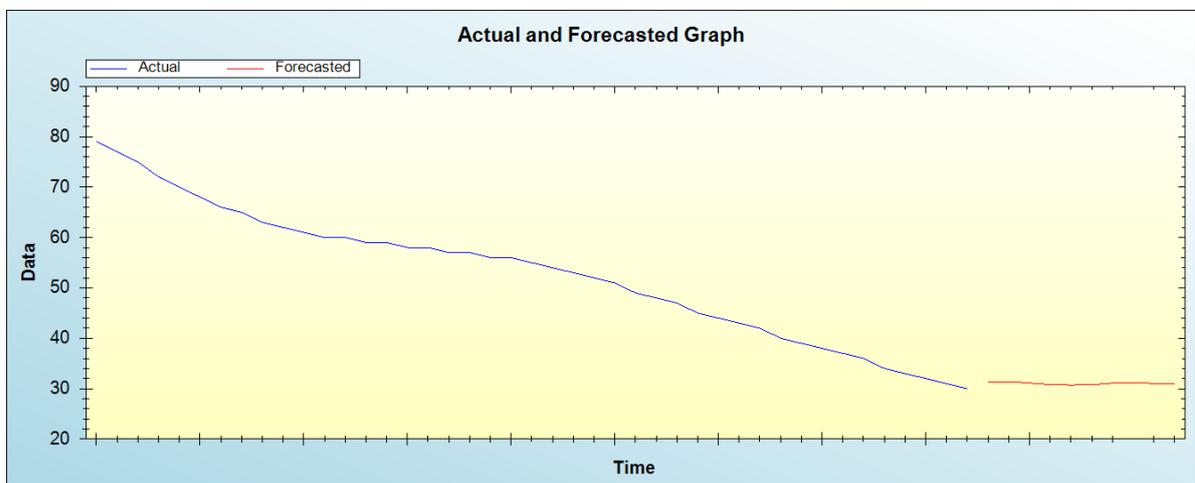


Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2021	31.3287
2022	31.4037
2023	31.1301
2024	30.7970
2025	30.7033
2026	30.7673
2027	31.1014
2028	31.1393
2029	31.0540
2030	31.0252

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 Gabon is likely to remain around 31/1000 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 Gabon. 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 Gabon. The applied model is the ANN model. In order to make sure that infant mortality in the country significantly declines, the government of Gabon 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 Gabon.
- iv. The government of Gabon should address preterm birth, low birth-weight and their outcomes.
- v. The government of Gabon 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 Gabon need to use newborn screening activities in order to detect hidden conditions.

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