International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 419-423, March-2021

https://doi.org/10.47001/IRJIET/2021.503072

Forecasting Infant Mortality Rate in Burkina Fasso Using Artificial Neural Networks

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***Abstract* - In this research paper, the ANN approach was applied to analyze infant mortality rate in Burkina Fasso. 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 Burkina Fasso. The ANN (12, 12, 1) model predicted that over the out-of-sample period the rate of infant mortality will be around 53/1000 live births per year. Therefore we implore the government to strengthen surveillance in maternal and child health programs and allocate more resources towards improving primary health care in the country. This must be done in line with suggested policy recommendations.**

Keywords: ANN, Forecasting, infant mortality rate.

I. INTRODUCTION

The demand for Artificial intelligence (AI) techniques is increasing at an alarming rate especially in the public health domain. Machine learning (ML) as part of AI is proving to be useful in public health surveillance. It is utilized in time series prediction problems thereby facilitating the detection of infectious disease outbreaks and act as early warning systems. Time series of epidemiologic data feature seasonality, nonstationarity and sparsity (Nyoni & Nyoni, 2020). Predicting such time series has major public health implications and has attracted attention from many researchers (Zeng et al, 2021; Panch et al, 2018). ML algorithms play a pivotal role in risk estimation and prediction of epidemiological trends (Zeng et al, 2021; Panch et al, 2018, Weng et al, 2017). Complex network analysis methods have been applied to study the spread of epidemics over typical network types such as small networks, scale free networks, and community networks (Nian & Wang, 2010; Ren & Wang, 2014). Researchers have tried to combine AI and compex networks for infectious disease transmission modeling. Bayesian networks, decision trees, support vector machine, K-nearest neighbors and artificial neural networks are the most widely used ML algorithms for time series prediction (Nyoni et al, 2020; Zhao et al, 2020; Kaushik & Sahi, 2018; Yan et al, 2018 Scavuzzo et al,2018; Gambhir et al, 2018; Laurean-Rosario et al, 2018; Weng et al, 2017; Guo et al, 2017;Althouse et al, 2011; Fojnica et al, 2016; Zhang, 2003; Kishan, 1997; Patterson, 1995). In this paper we aim to model and forecast infant mortality rate for Burkina Fasso using artificial neural network approach. The results of this study are envisioned to highlight the future trends of infant mortality rate and facilitate planning and resource allocation for maternal and child health services in the country in order to curb infant mortality.

II. LITERATURE REVIEW

Adenyika & Muhajarine (2020) modelled long-term U5MR with group method of data handling (GMDH)-type artificial neural network (ANN), and compared the forecasts with the commonly used conventional statistical methods—ARIMA regression and Holt-Winters exponential smoothing models. The historical dataset of annual U5MR in Nigeria from 1964 to 2017 was obtained from the official website of World Bank. The optimal models for each forecasting methods were used for forecasting mortality rates to 2030 (ending of Sustainable Development Goal era). The predictive performances of the three methods were evaluated, based on root mean squared errors (RMSE), root mean absolute error (RMAE) and modified Nash-Sutcliffe efficiency (NSE) coefficient. Statistically significant differences in loss function between forecasts of GMDH-type ANN model compared to each of the ARIMA and Holt-Winters models were assessed with Diebold-Mariano (DM) test and Deming regression. The study concluded that GMDH-type neural network performed better in predicting and forecasting of under-five mortality rates for Nigeria, compared to the ARIMA and Holt-Winters models. 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

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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. Kadir et al (2018) did a systematic review and summarized the current and past knowledge on the effects of armed conflict on child health and development. A systematic review was performed with searches in major and regional databases for papers published 1 January 1945 to 25 April 2017. Included studies provided data on physical and/or developmental outcomes associated with armed conflict in children under 18 years. Data were extracted on health outcomes, displacement, and social isolation, experience of violence, orphan status, and access to basic needs. The authors found out that the reviewed papers described mortality, injuries, illnesses, environmental exposures, limitations in access to health care and education, and the experience of violence, including torture and sexual violence.

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 Burkina Faso.

Data Issues

This study is based on annual infant mortality rates in Burkina Faso 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	W
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	0.015570
MSE	0.793802
MAE	0.750651

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Residual Analysis for the Applied Model

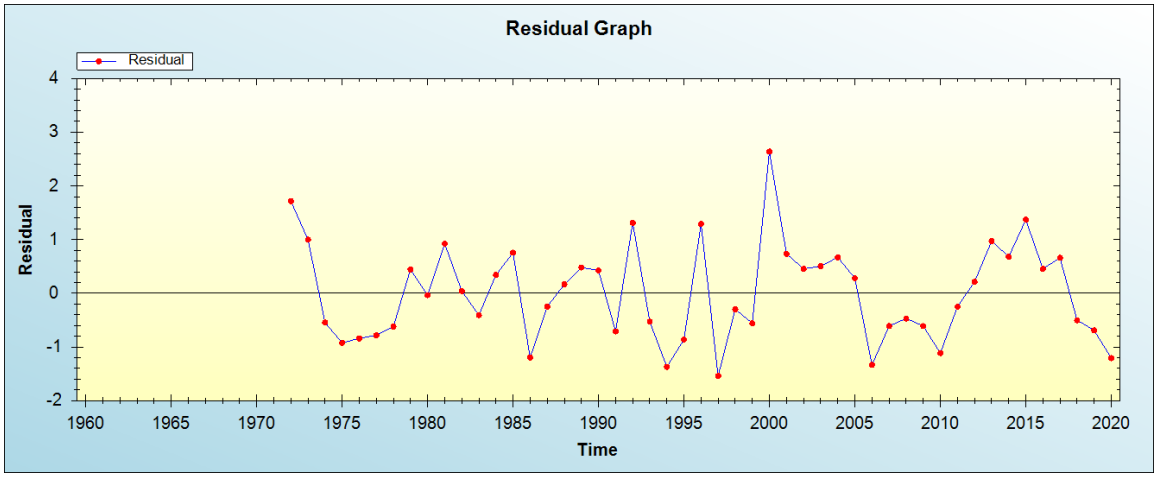

Figure 1: Residual analysis

In-sample Forecast for W

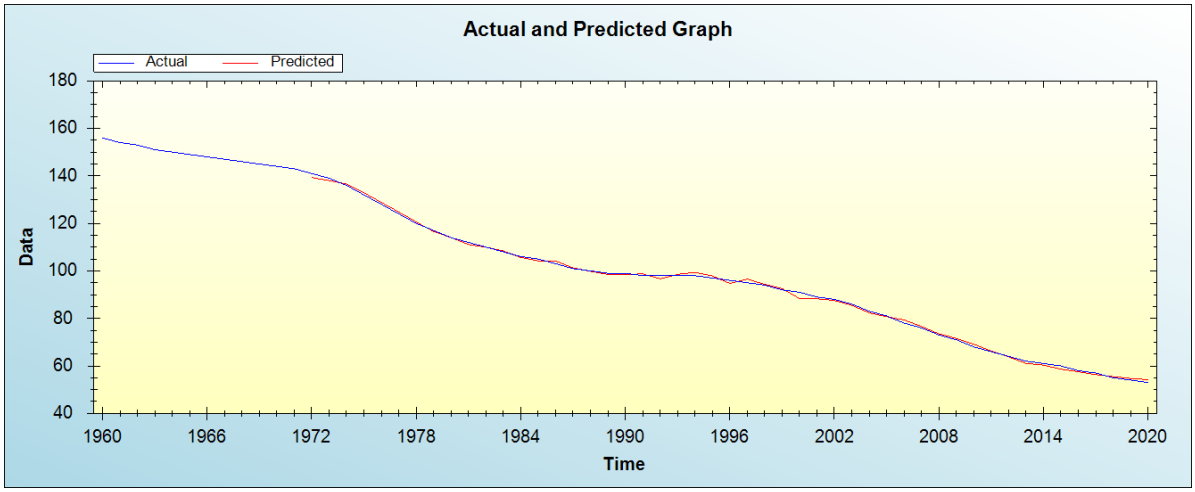

Figure 2: In-sample forecast for the W series

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

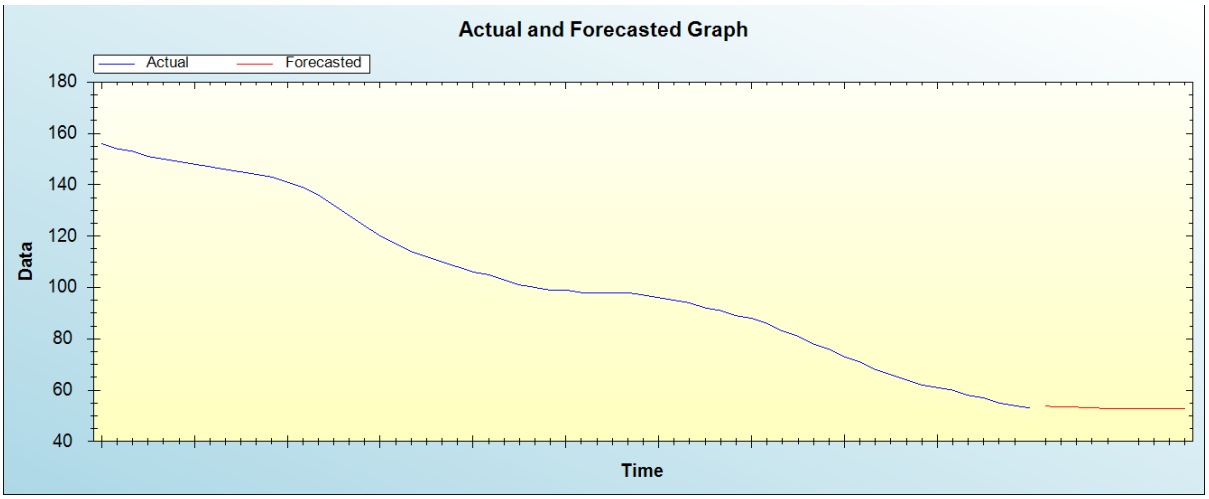

Figure 3: Out-of-sample forecast for W: actual and forecasted graph

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Out-of-Sample Forecast for W: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2021	53.7990
2022	53.4710
2023	53.3815
2024	53.1686
2025	52.7713
2026	52.8680
2027	52.7577
2028	52.7044
2029	52.7658
2030	52.7237

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 Burkina Faso is likely to remain around 53/1000 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 Burkina Faso. The government of Burkina Faso remains committed to ending preventable deaths infants in the country. The study used annual data to analyze the trends of infant mortality in Burkina Faso. The applied model is the ANN model. In order to make sure that infant mortality in the country significantly declines, the government of Burkina Faso 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 Burkina Faso.
iv. The government of Burkina Faso should address preterm birth, low birth-weight and their outcomes.
v. The government of Burkina Faso 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 Burkina Faso need to use newborn screening activities in order to detect hidden conditions.

REFERENCES

[1] Althouse BM &Ng YY (2011). Cummings DAT, Prediction of dengue incidence using serach query surveillance. Ploys Neglected Tropical Diseases 2011; 5:e1258. https://doi.org/10.1371/journal.pntd.0001258 PMID: 21829744

[2] Dan W. Patterson (1995) Artificial Neural networks Theory and Applications. Singapore; New York: Prentice Hall.

[3] Daniel Zeng., Zhidong Cao & Daniel B Neil (2021). Artificial intelligence enabled public health surveillance—from local detection to global epidemic monitoring and control. ELSEVIER pp 1-18.

[4] Fojnica, A., Osmanoviae & Badnjeviae A (2016). Dynamic model of tuberculosis-multiple strain prediction based on artificial neural network. In proceedings of the 2016 5th Mediterranean conference on embedded computing pp290-293.

[5] Gambhir S., Malik SK., & Kumar Y (2018). The diagnosis of dengue disease: An evaluation of three machine learning approaches. International Journal of Healthcare Information Systems and Informatics 2018; 13:1–19. https://doi.org/10.4018/ijhisi.2018040101 PMID: 3

[6] Guo P., Liu T., Zhang Q., Wang L., Xiao J & Zhang Q (2017). Developing a dengue forecast model using machine learning: A case study in China. PLoS Neglected Tropical Diseases 11:e0005973. https://doi.org/10.1371/journal.pntd.0005973 PMID: 29036169

[7] Kaushik AC & Sahi. S (2018). Artificial neural network-based model for orphan GPCRs.Neural.Comput.Appl. 29,985-992

[8] Kishan Mehrotra., Chilukuri K., Mohan, & Sanjay Ranka (1997) Elements of artificial neural networks

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https://doi.org/10.47001/IRJIET/2021.503072

[9] Laureano-Rosario AE., Duncvan AP., Mendez-Lazaro PA., Garcia-Rejon JE., Gomez-Carro S., & Farfan-Ale J (2018). Application of artificial neural networks for dengue fever outbreak predictions in the northwest coast of Yucatan, Mexico and San Juan, Puerto Rico. Tropical Medicine and Infectious Disease 2018;3:5

[10] Naizhuo Zhao., Katia Charland., Mabel Carabali., Elaine O., Nsoesie., Mathieu MaheuGiroux., Erin Rees., Mengru Yuan., Cesar Garcia Balaguera., Gloria Jaramillo Ramirez., & Kate Zinszer (2020). Machine learning and dengue forecasting: Comparing random forests and artificial neural networks for predicting dengue burden at national and sub-national scales in Colombia. PLOS Neglected Tropical Diseases | https://doi.org/10.1371/journal.pntd.0008056

[11] Nyoni S P & Nyoni T (2020). Modelling and forecasting infant deaths in Zimbabwe using ARIMA models. NOVATEUR PUBLICATIONS JournalNX- A Multidisciplinary Peer Reviewed Journal ISSN No: 2581 - 4230 VOLUME 6, ISSUE 7.

[12] Scavuzzo JM., Trucco F., Espinosa M., Tauro C B., Abril M., & Scavuzzo CM (2018). Modeling dengue vector population using remotely sensed data and machine learning. Acta Tropica 185:167–175. https://doi.org/10.1016/j.actatropica.2018.05.003 PMID: 29777650

[13] Smartson. P. Nyoni, Thabani Nyoni, Tatenda. A. Chihoho (2020) Prediction of new Covid-19 cases in Ghana using artificial neural networks. IJARIIE Vol-6 Issue-6 2395-4396

[14] Smartson. P. Nyoni., Thabani Nyoni., Tatenda. A. Chihoho (2020) Prediction of daily new Covid-19 cases in Egypt using artificial neural networks.IJARIIE- Vol-6 Issue-6 2395-4396

[15] Trashcan Panch., Peter Szolovits., & Rifat Atun (2018).Artificial intelligence, machine learning and health systems. Viewpoints• doi: 10.7189/jogh.08.020303 5 • Vol. 8 No. 2 • 020303

[16] Weng SF, Reps J, Kai J, Garibaldi JM, Qureshi N (2017) Can machine-learning improve cardiovascular risk prediction using routine clinical data?. PLOS ONE 12(4): e0174944. https://doi.org/10.1371/journal.pone.0174944

[17] Weng SF., Reps J., Kai J., Garibaldi J M, Qureshi N (2017) Can machine-learning improve cardiovascular risk prediction using routine clinical data? PLOS ONE 12(4): e0174944. https://doi.org/10.1371/journal.pone.0174944S

[18] Zhang G P (2003), "Time series forecasting using a hybrid ARIMA and neural network model", Neurocomputing 50: 159–175.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Forecasting Infant Mortality Rate in Burkina Fasso Using Artificial Neural Networks" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 419-423, March 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.503072

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