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

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 354-357, March-2021

https://doi.org/10.47001/IRJIET/2021.503060

Forecasting TB Incidence in Senegal Using the Multilayer Peceptron

[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 TB incidence in Senegal. The employed annual data covers the period 2000-2018 and the out-of-sample period ranges over the period 2019-2023. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting TB incidence in Senegal. The results of the study indicate that TB incidence is likely to remain high over the period 2019-2023. In order to contribute meaningfully to the national control strategy of a TB-free Senegal, authorities should, among other things, intensify TB surveillance and control programs**

Keywords: ANN, Forecasting, TB incidence.

I. INTRODUCTION

Tuberculosis(TB) is an ancient infectious disease but still remains a major public health problem internationally .Anti-TB drugs are widely available to cure the disease ,however we continue to see high morbidity and mortality especially in developing countries (Osei et al,2019).The burden of the disease is highest in Africa and Asia ,with Africa contributing 25 % of the global TB incidences (WHO,2017).In 2017 ,10 million people were estimated to be infected with TB (WHO,2018).In 2016,the estimated incidence of TB in Senegal was 140 cases per 100 000 population (WHO,2017;Diatta et al,2007;Strategic TB Plan,2017).The aim of the Senegalese National TB program is to identify and treat TB cases early especially sputum positive cases to curb the transmission of mycobacterium tuberculosis among communities. Despite the government's efforts to combat TB/HIV in Senegal, non-adherence to treatment remains a major issue of concern which may lead to treatment failure, development of drug resistant TB, relapse and prolonged illness and death among infected TB patients (WHO,2010). Many people in Senegal are living in poverty and this has worsened the burden of TB (World Bank,2017; Saunders & Evans ,2016).The Senegalese National TB program is committed to the global goal of 'ENDING TB' by 2035 and currently it is seized with the identification and treatment of all cases in order to reduce morbidity and morbidity due to TB(Alagna et al,2015).This paper aims to model and forecast the annual TB incidence in Senegal using the artificial neural network ,ANN (9,12,1) model .The study findings are expected to reveal the future trends of TB incidence and will act as a guiding tool in planning and implementation of the 'END TB ' strategy by 2035 .

II. LITERATURE REVIEW

Globally there are many empirical studies on TB. Diaw et al (2018) conducted a retrospective pre-post study in a Senegal health facility to compare TB retention in care and outcome between a year period and fourth year period after. The research concluded that the implementation of diagnostic procedures if integrated in socio -economic intervention impacts favorably on TB retention in care and treatment outcomes. Gashu et al (2018) analyzed patterns of TB case notifications in Ethiopia by applying the winter's multiplicative method of exponential smoothing. TB notifications for the period 2010-2016 were analyzed using SPSS version 20. The study revealed that TB is a seasonal disease in Ethiopia with a peak in quarter four and a low in the 2nd quarter of the fiscal year. The peak of TB case notification rate corresponds with the end of the dry season in the two agrarian regions of Ethiopia .In another similar study, Azeez et al (2016) modelled and forecasted TB incidence in a Health facility in Eastern Cape ,South Africa. The study applied the SARIMA and the SARIMA-NNAR hybrid model using monthly TB incidence data covering the period January 2010 to December 2015. The data was gathered from the Eastern Cape Health Facility Report of the electronic TB register. The study indicated that the hybrid model had a better TB incidence forecasting performance with a lower AIC. Agyei et al (2013) conducted a related and in the study the researchers modelled and forecasted monthly TB incidence in the Ashanti region of Ghana. The data covered the period January 2001-March 2013.The study applied the ARIMA model. The AR (1) was found to be the best model and that the TB epidemic in the Ashanti Region was expected to be stable over the period April 2013-April 2015. Aryee et al (2018) performed a time series analysis using the ARIMA model. Monthly TB cases reported

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 3, pp 354-357, March-2021
https://doi.org/10.47001/IRJIET/2021.503060

at the KBTH for the period 2008-2017 was used. The ARIMA (1,0,1) was found to be the best model based on AIC. The model predicted that monthly TB cases would be ranging from 53-55 for the year 2018. Moosazadeh et al (2015) predicted the incidence of smear positive TB cases in Iran using time series analysis. The used monthly TB incidence data recorded in the Iranian National TB Control Program and the data covered the period April 2005-March 2012.The SARIMA $(0,1,1)\ (0,1,1)_{12}$ was the best model basing on AIC. The model predicted that TB incidence for 2015 would be about 9.8 per 100 000 people.

III. METHOD

The Artificial Neural Network (ANN), which we intend to employ; is a data processing system consisting of a large number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from an experimental or real data set to describe the nonlinear and interaction effects with great accuracy. ANN-based curve fitting technique is one of the extensively applied artificial intelligence methods that are used for forecasting and prediction purpose. It consists of basically three layers i.e., input layer, hidden layer, and output layer, the present work includes the number of years as input layer and the annual TB incidence in Senegal as output data for the network. In this paper, our ANN is based on the hyperbolic tangent function.

Data Issues

This study is based on TB incidences (referred to as K series in this study) in Senegal. The annual data covers the period 2000-2018 while the out-of-sample forecast covers the period 2019-2923. All the data employed in this research paper was gathered from the World Bank online database.

IV. FINDINGS OF THE STUDY

DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Mean	Median	Minimum	Maximum
134.89	134.00	118.00	155.00
Std. Dev.	C.V.	Skewness	Ex. kurtosis
11.298	0.083758	0.26133	-1.0326
5% Perc.	95% Perc.	IQ range	Missing obs.
undefined	155.00	19.000	0

ANN MODEL SUMMARY FOR TB INCIDENCE (new cases per 100 000 population/year) IN SENEGAL

Table 2: ANN Model Summary

Variable	K
Observations	10 (After Adjusting Endpoints)
Neural Network Architecture:	
Input Layer Neurons	9
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	0.015304
MSE	0.098956
MAE	0.285531

Residual Analysis for the ANN model

International Research Journal of Innovations in Engineering and Technology (IRJIET)
ISSN (online): 2581-3048
Volume 5, Issue 3, pp 354-357, March-2021
https://doi.org/10.47001/IRJIET/2021.503060

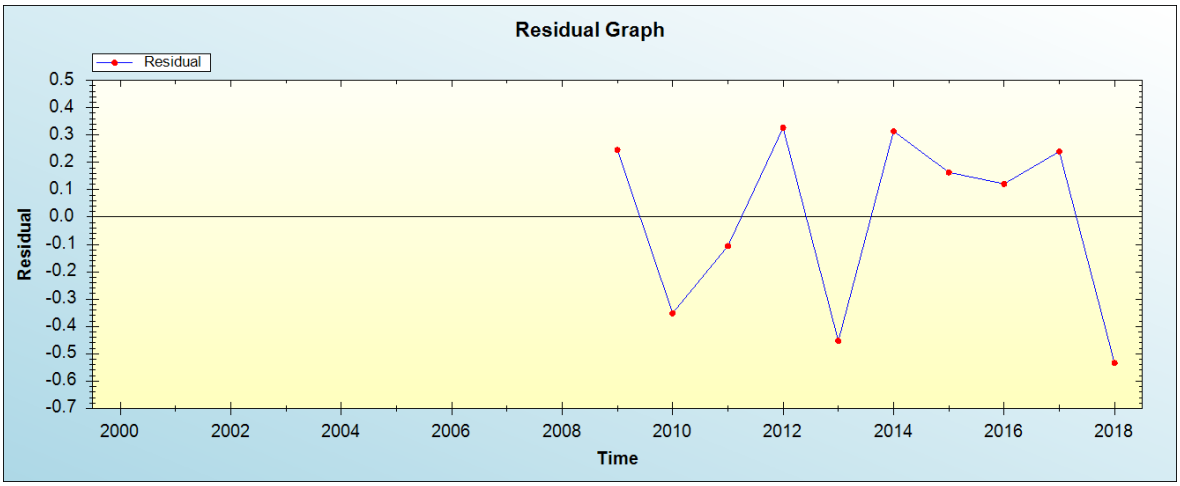

Figure 1: Residual analysis

In-sample Forecast for K

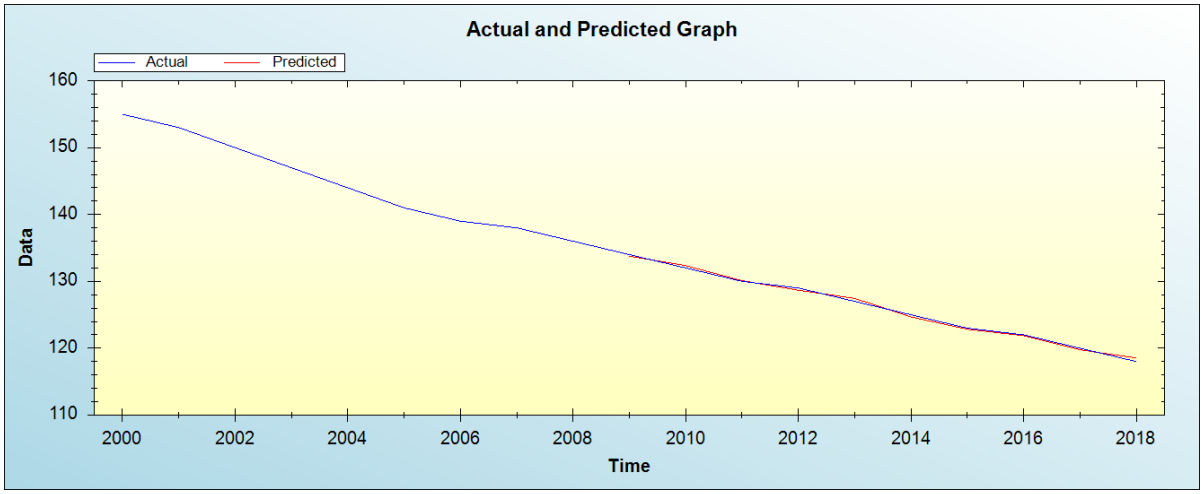

Figure 2: In-sample forecast for the K series

Figure 2 shows the in-sample forecast for K series.

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

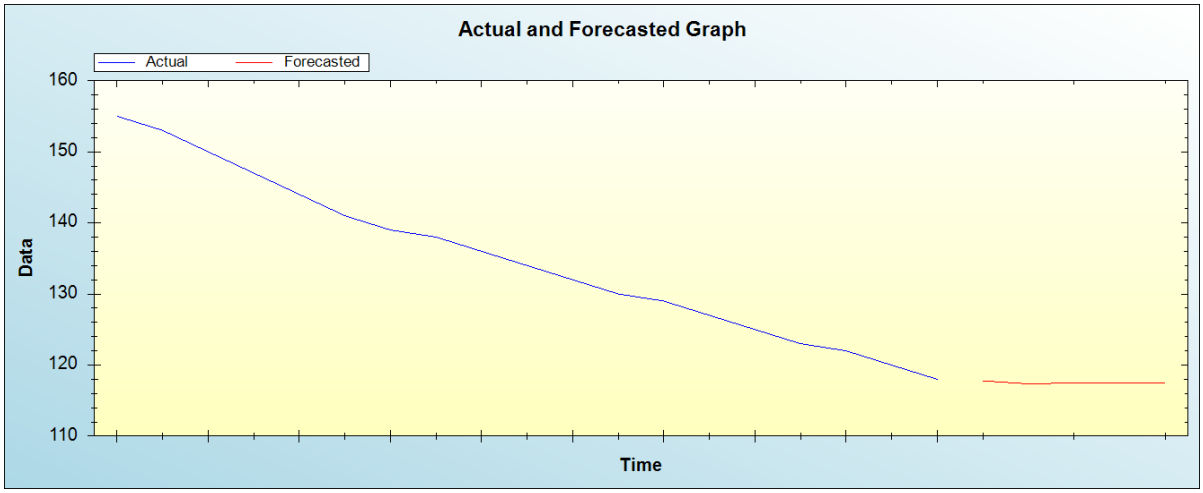

Figure 3: Out-of-sample forecast for K: actual and forecasted graph

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

ISSN (online): 2581-3048

Volume 5, Issue 3, pp 354-357, March-2021

https://doi.org/10.47001/IRJIET/2021.503060

Out-of-Sample Forecast for K: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Forecasts
2019	117.7848
2020	117.3558
2021	117.4931
2022	117.5407
2023	117.5218

Over the study period 2000-2018 the incidence of TB declined gradually. The minimum and maximum TB incidence was 118 and 155 cases per 100 000 population/year respectively with an average of 135 cases per 100 000 population /year. The applied data is positively skewed with an excess kurtosis of -1.0326 meaning that it is not normally distributed. The residuals and evaluation criteria reveal that the applied ANN (9,12,1) model is stable and suitable for predicting TB incidence in Senegal. Figure 2 tells us that the model simulates the observed values very well. The model predictions indicate that TB incidence is expected to be high at a plateau level of 118 cases per 100 000 population/year throughout the period 2019-2023.

V. CONCLUSION & RECOMMENDATIONS

Senegal is continuously making some efforts to control the spread of TB in the community. The country recorded a downward trajectory in the TB incidence over the period 2000-2018.Howver the model predicts that TB incidence will remain high over the period 2019-2023. Therefore the authorities are encouraged to intensify TB surveillance and control programs, allocate more resources towards TB/HIV programs and continuous health education among the communities.

REFERENCES

[1] Alagna R., Diaw MM., Centis R., Cirillo DM., & Besozzi G (2015). Universal health coverage and social support in Senegal: a comprehensive approach against tuberculosis. Eur Respir J; 46(3):869–71.

[2] Diatta A., Toure NO., Dia Kane Y., Ndiaye EH., Niang A &Thiam K (2007). Tuberculose familiale: depistage parmi le sujets contacts autor d'un cas index contageux. Rev Mal Respir; 24:32–40.

[3] Eric Osei1., Samuel Oppong., Daniel Adanfo., Bless Ativor Doepe., Andrews Owusu, Augustine Goma Kupour & Joyce Der (2019). Reflecting on tuberculosis case notification and treatment outcomes in the Volta region of Ghana: a retrospective pool analysis of a multicenter cohort from 2013 to 2017, 4:37

[4] Plan Strategies De Lutte Contre La Tuberculose Au Senegal; available at: http:// www.sante.gouv.sn/programmes-et-projets/programme-de-lutte-contre-latuberculose-pnt.

[5] Saunders MJ & Evans CA (2016). Fighting poverty to prevent tuberculosis. Lancet Infect Dis;16(4):395–6.

[6] The World Bank (2017). available at: http://data.worldbank.org/country/senegal.

[7] WH0 (2017). Global tuberculosis Report 2017. Geneva

[8] WHO (2018) Global tuberculosis report 2018. Geneva.

[9] WHO 9(2010). Treatment of Tuberculosis: guidelines-4th ed.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Forecasting TB Incidence in Senegal Using the Multilayer Peceptron" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 354-357, March 2021. Article DOI https://doi.org/10.47001/IRJIET/2021.503060

****

