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Predicting Future Trends of Under Five Mortality Rate for Panama Using Artificial Neural Networks

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***Abstract* - This study uses annual time series data on under five mortality rate for Panama from 1960 to 2020to 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 U5MR. ANN model projections indicate that U5MR will remain around 15 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Panama to address all the various problems that contribute to mortality among under five children.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Sustainable development goals are 17 objectives and 169 targets outlined in the 2030 Agenda for sustainable development. This global action plan is meant to deal with all the global challenges affecting people in different regions of the world. This plan of action is about people, planet and prosperity (UN, 2016; UN, 2015). All the UN member states have the desire to address all forms of poverty and deprivations, ensuring good health for all at all ages, upholding human rights and respecting international law and justice, creating equal employment opportunities, universal education and empowerment of women and girls. The welfare of women and children remains a top priority for the 2030 agenda for sustainable development. Hence, SDG3 pays special attention to the reduction of maternal, neonatal and under five deaths.High quality maternal and child care service provision isrequired for the achievement of the set sustainable development goals (SDGs) by 2030. SDG-3 aims to reduce global maternal mortality ratio (MMR) to below 70 maternal deaths per 100 000 live births and under five mortality rate to as low as 25 deaths per 1000 live births (UN, 2020; WHO, 2019; UNICEF, 2019; WHO, 2018). Panama's MMR decreased from 83.6 per 100 000 live births in 2006 to 24.9 maternal deaths per 100 000 live births in 2010. Infant mortality declined from 14.8 per 1000 live births in 2006 to 11.9 per 1000 live births in 2010 (Panama, 2012).The country's under five mortality rate graph continues on a downward path(World Bank, 2019).In line with the global agenda for sustainable development, this paper applies the artificial neural network technique to model and predict future trends of under-five mortality rate for Panama.The results of this study are expected to inform policy and decision making in order to timeously respond to the problem of under-five mortality in the country.

II. LITERATURE REVIEW

A description of household factors associated with under-five mortality in Bankass, a remote region in central Mali was done by Boettiger *et al.* (2021). The researchers analyzed baseline household survey data from a trial being conducted in Bankass. The survey was administered to households between December 2016 and January 2017. Under-five deaths in the five years prior to baseline were documented along with detailed information on household factors and women's birth histories. Factors associated with under-five mortality were analyzed using Cox regression. The study findings highlighted that U5 mortality is very high in Bankass and is associated with living a greater distance from healthcare and several other household factors that may be amenable to intervention or facilitate program targeting. Acevedo *et al.* (2020) investigated the relationship between distance to a woman's assigned health clinic and obstetric care utilization. The study employed a cross-sectional study design using baseline data from the evaluation of a conditional cash transfer programme to promote greater utilization of maternal and infant health services. Data were collected between December 2016 and January 2017. The findings of the study revealed that Distance is an important barrier to obstetric care utilization, with women in more distant locations suffering significantly lower use of prenatal, childbirth and postpartum care compared with women in closer vicinity to a health establishment. Juarez *et al.* (2020) did a quality improvement study to improve the detection of neonatal complications by lay midwives in rural Guatemala, thereby increasing referrals to a higher level of care. A quality improvement team in Guatemala reviewed drivers of neonatal health services provided by lay midwives. Improvement interventions included training on neonatal warning signs, optimized mobile health technology to standardize assessments and financial incentives for providers. The primary quality outcome was the rate of neonatal referral to a higher level of care. It was found that structured improvement interventions, including mobile health decision support and financial incentives, significantly increased the detection of neonatal complications and referral of neonates to higher levels of care by lay midwives operating in rural home-based settings in Guatemala.

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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 Panama.

Data Issues

This study is based on annual under five mortality rate in Panama 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	P
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	0.001844
MSE	0.128890
MAE	0.273819

Residual Analysis for the Applied Model

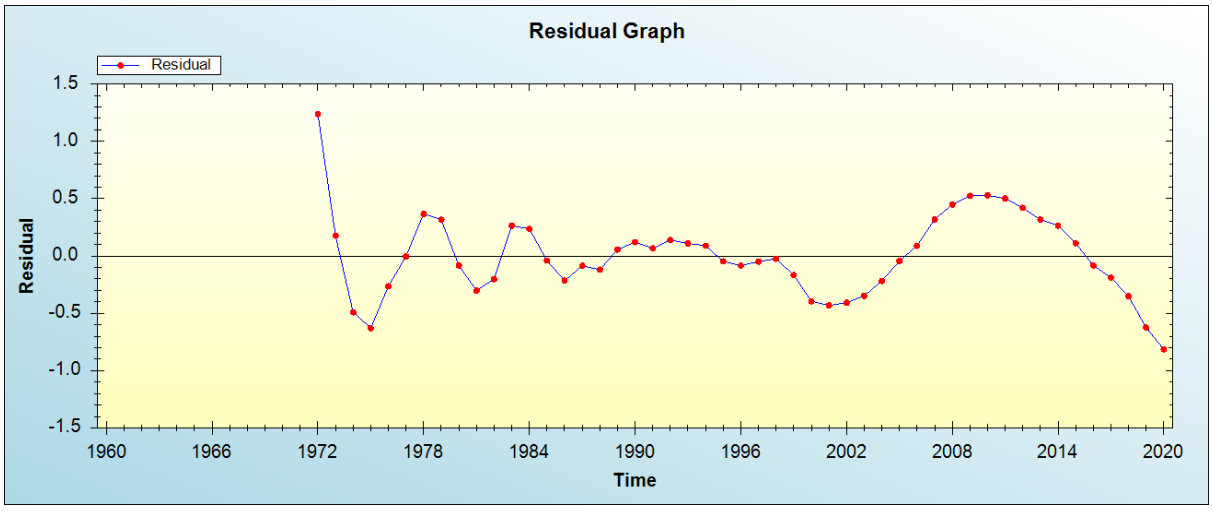

Figure 1: Residual analysis

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In-sample Forecast for P

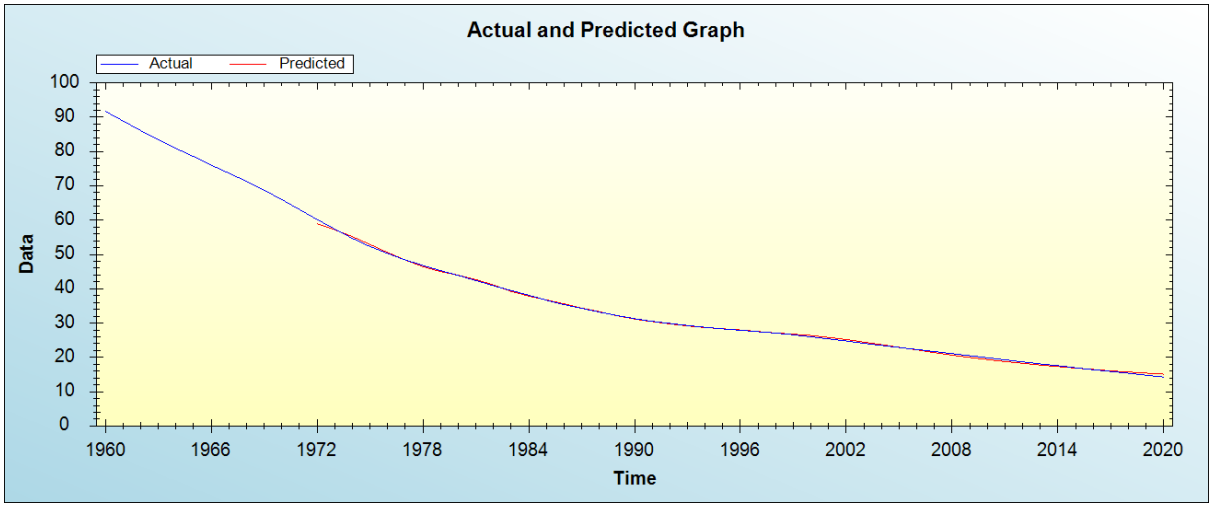

Figure 2: In-sample forecast for the P series

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

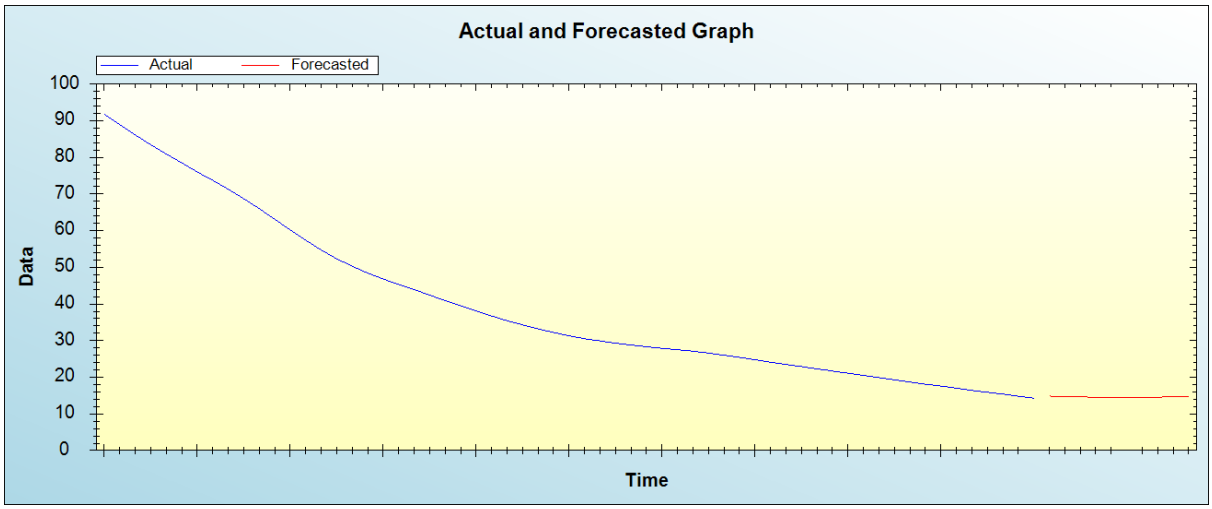

Figure 3: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	14.8450
2022	14.7312
2023	14.6443
2024	14.5444
2025	14.5926
2026	14.5242
2027	14.5019
2028	14.5335
2029	14.7074
2030	14.7238

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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 remain around 15 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The government of Panama has made significant progress in the reduction of under-five mortality. Over the past decades, the country witnessed a downward trend in under five mortality. In this study we applied the ANN model to forecast future trends of under-five mortality rate in Panama. The results of the study revealed that U5MR will remain around 15 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Panama to address all the various problems that contribute to under five mortality.

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