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# Analysis of Under Five Mortality Rate for the Philippines Using a Machine Learning Technique

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***Abstract* - This study uses annual time series data on under five mortality rate for Philippines from 1960 to 2020 to 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 under five mortality rate. ANN model projections indicate that annual U5MR will remain around 27 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Philippines government to address all the problems that significantly contribute to mortality among under five children.**

***Keywords:*** ANN, Forecasting, U5MR.

## I. INTRODUCTION

Maternal, neonatal and under 5 mortality remain a global health problem mainly affecting low and middle income countries (UNICEF, 2019).The third sustainable development goal (SDG3) target 3.2 was crafted to ensure a substantial reduction of newborn and under five deaths to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births respectively by 2030 (WHO, 2019, UNICEF, 2018; UN, 2015). Philippines has recorded a downward trend in neonatal mortality from 20 deaths per 1000 live births in 1990 to 12.6 deaths per 1000 live births in 2015 (World Bank, 2019). The country has also witnessed a similar trend in under five mortality (World Bank, 2019). Lack of equipment, and inadequate healthcare are the main contributing factors to adverse maternal and child health outcomes (Stanton &,Mwanri, 2013). In line with the objectives of the Agenda 2030 for sustainable development, this study applies the artificial neural network approach to forecast future trends of under-five mortality rate for the Philippines. The results are expected to inform maternaland child health (MNCH) policies and allocation of resources to keep under five deaths under control.

## II. LITERATURE REVIEW

Li *et al*. (2021) determined the proportion of mothers with history of neonatal deaths using the most recent Demographic and Health Surveys from 56 low- and middle-income countries. Logistic regression models were used to assess the association between maternal history of neonatal death and subsequent neonatal mortality. The adjusted models controlled for socioeconomic, child, and pregnancy-related factors. Country-specific analyses were performed to assess heterogeneity in this association across countries. Study findings revealed that maternal history of neonatal death could be an effective early identifier of high-risk pregnancies in resource-poor countries. In another study by Khader *et al.* (2021) investigated the healthcare professionals' perception about the usability of JSANDS. A descriptive qualitative approach, using focus group discussions, was adopted. A total of 5 focus groups including 23 focal points were conducted in five participating hospitals in Jordan. The study findings revealed that JSANDS was perceived positively by the current users. According to them, it provides a formative and comprehensive data on stillbirths and neonatal deaths and their causes. Nath *et al.* (2020) examined the effect of extreme prematurity and early neonatal deaths on infant mortality rates in England. Authors used aggregate data on all live births, stillbirths and linked infant deaths in England in 2006–2016 from the Office for National Statistic. Infant mortality decreased from 4.78 deaths/1000 live births in 2006 to 3.54/1000 in 2014 (annual decrease of 0.15/1000) and increased to 3.67/1000 in 2016 (annual increase of 0.07/1000). This rise was driven by increases in deaths at 0–6 days of life. A cross-sectional study in Ghana was carried out by Annan & Asiedu (2018) who applied the logistic regression model to assess the maternal, neonatal, and health system related factors that influence neonatal deaths in the Ashanti Region, Ghana. The study concluded that there was a high number of neonatal deaths which were mainly caused by birth asphyxia, infections, congenital anomalies and respiratory distress syndrome.

## 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

 

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activation function. This paper applies the Artificial Neural Network (ANN) approach in predicting annual under five mortality rate for the Philippines.

**Data Issues**

This study is based on annual under five mortality rate in the Philippines 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 | 0.001797 |
| MSE | 0.126133 |
| MAE | 0.252213 |

Residual Analysis for the Applied Model

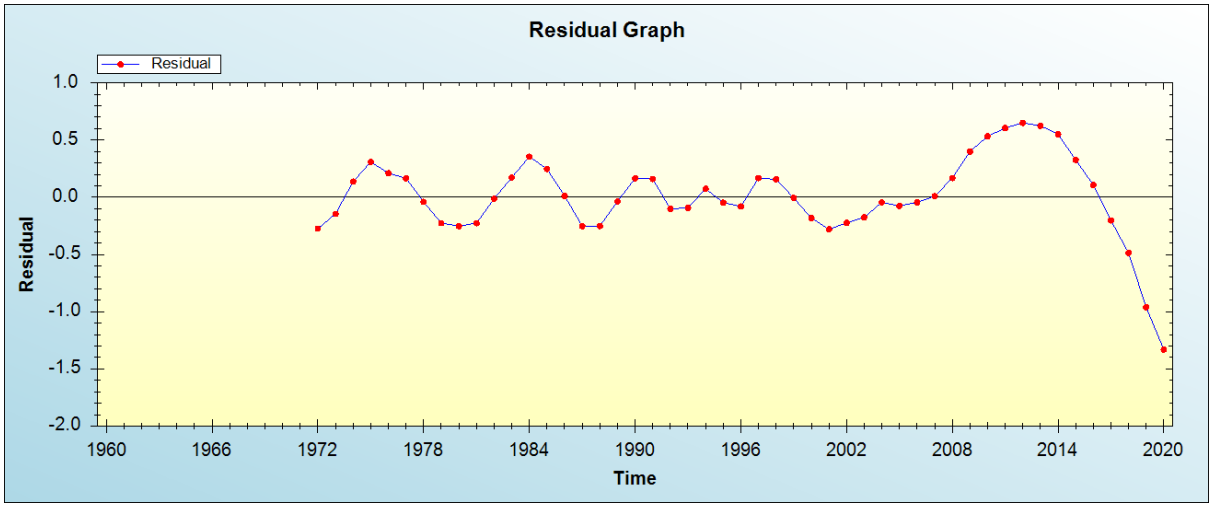


Figure 1: Residual analysis

 

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In-sample Forecast for P

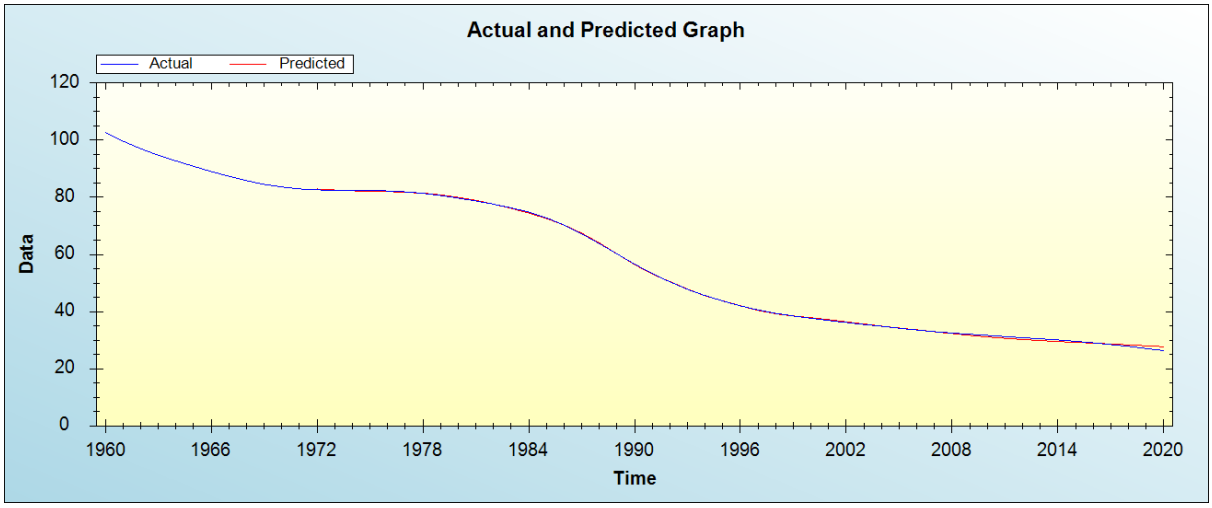


Figure 2: In-sample forecast for the P series

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

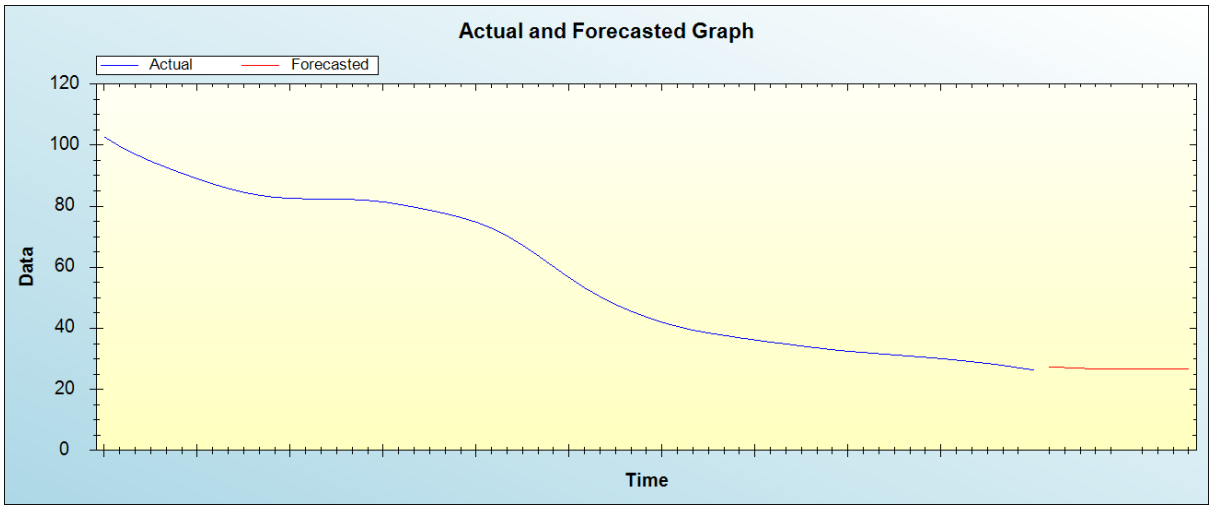


Figure 3: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 27.3905 |
| 2022 | 27.1617 |
| 2023 | 26.9409 |
| 2024 | 26.7221 |
| 2025 | 26.6709 |
| 2026 | 26.6114 |
| 2027 | 26.6239 |
| 2028 | 26.7723 |
| 2029 | 26.7728 |
| 2030 | 26.6104 |

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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 27 deaths per 1000 live births throughout the out of sample.

## V. POLICY IMPLICATION & CONCLUSION

Machine learning techniques are now widely used in the field of time series forecasting. In this study we applied the multilayer perceptron neural network to forecast future trends of under-five mortality rate. The forecast results indicate that U5MR will remain around 27 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Philippines to address all the problems that contribute to mortality among under five children.

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