

# Tracking Future Trends of Under Five Mortality Rate for Indonesia Using an Artificial Intelligence Technique

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**Abstract** - This study uses annual time series data on under five mortality rate for Indonesia 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 model is stable in forecasting U5MR. The ANN (12, 12, 1) model projections revealed that U5MR will remain around 20 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Indonesian government to address all the factors that significantly contribute to under five mortality across the country especially in the rural areas and disadvantaged communities.

**Keywords:** ANN, Forecasting, U5MR

## I. INTRODUCTION

Tracking the progress towards achieving sustainable development goals (SDGs) is a priority for every UN member state (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018; UN, 2016; UN, 2015). Data availability is critical for reviewing the progress and informing decisions and policy making. In public health careful data collection, processing, analysis and dissemination of useful information is important for the implementation of appropriate strategies for prevention and control of health problems. SDG3 focuses on ensuring healthy lives and promotion of well-being at all stages of life. Monitoring progress on achieving substantial reduction in maternal, newborn and under five deaths is one of the key priorities of the Cape Town global action plan and the 2030 Agenda for sustainable development. Child mortality is constituted by neonatal deaths (NND), postnatal deaths (PND) and under 5 deaths. Global neonatal mortality declined from 35 deaths per 1000 live births in 1990 to 19 deaths per 1000 live births in 2015 (Huge *et al.* 2019). Under five mortality has continued on a downward trajectory in Indonesia (World Bank, 2019). This study is carried out in line with the Agenda 2030 for sustainable development to forecast future trends of under-five mortality for Indonesia using a machine learning technique. The forecast results are expected to inform policy, planning, decision making and allocation of resources to maternal and child health programs in the country. It is also expected that evidence based MNCH interventions will be implemented timeously to curtail under five mortality in this Asian country.

## II. LITERATURE REVIEW

Schellekens (2021) estimated the contribution of maternal education to infant mortality decline in Indonesia. A longitudinal, individual-level analysis of the determinants of trends in infant mortality in Indonesia was done by utilizing pooled data from all available phases of the Demographic and Health Survey (1980-2015). The study findings indicated that maternal education explains 15% of the infant mortality decline in Indonesia from 1980 to 2015. A cross-sectional study by Irawaty *et al.* (2020) investigated the causes of infant mortality in rural Indonesia and suggested strategies for its reduction. The study utilized the 2017 Indonesian Demographic and Health Survey (IDHS) dataset for children. The information on infant deaths collected from those mothers who experienced infant deaths. Series of logistic regression models were used to select the significant predictors of infant mortality in rural Indonesia. Infant mortality was found to be associated with intermediate social determinants such as birth order, birth weight, and breastfeeding status. Socio-demographic factors such as the educational status of mothers, wealth quintile, the smoking habit of the mother, age of mother at first delivery and sex of the baby are also related to infant mortality. Soleman (2020) conducted a cross sectional study to describe the trend and examine the causes of child mortality in Indonesia for the period 2000-2017. The study findings showed a decline in neonatal, infant and under five mortality and the highest mortality was among neonates as a result of prematurity. The study revealed that the most crucial factors in rural Indonesia were the age of first-time mothers. A study by Dwomoh *et al.* (2019) investigated factors contributing to the decline in child mortality throughout the MDG period. This study used Demographic and Health Surveys (DHS) from 2003, 2008 and 2014 and data from World Bank Development Indicators (2000–2018). They employed modified Poisson with robust SE and multivariate decomposition approach to assess risk factors of child mortality using DHS data from 2003, 2008 and 2014. Penalized regression was used to assess the effect of 25 country-level contextual factors on child survival. The study findings revealed that multiple births and shorter birth spacing were associated with increased risk of infant and under-five deaths over the last decade. An Indonesian study by Suparmi *et al.* (2016) applied the cox proportion hazard regression to analyze the contribution of low birth weight on neonatal mortality. The study found out that children born with low birth weight and born from younger mothers had higher risk of neonatal mortality.

### 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 Indonesia.

#### Data Issues

This study is based on annual under five mortality rate in Indonesia 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	D
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	0.001787
MSE	0.892618
MAE	0.541150

#### Residual Analysis for the Applied Model

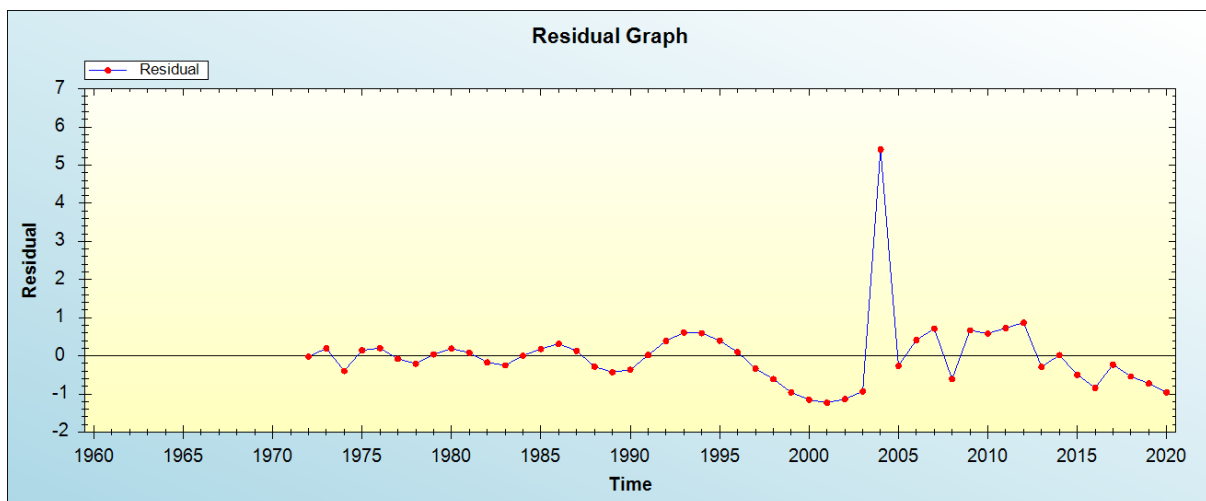


Figure 1: Residual analysis

In-sample Forecast for D

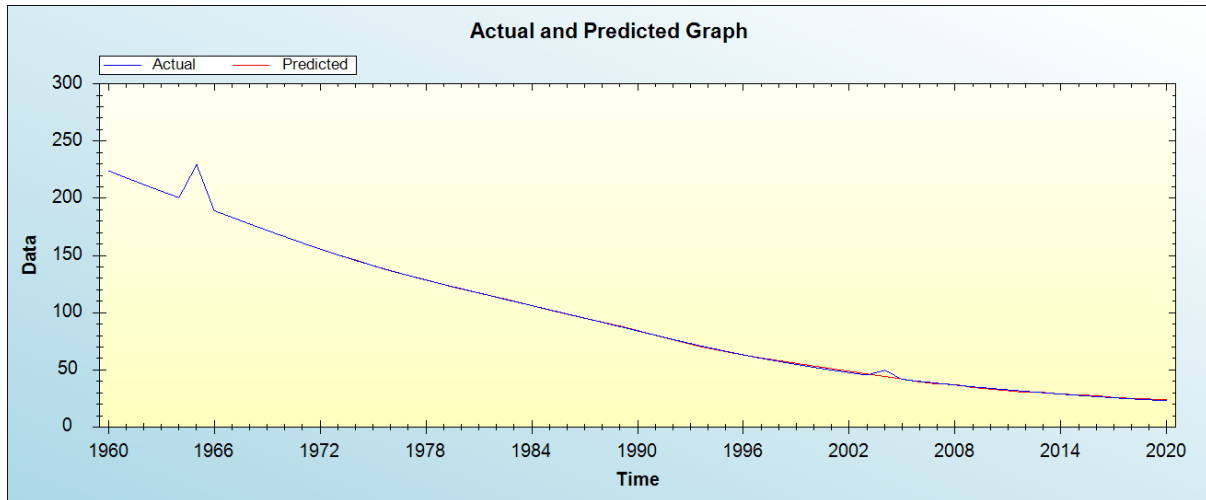


Figure 2: In-sample forecast for the D series

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

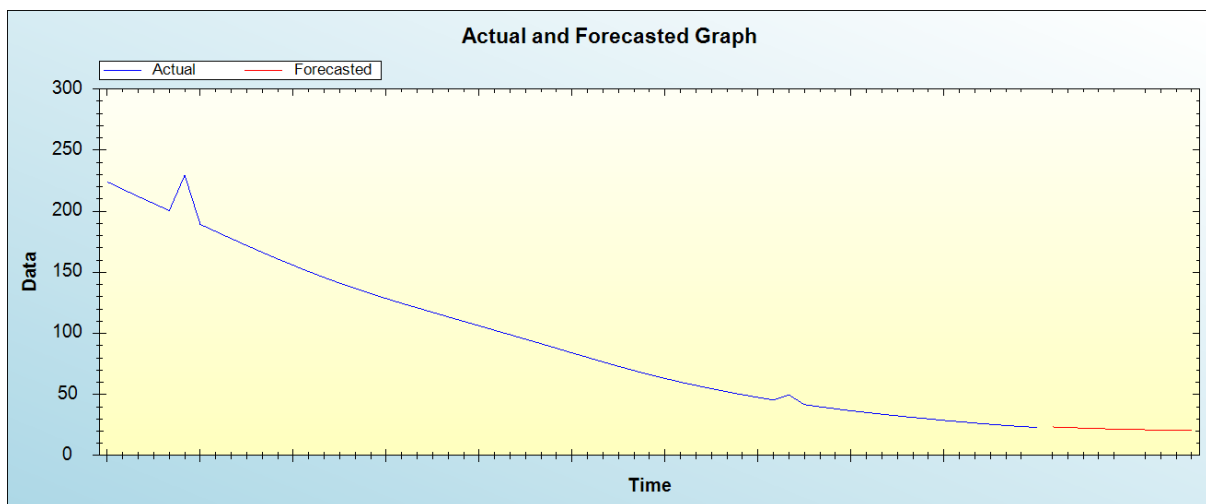


Figure 3: Out-of-sample forecast for D: actual and forecasted graph

Out-of-Sample Forecast for D: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	23.4390
2022	22.9557
2023	22.4761
2024	22.0206
2025	21.7424
2026	21.3983
2027	21.0875
2028	20.8039
2029	20.5429
2030	20.4066

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 20 deaths per 1000 live births throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

Sub-Saharan Africa and South Asia are known for reporting high absolute numbers of under five deaths as a result of several factors. These deaths are largely preventable hence appropriate measures should be implemented in order to substantially reduce mortality among under five children. This study proposed the artificial neural network approach to project U5MR for Indonesia and the forecast results suggest that U5MR will remain around 20 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Indonesian government to address all the challenges being faced by under five children across the country especially in the rural areas and disadvantaged communities.

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