

# Assessment of the Feasibility of Achieving Substantial Reduction of Under Five Mortality for Pakistan Using Artificial Neural Networks

<sup>1</sup>Dr. Smartson. P. NYONI, <sup>2</sup>Thabani NYONI

<sup>1</sup>ZICHIRE Project, University of Zimbabwe, Harare, Zimbabwe

<sup>2</sup>Independent Researcher & Health Economist, Harare, Zimbabwe

**Abstract - This study uses annual time series data on under five mortality rate for Pakistan from 1960 to 2020 to predict future trends of U5MR over the period 2021 to 2030. Residuals and forecast evaluation indicate that the applied ANN (12, 12, 1) model is stable in forecasting under five mortality in Pakistan. The ANN model projections indicate that U5MR will remain high throughout the out of sample period. Therefore, the government of Pakistan should address various challenges that hinder success of the maternal and child health (MNCH) program.**

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

## I. INTRODUCTION

In line with the Agenda 2030 for sustainable development, Pakistan developed a monitoring and evaluation strategy for the National Health vision 2016-2025 (NIPS & ICF, 2019). This national strategy was designed to track progress made in all health targets including that of maternal, neonatal and under five deaths. The aim is to ensure substantial reduction of maternal, neonatal and under five deaths by 2030 (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2015). In 2015 Pakistan reported a neonatal mortality rate of 44 per 1000 live births with rural areas reporting higher neonatal mortality rate (62 per 1000 live births) when compared to urban settings (38 per 1000 live births) (Lawn *et al.* 2016). The country has the third highest NMR in the world with 500 newborns dying on daily basis. In addition, the highest perinatal mortality rates in South Asia are reported by Pakistan (UNICEF, 2018; Basu & Mckeey, 2010). However, under five mortality continues to decline (World Bank, 2019).

The objective of this study is to model and forecast future trends of under-five mortality rate for Pakistan using the artificial neural network technique. Forecast results are expected to help in tracking Pakistan's progress towards achieving the set SDG 3 target 3.2 by 2030 and trigger implementation of appropriate maternal and child health (MNCH) interventions to control the problem of under five deaths in the 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. Aghai *et al.* (2020) examined the gender differences in neonatal mortality, stillbirths, and perinatal mortality in south Asia using the Global Network data from the Maternal Newborn Health Registry. It was noted that the risks of stillbirths, and early neonatal mortality were higher among male infants than their female counterparts. However, there was no gender difference in mortality after 7 days of age. A prospective, population-based research study was conducted by Dhaded *et al.* (2020) to investigate neonatal deaths in rural Karnataka, India for the period 2014–2018. Study staff collected demographic and health care characteristics on eligible women enrolled with neonatal outcomes obtained at delivery and day 28. Cause of neonatal mortality at day 28 was assigned by algorithm using prospectively defined variables. Study found that infants who were preterm and low-birth weight remained at highest risk for 28-day neonatal mortality in India. A prospective, population-based observational study was carried out by Aziz *et al.* (2020) to compare pregnancy outcomes in Pakistan to other low-resource countries and explore factors that might help explain these differences. The research included all pregnant women and their pregnancy outcomes in defined geographic communities in six low-middle income countries (India, Pakistan, Democratic Republic of Congo, Guatemala, Kenya, and Zambia). Study staff enrolled women in early pregnancy and followed them up soon after delivery and at 42 days to ascertain delivery, neonatal, and maternal outcomes. The Pakistani pregnancy outcomes were found to be much worse than those in the other GN sites. Reasons for these poorer outcomes likely include that the Pakistani sites 'reproductive-aged women are largely poorly educated, under-nourished, anemic, and deliver a high percentage of preterm and low-birth weight babies in settings of often inadequate maternal and newborn care.

### 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 Pakistan.

#### Data Issues

This study is based on annual under five mortality rate in Pakistan 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	0.001389
MSE	0.574208
MAE	0.516273

#### Residual Analysis for the Applied Model

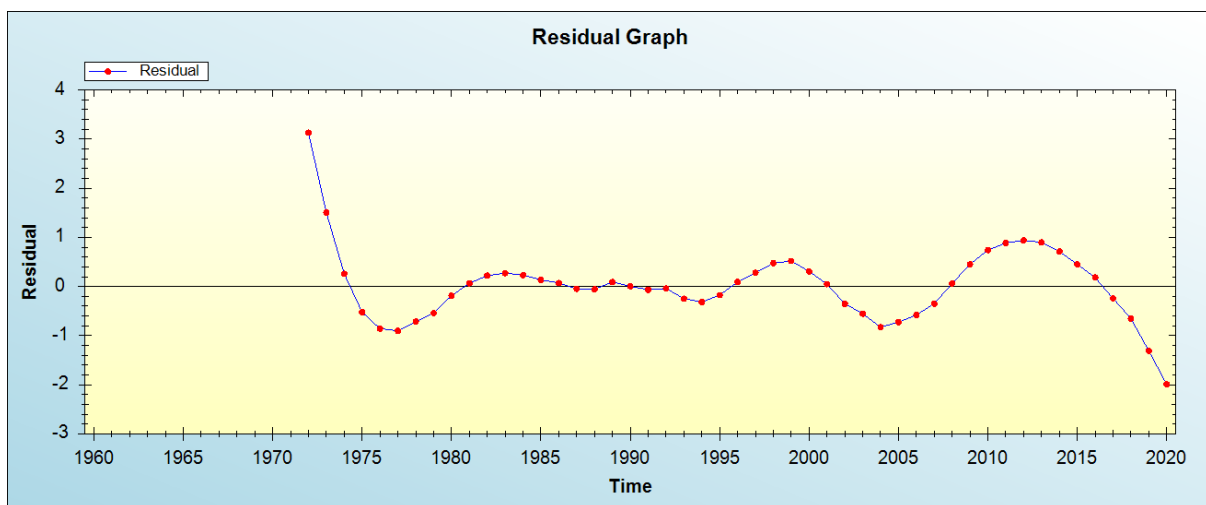


Figure 1: Residual analysis

In-sample Forecast for P

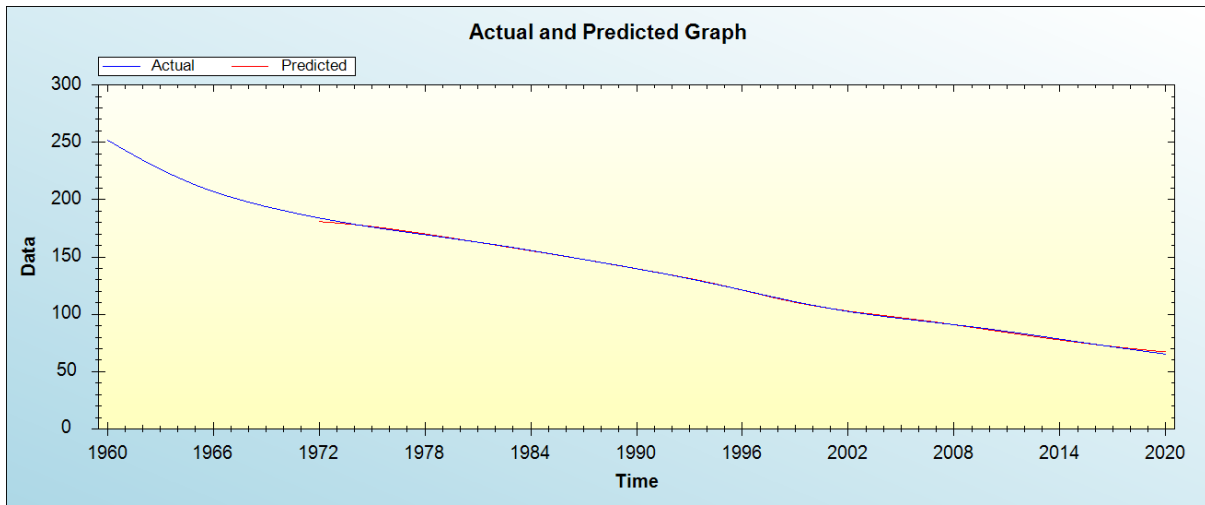


Figure 2: In-sample forecast for the P series

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

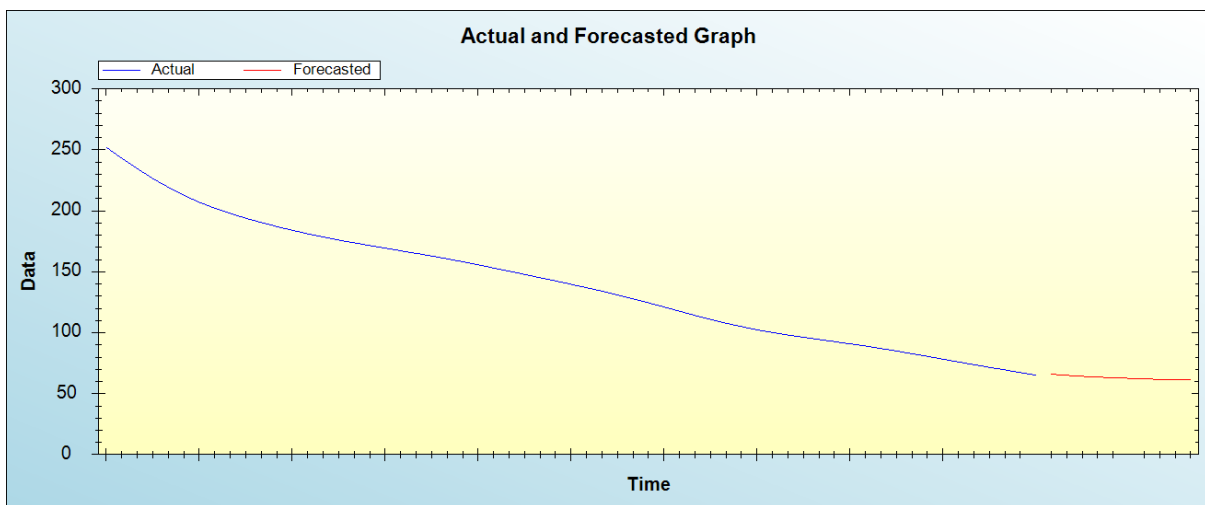


Figure 3: Out-of-sample forecast for P: actual and forecasted graph

Out-of-Sample Forecast for P: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	65.9166
2022	65.0979
2023	64.2525
2024	63.5910
2025	63.1250
2026	62.5721
2027	62.1377
2028	61.7154
2029	61.5748
2030	61.3721

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 high throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

Pakistan has made significant progress in the reduction of under-five mortality as indicated by the decline in under five and neonatal mortality rates over the past decades. However, the country continues to report worrying trends of neonatal mortality particularly in the rural areas. The ANN model was applied in this study to project under five mortality rate in Pakistan and forecast results indicate that U5MR will remain high throughout the out of sample period. Therefore, we encourage Pakistan to address all the challenges that hinder the success of the maternal and child health (MNCH) program.

## REFERENCES

- [1] UNICEF. (2019). Levels and trends in child mortality: report 2019. Estimates developed by the UN Inter-agency Group for child mortality estimation. New York: UNICEF.
- [2] United Nations. (2015). transforming our world: The 2030 agenda for sustainable development, A/RES/70/1. New York: UN General Assembly.
- [3] World Bank (2019). Mortality rate, under 5.
- [4] UN (2020) sustainable development goals. <https://www.un.org/sustainabledevelopment/development-agenda>
- [5] UNICEF (2018). Every Child alive. New York: UNICEF
- [6] World Health Organization (WHO) (2019). SDG 3: Ensure healthy lives and promote wellbeing for all at all ages.
- [7] Lawn J E., Blencowe H., and Waiswa P (2016), for The Lancet Ending Preventable Still- births Series study group with The Lancet Stillbirth Epidemiology investigator group, et al. Stillbirths: rates, risk factors, and acceleration towards 2030. Lancet. 2016.
- [8] Basu S., and McKee M (2010). Drivers of inequality in Millennium Development Goal progress: a statistical analysis. PLoS Med, 7, 3, e1000241.

### Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Assessment of the Feasibility of Achieving Substantial Reduction of Under Five Mortality for Pakistan Using Artificial Neural Networks" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 410-413, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607089>

\*\*\*\*\*