

Analysing Under Five Mortality in Vietnam Using the Multilayer Perceptron Neural Network

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Abstract - This study uses annual time series data on under five mortality rate (U5MR) for Vietnam from 1964 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. The multilayer perceptron neural network projections revealed that U5MR will hover around 22 deaths per 1000 live births throughout the out of sample period. Therefore, health authorities in Vietnam must address all the challenges that hinder the successful implementation of SDG3 with the aim of improving child survival.

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

Sustainable development goals were formed on the foundation and principles of the United Nations Charter. They recognize and respect human rights of all the people as well as respecting international law (UN, 2015). The 17 sustainable development goals together with their associated 169 targets were meant to bring peace, freedom, end poverty and hunger, and other deprivations. All the UN member states put forward a plan to ensure good health for all through universal health coverage and access to affordable healthcare services without discriminating against race, color, ethnicity, gender, and social status (UN, 2016). There was general consensus that ensuring good health and promotion of well-being needed support from the political leaders and global partners. It was realized that capacity building is an essential component for the successful implementation of SDGs. Training of different stake holders and regular technical support is necessary to achieve quality results and to coordinate activities to improve efficiency and reduce financial costs. Integration of SDGs into national programming and budgeting is expected to bring better results. The third sustainable development goal target 3.1 aims to reduce global maternal mortality to less than 70 maternal deaths per 100 000 live births by 2030. SDG3 target 3.2 was designed to address neonatal and under five mortality. The aim is to reduce neonatal and under five mortality to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live births by 2030 (Ouedraogo *et al.* 2020; UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018; UN, 2016). Most developing countries are lagging behind in terms of achieving the set SDG 3 targets by 2030 (World Bank, 2020). They continue to report high numbers of neonatal and under five deaths as a result of preventable causes (Kayode *et al.* 2017). The aim of this study is to predict future trends of under-five mortality rate in Vietnam using a machine learning technique. The findings are expected to inform policies, planning and allocation of resources to maternal and child health program activities.

II. LITERATURE REVIEW

Reis *et al.* (2021) evaluated the fetal and infant mortality rates due to congenital anomalies (CA) in Maranhão from 2001 to 2016 in Brazil. Data were obtained from the SINASC, and SIM databases. The study used simple linear regression, Poisson distribution, and ANOVA (Bonferroni's post hoc test) and analyzed the public data (2001–2016) of 1934858 births and determined the fetal, neonatal, perinatal, and post-neonatal mortality rates associated with CA by mesoregions. The results indicated mortality rates due to CA in Maranhão increased over the period 2001–2016 possibly as a result of improved maternal-infant health conditions eliminating other causes of death. Acevedo *et al.* (2020) assessed 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 showed 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) carried out 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. The study findings showed that structured improvement interventions, including mobile health decision support and financial incentives, significantly improved 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. A study conducted by

Souza *et al.* (2019) investigated the determinants of neonatal mortality in Foz do Iguassu in Brazil. The authors analyzed all neonatal deaths that occurred in Foz do Iguassu from 2012 to 2016. Birth and mortality data were extracted from two national governmental databases (SINASC and SIM). It was found that high rate of neonatal deaths in Foz do Iguassu is strongly associated with newborn characteristics and not associated with maternal socio-demographic characteristics.

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 Vietnam.

Data Issues

This study is based on annual under five mortality rate in Vietnam for the period 1964 – 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	
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	0.001800
MSE	0.099932
MAE	0.263272

Residual Analysis for the Applied Model

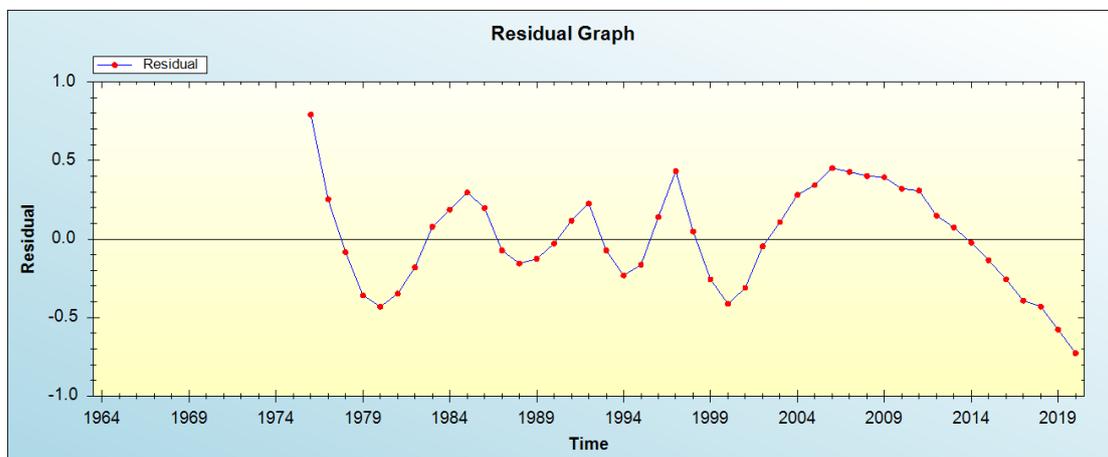


Figure 1: Residual analysis

In-sample Forecast for C

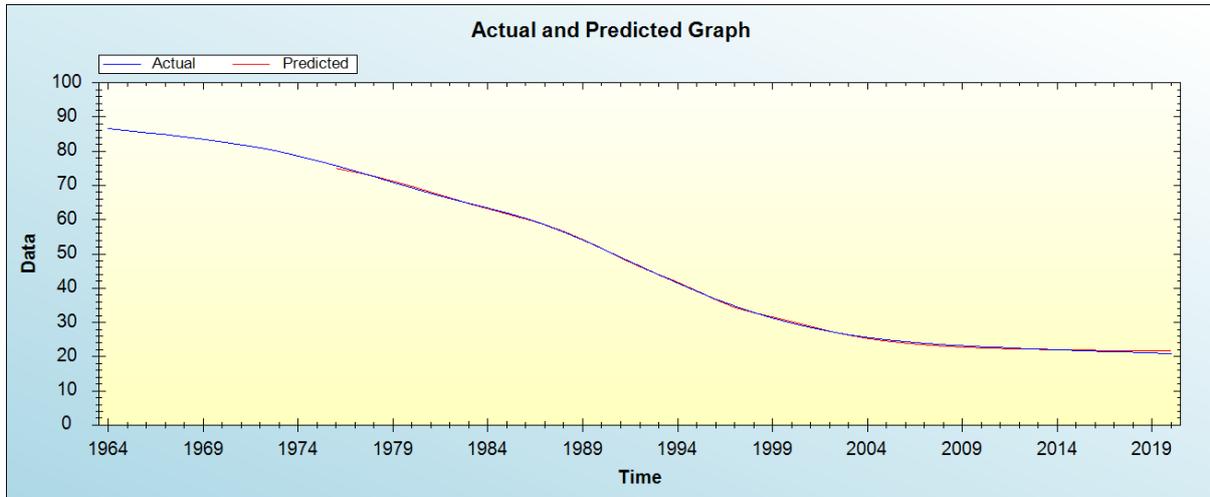


Figure 2: In-sample forecast for the C series

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

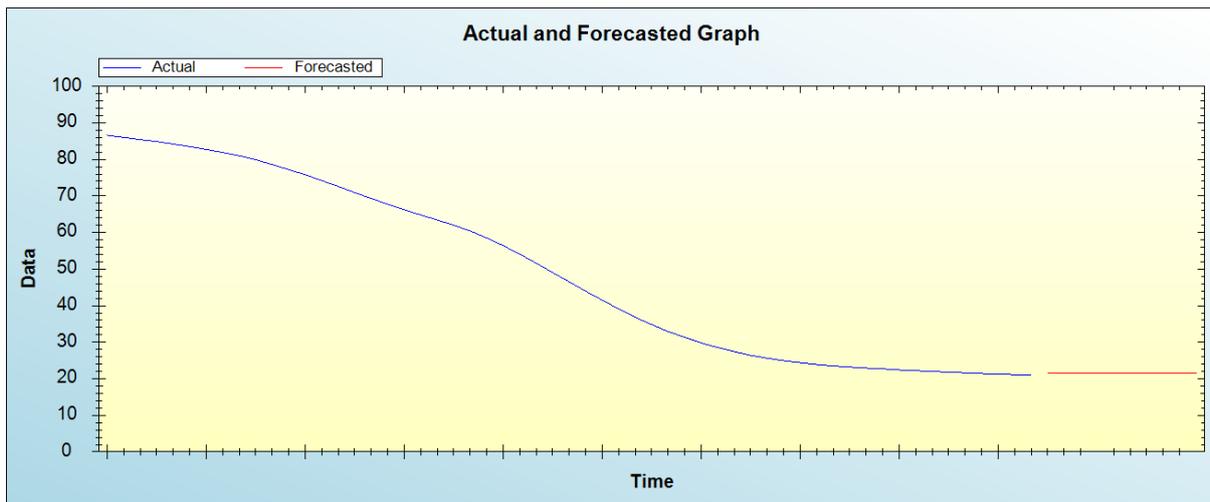


Figure 3: Out-of-sample forecast for C: actual and forecasted graph

Out-of-Sample Forecast for C: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	21.5817
2022	21.5925
2023	21.5747
2024	21.5982
2025	21.6175
2026	21.5976
2027	21.6160
2028	21.6326
2029	21.6202
2030	21.6149

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 hover around 22 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The maternal and child health program across the globe has brought positive results as most countries continue to report a decline in maternal and under five mortality rates. However, high absolute numbers of maternal and under five deaths are still being reported in developing countries. The aim of SDG3 target 3.1 and 3.2 is to substantially reduce maternal mortality ratio to less than 70 deaths per 100 000 live births and under five mortality to levels as low as 25 deaths per 1000 live births by 2030. Projection of under-five mortality will guide child health policies, decisions and allocation of resources. The ANN model was applied to forecast future trends of under-five mortality rate for Vietnam and forecast results indicate that U5MR will hover around 22 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage health authorities in Vietnam to address all the factors that hinder the successful implementation of the SDG3 so as to improve child survival.

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