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Forecasting Future Trends of Under Five Mortality for Malaysia Using a Machine Learning Technique

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***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Malaysia 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 models is stable in forecasting under five mortality rate. The ANN (12, 12, 1) model projections revealed that annual U5MR will hover around 8 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Malaysian government to continue supporting the maternal and child health program in order to keep under five mortality below 25 deaths per 1000 live births.**

Keywords: ANN, Forecasting, U5MR.

I. INTRODUCTION

All 193 UN member countries in September 2015 agreed to pursue a noble idea of creating a favorable environment for peace, health and prosperity for all the people in this planet (UN, 2016; UN, 2015). It was acknowledged that this world is currently battling a myriad of challenges that need urgent attention. We continue to see people dying from drought induced hunger, emerging highly infectious diseases, non-communicable diseases, war and harmful substances. In addition, women and children are being subjected to physical and sexual abuse especially in conflict zones. The 3rd sustainable development goal (SDG3) was crafted to help in the reduction of all preventable maternal, neonatal and under five deaths (UN, 2020; UNICEF, 2019; WHO, 2019; UNICEF, 2018). Target 3.2 pays special attention to the 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. This study uses the artificial neural network technique to forecast future trends of under-five mortality rate for Malaysia. The results are expected to inform maternal and child health policies and allocation of resources to keep under five mortality under control.

II. LITERATURE REVIEW

Abd Nasir *et al.* (2020) applied a state space model to forecast under five mortality in Malaysia using data covering the period 1980-2016. Forecast results indicated that the forecast trend is increasing slightly and the forecast trend for males is higher than that of females. 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. Simeoni *et al*. (2019) analyzed the infant (IMR) and neonatal (NMR) mortality rates of Italian and foreign children and evaluated if there is a disparity among geographical macro-areas. Data from 2006 to 2015 were collected by the Italian Statistics Bureau (ISTAT) and extracted from two different national databases, which considered i) underlying cause of death and ii) birth registry. The main analyses were made comparing Italian versus foreigners as a single category as well as by country origin and contrasting Northern residents versus Southern ones. Comparisons between groups were done using relative risks. The study findings indicated that Inequalities in neonatal and infant mortality are evident between Italians and immigrants and among geographical macro-areas. A descriptive study was carried out by McNamara *et al.* (2018) to reveal intrapartum fetal deaths and unexpected neonatal deaths in Ireland from 2011 to 2014. Anonymised data pertaining to all intrapartum fetal deaths and unexpected neonatal deaths for the study time period was obtained from the national perinatal epidemiology centre. The findings of the study indicated that the corrected intrapartum fetal death rate was 0.16 per 1000 births and the overall unexpected neonatal death rate was 0.17 per 1000 live births.Bandeira *et al.* (2016) described Portugal's achievements in the maternal and child health program. The study highlighted that the joint venture of pediatricians and obstetricians with adequate top-down government commissions for maternal and child health for the decision making by health administrators and a well-defined schedule of preventive and managerial measures in the community and in hospitals, registry of special diseases and training of medical personnel are the most likely explanations for this success. Chow *et al*. (2015) carried a selected review to examine the etiology of neonatal mortality rates in different countries by utilizing electronic databases. The findings indicated that mortality rates in neonatal ICU units vary in different countries but are still high in both developing and developed countries.

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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 Malaysia.

Data Issues

This study is based on annual under five mortality rate in Malaysia 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	Q
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	0.002846
MSE	0.257481
MAE	0.403892

Residual Analysis for the Applied Model

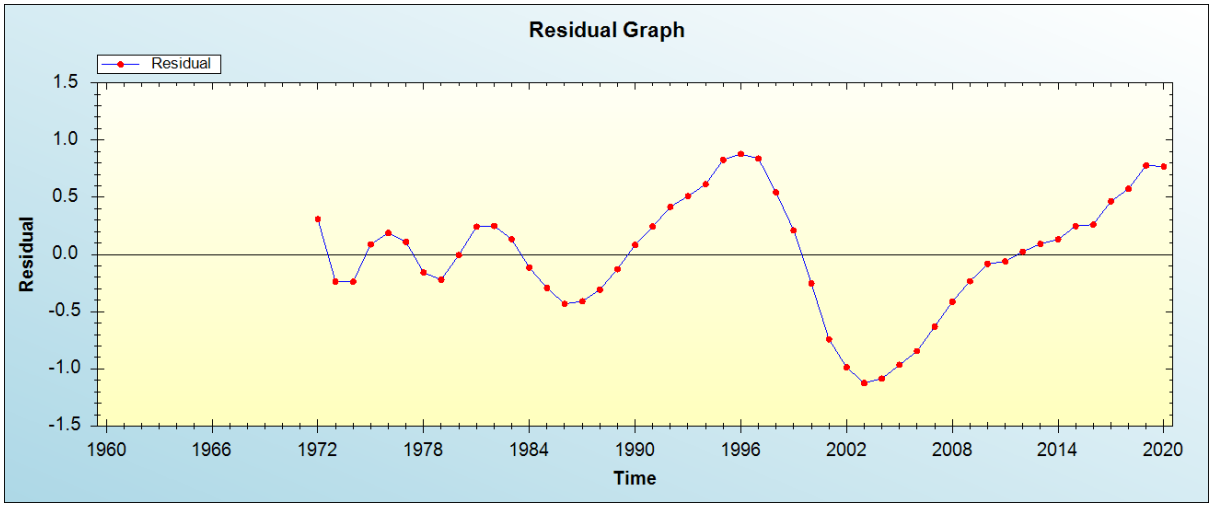

Figure 1: Residual analysis

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In-sample Forecast for Q

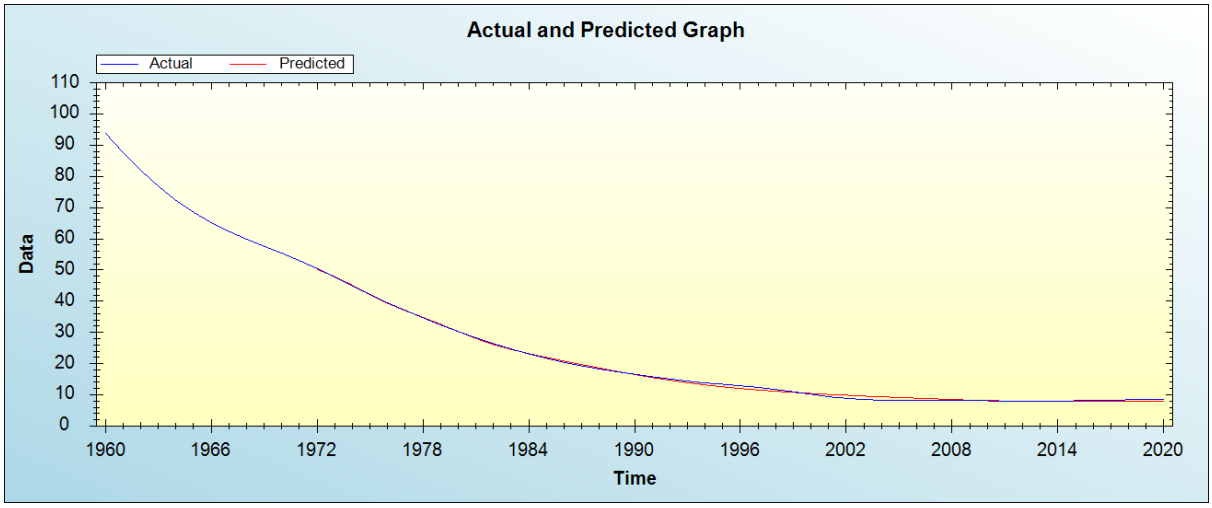

Figure 2: In-sample forecast for the Q series

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

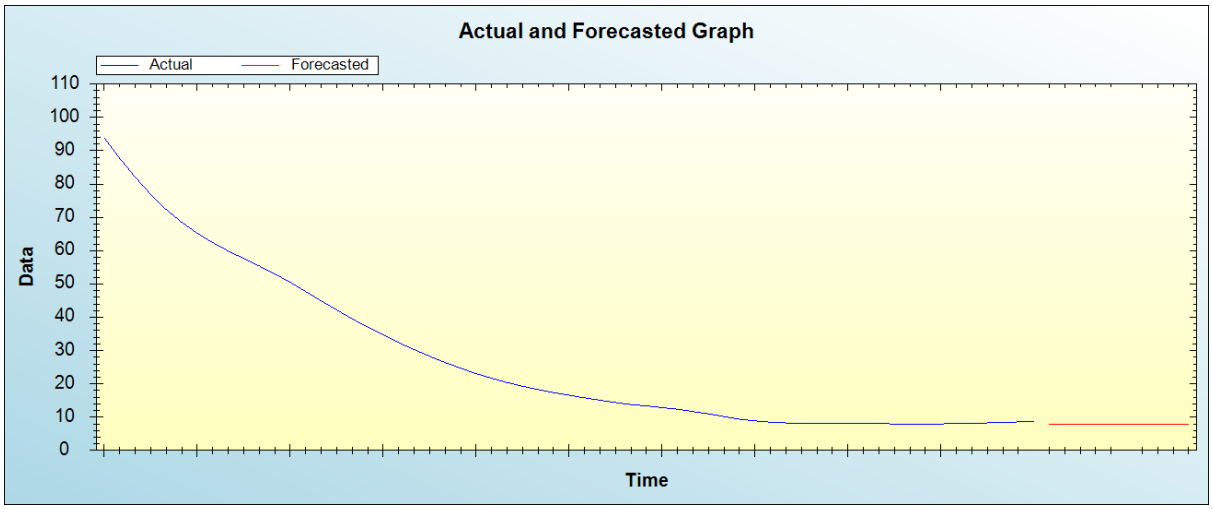

Figure 3: Out-of-sample forecast for Q: actual and forecasted graph

Out-of-Sample Forecast for Q: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	7.8338
2022	7.8638
2023	7.8446
2024	7.8210
2025	7.8723
2026	7.9000
2027	7.9015
2028	7.8407
2029	7.8391
2030	7.8295

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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 hover around 8 deaths per 1000 live births throughout the out of sample period.

V. POLICY IMPLICATION & CONCLUSION

The Malaysian government has made commendable progress in the reduction of under-five mortality. Over the past decades, under five mortality rate has been on a downward trajectory as a result of robust measures implemented by the government which include increase in the coverage of childhood immunizations and integrated management of childhood illnesses. This study applies the ANN model to project future trends of under-five mortality rate in Malaysia and the findings showed that annual U5MR will hover around 8 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the Malaysian government to continue supporting the maternal and child health program in order to keep under five mortality below 25 deaths per 1000 live births.

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