

# Forecasting Under Five Mortality Rate for Oman Using a Machine Learning Technique

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**Abstract** - This study uses annual time series data on under five mortality rate for Oman 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 U5MR will remain around 11 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage the government of Oman to address all the factors that significantly contribute to under five mortality in the country.

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

## I. INTRODUCTION

The success of the Agenda 2030 for sustainable development is dependent on leadership commitment in various countries and the involvement of different global partners (UN, 2016; UN, 2015). It is essential to promote the global action plan in different forums at international, regional, national and subnational levels. The health part of the global agenda plays a pivotal role in human capital development (UNICEF, 2019; WHO, 2019; UNICEF, 2018). The death of a mother or child has serious negative impacts on the family and society. Therefore it is necessary for public health practitioners to design maternal and child health policies that are effective and evidence based to address maternal and child mortality (UN, 2020). Substantial reduction of maternal and neonatal mortality is the focus of sustainable development goal 3 which aims to ensure good health for all at all ages (Newborns, 2015). SDG-3 targets 3.1 & 3.2 aim to reduce maternal mortality ratio (MMR) and neonatal mortality rate to 70 maternal deaths per 100 000 live births and 12 per 1000 live births respectively (UNICEF, 2019). In line with Agenda 2030, this paper projects future trends of under-five mortality rate for Oman using artificial neural networks. The findings of this study are expected to guide child health policy formulation, planning and allocation of resources to keep under five mortality within acceptable levels.

## 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. Rasmussen *et al.* (2021) investigated the recent figures and explored if potential differences could be explained by the well-known educational and income inequalities in stillbirth and infant death using a novel approach. Stillbirth and infant mortality varied considerably according to country of origin, with only immigrants from China, Norway, and Poland having an overall lower risk than Danish women. Women of Pakistani, Turkish, and Somali origin had a particularly high risk of both outcomes. A descriptive study by Zeitlin *et al.* (2020) examined the patterns of stillbirth and neonatal mortality rates in Europe between 2004 and 2010. Data about live births, stillbirths and neonatal deaths by gestational age (GA) were collected using a common protocol by the Euro-Peristat project in 2004 and 2010. The study concluded that stillbirths and neonatal deaths declined at all gestational ages in countries with both high and low levels of mortality in 2004. 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 Statistics. 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. Another study by Noori *et al.* (2020) utilized Nanoro HDSS data from 2009 to 2013 to estimate the association between under-5 mortality and accessibility to inpatient and outpatient 38 health facilities in Burkina Faso, seasonality of death, and age group. The study results revealed that significant predictors of under 5 mortality were seasonality of death (wet season greater than dry season) and time taken to reach the health facility.

### 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 Oman.

#### Data Issues

This study is based on annual under five mortality rate in Oman 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	O
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	0.000085
MSE	0.119842
MAE	0.274172

#### Residual Analysis for the Applied Model

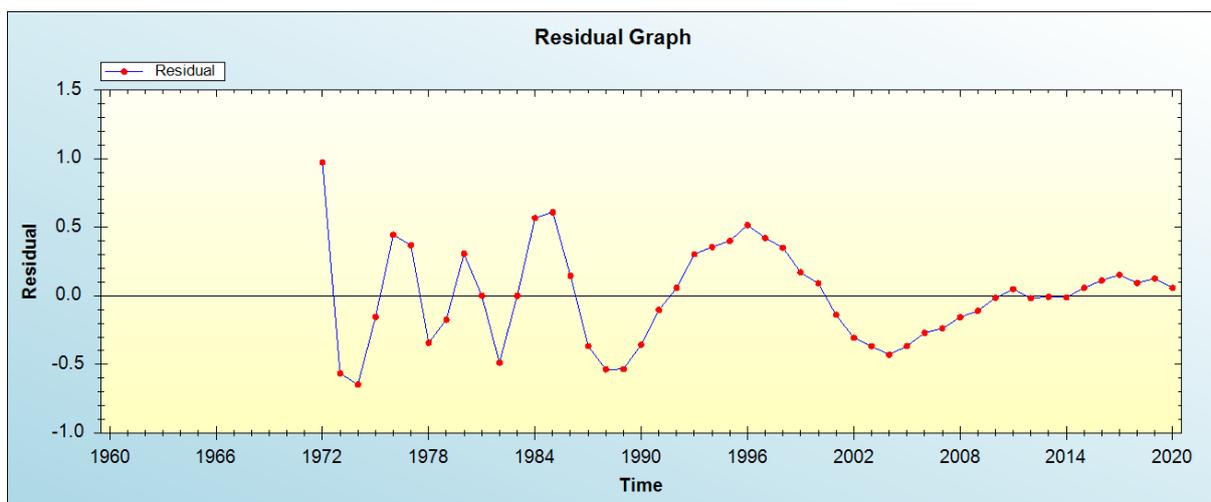


Figure 1: Residual analysis

In-sample Forecast for O

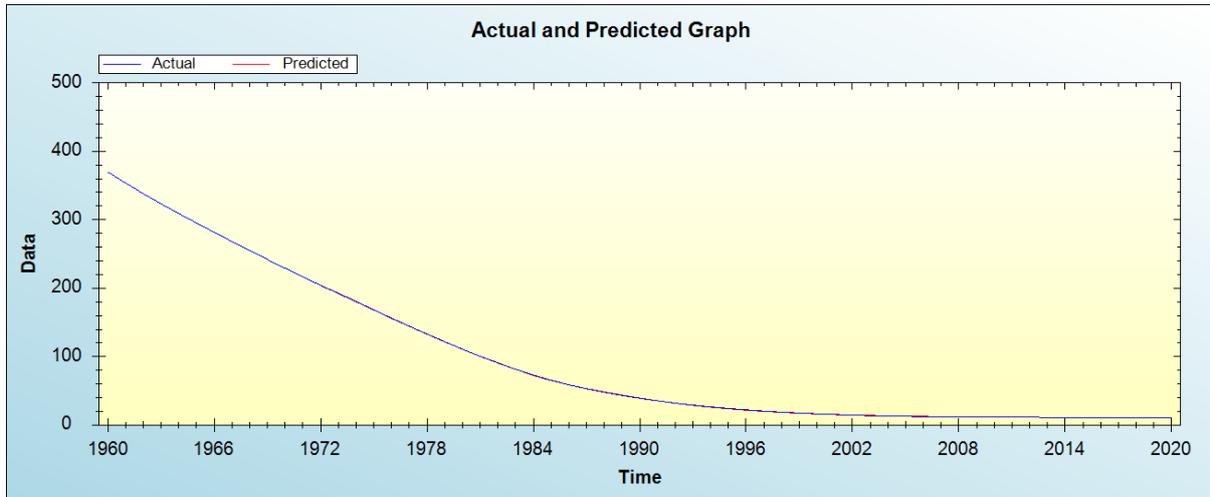


Figure 2: In-sample forecast for the O series

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

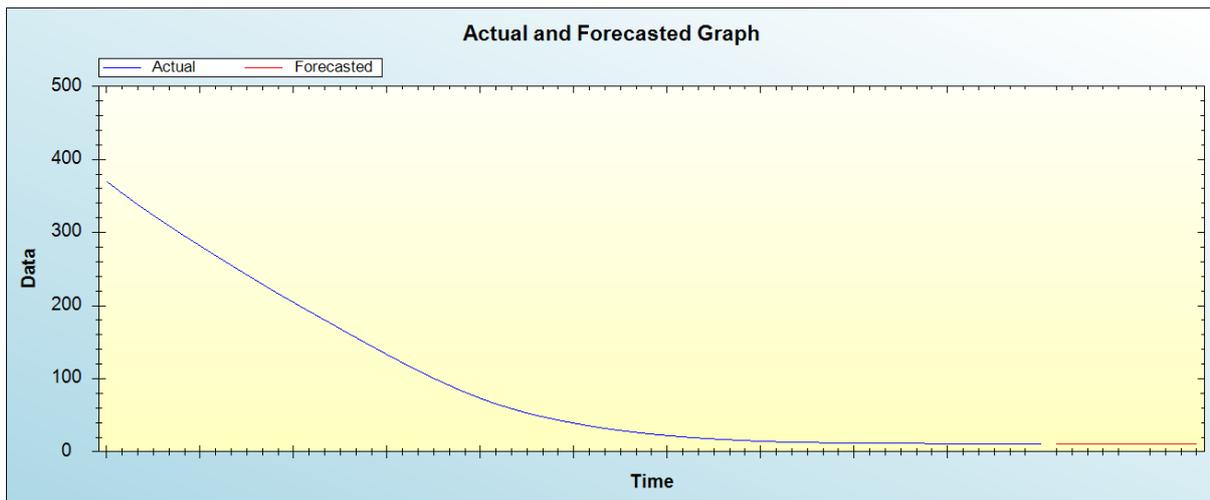


Figure 3: Out-of-sample forecast for O: actual and forecasted graph

Out-of-Sample Forecast for O: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	10.9343
2022	10.9186
2023	10.9052
2024	10.8913
2025	10.8783
2026	10.8672
2027	10.8617
2028	10.8540
2029	10.8481
2030	10.8426

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

## V. POLICY IMPLICATION & CONCLUSION

Reduction of under-five mortality is one of the targets of the 3<sup>rd</sup> sustainable development goal (SDG-3). All UN member states should strive to reduce under five mortality to levels as low as 25 deaths per 1000 live births by 2030. Applying time series forecasting techniques will guide child health policies, decisions and allocation of resources. The ANN model was applied in this study to project future trends of under-five mortality in Oman and forecast results indicated that U5MR will remain around 11 deaths per 1000 live births throughout the out of sample period. Therefore, we encourage authorities in Oman to identify and address all the factors that significantly contribute to under five mortality in the country.

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### Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Forecasting Under Five Mortality Rate for Oman Using a Machine Learning Technique" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 7, pp 406-409, July 2022. Article DOI <https://doi.org/10.47001/IRJIET/2022.607088>

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