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# Tracking the Future Path of Under Five Mortality Rate for Morocco Using a Machine Learning Algorithm

**[1]Dr. Smartson. P. NYONI, [2]Thabani NYONI**

[1]ZICHIRe Project, University of Zimbabwe, Harare, Zimbabwe
[2]Independent Researcher & Health Economist, Harare, Zimbabwe

***Abstract* - This study uses annual time series data on under five mortality rate (U5MR) for Morocco 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 revealed that U5MR will continue to decline throughout the out of sample period. Therefore, the Moroccan government must address all the major challenges that hinder the success of the maternal and child health (MNCH) program.**

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

## I. INTRODUCTION

Maternal health and improving child survival should be a priority for every UN member state (UN, 2020; WHO, 2019; UNICEF, 2019; UNICEF, 2018). The 3rd sustainable development goal was designed to push all countries to urgently address all the burning issues regarding the health of pregnant women and children (WHO, 2019; IOM, 2019; UNFPA, 2018; Scandall *et al.* 2016;UN, 2016; UN, 2015;every woman every child, 2015; UNPA *et al.* 2014). Several problems are affecting the health of women and children. Poverty, hunger, lack of education, inequalities, civil wars and lack of adequate clean water for human consumption. Governments are encouraged to adopt SDGs that are meant to solve maternal, newborn and under five mortality and integrate them into their national plans and budgets. The aim is to achieve significant reduction of neonatal and under five mortality to as low as 12 deaths per 1000 live births and 25 deaths per 1000 live respectively by 2030 (UNICEF, 2019). This paper aims to project future trends of under-five mortality rate in Morocco using the artificial neural network approach. The findings will inform policies, planning and allocation of resources to keep under five mortality under control.

## II. LITERATURE REVIEW

Garcia *et al.* (2020) described changes over time in the use of childbirth care in Egypt, focusing on location and sector of provision (public versus private) and the content of immediate postpartum care. The authors used five Demographic and Health Surveys conducted in Egypt between 1995 and 2014 to explore national and regional trends in childbirth care. The study findings suggested that Egypt achieved large increases in the percentage of women delivering in facilities and with skilled birth attendants. However, most women and newborns did not receive essential elements of high quality immediate postpartum care. Nove *et al.* (2020) estimated the potential impact of midwives on reducing maternal and neonatal deaths and stillbirths under several intervention coverage scenarios. The model used was the Lives Saved Tool to estimate the number of deaths that would be averted by 2035, if coverage of health interventions that can be delivered by professional midwives were scaled up in 88 countries that account for the vast majority of the world's maternal and neonatal deaths and stillbirths. The findings of the study showed that a substantial increase in coverage of midwife-delivered interventions could avert 41% of maternal deaths, 39% of neonatal deaths, and 26% of stillbirths, equating to 2·2 million deaths averted per year by 2035.Juarez *et al.* (2020) conducted a quality improvement study to increase 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. It was found that structured improvement interventions, including mobile health decision support and financial incentives, significantly increased 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.Another study by 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.

 

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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 Morocco.

### Data Issues

This study is based on annual under five mortality rate in Morocco 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 | K |
| 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 | 0.000765 |
| MSE | 0.434680 |
| MAE | 0.542160 |

Residual Analysis for the Applied Model

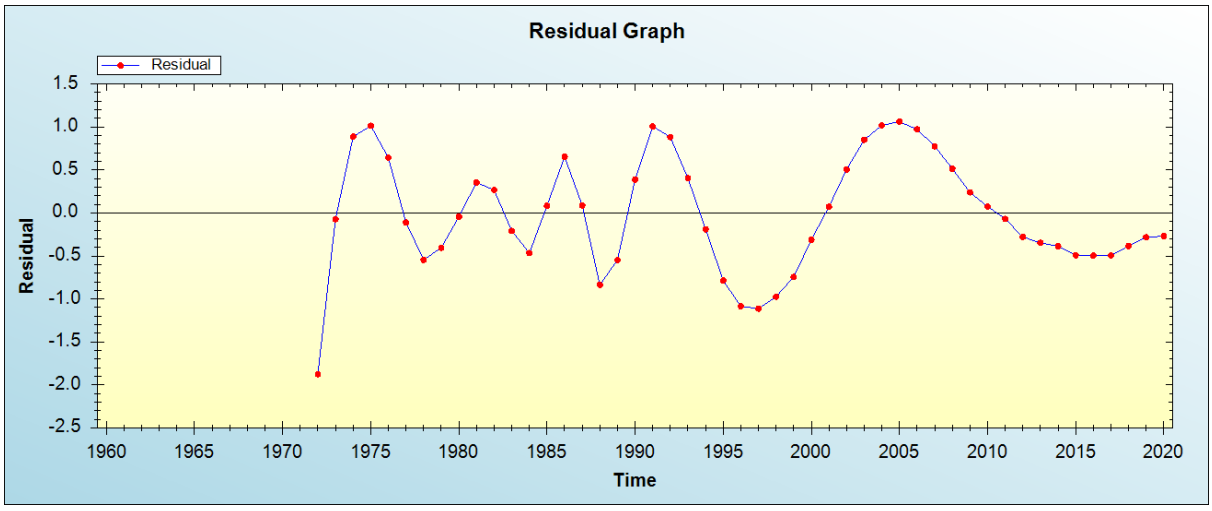


Figure 1: Residual analysis

 

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In-sample Forecast for K

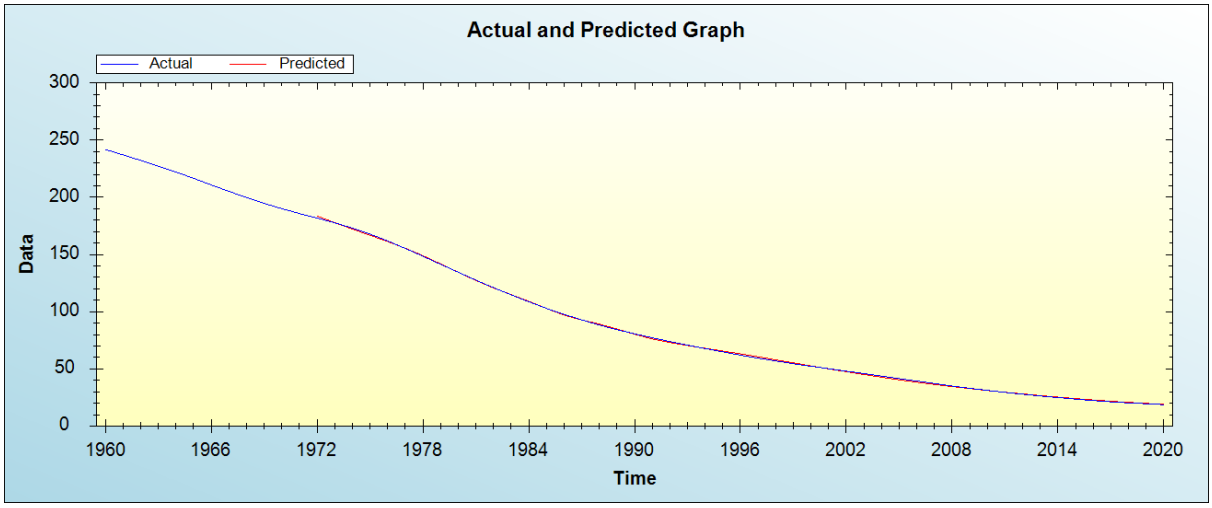


Figure 2: In-sample forecast for the K series

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

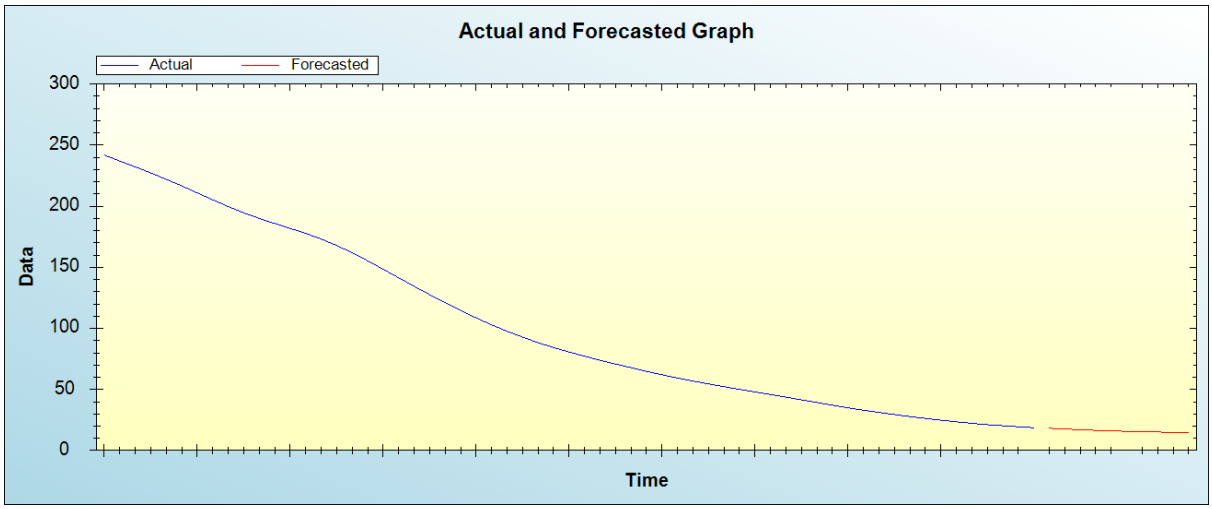


Figure 3: Out-of-sample forecast for K: actual and forecasted graph

Out-of-Sample Forecast for K: Forecasts only

Table 2: Tabulated out-of-sample forecasts

| | |
|---|---|
| 2021 | 18.2470 |
| 2022 | 17.6109 |
| 2023 | 17.0346 |
| 2024 | 16.5479 |
| 2025 | 16.1146 |
| 2026 | 15.7417 |
| 2027 | 15.4311 |
| 2028 | 15.1543 |
| 2029 | 14.9253 |
| 2030 | 14.7198 |

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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 continue to decline throughout the out of sample period.

## V. POLICY IMPLICATION & CONCLUSION

The government of Morocco has made significant milestones in the reduction of under-five mortality as the country recorded a down ward trend in under five mortality over the past 2 decades. However more needs to be done to end all preventable under five deaths especially in the rural areas. This study applied the ANN (12, 12, 1) model to project future trends of under-five mortality rate and forecast results revealed that U5MR will continue to decline throughout the out of sample period. Hence, we implore authorities in Morocco to address all the challenges that hinder the success of the maternal and child health program in the country.

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