

Prediction of Infant Mortality Rate in Nepal

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Abstract - In this research article, the ANN approach was applied to analyze infant mortality rate in Nepal. The employed annual data covers the period 1960-2020 and the out-of-sample period ranges over the period 2021-2030. The residuals and forecast evaluation criteria (Error, MSE and MAE) of the applied model indicate that the model is stable in forecasting infant mortality rate in Nepal. The ANN (12, 12, 1) model projections suggest that infant mortality will generally decline in Nepal over the next 10 years. The government is encouraged to intensify maternal and child health surveillance and control programs amongst other measures in order to curb infant mortality in Nepal. This can be specifically executed by adopting the suggested 7-fold policy recommendations.

Keywords: ANN, Forecasting, Infant mortality rate.

I. INTRODUCTION

Nepal is one of the poorest countries in Asia (Karki & Kittel, 2019; Nepal, 2016). Many people live in the rural areas and enjoy the traditional way of life. Approximately 80 % of the population are Hindus and 10 % are Buddhists and mainly residing in mountainous regions like Dolpa (Karki & Kittel, 2019). The country has made significant progress towards achieving sustainable development goals by 2030. Nepal has recorded a decline in under 5 and neonatal mortality (MOH Nepal, 2017; World Bank, 2019). The government is committed to addressing problems associated with child mortality and over the years the country has witnessed high coverage of vitamin A supplementation, immunization coverage, and deworming and moderate coverage of exclusive breastfeeding for at least 6 months (MOH Nepal, 2016; Reesha et al, 2013). Infant mortality ratio in Nepal is higher in comparison to other South East Asian countries such as India, which has an IMR of 42/1000 live births, Bangladesh 41/1000 live births and Sri Lanka 9/1000 live births (Lamichhane et al, 2017; MENA report India, 2013; Uzzal, 2014; Wang et al, 2013). The progress towards reducing IMR is relatively slow when compared with other health indicators (Adhikari & Podhisita, 2010; Deepak et al, 2013). Several studies done in Nepal have shown that socio economic, demographic, ecological and proximate determinants are associated with infant mortality (Adhikari & Podhisita, 2010; Pandey et al, 2013). In this paper we aim to predict IMR in Nepal using the multilayer perceptron (MLP). The model is composed of 3 layers which are the input, hidden and output layers which are connected by connection weights. The model is a feed forward neural network type (Nyoni et al, 2020; Zhao et al, 2020; Kaushik & Sahi, 2018; Yan et al, 2018; Fojnica et al, 2016; Zhang, 2003; Kishan, 1997; Patterson, 1995). The results of this study are envisioned to reveal the future trends of IMR and act as an early surveillance tool that will guide the government in the prevention and control of infant mortality in Nepal.

II. LITERATURE REVIEW

Ashish et al, 2016 carried a study's to improve adherence to the Helping Babies Breathe (HBB) neonatal resuscitation protocol and reduce perinatal mortality by using a quality improvement cycle (QIC) in a tertiary hospital in Nepal. The HBB QIC was implemented through a multifaceted approach, including the formation of quality improvement teams; development of quality improvement goals, objectives, and standards; HBB protocol training; weekly review meetings; daily skill checks; use of self-evaluation checklists; and refresher training. A cohort design, including a nested case-control study was used to measure changes in clinical outcomes and adherence to the resuscitation protocol through video recording, before and after implementation of the QIC. The study concluded that HBB QIC reduced intrapartum stillbirth and first-day neonatal mortality and led to use of suctioning and stimulation more frequently. Khadka et al (2015) explores distal socioeconomic and related proximate determinants of infant mortality and provides evidence for designing targeted interventions. Survival information on 5391 live born infants (2006–2010) was examined from the nationally representative Nepal Demographic Health Survey 2011. Bivariate logistic regression and multivariate hierarchical logistic regression approaches were performed to analyze the distal-socioeconomic and related proximate determinants of infant mortality. The authors concluded that socioeconomic distal and proximate determinants are associated with infant mortality in Nepal. Infant mortality was higher in the poor and middle classes than the wealthier classes. Population of Mountain ecological region and Far western development region had high risk of infant mortality. Similarly, infant dying was higher for infants whose birth size, as reported by mothers, was very small and who has

higher birth rank and short preceding birth interval. Suwal (2001) investigated factors that contribute to the incidence of a high or low level of infant mortality. Data on infant mortality obtained by the 1991 Demographic Health Survey of Nepal was analyzed in this study. A logistic regression model is used for analyzing the data. Several hypotheses were tested to explain the incidence of infant mortality in Nepal. The various reasons for the persistence of high infant mortality and the difficulties in lowering it are discussed. The findings suggested that among all the variables analyzed in the study, parity, place of residence, immunization, and ethnicity influence infant mortality the most.

III. METHODOLOGY

The Artificial Neural Network (ANN), which we intend to apply in this research article; is a data processing system consisting of a huge number of simple and highly interconnected processing elements resembling a biological neural system. It has the capability of learning from any data-set to describe the nonlinear and interaction effects with great accuracy. No strict rules exist for the determination of the ANN structure hence 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 infant mortality rates in Nepal.

Data Issues

This study is based on annual infant mortality rates in Nepal for the period 1960 – 2020. The out-of-sample forecast covers the period 2021 to 2030. Infant mortality rate, which is simply a proxy for infant deaths; for the purposes of this study, is defined as the number of infants dying before reaching one year of age, per 1000 live births in a given year. All the data employed in this paper was gathered from the World Bank.

IV. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	N
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	0.007957
MSE	0.712823
MAE	0.722956

Residual Analysis for the Applied Model

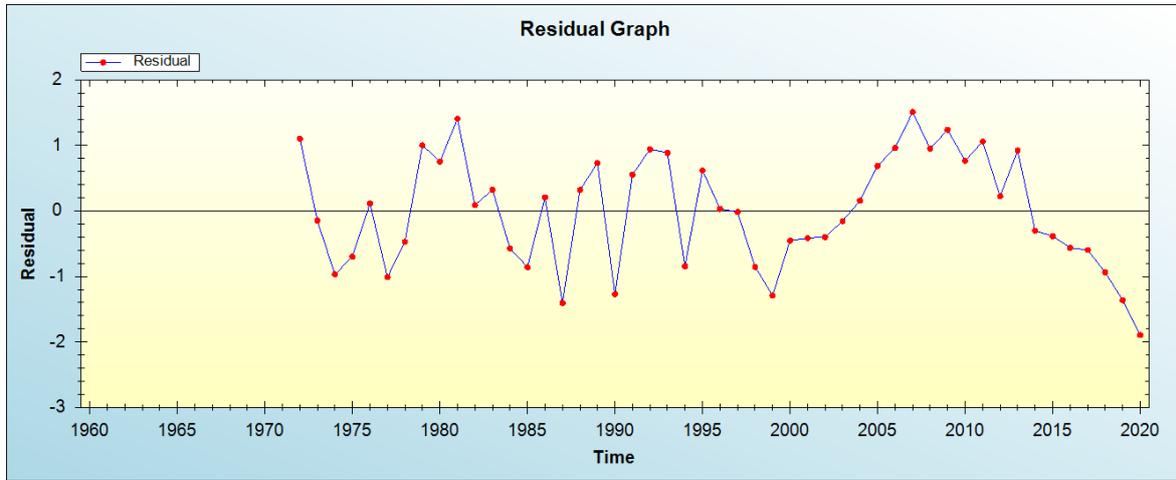


Figure 1: Residual analysis

In-sample Forecast for N

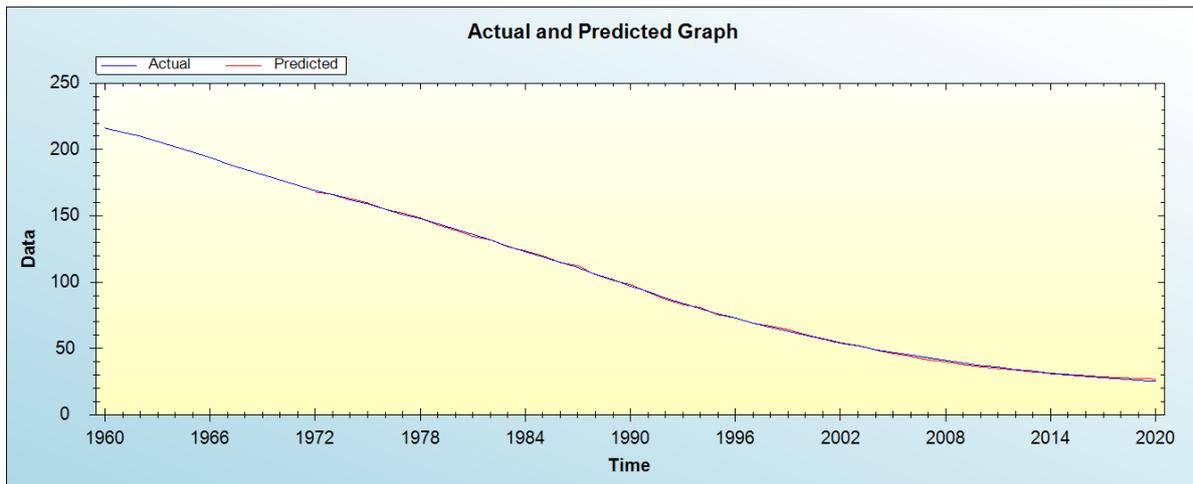


Figure 2: In-sample forecast for the N series

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

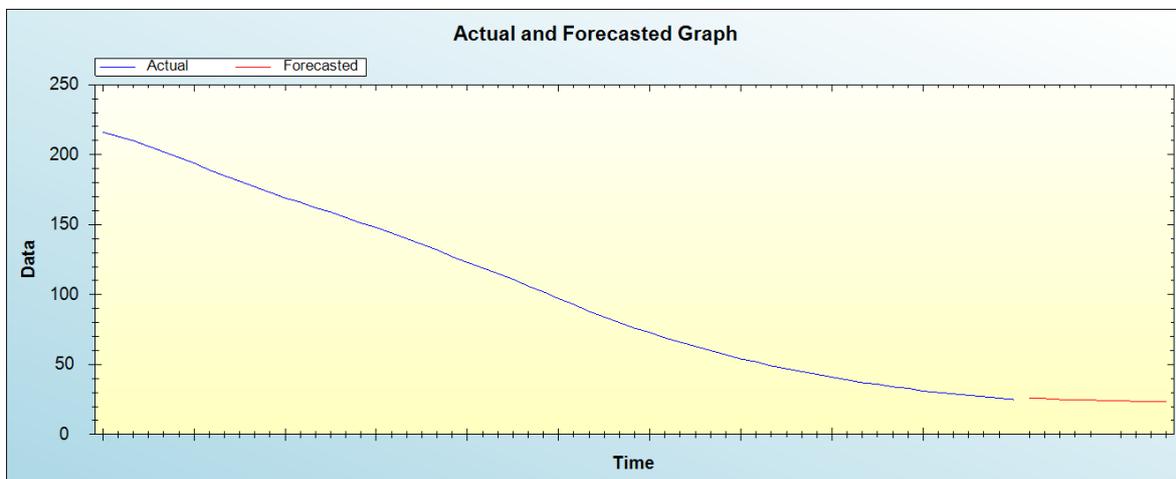


Figure 3: Out-of-sample forecast for N: actual and forecasted graph

Out-of-Sample Forecast for N: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Year	Predictions
2021	26.3003
2022	25.7325
2023	25.0116
2024	24.8775
2025	24.6692
2026	24.1618
2027	23.9571
2028	23.7475
2029	23.6480
2030	23.7140

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 infant mortality in Nepal is likely to decline from the current estimated 26 to nearly 24/1000 live births per year by 2030.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Preventing infant mortality remains one of the main objectives of the health ministry in Nepal. The Nepal government remains committed to ending preventable deaths infants in the country. The study used annual data to analyze the trends of infant mortality in Nepal. The applied model is the ANN model. In order to make sure that infant mortality in the country significantly declines, the government of Nepal ought to consider the following policy suggestions:

- i. The government of Nepal should continue to encourage mothers to breast-feed their babies adequately.
- ii. There is need for all child-bearing women in Nepal to be vaccinated against common illnesses.
- iii. There is need to prevent birth defects in Nepal.
- iv. The government of Nepal should address preterm birth, low birth-weight and their outcomes.
- v. The government of Nepal should also ensure adequate access to pre-pregnancy and prenatal care.
- vi. There is need to educate, especially, mothers on the importance of creating a safe infant sleep environment in the country.
- vii. Healthcare providers in Nepal need to use newborn screening activities in order to detect hidden conditions.

REFERENCES

- [1] Adhikari R., & Podhisita C (2010). Household headship and child death: evidence from Nepal. *BMC int health hum rights*. 10(1):13.
- [2] Bindu Kumari Karki., & Guenter Kittel (2019) Neonatal mortality and child health in a remote rural area in Nepal: a mixed methods study *BMJ Pediatrics Open* 2019;3 pp 1-7:e000519. doi:10.1136/ bmjpo-2019-000519
- [3] Dan W. Patterson (1995) *Artificial Neural networks Theory and Applications*. Singapore; New York: Prentice Hall.
- [4] Fojnica, A., Osmanoviae & Badnjeviae A (2016). Dynamic model of tuberculosis-multiple strain prediction based on artificial neural network. In *proceedings of the 2016 5th Mediterranean conference on embedded computing* pp290-293.
- [5] Kaushik AC & Sahi. S (2018). Artificial neural network-based model for orphan GPCRs. *Neural.Comput.Appl.* 29,985-992
- [6] Kishan Mehrotra., Chilukuri K., Mohan, & Sanjay Ranka (1997) *Elements of artificial neural networks*. Cambridge, Mass.: MIT Press.

- [7] MENA Report. India (2013): infant mortality rate in India. London: Albawaba (London) Ltd.
- [8] Ministry of Health and Population (MOHP) (2017). Nepal demographic and health survey. Kathmandu.
- [9] Ministry of Health. Nepal's Every Newborn Action Plan Government of Nepal Ministry of Health, 2016.
- [10] Moniruzzaman Uzzal (2014). Bangladesh exceeds MDG target for reducing child mortality. Dhaka, Bangladesh; 2014 [cited 27 March, 2014]. Available from: <http://www.dhakatribune.com/development/2014/mar/23/bangladeshexceeds-mdg-target-reducing-child-mortality>.
- [11] Naizhuo Zhao., Katia Charland., Mabel Carabali., Elaine O., Nsoesie., Mathieu MaheuGiroux., Erin Rees., Mengru Yuan., Cesar Garcia Balaguera., Gloria Jaramillo Ramirez., & Kate Zinszer (2020). Machine learning and dengue forecasting: Comparing random forests and artificial neural networks for predicting dengue burden at national and sub-national scales in Colombia. PLOS Neglected Tropical Diseases | <https://doi.org/10.1371/journal.pntd.0008056>
- [12] Pandey J P., Dhaka MR., Karki S., Poudel P., & Pradhan MS (2013). Maternal and child health in Nepal: the effects of caste, ethnicity, and regional identity: further analysis of the 2011 Nepal demographic and health survey. <http://preview.dhsprogram.com/pubs/pdf/FA73/FA73.pdf>. Accessed Mar 2013
- [13] Paudel Deepak., Thapa Anil., Shedain Purusotam Raj., & Paudel Bhuwan (2013). Trends and determinants of Neonatal mortality in Nepal: further analysis of demographic and health survey 2001–2011. The DHS Program 2013 [cited March 2013]; <http://www.dhsprogram.com/publications/publication-fa75further-analysis.cfm>.
- [14] Reesha J (2013). Improving neonatal health in Nepal: major challenges to achieving millennium development goal 4. Heal Sci J 2013; 7.
- [15] Reeta Lamichhane., Yun Zhao., Susan Paudel & Emmanuel O (2017). Adewuyi1Factors associated with infant mortality in Nepal: a comparative analysis of Nepal demographic and health surveys (NDHS) 2006 and 2011 BMC Public Health (2017) 17:53 pp 1-18 DOI 10.1186/s12889-016-3922-z
- [16] Smartson. P. Nyoni, Thabani Nyoni, Tatenda. A. Chihoho (2020) PREDICTION OF DAILY NEW COVID-19 CASES IN GHANA USING ARTIFICIAL NEURAL NETWORKS IJARIE Vol-6 Issue-6 2395-4396
- [17] Smartson. P. Nyoni., Thabani Nyoni., Tatenda. A. Chihoho (2020) PREDICTION OF DAILY NEW COVID-19 CASES IN EGYPT USING ARTIFICIAL NEURAL NETWORKS IJARIE- Vol-6 Issue-6 2395-4396
- [18] Wang H., Liddell CA., Coates MM., Mooney MD., Levitz CE., & Schumacher AE (2013). Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the global burden of disease study 2013. Lancet. 384(9947):957–79. Doi: 10.1016/S0140-6736.
- [19] Yan C Q., Wang R B., Liu C H., Jiang Y (2019). Application of ARIMA model in predicting the incidence of tuberculosis in China from 2018-2019. Zhonghua 40(6):633-637
- [20] Zhang G P, "Time series forecasting using a hybrid ARIMA and neural network model", Neurocomputing 50: 159–175.

Citation of this Article:

Dr. Smartson. P. NYONI, Thabani NYONI, "Prediction of Infant Mortality Rate in Nepal" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 5, Issue 3, pp 696-700, March 2021. Article DOI <https://doi.org/10.47001/IRJIET/2021.503122>
