International Research Journal of Innovations in Engineering and Technology (IRJIET)

ISSN (online): 2581-3048
Volume 6, Issue 12, pp 248-251, December-2022
https://doi.org/10.47001/IRJIET/2022.612047

Demonstrating Use of Machine Learning in the Detection of Adolescent Fertility for the Kingdom of Eswatini

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***Abstract* - This study uses annual time series data on adolescent fertility rate for Eswatini from 1960 to 2020 to predict future trends of adolescent fertility rate over the period 2021 to 2030. The forecast evaluation criteria of the applied model indicate that the ANN (12, 12, 1) model is stable in forecasting adolescent fertility rate. The neural network model projections revealed adolescent fertility will hover around 73 births per 1000 women aged 15-19 throughout the out of sample period. Therefore, we encourage the Kingdom of Eswatini to focus on improving the accessibility and affordability of sexual and reproductive health services among adolescents, strictly enforce laws that protect sexual and reproductive health rights of adolescent girls and women, and fund empowerment programs for youths.**

Keywords: ANN, Forecasting, adolescent fertility rate.

I. INTRODUCTION

Adolescent pregnancy remains a global health problem especially in sub-Saharan Africa (SSA). According to the United Nations, the global adolescent pregnancy rate decreased by 28% from 65 births per 1,000 women in 1990 to 47 births per 1,000 women in 2015. Low and middle income countries bear a huge burden of teenage pregnancy reporting an estimated 21 million adolescent pregnancies per year (Darroch *et al.* 2016). The largest proportion of these teenage pregnancies occur in Sub-Saharan Africa, where adolescent fertility rates can be as high as 200 births per 1,000 girls contributing about 33% to the world's teenage pregnancies (World Atlas, 2015). Unprotected sexual activity exposes adolescents to unintended pregnancies and STIs (Peltzer & Pengpid, 2015).Reducing the number of unintended pregnancies is the main objective in public health to reduce adverse sexual and reproductive health outcomes (Hultstranda *et al.* 2021).The prevalence of adolescent pregnancy in the Kingdom of Eswatini is around 45% (Central Statistical Office& Macro International, 2008). Twenty-three per cent of teenagers had started childbearing by the age of 15; 19% had had a live birth by the same age and 4% were pregnant with their first child age 15. Rural teenagers are more likely to have started childbearing than their urban counterparts (Central Statistical Office& Macro International, 2008). Rural teenagers in Eswatini have one of the highest rates of teenage pregnancies at 25% (Dlamini, 2016). The 2009 Annual Education Census (AEC) Report indicated that between 2009 and 2015 approximately 52,814 pupils dropped out of school each year due to lack of school fees, disciplinary or expulsion, sicknesses, absconding, death, family issues, and teenage pregnancies. Over the same period 18.1% of the pupils dropped out of school due to teenage pregnancy, of which 77.9% of the pupils were girls and 22.1% were boys (Ministry of Education and Training, 2009-2015). Therefore teenage pregnancies are regarded as a health and education issue, but there is limited evidence on how they affect the economy and the development path of a country as a whole (Dlamini, 2019). Studies conducted in the past established that there are several factors that contribute to adolescent pregnancy such as peer pressure, gender inequalities, poverty, religious, social norms, lack of parental guidance, inadequate SRH knowledge, and non-use of contraceptives (Yakubu & Salisu, 2018;Ayele, 2013; Fernando *et al.* 2013; Sayem, 2011; Elhag, 2003;).

This study uses a machine learning technique to forecast future trends of adolescent fertility in the out of the sample period. The findings are going to trigger an appropriate response to curb teenage pregnancy and child marriage in Eswatini.

II. METHODOLOGY

The Artificial Neural Network (ANN) approach, which is flexible and capable of nonlinear modelling; will be applied in this study. The ANN is a data processing system consisting of a large number of highly interconnected processing elements in

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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 adolescent fertility rate for Eswatini Kingdom.

Data Issues

This study is based on annual adolescent fertility rate in Eswatini Kingdom 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.

III. FINDINGS OF THE STUDY

ANN Model Summary

Table 1: ANN model summary

Variable	E
Observations	49
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	0.004111
MSE	0.699343
MAE	0.616127

Residual Analysis for the Applied Model

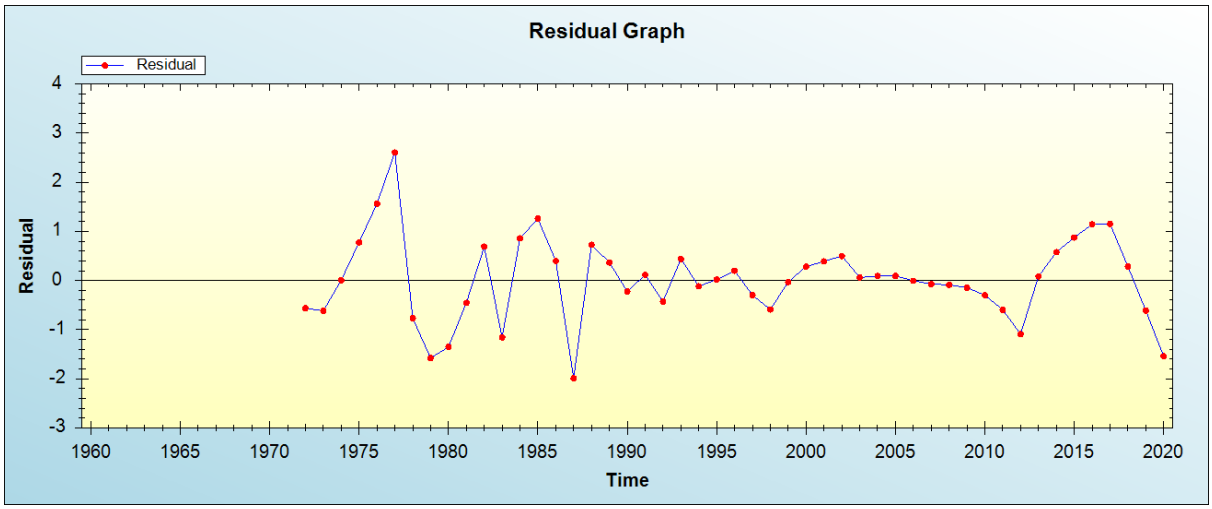

Figure 1: Residual analysis

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In-sample Forecast for E

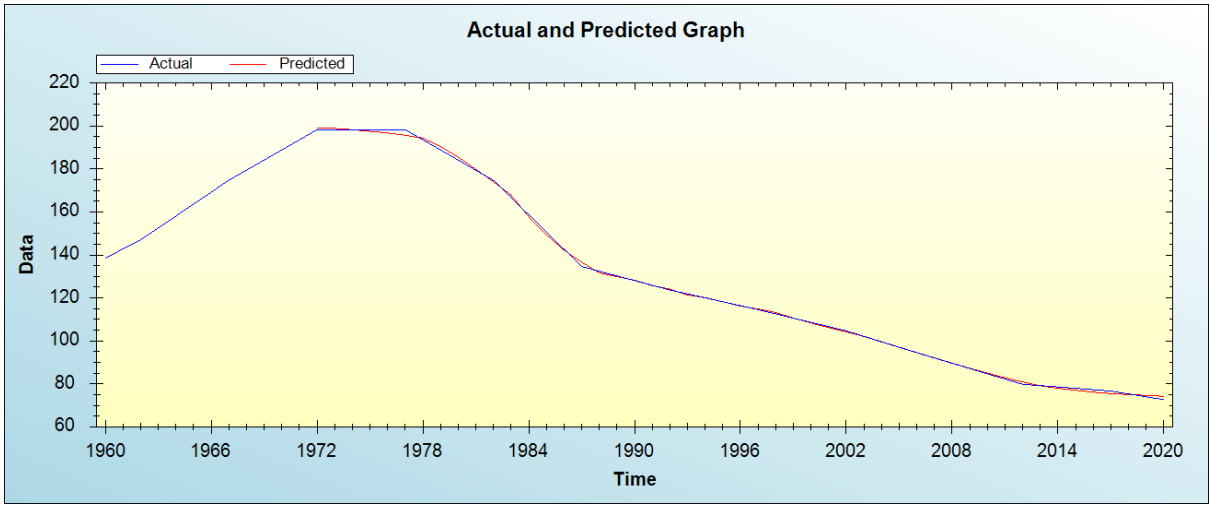

Figure 2: In-sample forecast for the E series

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

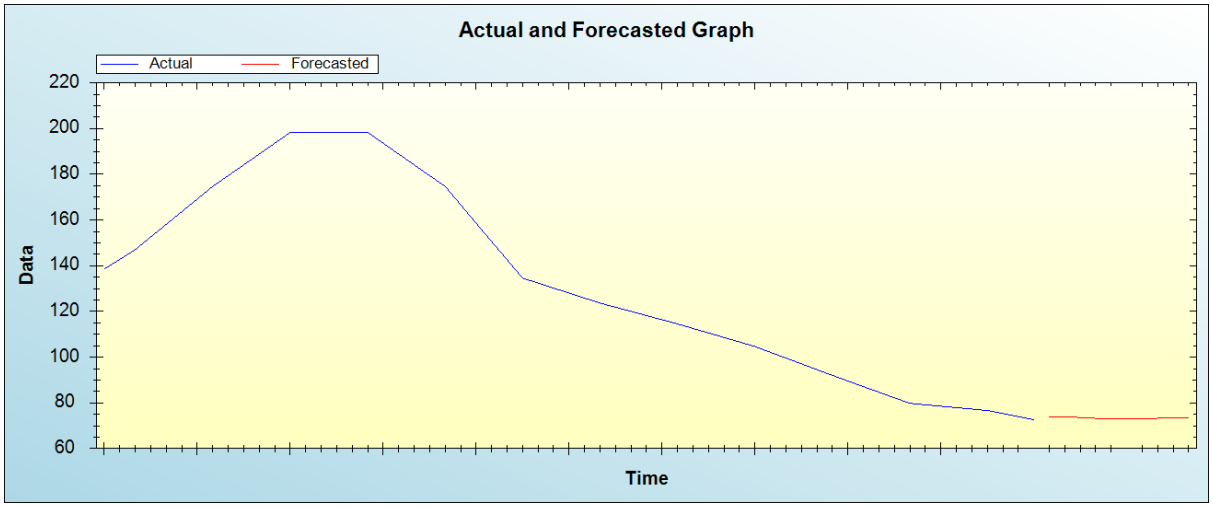

Figure 3: Out-of-sample forecast for E: actual and forecasted graph

Out-of-Sample Forecast for E: Forecasts only

Table 2: Tabulated out-of-sample forecasts

2021	73.8301
2022	73.8043
2023	73.6729
2024	73.2660
2025	73.1150
2026	73.0366
2027	73.1640
2028	73.2745
2029	73.3893
2030	73.3345

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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 adolescent fertility rate will hover around 73 births per 1000 women aged 15-19 throughout the out of sample period.

IV. POLICY IMPLICATION & CONCLUSION

Reducing the number of unintended pregnancies is one of the strategies employed in public health to avert adverse sexual and reproductive health outcomes. The prevalence of adolescent pregnancy in the Kingdom of Eswatini is around 45 percent. Adolescent fertility gradually declined over the period 1960-2020 to levels around 72 births per 1000 women aged 15-19 years. These figures indicate that adolescent births are still unacceptably high. This study applied a machine learning technique to forecast future trends of adolescent fertility for Eswatini Kingdom. Our study findings revealed that adolescent fertility will hover around 73 births per 1000 women aged 15-19 throughout the out of sample period. Therefore, the government is encouraged to focus on improving the accessibility and affordability of sexual and reproductive health services among adolescents, strictly enforce laws that protect sexual and reproductive health rights of adolescent girls and women, and fund empowerment programs for youths.

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Citation of this Article:

Smartson. P. NYONI, Thabani NYONI, "Demonstrating Use of Machine Learning in the Detection of Adolescent Fertility for the Kingdom of Eswatini" Published in *International Research Journal of Innovations in Engineering and Technology - IRJIET*, Volume 6, Issue 12, pp 248-251, December 2022. Article DOI https://doi.org/10.47001/IRJIET/2022.612047

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