

Using Artificial Neural Networks for Predicting New Assault Cases in Gokwe North in Zimbabwe

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Abstract - Assault against adolescents, men and women has become a public health threat as it is resulting in various infectious diseases being spread, unwanted pregnancies and abortions. This paper aims to predict the cases of assault at Gokwe North District Hospital using the ANN (12, 12, 1) model. Residual analysis of this model indicated that it was very stable and thus suitable for predicting assault cases at GNH over the out-of-sample period. In order to reduce these assault cases in future, the police and hospitals should basically make sure there are conducive platforms for the assessment and reporting of assault cases and victims and proper follow ups are done to get the perpetrators behind bars.

I. INTRODUCTION

Sexual violence is a major public health problem, especially due to the associated risk of acquiring sexually transmitted infections (STIs) including HIV, behavioral disorders, risk of committing suicide, physical injury, unwanted pregnancy, unsafe abortion, anxiety, shame, posttraumatic stress, and depression (Girgira, 2014). It is recorded that most sexual assaults are gender based and women usually suffer (Dartnall and Jewkes, 2013). The World Health Organization (WHO), in 2005 conducted a multi-country study on women health and domestic violence against women they found that violence against women is wide-spread and deeply ingrained, and has serious impacts on women's health and wellbeing and its continued existence is morally indefensible. Gender-based violence (GBV) is a growing global public health concern of the twenty-first century, Garcia-Moreno C(2011). In most African countries like Zimbabwe this is the most prevalence type of assault.

According to the Zimbabwe Demographic Health Survey (ZDHS) 2015, 14% of women aged 15-49 years have reported experiencing sexual violence at some point in their lifetime, and among these women, 55% reported the perpetrator as their current husband or partner. Hlavka (2017) Sexual violence in males is a sensitive issue and often not reported because they often feel ashamed, embarrassed, disempowered and emasculated by the sexual assault. In Zimbabwe GBV and general assault are considered as criminal behavior, hence one ought to report them to the police, the nearest clinic or the Adult Rape Clinic. Sexually related assaults are reported to most clinics, by considering that assault happens to both women and men this study sought to predict the number of assaults in terms of the type of assaults which according to Prabakaran and Mitra (2018).

The authors highlighted that assault ranged from Simple Sexual Assault (constraining a person to participate in any type of sexual action without unequivocal assent), Sexual Assault with a Weapon (incorporates the utilization or danger of the utilization of a weapon or damage to an outsider), Aggravated Sexual Assault (truly injured, mangled, fiercely beaten, or in threat of passing on because of a rape) and Verbal assault (oral ambush that outcomes in a passionate, mental, and additionally mental damage to the casualty, instead of physical substantial damage way). Motivated by the need to help reduce the incident of violence in Gokwe North, this paper analyzes assault cases recorded and managed in Gokwe North. This study is the first of its kind in Zimbabwe and is an eye-opener especially with regards to the need for effective crime management, identifying areas that can be improved, gaps in service provision and to inform policymakers on the impact of sexual violence in our communities.

1.1 OBJECTIVES OF THE STUDY

- i. To assess new assault cases in Gokwe North over the period January 2012 to December 2019.
- ii. To predict assault cases for Gokwe North over the period January 2020 to December 2021.
- iii. To determine whether assault cases are increasing or decreasing in Gokwe North over the out of sample period.

1.2 RELEVANCE OF THE STUDY

Assault in Zimbabwe has grown to be a public health problem that has detrimental trickle-down effects on the health sector of Zimbabwe when victims sought for care and treatment; this has led to the high occupancy in the hospital wards and seeking of medication. In Gokwe North, arguably due to the polarization of political parties and undermining of women’s rights; it has been recorded that both men and women are at risk of assault. However, there is not much preparation to deal with an influx of such cases and hence the need to forecast assault cases in this region. The Ministry of Health & Child Care in Zimbabwe is committed to decreasing the trends of assault cases in the country. To achieve this substantial goal, it is instructive to predict assault cases in order to suggest a reliable controlling model for use in Gokwe North and for duplication in other similar hospitals in the country.

II. RELATED STUDIES

Adeleke et al (2012), did a study for Nigeria and reviewed the patterns of sexual violence against women treated at a hospital over a 7-year period. He found that sexual assault cases constituted 2.1% of female consultation outside pregnancy during the period studied, he concluded that the proportion of cases increased over the years under review. Hence the need for a hospital-based management protocol to solve this health problem. In Zimbabwe Kufa et al (2019), did a research on the sexual assault cases recorded at the Parirenyatwa Adult Rape (ARC) from 2009 to 2019. His results showed that 36.8% of the clients presented their cases within 3 days after the sexual assault. He also found out that men were also victims and about 40% of male victims were assaulted by someone they knew and 27% were married. Tapesana et al (2017), carried his research in Kadoma, Zimbabwe to determine the quality of clinical care offered to sexual assault victims. Thirty percent of the victims sought care within 72 hours of the sexual assault. He also discovered that there was suboptimal clinical care over the period studied which resulted in delayed presentation by victims of sexual assault. After reviewing these country-specific case studies, we can see that none of them attempted to use ANN to predict or forecast the assault cases in Zimbabwe, hence the need for this study to do so and see their efficacy in this kind of prediction and see recommendations we may derive from the study.

III. METHODOLOGY

According to Fischer & Gopal (1994), 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 sexual assault cases at GNH.

3.1 Data Issues

This study is based on reported monthly assaultcases [for all age groups] (referred to as A series in this study) in Gokwe North. The data covers the period January 2012 to December 2019 while the out-of-sample forecast covers the period January 2020 to December 2021. All the data employed in this paper was gathered from Gokwe North District Hospital’s Health Information Department.

IV. FINDINGS OF THE STUDY

4.1 DESCRIPTIVE STATISTICS

Table 1: Descriptive statistics

Summary Statistics, using the observations 2012:01 - 2019:12 for the variable A (96 valid observations)

Mean	Median	Minimum	Maximum
7.8021	7.0000	1.0000	32.000
Std. Dev.	C.V.	Skewness	Ex. Kurtosis
4.7631	0.61049	2.1564	6.7884
5% Perc.	95% Perc.	IQ range	Missing obs.
3.0000	18.300	5.0000	0

4.2 ANN Model Summary

Table 2: ANN model summary

Variable	A
Observations	84 (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	0.147857
MSE	6.484256
MAE	2.075448

Residual Analysis for the Applied Model

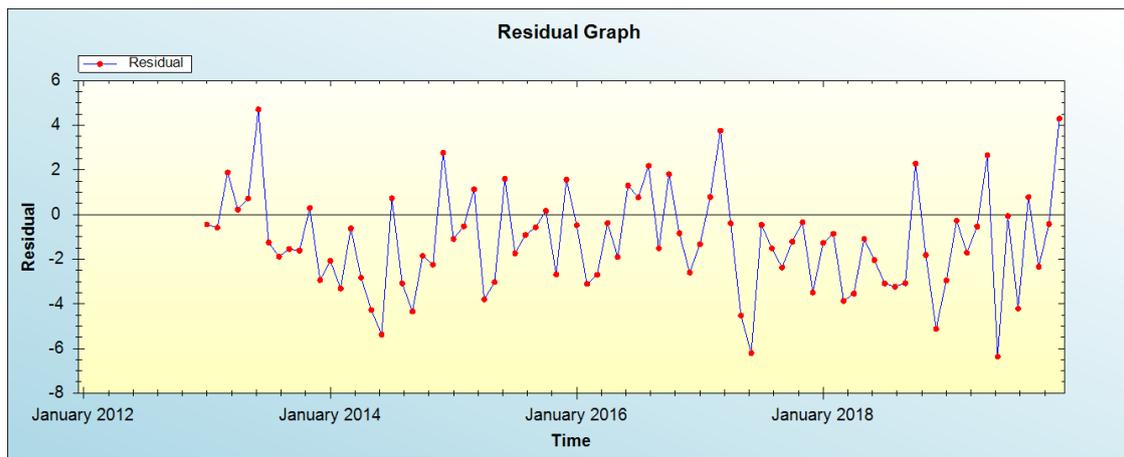


Figure 1: Residual analysis

In-sample Forecast for A

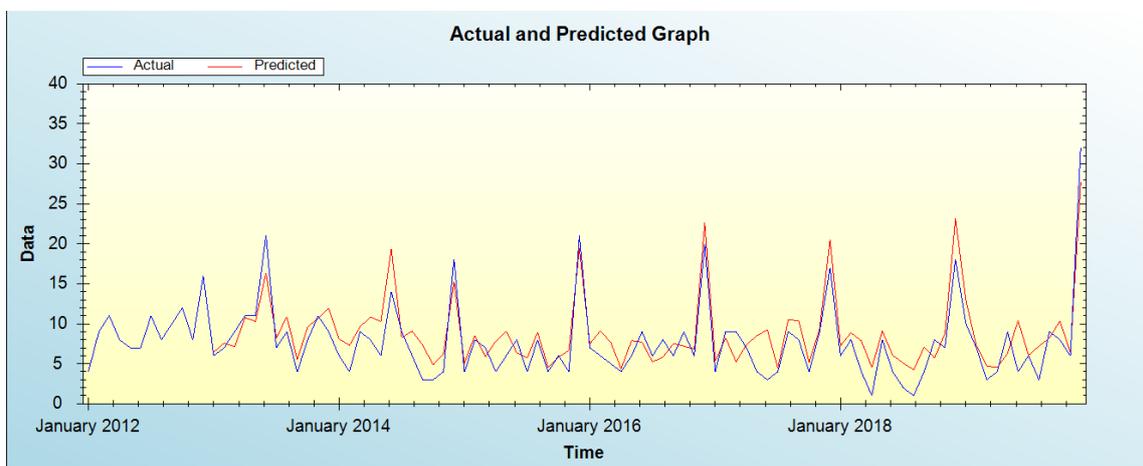


Figure2: In-sample forecast for the A series

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

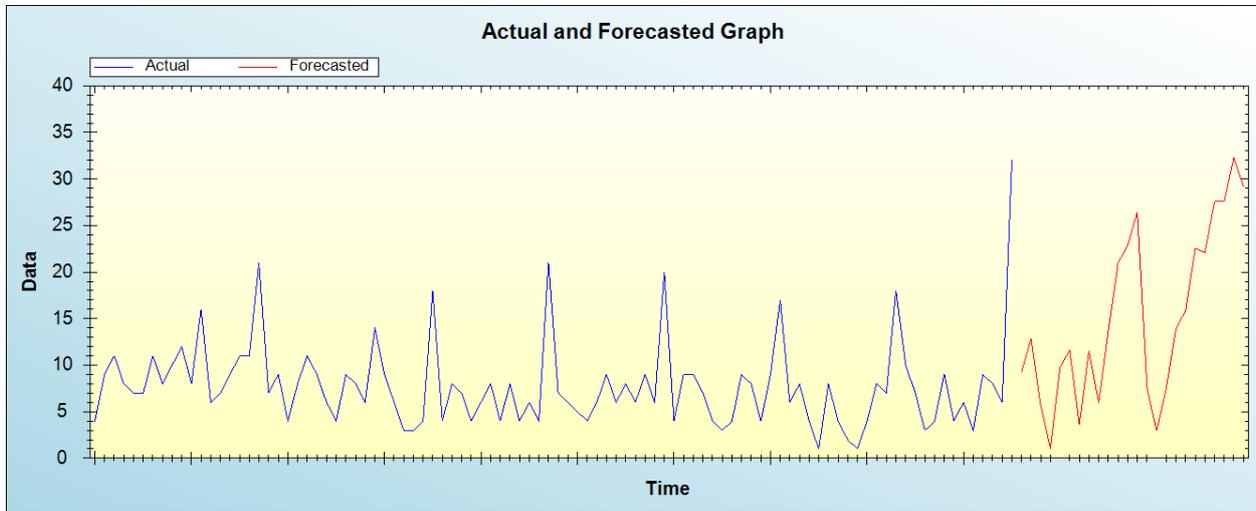


Figure 3: Out-of-sample forecast for A: actual and forecasted graph

Out-of-Sample Forecast for A: Forecasts only

Table 3: Tabulated out-of-sample forecasts

Month/Year	Forecasts
January 2020	9.2438
February 2020	12.8860
March 2020	5.6635
April 2020	1.0765
May 2020	9.7402
June 2020	11.6265
July 2020	3.6150
August 2020	11.5218
September 2020	5.9626
October 2020	13.6145
November 2020	20.9321
December 2020	22.8478
January 2021	26.4421
February 2021	7.6138
March 2021	2.9771
April 2021	7.4627
May 2021	13.9277
June 2021	15.8531
July 2021	22.5313
August 2021	22.0946
September 2021	27.5474
October 2021	27.5795
November 2021	32.2809
December 2021	29.2297

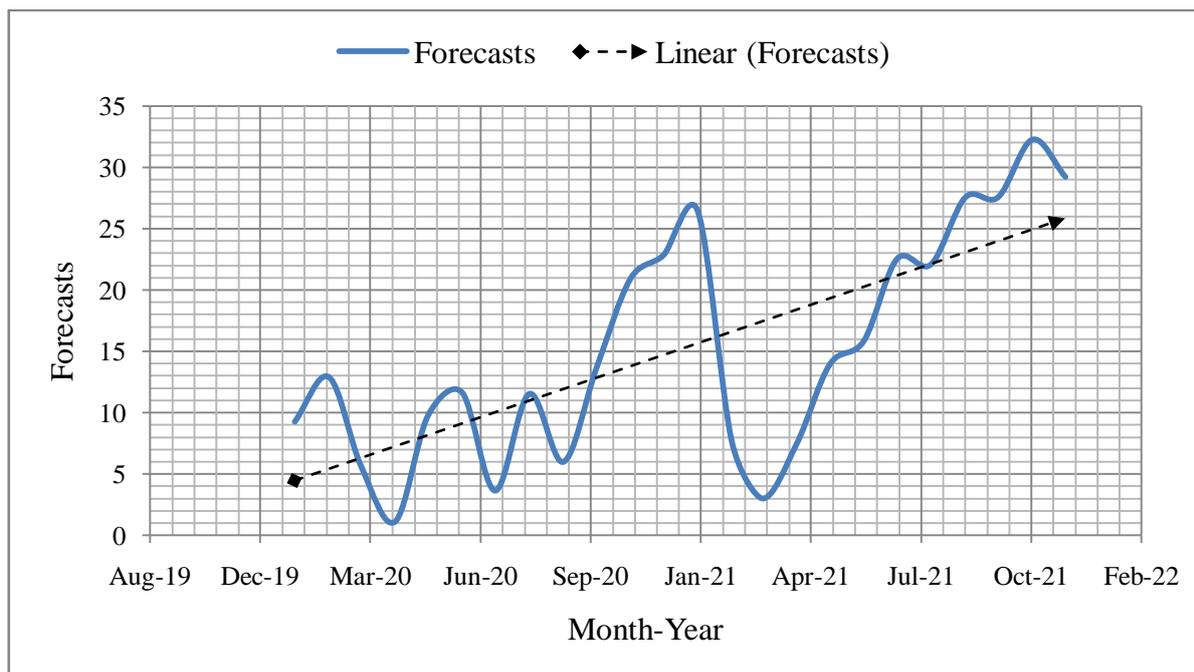


Figure 4: Graphical presentation of out-of-sample forecasts

4.3 DISCUSSION OF THE RESULTS

Table 1 shows the descriptive statistics of data. Table 2 is the ANN model summary and basically shows the ANN (12, 12, 1) neural network model, which has been based on the hyperbolic tangent function as its activation function. The “criteria” are the evaluation statistics and they all indicate the model is absolutely adequate. Figure 1 shows the residuals of the model and since the residuals are as close to zero as possible, the model is stable and acceptable for generating forecasts for Gokwe North Hospital. Figure 2 shows the in-sample forecast of the model and it can be inference that the model fits well with data. Figure 3, table 3 and figure 4 are out of sample forecasts. A striking feature of our forecast is that assault cases are rising in Gokwe District and this calls for more serious policy actions.

V. CONCLUSION AND POLICY RECOMMENDATIONS

Sexual assault against men and women is of public health significance in Gokwe North District with the adolescent being the most affected. There is a need to establish a rape management protocol at Gokwe District hospital in line with the WHO guidelines. This study practically demonstrated the importance of applying an ANN model to analyze monthly assault cases, as well as forecasting the future trend. Using time series data over the period January 2012 to December 2021, the study accurately forecasted monthly assault case volumes over the out-of-sample period. The following policy directions are therefore suggested:

- i. Advice to Gokwe District Hospital and Zimbabwe as a whole is to adhere to guidelines in managing sexual abuse victims, this ensures the efficiency of dealing with such cases in a space that is conducive and motivates the victims to report. The police in conjunction with hospitals should ensure that perpetrators are brought to book. Stiffer penalties for such crimes are also recommended for Zimbabwe’s judicial system.
- ii. Platforms that ensure confidentiality and privacy ought to be established within hospitals to allow male victims to report assault.
- iii. Gokwe District Hospital should also consider conducting public awareness campaigns on men and women rights and the need to report assault. The adolescents should be taught that assault is a crime and they ought to report such incidences earlier to avoid diseases and health implications associated with being assaulted as this is a public health threat.

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