

ON TIME SERIES ANALYSIS OF THE SCHOOL FEEDING PROGRAMME:
CASE STUDY OF ASEM CLUSTER OF SCHOOLS

ABSTRACT

Research Context: This paper sought to study and examine the need to investigate with quantitative data whether the objectives of higher enrolment has been met with the introduction of School Feeding Programme.

Research Method: Time series analysis was used to analyze the data obtained. A best fit model was found by using the Box Jenkin's approach to time series analysis. The fitted model was then used to forecast into the future.

Conclusion: Time series and forecasting has been used to model and forecast the enrolment of pupils of schools which were currently enrolled on the Ghana School Feeding Programme with Asem Cluster of Schools as a case study. The forecasted number of pupils who will be enrolled were obtained by using ARIMA (3, 1,3) model.

17 **Keywords:** Autocorrelation Function(ACF), Partial Autocorrelation Function (PACF), Autoregressive(AR), Mean Average (MA),
18 Autoregressive Integrated Mean Average(ARIMA), Akaike's Information Criteria(AIC), Schwarz's Bayesian Information Criteria (BIC)

19 1. INTRODUCTION

20 A **time series** is an ordered sequence of values of a variable at equally spaced time intervals. A time series may be measured continuously or
21 discretely. At the UN Millennium Summit in 2000, world leaders from countries all over the world committed themselves with respect to eight
22 goals to end extreme poverty worldwide by the year 2015. The set of eight time-bound targets are set at the highest political level. The first goal
23 is to "Eradicate extreme poverty and hunger", it aims to halve the proportion of people who suffer from poverty and hunger between the years
24 1990 and 2015. This goal has three targets.

- 25 1. Reduce by half the proportion of people living on less than one dollar a day;
- 26 2. Achieve full and productive employment and decent work for all, including women and young people;
- 27 3. Reduce by half the proportion of people who suffer from hunger (UNHTF, 2003).

28 The United Nations Hunger Task Force (UNHTF) recommended seven strategies to achieve the first millennium development goal (MDG). One
29 of the strategies, identified by the UNHTF, which could assist in achieving this goal, is school feeding programmes (SFPs) using locally
30 produced foods rather than imported food (aid). The UNHTF considers SFPs as a good linking of the education and agriculture sectors. Their
31 point of view is that by implementing SFPs, school attendance, especially of girls, could increase. It is also anticipated that the implementation
32 of SFPs could stimulate the local market demand for locally grown and produced foods (UNHTF, 2005).

33 An intervention by the Ghana government in the basic schools brought about the school feeding programme in 2003 (pilot bases) which was
34 extended to other parts of the country.

35 The programme started in 2005 providing lunch in over 1,000 schools (according to Wordpress.com), with the aim of reaching over 2900
36 schools and 1,040,000 students by the end of 2010 to contribute to poverty reduction, increase food security and enhancing enrolment in schools
37 in Ghana.

38 A new target was made to cater for the feeding of 4,500 schools- a minimum of two schools in a district and 1,113,928 pupils in April 2012.
39 Honorably, the target was reached by the feeding programme and benefited by over 1,567,839 pupils as at 20th September last year.

40

41 **2. METHODOLOGY**

42 The Box-Jenkins (ARIMA) method differences the series to stationarity and then combines the moving average with autoregressive parameters
43 to yield a comprehensive model amendable to forecasting. This method for analyzing stationary univariate time series data was developed by,
44 George E. P. Box and Gwilym M. Jenkins in 1972. The model developed serves not only to explain the underlying process generating the series,
45 but also as a basis for forecasting.

46 The univariate version of this methodology is a self- projecting time series forecasting method. The underlying goal is to find an appropriate
47 formula so that the residuals are as small as possible and exhibit no pattern. The model- building process involves a few steps, repeated as
48 necessary, to end up with a specific formula that replicates the patterns in the series as closely as possible and also produces accurate forecasts.

49 Time series is used for two main purposes,

50 i. Obtain an understanding of the underlying forces and structure that produced the observed data.

51 ii. Fit a model and proceed to forecasting, monitoring, or even feedback and feed-forward.

52

53

54 **3. LIMITATIONS**

55 i. The duration spanned the time from when the scheme was introduced to the stated date (2005-2012).

56 ii. The scope of research was limited to the Asem cluster of schools.

57 iii. No questionnaires were issued.

58

59 **4. DATA ANALYSIS.**

60 In this section, we will be looking at the information that can be derived from the data collected and draw inferences based on these information.
 61 This should enable us to come out with more emphatic conclusions and also to provide some recommendations. The data obtained for analysis
 62 were secondary termly time series data. The data were the termly enrolment figures for each basic school class of the Asem Cluster of Schools.
 63 The data ranges from September 2005 to September 2012 (See Table 1).

64

65

66 **TABLE 1**

BASIC	TERMS	2005	2006	2007	2008	2009	2010	2011	2012
1	1	184	142	167	235	177	230	197	185
	2	187	146	167	251	176	226	202	187
	3	186	145	167	250	176	226	201	186
2	1	165	204	166	246	230	221	215	256
	2	171	202	172	242	223	224	223	248
	3	169	201	172	241	222	224	223	248
3	1	173	158	178	280	240	235	267	253
	2	173	160	183	287	235	241	265	245

	3	170	157	182	285	237	241	263	245
4	1	198	190	207	277	215	241	240	268
	2	197	192	204	280	221	243	244	260
	3	196	188	201	280	220	242	242	260
5	1	187	222	218	246	212	260	253	265
	2	183	217	214	252	207	262	255	252
	3	184	217	212	252	207	262	253	251
6	1	174	213	222	281	244	273	254	250
	2	181	214	226	284	240	268	254	268
	3	179	213	223	284	240	268	254	257

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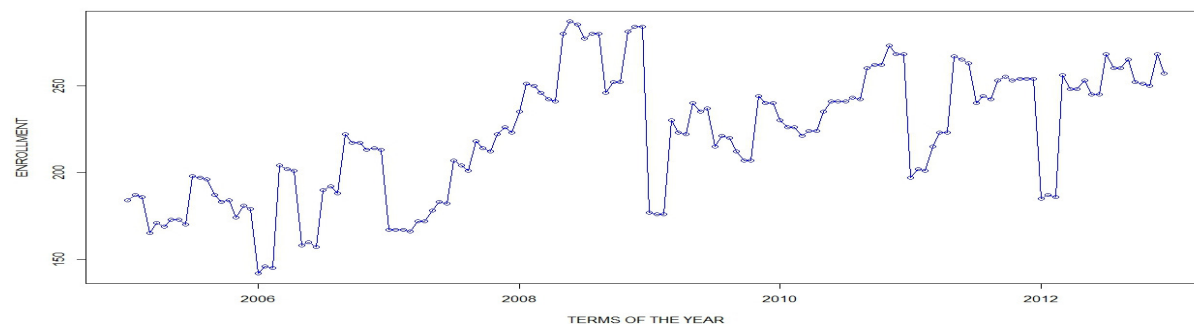
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A time series plot of enrolment figures

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75 **Figure 1** Termly time series plot of enrolment figure for each basic school class from 2005 to 2012

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77 Figure 1 shows the termly time series plot of enrolment figure for each basic school class from 2005 to 2012.

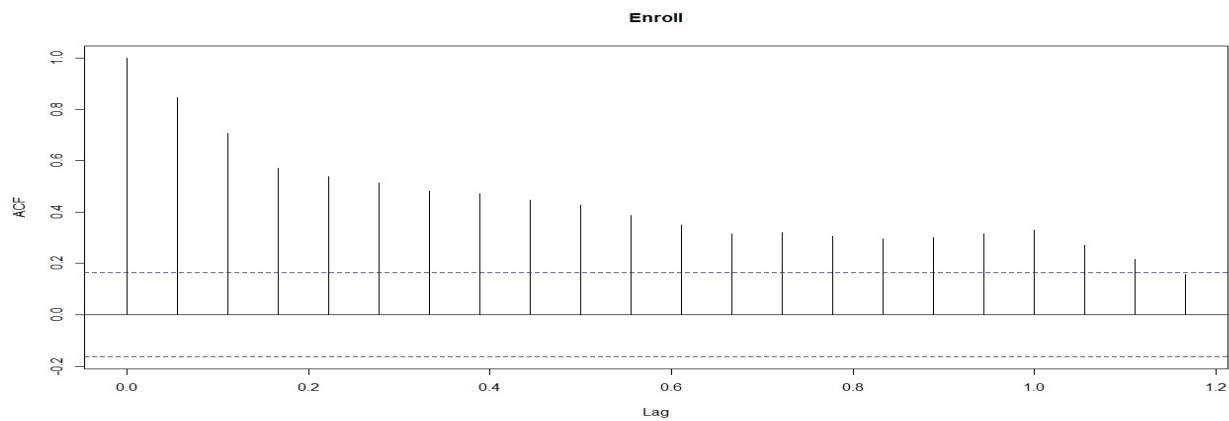
78 The enrolment plot fluctuates throughout the period. A careful observation of the enrolment plot from 2005 to 2012 indicates that there was an
 79 increase in enrolment.

80 From 2005, there was a gradual increase in enrolment till 2006 when there was a sharp decline. In the latter part of 2008, there was a peak
 81 increase in enrolment but there was a sharp decrease in 2009. The plot is non-stationary due to the trend component present.

82 **4.1.1 Autocorrelation Function of enrolment**

83 The Correlogram, shown in Figure 2, describes the correlation between the enrolments in different years as a function of time. The
 84 autocorrelation function is decreasing gradually and that means there is a trend in the enrolment figures.

85 Correlogram of enrolment



86
 87 **Figure 2** Describes the correlation between the enrolments in different years as a function of time

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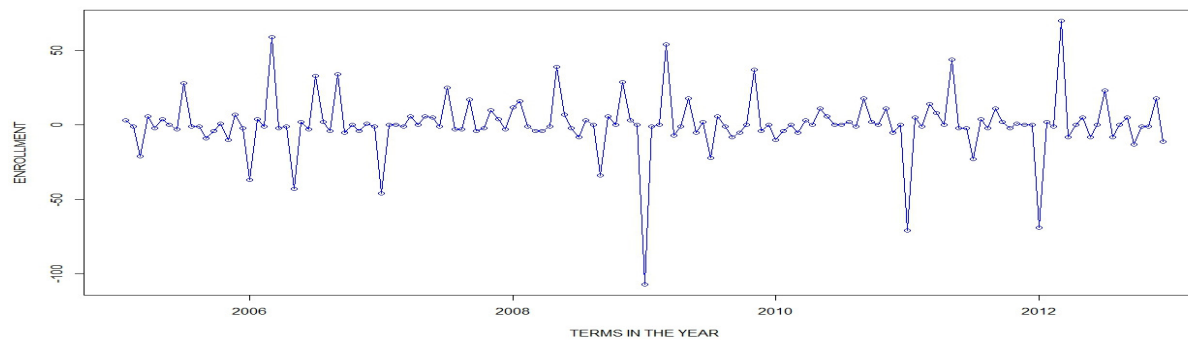
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90 4.1.2 Identification of a Suitable Model:

91 In order to attain stationarity, there is a need to remove the trend in the data. In order to attain stationarity there is a need to de-trend the data.

92 Figure 4.3 shows the plot of the first difference.

93 **Plot of First Difference**



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95 **Figure 3** Shows the plot of the first difference

96

97 After first differencing, we saw that the observations revert to the mean value as shown in figure 3. Due to this it was unnecessary to make a

98 second transformation to produce a new series that is compatible with the assumptions of stationarity. Thus the observations in the plot of first

99 difference move irregularly but revert to their mean value with an approximately constant variability. Thus, from the figure 3 there is
100 stationarity. Therefore, the rest of our analysis is based on our first differencing.

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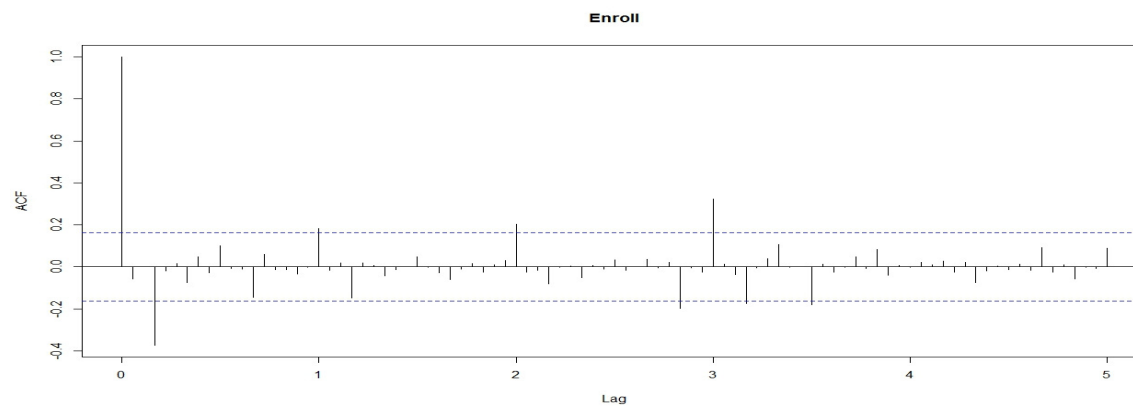
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105 **ACF and PACF of first difference**

106 **(ACF PLOT AFTER DIFFERENCING)**



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108 **Figure 4** Shows the ACF plot after differencing

109 From the ACF plot in Fig. 4, it is observed that the spikes cut off after lag 3. It suggests an $MA(3)$ model

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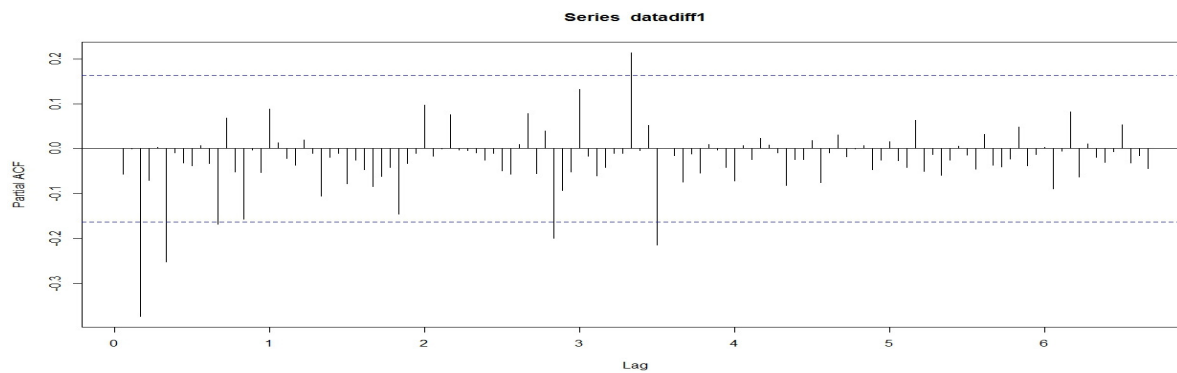
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116 **(PACF PLOT AFTER DIFFERENCING)**



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118 **Figure 5** PACF plot after differencing

119 From the PACF plot in Fig. 5, it is observed that the spikes cut off after lag 3. It suggests an $AR(3)$ model.

120 Under inspection therefore, the following models are suggested

121 • $ARIMA(3,1,3)$

122 • $ARIMA(2,1,3)$

123 • $ARIMA(3,1,2)$

124 4. 1. 3 Model Specification

- 125 • The model specification is based on the parameter estimates, the corresponding diagnostics of the residuals, the AIC , BIC and AIC_C .

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127

128

129

130 Table 2

131 Statistics of ARIMA Models

MODEL	AIC	AICc	BIC
ARIMA(3,1,3)	6.774117	6.79550	5.919035
ARIMA(2,1,3)	6.801881	6.821669	5.926197
ARIMA(3,1,2)	6.868618	6.888405	5.992933

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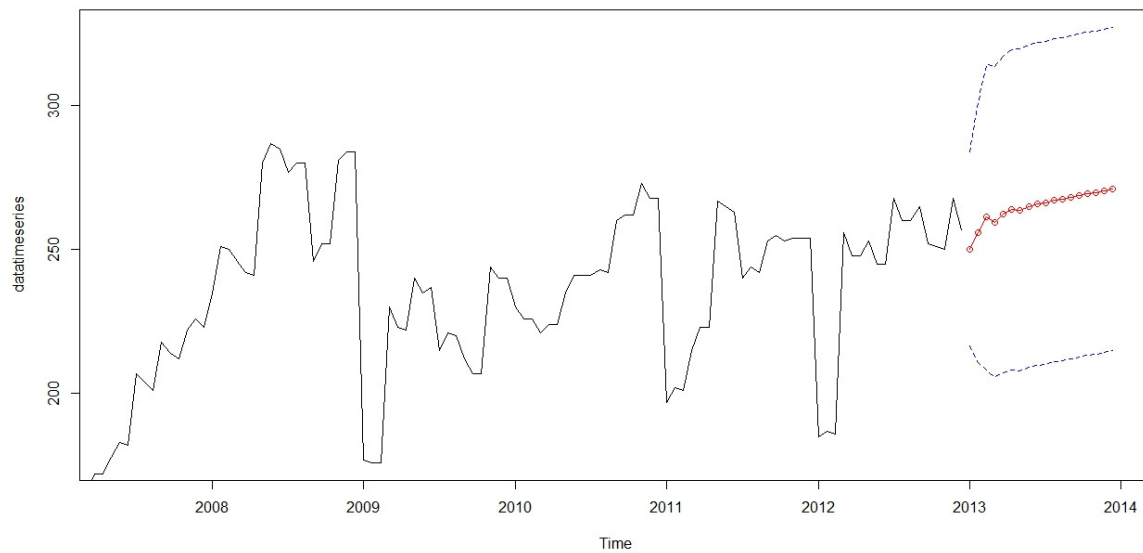
134 **4. 1.4 Model Selection**

135 The standardized residual plots of all the models have constant mean and few outliers. There is significance in the autocorrelation functions of
136 the residuals of all the models. The residuals appear to be normally distributed in all the models.

137 The ARIMA (3, 1, 3) model is chosen as the best model for forecasting since it has minimum AIC_c and AIC values.

138 **5. Forecasting**

139 Based on the observed data, we make predictions for the next year, 2013. The graph below (Figure 6) shows the prediction points and the
140 confidence interval of the forecasts.



141

142 **Figure 6** Shows the prediction points and the confidence interval of the forecasts

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144

145 **Forecast for the 2012/2013 academic year**

146 **TABLE 3**

UNDER PEER REVIEW

BASIC	TERMS	FORECAST
1	1	250
	2	256
	3	261
2	1	260
	2	262
	3	264
3	1	264
	2	265
	3	266
4	1	266
	2	267
	3	268
5	1	268
	2	269
	3	269
6	1	270

	2	271
	3	271

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149 **6. CONCLUSION**

150 The analyses based on Table 3 culminated in:

- 151 1. Clear understanding of the underlying forces and structure that produced the observed data, so as to explain the variations in the data.
- 152 2. Testing several time series models to find the best fit model and
- 153 3. Using the fitted model to forecast into the future.

154 **7. RECOMMENDATION:**

155 The following recommendations were made after careful analyses of the data

- 156 ➤ The school feeding programme should be continued. Based on the analysis, enrolment for basic schools has risen over the seven year
- 157 period.

- The teachers must be involved in the process of feeding the pupils, from the purchase of foodstuffs through food preparations to food services. This is because they are directly responsible for the nutritional needs of the pupils during classes hours.
- The food on the School Feeding menu should be examined to make the food more nutritious for the mental advancements of the pupils.

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