

Research paper

ON TIME SERIES ANALYSIS A MATHEMATICAL MODELING OF THE SCHOOL FEEDING PROGRAMME:

CASE STUDY OF IN THE ASEM – KUMASI CLUSTER OF SCHOOLS IN ASHANTI REGION OF GHANA

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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: in the Ashanti region of Ghana, 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. The AIC for the best selected model was calculated as 1236.17. The study concluded that the school feeding in the region should be continued to attract more pupils.

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

1-1.0 INTRODUCTION

~~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 discretely.~~ According to the United Nations World Food Programme, 66 million primary school age children go hungry every day, with 23 million hungry children in Africa alone (World Food Programme, 2009). Furthermore, 80% of these 66 million children are concentrated within just 20 countries. Additionally, 75 million school-age children (55% of them girls) do not attend school, with 47% of them living in sub-Saharan. Thus, the need to reduce hunger while increasing school enrollment in these children is evident, and school feeding programs have been developed to target this multifaceted problem (World Bank, 2013).

At the UN Millennium Summit in 2000, world leaders from countries all over the world committed themselves with respect to eight 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 is to "Eradicate extreme poverty and hunger", it aims to halve the proportion of people who suffer from poverty and hunger between the years 1990 and 2015. This goal has three ~~targets~~ targets. Reduce by half the proportion of people living on less than one dollar a day, achieve full and productive employment and decent work for all, including women and young people and reduce by half the proportion of people who suffer from hunger (UNHTF, 2003).

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

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

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anticipated that the implementation of SFPs could stimulate the local market demand for locally grown and produced foods (UNHTF, 2005).

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According to Wordpress.com (2010), an intervention by the Ghana government in the basic schools brought about the school feeding programme in 2003 (pilot bases) which was extended to other parts of the country.

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

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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. Honorably, the target was reached by the feeding programme and benefited by over 1,567,839 pupils as at 20th September last year.

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Global Development (2013) stated that proper nutrition is vital to ensuring pupils are able to concentrate. A report by the UN's World Food Programme looks at how school feeding programmes are helping support some of the world's most vulnerable families and children.

According to World Bank (2012), School feeding programme is defined as "targeted social safety nets that provide both educational and health benefits to the most vulnerable children, thereby increasing enrollment rates, reducing absenteeism, and improving food security at the household level." Beyond improvements in access to food, school feeding programmes also have a positive impact on nutritional status, gender equity, and educational status, each of which contributes to improving overall levels of country and human development.

From Wikipedia (2013), the Ghana School Feeding Programme (GSFP) is a pilot project to provide food to children at school. It is run by the GSFP Secretariat partnered by international agencies like the World Bank, the World Food Programme and UNICEF, as well as national organizations including Canadian International Development Agency (CIDA), the US Agency for International Development (USAID)) and the Dutch embassy. In 2009 it was announced the programme would be shifted from pilot to mainstream status, and that within two years the programme would be extended from primary to junior high school level, one reason being that some students were reluctant to move on to JHS because they would no longer be fed at school.

1.1 Objectives of the Paper

The objectives of this paper are:

1. to observe the pattern of school pupils enrolment of Asem cluster of schools in the Ashanti Region of Ghana from 2005 to 2012.
2. to model the school pupils enrolment of Asem cluster of schools in the Ashanti Region of Ghana.
3. to forecast the selected model to check whether the school pupils enrolment in the region will be increased or not.

1.2 Significance of the Reported Research

The significance of the contribution in this paper can be summarized as follows:

- i. This paper provides a method for assessing the effectiveness of school feeding programme.
- ii. This paper contributes to the research information on school feeding programme in the country, so that it can help in further work in the area of research to investigate the effects of the programme on Ghanaians.
- iii. The paper attempts to present both application and theory at a level accessible to a wide variety of students, practitioners and researchers.

1.3 Problem Statement

While school feeding programs have a variety of positive impacts, there are some possible negative impacts these programs can cause. For example, school feeding programs can increase the cost of schooling by requiring that communities provide fire-wood for cooking as well as other items such as fresh-fruit, vegetables, and condiments. Additionally, communities are also expected to provide people who can cook these meals and maintain stores of all of the required food products, as well as kitchens and other fundamentals of meal provision. By causing a variety of needs and requirements to increase in a given community, the net benefit to a community from school feeding programs may be reduced (Masset et al., 2013).

School feeding programs are very context-specific, and each community's program has to be altered based on the demographics, geography, and other patterns within and outside of schools. For this reason, there are a variety of challenges that emerge in the creation and implementation of school feeding programs. In order to have a successful program, countries must determine if school feeding is the most effective program that can be offered to target the countries' neediest children, define program goals and outcomes, select the type of food that will be served in a school, determine a method of procurement for the food,

plans for management, implementation, and monitoring within schools, and plan for a variety of other concerns (World Bank, 2012).

Because school feeding programs are community-specific and require a great deal of planning, the sustainability of school feeding programs is a main point of concern for many countries. Countries are very limited on the demands placed on the staff, resources, and infrastructure required for school-feeding programs, and often have to rely on outside financial and personnel help to continue programs for a significant amount of time (World Bank, 2012).

1.4 Limitations of the Paper

- i. The duration spanned the time from when the scheme was introduced to the stated date (2005 - 2012).
- ii. The scope of research was limited to the Asem cluster of schools in the Ashanti Region of Ghana.
- iii. No questionnaires were issued.

From the study of the open literature no research work has been so far reported on the model of school feeding in the Ashanti Region of Ghana. This paper therefore seeks to fill the research gap by studying the effectiveness of school feeding programme in the Ashanti Region of Ghana using time series analysis.

The remaining part of this paper is organized as follows. Section 1.5 surveys the research work relating to the subject of the paper. Section 2 discusses the data used, how they were obtained as well as the methods applied on them to obtain the needed results. Section 3 deals with data analysis, modeling and forecasting. Section 4 contains the summary and findings, conclusions and the recommendations of the paper.

2. METHODOLOGY

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 discretely. Time series is used for two main purposes.

- i. Obtain an understanding of the underlying forces and structure that produced the observed data.
- ii.i. Fit a model and proceed to forecasting, monitoring, or even feedback and feed-forward.

The Box-Jenkins (ARIMA) (Box *et al.*, 1994) method differences the series to stationarity and then combines the moving average with autoregressive parameters to yield a comprehensive model amendable

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to forecasting. This method for analyzing stationary univariate time series data was developed by, George E. P. Box and Gwilym M. Jenkins in 1972. The model developed serves not only to explain the underlying process generating the series, but also as a basis for forecasting.

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

~~Time series is used for two main purposes;~~

~~iii.i. Obtain an understanding of the underlying forces and structure that produced the observed data;~~

~~iv.i. Fit a model and proceed to forecasting, monitoring, or even feedback and feed-forward.~~

3. LIMITATIONS

- ~~i. The duration spanned the time from when the scheme was introduced to the stated date (2005-2012).~~
- ~~ii. The scope of research was limited to the Asem cluster of schools.~~
- ~~iii. No questionnaires were issued.~~

4.The basis of the Box-Jenkins approach to modeling time series is summarized below and consists of three phases: identification, estimation and testing, and application (Spyros et al., 1998).

2.1 Identification Stage

Transform data to stabilize variance.

2.1-1 Difference data to obtain stationary series:

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For non-seasonal data, first differencing is usually sufficient to attain stationarity. The first-order difference is denoted by equation (1).

$$\nabla Y_t = Y_t - Y_{t-1} \quad (1)$$

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2.1-2 Model selection:

Examine data, Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF) to identify potential models. The autocorrelation function (ACF), $\rho_{t,s}$, is given by the formula in equation (2)

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$$\rho_{t,s} = \text{Corr}(Y_t, Y_s) = \frac{\text{Cov}(Y_t, Y_s)}{\sqrt{\text{Var}(Y_t)\text{Var}(Y_s)}} \quad \forall t, s \in \{0, \pm 1, \pm 2, \pm 3, \dots\} \quad (2)$$

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$$\text{where } \text{Cov}(Y_t, Y_s) = E[(Y_t - \mu_t)(Y_s - \mu_s)] = E(Y_t, Y_s) - \mu_t \mu_s$$

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The autocorrelation coefficient estimated from sample observations at lag k is given by equation (3).

$$\gamma_k = \frac{\sum_{t=k+1}^n (Y_t - \bar{Y})(Y_{t-k} - \bar{Y})}{\sum_{t=1}^n (Y_t - \bar{Y})^2} \quad (\text{Spyros, 1998}) \quad (3)$$

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2.2 Testing Stage

2.2.1 Augmented Dickey-Fuller (ADF) Test

The hypotheses H_0 : Y_t is non-Stationary and H_1 : Y_t is Stationary can be tested in the regression equation (4).

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$$\Delta Y_t = \beta_0 + \alpha t + \beta_1 Y_{t-1} + \sum_{i=1}^p \gamma_i \Delta Y_{t-i} + \varepsilon_t \quad (4)$$

Accept H_0 if $P\text{-value} > 0.05$, else accept H_1 .

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2.2.2 Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test

An alternative approach to the ADF test is the KPSS test. A hypotheses of $H_0: Y_t$ is level or trend stationary is tested against $H_1: Y_t$ is non-stationary in the regression equation in (5).

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$Y_t = \alpha_t + \beta t + \mu_t$, where a random walk, $\alpha_t = \alpha_{t-1} + \varepsilon_t$ is allowed. (5)

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Accept H_0 if $P\text{-value} > 0.05$, else accept H_1 .

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2.3 Select best model using suitable criterion:

2.3.1 The Akaike's Information Criteria (AIC)

The AIC is equal to twice the number of parameters in the model minus twice the logarithm of the likelihood function. Mathematically, AIC is calculated by equation (6).

$AIC(p, q) = 2k - 2 \log(\text{Maximum Likelihood})$ (6)

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where $k = p + q + 1$ if the model contains an intercept or constant term and $k = p + q$ otherwise.

Given two or more competing models, the one with the smaller AIC value will be deemed more appropriate (Spyros et al., 1998).

2.3.2 The Schwartz's Bayesian Information Criteria (BIC)

Like the AIC, the BIC is an order selection criterion for ARIMA models. It is defined mathematically by equation (7).

$BIC(p, q) = k \times \log(n) - 2 \times \log(\text{Max. Likelihood})$ (7)

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2.4 Diagnostics

2.4.1 Testing the Model for Adequacy (Portmanteau Test)

After identifying an appropriate model for a time series data, it is very important to check that the model is adequate. Ljung and Box (1978) provided a modified portmanteau test statistic for checking the randomness of the error terms. Their statistic is given by equation (8).

$$Q^* = n(n+2) \times \sum_{k=1}^h \left(\frac{r_k^2}{n-k} \right) \quad (8)$$

which is approximately distributed as a χ^2 with $h-p-q$ degrees of freedom, where n is the length of the time series, h is the first h autocorrelations being checked, p is the order of the AR process and q is the order of the MA process and r is the estimated autocorrelation coefficient of the k^{th} residual term. If the calculated value of Q^* is greater than χ^2 for $h-p-q$ degrees of freedom, then the model is considered inadequate and the model is adequate if Q^* calculated is less than χ^2 for $h-p-q$ degrees of freedom. If the model is tested inadequate, then the forecaster should select an alternative model and test for the adequacy of the model (Spyros et al., 1998).

3 DATA ANALYSIS: AND RESULTS

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. This should enable us to come out with more emphatic conclusions and also to provide some recommendations. The data obtained for analysis were secondary termly time series data. The data were the termly enrolment figures for each basic school class of the Asem Cluster of Schools. The data ranges from September 2005 to September 2012 (See Table 1).

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

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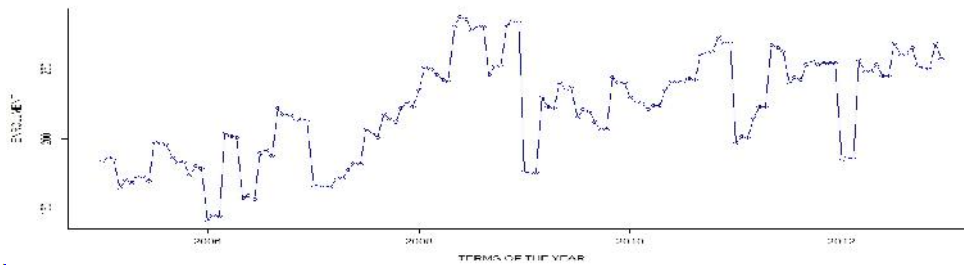
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3	3	169	201	172	241	222	224	223	248
	1	173	158	178	280	240	235	267	253
	2	173	160	183	287	235	241	265	245
4	3	170	157	182	285	237	241	263	245
	1	198	190	207	277	215	241	240	268
	2	197	192	204	280	221	243	244	260
5	3	196	188	201	280	220	242	242	260
	1	187	222	218	246	212	260	253	265
	2	183	217	214	252	207	262	255	252
6	3	184	217	212	252	207	262	253	251
	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

A time-series plot of enrolment figures



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

[This section deals with data analysis, modeling and forecasting.](#)

3.1 Time Plot of Termly Enrolment Figure for Each Basic School Class in the Ashanti Region

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

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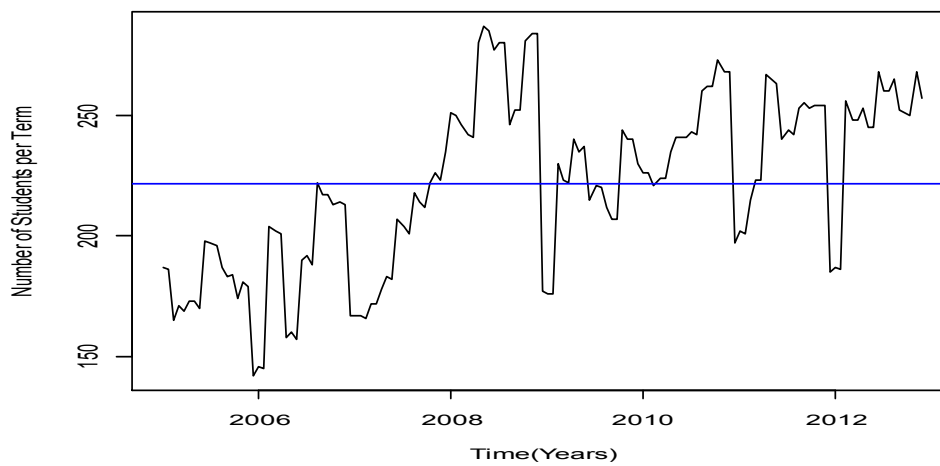


Figure 1: Termly time series plot of enrolment figure for each basic school class from 2005 to 2012

The enrolment plot fluctuates throughout the period as shown in Figure 1. A careful observation of the enrolment plot from 2005 to 2012 indicates that there was an increase in enrolment.

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From the year 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 increase in The enrolment increased again from 2007 to 2009, but there was a sharp decrease in 2009. The plot is non-stationary due to the trend component present.

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4.1.1 Autocorrelation Function of enrolment

In general, the trend in school enrolment in the Ashanti Region of Ghana seems to be irregular. The annual time plot in Figure 1 does not exhibit seasonal variation. The mean line is indicated blue. Most of the data points are a little bit far apart from the mean. This indicates that there is a clear case of non-stationarity in the mean.

3.1.1 Checking for Stationarity Using the autocorrelation function (ACF) and partial autocorrelation function (PACF)

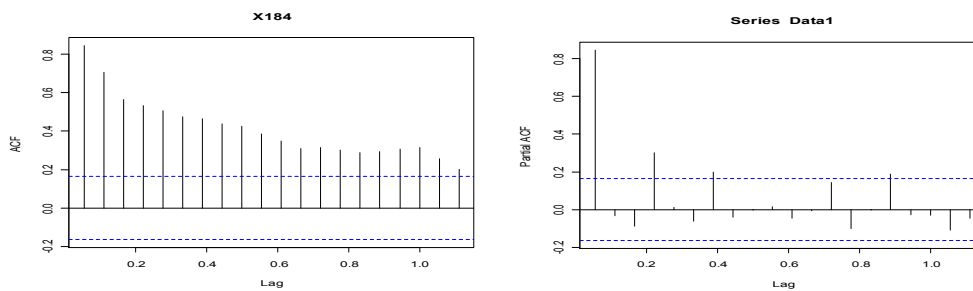


Fig. 2 (i)

Fig. 2 (ii)

Figure 2: The Autocorrelation Function and Partial Auto-Correlation Function of school enrolment

The Correlogram, shown in Figure 2- (i), describes the correlation between the enrolments in different years as a function of time. The autocorrelation function is decreasing gradually and that means there is a trend in the enrolment figures. Figure 2 (ii) exhibits the partial autocorrelation function (PACF) of the enrolment data. At lag zero the PACF is almost unity (1) which confirms that the enrolment time series is non-stationary.

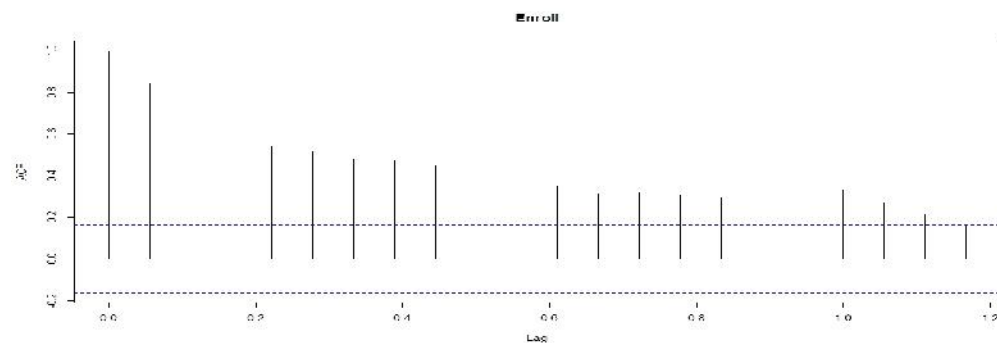
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Correlogram of enrolment



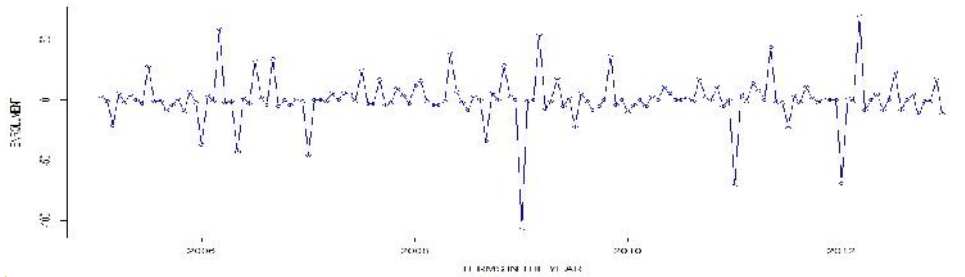
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Figure 2 Describes the correlation between the enrolments in different years as a function of time

4.1.2 Identification of a Suitable Model:

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. Figure 4.3 shows the plot of the first difference.

Plot of First Difference



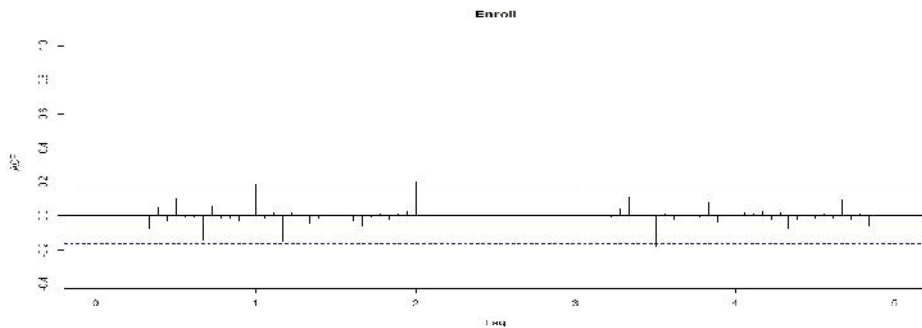
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Figure 3 Shows the plot of the first difference

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 second transformation to produce a new series that is compatible with the assumptions of stationarity. Thus the observations in the plot of first difference move irregularly but revert to their mean value with an approximately constant variability. Thus, from the figure 3 there is stationarity. Therefore, the rest of our analysis is based on our first differencing.

ACF and PACF of first difference

(ACF PLOT AFTER DIFFERENCING) _____

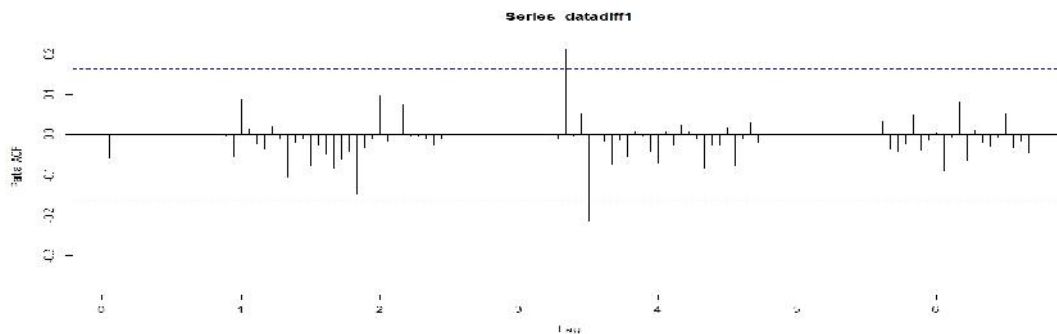


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Figure 4 Shows the ACF plot after differencing

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

(PACF PLOT AFTER DIFFERENCING)



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Figure 5 PACF plot after differencing

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

Under inspection therefore, the following models are suggested

- $ARIMA(3,1,3)$
- $ARIMA(2,1,3)$
- $ARIMA(3,1,2)$

4.1.3 Model Specification

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

Table 2

Statistics of ARIMA Models

Table 1: Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Tests

MODEL	Augmented	AIC	AICe	BIC
<u>Dickey-Fuller (ADF) Test</u>				
Dickey-Fuller		Lag Order		P-Value
		6.774117	6.795	5.919035
ARIMA(3,1,3)	-3.4155	5	50	0.05482
ARIMA(2,1,3)		6.801881	6.821669	5.92
<u>Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test</u>				
KPSS Level		Lag Parameter		P-Value
		6.868	6.888405	5.99293
ARIMA(3,1,2)	4.357	618	2	3
				0.01

4.1.4 Model Selection

From Table 1 the p-value for ADF test was greater than 0.05 and that of KPSS was less than 0.05 using a 5% significant level. The two tests confirmed that there was non-stationarity in the original school enrolment data which needs to be differenced to achieve mean stationarity.

3.2 First-Order Differencing of Termly Enrolment Figure for each Basic School Class in the Ashanti

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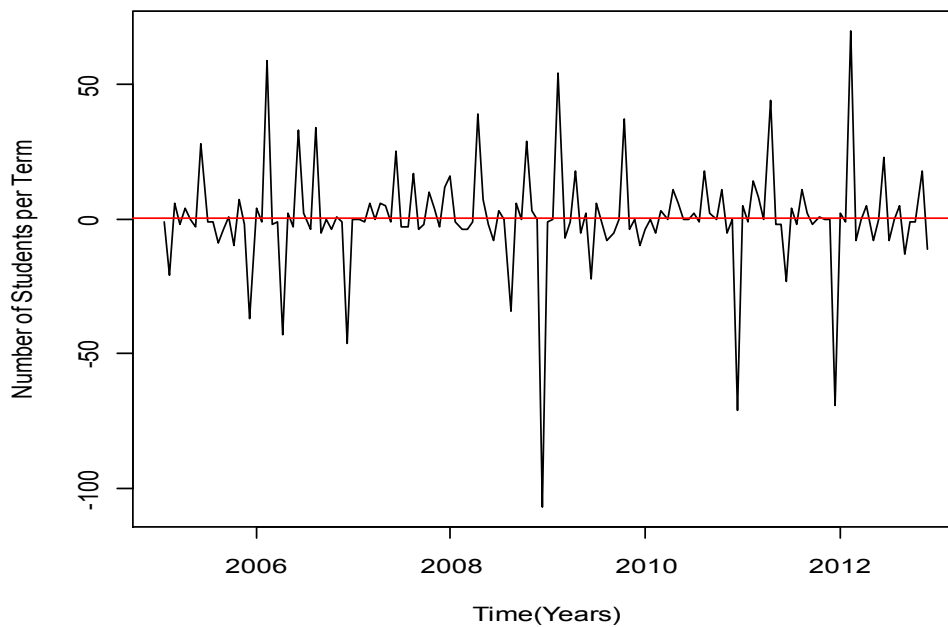


Figure 3: *First-Order Differencing of Termly Enrolment Figure for each Basic School Class in the Ashanti Region of Ghana*

After first differencing, we saw that the observations revert to the mean value as shown in Figure 3. The red line here depicts the mean. Thus the observations in the plot of first differencing move irregularly but revert to their mean value with an approximately constant variability. It follows from Figure 3 that there is stationarity. In general terms, there was no seasonal behavior in the time plot, and the school enrolment data now looks to be approximately stable for further investigations.

3.2.1 Objective Test for Stationarity for the First-Order Differenced Series

From Table 2, the p-value for ADF test was less than 0.05 and that of KPSS was greater than 0.05. It follows that the school enrolment data now looks to be approximately stationary in the mean for further investigations.

Table 2: Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Tests

Augmented Dickey-Fuller (ADF) Test			
Dickey-Fuller	Lag Order	P-Value	
-7.3238	5	0.01	.

Kwiatkowski-Phillips-Schmidt-Shin (KPSS) Test			
KPSS Level	Lag Parameter	P-Value	
0.0151	2	0.1	.

3.3 Selecting Competing Models Using ACF and PACF of the First-Order Differencing of School

Enrolment

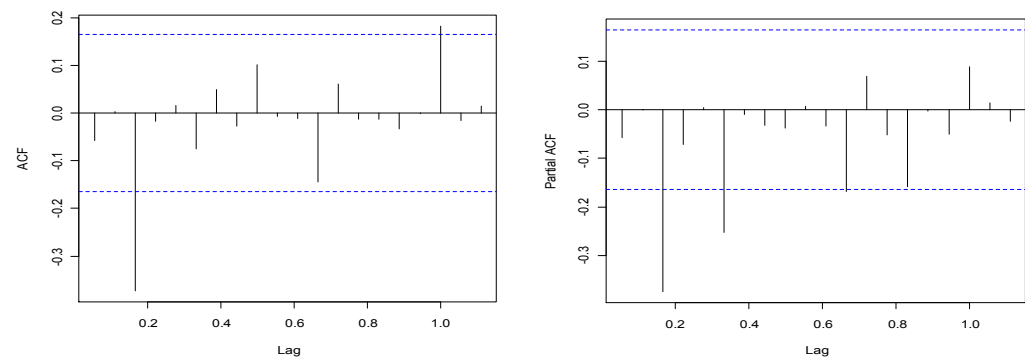


Fig. 4 (i)

Fig. 4 (ii)

Figure 4: ACF and PACF of first-order differencing of school enrolment in the Ashanti Region of Ghana

From Figure 4 (i), the PACF was tailing off and the ACF was cutting off at spikes 3 suggested an MA (3) model. Figure 4 (ii) shows the sample Partial Auto-Correlation Function (PACF) of the first order differencing of the school feeding programme in the Ashanti Region of Ghana at different lags. The ACF was tailing off and the PACF was cutting off at spikes 3 and 6 suggested an AR (3) model or AR (6) model.

As a preliminary analysis, we will fit both models. It follows that, in both the ACF and the PACF of the first order differencing of the enrolment data, the following models were suggested:

ARIMA (0, 1, 3),

ARIMA (3, 1, 0) and

ARIMA (3, 1, 3)

3.4 Estimation of Tentative Models

3.4.1 Parameter estimate and diagnostics of ARIMA (0, 1, 3) model

Table 3: Parameter estimate for ARIMA (0, 1, 3) with non-zero mean.

Coefficient	Estimate	Standard Error	/t-value/
ma1	-1.109	0.1317	8.4207
ma2	0.0342	0.0956	0.3577
ma3	0.0748	0.1337	0.5595
AIC	AICc	BIC	Constant
1252.44	1252.88	1267.18	0.0033

The coefficients of the estimated MA (3) parameters were not within the invertibility condition bounds since the absolute t-values of ma2 and ma3 were less than 2 as shown in Table 3. From Table 3, the estimated model for ARMA (0, 3) was given by equation (9):

$$Y_t = -1.109\omega_{t-1} + 0.0342\omega_{t-2} + 0.0748\omega_{t-3} + 0.0033 + \omega_t \quad (9)$$

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Table 4: Box-Ljung test of ARIMA (0, 1, 3) with non- zero mean

Box - Ljung Test		
X Squared	d f	p-value
33.2067	20	0.0320

Results from Table 4 showed that the model's residuals were significant with Ljung Box test statistic of 33.2067 and a p-value of 0.0320. Hence the model was not adequate for forecasting since its p-value was less than 0.05.

3.4.2 Parameter estimate and diagnostics of ARIMA (3, 1, 0) model

Table 5: Parameter estimate for ARIMA (3, 1, 0) with non-zero mean.

Coefficient	Estimate	Standard Error	/t-value/
ar1	-0.6174	0.0773	7.9871
ar2	-0.3224	0.0891	4.3569
ar3	-0.3882	0.0770	5.0416

AIC	AICc	BIC	Constant
1282.96	1283.40	1297.70	0.0006

The coefficients of the estimated AR(3) parameters were within the causality condition bounds since the absolute t-values were all greater than 2 as shown in Table 5. The estimated model for ARMA (3) was given by equation (10):

$$Y_t = -0.6174Y_{t-1} - 0.3224Y_{t-2} - 0.3882Y_{t-3} + 0.0006 + e_t \quad (10)$$

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Table 6: Box-Ljung test of ARIMA (2, 1, 0) with non- zero mean

Box - Ljung Test		
------------------	--	--

<u>X Squared</u>	<u>_d f</u>	<u>p-value</u>
<u>35.8667</u>	<u>20</u>	<u>0.0160</u>

Results from Table 6 shows that the model's residuals were significant with Ljung Box test statistic of 35.8667 and a p-value of 0.0160. Hence the model was not adequate for forecasting since its p-value was less than 0.05.

3.4.3 Parameter estimates and diagnostics of ARIMA (3, 1, 3) model

Table 7: Parameter estimate for ARIMA (3, 1, 3) with non-zero mean

<u>Coefficient</u>	<u>Estimate</u>	<u>Standard Error</u>	<u>/t-value/</u>
<u>ar1</u>	<u>0.2564</u>	<u>0.1857</u>	<u>1.3807</u>
<u>ar2</u>	<u>0.2071</u>	<u>0.1835</u>	<u>1.1286</u>
<u>ar3</u>	<u>-0.3343</u>	<u>0.0904</u>	<u>3.6637</u>
<u>ma1</u>	<u>-1.3812</u>	<u>0.2012</u>	<u>6.8648</u>
<u>ma2</u>	<u>0.1479</u>	<u>0.2848</u>	<u>0.5193</u>
<u>ma3</u>	<u>0.2333</u>	<u>0.1900</u>	<u>1.2280</u>
<u>AIC</u>	<u>AICc</u>	<u>BIC</u>	<u>Constant</u>
<u>1236.17</u>	<u>1237.26</u>	<u>1259.76</u>	<u>0.0023</u>

The coefficient of the estimated ARMA (3, 3) parameters was not within the causality condition bounds as shown in Table 7. The estimated ARMA (3, 3) model was given by equation (11).

$$Y_t = 0.2564 Y_{t-1} + 0.2071 Y_{t-2} - 0.3343 Y_{t-3} - 1.3812 \omega_{t-1} + 0.1479 \omega_{t-2} + 0.2333 \omega_{t-3} + 0.0023 \quad (11)$$

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Table 8: Box-Ljung test and Forecasts from ARIMA (3, 1, 3) with non- zero mean

<u>Box - Ljung Test</u>		
<u>X Squared</u>	<u>d f</u>	<u>p-value</u>
<u>17.6008</u>	<u>20</u>	<u>0.6137</u>

Results from Table 8 showed that the model's residuals were non-significant with Ljung Box test statistic of 17.6008 and a p-value of 0.6137. Hence the model was adequate for forecasting since its p-value was greater than 0.05.

3.5 Model Selection and Forecasting Using AIC and p-value of Box-Ljung test

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

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

5. Forecasting

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

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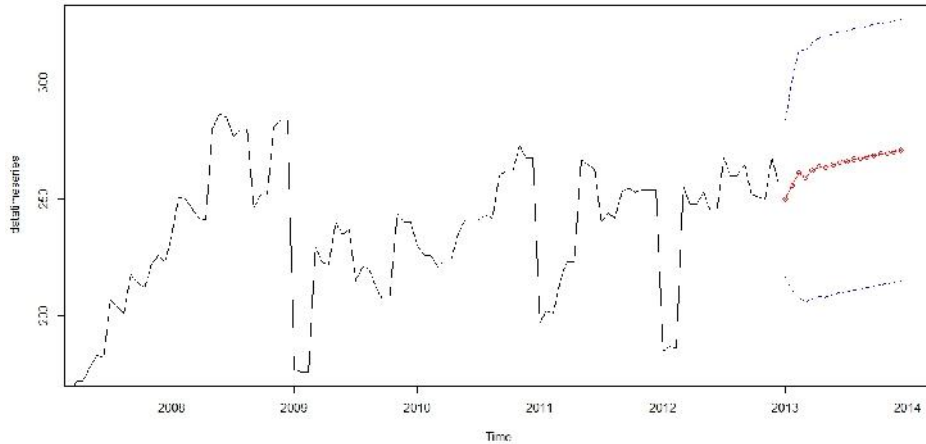


Figure 6 Shows the prediction points and the confidence interval of the forecasts

Forecast for the 2012/2013 academic year

TABLE 3

Table 9: Statistics of ARIMA Models

BASIC	TERMSModel	FORECASTAIC	AICc	BIC	P-Value
1	ARIMA(3,1,0)	2501282.96	1283.40	1297.70	0.0160
		2		256	
	ARIMA(0,1,3)	2611252.44	1252.88	1267.18	0.0320
2	1			260	
	2			262	
	3			264	

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3	ARIMA(3,1,3)	2641236.17	1237.26	1259.76	0.6137
4	2			265	
	3			266	
	1			266	
5	2			267	
	3			268	
	1			268	
6	2			269	
	3			269	
	1			270	
7	2			271	
	3			271	
	1			271	

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6. CONCLUSION

The analyses based on Table 3 culminated in:

Clear understanding of the underlying forces and structure that produced From Table 9 the ARIMA (3, 1, 3) model was chosen as the best model for forecasting since it had the minimum AIC_c and AIC values and also its p-value was greater than 0.5.

3.5-1 Forecasting From ARIMA (3, 1, 3)

1. Based on the observed data, so as to explain the variations in the data.
2. Testing several time series models to find predictions for the best fit model and

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3. Using next year, 2013 was made. Figure 5 showed the fitted model to forecast into the future prediction points and the confidence interval of the forecasts.

7.

The model was used to forecast one year ahead and showed that the school enrolment in the Ashanti Region of Ghana will be slightly increased from 2012 to 2013 as shown in the blue line of Figure 5 as well as Table 10, its forecast points.

Table 10: Forecast for the 2012/2013 academic year

<u>Basic</u>	<u>Terms</u>	<u>Forecast</u>
<u>1</u>	<u>1</u>	<u>250</u>
	<u>2</u>	<u>256</u>
	<u>3</u>	<u>261</u>
<u>2</u>	<u>1</u>	<u>260</u>
	<u>2</u>	<u>262</u>
	<u>3</u>	<u>264</u>
<u>3</u>	<u>1</u>	<u>264</u>
	<u>2</u>	<u>265</u>
	<u>3</u>	<u>266</u>
<u>4</u>	<u>1</u>	<u>266</u>
	<u>2</u>	<u>267</u>
	<u>3</u>	<u>268</u>

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<u>5</u>	<u>1</u>	<u>268</u>
	<u>2</u>	<u>269</u>
	<u>3</u>	<u>269</u>
<u>6</u>	<u>1</u>	<u>270</u>
	<u>2</u>	<u>271</u>
	<u>3</u>	<u>271</u>

From Figure 5, the yellow region depicts the 95% confidence interval, the red region is the 85% confidence interval and the blue line is the forecasting points.

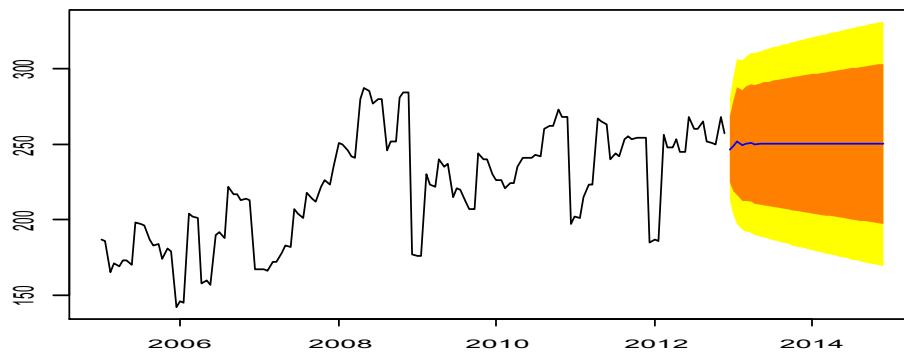


Figure 5: *Forecasts from ARIMA (3, 1, 3) with non-zero mean*

4.0 CONCLUSION, FINDINGS AND RECOMMENDATION

This section contains the conclusions, summary and findings and the recommendations of the paper.

4.1 Conclusion

Results from Table 9 showed that ARIMA (3, 1, 3) had the lowest AIC value of 1236.17. It was the best model so far as the AIC was concerned. It follows from our results that the required equation for the best selected model was

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$$Y_t = 0.2564 Y_{t-1} + 0.2071 Y_{t-2} - 0.3343 Y_{t-3} - 1.3812 \omega_{t-1} + 0.1479 \omega_{t-2} + 0.2333 \omega_{t-3} + 0.0023$$

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In conclusion, the research study reported in this monograph has found that school feeding data in the Ashanti Region of Ghana could best be modeled with ARIMA (3, 1, 3). The study again found out that the enrolment for basic schools in the Ashanti Region is expected to increase so the government should continue the feeding programme.

4.2 Findings:

Results from this paper shows that continuous use of feeding programme is having a significant impact on the rate of school enrolment in the Ashanti region of Ghana.

From definitions, the school enrolment data in the Ashanti Region of Ghana from 2005 to 2012 depicts a *Stochastic Time Series* and its model is *linear*.

The results also showed from Table 9 that the higher the AIC the smaller its p-value of Box-Ljung test and the smaller the AIC the bigger its p-value of Box-Ljung test.

4.3 Recommendations:

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

➤ The school feeding programme should be continued. Based on the analysis, enrolment for basic schools has risen over the seven year 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~~class hours.

➤ The food on the School Feeding menu should be examined to make the food more nutritious for the mental ~~advancements of the pupils.~~ advancements of the pupils.

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