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Evaluation of plastic pipes production quantities with some selected traditional forecasting techniques using historical data

Aguh Patrick Sunday[1*], Umeh Maryrose Ngozi[2] and Mbeledogu Njideka N[3].

[1]Department of Industrial and Production Engineering, Nnamdi Azikiwe University, Awka, P.M.B 5025, Nigeria.
[2,3]Department of Computer Science, Nnamdi Azikiwe University, Awka, P. M. B 5025, Nigeria.

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ABSTRACT

This work focused on the use of forecasting methods to model and analyzes the production of pipe products in Finoplastika manufacturing industry. The literature revealed that no study has ever being revealed and other literatures have not intensively express about its prediction and forecasting of their production quantity. The case company has no specific method of foreseen the future productivity of the production output in the case company. This serves as the knowledge gap which the researcher tends to revealed. Data on production yield were collected from the industry covering a period of three years. The forecasting models developed were used to forecast the outputs of the future production of the products type investigated. From the results of the evaluation of the forecasting accuracy measure, it can be deduced that the production output for product 1(P1) is 12910.1 units, production output for product 2 (P2) is 4882.3 units, production output for product 3 (P3) is 9877.3 units and the production output for product 4 (P4) is 11013.5 units. The results show that the model with the list error is the most appropriate method to achieve the best forecasting result. The study concludes that the forecasting models are appropriate and it has predicted the appropriate results for the future productivity. These methods were also applied for other products for monthly yield of the product types investigated.

1. Introduction

Forecasting, also known as prediction, is the method of using statistical models to predict future outcomes. Forecasting is also defined as the use of historical data to determine the direction of future trends. Armstrong [1] observed that forecasting of product demand is the basis for most important planning decisions. Planning decisions regarding scheduling, inventory, production, facility layout and design, workforce, distribution, purchasing, etc, are functions of customer demand. Decisions made by top management are based on forecasts on product/ customer demands. Forecasting is the process of making statements about events whose actual outcomes (typically) have not yet been observed. A simple explanation might be estimation of some variables of interest at some specified future dates. Prediction is a similar word to estimation, but it is a more general term. Both might refer to formal statistical methods [2; 3]) employing time series, cross-sectional or longitudinal data, or alternatively to less formal judgmental methods. In any case, the data must be up to date in order for the forecast to be as accurate as possible. Over the years, the case study company has made substantial progress. They have a planned method of producing the actual quantity of the products. However, there is no formalized way of determining what quantity of different products to be produced over any given period of time. This leads to inconsistencies in planning and production. To avoid any of these problems during production, there is need to predict in advance the quantity of products produced, in other to support decision making regarding quantity of the plastic products necessary for their production every month.

1.1 Objective of the Study

The objectives of this study include:

i. The application of existing forecasting models to model the Finoplastika productions.
ii. The application of graphical modeling technique to model the time responses of production for future production planning.

Corresponding author: ps.aguh@unizik.edu.ng

Forecasts are vital to every business organization and for every significant management decision. Forecasting is essentially used in the following areas:

- The process of climate change and increasing energy prices has led to the use of Egain software tool in Forecasting energy consumption in buildings. The method uses forecasting to reduce the energy needed to heat the building, thus reducing the emission of greenhouse gases.
- Forecasting is also used in Customer Demand Planning in everyday business operations for most industries
- Forecasting has also been used to predict the development in conflict situations.

Experts in forecasting perform research that use empirical results to gauge the effectiveness of certain forecasting models. Research has shown that there is little difference between the accuracy of forecasts performed by experts knowledgeable in the conflict situation of interest and that performed by individuals who knew much less. Rowe and Wright [4] stated that experts' opinion is often necessary in forecasting tasks because of lack of appropriate or available information for using statistical procedures. They stated that the way to get the best forecast from experts is to use a structured group technique, such as Delphi, for eliciting and combining expert judgements. The discipline of demand planning, also sometimes referred to as supply chain forecasting, embraces both statistical forecasting and a consensus process. An important, albeit often ignored aspect of forecasting, is the relationship it holds with planning [3]. Forecasting can be described as predicting what the future will look like, whereas planning predicts [5] what the future should look like. There is no single right forecasting method to use. Selection of a method should be based on your objectives and your conditions (data etc). Forecasting has application in many situations: Forecasting can be used in supply chain management to make sure that the right product is at the right place at the right time. Accurate forecasting will help retailers reduce excess inventory and therefore increase profit margin. Studies have shown that extrapolations are the least accurate, while company earnings forecasts are the most reliable [6]. Accurate forecasting helps companies to meet consumer demand.

Gor [7] stated that forecasting is vital to every business organization and for every significant management decision. It enables management to change operations at the right time in order to reap the greatest benefit. It also helps the company prevent losses by making the proper decisions based on relevant information. Forecasting is also important when it comes to developing new products or new product lines. It helps management decide whether the product or product line will be successful. Forecasting prevents the company from spending time and money developing, manufacturing, and marketing a product that will fail. Stockholder expectations highlight another reason behind the importance of forecasting. Public companies will experience scrutiny and pressure for short-term performance from their investors. Operational results will be examined by investors and investment analysts, and actual results that differ from forecasts will be bad for the company and its stock price. This is because both (actual and prediction) not meeting predictions and exceeding predictions will reduce investor confidence. This will cause investors to believe that the company does not understand its own business model.

1.2 The Forecasting Model Development Process:

Armstrong [1] proposes a heuristic forecasting process. Guided by the five general steps of Armstrong's development Framework, analysts can produce more accurate and efficient forecasts. These steps are graphically depicted in Figure 1 and include formulating the problem, obtaining information, selecting and applying forecasting methods, evaluating models, and using the forecasts [8; 2].

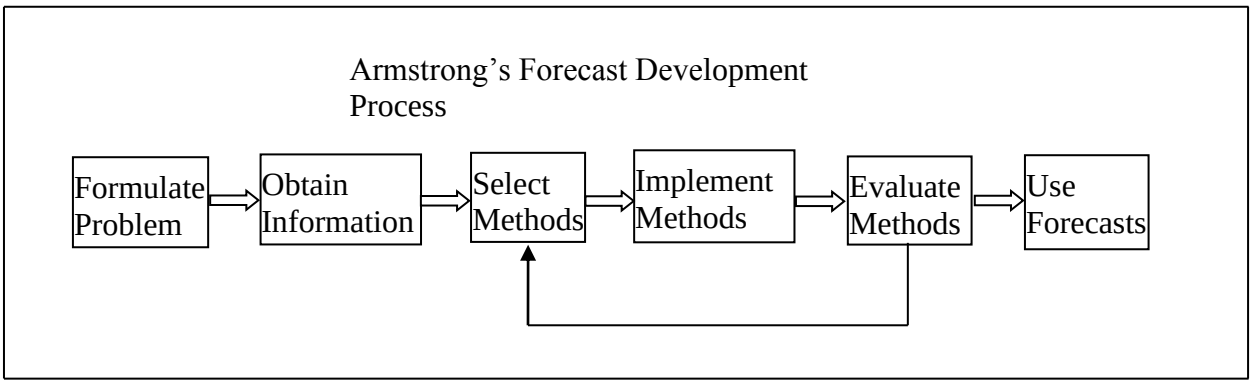

Figure 1: Forecast Development Process (Source: [1])

1.3 Types of forecasting problems:

One way of classifying forecasting problems is to consider the timescale involved in the forecast, that is how far forward into the future we are trying to forecast. Short, medium and long-term are the usual categories but the actual meaning of each will vary according to the situation that is being studied, for example, in forecasting energy demand in order to construct power stations 5-10 years would be short-term and 50 years would be long-term, whilst in forecasting consumer demand in many

business situations up to 6 months would be short-term and over a couple of years long-term. Table 1 below shows the timescale associated with business decisions.

Table 1: Classification of Forecasting Problems.

Timescale	*Type of decision*	*Examples*
Short term *Up to* 3– 6 *months*	*Operating*	*Inventory control* Pr*oduction planning, distribution*
Medium term 3– 6 *months* – 2 *years*	*Tactical*	*Lea*sin*g of plant and equipment,* *Employment changes.*
Long term *Above* 2 *years*	*Strategic*	Re*search and development,* *Acquisitions and mergers,* Pr*oduct changes.*

Gor [7] observed that the basic reason for forecasting classification is based on time period and use. In general, he stated that short-term forecasting guides current operations. Medium- term and long-term forecasting support strategic and competitive decisions.

1.4 Steps in the Forecasting Process:

Many forecasting methods are available to business firms because of the shifting emphasis from manufacturing to service [7]. An increasing number of business firms are specializing in providing service of some kind (e.g. tourism, health services, entertainment, etc.). For such companies forecasting "sales" becomes forecasting the demand for services, which translates into forecasting staffing needs to provide those services. For any type of forecast to bring about later success, it must follow a step-by-step process comprising five major steps as follows: goal of the forecast and the identification of resources for conducting it; time horizon; selection of a forecasting technique; conducting and completing the forecast; and monitoring the accuracy of the forecast.

i. Identify the Goal of the Forecast: This indicates the urgency with which the forecast is needed and identifies the amount of resources that can be justified and the level of accuracy necessary.
ii. Establish a Time Horizon: Decide on the period to be covered by the forecast, keeping in mind that accuracy decreases as the time horizon increases.
iii. Select a Forecasting Technique: The selection of a forecasting model will depend on the computation and financial resources available in an organization, as well as on the complexity of the problem under investigation.
iv. Conduct the Forecast: This is done by using the appropriate data, and making appropriate assumptions with the best possible forecasting model. However, health care managers often have to make assumptions based on experience with a given situation, and sometimes by trial and error.
v. Monitor Accuracy: Since there is an arsenal of techniques available, appropriate for different situations and data representations, health care managers must examine their data and circumstances carefully to select the appropriate forecasting approach. Be prepared to use another technique if the one in use is not providing acceptable results. In the same vein
production managers must also be alert to how frequently the forecast should be updated, especially when trends or data change dramatically.

2. Theoretical Background of Forecasting

The forecasting techniques were developed in the 19th century. For instance, the regression techniques are used to forecast in business to predict sales and other variables. As well some techniques were developed recently and have been recognized by the business community at large. Recently with the development of more sophisticated forecasting techniques along with the proliferation of personal computers and associated software, forecasting received more and more attention by business managers in all types of businesses. Managers are aware of the fact that they must use the correct technique so that the forecasts are as accurate as possible, and to use wisely the forecasting techniques available in the modern times. If managers use inappropriate forecasting techniques, it may lead them to make poor decisions. A particular focus in forecasting is on the errors that are inherent in any forecasting procedure and an endeavor to make the inevitable errors as small as possible. The use of forecasting has been made by researchers over the past years and there is need to see their analyses, results and effect of their forecast in other to have more concentration and a better idea in which particular method of forecast is to be adopted [9; 10; 11; 8].

Nowneow and Rungreunganun [12] applied ARIMA simulation models to predict the appropriate price of the Poly Vinyl Chloride (PVC) pellets. The model was applied and analyzed to forecast the PVC pellet price using crude oil price and exchange rate as independent variables. The analysis data for ten (10) years period showed variation in the plastic pellet price, crude oil price and exchange rate. The results from the analysis were compared for their consistency using the mean absolute percentage error (MAPE). The result showed that ARIMA 1,1 and was the appropriate forecasting model for the plastic pellet price with 0.511 for the MAPE. Okolie et. al. [13] investigated the application of forecasting techniques in the modeling and analysis of production of plastic products in a manufacturing industry. The three models (weighted moving average, winters and exponential

smoothing) applied showed that 10 (litres capacity bucket) product was to be produced for 13997.6, 15854 and 10206 units respectively for the months of January 2014, while for the month of February 2014, the model show that 10 (litres capacity bucket) product was to be produced for 8554.12, 15024.1 and 9791.2 units respectively. The production result obtained, the decrease in trend depicts a continuous decrease in the product future production output. Minh et al. [14] observed that product-based organization (packaging company) used forecast demand to minimize the cost of inventory and safety stock inventory model prevents the company from profit loss and customers' loss due to out of stock their products. Shvachychi et. al. [15] analyzed some indicators of the activity of Ukraine's Metallurgical plants for the period of four (4) months. They performed mathematical modeling of the pipe production process forecast based on polynomial regression analysis. Their findings show that the mathematical models used provided adequate results for predicted indicators of economic activity of the company. Fadeyi et. al. [16] worked on addressing the problem of non-predicting precisely the optimum production yield of Finoplastika manufactured products in the company. Three years data with eight products were investigated. They employed simple regression models forecasting in simulation using Matlab tool. Charts developed showed that five (5) products had a downward trend while three (3) products had upward trend. This mean that three products will increase in future production output while five will decrease. They used the models to suggest optimum monthly production for the different products.

Nehalah and Mohamed [17] investigated the problem faced by ARIFCO plastic factory in their sales in the Saudi Arabia region. There was a big difference or change between the actual sales and the targeted budget. Data from interviews and existing sales report were used to generate their findings. Three forecasting methods (exponential smoothing, three moving average and decomposition methods) were applied in the investigation. Both qualitative and quantitative methods of forecasting were used to determine the best forecasting method. Their key findings showed that decomposition method provided the best-fit method of forecasting with 1% error. This shows that decomposition method will increase the revenue and reduce the losses of the factory. Sokhanvar [18] investigated and compared the forecasting performance of alternative forecasting models in relation to exchange rates. The four (4) models applied in the study include naïve method, moving average and simple exponential smoothing methods, and time series regression. His findings revealed that when two, three and twenty-period moving average models are compared with naïve model, given more weight to recent data, more accurate forecasts are obtained. The investigation also revealed that time series regression is not appropriate model to forecast the exchange.

For this research work, it was observed that time-series analysis and forecasting methods are best technique to be used for forecasting and prediction of the production output, which has not being applied to the case company data and the data collected are periodic. The researcher applied the techniques to foreseen the future production quantity of the case company under investigation. However, the forecasting methods and their models were used to analyze and predict the product types investigated in the case company. The product investigated was plastic and the methods of production used are injection and extrusion methods.

3. Research Methodology

The research method used in this work is a quantitative research approach. The data gathered were the monthly record of plastic pipes production over the month for three years. The research method followed the steps shown in figure 2.

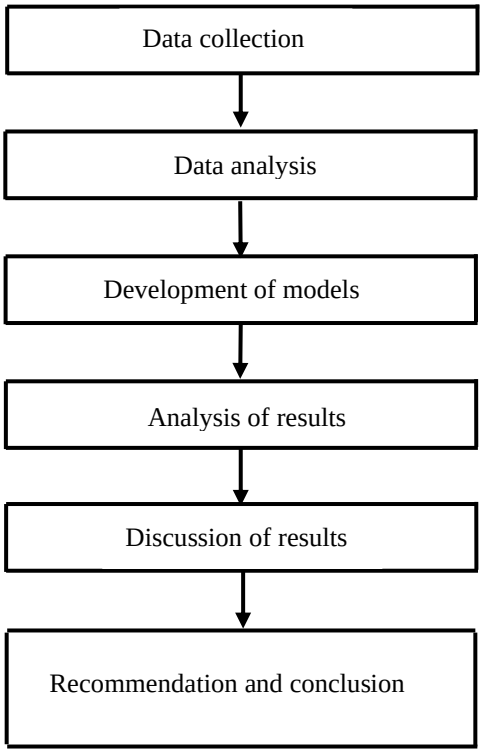

Figure 2: Research Methodology Flow Chart.

3.1 Models Applied in Forecasting.

i. Moving Average Methods.

$$F_t = MA_n = \frac{\sum_{i=1}^{n} A_{t-i}}{n} \quad (1)$$

Where, i = an index that corresponds to time periods.

n = Number of periods (data points) in the moving average.

A_i= Actual value in period $t - i$

MA =Moving average.

F_t= Forecast for time period t

ii. Weighted Moving Average Method.

In general, $F_t = W_n A_{t-n} + W_{n-1} A_{t-(n-1)} + w_1 A_{t-1}$ (2)

$W_i = weightedvalue$

$A_i =$ Actual demand

iii.: Exponential Smoothing.

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \quad (3)$$

$$F_t = \alpha A_{t-1} + (1-\alpha)(F_{t-1}) \quad (4)$$

$whereF_t$= Forecast for period t

F_{t-1}= Forecast for the previous period.

α = Smoothing constant (represents the percentage of the forecast error).

A_{t-1}= Actual demand or sales for the previous period.

iv. Double Exponential Smoothing.

Double Exponential Smoothing forecast (DEF) is composed of two elements: a smoothed error and a trend factor.

$$DEF_{t-1} = S_t + T_t \quad (5)$$

Where S_t = Previous forecast plus smoothed error

T_t= Current trend estimate.

And $S_t = DEF_t + \alpha(A_t - DEF_t)$ (6)

$$T_t = T_{t-1} + \beta(DEF_t - DEF_{t-1} - T_{t-1}) \quad (7)$$

Where α and β = smoothing constants.

v. Graphical Model.

$$F_t = bt + a \quad (8)$$

Where t = Specified number of time periods from t=o

$F_t =$ Forecast for period t

$a =$ Value of F_t at t = 0

$b =$ Slope of the line

$$b = \frac{n\sum ty - \sum t \sum y}{n\sum t^2 - (\sum t)^2} \quad (9)$$

$$a = \frac{\sum y - b\sum t}{n} \text{ or } \bar{y} - b\bar{t} \quad (10)$$

Where n = Number of periods

y = Value of the time series

vi. Winter Modeling.

$$T_t = \beta(F_t - F_{t-1}) + (1-\beta)T_{t-1} \quad (11)$$

T_t =Trend estimate at time t

F_t=Exponential average at time t

β =fractions

$$f_t = (F_{t-1} - T_{t-1}) \quad (12)$$

$$F_t = \alpha D_t + (1-\alpha)(F_{t-1} - T_{t-1}) \quad (13)$$

$where F_t$= Forecast for period t

F_{t-1} = Forecast for the previous period

α = Smoothing constant (represents the percentage of the forecast error)

D_t=Demand

$$f_{t+1} = (F_t - T_t) \quad (14)$$

f_{t+1}= Winter Forecast

Table 2: Presentation of 2009-2011 Monthly Data on Production Yield.

Year	*Month*	M. Code	*p1(units)*	*p2(units)*	*p3(units)*	*p4(units)*	*p5(units)*	*p6(units)*	*p7(units)*	*p8(units)*
2009	Jan	1	*16526*	*3860*	*9618*	*15571*	*0*	*4493*	*420*	*0*
	Feb	2	*29250*	*40*	*14773*	*10680*	*390*	*18718*	*2180*	*0*
	Mar	3	*26666*	*9960*	*16571*	*11280*	*453*	*6740*	*2340*	*0*
	April	4	*52029*	*10315*	*32339*	*11660*	*0*	*12940*	*4484*	*0*
	May	5	*14160*	*17241*	*10788*	*14540*	*0*	*9560*	*4415*	*0*
	June	6	*23087*	*2340*	*878*	*6146*	*0*	*8475*	*6684*	*0*
	July	7	*29890*	*26785*	*15885*	*1140*	*0*	*3040*	*700*	*214*
	Aug	8	*17981*	*20280*	*9062*	*1540*	*0*	*12140*	*50*	*0*
	Sept	9	*3248*	*0*	*7570*	*2260*	*0*	*0*	*460*	*0*
	Oct	10	*7045*	*7530*	*2611*	*2120*	*0*	*454*	*1716*	*0*
	Nov	11	*16014*	*3768*	*5883*	*2980*	*0*	*6002*	*5914*	*0*
	Dec	12	*3171*	*280*	*0*	*1160*	*0*	*260*	*0*	*0*
2010	Jan	13	*7113*	*6311*	*8445*	*4693*	*0*	*1360*	*540*	*0*
	Feb	14	*7284*	*0*	*4595*	*1760*	*0*	*390*	*2125*	*0*
	Mar	15	*22119*	*24975*	*9535*	*7295*	*560*	*6340*	*20*	*0*
	April	16	*21134*	*0*	*18843*	*15480*	*0*	*2930*	*6279*	*0*
	May	17	*18848*	*4545*	*4497*	*4180*	*0*	*7760*	*6367*	*0*
	June	18	*22172*	*4920*	*14296*	*2589*	*0*	*3733*	*1205*	*143*
	July	19	*8767*	*13790*	*2351*	*2278*	*0*	*3040*	*3061*	*0*
	Aug	20	*14790*	*1740*	*10885*	*3900*	*0*	*2080*	*4454*	*0*
	Sept	21	*11975*	*0*	*15023*	*0*	*0*	*1360*	*1101*	*0*
	Oct	22	*5518*	*2245*	*5049*	*1740*	*583*	*3760*	*6843*	*0*
	Nov	23	*17532*	*1830*	*9948*	*3640*	*60*	*2730*	*0*	*0*
	Dec	24	*18452*	*360*	*9489*	*8120*	*0*	*280*	*23754*	*0*
2011	Jan	25	*22225*	*160*	*20184*	*3724*	*651*	*2860*	*2860*	*816*
	Feb	26	*14123*	*2140*	*4721*	*5620*	*0*	*2340*	*1408*	*1377*
	Mar	27	*14502*	*2200*	*11137*	*6680*	*262*	*7600*	*0*	*244*
	April	28	*16014*	*910*	*1970*	*8880*	*0*	*4560*	*3497*	*406*
	May	29	*24134*	*1062*	*21265*	*7720*	*255*	*8060*	*570*	*0*
	June	30	*29097*	*5300*	*20838*	*16160*	*607*	*7750*	*0*	*0*
	July	31	*16981*	*17170*	*6210*	*7500*	*605*	*10822*	*2604*	*0*
	Aug	32	*17298*	*7545*	*11877*	*11420*	*733*	*6020*	*4095*	*0*
	Sept	33	*5617*	*20085*	*2421*	*5980*	*277*	*6820*	*620*	*0*
	Oct	34	*20631*	*5960*	*16326*	*6220*	*604*	*14310*	*5496*	*0*
	Nov	35	*4391*	*0*	*1720*	*4173*	*52*	*1280*	*0*	*0*
	Dec	36	*11909*	*1760*	*1706*	*6610*	*558*	*6510*	*0*	*0*

Source: Finoplastika grouped data.

P_1= 110mm Waste pipe, P_2= 20mm pressure pipe, P_3= 50mm Waste pipe, P_4= 32mm Pressure pipe, P_5= 160mm Waste pipe, P_6= 25mm Pressure pipe, P_7= 40mm Pressure pipe, P_8 = 90mm Waste pipe.

3.2 Comparison of Models: The monthly forecasting results of different models are presented in Tables 3, 4, 5 and 6 for products P1, P2, P3 and P4 analyzed. Table 2 shows the production quantity of the Finoplastika manufacturing industry over the three years of production output. The production outputs used are the extrusion plastic pipes. Table three (3) shows the forecasting results of product one (P1) for monthly production output of the 110mm waste plastic pipe products.

Table 3: P1 Product Monthly Forecast Results.

P1 PRODUCT MONTHLY FORECAST RESULTS							
Year	*Month*	M. Code	*Graphical Method*	*Moving Average Method*	*Weighted Moving Average*	*Double Exponential Smoothing*	*Winters model*
2012	Jan	**37**	18001	12310.33	12210	13786.6	12910.1
	Feb	**38**	18642	9536.778	10180	13691.7	14162.1
	Mar	**39**	19329	11252.04	11119.75	13596.8	18794.7
	April	**40**	20062	11033.05	11157.38	13501.9	27207.5
	May	**41**	20842	10607.29	10903.63	13407.1	18124.0
	June	**42**	21668	10964.12	11021.09	13312.2	23733.0
	July	**43**	22540	10868.15	11025.8	13217.3	17056.5
	Aug	**44**	23459	10813.19	10994.08	13122.4	15654.2
	Sept	**45**	24424	10881.82	11008.76	13027.6	5995.5
	Oct	**46**	25435	10854.39	11009.35	12932.7	10387.6
	Nov	**47**	26492	10849.8	11005.38	12837.8	11195.4
	Dec	**48**	27596	10862	11007.22	12742.9	10351.9
2013	Jan	**49**	28746	10855.4	11007.29	12648.1	10925.1
	Feb	**50**	29942	10855.73	11006.8	12553.2	12177.1
	Mar	**51**	31185	10857.71	11007.03	12458.3	16809.7
	April	**52**	32474	10856.28	11007.04	12363.4	25222.5
	May	**53**	33809	10856.58	11006.97	12268.6	16139.0
	June	**54**	35190	10856.86	11007	12173.7	21748.0
	July	**55**	36618	10856.57	11007	12078.8	15071.4
	Aug	**56**	38092	10856.67	11007	11984.0	13669.2
	Sept	**57**	39612	10856.7	11007	11889.1	4010.4
	Oct	**58**	41179	10856.65	11007	11794.2	8402.6
	Nov	**59**	42792	10856.67	11007	11699.3	9210.4
	Dec	**60**	44451	10856.67	11007	11604.5	8366.9
2014	Jan	**61**	46157	10856.66	11007	11509.6	8940.0
	Feb	**62**	47908	10856.67	11007	11414.7	10192.1
	Mar	**63**	49706	10856.67	11007	11319.8	14824.7
	April	**64**	51551	10856.67	11007	11225.0	23237.5
	May	**65**	53441	10856.67	11007	11130.1	14154.0
	June	**66**	55378	10856.67	11007	11035.2	19763.0
	July	**67**	57361	10856.67	11007	10940.3	13086.4
	Aug	**68**	59391	10856.67	11007	10845.5	11684.2
	Sept	**69**	61467	10856.67	11007	10750.6	2025.4
	Oct	**70**	63589	10856.67	11007	10655.7	6417.6
	Nov	**71**	65757	10856.67	11007	10560.8	7225.4
2015	Dec	**72**	67972	10856.67	11007	10466.0	6381.8
	Jan	**73**	70232	10856.67	11007	10371.1	6955.0
	Feb	**74**	72540	10856.67	11007	10276.2	8207.1
	Mar	**75**	74893	10856.67	11007	10181.4	12839.7
	April	**76**	77293	10856.67	11007	10086.5	21252.5
	May	**77**	79739	10856.67	11007	9991.6	12169.0
	June	**78**	82231	10856.67	11007	9896.7	17778.0
	July	**79**	84770	10856.67	11007	9801.9	11101.4
	Aug	**80**	87355	10856.67	11007	9707.0	9699.1
	Sept	**81**	89986	10856.67	11007	9612.1	40.4
	Oct	**82**	92664	10856.67	11007	9517.2	4432.6
	Nov	**83**	95387	10856.67	11007	9422.4	5240.3
	Dec	**84**	98157	10856.67	11007	9327.5	4396.8
2016	Jan	**85**	100974	10856.67	11007	9232.6	4970.0

	Feb	**86**	103836	10856.67	11007	9137.7	6222.1
	Mar	**87**	106745	10856.67	11007	9042.9	10854.7
	April	**88**	109700	10856.67	11007	8948.0	19267.5
	May	**89**	112702	10856.67	11007	8853.1	10184.0
	June	**90**	115750	10856.67	11007	8758.2	15793.0
	July	**91**	118844	10856.67	11007	8663.4	9116.4
	Aug	**92**	121984	10856.67	11007	8568.5	7714.1
	Sept	**93**	125171	10856.67	11007	8473.6	-1944.6
	Oct	**94**	128404	10856.67	11007	8378.8	2447.6
	Nov	**95**	131683	10856.67	11007	8283.9	3255.3
	Dec	**96**	135008	10856.67	11007	8189.0	2411.8

Table three (3) above shows the product one (P1) forecasting results using time series forecasting techniques. The time series forecasting techniques applied for the product are; graphical methods, moving average method, double exponential smoothing method, weighted moving average method and winters method of time series techniques. The forecasting results show that the winters forecasting method is most appropriate forecasting results based on the least forecasting accuracy errors in the results. Table four (4) shows the forecasting results of product two (P2) for monthly production output of the 20mm pressure plastic pipe products.

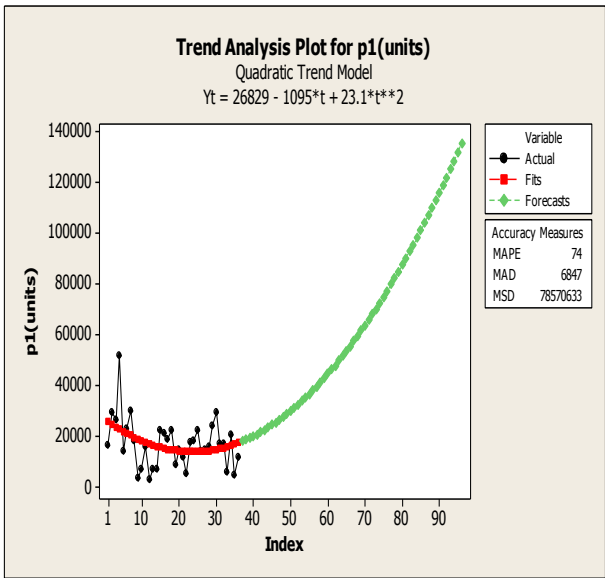

Fig. 3 Trend Analysis Plot for p1

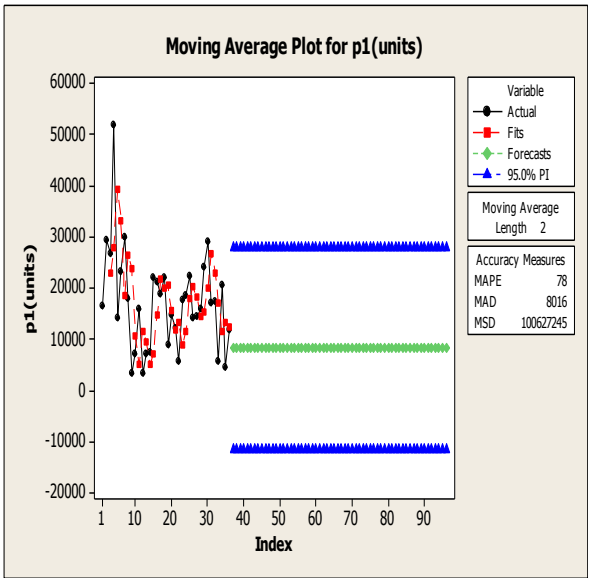

Fig. 4 Moving Average Plot for p1

Figure three (3) shows the trend method of time series forecasting technique. The quadratic model developed on the trend method is selected based on the least error on forecasting accuracy measures of the quadratic model. The plot revealed an upward movement of the production trend of the product (P1). Figure four (4) shows the moving average method of forecasting techniques. It shows that the production quantity produced is within the average mean of the historical data and the moving average length is two (2). The moving average forecast has the highest error in the forecasting accuracy measure than other forecasting techniques plotted for product one (P1).

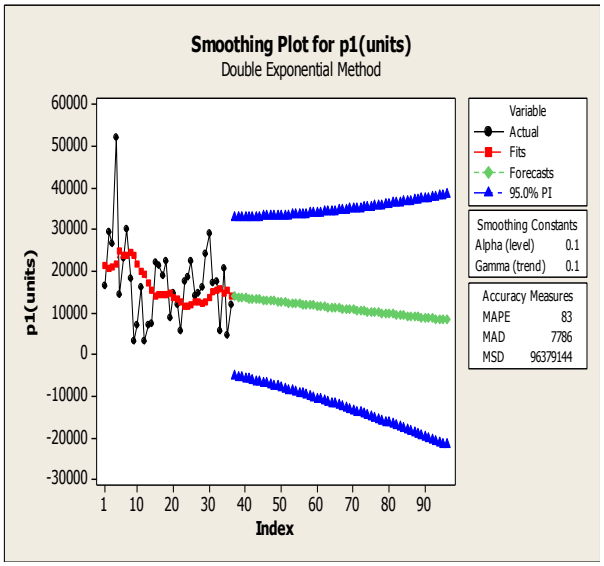

Fig. 5 Double Exponential Smoothing Plot for p1

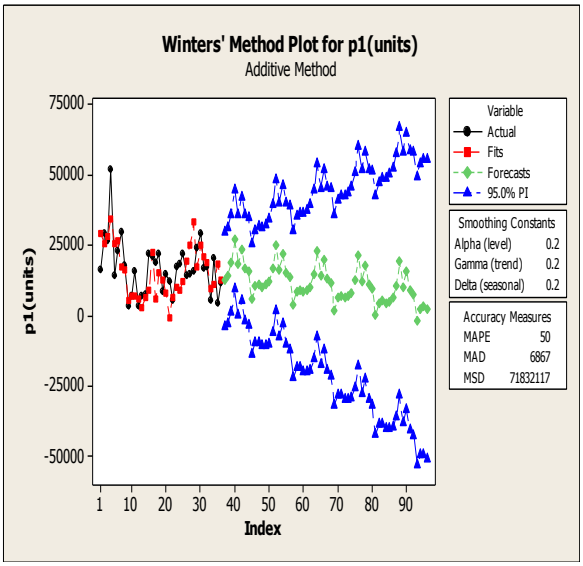

Fig. 6 Winters' Method Plot forp1

Figure five (5) shows the double exponential smoothing method of time series forecasting. It shows that the forecasting results of the trend are decreasing to negative. As a result of the negative decrease, the company is advice to have a strong decision making on the product and re-strategies on how to go about the production planning and control of the product under investigation. Figure six (6) shows the winter's method of time series forecasting techniques. It shows that the forecasting result of the winter's method has a downward negative trend. The winter's method agreed with the double exponential smoothing method. However, the winter's method has the least error for forecasting accuracy measures. It is recommended that the winter's method of forecasting is more appropriate due to its least error on the forecasting accuracy measure.

Table 4: P2 Product Monthly Forecast Results

P2 PRODUCT MONTHLY FORECAST RESULTS							
Year	*Month*	M. Code	*Graphical Method*	*Moving Average Method*	*Weighted Moving Average*	*Double Exponential Smoothing*	*Winters model*
2012	Jan	**37**	6217.6	2573.333	2370	4159.21	4882.3
	Feb	**38**	6461.8	1444.444	1625	4125.95	2942.1
	Mar	**39**	6725.7	1925.926	1845	4092.70	14891.4
	April	**40**	7009.3	1981.235	1921.25	4059.44	6941.6
	May	**41**	7312.6	1783.868	1828.125	4026.19	11327.8
	June	**42**	7635.6	1897.01	1855.625	3992.94	9081.5
	July	**43**	7978.3	1887.371	1865.156	3959.68	24379.1
	Aug	**44**	8340.8	1856.083	1853.516	3926.43	15580.0
	Sept	**45**	8722.9	1880.154	1856.953	3893.17	13880.8
	Oct	**46**	9124.7	1874.536	1858.145	3859.92	12245.1
	Nov	**47**	9546.2	1870.258	1856.689	3826.66	9435.8
	Dec	**48**	9987.4	1874.983	1857.119	3793.41	9166.8
2013	Jan	**49**	10448.3	1873.259	1857.268	3760.16	11408.1
	Feb	**50**	10928.9	1872.833	1857.086	3726.90	9467.9
	Mar	**51**	11429.3	1873.692	1857.14	3693.65	21417.3
	April	**52**	11949.3	1873.261	1857.159	3660.39	13467.4
	May	**53**	12489.0	1873.262	1857.136	3627.14	17853.7
	June	**54**	13048.4	1873.405	1857.142	3593.88	15607.3
	July	**55**	13627.6	1873.309	1857.145	3560.63	30904.9
	Aug	**56**	14226.4	1873.325	1857.142	3527.38	22105.9
	Sept	**57**	14844.9	1873.347	1857.143	3494.12	20406.6
	Oct	**58**	15483.2	1873.327	1857.143	3460.87	18770.9
	Nov	**59**	16141.1	1873.333	1857.143	3427.61	15961.7
	Dec	**60**	16818.8	1873.336	1857.143	3394.36	15692.6
2014	Jan	**61**	17516.1	1873.332	1857.143	3361.11	17933.9
	Feb	**62**	18233.1	1873.334	1857.143	3327.85	15993.8
	Mar	**63**	18969.9	1873.334	1857.143	3294.60	27943.1
	April	**64**	19726.3	1873.333	1857.143	3261.34	19993.2

	May	**65**	20502.5	1873.333	1857.143	3228.09	24379.5
	June	**66**	21298.3	1873.333	1857.143	3194.83	22133.2
	July	**67**	22113.9	1873.333	1857.143	3161.58	37430.7
	Aug	**68**	22949.2	1873.333	1857.143	3128.33	28631.7
	Sept	**69**	23804.1	1873.333	1857.143	3095.07	26932.4
	Oct	**70**	24678.8	1873.333	1857.143	3061.82	25296.8
	Nov	**71**	25573.1	1873.333	1857.143	3028.56	22487.5
2015	Dec	**72**	26487.2	1873.333	1857.143	2995.31	22218.4
	Jan	**73**	27421.0	1873.333	1857.143	2962.05	24459.8
	Feb	**74**	28374.4	1873.333	1857.143	2928.80	22519.6
	Mar	**75**	29347.6	1873.333	1857.143	2895.55	34468.9
	April	**76**	30340.5	1873.333	1857.143	2862.29	26519.1
	May	**77**	31353.1	1873.333	1857.143	2829.04	30905.3
	June	**78**	32385.3	1873.333	1857.143	2795.78	28659.0
	July	**79**	33437.3	1873.333	1857.143	2762.53	43956.6
	Aug	**80**	34509.0	1873.333	1857.143	2729.28	35157.5
	Sept	**81**	35600.4	1873.333	1857.143	2696.02	33458.3
	Oct	**82**	36711.5	1873.333	1857.143	2662.77	31822.6
	Nov	**83**	37842.2	1873.333	1857.143	2629.51	29013.4
	Dec	**84**	38992.7	1873.333	1857.143	2596.26	28744.3
2016	Jan	**85**	40162.9	1873.333	1857.143	2563.00	30985.6
	Feb	**86**	41352.8	1873.333	1857.143	2529.75	29045.4
	Mar	**87**	42562.4	1873.333	1857.143	2496.50	40994.8
	April	**88**	43791.7	1873.333	1857.143	2463.24	33044.9
	May	**89**	45040.7	1873.333	1857.143	2429.99	37431.2
	June	**90**	46309.4	1873.333	1857.143	2396.73	35184.8
	July	**91**	47597.8	1873.333	1857.143	2363.48	50482.4
	Aug	**92**	48905.9	1873.333	1857.143	2330.22	41683.4
	Sept	**93**	50233.7	1873.333	1857.143	2296.97	39984.1
	Oct	**94**	51581.2	1873.333	1857.143	2263.72	38348.4
	Nov	**95**	52948.5	1873.333	1857.143	2230.46	35539.2
	Dec	**96**	54335.4	1873.333	1857.143	2197.21	35270.1

Table four (4) above shows the product two (P2) forecasting results using time series forecasting techniques. The time series forecasting techniques applied for product are; graphical methods, moving average method, double exponential smoothing method, weighted moving average method and winters method of time series techniques. The forecasting results show that the winters forecasting method is the most appropriate forecasting results based on the least forecasting accuracy errors in the results. Table five (5) shows the forecasting results of product three (P3) for monthly production output of the 50mm waste plastic pipe products.

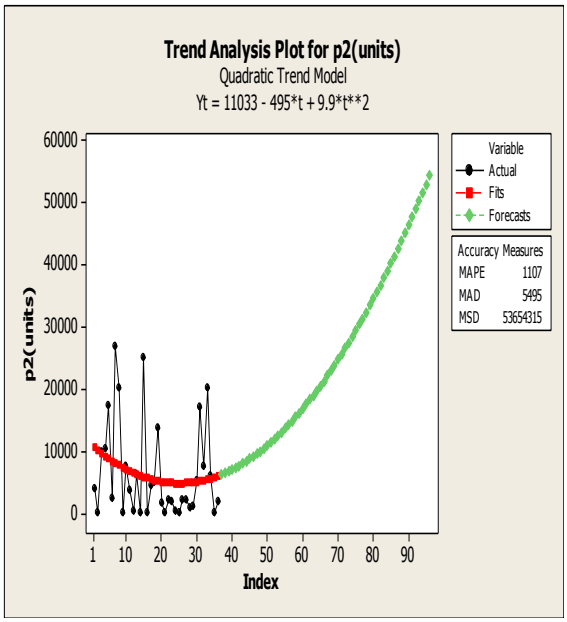

Fig. 7Graphical Method and Analysis Plot for p2

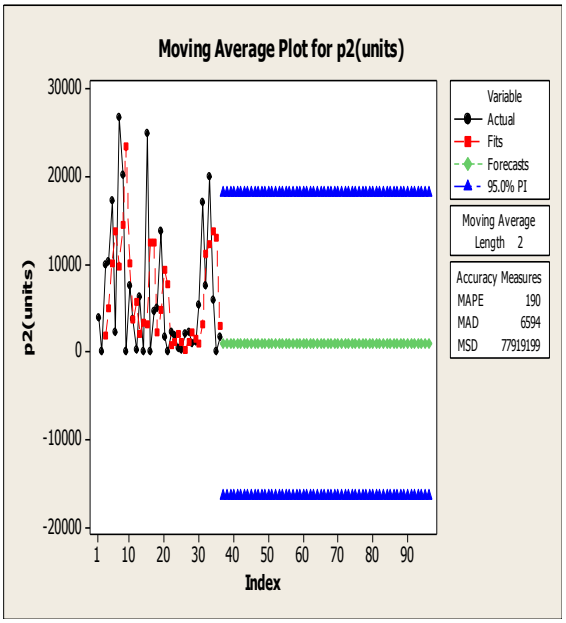

Fig. 8 Moving Average Plot for p2

Figure seven (7) shows the trend method of time series forecasting technique. The quadratic model developed on the trend method is selected based on the least error on forecasting accuracy measures of the quadratic model. The plot revealed an upward movement of the production trend of the product (P2). Figure eight (8) shows the moving average method of forecasting techniques. The moving average forecasting result shows the expected production quantity that is necessary to be produced and the moving average length is two (2). The moving average forecast has the highest error in the forecasting accuracy measure than other forecasting techniques plotted for product two (P2).

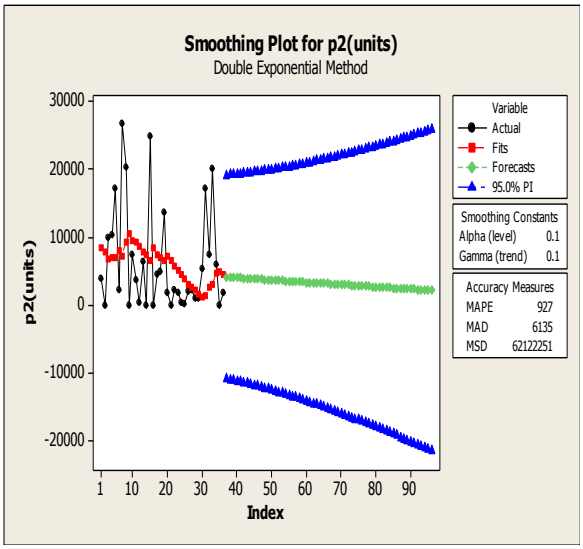

Fig. 9 Double Exponential Smoothing Plot for p2

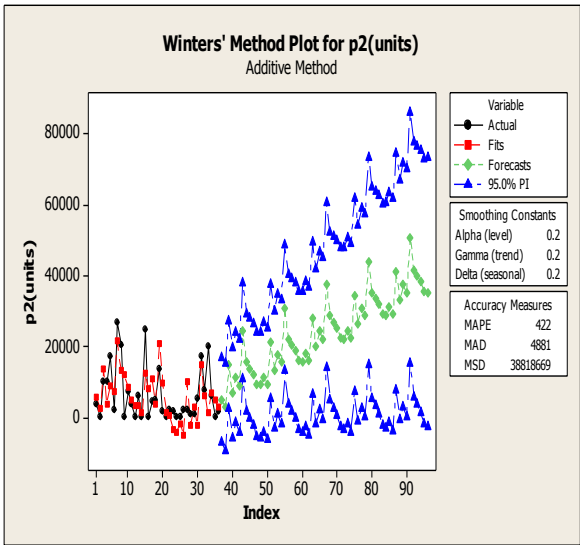

Fig. 10 Winters' Method Plot for p2

Figure nine (9) shows the double exponential smoothing method of time series forecasting. It shows that the forecasting results of the trend are decreasing as the forecasting period increases but not up to negative production output. As a result of the decrease in production, the company is advice to have a strong decision making on the product and re-strategies on who to go about the production planning and control of the product under investigation. Figure ten (10) shows the winter's method of time series forecasting techniques. It shows that the forecasting result of the winter's method has an upward positive trend. Also, the

winter's method has the least error for forecasting accuracy measures. It's recommended that the winter's method of forecasting is more appropriate due to its least error on the forecasting accuracy measure.

Table 5: P3 Product Monthly Forecast Results

P3 PRODUCT MONTHLY FORECAST RESULTS							
Year	*Month*	M. Code	*Graphical Method*	*Moving Average Method*	*Weighted Moving Average*	*Double Exponential Smoothing*	*Winters model*
2012	Jan	**37**	9877.3	6584	5364.5	8802.73	11131.6
	Feb	**38**	10053.5	3336.667	3538.75	8735.90	5709.7
	Mar	**39**	10244.2	3875.556	3537	8669.06	10228.5
	April	**40**	10449.2	4598.741	3994.313	8602.23	14888.0
	May	**41**	10668.6	3936.988	3766.094	8535.40	10538.6
	June	**42**	10902.3	4137.095	3765.875	8468.56	10236.0
	July	**43**	11150.4	4224.274	3823.039	8401.73	5287.3
	Aug	**44**	11412.8	4099.452	3794.512	8334.90	7945.1
	Sept	**45**	11689.6	4153.607	3794.484	8268.06	5236.5
	Oct	**46**	11980.8	4159.111	3801.63	8201.23	5206.0
	Nov	**47**	12286.3	4137.39	3798.064	8134.40	2229.3
	Dec	**48**	12606.2	4150.036	3798.061	8067.56	68.2
2013	Jan	**49**	12940.5	4148.846	3798.954	8000.73	7347.8
	Feb	**50**	13289.1	4145.424	3798.508	7933.90	1926.0
	Mar	**51**	13652.0	4148.102	3798.508	7867.06	6444.8
	April	**52**	14029.3	4147.457	3798.619	7800.23	11104.3
	May	**53**	14421.0	4146.994	3798.563	7733.40	6754.9
	June	**54**	14827.1	4147.518	3798.563	7666.57	6452.3
	July	**55**	15247.5	4147.323	3798.577	7599.73	1503.6
	Aug	**56**	15682.2	4147.279	3798.57	7532.90	4161.4
	Sept	**57**	16131.3	4147.373	3798.57	7466.07	1452.8
	Oct	**58**	16594.8	4147.325	3798.572	7399.23	1422.3
	Nov	**59**	17072.7	4147.326	3798.571	7332.40	-1554.4
	Dec	**60**	17564.9	4147.341	3798.571	7265.57	-3715.5
2014	Jan	**61**	18071.4	4147.331	3798.572	7198.73	3564.1
	Feb	**62**	18592.3	4147.332	3798.571	7131.90	-1857.7
	Mar	**63**	19127.6	4147.335	3798.571	7065.07	2661.1
	April	**64**	19677.2	4147.333	3798.571	6998.23	7320.6
	May	**65**	20241.2	4147.333	3798.571	6931.40	2971.1
	June	**66**	20819.6	4147.334	3798.571	6864.57	2668.6
	July	**67**	21412.3	4147.333	3798.571	6797.73	-2280.1
	Aug	**68**	22019.4	4147.333	3798.571	6730.90	377.7
	Sept	**69**	22640.8	4147.333	3798.571	6664.07	-2330.9
	Oct	**70**	23276.6	4147.333	3798.571	6597.23	-2361.4
	Nov	**71**	23926.7	4147.333	3798.571	6530.40	-5338.1
2015	Dec	**72**	24591.3	4147.333	3798.571	6463.57	-7499.2
	Jan	**73**	25270.1	4147.333	3798.571	6396.73	-219.6
	Feb	**74**	25963.4	4147.333	3798.571	6329.90	-5641.4
	Mar	**75**	26670.9	4147.333	3798.571	6263.07	-1122.6
	April	**76**	27392.9	4147.333	3798.571	6196.23	3536.9
	May	**77**	28129.2	4147.333	3798.571	6129.40	-812.6
	June	**78**	28879.9	4147.333	3798.571	6062.57	-1115.1
	July	**79**	29644.9	4147.333	3798.571	5995.73	-6063.8
	Aug	**80**	30424.3	4147.333	3798.571	5928.90	-3406.0
	Sept	**81**	31218.0	4147.333	3798.571	5862.07	-6114.6
	Oct	**82**	32026.1	4147.333	3798.571	5795.23	-6145.1
	Nov	**83**	32848.6	4147.333	3798.571	5728.40	-9121.9
	Dec	**84**	33685.4	4147.333	3798.571	5661.57	-11282.9
2016	Jan	**85**	34536.6	4147.333	3798.571	5594.73	-4003.3
	Feb	**86**	35402.1	4147.333	3798.571	5527.90	-9425.1
	Mar	**87**	36282.0	4147.333	3798.571	5461.07	-4906.3
	April	**88**	37176.3	4147.333	3798.571	5394.23	-246.8

	May	**89**	38084.9	4147.333	3798.571	5327.40	-4596.3
	June	**90**	39007.9	4147.333	3798.571	5260.57	-4898.8
	July	**91**	39945.3	4147.333	3798.571	5193.73	-9847.5
	Aug	**92**	40897.0	4147.333	3798.571	5126.90	-7189.7
	Sept	**93**	41863.0	4147.333	3798.571	5060.07	-9898.3
	Oct	**94**	42843.4	4147.333	3798.571	4993.23	-9928.8
	Nov	**95**	43838.2	4147.333	3798.571	4926.40	-12905.6
	Dec	**96**	44847.3	4147.333	3798.571	4859.57	-15066.6

Table five (5) above shows the product three (P3) forecasting results using time series forecasting techniques. The time series forecasting techniques applied for product are; graphical methods, moving average method, double exponential smoothing method, weighted moving average method and winters method of time series techniques. The forecasting results show that the trend analysis forecasting method is the most appropriate forecasting results based on the least forecasting accuracy errors in the results. Table six (6) shows the forecasting results of product four (P4) for monthly production output of the 32mm pressure plastic pipe products.

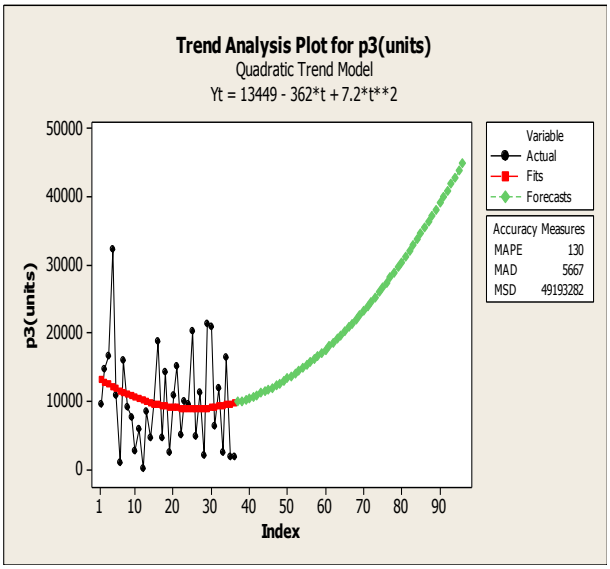

Fig. 11 Trend Analysis Plot for p3

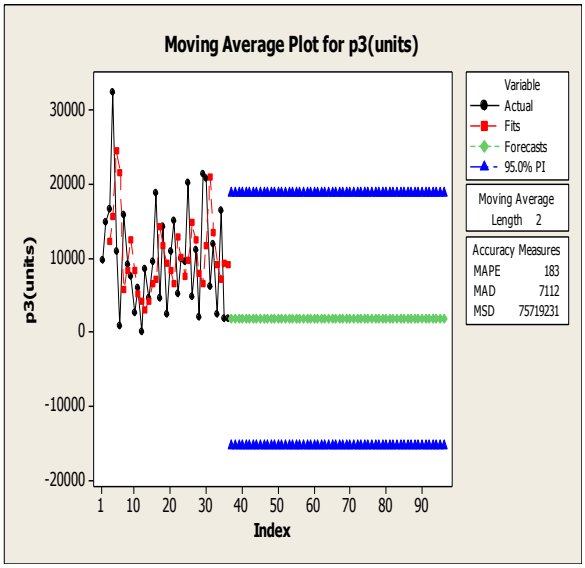

Fig. 12 Moving Average Plot for p3

Figure eleven (11) shows the trend method of time series forecasting technique. The quadratic model developed on the trend method is selected based on the least error on forecasting accuracy measures of the quadratic model. The plot revealed an upward movement of the production trend of the product (P3). However, the trend method has the least error for forecasting accuracy measures. It's recommended that the trend method of forecasting is more appropriate due to its least error on the forecasting accuracy measure. Figure twelve (12) shows the moving average method of forecasting techniques. The moving average forecasting result shows the expected production quantity that is necessary to be produced and the moving average length is two (2). The moving average forecast has the highest error in the forecasting accuracy measure than other forecasting techniques plotted for product three (P3).

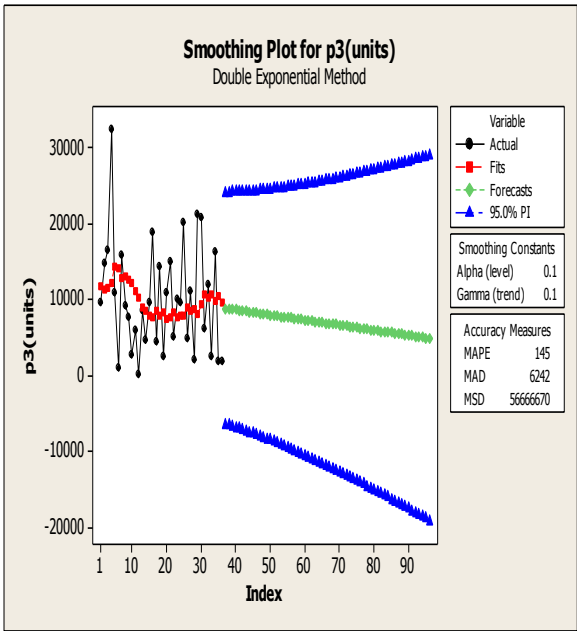

Fig. 13 Double Exponential Smoothing Plot for p3

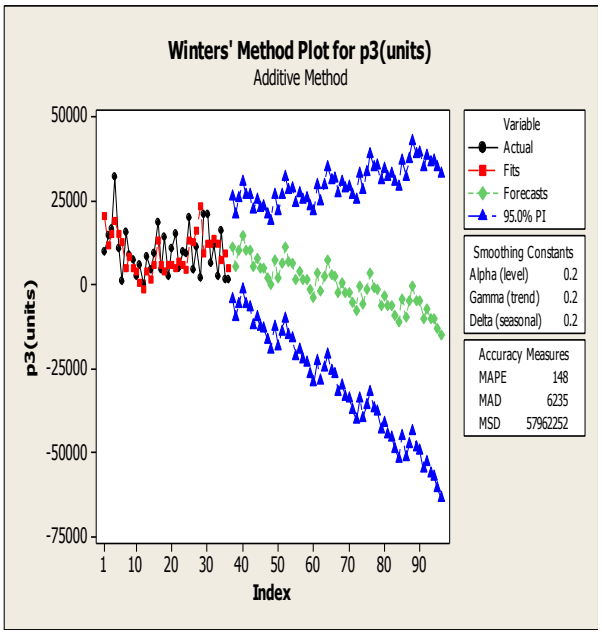

Fig. 14 Winters' Method Plot for p3

Figure thirteen (13) shows the double exponential smoothing method of time series forecasting. It shows that the forecasting result of the trend is slightly decreasing as the forecasting period increases. As a result of the slight decrease in production, the company is advice to have a strong decision making on the product and re-strategies on who to go about the production planning and control of the product three under investigation. Figure fourteen (14) shows the winter's method of time series forecasting techniques. It shows that the forecasting result of the winter's method has a downward trend movement. The winter's method agreed with the double exponential smoothing method on downward movement of the generated forecast.

Table 6: P4 Product Monthly Forecast Results

P4 PRODUCT MONTHLY FORECAST RESULTS							
Year	*Month*	M. Code	*Graphical Method*	*Moving Average Method*	*Weighted Moving Average*	*Double Exponential Smoothing*	*Winters model*
2012	Jan	**37**	11019	5667.667	5903.25	5969.75	11013.5
	Feb	**38**	11836	5483.556	5647.375	5910.50	9733.2
	Mar	**39**	12697	5920.407	5952	5851.26	12559.1
	April	**40**	13602	5690.543	5863.656	5792.01	16578.9
	May	**41**	14552	5698.169	5831.672	5732.77	13667.0
	June	**42**	15547	5769.706	5869.75	5673.52	13919.4
	July	**43**	16586	5719.473	5858.707	5614.28	9325.4
	Aug	**44**	17669	5729.116	5854.709	5555.03	11604.3
	Sept	**45**	18797	5739.432	5859.469	5495.79	8767.3
	Oct	**46**	19969	5729.34	5858.088	5436.54	9643.6
	Nov	**47**	21186	5732.629	5857.589	5377.30	10065.0
	Dec	**48**	22447	5733.8	5858.184	5318.06	12149.3
2013	Jan	**49**	23752	5731.923	5858.011	5258.81	14303.9
	Feb	**50**	25102	5732.784	5857.949	5199.57	13023.6
	Mar	**51**	26496	5732.836	5858.023	5140.32	15849.5
	April	**52**	27935	5732.515	5858.001	5081.08	19869.3
	May	**53**	29418	5732.712	5857.994	5021.83	16957.4
	June	**54**	30946	5732.687	5858.003	4962.59	17209.8
	July	**55**	32518	5732.638	5858	4903.34	12615.8
	Aug	**56**	34134	5732.679	5857.999	4844.10	14894.7
	Sept	**57**	35795	5732.668	5858	4784.85	12057.7
	Oct	**58**	37501	5732.662	5858	4725.61	12934.0
	Nov	**59**	39250	5732.67	5858	4666.36	13355.4
	Dec	**60**	41044	5732.666	5858	4607.12	15439.7
2014	Jan	**61**	42883	5732.666	5858	4547.87	17594.3
	Feb	**62**	44766	5732.667	5858	4488.63	16314.0
	Mar	**63**	46693	5732.667	5858	4429.38	19139.9

	April	**64**	48665	5732.667	5858	4370.14	23159.7
	May	**65**	50681	5732.667	5858	4310.89	20247.8
	June	**66**	52742	5732.667	5858	4251.65	20500.2
	July	**67**	54847	5732.667	5858	4192.40	15906.2
	Aug	**68**	56997	5732.667	5858	4133.16	18185.1
	Sept	**69**	59190	5732.667	5858	4073.91	15348.1
	Oct	**70**	61429	5732.667	5858	4014.67	16224.4
	Nov	**71**	63712	5732.667	5858	3955.42	16645.8
2015	Dec	**72**	66039	5732.667	5858	3896.18	18730.1
	Jan	**73**	68410	5732.667	5858	3836.94	20884.7
	Feb	**74**	70826	5732.667	5858	3777.69	19604.4
	Mar	**75**	73287	5732.667	5858	3718.45	22430.3
	April	**76**	75792	5732.667	5858	3659.20	26450.1
	May	**77**	78341	5732.667	5858	3599.96	23538.2
	June	**78**	80935	5732.667	5858	3540.71	23790.6
	July	**79**	83573	5732.667	5858	3481.47	19196.6
	Aug	**80**	86256	5732.667	5858	3422.22	21475.5
	Sept	**81**	88983	5732.667	5858	3362.98	18638.5
	Oct	**82**	91754	5732.667	5858	3303.73	19514.8
	Nov	**83**	94570	5732.667	5858	3244.49	19936.2
	Dec	**84**	97430	5732.667	5858	3185.24	22020.5
2016	Jan	**85**	100335	5732.667	5858	3126.00	24175.1
	Feb	**86**	103284	5732.667	5858	3066.75	22894.8
	Mar	**87**	106278	5732.667	5858	3007.51	25720.7
	April	**88**	109316	5732.667	5858	2948.26	29740.5
	May	**89**	112398	5732.667	5858	2889.02	26828.6
	June	**90**	115525	5732.667	5858	2829.77	27081.0
	July	**91**	118696	5732.667	5858	2770.53	22487.0
	Aug	**92**	121912	5732.667	5858	2711.28	24765.9
	Sept	**93**	125172	5732.667	5858	2652.04	21928.9
	Oct	**94**	128476	5732.667	5858	2592.79	22805.2
	Nov	**95**	131825	5732.667	5858	2533.55	23226.6
	Dec	**96**	135219	5732.667	5858	2474.30	25310.9

Table six (6) above shows the product four (P4) forecasting results using time series forecasting techniques. The time series forecasting techniques applied for product are; graphical methods, moving average method, double exponential smoothing method, weighted moving average method and winters method of time series techniques. The forecasting results show that the winter's forecasting method is the most appropriate forecasting results based on the least forecasting accuracy errors in the results.

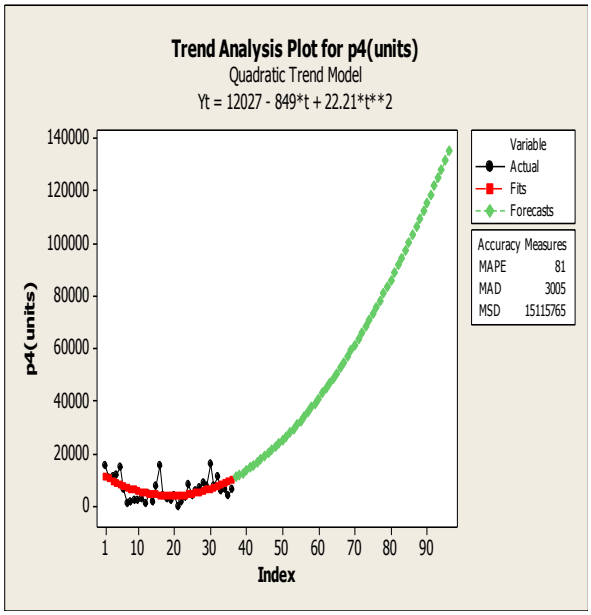

Fig. 15 Graphical Method and Analysis Plot for p4

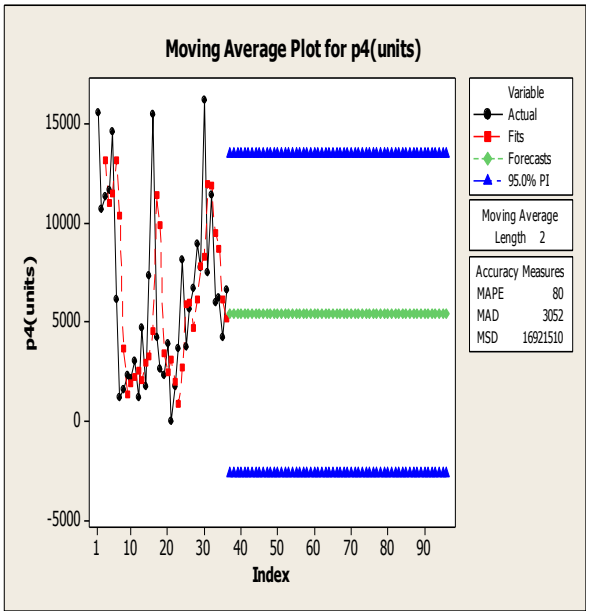

Fig. 16 Moving Average Plot for p4

Figure fifteen (15) shows the trend method of time series forecasting technique. The quadratic model developed on the trend method is selected based on the least error on forecasting accuracy measures of the quadratic model. The plot revealed an upward movement of the production trend of the product (P4). However, the trend method has the least error for forecasting accuracy measures. It's recommended that the trend method of forecasting is more appropriate due to its least error on the forecasting accuracy measure. Figure sixteen (16) shows the moving average method of forecasting techniques. The moving average forecasting result shows the expected production quantity that is necessary to be produced and the moving average length is two (2). The moving average forecast has the highest error in the forecasting accuracy measure than other forecasting techniques plotted for product four (P4).

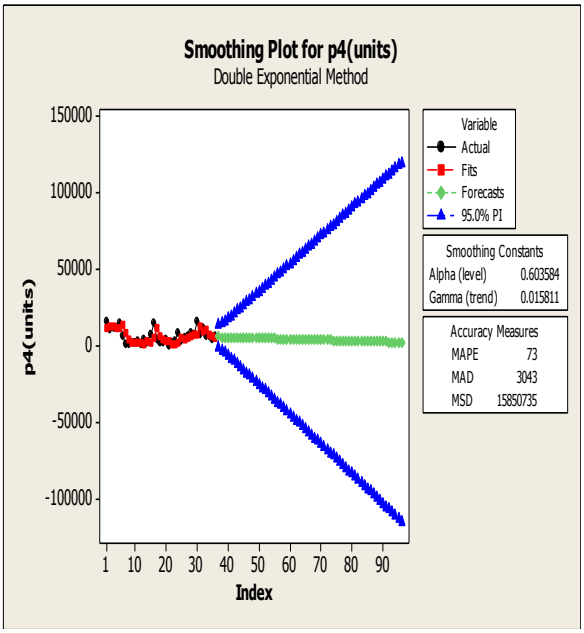

Fig. 17 Double Exponential Smoothing Plot for p4

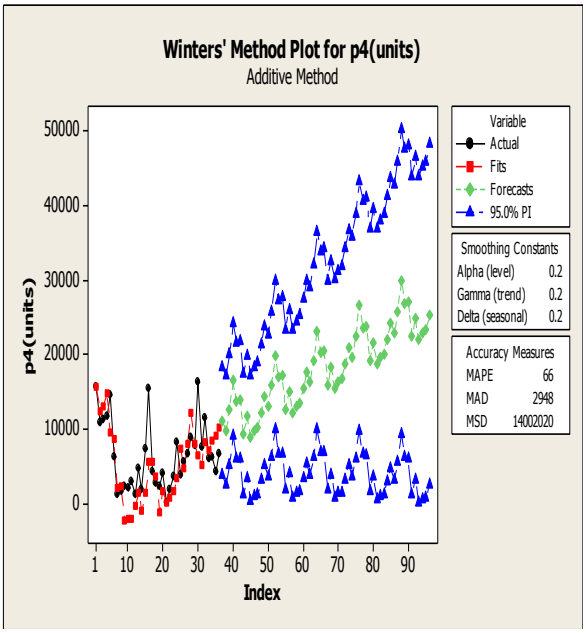

Fig. 18 Winters' Method Plot for p4

Figure seventeen (17) shows the double exponential smoothing method of time series forecasting. It shows that the forecasting results of the trend are decreasing as the forecasting period increases but not up to negative production output. As a result of the decrease in production, the company is advice to have a strong decision making on the product and re-strategies on who to go about the production planning and control of the product four (P4) under investigation. Figure eighteen (18) shows the winter's method of time series forecasting techniques. It shows that the forecasting result of the winter's method has an upward positive trend. However, the winter's method has the least error for forecasting accuracy measures. It's recommended that the winter's method of forecasting is more appropriate due to its least error on the forecasting accuracy measure.

Conclusion

The research has revealed the application of some selected forecasting techniques in modeling and evaluating the forecasting results of the manufacturing industry. Comparison of the forecasting methods show that in Figures 3, 4, 5 and 6 for product 1 (P1), Figures 7, 8, 9, and 10 for product 2 (P2) and Figures 15, 16, 17 and 18 for product 4 (P4), Winter's method of forecasting is more appropriate due to its least error for the forecasted accuracy measure. Figures 11, 12, 13 and 14 show that trend analysis method of forecasting is more appropriate due to its least error for the forecasted accuracy measure. From the results of the evaluation of the forecasting accuracy measure, it can be deduced that the production output for product 1 (P1) is 12910.1 units, production output for product 2 (P2) is 4882.3 units, production output for product 3 (P3) is 9877.3 units and the production output for product 4 (P4) is 11013.5 units.

Recommendation.

The researchers recommend the results of the evaluation to the case company and other manufacturing industries for their production planning and control and for appropriate decision-making system. It is to be noted that the winter's method of forecasting is more appropriate for the monthly production of waste pipe of dimension 110mm, pressure pipe of dimension 20mm and pressure pipe of dimension 32mm for the unit quantities of 12910.1, 4882.3 and 11013 respectively. For the waste pipe of dimension 50mm, the trend analysis method of forecasting is more appropriate for the monthly production for the unit quantity of 9877.3.

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