



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

Aguh Patrick Sunday^{1*}, Umeh Maryrose Ngozi² and Mbeledogu Njideka N³.

¹Department 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:

- The application of existing forecasting models to model the Finoplastika productions.
- 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].

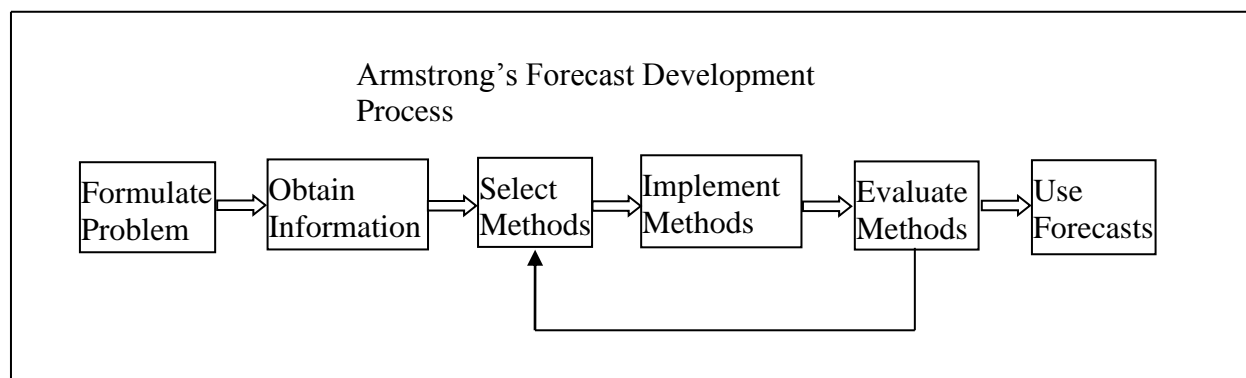


Figure 1: Forecast Development Process (Source: [1])

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.

<i>Timescale</i>	<i>Type of decision</i>	<i>Examples</i>
<i>Short term</i> <i>Up to 3– 6 months</i>	<i>Operating</i>	<i>Inventory control</i> <i>Production planning, distribution</i>
<i>Medium term</i> <i>3– 6 months – 2 years</i>	<i>Tactical</i>	<i>Leasing of plant and equipment,</i> <i>Employment changes</i>
<i>Long term</i> <i>Above 2 years</i>	<i>Strategic</i>	<i>Research and development,</i> <i>Acquisitions and mergers,</i> <i>Product changes</i>

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.

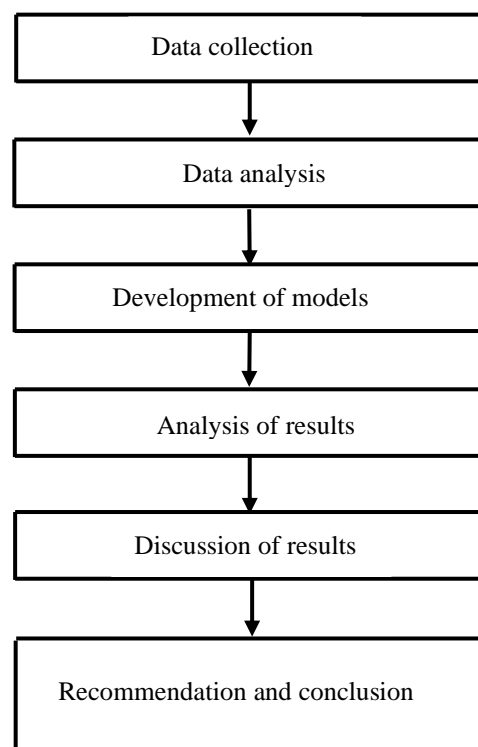


Figure 2: Research Methodology Flow Chart.

3.1 Models Applied in Forecasting.

i. Moving Average Methods.

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

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

W_i = weighted value

A_i = Actual demand

iii.: Exponential Smoothing.

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

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

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).

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.

$$DEF_{t-1} = S_t + T_t \tag{5}$$

Where S_t = Previous forecast plus smoothed error

T_t = Current trend estimate.

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

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

Where α and β = smoothing constants.

v. Graphical Model.

$$F_t = bt + a \tag{8}$$

Where t = Specified number of time periods from $t=0$

F_t = Forecast for period t

a = Value of F_t at $t = 0$

b = Slope of the line

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

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

Where n = Number of periods

y = Value of the time series

vi. Winter Modeling.

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

T_t =Trend estimate at time t

F_t =Exponential average at time t

β =fractions

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

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

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

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

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.

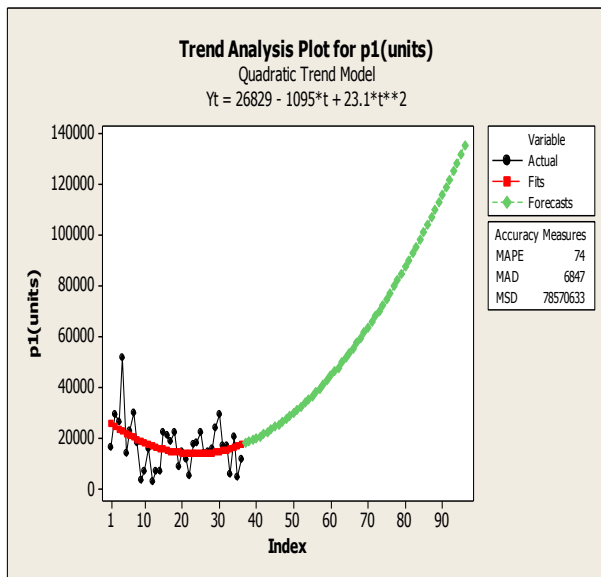


Fig. 3 Trend Analysis Plot for p1

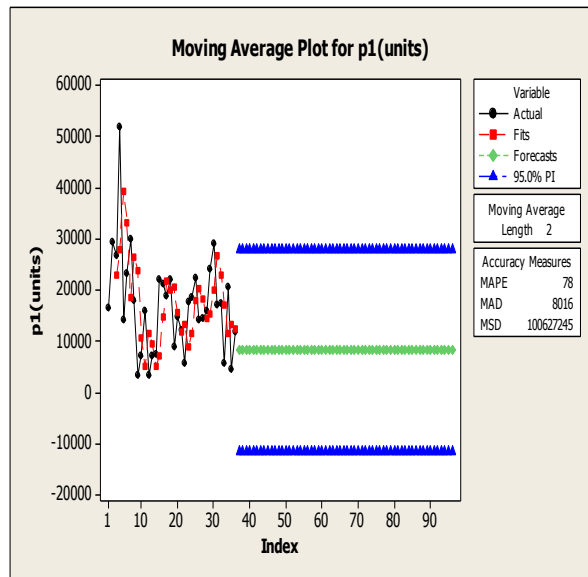


Fig. 4 Moving Average Plot for p1

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).

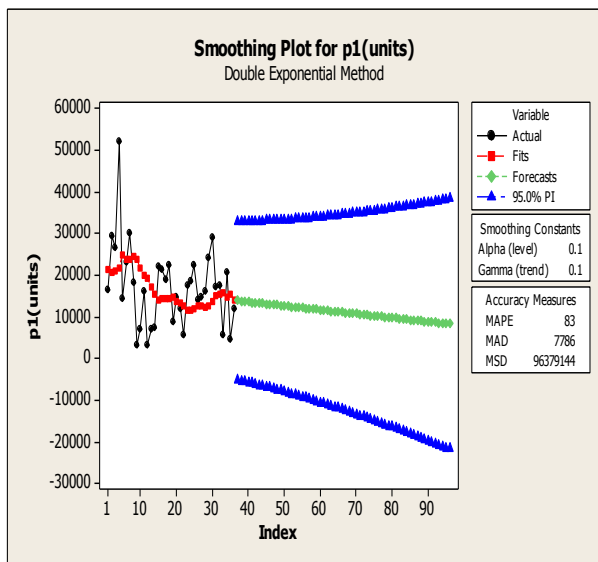


Fig. 5 Double Exponential Smoothing Plot for p1

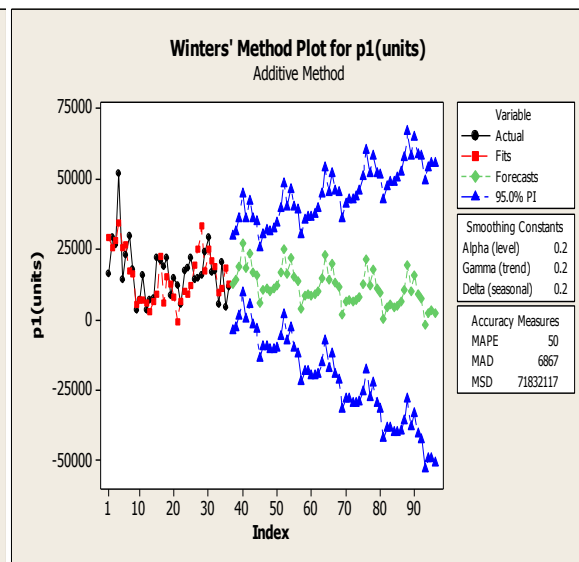


Fig. 6 Winters' Method Plot for p1

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.

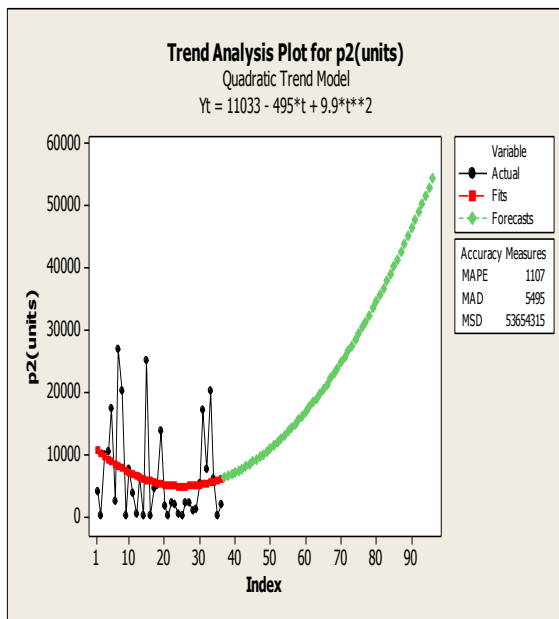


Fig. 7 Graphical Method and Analysis Plot for p2

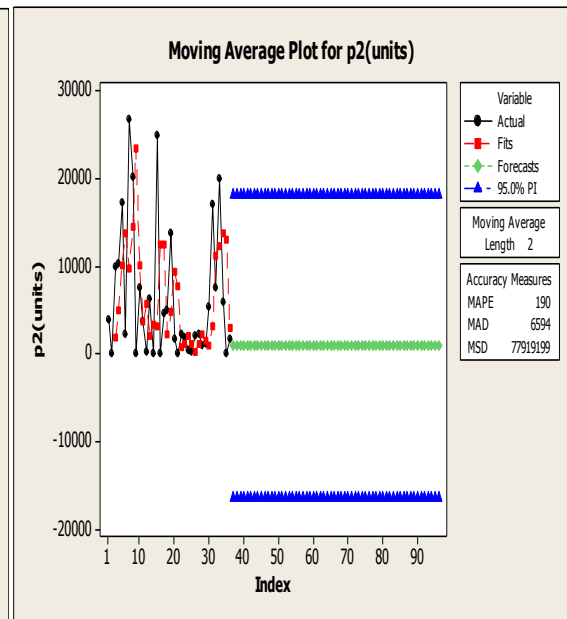


Fig. 8 Moving Average Plot for p2

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).

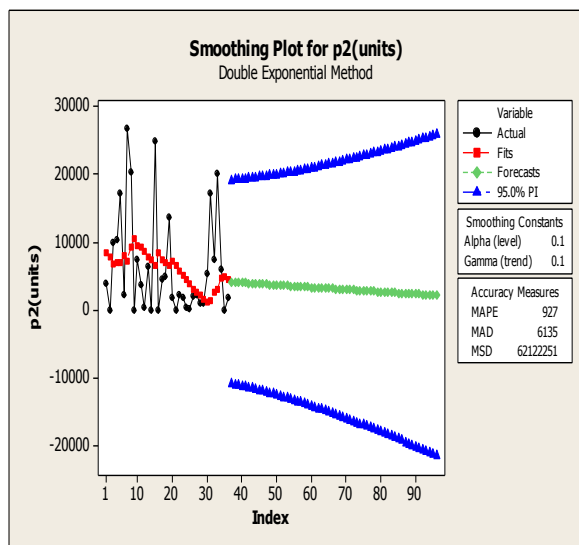


Fig. 9 Double Exponential Smoothing Plot for p2

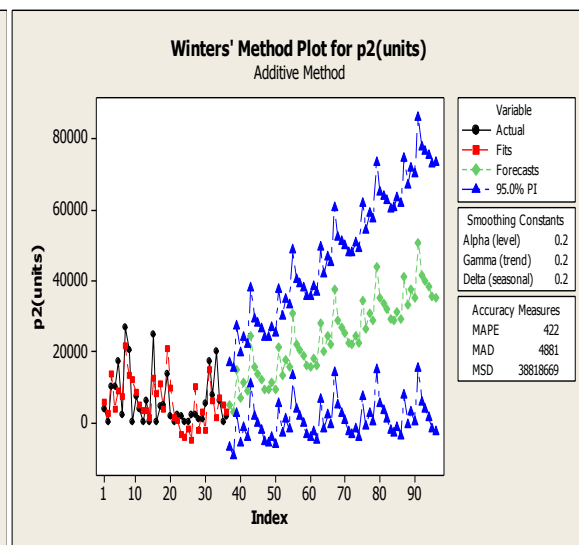


Fig. 10 Winters' Method Plot for p2

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.

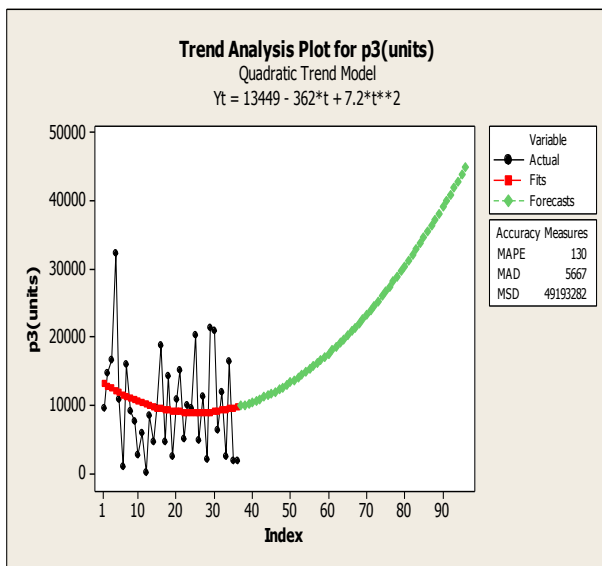


Fig. 11 Trend Analysis Plot for p3

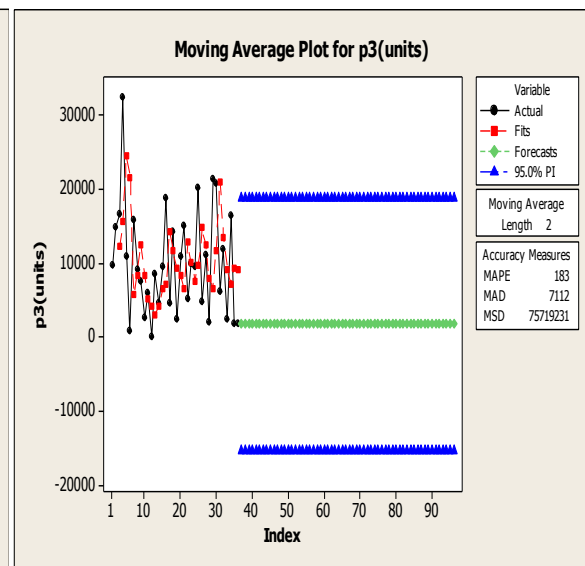


Fig. 12 Moving Average Plot for p3

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).

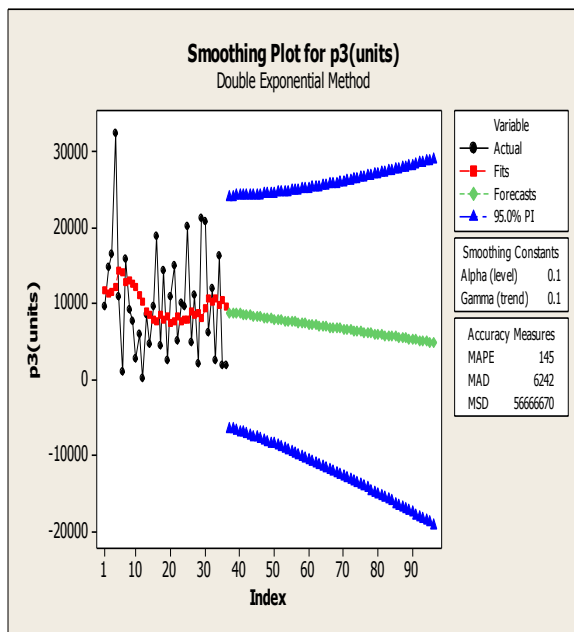


Fig. 13 Double Exponential Smoothing Plot for p3

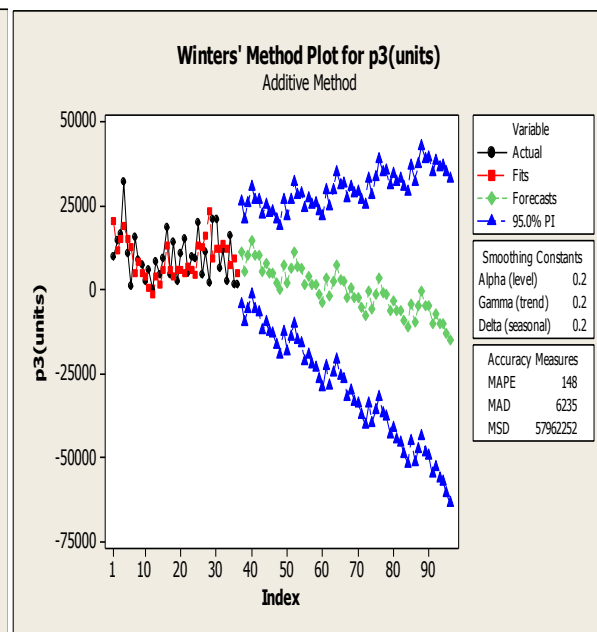


Fig. 14 Winters' Method Plot for p3

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.

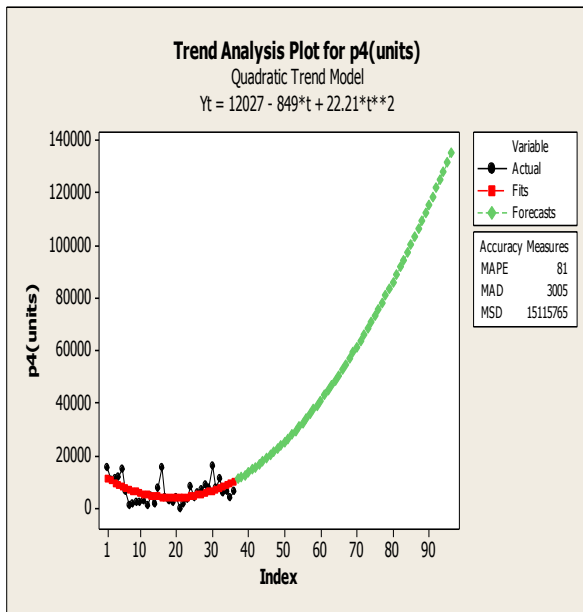


Fig. 15 Graphical Method and Analysis Plot for p4

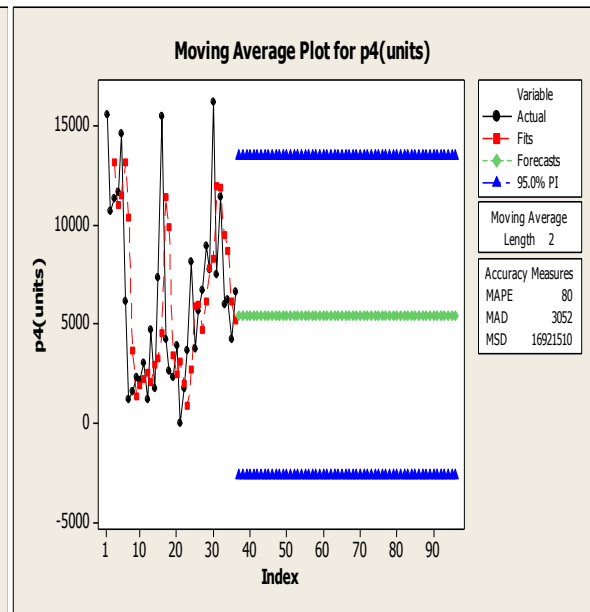


Fig. 16 Moving Average Plot for p4

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).

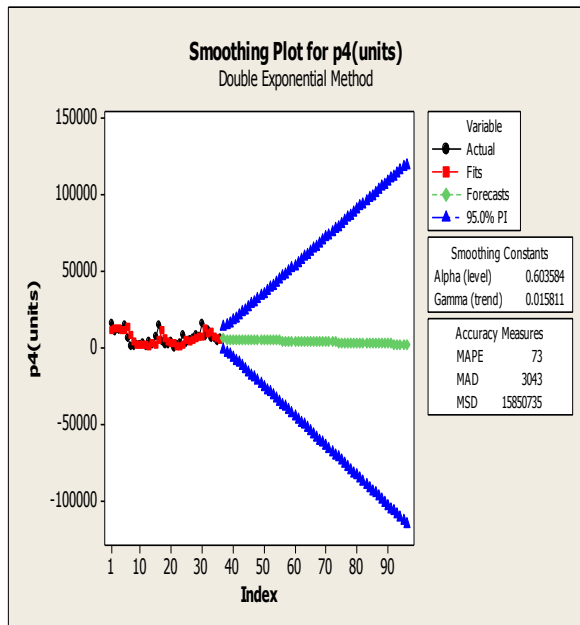


Fig. 17 Double Exponential Smoothing Plot for p4

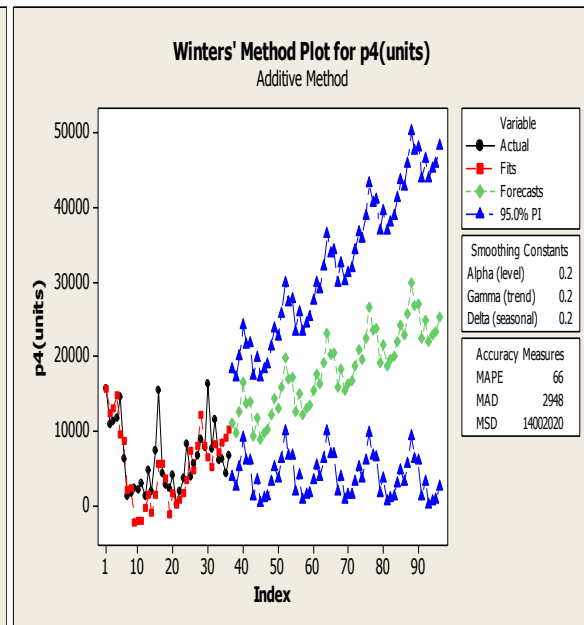


Fig. 18 Winters' Method Plot for p4

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 advised 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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