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Productivity Evaluation in a Manufacturing Industry Using a Forcasting Model

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ABSTRACT: *In this paper, the production quantity of four selected products in British American Tobacco, Ibadan, Nigeria, was forecasted using the winters forecasting model, in order to foresee the future production quantities of their products for the next five years (2015-2019). Time series decomposition analysis was used to study the trend and seasonality in the existing data gotten from the case study company from (2010-2014). The total result obtained for five years based on the data analysed for the production quantity of each product for the period of five years were presented in order of actual and winters result respectively. X1=28957095, X1=30307473, X2=6228361, X2=8465290, X3=9530198, X3=11462915, X4=2041990, X4=-739949. The results obtained using the adopted model showed that Benson and Hedges(X1), London menthol(X2) and Rothmans(X3) will be increasing gradually in (their quantity output) for the next five years (2015-2019) while Pall Mall(X4) will be reducing gradually in their production for the next five years (2015-2019). There is indeed a significant increase from the results in the production output of the selected products using the winters' model as against the actual production output of the products, as could be seen in the time series decomposition trend which justifies the research work.*

I. INTRODUCTION

The use of tobacco as generically known is as early as the existence of man [1].With the world population increasing rapidly over the years, the number of smokers has also been on the increase. This mounted enormous pressure on the manufacturers to meet this ever-rising demand and to make sure that the consumers are satisfied with the quality of the products. Quality and quantity of products are examples of process (production) characteristics and they are both immanent to modern economics where business entities are operating in rapidly changeable and unstable environment.

Forecasting is defined as the use of historical data to determine the direction of future trends [2]. Forecasting can also be defined as the process of making predictions of the future based on past and present data and analysis of trends [3].Forecasting is essential for decision making, unless insurance is selected to deal with the future [4]. Statistical analysis of time series data started a long time ago [5], and forecasting has an even longer history. Objectives of the two studies may differ in some situations but forecasting is often the goal of a time series analysis. A common place example might be estimation of some variable of interest at some specified future date. Prediction is a similar but more general term. Both might refer to formal statistical methods or longitudinal data or alternatively to less formal judgmental methods. Usage can differ between areas of application: for example, in hydrology, the teams "forecast" and "forecasting" are sometimes reserved for estimates of values at certain specific future times. While the term "prediction" is used for more general estimates, such as the number of times flood will occur over a long period [6].

Forecasting is divided into two categories, which are qualitative and quantitative methods [7]. Qualitative methods are subjective, based on the opinion and judgment of consumers and experts. They are appropriate when past data are not available. Quantitative forecasting methods are used to forecast future data as a function of past data. They are appropriately used when past numerical data is available and when it is reasonable to assume that some patterns are expected to continue into the future. These methods are usually applied to start or inter mediate range decisions. Examples of quantitative forecasting models are last period demand, simple exponential smoothing and multiplicative seasonal indexes etc. Forecasting models can be broken into approaches like average approach, casual econometric methods, naïve approach, drift method, seasonal naïve approach, artificial intelligence methods and time series methods [8].

Time series methods use historical data as the basis of estimating future outcomes. Examples are: Moving average, Weighted moving average, Winters model, Exponential smoothing model, Kalmau filtering, Auto regressive moving average (ARMA), Autoregressive integrated moving average (ARIMA), Extrapolation, Linear prediction, Trend estimation, Growth curve (statistics). A time series is a sequence of data points, typically consisting of successive measurements made over a time interval [9].Time series are used in mechanical engineering, statistics, signal processing, pattern recognition, econometrics, mathematical finance, weather forecasting, intelligent transport and trajectory forecasting, earthquake prediction, electro encephalography, control engineering astronomy, communications engineering and largely in any domain of applied science and engineering [9].

Exponential Smoothing is a procedure for continually revising a forecast with light of none recent experience [8].It assigns exponentially decreasing weights as the observation get older. In other words, recent observations are given relatively no weight in forecasting than the older observations. This is a rule of thumb technique for smoothing time series data, particularly for computing in a finite amount of time by applying as many as three low-pass filters (three filters that passes signals with a frequency lower than a certain cut off frequency and reduces in degree the signals with frequencies higher than the cut off frequency) with exponential window functions [10]. Exponential Smoothening is categorized into three, which are; single, double and triple exponential smoothening. The single exponential smoothening is used for short range forecasting, usually first one month into the future, whereas the Double Exponential Smoothening is used when the data shows a trend. For data showing trend and seasonality, the Triple Exponential Smoothening, also called the Winters Model is used [11].

A few examples of works on forecasting includes the Sales forecast in Apparel and Fashion industry using data mining techniques, extrapolation techniques based on pre-sales and triple exponential smoothing [12] and forecasting of the production quantity done on Louis Carter plastic industry using historical data [13].
Having seen so many researches in the area of forecasting especially in industries, this paper is therefore aimed at the forecasting of production quantity of some selected tobacco products in a tobacco industry using the double exponential smoothing model and winters model as the forecasting techniques/ models.

II. METHODOLOGY

2.1 Data collection

Production data of four different products on a monthly basis for a period of five years (2010-2014), was collected from British America Tobacco (Nigeria) Limited located at Ibadan, Oyo state, Nigeria.

Table 1: Presentation of 2010-2014 Monthly Data on X1-X4 Sticks Production in thousands of sticks.

Year	*Month*	M. Code	*X1(sticks)*	*X2(sticks)*	*X3(sticks)*	*X4(sticks)*
2010	Jan	1	456,323	58,313	96,443	30,111
	Feb	2	463,582	75,441	160,337	30,672
	Mar	3	458,779	102,383	163,256	25,911
	April	4	473,186	103,321	134,793	27,336
	May	5	488,663	74,102	170,225	32,212
	June	6	493,218	88,557	167,518	34,190
	July	7	393,674	114,338	172,316	28,233
	Aug	8	476,338	100,318	83,603	40,018
	Sept	9	502,313	112,006	166,441	39,774
	Oct	10	411,278	79,201	132,559	35,301
	Nov	11	401,223	80,012	137,212	41,188
	Dec	12	306,113	79,663	131,119	40,033
2011	Jan	13	474,310	111,088	132,793	57,000
	Feb	14	590,911	133,384	204,803	36,831
	Mar	15	577,583	125,596	178,271	25,043
	April	16	540,714	71,077	124,344	45,072
	May	17	591,233	69,254	256,062	46,411
	June	18	526,084	111,263	189,077	49,311
	July	19	676,912	100,154	116,972	55,290
	Aug	20	388,532	113,651	82,704	38,211
	Sept	21	460,761	112,488	157,876	63,354
	Oct	22	493,897	128,045	183,064	2,093
	Nov	23	317,681	110,573	137,226	28,668
	Dec	24	162,321	70,126	137,299	0

2012	Jan	25	481,513	59,834	92,681	0
	Feb	26	493,674	133,636	174,976	39986
	Mar	27	511,846	130,951	184,293	35,374
	April	28	581,633	110,107	244,164	32,297
	May	29	590,244	107,174	160,546	42,189
	June	30	514,382	122,546	249,823	23,174
	July	31	594,445	59,926	154,126	54,570
	Aug	32	400,617	142,000	114,173	0
	Sept	33	451,783	50,890	124,096	0
	Oct	34	478,271	74,317	202,630	45,026
	Nov	35	400,667	107,936	84,900	16,111
	Dec	36	318,799	92,000	181,317	11,780
2013	Jan	37	493,460	120,094	138,469	47,223
	Feb	38	593,611	142,671	300,116	42,453
	Mar	39	586,423	134,562	211,793	34,230
	April	40	553,007	80,626	146,555	61,169
	May	41	596,178	78,712	312,446	46,432
	June	42	534,629	120,167	200,662	38,631
	July	43	680,442	109,169	186,472	44,662
	Aug	44	492,337	126,445	100,652	27,851
	Sept	45	500,681	124,339	176,442	36,781
	Oct	46	511,556	139,452	198,279	54,972
	Nov	47	397,442	119,697	146,476	31,930
	Dec	48	300,651	87,457	148,568	30,881
2014	Jan	49	449,650	140,980	106,340	25,450
	Feb	50	451,880	52,130	162,210	33,070
	Mar	51	555,674	124,780	166,948	37,260
	April	52	434,658	73,860	135,565	28,712
	May	53	574,416	109,510	157,300	26,100
	June	54	503,217	122,671	106,360	30,448
	July	55	684,346	110,231	85,490	46,323
	Aug	56	481,229	131,442	142,660	45,118
	Sept	57	500,391	126,317	156,379	62,390
	Oct	58	511,372	130,119	172,600	27,114
	Nov	59	332,116	117,143	144,372	30,020
	Dec	60	294,226	90,116	143,006	0
	Total		28957095	6228361	9530198	2041990

2.2 Winters Model

The winters model was adopted for this work in order to capture seasonality. It comprises the forecast equation and three smoothing equations- one for the level $\{l_t\}$, one for the trend $\{b_t\}$, and one for the seasonal component denoted by $\{S_t\}$, with smoothing parameters α, γ and Δ [14]. We use 'm' to denote the period of the seasonality i.e the number of seasons in a year. For example, for quarterly data m = 4, and for monthly data m = 12.There are two variations to this method that differ in the nature of the seasonal component; the additive method and multiplicative method. Due to the multiplicative nature of the seasonal component, the multiplicative method was adopted.

The component form for the multiplicative method is:

$$y_t + {}^{h}/_{t} = (I_t + hb_t)S_{t-m} + h_m$$

$$I_t = \alpha \frac{y_t}{S_{t-m}} + (1-\alpha)(I_{t-1} + b_{t-m})$$

$$b_t = \gamma(I_t - I_{t-1}) + (1-\gamma)b_{t-1}$$

$$s_t = \Delta \frac{y_t}{l_{t-1} + b_{t-1}} + (1-\Delta)s_{t-m}$$

And the error correction representation is:

$$I_t = I_{t-1} + b_{t-1} + \Delta \frac{e_t}{S_{t-m}}$$

$$b_t = b_{t-1} + \alpha\,\gamma \frac{e_t}{S_{t-m}}$$

$$s_t = s_{t-1} = \Delta \frac{e_t}{l_{t-1} + b_{t-1}}$$

where $e_t = y_t - (I_{t-1} + b_{t-1}) s_{t-m^0}$

2.3 Time series Decomposition

Time series decomposition was employed to study the actual data for the sticks, the duration is 60 months, and the model assumes the seasonal effect to be the same for all the years.

III. RESULTS ANALYSIS

Modeling with Historical Data

Historical data were used to model, analyze and to forecast the future production output of the four different product of the case company. The model computed a seasonal period of 1-12 implying January to December and the seasonal index is the effect of season in each month.

Table 2: Time series decomposition for x1(sticks)

Data X1(sticks)

Length 60

NMissing 0

Accuracy Measures

MAPE	9
MAD	38230
MSD	2536357839

Seasonal Indices

Period	Index
1	0.96097
2	1.10020
3	1.12759
4	1.06382
5	1.17518
6	1.05092
7	1.25788
8	0.88326
9	0.97570
10	0.98495
11	0.79958
12	0.61996

From table 2, the lowest seasonal index (0.61996) in the 12th month implies that it is not affected much by season which shows a better production output as compared to the 7th month which has the highest seasonal index of 1.25788, where production output will be affected negatively due to the effect of season.

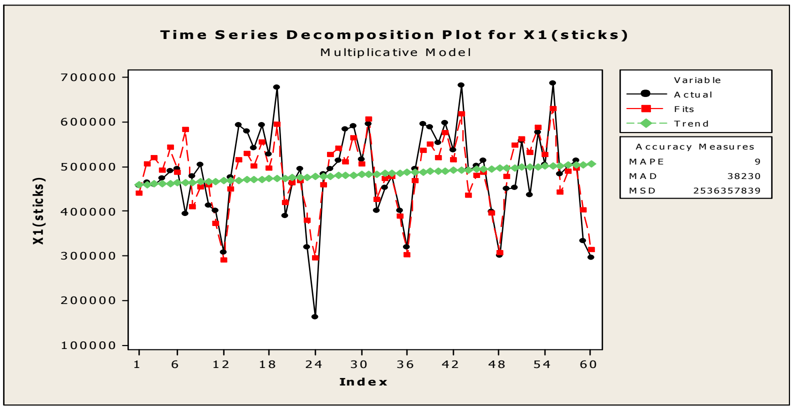

Figure 1: Time Series Decomposition Plot for X1(sticks)

Figure 1 show the time series trend in the data which reveals that the future production of Benson& Hedges tobacco sticks will gradually and continuously increase in their future production. This is because the trend which is the green spotted on the figure is seen to be increasing gradually and this is a sign that the actual future production of the X1 sticks is on an increasing side.

Table 3: Time Series Decomposition for X2(sticks)

Data X2(sticks)
Length 60
NMissing 0

Accuracy Measures
MAPE 18
MAD 14604
MSD 517174737

Seasonal Indices

Period	Index
1	1.11101
2	1.26234
3	1.21475
4	0.68719
5	0.80723
6	1.04551
7	0.92451
8	1.08452
9	1.08395
10	0.98928
11	1.01651
12	0.77320

From The Time series decomposition for X2 sticks as in table 3 above, it can be deduced that the 4th and 2nd months have the lowest and highest seasonal index of 0.68719 and 1.26234 respectively. This implies that the 4th month is not affected much by season which gives a better production output as compared to the 2nd month which has the highest seasonal index and consequently negatively affected production output.

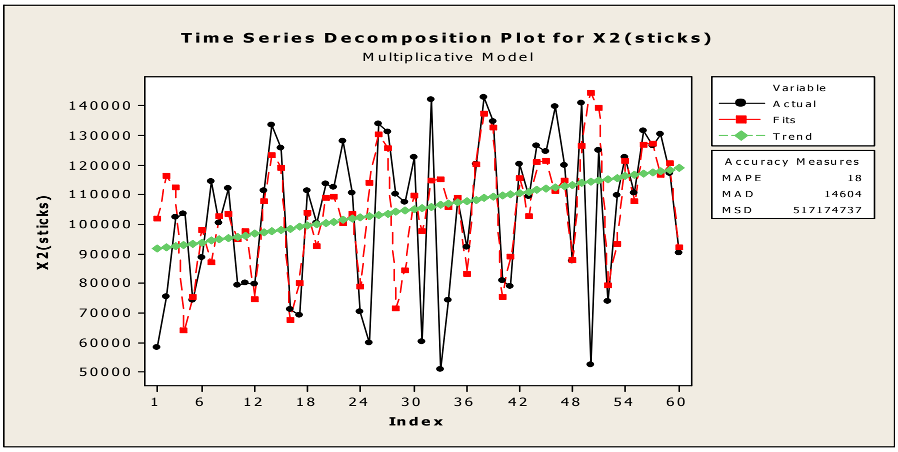

Figure 2: Time Series Decomposition Plot for X2(sticks)

The trend in figure 2 above reveals that the future production of the London Menthol Nigeria tobacco sticks will gradually and continuously increase in their future production. This is because the trend which is the green spotted on the figure is seen to be increasing gradually and this is a sign that the actual future production of the X2 sticks is on a continuous increase in production.

Table 4: Time Series Decomposition for X3(sticks)

Data X3(sticks)
Length 60
NMissing 0

Accuracy Measures
MAPE 17
MAD 25489
MSD 1328455961

Seasonal Indices

Period	Index
1	0.74591
2	1.23125
3	1.15161
4	0.87729

5 1.37024
6 1.12466
7 0.96117
8 0.56126
9 1.02646
10 1.15282
11 0.87740
12 0.91993

In the Time Series Decomposition for X3(sticks) in table 4 above, the month with the lowest seasonal index (0.56126) is the 8th month, which implies that it is not affected much by season which gives a better production output when compared to the 2nd month with the highest seasonal index of 1.23125 which will have its production output affected negatively due to the effect of season.

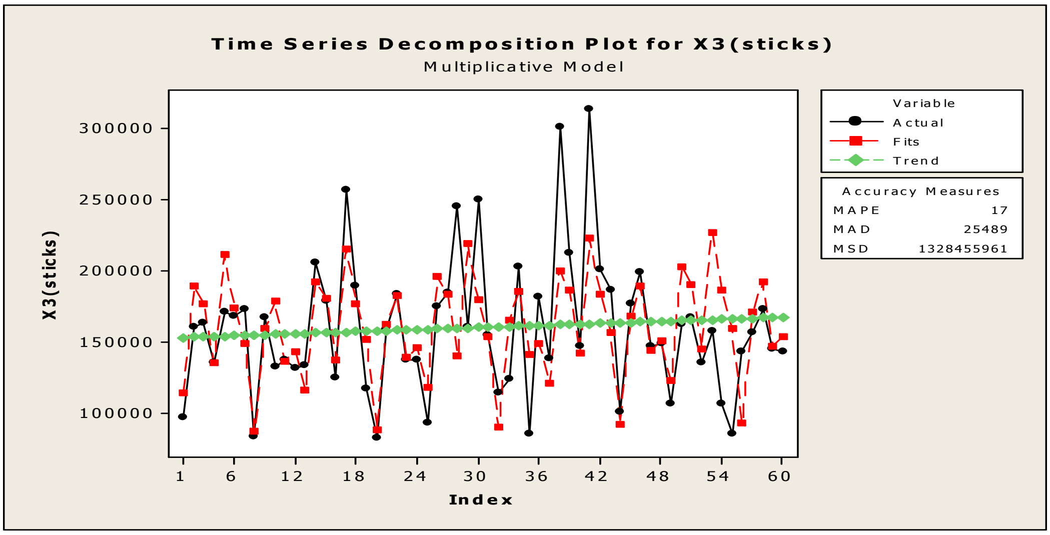

Figure 3: Time Series Decomposition Plot for X3(sticks)

The trend in figure 3 above reveals that the future production of the Rothmans Nigeria tobacco sticks will gradually and continuously increase in their future production. This is because the trend which is the green spotted on the figure is seen to be increasing gradually and this is a sign that the actual future production of the X3 sticks is on a positive increase.

Table 5: Time Series Decomposition for X4(sticks)

Data X4(sticks)
Length 60
NMissing 0

Accuracy Measures
MAPE 56
MAD 10936
MSD 202082031

Seasonal Indices

Period	Index
1	1.02105
2	1.06719
3	0.94503
4	1.17094
5	1.11365
6	0.91201
7	1.29320
8	0.87328
9	0.97950
10	1.15845
11	0.85838
12	0.60731

The time series decomposition for X4 sticks in table 5 above shows that The 12th month has the lowest seasonal index (0.85838), which implies that it will not be affected much by season, which gives a better production output as compared to the 7th month with the highest seasonal index of 1.29320.

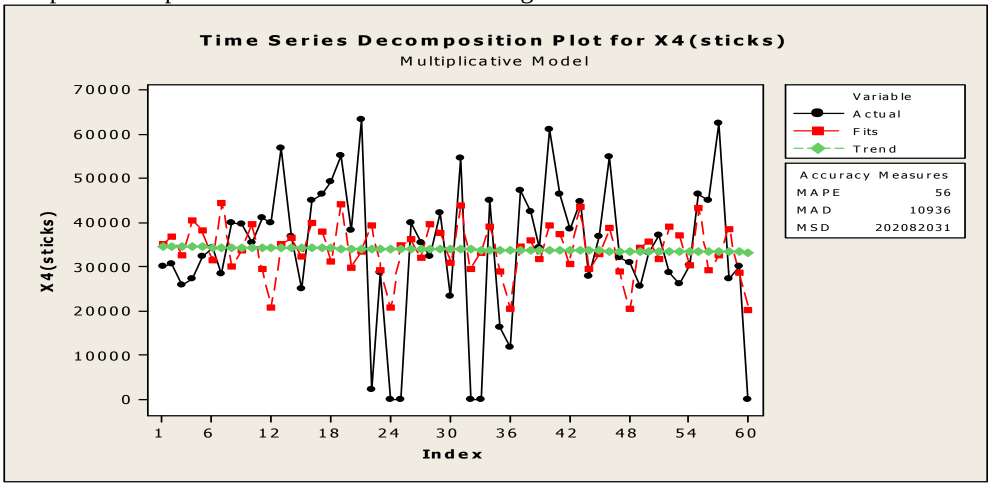

Figure 4: Time Series Decomposition Plot for X4(sticks)

The time series trend in figure 4 above reveals that the future production of the Pallmall Nigeria sticks will gradually and continuously decrease in their future production. This is because the trend which is the green spotted on the figure is seen to be decreasing gradually and this is a sign that the actual future production of the X4 sticks is on a continuous decrease of their future production.

Table 6: Winters' Method for X1(sticks)

Multiplicative Method		Accuracy Measures		Smoothing Constants	
		MAPE	11	Alpha (level)	0.2
Data	X1(sticks)	MAD	49098	Gamma (trend)	0.2
Length	60	MSD	3811379937	Delta (seasonal)	0.2

Time	X1(sticks)	Smooth	Predict	Error	Time	X1(sticks)	Smooth	Predict	Error
1	456323	489689	481025	-24702	31	594445	564146	565439	29006
2	463582	524221	513594	-50012	32	400617	437955	439836	-39219
3	458779	522234	509139	-50360	33	451783	470531	470872	-19089
4	473186	479209	464701	8485	34	478271	456683	456269	22002
5	488663	512773	497195	-8532	35	400667	357269	357630	43037
6	493218	448513	434103	59115	36	318799	260676	262158	56641
7	393674	525201	511015	-117341	37	493460	499913	506764	-13304
8	476338	360330	346376	129962	38	593611	552071	558992	34619
9	502313	401757	392310	110003	39	586423	577942	586424	-1
10	411278	412580	407555	3723	40	553007	582537	590962	-37955
11	401223	313766	310019	91204	41	596178	622940	630316	-34138
12	306113	245286	245212	60901	42	534629	565638	571091	-36462
13	474310	435590	439588	34722	43	680442	640965	645506	34936
14	590911	487918	493803	97108	44	492337	489009	493460	-1123
15	577583	532086	542215	35368	45	500681	541592	546430	-45749
16	540714	537648	548947	-8233	46	511556	532849	535832	-24276
17	591233	598321	610313	-19080	47	397442	416355	417933	-20491
18	526084	562190	572599	-46515	48	300651	298698	299245	1406
19	676912	624640	634119	42793	49	449650	527713	528776	-79126
20	388532	521592	530674	-142142	50	451880	569664	567330	-115450
21	460761	535027	538645	-77884	51	555674	550418	543387	12287
22	493897	500386	500867	-6970	52	434658	536581	530152	-95494
23	317681	400310	400472	-82791	53	574416	546627	535664	38752
24	162321	285060	282722	-120401	54	503217	492205	483680	19537
25	481513	426986	415174	66339	55	684346	564917	555945	128401
26	493674	476397	466214	27460	56	481229	432038	429188	52041
27	511846	479562	470326	41520	57	500391	476292	475460	24931
28	581633	462594	455273	126360	58	511372	479531	479697	31675
29	590244	523959	521487	68757	59	332116	380880	382002	-49886
30	514382	492059	492316	22066	60	294226	270868	270232	23994

Table 6 above, shows the time which is the length of period i.e. 1-60months, the X1 sticks which is the actual data of the X1 sticks, the smooth which is the smoothened data of the actual data, the predict which is the predicted data of the model and the error which is the actual data minus the predicted data.

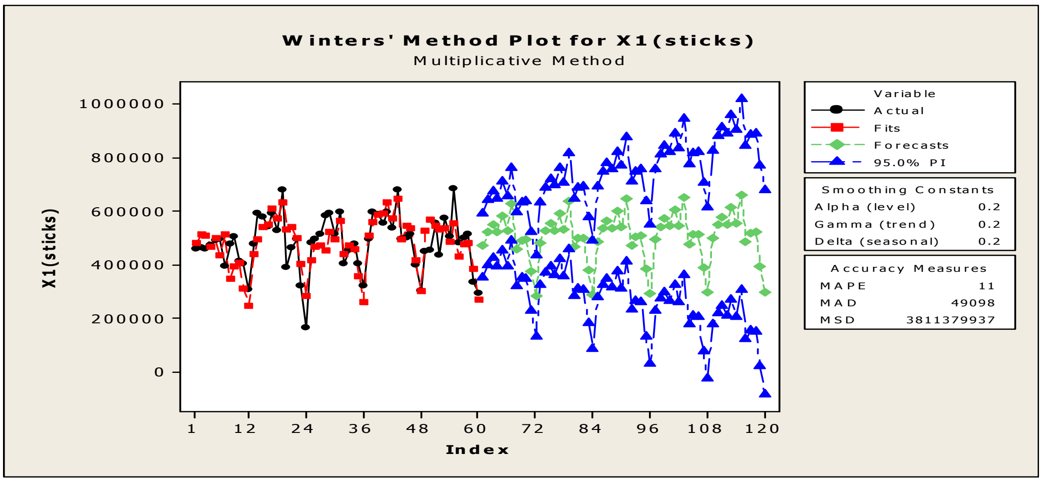

Figure 5: Winters' Method Plot for X1(sticks)

Figure 5 shows the actual data and fit versus months' plot (from 2010-2014 or 1-60) and the future prediction of the Benson & Hedges tobacco production sticks over the next period of five years (i.e. from 2015 to 2019 or from 60-120). The forecast on the chart which is the green marked shows a gradual and a continuous increment of the production quantity in the next five years (from 2015- 2019). The values of the forecast are shown in table 10 and it shows that at the end of 2019 i.e. 120th month, they will be producing up to 30,307,473,000 sticks (∑ of the 3rd column) as against the actual value of 28,957,095,000 sticks in table 1.

Table 7: Winters' Method for X2(sticks**)**

Multiplicative Method

Data X2(sticks) Smoothing Constants Accuracy Measures

Length 60 MAPE 22

Alpha (level) 0.2 MAD 18866

Gamma (trend) 0.2 MSD 629041633

Delta (seasonal) 0.2

Time	X2(sticks)	Smooth	Predict	Error	Time	X2(sticks)	Smooth	Predict	Error
1	58313	78596	79462	-21149.2	31	59926	114975	116838	-56911.8
2	75441	82722	82744	-7303.3	32	142000	121496	121019	20980.9
3	102383	93313	93003	9379.9	33	50890	114004	114334	-63444.0
4	103321	67448	67494	35827.1	34	74317	101634	99426	-25108.8
5	74102	74329	75802	-1699.9	35	107936	89889	86830	21105.8
6	88557	97173	98982	-10424.8	36	92000	71416	69679	22321.2
7	114338	84706	85923	28414.8	37	120094	83228	82281	37813.2
8	100318	113632	116551	-16233.1	38	142671	114324	115043	27628.0
9	112006	97062	99006	13000.0	39	134562	131234	133220	1341.8
10	79201	106220	108796	-29594.8	40	80626	98694	100202	-19575.9
11	80012	99897	101250	-21237.6	41	78712	89830	90506	-11794.3
12	79663	75971	76364	3298.8	42	120167	112898	113159	7007.6
13	111088	86580	8717123	917.0	43	109169	97285	97746	11423.4
14	133384	10434	9106105	27278.5	44	126445	129519	130707	-4262.0
15	125596	131995	135364	-9768.2	45	124339	103643	104454	19884.6
16	71077	100531	102775	-31697.8	46	139452	115322	117031	22420.6
17	69254	88842	89741	-20486.9	47	119697	125328	128016	-8319.1
18	111263	108778	108879	2384.0	48	87457	100163	102030	-14572.6
19	100154	102100	102284	-2129.8	49	140980	113295	114763	26217.0
20	113651	117615	117729	-4077.9	50	52130	148316	151427	-99296.7
21	112488	104601	104557	7931.1	51	124780	138364	137457	-12677.5
22	128045	103732	103999	24046.3	52	73860	96354	95345	-21484.7
23	110573	106875	108082	2491.3	53	109510	85919	84156	25354.5
24	70126	88729	89797	-19670.8	54	122671	117922	116932	5738.7
25	59834	99848	100174	-40340.3	55	110231	101116	100465	9766.1
26	133636	104272	102815	30821.5	56	131442	129548	129218	2224.2
27	130951	122632	122380	8571.4	57	126317	107088	106889	19427.6
28	110107	89643	89708	20399.0	58	130119	117835	118450	11668.9
29	107174	87708	88533	18641.4	59	117143	119727	120799	-3656.1
30	122546	122271	124352	-1805.6	60	90116	93931	94656	-4539.7

Table 7, it shows the time which is the length of period i.e. 1-60months, the X2 sticks which is the actual data of the X2 sticks, the smooth which is the smoothened data of the actual data, the predict which is the predicted data of the model and the error which is the actual data minus the predicted data.

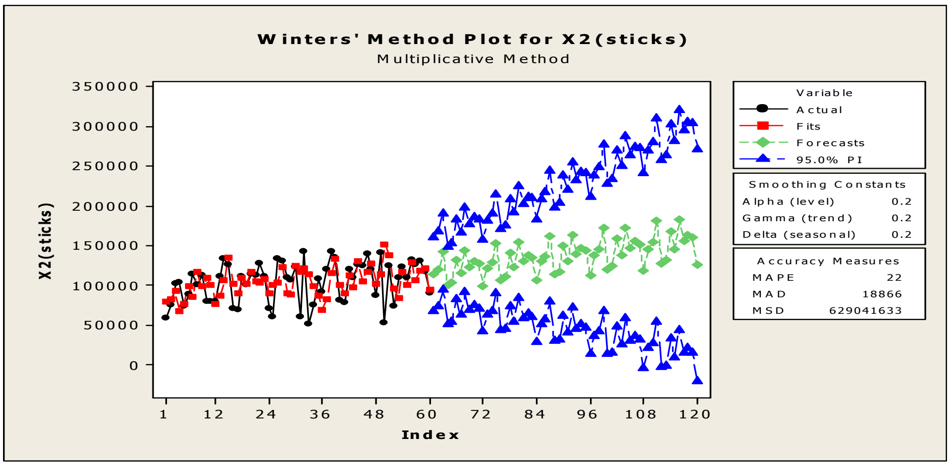

Figure 6: Winters' Method Plot for X2(sticks)

Figure 6 above, shows the actual data and fit versus months' plot (from 2010-2014 or 1-60) and the future prediction of the London Menthol tobacco production sticks over the next period of five years (i.e. from 2015 to 2019 or from 60-120). The forecast on the chart shows a gradual and a continuous increment of the production quantity in the next five years (from 2015- 2019). The values of the forecast are shown in table 10 and it shows that at the end of 2019 i.e.120th month, they will be producing up to 8,465,290,000 sticks (∑ of the 3rd column) as against the actual value of 6,228,361,000 sticks (∑ of the 5th column in table 1).

Table 8: Winters' Method for X3(sticks)

Multiplicative Method	Smoothing Constants	Accuracy Measures
Data X3(sticks)	Alpha (level) 0.2	MAPE 19
Length 60	Gamma (trend) 0.2	MAD 28747
	Delta (seasonal) 0.2	MSD 1398896094

Time	X3(sticks)	Smooth	Predict	Error	Time	X3(sticks)	Smooth	Predict	Error
1	96443	104340	103994	-7551	31	154126	158475	161512	-7386
2	160337	181243	180098	-19761	32	114173	109298	111171	3002
3	163256	158940	157193	6063	33	124096	181982	185226	-61130
4	134793	137529	136223	-1430	34	202630	187267	188132	14498
5	170225	182847	181014	-10789	35	84900	147060	148172	-63272
6	167518	154640	152682	14836	36	181317	146587	145053	36264
7	172316	121889	120820	51496	37	138469	118332	118267	20202
8	83603	95940	96665	-13062	38	300116	212678	213969	86147
9	166441	140314	140616	25825	39	211793	216601	221039	-9246
10	132559	165871	167391	-34832	40	146555	198163	201841	-55286
11	137212	117310	117402	19810	41	312446	235108	236915	75531
12	131119	138355	139363	-8244	42	200662	237779	242334	-41672
13	132793	104172	104686	28107	43	186472	174178	176329	10143
14	204803	193862	196740	8063	44	100652	123246	125012	-24360
15	178271	183365	186324	-8053	45	176442	183759	184970	-8528
16	124344	159125	161396	-37052	46	198279	212820	213830	-15551
17	256062	205471	206525	49537	47	146476	148298	148571	-2095
18	189077	191834	194523	-5446	48	148568	179790	180019	-31451
19	116972	158579	160606	-43634	49	106340	133460	132670	-26330
20	82704	102236	102425	-19721	50	162210	228704	225395	-63185
21	157876	154518	153577	4299	51	166948	186841	181716	-14768
22	183064	164941	164120	18944	52	135565	155168	150206	-14641
23	137226	130524	130474	6752	53	157300	199445	191933	-34633
24	137299	145053	145296	-7997	54	106360	161818	154036	-47676
25	92681	114223	114162	-21481	55	85490	111722	104231	-18741
26	174976	186729	185164	-10188	56	142660	66576	61116	81544
27	184293	167022	165224	19069	57	156379	121483	118034	38345
28	244164	140998	140135	104029	58	172600	145334	143119	29481
29	160546	231529	236273	-75727	59	144372	105886	105150	39222
30	249823	188220	189679	60144	60	143006	133454	134438	8568

Table 8, it shows the time which is the length of period i.e. 1-60months, the X3sticks which is the actual data of the X3 sticks, the smooth which is the smoothened data of the actual data, the predict which is the predicted data of the model and the error which is the actual data minus the predicted data.

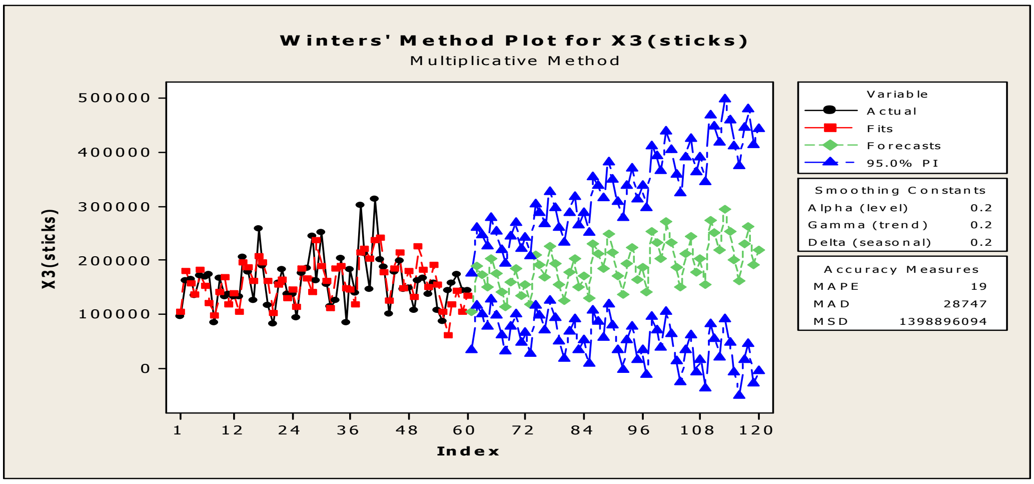

Figure 7: Winters' Method Plot for X3(sticks)

Figure 7 shows the actual data and fit versus months' plot (from 2010-2014 or 1-60) and the future prediction of the Rothmans tobacco production sticks over the next period of five years (i.e. from 2015 to 2019 or from 60-120). The forecast on the chart which is the green marked shows a gradual and a continuous increment of the production quantity in the next five years (from 2015- 2019). The values of the forecast are shown in table 10 and this shows that at the end of 2019 i.e. the 120th month they will be producing up to 11,462,915,000 sticks (∑ of 3rd column) as against the actual value of 9,530,198,000 sticks in table 1.

Table 9: Winters' Method for X4(sticks)

Multiplicative Method	Smoothing Constants	Accuracy Measures
Data X4(sticks)	Alpha (level) 0.2	MAPE 71
Length 60	Gamma (trend) 0.2	MAD 13169
	Delta (seasonal) 0.2	MSD 277357360

Time	X4(sticks)	Smooth	Predict	Error	Time	X4(sticks)	Smooth	Predict	Error
1	30111	24226.3	25372.1	4738.9	31	54570	28527.4	27217.9	27352.1
2	30672	30152.6	31682.5	-1010.5	32	0	24297.4	24137.4	-24137.4
3	25911	27151.9	28436.5	-2525.5	33	0	25297.3	23822.7	-23822.7
4	27336	34438.2	35897.5	-8561.5	34	45026	12433.3	10849.7	34176.3
5	32212	33964.8	35074.5	-2862.5	35	16111	19806.4	19563.8	-3452.8
6	34190	31364.2	32268.9	1921.1	36	11780	9460.7	9269.9	2510.1
7	28233	42570.8	43850.4	-15617.4	37	47223	17426.6	17265.3	29957.7
8	40018	26880.3	27312.6	12705.4	38	42453	34961.3	36520.3	5932.7
9	39774	39949.3	41207.9	-1433.9	39	34230	31205.7	32692.3	1537.7
10	35301	33282.2	34259.2	1041.8	40	61169	38316.8	40114.3	21054.7
11	41188	30984.9	31900.5	9287.5	41	46432	47458.0	50284.3	-3852.3
12	40033	18866.6	19586.0	20447.0	42	38631	41830.5	44088.0	-5457.0
13	57000	47046.8	50101.6	6898.4	43	44662	58663.7	61445.9	-16783.9
14	36831	57032.1	60722.0	-23891.0	44	27851	30463.9	31570.9	-3719.9
15	25043	47799.1	50135.2	-25092.2	45	36781	40385.4	41640.7	-4859.7
16	45072	54181.7	55781.9	-10709.9	46	54972	43419.4	44552.1	10419.9
17	46411	54781.8	55978.6	-9567.6	47	31930	38727.1	40013.9	-8083.9
18	49311	50278.2	51035.2	-1724.2	48	30881	20642.8	21160.8	9720.2
19	55290	61453.2	62287.4	-6997.4	49	25450	47733.9	49607.2	-24157.2
20	38211	45729.0	46145.2	-7934.2	50	33070	57213.0	58371.9	-25301.9
21	63354	55512.4	55635.6	7718.4	51	37260	43357.4	43476.9	-6216.9
22	2093	46993.9	47348.8	-45255.8	52	28712	52374.7	52214.4	-23502.4
23	28668	35770.5	34411.2	-5743.2	53	26100	46690.3	45609.0	-19509.0
24	0	20266.4	19298.3	-19298.3	54	30448	34954.9	33394.7	-2946.7
25	0	27532.2	24429.1	-24429.1	55	46323	43574.6	41345.6	4977.4
26	39986	19747.8	15624.8	24361.2	56	45118	22831.9	21737.3	23380.7
27	35374	17124.7	14494.2	20879.8	57	62390	34610.0	34401.2	27988.8
28	32297	23825.2	21534.2	10762.8	58	27114	45093.0	46119.7	-19005.7
29	42189	24281.8	22374.6	19814.4	59	30020	32786.0	32992.4	-2972.4
30	23174	25069.2	24008.3	-834.3	60	0	19238.1	19290.1	-19290.1

Table 9 shows the time which is the length of period i.e. 1-60months, the X4sticks which is the actual data of the X4 sticks, the smooth which is the smoothened data of the actual data, the predict which is the predicted data of the model and the error which is the actual data minus the predicted data.

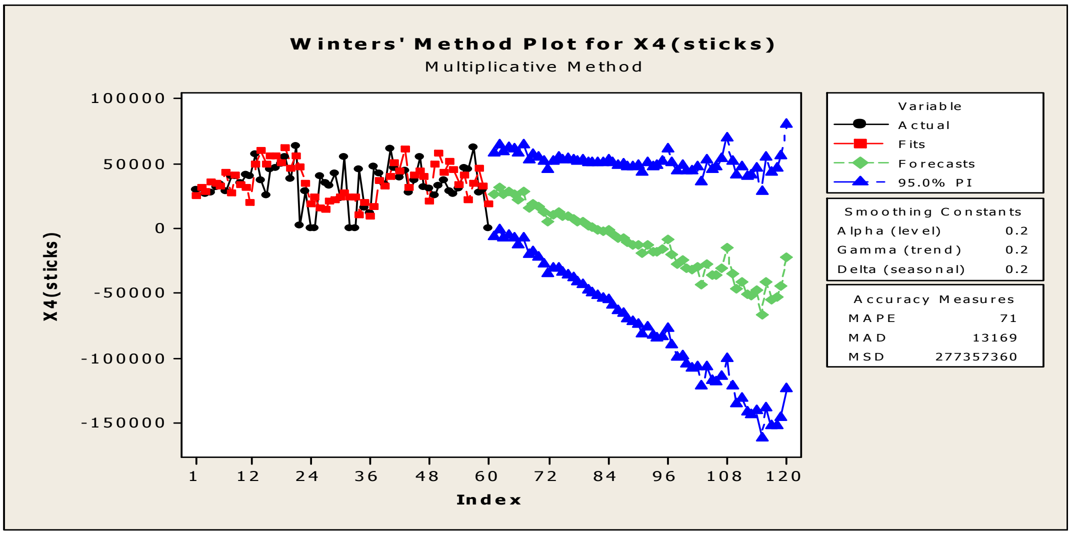

Figure 8: Winters' Method Plot for X4(sticks)

Figure 8 it shows the actual data and fit versus months' plot (from 2010-2014 or 1-60) and the future prediction of the Pall Mall tobacco production sticks over the next period of five years (i.e. from 2015 to 2019 or from 60-120). The trend on the chart which is the green marked shows a gradual and a continuous decrement of the production quantity in the next five years (from 2015- 2019). The values of the forecast are shown in table 10 and this shows that at the end of 2019, the production quantity becomes lesser than the actual production quantity which is -739,949,000 (∑ of 3rd column) as against the actual value of 2,041,990,000 sticks in table 1.

Table 10: presentation of 2015-2019 monthly forecasting results of all Tobacco sticks production

Year	*Month*	M. unit	*X1(sticks)*	*X2(sticks)*	*X3(sticks)*	*X4(sticks)*
2015	Jan	1	472799	114235	105166	26020.2
	Feb	2	520700	120633	187758	31981.0
	Mar	3	547720	142933	172456	26070.7
	April	4	521064	100288	150700	28837.2
	May	5	581747	103405	203053	26837.7
	June	6	524935	132476	175033	22505.8
	July	7	626391	114926	139883	28899.6
	Aug	8	458463	144376	112648	16253.5
	Sept	9	492121	122927	160079	19200.9
	Oct	10	492793	129870	183682	16616.2
	Nov	11	374428	126847	134726	12472.2
	Dec	12	282813	99486	153606	5437.4
2016	Jan	13	479476	122129	117347	10748.1
	Feb	14	528045	128921	209297	12244.9
	Mar	15	555436	152697	192052	9109.7
	April	16	528397	107100	167663	9001.0
	May	17	589924	110390	225697	7254.3
	June	18	532304	141374	194372	5020.1
	July	19	635174	122602	155197	4892.0
	Aug	20	464885	153966	124869	1747.1
	Sept	21	499006	131047	177290	686.9
	Oct	22	499679	138402	203256	-805.5
	Nov	23	379654	135134	148956	-1856.5
	Dec	24	286755	105951	169689	-1470.8
2017	Jan	25	486152	130022	129527	-4524.1
	Feb	26	535389	137209	230835	-7491.2
	Mar	27	563153	162461	211648	-7851.2
	April	28	535729	113912	184626	-10835.2
	May	29	598100	117374	248341	-12329.0
	June	30	539674	150272	213712	-12465.5
	July	31	643958	130278	170512	-19115.7
	Aug	32	471306	163556	137091	-12759.4

	Sept	33	505891	139167	194502	-17827.2
	Oct	34	506565	146933	222830	-18227.1
	Nov	35	384880	143422	163187	-16185.3
	Dec	36	290698	112416	185773	-8379.0
2018	Jan	37	492829	137916	141708	-19796.3
	Feb	38	542734	145497	252374	-27227.2
	Mar	39	570869	172225	231244	-24812.2
	April	40	543061	120724	201589	-30671.3
	May	41	606277	124358	270985	-31912.4
	June	42	547043	159169	233051	-29951.1
	July	43	652741	137954	185826	-43123.3
	Aug	44	477727	173145	149312	-27265.9
	Sept	45	512775	147287	211713	-36341.2
	Oct	46	513451	155465	242404	-35648.7
	Nov	47	390106	151710	177418	-30514.0
	Dec	48	294641	118881	201856	-15287.2
2019	Jan	49	499506	145809	153888	-35068.5
	Feb	50	550078	153785	273912	-46963.3
	Mar	51	578585	181989	250840	-41773.2
	April	52	550393	127536	218553	-50507.5
	May	53	614454	131342	293628	-51495.8
	June	54	554413	168067	252390	-47436.8
	July	55	661525	145630	201141	-67131.0
	Aug	56	484148	182735	161534	-41772.3
	Sept	57	519660	155407	228925	-54855.3
	Oct	58	520337	163997	261978	-53070.3
	Nov	59	395332	159997	191648	-44842.8
	Dec	60	298584	125346	217939	-22195.4
	Total		30307473	8465290	11462915	-739949

Table 10above shows the monthly forecasting results of all the cigarette brands using the winters method over a period of five years (2015-2019) as earlier discussed.

IV. CONCLUSION

The total result obtained using the data for the production quantity of each of the products for the period of five years in thousands of sticks is presented in order of actual and Winters' result respectively, X1=28957095, X1=30307473, X2=6228361, X2=8465290, X3=9530198, X3=11462915, X4=2041990, X4=-739949. From the forecast of the production quantity of four different cigarette brands (Benson and Hedges, London Menthol, Rothmans and Pall Mall) using Winter's method, it can be seen that the future production of Pall Mall will gradually decrease while the rest will gradually keep on increasing, as could been seen in the time series decomposition trend.

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