Selecting the Best Forecasting Method at PT. Indaco Warna Dunia

Maharani Sari M M[1)], Irwan Iftadi[2)]

Department of Industrial Engineering, Sebelas Maret Uiversity,
Jl. Ir. Sutami No. 36 A, Surakarta, 57126, Indonesia[1),2)]
E-Mail : maharanisans99@gmail.com[1)], iftadi@gmail.com[2)]

ABSTRACT

PT. Indaco Warna Dunia is a decorative paint company in Indonesia that produces products under the brands Envi, Belazo, and Top Seal. Preliminary observations revealed that the forecasting method used by the company is ineffective and inaccurate. This inaccurate forecast result company's problem in fulfilling the demand. This study aims to select the best forecasting method to improve forecast effectiveness and accuracy. The research was conducted at the Tarakan depot, and the products understudy were a fast-moving product category, specifically the Envi brand. Several forecasting methods such as Moving Average, Weighted Moving Average, Single Exponential Smoothing, Exponential Smoothing with Trend, and Holt's Double Exponential Smoothing. The accuracy of forecasting is the most important and it can be measured with MAPE (Mean Absolute Percentage Error). The results showed that Holt's Double Exponential Smoothing method is the best for three products, while the Exponential Smoothing with Trend method, and Single Exponential Smoothing method are the best for one of the products, respectively.

Keywords: Moving Average, Weighted Moving Average, Single Exponential Smoothing, Exponential Smoothing with Trend, Holt's Double Exponential Smoothing.

1. Introduction

The development of the business world in Indonesia is growing rapidly with many kinds of competition. Every company must be able to meet consumer needs appropriately and promptly to create and retain customers. In order to fulfill those conditions, it requires inventory control. Forecasting is very important in making decisions for inventory planning. Forecasting is a method that can analyze factors that are known to influence the occurrence of an event over a long period between the need for knowledge of an event in the future with the time that the event has occurred in the future then (Kurniadi, 2018). Forecasting is an important tool in planning effectively and efficiently, especially in economics. Forecasting is part of the decision-support system that can help decision-makers; various methods have been applied in a decision-support system (Chamid & Murti, 2018). In modern organizations knowing the future state is important to see good or bad and aims to prepare to forecast. Several forecasting methods, such as single-moving averages, are often used to support decisions in forecasting historical data. Decision support systems can provide input for decision-makers objectively (Chamid et al., 2015).

PT. Indaco Warna Dunia is a decorative paint company in Indonesia that produces products under the brands Belazo, Envi, and Top Seal. There are various sizes, such as cans, gallons, and pails, and various colors. Each product has a different demand for each period. Sometimes the number of demands has increased drastically and decreased significantly. PT. Indaco Warna Dunia makes production scheduling based on historical sales data for the previous six periods. There is a problem that is often found, that is, the difference between the forecast results and the actual demand. This is an example of the difference between forecasting results and actual demand in the Tarakan depot. Based on the data in Table 1, in July 2019 PT. Indaco Warna Dunia, as the center, sent 260 units of 845G paint to the Tarakan depot and the number of sales for that month was 58 units. There was a surge in demand in August 2019 of 170 units which caused a reduction in

the stock of 845G paint products at the Tarakan depot. So, the Tarakan depot requested the center to send products. The unpredictable increase in demand caused the center to be unable to fulfill the demand for the Tarakan depot. Furthermore, sales in September and October were 100 units and 70 units. The center, PT. Indaco Warna Dunia, could not fulfill demand on time. They sent the products in November 2019 and only 32 units which is far from the Tarakan depot's request. The center receives complaints from the depot because they were unable to fulfill demand on time due to an unexpected spike in market demand.

Table 1. Recapitulation of Delivery and Sales at the Tarakan Depot

Period	845G		DBBYCG	
	Delivery	Sale	Delivery	Sale
01/07/2019	260	58		36
02/07/2019		170	40	20
03/07/2019		100		32
04/07/2019		70	60	20
05/07/2019	32	80		13
06/07/2019		94		14
Total	292	572	100	135

Based on the existing problems, a sales strategy is needed, one of which is by predicting or forecasting sales (Margi S & Pendawa, 2015).

A more measured scheme of demand will make the cost lower. It needs a method that can be applied in controlling inventory to reduce costs arising from the fluctuating demand.

This study aims to select the best demand forecasting method to improve forecast effectiveness and accuracy for each product, that is MBYCG, DBBYCG, 845G, 850G, and 870G based on historical demand data.

2. Methodology

This chapter describes the steps in conducting research, starting with the initial identification stage, calculating forecasting using several methods, and the conclusion stage.

At the initial identification stage, observations were done at the Logistics Department of the VMI section. The purpose of this observation is to find a preliminary assumption that the forecasting method used by the company is ineffective and causing forecast errors. This forecasting error failed to fulfill the demand for the depot on time and in the right demand, so the company received complaints from the depot. Therefore, the calculation of the error value is carried out using the company forecasting method as an initial identification to strengthen the assumption obtained at the observation.

The research was conducted at the Tarakan depot and on fast-moving products or PUSH categories (according to the company). The products studied included MBYCG, DBBYCG, 845G, 850G, and 870G.

Forecasting calculations are carried out using the company method, then the tracking signal and MAPE value. The data needed is product demand data and the value of the lead time for sending products from the center to the Tarakan depot, which is 27 days. From this MAPE calculation, it can be seen that the forecasting method used by the company has a high error value. Improvements are needed by looking for a proposed method with a smaller error to improve forecast effectiveness and accuracy.

The next step is to calculate forecasting using various methods including Moving Average, Weighted Moving Average, Single Exponential Smoothing, Exponential Smoothing with Trend, and Holt's Double Exponential Smoothing, and then calculate the MAPE value for each method. The accuracy of forecasting is the most important and it can be measured with MAPE. Selection of the best method based on the smallest MAPE value and tracking signal within the limits (-4 to +4).

And the last stage is conclusions and suggestions. The conclusion contains a summary of this research and suggestions containing suggestions for future research.

3. Results and Discussion

This chapter describes the initial identification, forecasting calculations, and selecting the best method.

3.1. Initial Identification

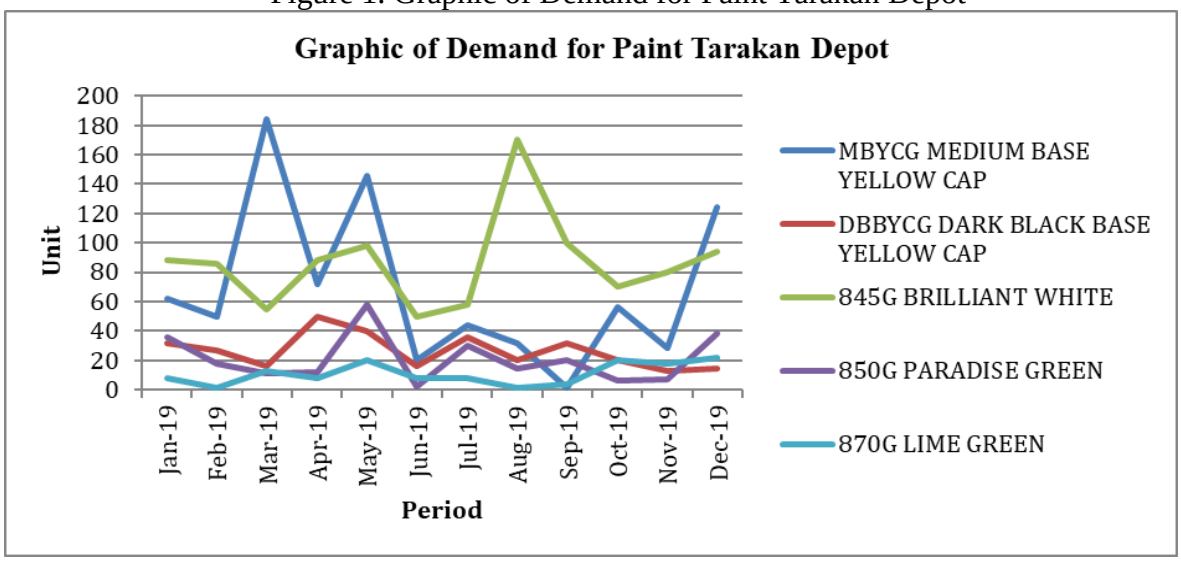
At this stage, data collection is carried out, that is demand data in product sales by the depot and data on the delivery of products to the depot. The result of this stage is that the company forecasting method has a high error value based on MAPE.

From the preliminary observations, it is obtained an assumption that the forecasting method used by the company is ineffective, causing forecast errors. Forecasting calculations used by the company method is using product demand data and the value of the lead time for delivery of products from the center to the Tarakan depot (27 days). Demand data used is for 6 months, from July 2019 to December 2019. Product demand data from January 2019 to December 2019 can be seen in Table 2.

Table 2. Demand for Paint Tarakan Depot

Period	Products				
	MBYCG	DBBYCG	845G	850G	870G
	MEDIUM BASE YELLOW CAP	DARK BLACK BASE YELLOW CAP	BRILLIANT WHITE	PARADISE GREEN	LIME GREEN
Jan-19	62	32	88	36	8
Feb-19	50	27	86	18	1
Mar-19	184	16	55	11	13
Apr-19	72	50	88	12	8
May-19	146	40	98	58	20
Jun-19	20	16	50	2	8
Jul-19	44	36	58	30	8
Aug-19	32	20	170	14	1
Sep-19	1	32	100	20	4
Oct-19	56	20	70	6	20
Nov-19	28	13	80	7	18
Dec-19	124	14	94	38	22

Figure 1. Graphic of Demand for Paint Tarakan Depot



Forecasting calculations with the company method are done by multiplying the median value of demand with the multiplier number that has been determined by the

company. If the product is less than the average demand for 6 months, an adjustment is needed to increase the multiplier value without exceeding the maximum adjustment limit. There are three product categories, that is PUSH, PULL, and MIXING. PUSH products are fast-moving products, for forecasting multiplied by the number 1.5, and adjustments can be made up to the number 3. PULL products are medium-moving products, for forecasting multiplied by the number 1, and adjustments can be made up to number 2. MIXING products are paint products. slow-moving whose fulfillment can be done by tinting because of the low demand for that category. Forecasting for the MIXING product category is multiplied by number 1 and adjustments can be made up to 1.5. This research is specifically for PUSH products, the multiplier number is 1.5. Then calculate the error value and get high error results based on MAPE. Recapitulation of the observation results can be seen in Table 3.

Table 3. Recapitulation of Error Value Calculation using Company Method

Produk	*Tracking Signal*	MAPE
MBYCG	-6,00	2109,64%
DBBYCG	-6,00	148,55%
845G	-6,00	141,34%
850G	-6,00	267,08%
870G	-6,00	640,44%

Based on the calculation, it can be seen that the company's forecasting method has a high MAPE value, and the tracking signal is out of limits (-4 to +4). So that improvement is needed in choosing the forecasting method.

3.2. Forecasting Calculations

At this stage, forecasting calculations are carried out using several methods including Moving Average, Weighted Moving Average, Single Exponential Smoothing, Exponential Smoothing with Trend, and Holt's Double Exponential Smoothing then calculating the MAPE value for each method. The data needed is product demand data.

The first method is the Moving Average method. The moving average forecast uses a number of historical actual data values to generate a forecast (Sinaga & Irawati, 2018). The moving average method is used if the past data is data that does not have trend elements or seasonal factors. Moving average forecasting is widely used to determine the trend of a time series (Nurlifa & Kusumadewi, 2017). It is also used as a means for computing short-term forecasts of time series (Perry, 2010).

The Single Moving Average method uses several actual data requests to generate forecast values. The calculation is done by taking a group of values or data and then calculating the average and with the average used to calculate the next period forecast. From the results of the prediction or calculation, product sales can be used to make policies in the production, so that the company gets information for the production in the following month, or in certain months according to the results of predictions of product sales (Dewi & Chamid, 2019).

In this method, data is used at least 3 periods (Gusdian et al., 2016). This method is called a moving average because every time new observation data is available, new average figures are available calculated, and used as a forecast. The Simple Moving Average technique has the characteristic that the causal factors that have occurred in the past are used in the future (Utari et al., 2016). The results of forecasting calculations using the Moving Average Method can be seen in Table 4.

Table 4. Results of Forecasting Calculations using the Moving Average Method

Produk	*Tracking Signal*	MAPE
MBYCG	-1,66	452,61%
DBBYCG	-1,37	51,06%
845G	0,94	34,20%
850G	0,56	220,19%
870G	3,17	166,95%

The concept of the Weighted Moving Average method is similar to the Moving

Average method but provides weighting. The essence of this method is that the company assigns to each value in a year a specific weight (expressed in fractions of one), thereby assessing the significance of the year in question for the value of the predicted parameter, in connection with certain events of those years (Vlasov et al., 2018).

This method is more responsive to changes because data from a new period are usually given greater weight. The results of forecasting calculations using the Weighted Moving Average Method can be seen in Table 5.

Table 5. Results of Forecasting Calculations with the Weighted Moving Average Method

Produk	*Tracking Signal*	MAPE
MBYCG	-0,93	654,67%
DBBYCG	-3,36	51,92%
845G	0,58	32,79%
850G	1,05	251,24%
870G	2,77	166,53%

Single exponential smoothing is also known as simple exponential smoothing. Exponential smoothing methods are the most widely used techniques in forecasting due to their simplicity, robustness, and accuracy as an automatic forecasting procedure (Yapar et al., 2018). Simple smoothing is used for short-range forecasting, usually just one month into the future. The model assumes that the data fluctuates around a reasonably stable mean (no trend or consistent pattern of growth) (Kalekar, 2004). Although exponential smoothing is a common method, there are some shortcomings, for example, there is no consistent rule in the literature about the choice of initial value and smoothing constant. These negatively affect the accuracy of forecasts (Efe et al., 2018).

This method is calculated using weighted averages where the weight decreases exponentially as observations come from further in the past. The smallest weight is associated with the oldest observations. The smoothing parameter α is between 0 and 1. The closer α to 0 then the more weight is given to observations from the more distant past. The closer α to 1 then the more weight is given to recent observations.

The results of forecasting calculations using the Single Exponential Smoothing Method can be seen in Table 6.

Table 6. Results of Forecasting Calculations using the Single Exponential Smoothing Method

Produk	α	*Tracking Signal*	MAPE
MBYCG	0,9	0,99	399,43%
DBBYCG	0,6	-2,46	51,72%
845G	0,2	0,24	28,07%
850G	0,4	-2,06	229,89%
870G	0,8	2,43	173,20%

The trend line analysis model is used when the historical data of actual demand data shows a trend. Selecting optimal α and β values is usually done by trial and error depending on the minimum MAPE value and the tracking signal is between -4 to 4. The results of forecasting calculations using the Exponential Smoothing with Trend Method can be seen in Table 7.

Table 7. Results of Forecasting Calculations using the Exponential Smoothing with Trend Method

Produk	α	β	*Tracking Signal*	MAPE
MBYCG	0,8	0,4	1,25	302,45%
DBBYCG	0,6	0,2	-1,95	50,76%
845G	0,2	0,1	0,28	28,15%
850G	0,3	0,2	-2,14	223,85%
870G	0,7	0,3	2,05	176,89%

The Double Exponential Smoothing method is appropriately used when the data to be forecasted shows a trend. This method is a development of the Single Exponential which adds a trend element to the weight of the calculation so that in Double Exponential Smoothing (Holt's Method) there are two types of weights in the calculation, namely level (α) and trend (β) which are between 0 and 1 (Alfarisi, 2017). Choosing optimal α and β values is usually done in trial and error

depending on the minimum MAPE value and the tracking signal is between -4 to 4. The results of forecasting calculations using Holt's Double Exponential Smoothing method can be seen in Table 8.

Table 8. The Results of Forecasting Calculations using Holt's Double Exponential Smoothing Method

Produk	α	β	*Tracking Signal*	MAPE
MBYCG	0,6	0,8	3,55	165,44%
DBBYCG	0,4	0,9	-3,99	59,95%
845G	0,4	0,9	-1,91	43,20%
850G	0,3	0,6	3,77	142,22%
870G	0,7	0,9	1,77	115,16%

3.3. Selection of the Best Forecasting Method

At this stage, the best forecasting method is chosen for each product. The method chosen is the method with the smallest MAPE value. So, the best method for each product is MBYCG, 850G, and 870G using Holt's Double Exponential Smoothing method, DBBYCG using the Exponential Smoothing with Trend method, and 845G using the Single Exponential Smoothing method. The comparison of MAPE values between several methods can be seen in Table 9.

The lowest MAPE value obtained from the calculation is still high. This is probably because other aspects influence demand patterns. Tracking signals also indicate other aspects that affect demand patterns. This aspect produces a fluctuating demand pattern. Things that can influence demand patterns include the presence of competitive products, promos so that sales increase, or other marketing strategies.

4. Conclusion

This study concludes that the forecasting method used by the company has a high error. The forecasting method which is most effective for each product is as follows:

- For MBYCG, 850G, and 870G paint products using Holt's Double Exponential Smoothing method. Furthermore, DBBYCG paints products using the Exponential Smoothing with Trend method. The 845G product uses the Single Exponential Smoothing method.
- For the next research, it is expected to be able to find a forecasting method with a smaller error rate for all products so that forecasting uses the same 1 method. In future work, to further reduce the forecasting error and to find more appropriate forecasting methods, extension or modification of the methods used in this research will be studied, and their performance compared with other forecasting methods. Additionally, forecast prices with longer periods (i.e., more than three months) should be determined.
- Further research can be carried out on aspects that affect demand patterns to determine a more accurate forecasting method. The suggestion for the company is that it can consider the proposed method chosen as an improvement.

Table 9. Comparison of MAPE Value Between Methods

Product	MAPE					
	Company	MA	WMA	SES	EST	Holt's DES
MBYCG	2109,64%	452,61%	654,67%	399,43%	302,45%	165,44%
DBBYCG	148,55%	51,06%	51,92%	51,72%	50,76%	59,95%
845G	141,34%	34,20%	32,79%	28,07%	28,15%	43,20%
850G	267,08%	220,19%	251,24%	229,89%	223,85%	142,22%
870G	640,44%	166,95%	166,53%	173,20%	176,89%	115,16%

References

Alfarisi, S. (2017). Sistem Prediksi Menggunakan Metode Single Exponential Smoothing. *Journal of Applied Business and Economics*, *4*(1), 80–95.

Chamid, A. A., & Murti, A. C. (2018). Prioritization of Natural Dye Selection In Batik Tulis Using AHP and TOPSIS Approach. *IJCCS (Indonesian Journal of Computing and Cybernetics Systems)*, *12*(2), 129. https://doi.org/10.22146/ijccs.29813

Chamid, A. A., Surarso, B., & Farikhin, F. (2015). Implementasi Metode AHP Dan Promethee Untuk Pemilihan Supplier. *Jurnal Sistem Informasi Bisnis*, *5*(2), 128–136. https://doi.org/10.21456/vol5iss2pp128-136

Dewi, E. N. S., & Chamid, A. A. (2019). Implementation of Single Moving Average Methods For Sales Forecasting Of Bag In Convection Tas Loram Kulon. *Jurnal Transformatika*, *16*(2), 113. https://doi.org/10.26623/transformatika.v16i2.1047

Efe, İ. E., ÇOBAN, B., & FİRUZAN, E. (2018). Comparison of Single and Modified Exponential Smoothing Methods in the Presence of a Structural Break. *Uluslararası İktisadi ve İdari İncelemeler Dergisi*. https://doi.org/10.18092/ulikidince.354325

Gusdian, E., Muis, A., & Lamusa, A. (2016). Peramalan Permintaan Produk Roti Pada Industri " Tiara Rizki " Di Kelurahan Boyaoge Kecamatan Kecamatan Tatanga Kota Palu. *E-J, Agrotekbis*, *4*(1), 97–105.

Kalekar, P. (2004). Time Series Forecasting Using Holt-Winters Exponential Smoothing. *Kanwal Rekhi School of Information Technology*, *04329008*, 1–13. http://www.it.iitb.ac.in/~praj/acads/seminar/04329008_ExponentialSmoothing.pdf

Kurniadi, W. (2018). Pendukung Keputusan Dalam Peramalan Penjualan Ayam Broiler dengan Metode Trend Moment dan Simple Moving Average Pada CV. Merdeka Adi Perkasa. *Jurnal Media Informatika Budidarma*, *2*(3), 76–90. https://doi.org/10.30865/mib.v2i3.652

Margi S, K., & Pendawa, S. (2015). Analisa Dan Penerapan Metode Single Exponential Smoothing Untuk Prediksi Penjualan Pada Periode Tertentu (Studi Kasus: PT.Media Cemara Kreasi). *Prosiding SNATIF*, *2*(1998), 259–266.

Nurlifa, A., & Kusumadewi, S. (2017). Sistem Peramalan Jumlah Penjualan Menggunakan Metode Moving Average Pada Rumah Jilbab Zaky. *INOVTEK Polbeng - Seri Informatika*, *2*(1), 18. https://doi.org/10.35314/isi.v2i1.112

Perry, M. B. (2010). The Weighted Moving Average Technique. *Wiley Encyclopedia of Operations Research and Management Science*. https://doi.org/10.1002/9780470400531.eorms0964

Sinaga, H., & Irawati, N. (2018). *A Medical Disposable Supply Demand Forecasting By Moving Average And Exponential Smoothing Method*. 1–5. https://doi.org/10.4108/eai.24-1-2018.2292378

Utari, H., Mesran, & Silalahi, N. (2016). Perancangan Aplikasi Peramalan Permintaan Kebutuhan Tenaga Kerja Pada Perusahaan Outsourcing Menggunakan Algoritma Simple Moving Average. *Jurnal TIMES*, *5*(2), 1–5. http://ejournal.stmik-time.ac.id/index.php/jurnalTIMES/article/view/546

Vlasov, V. M., Novikov, A. N., Novikov, I. A., & Shevtsova, A. G. (2018). Definition of Perspective Scheme of Organization of Traffic Using Methods of Forecasting and Modeling. *IOP Conference Series: Materials Science and Engineering*, *327*(4). https://doi.org/10.1088/1757-

899X/327/4/042116

Yapar, G., Capar, S., Selamlar, H. T., & Yavuz, I. (2018). *Modifed Holt's Linear Trend Method*. *47*(5), 1394–1403.

Appendices

Appendix 1. Results of MBYCG Forecasting Calculations using Company Method

MBYCG																
Period	Xt	Mean	Mean (days)	LT	Min	ROP	Dev	Max	Med	Ft	E	|E|	RSFE	MAD	TS	MAPE
Jul-19	44	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	-74,76	74,76	-74,76	74,76	-1,00	169,92%
Agu-19	32	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	-86,76	86,76	-161,53	80,76	-2,00	271,14%
Sep-19	1	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	-117,76	117,76	-279,29	93,10	-3,00	11776,32%
Okt-19	56	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	-62,76	62,76	-342,05	85,51	-4,00	112,08%
Nov-19	28	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	-90,76	90,76	-432,82	86,56	-5,00	324,15%
Des-19	124	47,5	2,159	27	58,30	58,30	41,76	100,06	79,18	118,76	5,24	5,24	-427,58	73,01	-5,86	4,22%
Jan-20										**119,00**					**MAPE**	**2109,64%**

Appendix 2. Results of MBYCG Forecasting Calculations using Moving Average Method

MBYCG								
Period	Demand	Forecast	Error	|Error|	RSFE	MAD	Tracking Signal	MAPE
Jan-19	62							
Feb-19	50							
Mar-19	184							
Apr-19	72	98,67	-26,67	26,67	-26,67	26,67	-1,00	37,04%
Mei-19	146	102,00	44,00	44,00	17,33	35,33	0,49	30,14%
Jun-19	20	134,00	-114,00	114,00	-96,67	61,56	-1,57	570,00%
Jul-19	44	79,33	-35,33	35,33	-132,00	55,00	-2,40	80,30%
Agu-19	32	70,00	-38,00	38,00	-170,00	51,60	-3,29	118,75%
Sep-19	1	32,00	-31,00	31,00	-201,00	48,17	-4,17	3100,00%
Okt-19	56	25,67	30,33	30,33	-170,67	45,62	-3,74	54,17%
Nov-19	28	29,67	-1,67	1,67	-172,33	40,13	-4,29	5,95%
Des-19	124	28,33	95,67	95,67	-76,67	46,30	-1,66	77,15%
Jan-20		**70,00**					**MAPE**	452,61%

Appendix 3. Results of MBYCG Forecasting Calculations using Weighted Moving Average Method

MBYCG								
Period	Demand	Forecast	Error	|Error|	RSFE	MAD	Tracking Signal	MAPE
Jan-19	62							
Feb-19	50							
Mar-19	184							
Apr-19	72							
Mei-19	146	100,2	45,8	45,8	45,8	45,8	1,00	31,37%
Jun-19	20	121,8	-101,8	101,8	-56,0	73,8	-0,76	509,00%
Jul-19	44	84,6	-40,6	40,6	-96,6	62,7	-1,54	92,27%
Agu-19	32	60,0	-28,0	28,0	-124,6	54,1	-2,31	87,50%
Sep-19	1	44,6	-43,6	43,6	-168,2	52,0	-3,24	4360,00%
Okt-19	56	20,8	35,2	35,2	-133,0	49,2	-2,71	62,86%
Nov-19	28	33,5	-5,5	5,5	-138,5	42,9	-3,23	19,64%
Des-19	124	31,4	92,6	92,6	-45,9	49,1	-0,93	74,68%
Jan-20		**70,0**					**MAPE**	**654,67%**

Appendix 4. Results of MBYCG Forecasting Calculations using Single Exponential Smoothing Method

MBYCG									
Period	Demand	α	Forecast	Error	|Error|	RSFE	MAD	Tracking Signal	MAPE
Jan-19	62	0,9	62,00						
Feb-19	50	0,9	62,00	-12,00	12,00	-12,00	12,00	-1,00	24,00%
Mar-19	184	0,9	51,20	132,80	132,80	120,80	72,40	1,67	72,17%
Apr-19	72	0,9	170,72	-98,72	98,72	22,08	81,17	0,27	137,11%
Mei-19	146	0,9	81,87	64,13	64,13	86,21	76,91	1,12	43,92%
Jun-19	20	0,9	139,59	-119,59	119,59	-33,38	85,45	-0,39	597,94%
Jul-19	44	0,9	31,96	12,04	12,04	-21,34	73,21	-0,29	27,37%
Agu-19	32	0,9	42,80	-10,80	10,80	-32,13	64,30	-0,50	33,74%
Sep-19	1	0,9	33,08	-32,08	32,08	-64,21	60,27	-1,07	3207,96%
Okt-19	56	0,9	4,21	51,79	51,79	-12,42	59,33	-0,21	92,49%
Nov-19	28	0,9	50,82	-22,82	22,82	-35,24	55,68	-0,63	81,50%
Des-19	124	0,9	30,28	93,72	93,72	58,48	59,13	0,99	75,58%
Jan-20			**114,63**					**MAPE**	**399,43%**

Appendix 5. Results of MBYCG Forecasting Calculations using Single Exponential Smoothing with Trend Method

MBYCG												
Period	Demand	α	β	Et	Trend	Forecast	Error	|Error|	RSFE	MAD	TS	MAPE
Jan-19	62	0,8	0,4	62,00	0,00	62,00						
Feb-19	50	0,8	0,4	62,00	0,00	62,00	-12,00	12,00	-12,00	12,00	-1,00	24,00%
Mar-19	184	0,8	0,4	52,40	-3,84	48,56	135,44	135,44	123,44	73,72	1,67	73,61%
Apr-19	72	0,8	0,4	157,68	39,81	197,49	-125,49	125,49	-2,05	90,98	-0,02	174,29%
Mei-19	146	0,8	0,4	89,14	-3,53	85,60	60,40	60,40	58,35	83,33	0,70	41,37%
Jun-19	20	0,8	0,4	134,63	16,08	150,70	-130,70	130,70	-72,36	92,81	-0,78	653,52%
Jul-19	44	0,8	0,4	42,93	-27,03	15,89	28,11	28,11	-44,25	82,02	-0,54	63,88%
Agu-19	32	0,8	0,4	43,79	-15,88	27,91	4,09	4,09	-40,15	70,89	-0,57	12,79%
Sep-19	1	0,8	0,4	34,36	-13,30	21,06	-20,06	20,06	-60,21	64,54	-0,93	2005,96%
Okt-19	56	0,8	0,4	7,67	-18,65	-10,98	66,98	66,98	6,77	64,81	0,10	119,61%
Nov-19	28	0,8	0,4	46,33	4,27	50,61	-22,61	22,61	-15,84	60,59	-0,26	80,74%
Des-19	124	0,8	0,4	31,67	-3,30	28,36	95,64	95,64	79,80	63,77	1,25	77,13%
Jan-20				114,77	31,26	**147,00**					**MAPE**	**302,45%**

Appendix 6. Results of MBYCG Forecasting Calculations using Holt's Double Exponential Smoothing Method

MBYCG												
Period	Demand	α	β	St	Tt	Forecast	Error	|Error|	RSFE	MAD	TS	MAPE
Jan-19	62	0,6	0,8	62,00	-62,00							
Feb-19	50	0,6	0,8	30,00	-38,00	0,00	50,00	50,00	50,00	50,00	1,00	100,00%
Mar-19	184	0,6	0,8	107,20	54,16	-8,00	192,00	192,00	242,00	121,00	2,00	104,35%
Apr-19	72	0,6	0,8	107,74	11,27	161,36	-89,36	89,36	152,64	110,45	1,38	124,11%
Mei-19	146	0,6	0,8	135,20	24,22	119,01	26,99	26,99	179,63	89,59	2,01	18,49%
Jun-19	20	0,6	0,8	75,77	-42,70	159,43	-139,43	139,43	40,20	99,56	0,40	697,13%
Jul-19	44	0,6	0,8	39,63	-37,46	33,07	10,93	10,93	51,13	84,78	0,60	24,85%
Agu-19	32	0,6	0,8	20,07	-23,14	2,17	29,83	29,83	80,96	76,93	1,05	93,21%
Sep-19	1	0,6	0,8	-0,63	-21,18	-3,07	4,07	4,07	85,03	67,83	1,25	406,90%
Okt-19	56	0,6	0,8	24,88	16,17	-21,81	77,81	77,81	162,84	68,94	2,36	138,95%
Nov-19	28	0,6	0,8	33,22	9,91	41,04	-13,04	13,04	149,80	63,35	2,36	46,57%
Des-19	124	0,6	0,8	91,65	48,73	43,12	80,88	80,88	230,68	64,94	3,55	65,22%
Jan-20						**140,38**					**MAPE**	**165,44%**