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Evaluation of time series forecasting methods for Sales of printed bed sheet in Bahir Dar Textile Share Company

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Abstract: Sales forecasting is a key element in effective organizational planning. Good forecasting helps to forecast and budget effectively. The objective of this research is to apply and evaluate the performance of different time series forecasting methods for sales forecasting of printed bed sheet in Bahir Dar Textile Share Company. The study employed necessary monthly data spreading from January 2013 to December 2014 on the sales of printed bed sheet from the company's sales and marketing department. Time series forecasting techniques such as naïve method, simple moving average method, weighted moving average method and exponential smoothing method were selected to forecast sales demand of the printed bed sheet and POM-QM software was applied to compare the forecasting techniques based on accuracy measuresusing mean Forecast Error (MFE), mean Absolute Deviation (MAD), mean Square Error (MSE) and mean absolute percentage error (MAPE).A comparison with the other time series forecasting methods has shown that Weighted Moving Average Method (weight 1= 0.5, weight 2=0.3 and weight 3=0.2) is the best technique for accurate sales forecast of the printed bed sheet.

Keywords: forecasting, time series, forecasting error, printed bed sheet

1. Introduction

Sales forecasting is the process of estimating future sales. Companies base their forecasts on past sales data. Good sales forecast enable companies to make informeddecisions in the management of the production systems such as inventory management and production planning [1]. In apparel and fashion industry, it is known that customer demand is ever changing and highly volatile [2].So, accurate forecasting helps the industries to predict their demand effectively. In this work, a case study has been carried out at Bahir Dar Textile Share Company which produces different products like Printed Bed sheet, Dyed Bed sheet, Grey Fabric, Printed fabric, Reeled yarns. The printed bed sheet produced by the Company has a varied demand in the market. Due to this, most of the time a high size of deviation occurs between the actual demand and the forecast. This leads to problem of high inventory level and high labour cost when the forecast is higher than the demand and lead to unmet customer needs when the forecast is lower than the demand. Therefore, a development of an accurate forecasting system must be adopted by the company. So the main goal of this work is to apply and evaluate the performance of different time series forecasting methods for sales forecasting of printed bed sheet. The study usesPOM-QM software to select the best fitting forecasting technique that produces the optimal outcome based on its accuracy and simplicity using the historical sales data from the company.

2. Literature Review

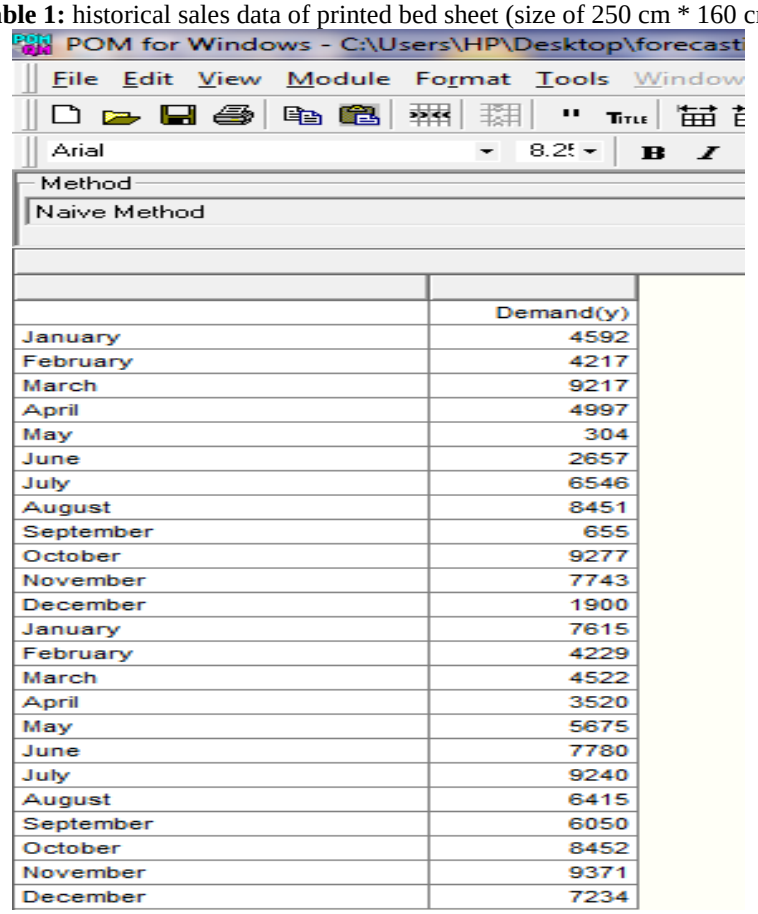
In this study, it has been tried to review some papers to know what is going on in this field of study. Several researches have been done using different time series forecasting methods such as naïve method, moving average, double moving average, simple exponential smoothing; and semi average methods. Time series forecasting methods are techniques that rely on mathematical computations. Salah H. E. Saleh Ahmed, Nassar Mansur and Ali Naji Abdalaziz [3] conducted a research on determining electricity demand for 2011-2022 in Libya based on data from 2000-2010.The objectives of this research was to forecast long-term electricity demand for 2011-2022 and to provide mathematical data that can be used as consideration in deciding a particular policy in the field of electricity supply. Thus, this paper studied a load demand based on quantitative forecasting model using a time Series Stochastic Method. SPSS and EViews7 Software analysis were applied. Application of stochastic time series forecasting based on data from 2000- 2010 and Mathematical analysis indicated a continuous growth of demand for oil and electricity thereby increasing cost of energy due to rapid population growth in Libya from 2011-2022. MA Rahman , BR Sarker and Escobar LA [4] studied on actual demand-forecasting problem of the US apparel dealers. Demand was highly fluctuating during the peak sale season and low prior to the peak season. The model was described by the continuous time stochastic process applying the Bayesian process. The standard gamma distribution was selected for the demand process and an inverse gamma distribution was chosen as the conjugate prior for the model. The proposed

Bayesian models predicted the probability of the future demand expressed explicitly conditional on the observed demand prior to the peak season. The data set illustrated partial demand of a seasonal product procured by the US dealers from overseas. The model was extended to contribute to forecast from an unrecorded data set due to supply disruption. Forecasts were compared with real data and a widely implemented adaptive Holt-Winters (H-W) seasonal forecasting model. Results showed that the forecasts calculated by the proposed methods did better than those of the adaptiveH-W model. Maria K. Voulgaraki [5] conducted a study on which the demand forecast of car sales was considered. In this study the dataset used in forecasting models was collected which is car sales in the market from 1998 to 2007. The error measures for this period indicated that a seasonal Naive model can best capture the fluctuations of car sales in the market from 2008 to 2010.That gave evidence of a stable economic activity and an efficient market since the seasonal Naive model resulted as the best technique in Forecasting car sales levels in the Greek retail market.

3. Methodology

To achieve the research objectives of this project, 24 months historical sales data of the printed bed sheet starting from January 2013 to December 2014 have been collected and recorded on monthly basis from the company's sales and marketing department. A decision science software package known as POM-QM software has been used for analyzingthe data using different time series forecasting methods.

Table 1: historical sales data of printed bed sheet (size of 250 cm * 160 cm)



	Demand(y)
January	4592
February	4217
March	9217
April	4997
May	304
June	2657
July	6546
August	8451
September	655
October	9277
November	7743
December	1900
January	7615
February	4229
March	4522
April	3520
May	5675
June	7780
July	9240
August	6415
September	6050
October	8452
November	9371
December	7234

Data analysis using different time series forecasting methods

This study evaluated different forecasting methods using printed bed sheet data from Bahir Dar textile Share Company sales and marketing department. Monthly data from January 2013 to December 2014 have been collected and used to forecast the printed bed sheet sale. The forecast methods used in the analysis included naive Method, simple moving average of 2 months and 3 months, weighted moving average of 2 months and 3 months, single exponential method with smoothing constant of 0.4, 0.6 and 0.8. The most appropriate forecasting method is determined on the basis of accuracy. In this research, several common accuracy methods have been used: mean forecast error (MFE), mean absolute deviation (MAD), mean square error (MSE) and mean absolute percentage error (MAPE).The ranking is assigned to each forecasting method.

Table 2: Summary table of results using naïve method

Method: Naive Method

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	114.87
MAD (Mean Absolute Deviation)	3086.7
MSE (Mean Squared Error)	14634390
Standard Error (denom=n-2=21)	4003.52
MAPE (Mean Absolute Percent Error)	1.68
Forecast	
next period	7234

Table 3: Summary table of results using simple moving average of two months

Method: Moving Averages # Periods to average: 2

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	245.75
MAD (Mean Absolute Deviation)	3001.25
MSE (Mean Squared Error)	12871160
Standard Error (denom=n-2=20)	3762.75
MAPE (Mean Absolute Percent Error)	1.94
Forecast	
next period	8302.5

Table 4: Summary table of results using simple moving average of three months

Method: Moving Averages # Periods to average: 3

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	130.46
MAD (Mean Absolute Deviation)	2550.33
MSE (Mean Squared Error)	9091126
Standard Error (denom=n-2=19)	3169.87
MAPE (Mean Absolute Percent Error)	1.68
Forecast	
next period	8352.33

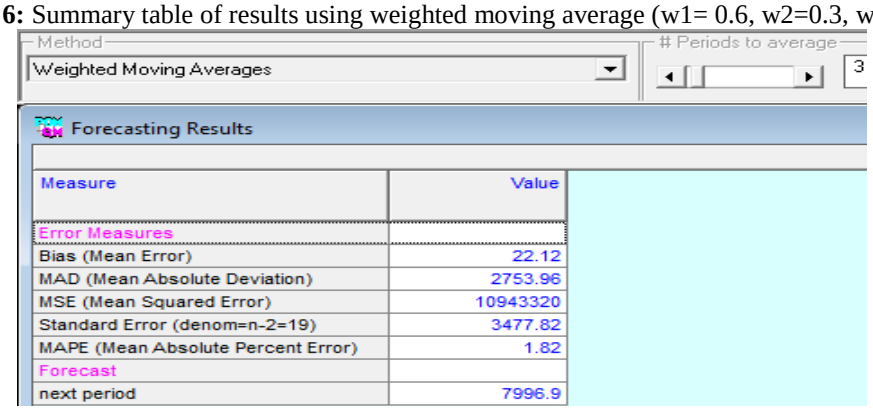
Table 5: Summary table of results using weighted moving average (w1= 0.5, w2=0.3, w3=0.2)

Method: Weighted Moving Averages # Periods to average: 3

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	65.05
MAD (Mean Absolute Deviation)	2658.4
MSE (Mean Squared Error)	9849403
Standard Error (denom=n-2=19)	3299.42
MAPE (Mean Absolute Percent Error)	1.75
Forecast	
next period	8118.7

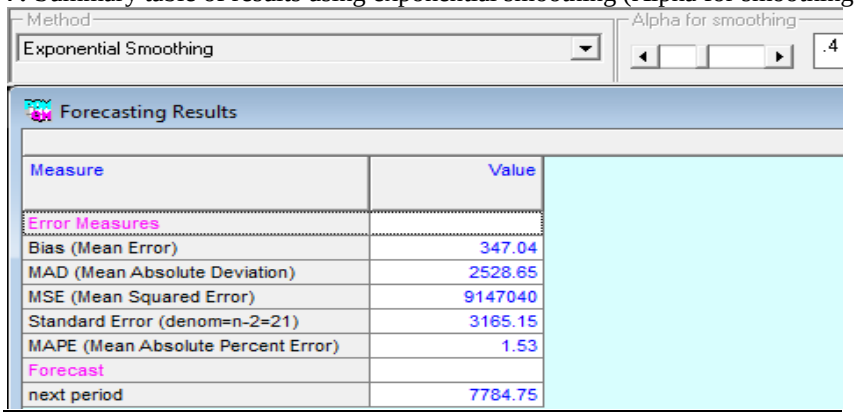
Table 6: Summary table of results using weighted moving average (w1= 0.6, w2=0.3, w3=0.1)


Method: Weighted Moving Averages
Periods to average: 3

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	22.12
MAD (Mean Absolute Deviation)	2753.96
MSE (Mean Squared Error)	10943320
Standard Error (denom=n-2=19)	3477.82
MAPE (Mean Absolute Percent Error)	1.82
Forecast	
next period	7996.9

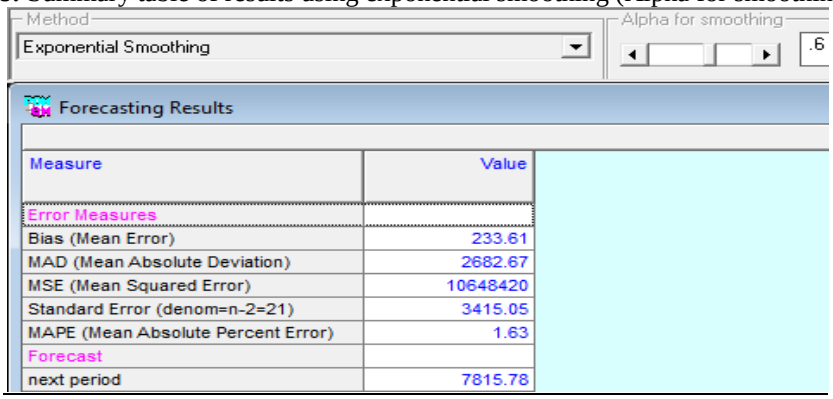
Table 7: Summary table of results using exponential smoothing (Alpha for smoothing=0.4)


Method: Exponential Smoothing
Alpha for smoothing: .4

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	347.04
MAD (Mean Absolute Deviation)	2528.65
MSE (Mean Squared Error)	9147040
Standard Error (denom=n-2=21)	3165.15
MAPE (Mean Absolute Percent Error)	1.53
Forecast	
next period	7784.75

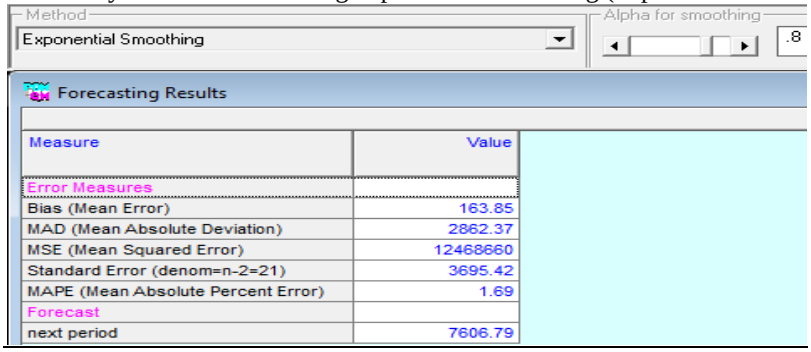
Table 8: Summary table of results using exponential smoothing (Alpha for smoothing=0.6)


Method: Exponential Smoothing
Alpha for smoothing: .6

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	233.61
MAD (Mean Absolute Deviation)	2682.67
MSE (Mean Squared Error)	10648420
Standard Error (denom=n-2=21)	3415.05
MAPE (Mean Absolute Percent Error)	1.63
Forecast	
next period	7815.78

Table 9: Summary table of results using exponential smoothing (Alpha for smoothing=0.8)


Method: Exponential Smoothing
Alpha for smoothing: .8

Forecasting Results

Measure	Value
Error Measures	
Bias (Mean Error)	163.85
MAD (Mean Absolute Deviation)	2862.37
MSE (Mean Squared Error)	12468660
Standard Error (denom=n-2=21)	3695.42
MAPE (Mean Absolute Percent Error)	1.69
Forecast	
next period	7606.79

Evaluation of the time series forecasting methods

In this study, the most appropriate forecasting method is selected on the basis of accuracy. The various time series forecasting methods have been used to forecast future demand of printed bed sheet in the company. The accuracy of the forecasting methodswas assessed using mean forecast error (MFE), mean absolute deviation (MAD), mean square error (MSE) and root mean square error (RMSE).

Table 10: Summary of Forecast Accuracy

Method	**MFE**	**MAD**	**MSE**	**MAPE**
Naïve method	114.87	3086.7	14634230	1.68
Simple moving average (n=2)	245.75	3001.43	12870550	1.94
Simple movingaverage (n=3)	130.46	2550.46	9090988	1.68
Weighted moving average (wt 1= 0.5, wt 2= 0.3, wt 3= 0.2)	193.82	2429.11	8820975	1.56
Weighted moving average (wt 1= 0.6, wt 2= 0.3, wt 3= 0.1)	236.74	2422.8	9229512	1.51
Exponential smoothing(alpha for smoothing = 0.4)	347.04	2528.63	9146768	1.53
Exponential smoothing (alpha for smoothing = 0.6)	233.61	2682.63	10648130	1.62
Exponential smoothing (alpha for smoothing = 0.8)	163.85	2862.32	12468350	1.69

4. Result and discussion

In this study, four accuracy models- mean forecast error (MFE), mean absolute deviation (MAD), mean square error (MSE) and root mean square error (RMSE) were adopted to assess the accuracy of forecasting methods. The method that has a smaller forecast error is the more accurate forecasting method and it has been ranked first in the overall ranking of the forecasting methods.

Table 11: Overall Ranking of Forecasting Method for printed bed sheet

METHOD	MFE	MAD	MSE	MAPE	Ranking total	Overall ranking
naïve method	1	8	8	5	22	6
simple moving average (n=2)	7	7	7	8	29	8
simple moving average (n=3)	2	4	2	6	14	3
weighted moving (wt 1= 0.5, wt 2= 0.3, wt 3= 0.2)	4	2	1	3	10	1
weighted moving (wt 1= 0.6, wt 2= 0.3, wt 3= 0.1)	6	1	4	1	12	2
exponential smoothing ($\alpha = 0.4$)	8	3	3	2	16	4
exponential smoothing ($\alpha = 0.6$)	5	5	5	4	19	5
exponential smoothing ($\alpha = 0.8$)	3	6	6	7	22	6

As shown in table 11, Weighted Moving Average Method (weight 1= 0.5, weight 2=0.3, weight 3=0.2) has been ranked first because it has small errors (MFE= 193.82, MAD=2429.11, MSE=8820975, MAPE=1.56).Weighted moving average method (weight 1=0.6, weight 2=0.3 and weight 3=0.1) has been ranked second. This method obtained the second rank because it hasminimum errors (MFE= 236.74, MAD = 2422.8, MSE = 9229512, MAPE = 1.51).Simple moving average (n=3) has been ranked third because the total ranking is 14 as shown in Table 11.Exponential smoothingmethod (alpha for smoothing =0.4) produced large errors (MFE= 347.04, MAD = 2528.63, MSE = 9146768, MAPE = 1.53). So this method is ranked fourth.Exponential smoothing Method (alpha for smoothing =0.6) is ranked fifth because it has large errors (MFE = 233.61, MAD = 2682.63, MSE = 10648130, MAPE = 1.62) and the total ranking is 19 as shown in Table 11.Exponential smoothing method (alpha for smoothing =0.8) is ranked sixth because the total ranking of this method is 22 as shown in Table 11. Naïve method has been ranked seventh due to its large errors (MFE = 114.87, MAD = 3086.7, MSE = 14634230, MAPE = 1.68) and the total ranking is 22.Simple Moving Average Method (n=2) has been ranked eighth because it has large errors (MFE= 245.75, MAD = 3001.43, MSE = 12870550, MAPE = 1.94) and the total ranking of this method is 29 as shown in Table 11.

5. Conclusion and Recommendation

The purpose of this research was to investigate and compare the performance of different time series forecasting methods for sales of printed bed sheet in BahirDar Textile Share Company. Todo this, a 24 month sales data of printed bed sheet were collected and analyzed using POM-QM software. The performances of four commonly used time series forecasting techniques: naïve, simple moving average, weighted moving average and exponential smoothing were compared using four commonly accuracy measures, namely the MFE, MAD, MSE and MAPE. Then the study identified the most appropriate forecasting method based on accuracy. The result showed that Weighted Moving Average Method (weight 1= 0.5, weight 2=0.3 and weight 3=0.2) obtained the best accuracy and it is selected as the most appropriate forecasting method for sales forecasting of printed bed sheet in the company. Simple Moving Average Method (n=2) was ranked last because it had a lot of errors. Based on the finding, the researcher recommends the company to use the weighted moving average (weight 1= 0.5, weight= 0.3 and weight=0.2) for accurate sales forecast of the printed bed sheet.

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