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Demand Forecasting of Power Thresher in a Selected Company

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Abstract

The purpose of this study is to assess the present status of demand forecasting used by the manufacturer of agricultural machineries and to identify the best suitable method for forecasting. For this a renowned manufacturer of agricultural machineries has been selected to explore the current situation. At present their forecasting technique for particular month is on the basis of 10% allowance of previous year's corresponding month sale. We collected four years secondary sales data of Power Thresher to evaluate the performance of different forecasting techniques. For the verification, various established time series smoothing methods such as moving average, exponential smoothing, multiplicative and additive models are applied. The mean absolute deviation (MAD) is the comparative parameter here. Multiplicative model is best suited for forecasting demand since it gives lowest value of MAD. Establishment of selected method can reduce the deviation of demand and forecast the demand of products more precisely.

Keywords: Time series, Smoothing technique, Decomposition, MAD, Accuracy.

1. Introduction

Bangladesh Agro Machinery sector is on a significant growth path. This sector is packed with good tidings, both in terms of domestic market penetration and in terms of its contribution to the world agro equipment scenario. In fact, trends already point to an exponential rise in Bangladesh share in the global farm equipment market in years ahead. The performance of that sector is a result of efforts put in by both the government and the private sector towards promotion and adoption of mechanization in Bangladesh agricultural systems.

Forecasting product demand is crucial to any supplier, manufacturer, or retailer. Forecasts of future demand will determine the quantities that should be purchased, produced, and shipped. Demand forecasts are necessary since the basic operations process, moving from the suppliers' raw materials to finished goods in the customers' hands, takes time. In the competitive market environment manufacturers have to maintain finished goods inventories at a good standard to deliver their products to customers on time. That's why almost every organization involved needs to manufacture or at least order parts based on a forecast of future demand. The accuracy achieved in the forecasts has consequences for companies at all levels of the supply chain, from the retailer to the raw materials supplier [1]. In general practice, accurate demand forecasts lead to efficient operations and high levels of customer service, while inaccurate forecasts will inevitably lead to inefficient, high cost operations and/or poor levels of customer service. In many supply chains, the most important action we can take to improve the efficiency and effectiveness of the logistics process is to improve the quality of the demand forecasts [2].

Forecasting is used by companies to determine how to allocate their budgets for an upcoming period of time. This is typically based on demand for the goods and services it offers, compared to the cost of producing them. Forecasting is important because it contributes to better accountability, cost containment, productivity, profit, maximization, and customer and employee satisfaction [3]. Forecasting is important in operations management and in other functions within an organization [4]. Forecasts are vital to every business organization and for every significant management decision. Forecasting is the basis of corporate long run planning [5]. Forecasting is a planning tool that helps management in its attempts to cope with the uncertainty of the future, depend mainly on past data and analysis of trends. Forecasting uses historic data to determine the direction of future trends [6]. Time series modeling is widely used statistical methods of forecasting. A study is conducted by Andrew et al.[7] to develop a forecasting model for hotel occupancy rates. The results of the study indicated that time-series models did give accurate forecasts.

In this paper various forecasting methods such as simple moving average, three months moving average, weighted moving average, single exponential smoothing, double exponential smoothing, multiplicative and additive model are applied to evaluate the most suitable techniques for forecasting the demand that will give lowest value of mean absolute deviation (MAD).

2. Methodology

There are two main methods of forecasting [4] such as Subjective or qualitative methods and Quantitative methods. Quantitative forecasting methods use a mathematical expression or model to show the relationship between demand and some independent variable(s). There are two major types of quantitative forecasting methods for example Time series methods and Causal or explanatory methods. Time series models use time as the independent variable and project the “demand pattern” (that is the past relationship between demand and time) to estimate demand in the future [8]. There are two types of time series method. They are Smoothing method and Decomposition method.

Smoothing methods such as simple moving average, weighted moving average, exponential smoothing attempt to forecast by removing extreme changes in past data. This method, when properly applied, reveals more clearly the underlying pattern to the data series from randomness [9]. The underlying pattern can also be broken down into the sub pattern to identify the component factors that influence each of the values in a series. This procedure is called decomposition [9].

Mathematical representation of the decomposition approach is $Y_t = f(S_t, T_t, E_t)$ where Y_t is the time series value (actual data) at period t, S_t is the time seasonal component (index) at period t, T_t is the trend cycle components at period t and E_t is the irregular (remainder) component at period t. The exact functional form depends on the decomposition model actually used. The major advantage of multiplicative model is that the end user has an appreciation of how the forecast was developed; he or she may have more confidence in its use for decision making [10].

A case study research has been performed in Alim Industries Ltd. which was established in 1990 at the BISCIC Industrial Estate, Gutatikar, Sylhet. Since then the company is engaged in production, assembly, import and marketing of agricultural machineries. Power thresher is chosen from a variety of products in order to conduct a study of demand forecasting. The information as well as data have been gathered through questionnaire, interview, and past sales record from sales manager. Data have been analyzed by using various time series model such as simple moving average, three months moving average, weighted moving average, single exponential smoothing, double exponential smoothing, multiplicative model and additive model. The estimated forecasts were then compared with the actual sales to calculate the MADs. The MAD is the mean of the error made by the forecast model over a series of time periods, without regard to whether an error was an overestimate or an underestimate [4]. Mathematically

$$MAD = \frac{\sum_{t=1}^{n} |A_t - F_t|}{n} \tag{1}$$

Where, A_t= actual demand in period t, F_t=forecast demand in period t, n=number of period being used, Maximize accuracy and minimize bias are the two major criteria for selecting forecasting method. Here best suited forecasting technique has been selected on the basis of lowest mean absolute deviation (MAD).

3. Data collection and analysis

The case study deals with the demand forecasting of Power thresher. The company determines their products' demand from previous year's sales data. They forecast for a particular month on the basis of 10% allowance of previous year's corresponding month sale. The company maintains a high level of inventory to avoid demand

Table 1. Sales data of power thresher

Months	2009	2010	2011	2012
January	87	108	84	112
February	373	238	325	298
March	975	885	798	890
April	860	758	832	820
May	202	347	364	307
June	103	119	96	118
July	145	128	125	119
August	155	136	122	172
September	57	23	47	36
October	87	113	105	98

November	345	243	317	321
December	44	107	79	86

uncertainties. The sales data of power thresher for the year 2009, 2010, 2011, and 2012 are given in table 1. After collecting sales data different forecasting techniques are used to calculate mean absolute deviation (MAD) for each year.

3.1 Calculation of MAD using time series smoothing

Different smoothing methods such as simple moving average, three months moving average, three months weighted moving average, single exponential smoothing, double exponential smoothing, and 36-months moving average have been used to forecast the demand of power thresher. Absolute deviations have also been calculated for the corresponding months of the year. The mean absolute deviations (MADs) found from these calculations are listed in table 2.

Table 2. Values of MAD using smoothing methods for power thresher

Type of smoothing	MAD for the year			
	2009	2010	2011	36 months
Simple moving average	248	198	220	222
Three months moving average	246	201	227	237
Three months weighted moving average	218	177	205	216
Single exponential smoothing	256	214	236	224
Double exponential smoothing	494	425	439	298

In smoothing method seasonal effects have not been considered, that's why the values of MAD found are very high. But there is a seasonal variation in demand of agricultural machinery. Figure-1 shows the variation of sales of power thresher in 2009, 2010, and 2011. Sales rise mainly in March, April and November. To reflect the seasonal variations in demand forecasting, decomposition analysis is crucial.

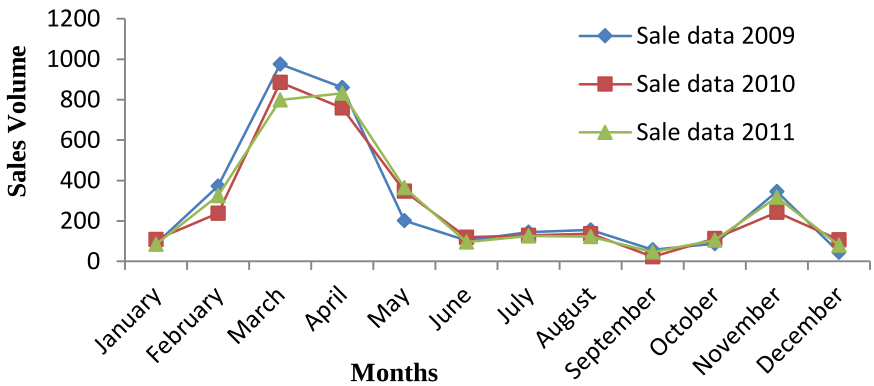

Fig. 1. Trend of sale for power thresher

3.2 Decomposition analysis for forecasting demand

The two common approaches of decomposition method are multiplicative model and additive model.

3.2.1 Multiplicative model

This model requires baseline demand and seasonal factors to get the forecast [13]. Baseline demand is calculated by taking average of each year demand. Baseline averages are used to forecast the baseline for next year by applying trend. This is shown in table 3.

Table 3. Calculation of baseline demand for Power thresher

Average demand of the year			Trend/year	Baseline demand for the year 2012
2009	2010	2011		
286.08	267.08	274.5	-5.79	269

Seasonal factor for each month is calculated by taking the ratio of actual data to baseline average for three different years. Average seasonal factor is calculated for each month which is shown in table 4. Forecast for each month of the year 2012 is predicted by multiplying baseline demand with the average seasonal factor that is shown in result and discussion section.

Table 4. Calculation of seasonal factors for Power thresher

Months	Seasonal factor for the year			Average seasonal factor
	2009	2010	2011	
January	0.30	0.40	0.31	0.34
February	1.30	0.89	1.18	1.13
March	3.41	3.31	2.91	3.21
April	3.01	2.84	3.03	2.96
May	0.71	1.30	1.33	1.11
June	0.36	0.45	0.35	0.39
July	0.51	0.48	0.46	0.48
August	0.54	0.51	0.44	0.50
September	0.20	0.09	0.17	0.15
October	0.30	0.42	0.38	0.37
November	1.21	0.91	1.15	1.09
December	0.15	0.40	0.29	0.28

3.2.2 Additive model

An additive seasonal variation simply assumes that the seasonal amount is a constant no matter what the trend or average amount is [13]. At first centered moving average of order 4 is calculated. Trend-cycle component is calculated by taking average of two consecutive centered moving average. The seasonal factors are computed by subtracting the trend-cycle components from the data (S= Y - T) that are shown in table 5. It is assumed that the time series is additive. So, forecasts are calculated by adding seasonal factor with the baseline demand that is shown in result and discussion section.

Table 5. Average seasonal factors calculation for power thresher

Months	Seasonal factor for the year			Average seasonal factor
	2009	2010	2011	
January	0.00	-143.25	-175.13	-159.19
February	0.00	-170.00	-94.13	-132.06
March	386.88	357.88	253.25	332.67
April	291.25	215.88	280.88	262.67
May	-229.25	-85.63	-74.38	-129.75
June	-136.38	-141.25	-169.50	-149.04
July	11.88	-14.00	-12.13	-4.75
August	42.00	35.25	23.38	33.54
September	-79.00	-91.38	-76.75	-82.38
October	-60.13	-12.13	-37.38	-36.54
November	205.38	113.88	0.00	159.62
December	-120.88	-56.25	0.00	-88.56

4. Result and discussion

The calculated Mean absolute deviations (MADs) of forecasted data by different forecasting techniques are plotted in figure 2. It is seen that three months weighted moving average gives lowest value of MAD for the year 2009, 2010, 2011 and 36-months average.

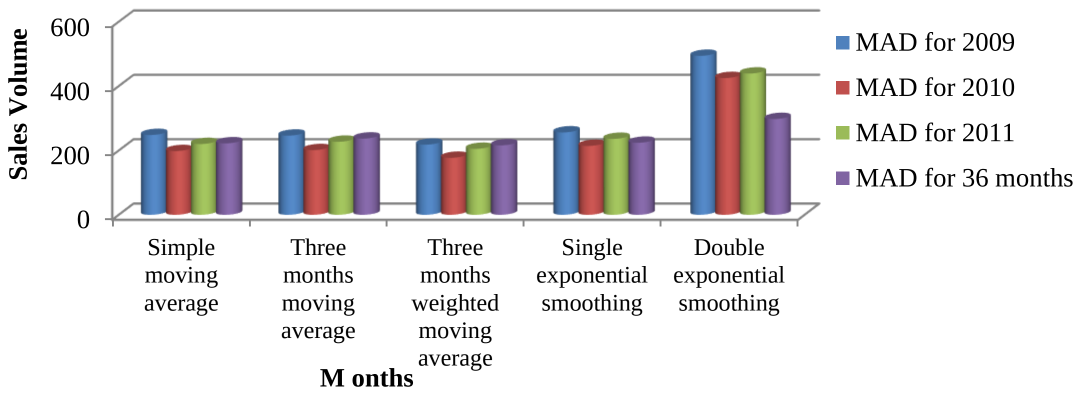

Fig. 2. Values of MAD using time series smoothing methods for power thresher

The forecast for each month of the year 2012 by multiplicative model along with actual sale is shown in figure 3. Forecast exceeds the actual sale in February and July. In October forecast is very close to actual sale. In rest of the month actual sales surplus the forecast due to conservative estimate. The maximum absolute deviation is occurred on August and its value is 38.

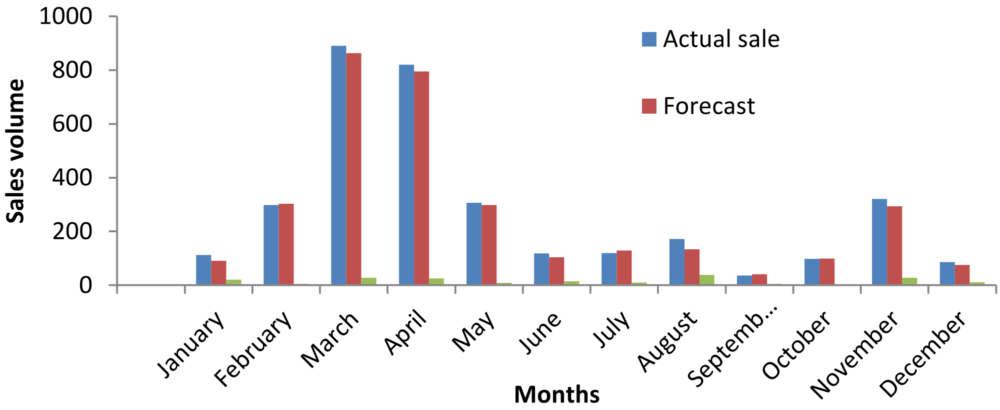

Fig. 3. Actual sales and forecast for the year 2012 by multiplicative model.

Figure 4 shows the comparison between actual sale and forecast for the year 2012 by additive model. In the month of February, March, April and May actual sales cross the forecast in a great amount. The absolute deviation between actual and forecast for at least five months is over 50. It indicates seasonal amount is not constant.

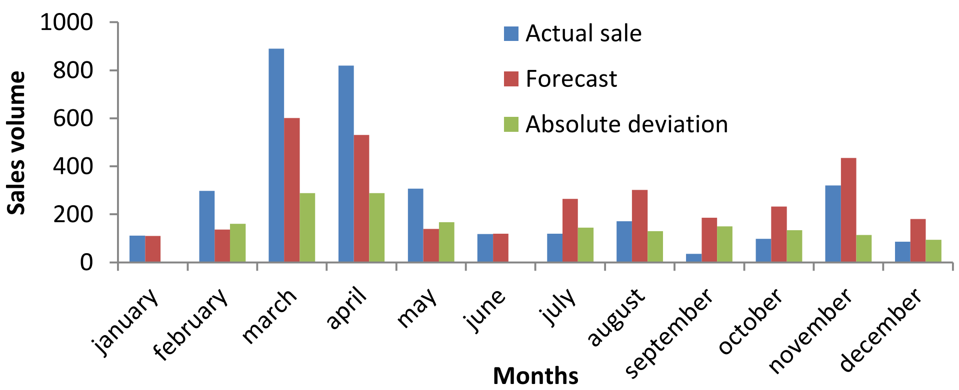

Fig. 4. Comparison between actual sale and forecast for the year 2012 by additive model

Mean absolute deviations (MADs) by multiplicative and additive model are calculated and found as 16 and 139 respectively. MAD of additive model is eight times more than multiplicative model. This is because constant nature of seasonal factor is not justified for those sales data. From the analysis it is said that multiplicative model is the best suited method for power thresher since it gives lowest MAD.

5. Conclusion

Forecasting plays a major role in decision making. In this study four years secondary sales data of power thresher have been collected from Alim Industries Ltd. Time series smoothing methods are used to forecast the sales of that product. Mean absolute deviations (MAD) are also calculated for each forecasting technique. The calculated MADs are found very high because of seasonal variation in their sales. To offset the seasonal effect, time series decomposition methods namely multiplicative and additive model have been used for forecasting demand for the year 2012. By comparing the actual sales data of the year 2012 with the forecasted data, it is found that multiplicative model shows the lowest mean absolute deviation. From the analysis it can be concluded that Multiplicative model is best suited to forecast the sales of the product since it gives lowest value of mean absolute deviation (MAD). With the help of proper forecasting technique, underproduction and overproduction of product can be avoided. It can also help in inventory management and thus reduces the cost of warehousing.

6. References

[1] P.M. Yelland, "Stable seasonal pattern models for forecast revision: A comparative study", *International Journal of Forecasting,* Vol.22, No.4, pp. 799-818, 2006.

[2] R. Fildes and C. Beard, "Forecasting systems for production and inventory control", *International Journal of Production and Operations Management,* Vol.12, No.5, pp. 4-27, 1992.

[3] M. A. Moon, J. T. Mentzer and C. D. Smith, "Conducting a sales forecasting audit", *International Journal of Forecasting,* Vol.19, pp. 5-25, 2003.

[4] J. B. Dilworth, Production and Operation Management, *McGraw-Hill Publishing Company Limited,* Fifth Edition, pp. 128-166, 1993.

[5] L. J. Krajeski and L. Ritzman, Operations Management Strategy and Analysis, *McGraw-Hill Publishing Company Limited,* 11^{th} Edition, pp. 536-573, 2006.

[6] J. G. De Gooijer, and R. J. Hyndman, "25 years of time series forecasting", *International Journal of Forecasting,* Vol.22, No.3, pp. 443-473, 2006.

[7] W. P. Andrew, D.A. Cranage, and C.K. Lee, "Forecasting hotel occupancy rates with time series models: An empirical analysis", *Journal of Hospitality and Tourism Research,* Vol.14, No.2, pp. 173-181, 1990.

[8] R.K. Jain, Planning Process and Management, *Khanna publishers,* 16^{th} Edition, pp. 110-111, 2001.

[9] R. B. Chase, N. J. Aquilano and F. R. Jacobs, Production and Operations Management, *McGraw-Hill Publishing Company Limited,* Eighth Edition, pp. 521-523, 1999.

[10] J. S. Armstrong, Principle of forecasting, *McGraw-Hill Publishing Company Limited,* Third Edition, pp. 25-69, 1997.