Application of Proper Forecasting Technique in Juice Production: A Case Study

Dalgobind Mahto[1]

[1] Green Hills Engineering College, Solan

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Abstract
Every organisation that produces product evaluates their performance at certain intervals to keep the pace with the market. Forecasts are evaluated to improve models to achieve better policy and planning outcomes. The purpose of this study is to observe whether the forecast errors are within the reasonable limit of expectations or whether these errors are irrationally large and require an improvement in the statistical models and process of producing these forecasts. Statistical time series modelling techniques like â??" Moving Average, Simple Exponential Smoothing and Least Square methods are used for the study and their performance evaluated in terms of Mean Average Deviation (MAD), Mean Squared Error (MSE).

Index terms— moving average method, simple exponential smoothing method, least square method, mean average deviation, mean squared error (MSE).

1 Introduction

odern production activities are becoming more complex technologically, the basic inputs are becoming expensive and there are lot of restrictions on them. The planning of the production activities is, therefore, essential to put the resources for best use. Planning is a fundamental activity of management. Forecasting forms the basis of planning and it enables the organisation to respond more quickly and accurately to market changes. It plays a crucial role in the development of plans for the future. It is essential for the organisations to know for what level of activities one is planning before investments in inputs i.e. men, machines and materials. It uses many statistical techniques. Therefore, it is also called as Statistical Analysis. It refers to a systematic analysis of past and present circumstances. It is essentially a technique of anticipation. Before making an investment decision, questions may arise like:

? What should be the size of the order and safety stock?

? What should be the capital cost required for the work?

? What should be the capacity of the plant?

? How much labour is required?

The answers to the above questions depend upon the forecast for the future level of operations. The success of a business greatly depends upon the efficient forecasting and preparing for future events. It should be no surprise that forecasts are not always accurate -they are essentially about predicting the future with incomplete information. Nevertheless, forecast inaccuracies, particularly consistent underestimation of revenues and budget surpluses generally draws intense criticism. Forecast accuracy has been a matter of concern and subject of review. In general, the reasons for inaccuracies may fall into the following categories:

? Technical issues, such as data accuracy, forecasting methodology, process and agency structures.

? Effects of fiscal objectives.

? The economic cycle. Forecasting agencies generally review and improve data and models on an ongoing basis, and issues identified in major reviews are generally marginal.

2 II.

3 Aims and Objectives

The main emphasis of this work is to compare the various forecasting techniques prevalent in the industries based on the data obtained from a juice producing factory. In this manuscript an attempt has been made to forecast juice production by using the Moving Average Method, Simple Exponential Smoothing and Least Square Method. The aim is to evaluate the performances in terms of

4 Methodology

This study was carried out on the basis of juice production data collected for the period 2000 to 2011 as shown in the table 1. When demand for a product is neither growing nor declining rapidly and if it does not have seasonal characteristics, a moving average can be useful in removing the random fluctuations for forecasting. Although moving averages are frequently centered, it is more convenient to use past data to predict the following period directly. Although it is important to select the best period for the moving average, there are several conflicting effects of different period lengths. The different moving averages produce different forecasts. The greater the number of periods in the moving average, the greater the smoothing effect. If the underlying trend of the past data is thought to be fairly constant with substantial randomness, then a greater number of periods should be chosen. The formula for a simple moving average isF t = (A t-1 + A t-2 + A t-3 + A t-n) n**(1)**

Where , F t = Forecast for the coming period, n = Number of period to be averaged n and A t-1 , A t-2 , A t-3 = Actual occurrences in the in the past period, two periods ago, three periods ago and so on respectively.

Equal weighting is given to each of the values used in the moving average calculation, whereas it is reasonable to suppose that the most recent data is more relevant to current conditions. An n period moving average requires the storage of (n-1) value to which is added the latest observation. This may not seem much of a limitation when only a few items are considered. The moving average calculation takes no account of data outside the period of average, so full use is not made of all the data available. The use of the unadjusted moving average as a forecast can cause misleading results when there is an underlying seasonal variation.

5 b) Simple Exponential Smoothing Method

In the previous forecasting method, the major drawback is the need to continually carry a large amount of historical data. As each new piece of data is added in these methods, the oldest observation is dropped, and the new forecast is calculated. The reason this is called exponential smoothing is that each increment in the past is decreased by **??**1-?).This method provides short term forecasts. The simplest formula is New forecast = Old forecast + ? (Latest Observation -Old Forecast)

Or more mathematically,F t = F t-1 + ? (A t-1 -F t-1).

(2) Where, Ft = The exponentially smoothed forecast for period t, F t-1 = The exponentially smoothed forecast made for the prior period, A t-1 = The actual demand in the prior period, ? = The desired response rate, or smoothing constant.

The value of smoothing constants ? varies from 0 to 1. The higher value of ? (i.e. the nearer to 1), the more sensitive the forecast becomes to current conditions, whereas the lower the value, the more stable the forecast will be, i.e. it will react less sensitively to current conditions. Here the value of alpha is taken as 0.3.Greater weight is given to more recent data. All past data are incorporated there is no cut-off point as with moving averages. Less data needs to be stored than with the longer period moving averages. Like moving averages it is an adaptive forecasting system. That is, it adapts continually as new data becomes available and so it is frequently incorporated as an integral part of stock control and production control systems. To cope with various problems (trend, seasonal factors, etc) the basic model needs to be modified. Whatever form of exponential smoothing is adopted, changes to the model to suit changing conditions can simply be made by altering the value of ?. The selection of the smoothing constant ? is done through trial-error by the researcher/analyst. It is done by testing several values of ? (within the range 0 to 1) and selecting one which gives a forecast with the least error (one can take standard error). It has been found that values in the range 0.1 to 0.3 provide a good starting point.

6 c) Least Squares Method

This is the mathematical method of obtaining the line of best fit between the dependent variable and an independent variable. In this, the sum of the square of the deviations of the various points from the line of best fit is minimum or least. (5)

These two equations are called normal equations. It is useful for long-term forecasting of major occurrences and aggregate planning. The major restriction in using linear forecasting is that past data and future projections are assumed to fall about a straight line. Although, this does limits its application.

7 d) Evaluating the Forecast Accuracy

There are many ways to measure forecast accuracy. Some of these measures are the mean absolute forecast error, called the MAD (Mean Absolute Deviation), the mean absolute percentage error (MAPE) and the mean square error (MSE). This error estimate helps in monitoring erratic demand observations. In addition, they also help to determine when the forecasting method is no longer tracking actual demand and it need to be reset. For this tracking signals are used to indicate any positive or negative bias in the forecast. The mean absolute deviation (MAD) is also important because of its simplicity and usefulness in obtaining tracking signals. MAD is the average error in the forecasts, using absolute values. It is valuable because MAD, like the standard deviation, measures the dispersion of some observed value from some expected value. The only difference is that like standard deviation, the errors are not squared. Standard error a square root of a function, it is often more convenient to use the function itself. This is called the mean square error (MSE) or variance. The mathematical formulas may be used while evaluating data are

8 result analysis

In this study, we used the data for juice production for the period 2000-01 to 2010-2011. All the three methods are applied one by one and their performance evaluated in terms of MAD, MAPE and MSE.

9 a) Moving Average Method

10 Discussion

Initially time series plot (Figure 1) was created to determine the trends in the juice production from 2003 to 2011, the graph shows an increasing trend in juice production during the study period and hence showed that the series was not stationary. It is very clear from the graph that the trend line of Least Square Average method flow on the actual trend line of juice production. The trend line of Simple exponential method is far away from the actual trend line. And finally the performance of the various methods evaluated on the basis of MAPE, MAD and MSE which is shown in the table 6. By comparing the performance of the methods, it was found that Least Square method have least value of MAPE (15.74%), MAD (0.25) and MSE (0.09) and hence the results produced by the least square method have less error and more accurate than the other method.

11 VI.

12 Conclusion

Forecasting of juice production done by using statistical methods, (Moving Average method, Simple Exponential Method and Least Square Method). Statistical methods are chosen because for their rich historic data and ease of their use. Finally, their performance evaluated by comparing the MAPE, MAD and MSE obtained from the different methods. The results show that least Square method is more accurate than the other methods.

The forecasting technique may be different for different industries. It depends upon the variable factors like place, manpower skill, equipment capacity, raw material availability, inventory characteristics and management policies etc. Hence this work may be extended to other industries. [1]

12 CONCLUSION

4

Figure 1: 4)?

1

S. No.	Year	company Production (in millions)
1	2000-01	16.6
2	2001-02	19.3

Figure 2: Table 1 :

2

Technique		Measures
Mean Squared Error (MSE)	The average of squared errors	over the sample period
Mean Error (ME)	The average dollar amount or percentage points by which forecasts differ from outcomes	
Mean Percentage Error (MPE)	The average of percentage errors by which forecasts differ from	outcomes
Mean Absolute Error (MAE)	The average of absolute dollar amount or percentage points by which a forecast differs from an outcome	
Mean Absolute Percentage Error (MAPE)	The percentage amount by which forecasts differ from outcomes	average of absolute
IV.		

Figure 3: Table 2 :

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S. No.	Year	Production (in millions) P	Forecast F	Error E	Squared Error E 2	Absolute Percentage Error (E/P)x 100
1 2 3 4 5	2000-01 2001-02 2002-03 2003-04 2004-05	16.6 19.3 20.8 23.8 26.5	18.9 21.3	4.9 5.2	24.01 27.04	20.59 19.62
6	2005-06	29	23.7	5.3	28.09	18.28
7	2006-07	31.1	26.43	4.67	21.78	15.01
8	2007-08	33.4	28.87	4.53	20.55	13.57
9	2008-09	36.4	31.17	5.23	27.39	14.38
10	2009-10	38.9	33.63	5.27	27.74	13.54
11	2010-11	40.7	36.23	4.47	19.95	10.97

Figure 4: Table 3 :

4

S. No.	Year	Production (in millions) P	Forecast F	Error E	Squared Error E 2	Absolute Percentage Error (E/P)x 100
1	2000-01	16.6				
2	2001-02	19.3	16.6	2.7	7.29	13.99
3	2002-03	20.8	16.87	3.93	15.44	18.89
4	2003-04	23.8	17.26	6.54	42.73	27.47
5	2004-05	26.5	17.92	8.58	73.67	32.39
6	2005-06	29	18.78	10.22	104.55	35.26
7	2006-07	31.1	19.80	11.30	127.75	36.34
8	2007-08	33.4	20.93	12.47	155.56	37.34
9	2008-09	36.4	22.17	14.23	202.35	39.08
10	2009-10	38.9	23.60	15.30	234.17	39.34
11	2010-11	40.7	25.13	15.57	242.50	38.26
			c) Least Square Method			

Figure 5: Table 4 :

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X	Production (in millions) P	XP	X 2	P 2	Forecast F	Error E	Squared Error E 2	Absolute Percentage Error (E/ 100
1	16.6	16.6	1	275.56	16.52	0.08	0.01	0.48
2	19.3	38.6	4	372.49	18.98	0.32	0.10	1.69
3	20.8	62.4	9	432.64	21.43	0.63	0.40	2.94
4	23.8	95.2	16	566.44	23.88	0.08	0.01	0.34
5	26.5	132.5	25	702.25	26.33	0.17	0.03	0.65
6	29	174	36	841	28.78	0.22	0.05	0.76
7	31.1	217.7	49	967.21	31.23	0.13	0.02	0.42
8	33.4	267.2	64	1115.56	33.69	0.29	0.08	0.86
9	36.4	327.6	81	1324.96	36.14	0.26	0.07	0.72

10 11 ?X=66 Mean X = 6 Therefore general equation for forecast is F = 14.07 + 2.45X 38.9 389 10

Least squar

Production Year

Figure 6: Table 5 :

6

best forecasting method for juice production

Measures of accuracy	Moving Average Method	Simple Exponential Method	Least Square Method
MAPE	15.74 %	31.83 %	0.95%
MAD	4.95	10.08	0.25
MSE	24.57	120.60	0.09

Figure 7: Table 6 :

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