

Selection of a Forecasting Technique for Beverage Production: A Case Study

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Performance evaluation of an organization at certain intervals helps to keep pace with the market. For developing models to achieve better policy and planning results, forecast of sales volume is a must. The objective of this study is to apply forecasting techniques to a beverage production company and notice whether the forecast errors are irrationally large and require an improvement in the statistical models and process of producing these forecasts. Statistical time series modeling techniques like – Moving Average, Simple Exponential Smoothing and Least Square methods are used for the study which is compared with the value of actual sales volume and a large gap is found between forecasted value and actual one. Also performance of those models is evaluated in terms of Mean Average Deviation (MAD), Mean Squared Error (MSE). From the study it was found that Simple Exponential Smoothing method shows better result for forecasting sales of beverage products.

Keywords: Performance, forecast, time series forecasting models, measures of forecast accuracy.

1. Introduction

In recent competitive market production activities are demanding more technologically updated systems to optimize the resources. 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 organization 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 organizations 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, various questions regarding safety stock, production size etc. may arise. The answers to those 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.

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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. Objective of this study is to use different forecasting techniques in beverage production of Abdul Monem Ltd. and select the appropriate technique in terms of less relative error. The rest of the paper is organized as follows: Section 2 presents some related works. Methodology has been presented in Section 3. Section 4 contains data collection and calculation. Section 5 discusses the evaluation of forecasting accuracy. Section 6 explains the results and discussions and this paper is concluded with section 7 which explains conclusions and the future work.

2. Literature Review

Various researches and works had been conducted on last few decades among them several significant works are discussed here to clarify the purpose of this paper. Yenradeea et. al. (2001) stated that demand forecasting and production planning for highly seasonal product is very important. Three forecasting models, namely, Winter's, decomposition, and Auto-Regressive Integrated Moving Average (ARIMA), were applied to forecast the product demands and it is found that the decomposition and ARIMA models provide lower forecast errors in all product groups which minimizes the total overtime and inventory holding costs based on a fixed workforce level and an available overtime. Kumar, R. and Mahto, D. (2013) applied various statistical time series models to observe forecast errors in the demand of juice production are within the expectation limit and to select a forecasting technique which have less relative error. Author showed that Least Square Method is more accurate than the others. Pal et.al. (2007) attempted to forecast milk production in India using statistical time series modeling- Double Exponential Smoothing and Auto- Regressive Integrated Moving Average and concluded that ARIMA performed better than the other one. Barbosa, N. de P. et.al.(2015) applied methods to forecast the demand for products of a food industry, which directs its sales to the food service market, in order to base the short to medium term production planning. The forecasts were evaluated using the error measure MAPE and compared to the demand considered by the company. Authors concluded that the Holt-Winters method, which was applied in the time series analyzed in their work, showed its effectiveness for forecasting demand of products that presents trend and seasonality patterns in sales history. Lee, Y. and Tong, L. (2011) proposed a hybrid forecasting model for nonlinear time series by combining ARIMA with genetic programming (GP) to improve upon both the ANN and the ARIMA forecasting models. Eksoz, C. et. al. (2014) proposed a framework which serves as a guide for practitioners when initiating and conducting long-term collaborative forecasting partnerships. Authors research was limited to examining the manufacturer–retailer dyadic collaboration, and focuses on specific food product categories. After reviewing the literatures it has found that many work has done on forecasting but sales forecasting of beverage product is in a very few number. This paper analyses various forecasting methods and finds out the best method for forecasting beverage product which is a semi seasonal product.

3. Methodology

The approach of this paper work is a deductive approach. Quantitative method in data collection that provides a better understanding of the problem is used. This paper covers both primary and secondary data. Forecasting is done with traditional time series forecasting models and errors are calculated and forecasting model with less relative error is selected.

3.1 Forecasting

A forecast is an estimate of an event which will happen in future. The event may be demand of a product, rainfall at a particular place, population of a country, or growth of a technology. The forecast value is not a deterministic quantity. Since, it is only an estimate based on the past data related to a particular event, proper care must be given in estimating it. Forecasting provides a basis for coordination of plans for activities in various part of a company. All the functional managers in any organization will base their decisions on the forecast value. So, it is vital information for the organization. Due to these reasons, proper care should be exercised while estimating forecast values.

Types of Forecasts

- Technology forecast
- Economic forecast
- Demand forecast

The demand forecast gives the expected level of demand for goods or services. This is the basis input for business planning and control. Hence, the decisions for all the functions of any corporate house are influenced by the demand forecast.

3.2 Forecasting Models

The forecasting techniques can be classified into qualitative techniques and quantitative techniques. Qualitative techniques use subjective approaches. These are useful where no data is available and are useful for new products.

- Delphi type method
- Market surveys

Quantitative techniques are based on historical data. These are more accurate and computers can be used to speed up the process.

- Single moving average
- Single exponential smoothing
- Double moving average
- Double exponential smoothing
- Simple regression
- Semi average method
- Multiple regression
- Box Jenkins

3.3 Measures of Forecast Accuracy

Mean Absolute Deviation (MAD)

It is the mean absolute deviations (MAD) of forecast demands from actual demand values. The MAD is sometimes called as the mean absolute error (MAE).

$$MAD = \frac{\sum |D_t - F_t|}{n}$$

Where,

D = Actual demand for the period t,
F = Forecast demand for the period t,
n = number of time period used.

Mean Forecast Error (MFE)

Mean forecast error (MFE) is the mean of the deviations of the forecast demand from the actual demands.

$$MFE = \frac{\sum (D_t - F_t)}{n}$$

Mean Square Error (MSE)

Mean square error (MSE) is the mean of the squares of the deviation of the forecast demand from the actual values.

$$MSE = \frac{\sum (D_t - F_t)^2}{n}$$

Mean Absolute Percentage Error (MAPE)

Mean absolute percentage error (MAPE) is the mean of the percent deviation of the forecast demands from the actual demands.

$$MAPE = \frac{1}{n} \sum \frac{|D_t - F_t|}{D_t} \times 100$$

4. Data Collection and Calculation

4.1 Statistical Data from Selected Company

This study was carried out on the basis of beverage (Coca-cola) production data collected from Abdul Monem Ltd. for the period 2010 to 2014 as shown in the table 1.

Table 1: Recorded Coca-cola production data of the company

S. No	Year	Production(in bottles)	Sales(in bottles)
1	2009-2010	4878379	4878379
2	2010-2011	5560306	5560306
3	2011-2012	6387338	5856712
4	2012-2013	5684914	5684914
5	2013-2014	7181598	6545886

From the production & sales data of the company it is seen that, at the year 2009-2010 the amount of product manufactured in the company that is 4878379 bottles of Coca-cola were completely sold. Since in the next year Abdul Monem Ltd. produced 5560306 bottles of Coca-cola which was also sold in whole. That means the demand of Coca-cola was either equal or more than the production in that time. In the year 2011-2012 the production was increased to the amount of 6387338 bottles & the sales was less than the production. In 2012-2013 the produced amount was completely sold again. Next year the company again made over production. It is seen that every time there is a deviation of production with actual sales. To minimize this deviation the company should use proper forecasting technique.

5. Application of Different Method for Demand Forecasting

5.1 Simple Moving Average Method

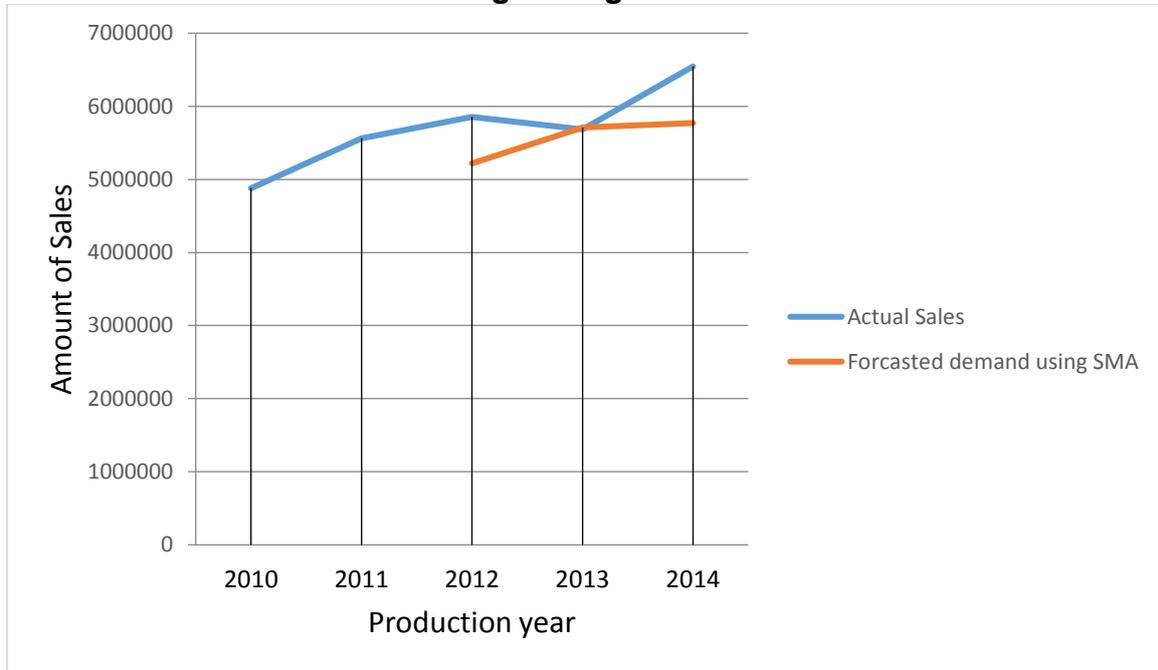
When demand for a product is neither growing nor declining rapidly and if it does not have seasonal characteristics, a moving average can be useful in removing the random fluctuations for forecasting. Although moving averages are frequently centered, it is more convenient to use past data to predict 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 is

$$F_t = \frac{A_{t-1} + A_{t-2} + A_{t-3} + \dots + A_{t-n}}{n}$$

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. Here, the number of periods to be averaged (n) is 2.

Applying this technique, three forecasts were made. They are 5219343, 5708509, 5770813 at the year 2012, 2013, 2014 respectively and the errors were 637369, -23595, 775073 between the actual sales and forecast values at the corresponding years.

Figure 1: Graphical comparison of actual sales with forecasted demand of simple moving average method.



5.2 Weighted Moving Average Method

In the simple moving average each observation is weighted equally. For example, in a three-period moving average each observation weighted one-third. In a five-period moving average each observation is weighted one-fifth. Sometimes a manager wants to use a moving average but gives higher or lower weights to some observations based on knowledge of the industry. This is called a weighted moving average. In a weighted moving average, each observation can be weighted differently provided that all the weights add up to 1.

$$F_{t+1} = \sum C_t A_t = C_1 A_1 + C_2 A_2 + \dots + C_t A_t$$

Where,

F_{t+1} = next period's forecast,

C_t = weight placed on the actual value in period t,

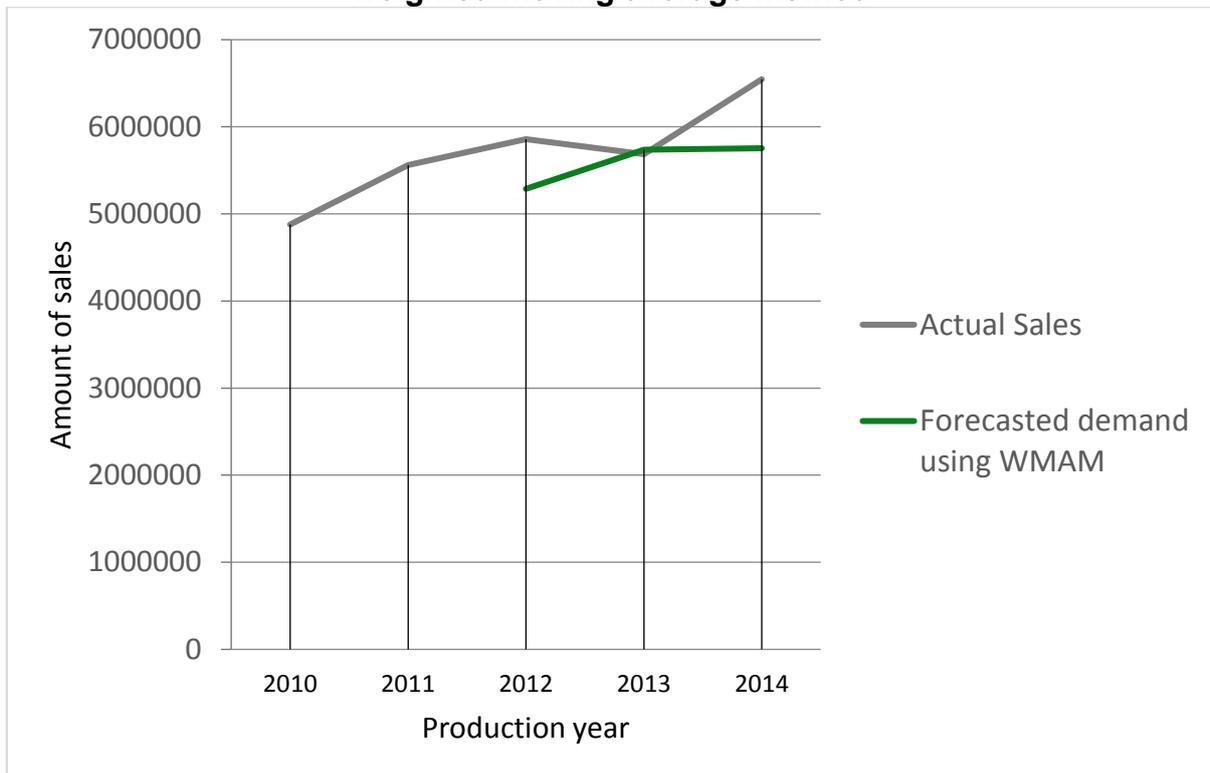
A_t = actual value in period

Assigning Weight to Different Data: In weighted moving average method, different weight has given to different data of different period. Since the data of the very last year is most important for forecasting for that reason most recent data has given more emphasize. Then demand forecasting in the terms of moving average period (n) of 2 years was calculated. So, while assigning weight, a weight valued 0.6 has given to the very last year's data and 0.4 to the data of previous year of the last year. Here, $5560306 / (5560306 + 4878379) =$

0.53266 ~ 0.6 because the weight assigned to this data must be greater than the weight assigned to 4878379.

After calculation using weighted moving average method three forecasts were made. They are 5287535, 578149, 5753633 bottles at the year 2012, 2013, 2014 respectively and the errors were 569177, -53235, 792253 with the actual sales.

Figure 2: Graphical comparison of actual sales with forecasted demand using weighted moving average method



5.3 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 pasts decreased by $(1-\alpha)$. This method provides short term forecasts. The simplest formula is, New forecast = Old forecast + α (Latest Observation – Old Forecast)

Or more mathematically, $F_t = F_{t-1} + \alpha (A_{t-1} - F_{t-1})$.

Where,

F_t = the exponentially smoothed forecast for period t,

F_{t-1} = the exponentially smoothed forecast made for the prior period,

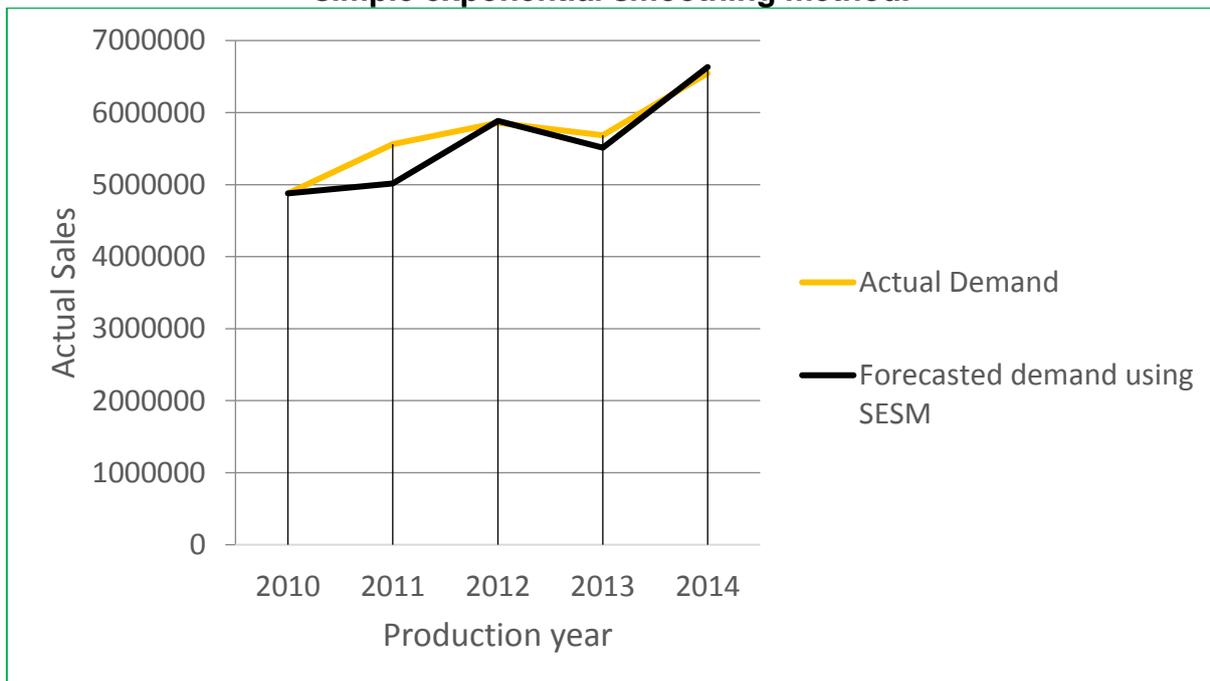
A_{t-1} = the actual demand in the prior period,

α = the desired response rate, or smoothing constant.

The value of smoothing constants α varies from 0 to 1. The higher value of α (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 α . The selection of the smoothing constant α is done through trial-error by the researcher/analyst. It is done by testing several values of α (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. Here, $\alpha =$ Smoothing Constant weight given to previous data is 0.2. After calculation using simple exponential smoothing average method the forecasted values are 4878379, 5014765, 5886353, 5513116, 6631983 and the errors are 0, 545541, 148203, -85899, and 430486 at year 2010, 2011, 2012, 2013, 2014 respectively.

Figure 3: Graphical comparison of actual sales with forecasted demand using simple exponential smoothing method.



5.4 Least Square 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. For straight line, $y = a + b x$

Where,

Y = forecast for period X,

X = the number of time periods from X=0,

a = value of Y at X=0 (Y intercept), b=slope of the line

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The coefficients 'a' and 'b' are computed using the least-squares method, which minimizes the sum of the squared errors. The steps for computing the forecast using a linear trend line are as follows:

Step 1: Compute parameter b: $b = \frac{\sum XY - nxy}{\sum X^2 - nx^2}$

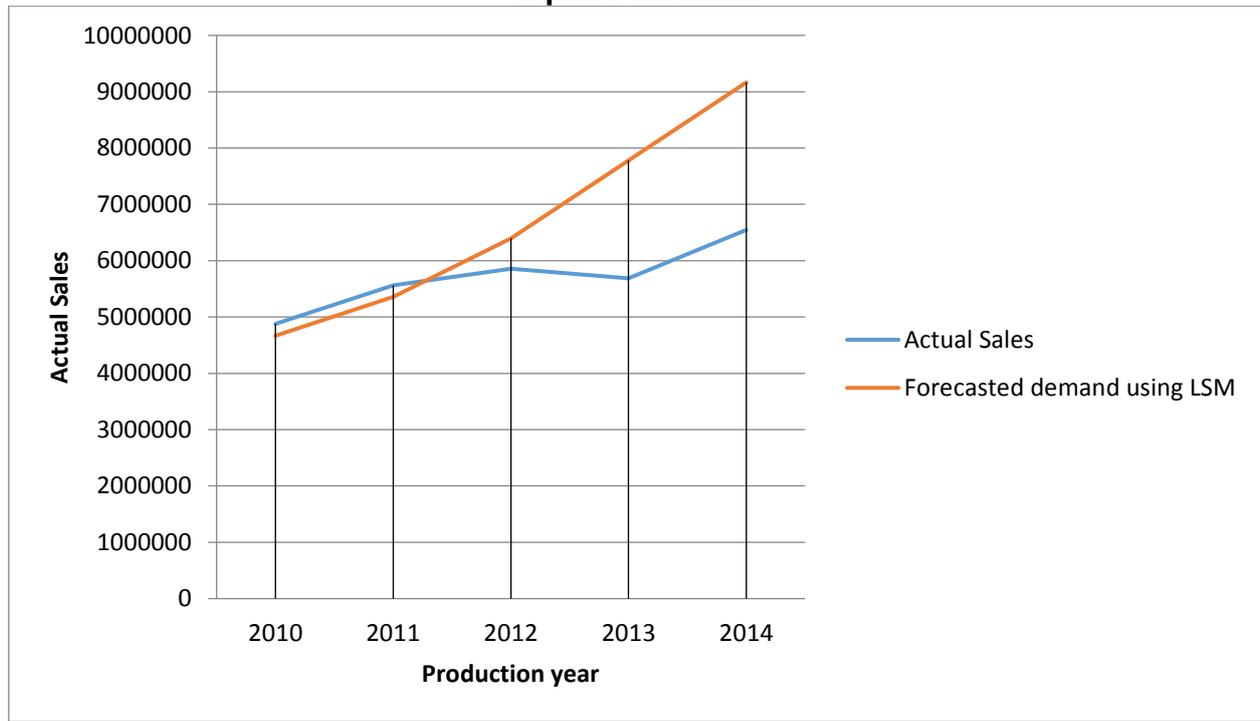
Step 2: Compute parameter a: $a = y - b x$

Step 3: Generate the linear trend line: $Y = a + b X$

Step 4: To make a forecast for the dependent variable (Y), substitute the appropriate value for the independent variable (X).

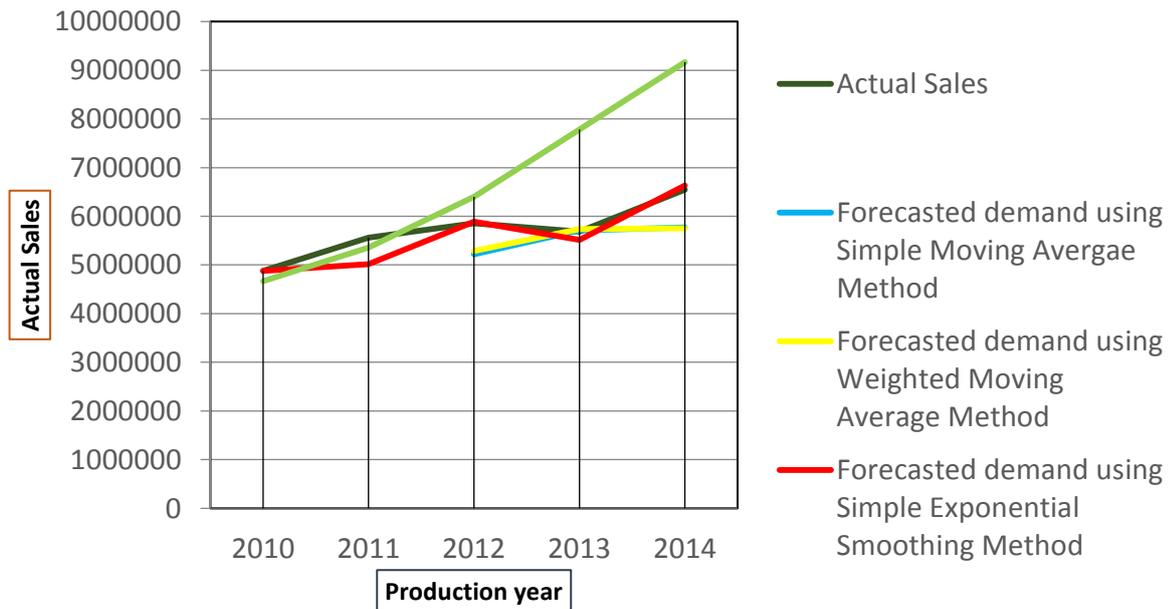
Using least square method forecast values were calculated as 4667350, 5359276, 6397165, 7781017, 9164869 bottles and the errors were 211029, 201030, -540453, -2096103, -2618983 at the year 2010 to 2014 respectively.

Figure 4: Graphical comparison of actual sales with forecasted demand using least square method.



Time series plot (Figure 5) has done to determine the trends in the coca-cola production from 2010 to 2014. It shows an increasing trend in coca-cola 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 Simple Exponential Smoothing method flows near the actual trend line of coca-cola production

Figure 5: Time series plot of Coca-Cola production



5.5 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

$$\text{Error} = \text{Actual Observed value} - \text{Forecasted value}$$

$$\text{Absolute Percentage Error} = (\text{Error} / \text{Actual Observed Value}) \times 100$$

Where,
 MAD = the average of the absolute errors.
 MAPE = the average of the Absolute Percentage Errors.
 MSE = the average of the squared errors.

Using the data the value of MAD, MAPE and MSE has calculated and showed in the following table.

Table 2: Measures of accuracy of forecasted demand of different methods

Measures of accuracy	Simple Moving Average Method	Weighted Moving Average Method	Simple Exponential Smoothing Method	Least Square Method
MAPE	7.71%	7.59%	5.54%	18.81%
MAD	478679	471555	242025	1133519
MSE	3.4×10^{11}	3.18×10^{11}	1.02×10^{11}	2.33×10^{12}

6. Results and Discussion

Initially time series plot (Figure 5) was created to determine the trends in the coca-cola production from 2010 to 2014, the graph shows an increasing trend in coca-cola 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 Simple Exponential Smoothing method flow near the actual trend line of coca-cola production. And finally the performance of various methods evaluated on the basis of MAPE, MAD and MSE which is shown in the table 2.

The data of table 2 shows that in case of moving average method, value of MAPE, MAD and MSE are 7.71%, 478679 and 3.4×10^{11} respectively. For Simple Exponential Method, value of MAPE, MAD and MSE are 5.54%, 242025 and 1.02×10^{11} , respectively. For weighted moving average method, value of MAPE, MAD and MSE are 7.59%, 471555 and 3.18×10^{11} . Similarly, in case of Least Square Method value of MAPE, MAD and MSE are 18.81%, 1133519 and 2.33×10^{11} . By comparing the performance of the methods, it was found that Simple Exponential Smoothing method have least value of MAPE (5.54%), MAD (242025) and MSE (1.02×10^{11}) and hence the results produced by the simple exponential smoothing method have less error and more accurate than the other method.

7. Conclusion

Forecasting of Coca-Cola production has done by using statistical methods, (Moving Average method, Simple Exponential Method and Least Square Method). Statistical methods are chosen because of their rich historic data and ease of their use. Finally, their performance was evaluated by comparing the MAPE, MAD and MSE obtained from the different methods. The results show that Simple Exponential Smoothing 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. Sales forecasting of beverage products may be done using Artificial Neural Network (ANN), Genetic Algorithm, ARIMA etc.

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