International Journal of Inventive Engineering and Sciences (IJIES)
ISSN: 2319–9598, Volume-1, Issue-9, August 2013

Demand Forecasting For Sales of Milk Product (Paneer) In Chhattisgarh

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Abstract— This paper examines forecasting method for sales of milk product (paneer) in Chhattisgarh. Forecasting method assessed includes single moving average (SMA), double moving average method (DMA), single exponential smoothing (SES), semi average method (SAM) and Naïve Method. The mean forecast error (MFE), mean absolute deviation (MAD), mean square error (MSE), root mean square error (RMSE) is used to measure the accuracy of forecasting methods. Based on accuracy, single exponential smoothing (SES) with α=0.3 produces the most accurate forecasting. Method used in this paper is readily transferable to other milk product data sets with weekly demand figures.

I. INTRODUCTION

Forecasting can be broadly considered as a method or a technique for estimating many future aspects of a business or other operations. All forecasting method can be divided into two broad categories: qualitative and quantitative. Many forecasting techniques use past or historical data in the form of time series. A time series is simply a set of observations measured at successive point in time or essentially provide future values of the time series on a specific variable such as sales volume. Exponential smoothing is one the time series technique which is widely used in forecasting. Exponential smoothing gives greater weight to more recent observations and takes into account all previous observations. In ordinary terms, an exponential weighting scheme assigns the maximum weight to the most recent observation and the weight decline in a systematic manner as older and older observations are included. Weight in the exponential smoothing technique is given by exponential smoothing (α). Forecast values are varied with the values of this constant. So, Forecast errors are also depended on α. Many authors used exponential smoothing method in forecasting. Synder et al. (2002) has shown that exponential smoothing remains appropriate under more general conditions, where the variance is allowed to grow or contract with corresponding movements in the underlying level. Taylor (2003) investigated a new damped multiplicative trend approach. Gardner (2006) reviewed the research in exponential smoothing since the original work by Brown and Holt and brought the state of the art up to date and invented a complete statistical rationale for exponential smoothing based on a new class of state space model with a single source of error.

Manuscript received August, 2013.

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McKenzie and Gardner(2010) provided a theoretical rationale for the damped trend method based on Brown's original thinking about the form of underlying models for exponential smoothing. Hyndman (2002) provided a new approach to automatic forecasting based on an extended range of exponential methods.

II. DATA COLLECTION

The data for this study were collected and recorded on weekly basis. The data contain sales of product (paneer) from October 2011 to October 2012. All the data was saved into an Excel spreadsheet.

Table 1: Demand of product (paneer) (in kg)

Week No.	Demand	Week No.	Demand
1	905.4	29	839.8
2	647	30	1045
3	591	31	858.6
4	590.2	32	637.8
5	597	33	605
6	744.4	34	656.8
7	606.4	35	584.8
8	518.2	36	729
9	572.4	37	1029
10	556.2	38	885.6
11	539	39	1441.2
12	488.6	40	841.6
13	614.2	41	689.8
14	641.2	42	784.8
15	565	43	846.8
16	693.2	44	1229.6
17	762.4	45	891.2
18	589.4	46	979.2
19	655.4	47	938.6
20	586.4	48	928.6
21	607.8	49	882.2
22	515	50	967.4
23	515.2	51	817.3
24	550.6	52	895.6
25	451.8	53	757.2
26	583.4	54	805
27	652.2	55	928
28	688	56	977

III. METHODOLOGY

This study evaluated different forecasting models using sales demand data from October 2011 to October 2012. The data were adjusted into MS excel spreadsheet. The forecasting models used in the analysis were the following: naïve model, moving average, double moving average, simple exponential smoothing; and semi average method. The most appropriate forecasting method in this paper was determined on the basis of accuracy and easy of use. In this research paper several common accuracy method were used as following: Forecast Error (MFE), mean Absolute Deviation (MAD), mean Square Error (MSE), root mean square Error (RMSE). A ranking was assigned to each forecasting method.

IV. FORECASTING METHODS

Moving Average Method. The moving average method involves calculating the average of observations and then employing that average as the predictor for the next period. The moving average method is highly dependent on n, the number of terms selected for constructing the average. The equation is as follows:

$$F_{t+1} = (Y_t + Y_{t-1} + Y_{t-2} + \ldots\ldots + Y_{t-n+1})/n$$

Where:

F_{t+1} = the forecast value for the next period
Y_t = the actual value at period t
n = the number of term in the moving average

The optimal n value can be determine by interactive model that the smallest error. In some method the general approach has been to use MSE. In this study, the value of n taking 1, 2 and 3.

Double Moving Average Method. Hanke and Reitsch (1998) recommended the use of the double moving average method to forecast time series data. Forecasting with a double moving average requires determining two averages. The first moving average is computed; a second moving average is calculated. Five equations are used in the double moving average:

$$M_t = F_{t+1} = (Y_t + Y_{t-1} + Y_{t-2} + \ldots\ldots + Y_{t-n+1})/n$$

$$M'_t = (M_t + M_{t-1} + M_{t-2} + \ldots\ldots + M_{t-n+1})/n$$

$$A_t = 2M_t - M'_t$$

$$B_t = \frac{2}{n-1}(M_t - M'_t)$$

$$F_{t+p} = A_t + B_t p$$

Where:

n = the number of period in the double moving average
Y_t = the actual series value at time period t
P = the number of period ahead to be forecast

Simple Exponential Smoothing Method. The exponential smoothing method is a technique that uses a weighted moving average of past data as the basis for a forecast. This method keeps a running average of demand and adjusts it for each period in proportion to the difference between the latest actual demand figure and the latest value of the average. The equation for the simple exponential smoothing method is:

$$F_{t+1} = \alpha Y_t + (1-\alpha) F_{t-1}$$

Where:

F_{t+1} = the new smoothing value or the forecast value for the next period
α= the smoothing constant ($0 < \alpha < 1$)
Y_t = the new observation or actual value of the series in period t
F_t = the old smoothed value or forecast for period t

The accuracy of the simple exponential smoothing method strongly depended on the optimal value of (α).The preferred range for α is from 0.1 to 0.3. In this study, the value of α taking 0.1, 0.2 and 0.3.

Semi – Average Method. According to this method, the original data are divided into two equal parts and the values of each part are then summed up and averaged. The average of each part is centered in the period of the time of the part from which it has been calculated and then plotted on graph. Then a straight line is drawn to pass through the plotted points. This line constitutes the semi – average trend line. When the number of year is odd, the middle year is not considered while dividing the data into two equal parts and obtaining the average.

Naïve Method. Naïve method are forecasting techniques obtained with a minimal amount of effort and data manipulation and are based on the most recent information available (Shim, 2000). The naïve method uses data from the previous week to forecast the current week (one week lag):

$$F_{t+1} = Y_t$$

Where:

F_{t+1} = the forecast value for the next period
Y_t = the actual value at the next period

V. MEASURING FORECASTING ERROR

There is no consensus among researcher as to which measure is best for determining the most appropriate forecasting method (Levine et al., 1999). Accuracy is the criterion that determines the best forecasting method; thus, accuracy is the most important concern in evaluating the quality of a forecast. The goal of the forecasts is to minimize error. Forecast error is the difference between an actual value and its forecast value (Hanke & Reitsch, 1998).

Some of the common indicators used evaluate accuracy are mean forecast error, mean absolute deviation, mean squared error, and root mean squared error. Regardless of the measure being used, the lowest value generated indicates the most accurate forecasting model.

Mean Forecast Error. Mean forecast error (MFE) is the mean of the deviation of the forecast demands from the actual demands.

$$\text{MFE} = \frac{\sum_{t=1}^{n}(Y_t - F_t)}{n}$$

Where:

Y_t = the actual value in time period t
F_t = the forecast value in time period t
n = the number of periods

Mean Absolute Deviation. A common method for measuring overall forecast error is the mean absolute deviation (MAD). Heizer and Render (2001) noted that this value is computed by dividing the sum of the absolute values of the individual forecast error by the sample size (the number of forecast periods). The equation is:

$$\text{MAD} = \frac{\sum_{t=1}^{n}(Y_t - F_t)}{n}$$

Where:

Y_t = the actual value in time period t
F_t = the forecast value in time period t
n = the number of periods

Mean Square Error. Jarrett (1991) stated that the mean square error (MSE) is a generally accepted technique for evaluating exponential smoothing and other methods. The equation is:

$$MSE = \frac{1}{n}\sum_{t=1}^{n}(Y_t - F_t)^2$$

Where:

Y_t = the actual value in time period t
F_t = the forecast value in time period t
n = the number of periods

Root Mean Square Error. Root mean square error (RMSE) is the square root of MSE. This measures error in term of units that are equal to the original value (Jarrett, 1991).Symbolically, the equation is:

$$RMSE = \sqrt{\frac{1}{n}\sum_{t=1}^{n}(Y_t - F_t)}$$

Where:

Y_t = the actual value in time period t
F_t = the forecast value in time period t
n = the number of periods

VI. EVALUATION OF FORECASTING METHOD

In this study the most appropriate forecasting method was selected on basis of both accuracy and easy of use. After the forecasts were completed using various forecasting methods, the accuracy of the forecasting methods was assessed using mean absolute deviation (MAD), mean forecast error (MFE), mean square error (MSE) and root mean squared error (RMSE). Since there is no standard universally accepted model for forecast accuracy, which model to adopt was considered. Both accuracy outcomes and ease of use were taking into consideration.

In the case of milk product demand forecasting, special consideration as to each method's ease of use was required, since the person in charge of forecasting usually has little time and – in some instances – little knowledge of how to implement the forecasts. The ease of the use of the forecasting method is sometimes far more important in practice than the accuracy of the forecasting method.

VII. RESULT AND DISCUSSION

The purpose of this research was to identify an appropriate forecasting method for demand of milk product at Raipur dugdh sangh (Devbhog). 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 smaller the forecast error, the more accurate forecasting method.

Table 2: Summary of Forecast Accuracy (Paneer)

METHOD	MFE	MAD	MSE	RMSE
Simple Moving Average Method (n=2)	6.094	109.61	25190.5	158.71
Simple Moving Average Method (n=3)	9.6404	111.45	26479.8	162.72
Simple Moving Average Method (n=4)	12.1696	115.05	27630.7	166.22
Double Moving Average Method (n=2)	7.78929	133.959	33103.5	181.944
Double Moving Average Method (n=3)	5.57937	142.84	40615.3	201.532
Double Moving Average Method (n=4)	0.53371	136.41	47454.7	217.841
Single Exponential Method(α=0.1)	-4.8994	131.87	33178.662	182.150
Single Exponential Method(α=0.2)	-0.9244	116.75	27132.143	164.7183
Single Exponential Method(α=0.3)	-0.3084	115.04	25480.467	159.6260
Semi average Method	-18.565	91.997	20490.6	143.145
Naïve Model	1.278	117.91	28414.201	168.565

Table 3: Overall Ranking of Forecasting Method for Paneer

Method	MFE	MAD	MSE	RMSE	Ranki-ng Total	Overall Rankin-g
Simple Moving Average Method (n=2)	7	2	2	2	13	2
Simple Moving Average Method (n=3)	9	3	4	4	20	5
Simple Moving Average Method (n=4)	10	5	6	6	27	7
Double Moving Average Method (n=2)	8	9	8	8	33	9
Double Moving Average Method (n=3)	6	11	10	10	37	11
Double Moving Average Method (n=4)	2	10	11	11	34	10
Single Exponential Method(α= 0.1)	5	8	9	9	30	
Single Exponential Method(α= 0.2)	3	6	5	5	19	4

Single Exponential Method(α= 0.3)	1	4	3	3	11	1
Semi average Method	11	1	1	1	14	3
Naïve Model	4	7	7	7	25	6

Single Exponential Method (α=0.3) was ranked first because it had small errors and the total ranking of the Single Exponential Method(α=0.3) is 11 as shown in Table 3. In this method (MFE=-0.3084, MAD=115.0489, MSE=25480.467, RMSE=159.6260) outperformed all the other methods.

Simple Moving Average Method (n=2) was ranked second because the total ranking of this method is 13 as shown in Table 3. Semi average Method obtained the second minimum errors (MFE= 6.094, MAD = 109.611, MSE = 25190.5, RMSE = 158.715) as shown in Table 2.

Semi average Method was ranked third because total ranking is 14 as shown in Table 3. Semi average Method produced third smallest error (MFE= -18.565, MAD = 91.997, MSE = 20490.6, RMSE = 143.145) as shown in Table 2.

Single Exponential Method (α=0.2) method produced large errors (MFE= -0.9244, MAD = 116.7520, MSE = 27132.143, RMSE = 164.7183) as compare to semi average method, Simple Moving Average method (n=2) and Single Exponential Method (α=0.3). So this method ranked is fourth.

Simple Moving Average Method (n=3) was ranked fifth because it had large errors (MFE = 9.64048, MAD = 111.458, MSE = 26479.8, RMSE = 162.726) and total ranking is 20 as shown in Table 3.

Naïve Model was ranked sixth because the total ranking of this method is 25as shown in Table 3. Simple Naïve Model obtained the sixth minimum errors (MFE= 1.278, MAD = 117.910, MSE = 28414.201, RMSE = 168.565) as shown in Table 2.

Simple Moving Average Method (n=4) was ranked seventh because it had large errors (MFE = 12.1696, MAD = 115.051, MSE = 27630.7, RMSE = 166.225) and total ranking is 27 as shown in Table 3.

Single Exponential Method (α=0.1) was ranked eight because the total ranking of this method is 31 as shown in Table 3. Single Exponential Method(α=0.1) obtained the eight minimum errors (MFE= -4.8994, MAD = 131.87122, MSE = 33178.662, RMSE = 182.150) as shown in Table 2.

Double Moving Average Method (n=2) was ranked ninth because total ranking is 33 as shown in Table 3. In Double Moving Average Method (n=2) produced ninth smallest error as shown in Table 2.

Double Moving Average Method (n=4) had large error (MFE = 0.53371, MAD = 136.41, MSE = 47454.7, RMSE = 217.841) as shown in Table 2. So this model ranked is tenth.

Double Moving Average Method (n=3) was ranked eleventh because total ranking is 37 as shown in Table 3. In Double Moving Average Method with n=3 produced maximum error as shown in Table 2.

VIII. CONCLUSIONS

This study identified the most appropriate forecasting method based on accuracy and simplicity. The result showed that Single Exponential Method (α=0.3) obtained the best accuracy; however, it was selected as the most appropriate forecasting method for sales forecasting of milk product (paneer) in Chhattisgarh, India.

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