Uncertain Supply Chain Management 1 (2013) 133–144

Contents lists available at GrowingScience

Uncertain Supply Chain Management

homepage: www.GrowingScience.com/uscm

Survey of demand fluctuation of dairy products at raipur Dugdh Sangh, Chhattisgarh, India for selection of appropriate forecasting

Pradeep Ku Sahu* **and Rajesh Kumar**

Chhatrapati Shivaji Institute of Technology Durg, Chhattisgarh, India

C H R O N I C L E

Article history:
Received June 10, 2013
Received in revised format 25 July 2013
Accepted August 9 2013
Available online August 10 2013

Keywords:
Dairy product
Demand forecast

A B S T R A C T

The purpose of in this paper is to study demand fluctuation of dairy product and the forecasting practices that have been used by Raipur Dugdh Sangh (Devbhog dairy industry) in Chhattisgarh. The objective is to detect how these industries have used forecasting method, what are the main factors that influence their choice and what are the main difficulties in the use of forecasting methods. Based on literature survey, weekly data collected over October 2011 to October 2012 from Raipur Dugdh Sangh (Devbhog dairy industry) in Chhattisgarh. Data were analyzed by statistics technique using the Microsoft excel software. The result shows that the demand of milk product fluctuated over the period of time. The factors that influence the choice of forecasting model are the type of product, time spent in forecasting and main difficulties are the availability of software.

1. Introduction

Raipur dugdh sangh (also known as Devbhog) is the highest milk producer in the Chhattisgarh. The main objective of the Devbhog dairy industry is to improve the status of farmer and villagers and increase the production of milk in suitable price on the basis of fat, SNF and quality of milk. Devbhog dairy industries were established in 1st October 1987. Plant has a capacity of 1 lack liter per day but it receives only 35,000-40,000 liter/ day milk. It receives milk from six milk routes including various milk societies and milk chilling centers. It sells approximately 31,000 liters of milk per day, in the cities and the villages of Chhattisgarh. The Devbhog dairy industry engages in the production and processing of milk & cream. This industry is involved in the production of various dairy product like Srikhand, sweet curd cheese, plain curd, sterilized flavored milk (SFM), Matha (salted butter milk), butter etc. The Devbhog dairy industry specializes in the procurement, production, processing, storage and distribution of dairy products.

* Corresponding author.
E-mail addresses: ipeng.sahu9@gmail.com (P. K. Sahu)

doi: 10.5267/j.uscm.2013.08.003

This plant is well equipped with processing hall, pipelines, quality control lab, cold storage and machines of branded companies (ALFA LAVAL, HMT, SEIMENS, KIRLOSKAR etc), electrical section, boiler section, compressor section and suitable water supply.

It sells product with a brand name “Devbhog”. It manufactures many types of milk such as toned, double toned and standard milk. Sterilized flavored milk as well as different delicious milk product such as pineapple, cardamom, apple, lemon etc. (Panneerselvam, 2009; West, 2003).

2. Literature survey

(a) Alfares and Nazeerudin (2002) categorized the electric load forecasting technique. A wide range methodologies and model for forecasting are given in literature. These technique are classified into nine categories: (1) multiple regression, (2) exponential smoothing, (3) iterative reweighted least-squares, (4) adaptive load forecasting, (5) stochastic time series, (6) ARMAX model based on genetic algorithms, (7) fuzzy logic, (8) neural networks and (9) expert systems. The methodology for each category is briefly described, the advantage and disadvantages discussed. Feridun (2005) discussed forecasting inflation in Nigeria.

Cacatto et al. (2012) introduced the forecasting practices that have been used by food industries in Brazil and detected how these companies use forecasting methods and what are the main factors that influence their choice. The data were analyzed by multivariate statistics techniques using the SPSS software. They stated that the companies did not use sophisticated forecasting methods, the historical analysis model was the mostly used. The factor that influence the choice of the models are the type of product and the time spent during the forecasting, and the main difficulties are the availability of software.

Ryu et al. (2003) evaluated the forecasting method for institutional food service facility. They are identifying the most appropriate forecasting method of forecasting meal count for an institutional food service facility. The forecasting method analyzed included: naïve model 1,2 and 3; moving average method, double moving method, exponential smoothing method, double exponential method, Holt’s method, Winter method, linear regression and multiple regression method. The accuracy of forecasting methods was measured using mean absolute deviation, mean squared error, mean percentage error, mean absolute percentage error method, root mean squared error and Theil’s U-statistic. The result of this study showed that multiple regressions was the most accurate forecasting method, but naïve method 2 was selected as the most appropriate forecasting method because of its simplicity and high level of accuracy.

Rachel et al. (2003) examined the advantage and disadvantage of basic, intermediate and advanced method for visitor use forecasting where seasonality and limited data are characteristics of the estimation problem. Forecasting method include the naïve model 1 and 2, moving average method, double moving method, exponential smoothing method, double exponential method, Holt’s method, Winter method and seasonal autoregressive integrated moving average (SARIMA) are used Milwaukee county zoo visitor forecasting (Patil et al., 2013; Sharma et al., 2013). The series ranged from January 1981 to 1999 or a total of 228 months. The last 12, 24 or 60 month of those data were excluded from the original analysis and they were used to evaluate the various methods. SARIMA and SMA with classical decomposition procedure were found to be roughly equivalent in performance, as judged by modified mean absolute percentage error method and modified root mean squared error value of longer estimation period with shorter period ahead forecasts. This study also found that the SMA with classical decomposition method was more accurate than other technique when shorter estimation period with longer period ahead forecast are included. Strasheim (1992) introduced variety of alternative forecasting techniques and they were evaluated for purpose of stock replenishment is an important function of part in the typical reordering motor vehicle spare parts with aim of selecting one optimal technique to be implemented in automatic reordering module of real time computerized inventory management system. A large number of forecasting technique were evaluated, namely simple moving average(Averages, Moving Averages, Double Moving Averages), Exponential Smoothing(Single Exponential Smoothing, Adaptive Exponential Smoothing, Double Exponential Smoothing (Brown's one 'parameter linear method and Holt's two parameter method), Triple Exponential Smoothing (Brown's one parameter quadratic method and Winter's three parameter trend and seasonality method)), linear Regression, Multiple Regression. The accuracy of forecasting methods was measured using statistical measures (mean error, mean absolute deviation, mean squared error), relative measures (percentage error, mean percentage error, mean absolute percentage error method) and others measures (Theil's U- statistic, Durban- Watson value and forecasting index).

Some other researchers analyzed the problem of forecast accuracy on three different forecasting horizons: during the actual economics crisis, in few years before the crisis and on the large horizon. The accuracy of forecast made by European commission, national commission for prognosis (NCP) and Institute for economic forecasting (IEF) for unemployment rate in Romania (Chary, 2009; Bratu, 2012). The multi criteria ranking was applied to make a hierarchy of the institution regarding the accuracy and five accuracy measures were taken into account at the same time: mean errors, mean square error, root mean square error, U1 and U2 statistics of Theil.

(b) The Raipur dugdh sandh (also known as Devbhog) plays vast role in Chhattisgarh and its product can be categorized by different segments such as Srikhand, sweet curd cheese, plan curd, sterilized flavored milk (SFM), Matha (salted butter milk), butter etc. Each segment need different production strategies such as procurement and sourcing, inventory management, warehouse management, packaging and labeling system, and distribution management. In Raipur dugdh sandh (also known as Devbhog) we found that dairy industry production process depends on daily product requirement basis. Therefore, that uncertainty produces in production operation of particular product. The data for this study were collected and recorded on weekly basis. The data contain sales of food product like srikhand, sweet curd cheese, plan curd, sterilized flavored milk (SFM), matha (salted butter milk), butter etc. from October 2011 to October 2012. All the data was saved into an Excel spreadsheet Table 1. In addition, Visual comparisons of demand of milk product from Table 1 are ploted in Fig. 1 and Fig. 2. Fig. 1 represents the demand of milk product, which can be measured in liters like sterilized flavored milk (SFM), salted butter milk (S.B.Milk) and lassi. Fig. 2 represents the demand of milk product, which can be measured in kilograms like sweet curd, shrikhand, paneer, plan curd and butter. There were extremely high and low graphs in the data due to several factors, such as weather, special holiday and festival.

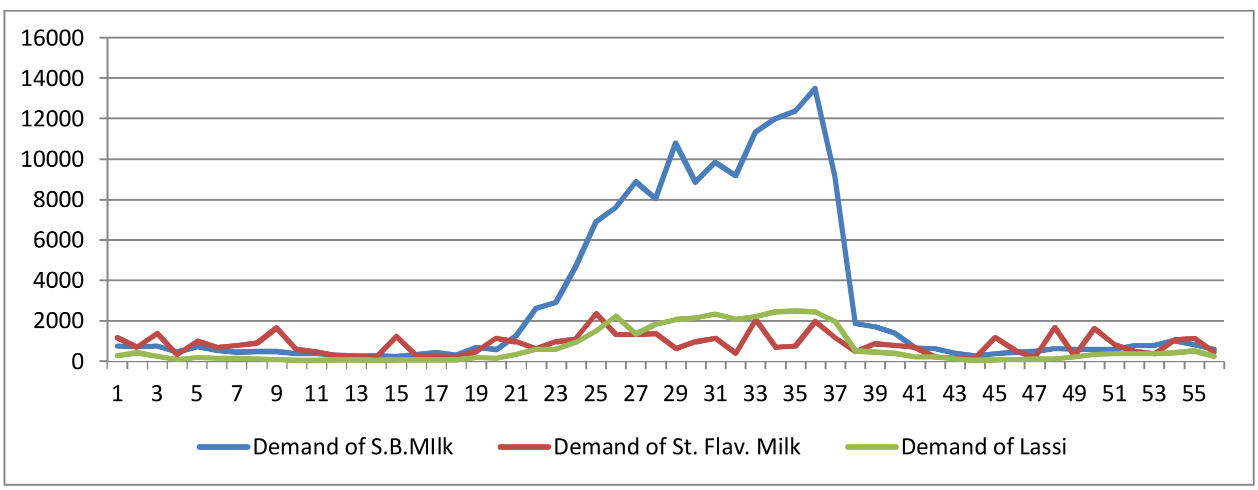

Fig. 1. Demand of Milk Product (in liter)

Table 1
Data collection

S.NO.	Shrikhand Demand (in kg.)	S.B.Milk Demand (in liter)	Sweet Curd Demand (in kg.)	St.Flav.Milk Demand(in liter)	Paneer Demand (in kg.)	Lassi Demand(in liter)	Plan Curd Demand (in kg.)	Butter Demand (in kg.)
1	259.3	740.4	148.2	1164.4	905.4	277	178	500.318
2	163.6	722.4	121	678.8	647	429.8	156	283.89
3	152.3	758.4	269	1384.2	591	234	6	763.945
4	114.8	465	65.2	326.4	590.2	100.6	44	1183.657
5	165.3	713.2	114	982	597	188.6	24	2041.426
6	131.4	544	76.5	681.6	744.4	140.4	31	1943.582
7	152.4	467	20.5	792	606.4	151.2	3	2350.77
8	146.1	469.2	0	888	518.2	115.2	2	1080.628
9	141.4	479	116.5	1648.4	572.4	82.8	25	1626.325
10	154.9	353	26.3	566.4	556.2	39.6	41	1623.654
11	119.4	377	9.3	465.6	539	21.6	3	937.998
12	156.4	292	79	288	488.6	75.6	16	1463.768
13	102.2	286	61	253.6	614.2	54	2	632.86
14	98.5	268	59.5	225.6	641.2	43.2	4	1483.743
15	104.6	245	58	1219.8	565	63	1	1239.588
16	116.9	322.6	66.7	280	693.2	65.6	41	907.211
17	91	411	46	254.4	762.4	72	31	1463.209
18	109.6	293.6	49.5	206.4	589.4	53.4	22	1689.347
19	192.9	681.8	133.2	468.6	655.4	176.4	4	1026.83
20	167.3	579.4	126.7	1128	586.4	166	98	997.454
21	228	1278	183	969.6	607.8	325	40	1337.291
22	298.8	2629	266.1	641	515	611.6	34	846.605
23	276	2901.8	250	960	515.2	594.2	26	1117.951
24	422.5	4681	392.5	1113.6	550.6	922.6	4	1359.5
25	462.5	6914	478	2367.2	451.8	1481.6	30	1722.541
26	653.4	7630	590.4	1317.2	583.4	2247.6	76	1492.251
27	541.2	8894	333.6	1305.6	652.2	1360	8	860.721
28	413.8	8054	432.2	1382	688	1821.6	39	903.284
29	423.6	10804.2	470.7	628.8	839.8	2054.4	89	1194.2
30	386.5	8869.4	447	951.6	1045	2155.6	116	353.52
31	392.9	9835.8	522.2	1136.8	858.6	2324.8	86	1125.448
32	445.7	9184.4	478.6	387.2	637.8	2103.1	54	886.22
33	384.3	11352	543	2055.6	605	2199.8	12	839.84
34	432	12007.2	531.1	676.8	656.8	2437	27	384.642
35	419	12366.8	619.4	754.8	584.8	2479.8	3	562.473
36	409.6	13497.6	612	1974.8	729	2463.2	15	1697.786
37	378.6	9156.6	463.2	1182	1029	1963.2	124	926.186
38	233.5	1855	205.3	471.6	885.6	508	33	776.55
39	317.1	1715.8	255	868.8	1441.2	450.4	114	484.439
40	193.5	1372	168	782.4	841.6	405	22	849.857
41	170.7	668	156.1	679	689.8	208.4	27	1870.555
42	181.4	645	140.4	203.6	784.8	205.2	3	4734.751
43	130.5	406.6	103.2	142.2	846.8	116.6	15	1998.405
44	122.4	263	69	135.2	1229.6	38	7	2654.7
45	120.9	372.2	96.7	1174.4	891.2	52.8	24	1194.211
46	134.3	444	111.9	548	979.2	90	4	814.952
47	110.6	473	96.7	184.6	938.6	80.6	9	757.227
48	146.1	630.4	123.2	1661.6	928.6	114	27	1880.794
49	215.5	588.2	118.3	267.2	882.2	226	59	812.069
50	231.2	607	123.6	1611	967.4	346.6	55.4	1025.02
51	158	607.6	137.6	802.2	817.3	352.2	34.8	1269.392
52	260.3	778.6	160.5	469.6	895.6	371.2	22	5325.337
53	158.1	788	128	374.4	757.2	362.8	279.6	6684.259
54	209.3	1014.4	163.7	1042.2	805	418.8	214	5509.13
55	316.5	819.6	185	1136.8	928	510.6	276.7	3041.328
56	150.8	588.6	145.4	438	977	231.8	710.2	774.731

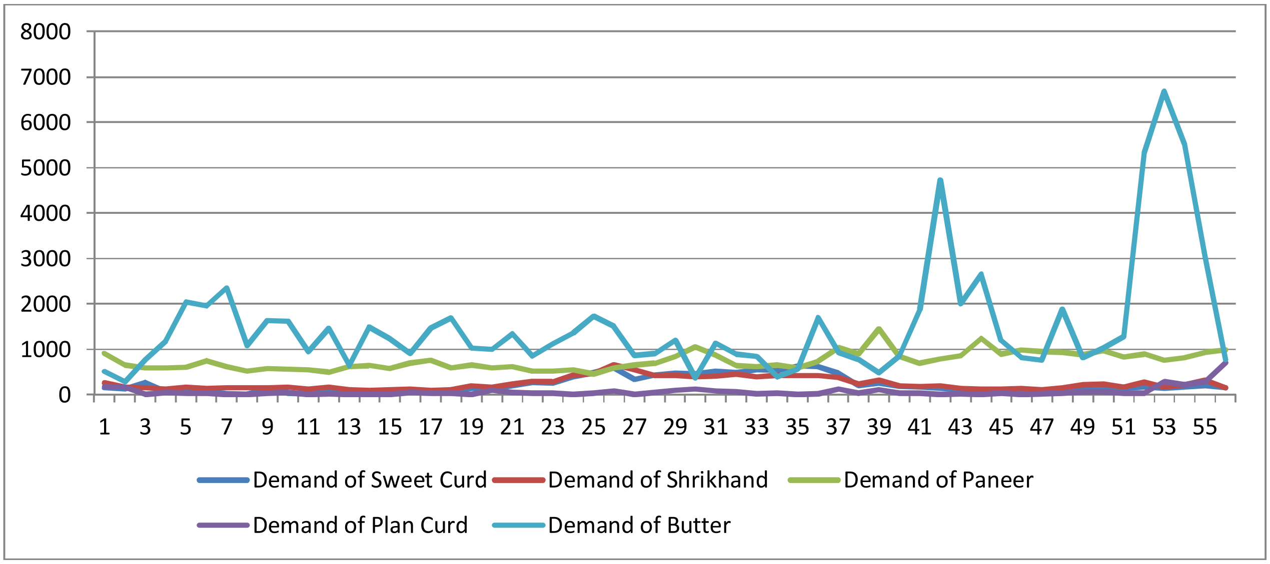

Fig. 2. Demand of Milk Product (in kg.)

3. Methodology

Uncertainty in demand of product can be reduced by forecasting methods. There are various forecasting model used in the analysis, included simple moving average method, double moving average method, single exponential method , double exponential method , triple exponential method , linear regression method, multiple regression method, semi average method, naïve Model. The most appropriate forecasting method was determined on the basis of accuracy. In this research, several common accuracy methods were used: Mean Forecast Error (MFE), Mean Absolute Deviation (MAD), Mean Absolute Percentage Error (MAPE), Mean Percentage Error (MPE), Mean Square Error (MSE), Root Mean Square Error (RMSE) and u-statistics (Theil method). The ranking was assigned to each forecasting method.

3.1 Forecasting Methods

3.1.1 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 (Chary, 2003, 2008; Floros, 2005; Chopra & Meindl, 2010). 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 determined by interactive model that the smallest error. In some methods, the general approach has been to use MSE. In this study, the value of *n* has been taken as 3.

3.1.2 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

3.1.3 Simple Exponential Smoothing Method

The exponential smoothing method is a technique that uses 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 (Paul, 2011). 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 has been taken as 0.1, 0.2 and 0.3.

3.1.4 Double Exponential Smoothing Method

The double exponential smoothing model is recommended to forecast time series data that have a linear trend (Hanke & Reitsch, 1998; Lim & Nayar, 2012). Five equations are employed:

$$A_t = \alpha Y_t + (1-\alpha) A_{t-1},$$
$$A'_t = \alpha Y_t + (1-\alpha) A'_{t-1},$$
$$a_t = 2A_t - A'_t,$$
$$b_t = \alpha (A_t - A'_t)/(1-\alpha),$$
$$F_{t+p} = a + b_t p,$$

where:

A_t= the exponentially smoothed value of Y_t at time t,
A'_t = the double exponentially smoothed value of Y_t at time t,
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.

As in the simple exponential smoothing, the accuracy of the forecasting method strongly depends on the optimal value of alpha. The method generating the lowest MSE value was selected as the optimal alpha. Also, a tracking system was developed to monitor the change of patterns.

3.1.5 Holt's Method

A technique frequently used to handle a linear trend is holt's method. It smoothes trend by using different (alpha & beta) smoothing constants. Three equations are used:

$$L_t = \alpha\, Y_t + (1\text{-}\alpha)\,(L_{t-1} + T_{t-1}),$$
$$T_t = \beta\,(L_t - L_{t-1}) + (1\text{-}\beta)\, T_{t-1},$$
$$F_{t+p} = L_t + pT_t,$$

where:

L_t = the new smoothed value,
α= the smoothing constant ($0 < \alpha < 1$),
Y_t = the new observation or actual value of the series in period t,
β = the smoothing constant for trend estimate ($0 < \alpha < 1$),
T_t = the trend estimate,
p = the periods to be forecast into the future,
F_{t+p} = the forecast for p periods into the future.

The initial value for the smoothed series and the trend must be set in order to start the forecasts. In this research, the first estimate of the smoothed series assigns a value equal to the first observation. The trend then estimates to equal zero. Accuracy of Holt's exponential smoothing method requires optimal value of alpha (α) and beta (β). The optimal alpha and beta value were selected on the basis of minimizing the MSE. As in simple and double exponential smoothing method, this method also required a tracking signal to monitor pattern changes.

3.1.6 Winter's Method

Winter's method provides a useful way to explain the seasonality when time series data have a seasonal pattern. The formula of this method includes four equations:

$$A_t = \alpha\, Y_t / S_{t-L} + (1\text{-}\alpha)\,(A_{t-1})(A_{t-1} + T_{t-1}),$$
$$T_t = \beta\,(A_t - A_{t-1}) + (1\text{-}\beta)\, T_{t-1},$$
$$S_t = \gamma\, Y_t / A_t + (1\text{-}\gamma)\, S_{t-L},$$
$$F_{t+p} = (A_t + pT_t)S_{t-L+p},$$

where:

A_t = the new smoothed value,
α= the smoothing constant ($0 < \alpha < 1$),
Y_t = the new observation or actual value of the series in period t,
β = the smoothing constant for trend estimate,
T_t = the trend estimate,
γ = the smoothing constant for the seasonality estimate,
S_t = the seasonal estimate,
p = the periods to be forecast into the future,
L = the length of seasonality,
F_{t+p} = the forecast for p periods into the future.

To start the forecasts the initial values of the smoothed series L_t, the trend T_t, and the seasonality indices S_t must be given. In this research, the six new smoothed values were considered the same as the first six observations, and the first six trend estimates were set as zero. The first six seasonality indices were assigned the value one. The accuracy of Winter's method strongly depends on the optimal values of alpha (α), beta (β), and gamma (γ). The optimal α, β and γ were determined by minimizing a measure of forecast error of MSE. In addition, like other Exponential smoothing methods, a tracking signal was needed to monitor the change of patterns.

3.1.7 Linear Regression

Jarrett (1991) noted that one purpose of regression is to estimate the nature of the relationship between a dependent variable and an independent variable. A simple regression model can be expressed in the form of a straight line with the following formula:

$$Y = \beta_0 + \beta_1 X + \varepsilon.$$

Here, $\beta_0 + \beta_1 X$ is the mean response with X. The deviation ε is assumed to be independent and normally distributed with a mean of zero and standard deviation σ. β_0 , β_1 and σ are the unknown constants.

3.1.8 Multiple Regression

Multiple regression is used to estimate the nature of the relationship between a dependent variable and several independent variables. The relationship between two variables allows forecasting the dependent variable from knowledge of the independent variables. It allows us to apply several independent variables instead of just one. Symbolically, the equation for multiple regressions is:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots\ldots + \beta_k X_k + \varepsilon$$

Here, Y represents the dependent variable as in the simple regression, and $X_1, X_2, \ldots, X_k$ represent the independent variables. β_k and σ are the unknown constants. Padhan (2012) used this type of models for forecasting cement productions in India.

3.1.9 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.

3.1.10 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,

3.2 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; Armstrong & Collopy, 1992).

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.

3.2.1 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.

3.2.2 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.

3.2.3 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:

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

where:

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

3.2.4 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:

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

where:

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

4. Results

In this study, various type of forecasting method used for the determination of future demand of the product. The forecasting method will be selected on the basis of forecast error. The smaller the forecast error, the more accurate forecasting method. The specific purpose of this study was to identify (1) the best quantitative method, based on level of accuracy, to forecast demand of the Devbhog dairy industry product and (2) the most appropriate forecasting method, based on level of accuracy and ease of use in practice. Selections criteria of forecasting method for Devbhog dairy industry product are as shown in Table 2.

Table 2
Check list selecting an appropriate method for the demand of Devbhog dairy industry product

Method / criteria	Estimation technique	Accuracy	Ease of learning
Simple Moving Average Method	Spreadsheet	Reasonable to good	Easy
Double Moving Average Method	Spreadsheet	Reasonable to good	Easy to moderate
Simple Exponential Smoothing Method	Spreadsheet or statistical packages (e.g., MiniTab)	Inaccurate	Moderate to difficult
Double Exponential Smoothing Method	Spreadsheet or statistical packages (e.g., MiniTab)	Inaccurate	Moderate to difficult
Holt's Method	Spreadsheet or statistical packages (e.g., MiniTab)	Reasonable to good	Moderate to difficult
Winter Method	Spreadsheet or statistical packages (e.g., MiniTab)	Reasonable to good	Moderate to difficult
Linear Regression Method	Spreadsheet	Good	Easy
Multiple Regression Method	Spreadsheet	Good	Easy to moderate
Semi Average Method	Spreadsheet	Reasonable to good	Easy
Naïve Method	Visual or Spreadsheet	Reasonable to good	Easy

5. Conclusion

This study identified the many real-life forecasting situations were more complicated and difficult due to such variables as weather and special festival. Therefore, to obtain better forecasting accuracy, it is recommended that Raipur Dugdh Sangh (Devbhog dairy industry) applies appropriate quantitative methods.

Raipur Dugdh Sangh (Devbhog dairy industry) need forecasts of product to establish their strategic production plan of milk product. Such forecasts can provide valuable information for production, facility monitoring, seasonal employment, short term and long- term budgeting.

References

Alfares, H. K., & Nazeeruddin, M. (2002). Electric load forecasting: literature survey and classification of methods. *International Journal of Systems Science*,*33*(1), 23-34.

Armstrong, J. S., & Collopy, F. (1992). Error measures for generalizing about forecasting methods: Empirical comparisons. *International Journal of Forecasting*, *8*(1), 69-80.

Bratu, M. (2012). The accuracy of unemployment rate forecasts In Romania and the actual economic crisis. *Scientific Bulletin-Economic Sciences*, *11*(2), 56-67.

Cacatto, C., Belfiore, P., & Vieira, J.G.V. (2012). Forecasting practices in Brazilian food industry. *Journal of logistics management*, 1(4), 24-36.

Chary, S. N. (2009). *Production and operations management*. Tata McGraw-Hill Education.

Chen, R. J., Bloomfield, P., & Fu, J. S. (2003). An evaluation of alternative forecasting methods to recreation visitation. *Journal of Leisure Research*, *35*(4), 441-454.

Chen, R. J., Bloomfield, P., & Cubbage, F. W. (2008). Comparing forecasting models in tourism. *Journal of Hospitality & Tourism Research*, *32*(1), 3-21.

Chopra, S., & Meindl, P. (2010). *Supply Chain Management Strategy, Planning and Operation*. Pearson, 4th Ed, India.

Feridun, M. (2005). Forecasting inflation in developing economies: The case of Nigeria. *International Journal of Applied Econometrics and Quantitative Studies*, *2*(4), 103-132.

Floros, C. (2005). Forecasting the UK unemployment rate: model comparisons. *International Journal of Applied Econometrics and Quantitative Studies*, *2*(4), 57-72.

Lim, P.Y., & Nayar, C.V. (2012). Solar irradiance and load demand forecasting based on single exponential smoothing method. *IACSIT International Journal of Engineering and Technology*, 4(4), 451-455.

Padhan, P. C. (2012). Use of univariate time series models for forecasting cement productions in India. *International Research Journal of Finance and Economics*, (83), 167-179.

Panneerselvam, R. (2009*). Production and Operation Management*. 2nd edition, PHI Learning Private Limited, New Delhi (India).

Patil, D. P., Shrotri, A. P., & Dandekar, A. R. (2013). Management of uncertainty in supply chain. *International Journal of Emerging Technology and Advanced Engineering*, 2(5), 303-308.

Paul, S.K. (2011). Determination of exponential smoothing constant to minimize mean square error and mean absolute deviation. *Global Journal of Researches In Engineering*, *11*(3).

Ryu, K., & Sanchez, A. (2003). The evaluation of forecasting methods at an institutional foodservice dining facility. *The Journal of Hospitality Financial Management*, *11*(1), 27-45.

Strasheim, J. J. (1992). Demand forecasting for motor vehicle spare parts. *A Journal of Industrial Engineering*, 6(2), 18-19.

Sharma, A.K., Gupta, A., & Sharma, U. (2013). Electricity forecasting of Jammu & Kashmir: A methodology comparison. *International Journal of Electrical Engineering & Technology (IJEET)*, 4(2), 416-426.

West, C. T. (2003). The status of evaluating accuracy of regional forecasts. *The Review of Regional Studies*, *33*(1), 85-103.