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# The Implementation of Different Forecasting Techniques for Demand Forecasting in Jute Product Section in Bangladesh

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## Abstract

*This paper illustrates a case study of forecasting method selection based on its error determinants for a jute products manufacturing industry in Bangladesh. The historical demand data of jute yarn for the year 2010, 2011, 2012, and 2013 from Akij Jute Mills, Akij Group Ltd. in Noapara, Jessore were used to forecast for the upcoming periods. The analysis shows that, the Mean absolute percent error (MAPE) value of the Naïve forecast is 26.55, simple moving average varies between 27-35 for the 1 year, 6 month and 3 month, the exponential smoothing value ranging from 28-30 with smoothing constant α =0.1 to 0.9 and the least square linear regression is 25.83. In summary, the weighted moving average gives the best performance of forecast with the minimum MAPE value of 16.29. This study will provide an outline for the Bangladeshi manufacturers to select the best forecasting method for their industry.*

Keywords: Forecasting, forecasting error, jute industry.

## 1. Introduction

The forecasting is a technique that is used to predict future event and occurrences. It is one of the key tools for the management decision making. Therefore, every organization typically contains a forecasting function for planning and controlling their operations. Availability of future value makes easy for future planning and decision making activities [1]. Different methods are developed to forecast and the selection of the best technique is based on various measures of performance. In general, accuracy of the forecasting is measured in each case using different criteria such as MSE, MAD and MAPE etc.

Time series forecasting have passed much precise experiment for the last quarter century. Hooker (1921) first introduced moving-averages which consider several period averages to predict the future event [2]. On the other hand, Roberts (1959) first developed the exponentially weighted moving average for identifying small modifications in the mean of a process [3]. Brown (1950) expanded simple exponential smoothing to detached data and promoted methods for trends and seasonality [4]. Pegels (1969) presented a simple and suitable taxonomy of the trend and the seasonal patterns depending on their linearity and nonlinearity [5]. Business firms prepare sales forecasts using method that provides accuracy of their predictions. Business firms commonly use subjective, extrapolation and naive techniques in various forecasting situations [3]. As forecasting errors are the main concern, business firms are using computers and seasonal adjustments in more for reducing these errors [6]. Kolmogorov (1941), Levinson (1947) and Wiener (1949) were the pioneers in the field of linear prediction who described the methodology of using in multivariate processes [7-9]. The least-squares method was expressed by Legendre (1805) while, Gauss (1809) provided such type of prediction which is used in forecasting [10]. The short-term and long-term study shows that, daily seasonality differences accounted for a large portion of the variance which makes urgent the consideration of seasonality when forecasting [11]. The foremost purpose of this study is to validate the feasibility of forecasting methods namely Naïve Approach, Simple Moving Average, Weighted moving average, Exponential Smoothing, and Linear Least Square Regression for choosing the most suitable one.

## 2. Importance of forecasting in industries in Bangladesh:

In general, every industry in Bangladesh uses forecasting technique for various purposes. Forecasting is needed to predict future sells and inventory management. Some industries may work on the order basis but they need to ensure the availability of all raw materials just in time. Most of the manufacturing industries in Bangladesh do not produce all the raw materials what they need. In this case, to acquire these materials they need proper method in order to avoid the excess cost. Forecasting certainly is a way to solve this problem. On the other hand, supplier type industries supply their materials to various industries. So they need to maintain proper inventory management system which is impossible without following forecasting technique. Industries which do not operate in order basis, forecast market demand of their products. In Bangladesh all the industries, suppliers or manufacturers either operate or do not operate in order basis, need to follow forecasting technique.

## 3. Methodology

This paper involves comparing five different forecasting methods and selecting the one based on various measures of forecasting accuracy namely Mean absolute deviation (MAD), Mean square error (MSE) and Mean absolute percent error (MAPE). The sample demand data for forecasting were collected from Akij Jute Mills, Akij Group Ltd. in Noapara, Jessore. Quantitative techniques are used here as they are based on the idea that past demand data can be used to predict future demand. Among the quantitative techniques Naïve Approach, Simple Moving Average, Weighted moving average, Exponential smoothing and Linear Least Square Regression are used. Trends, seasonal and random components of demand are incorporated to calculate the seasonality index which is used in each technique. Required calculations are performed to analyze relevant data and make the forecast. Various equations used for our research purpose are listed below.

**Naive Forecasts:**

$$\text{Forecast next period, } F_{t+1} = F_t \tag{1}$$

Where, $F_t$ = Previous actual value

**Simple moving average:**

$$F_t = MA_n = \frac{\sum A_i}{n} \tag{2}$$

Where, $F_t$ = Forecast for time period i

$MA_n$ = Moving average with n periods

$A_i$ = Actual value with age i

$i$ = Age of the data ($i$ = 1, 2, 3…….)

$n$ = Number of periods in moving average

**Weighted Moving Average:**

$$F_{t+1} = w_t A_t + w_{t-1} A_{t-1} + \cdots\cdots\cdots\cdots + w_{t-n} A_{t-n} \tag{3}$$

Where, $w_t + w_{t-1} + \cdots\cdots\cdots\cdots + w_{t-n} = 1$

$t$ = The current period

$F_{t+1}$ = The forecast for next period

$n$ = The forecasting horizon (how far back we look),

$A$ = The actual sales figure from each period.

$w$ = The importance (weight) we give to each period

**Exponential smoothing:**

$$F_t = F_{t-1} + \alpha(A_{t-1} - F_{t-1}) \tag{4}$$

Where, $F_t$ = Forecast for period t

$F_{t-1}$ = Forecast for the previous period

$\alpha$ = Smoothing constant

$A_{t-1}$ = Actual demand

**Least square Linear Regression Analysis:**

$$Y = \alpha + \beta X \tag{5}$$

**Addressing Seasonality in the Model:**

$$C_i = \left( \sum_{j=-2}^{1} d_{i-j} + \sum_{j=-1}^{2} d_{i-j} \right) / 2 \quad (6)$$

$$r_i = \frac{d_i}{C_i} \quad (7)$$

$$u_{t,i/12+i} = \left( \sum_{j=0}^{N-1} r_i + 12_j \right) / N \quad (8)$$

$$S_t = \frac{n \times ut}{\sum ut} \quad (9)$$

**Addressing both Trend and Seasonality in the Model:**

$$Y_t = X_t \times S_t \quad (10)$$

Error, $E_t$ = Actual – forecast (11)

Mean Absolute Deviation, $MAD = \frac{\sum_{t=1}^{N} |E_t|}{N}$ (12)

Mean Squared Error, $MSE = \frac{\sum_{t=1}^{N} E_t^2}{N}$ (13)

Mean Absolute Percent Error, $MAPE = \frac{\sum_{t=1}^{N} \left| \frac{E_t}{Y_t} \right|}{N} \times 100$ (14)

## 4. Result and Discussion

From demand data of Jute Yarn in the year 2010, demand was steady 1-4 weeks, than it sharply increased to a value 726 ton at week 5, it continued steady till week 8 and suddenly it decreased to a value 503 ton as presented in Table 1.

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**Table 1.** The demand data of Jute yarn of Akij Jute Mill (2010-2013)

| Year | Week | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| 2010 | 403 | 405 | 427 | 420 | 726 | 729 | 745 | 757 | 503 | 505 | 507 | 509 | 510 |
| 2011 | 680 | 695 | 670 | 685 | 940 | 970 | 992 | 995 | 770 | 725 | 750 | 765 | 710 |
| 2012 | 711 | 723 | 727 | 730 | 1056 | 1065 | 1077 | 1099 | 844 | 833 | 827 | 824 | 820 |
| 2013 | 990 | 995 | 993 | 991 | 1577 | 1586 | 1589 | 1598 | 1250 | 1245 | 1237 | 1230 | 1225 |
| Year | Week | | | | | | | | | | | | |
| | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 |
| 2010 | 480 | 470 | 460 | 455 | 565 | 569 | 575 | 579 | 585 | 587 | 592 | 578 | 560 |
| 2011 | 650 | 664 | 633 | 620 | 700 | 705 | 712 | 727 | 732 | 750 | 755 | 767 | 778 |
| 2012 | 775 | 767 | 765 | 760 | 990 | 992 | 994 | 995 | 993 | 975 | 977 | 976 | 978 |
| 2013 | 1187 | 1180 | 1178 | 1175 | 1319 | 1329 | 1327 | 1337 | 1345 | 1365 | 1367 | 1375 | 1377 |
| Year | Week | | | | | | | | | | | | |
| | 27 | 28 | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 |
| 2010 | 498 | 490 | 487 | 485 | 478 | 990 | 992 | 997 | 999 | 427 | 419 | 415 | 412 |
| 2011 | 787 | 745 | 737 | 732 | 706 | 702 | 1001 | 1050 | 1080 | 1097 | 600 | 604 | 607 |
| 2012 | 979 | 960 | 962 | 963 | 967 | 1275 | 1285 | 1287 | 1290 | 1295 | 895 | 890 | 845 |
| 2013 | 1380 | 1282 | 1283 | 1287 | 1290 | 1790 | 1793 | 1795 | 1797 | 1799 | 1097 | 1060 | 1050 |
| Year | Week | | | | | | | | | | | | |
| | 40 | 41 | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 50 | 51 | 52 |
| 2010 | 522 | 517 | 505 | 500 | 530 | 533 | 537 | 545 | 567 | 520 | 546 | 555 | 569 |
| 2011 | 609 | 703 | 702 | 705 | 715 | 635 | 681 | 603 | 607 | 627 | 617 | 615 | 621 |
| 2012 | 820 | 982 | 984 | 987 | 989 | 991 | 993 | 995 | 994 | 985 | 983 | 981 | 979 |
| 2013 | 1036 | 1240 | 1252 | 1265 | 1243 | 1340 | 1342 | 1343 | 1347 | 1133 | 1123 | 1120 | 1128 |

It was quite steady from week 9-17 and in week 18 a medium increased in demand was found then it was quite same till week 31. The trend of demand found in weeks 32-35 was highest and here the seasonality found. After that it sharply decreased and continued with slight fluctuations. The trend of demand in 2011 was quite same as 2010 with little variations. Here demand in each week was above 600 ton, seasonality trends were found in weeks 5-8 and 33-36 and in both cases that was increasing trends. In week 18-32, 37-40, 41-44 and 47-52 the demands were steady and the demands in the remaining weeks fluctuated slightly. Demand data 2012 showed that the trend was quite same like year 2010 and 2011 however, here the average demand increased and both the lowest and highest demands were greater than the previous years. Seasonality trends were found in weeks 5-9 and 32-36. In week 37-40 demands fluctuated and in case of other trend demands were very steady.

Demand data 2013 showed great change in demand at every week and these values were greater than the previous years. The lowest value of demand was above 1000 ton. The trends of data were similar to the previous years but it varied slightly from the demand data 2012. Here demand data from week 41-53 fluctuated heavily.

Table 2 shows the various measure of forecasting accuracy using different approaches. MAD value in different methods varies 209.94 to 487.63, MSE value varies 52047.65 to 294600.20 and MAPE value varies 16.29 to 35.70. Among these methods weighted moving average displays the minimum value in each case which is an indication of greater accuracy and implies the suitability of this method.

**Table 2.** Accuracy measurements of different forecasting methods

| Forecasting Model | | MAD Value | MSE Value | MAPE Value |
|---|---|---|---|---|
| Naïve Approach | | 363.5962 | 156659.2 | 26.55625 |
| Simple Moving Average | | | | |
| 1 Year moving Average | | 487.6331 | 294600.2 | 35.70618 |
| 6 month moving average | | 391.1026 | 195637.3 | 28.77705 |
| 3 month moving average | | 374.3141 | 173320.3 | 27.78583 |
| Weighted moving average | | 209.9423 | 52047.65 | 16.2936 |
| Exponential smoothing | | | | |
| | $\alpha$=0.1 | 422.67 | 244408.34 | 30.64 |
| | $\alpha$=0.2 | 403.05 | 213711.98 | 29.50 |
| | $\alpha$=0.3 | 394.87 | 201738.28 | 29.00 |
| | $\alpha$=0.4 | 387.99 | 194513.50 | 28.55 |
| | $\alpha$=0.5 | 386.68 | 190005.67 | 28.55 |
| | $\alpha$=0.6 | 383.71 | 186271.45 | 28.38 |
| | $\alpha$=0.7 | 382.27 | 183335.37 | 28.34 |
| | $\alpha$=0.8 | 381.16 | 181028.22 | 28.31 |
| | $\alpha$=0.9 | 380.23 | 179250.41 | 28.29 |
| Linear Least Square Regression | | 361.2609 | 182250.7 | 25.8384 |

## 5. Conclusions

Forecasting is the best renowned method used in various firms to predict the future event. To select a suitable method among various methods is very essential for a firm. This paper selects weighted moving average as the best method which yields a MAPE value 16.29. As the firm does not apply any particular method for forecasting their demand, this method can be useful for them to predict their actual demand. The analysis of various techniques for demand forecasting in this paper can be a guide for other firms to select their appropriate forecasting method.

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