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Establishing a Forecasting Model for High Speed Diesel for Bangladesh: A Case Study on Meghna Petroleum Limited

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The research emphasizes on establishing a forecasting model for High Speed Diesel (HSD) for Bangladesh; aiming that the study collected data from Meghna Petroleum Limited to analyze the data pattern of HSD sales. During scrupulous revise the research identified and classified data pattern of HSD sales by various graphs. Following to the classification the study prepares forecasting system using Classical Decomposition Model which is a combination of trend and seasonality forecasting. The study tests the accuracy level of the model using two different methods and results are satisfactory. The paper identifies the sectors that can use the forecast to enhance the management system. This research divulge a set of recommendations for Meghna petroleum limited as well as for the similar organizations who are working in this area to perform smoothly and help the Government to reduce the subsidy level in fuel sector.

Keywords: Forecast, High Speed Diesel, Trend, Seasonality, Classical Decomposition Model, Control Chart

1. Introduction

The energy sector is an important part of all the countries of the world, and especially, the countries that are developing from an economic point of view. It is observed that the energy sector has played a crucial role in the context of the global economy. Prices of oil and such other sources of energy is affecting the economies of various developing nations and playing pivotal roles in shaping them. Economic condition of Bangladesh is highly correlated with energy production and proper management of energy. According to development data (World Data bank of The World Bank 2013) the Gross Domestic Product (GDP) of Bangladesh reached US $115 billion in the year 2012 and estimated to mark US $120 billion by 2013. The GDP growth rate (Trading Economics 2013) is expected to be 6.30%. About 70% of fuel requirement of the country is imported from world market. Among all the fuel items the most responsive and important product is High Speed Diesel (HSD). The demand of HSD basically leads the petroleum demand in the fuel sector of Bangladesh.

Because of rapid urbanization proper distribution of petroleum products on time is very important for Bangladesh. As the government tries to evolve from energy crisis (Kamrul 2013) transportation and industry are the most important energy intensive sectors of Bangladesh, accounting for around 50% and 43% of total commercial energy consumption respectively. Any kind of shortage or uncontrolled system can become a dark sign for economy. To ensure proper management of Diesel the study focused on preparing a forecasting model for High

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Speed Diesel for Bangladesh under Meghna Petroleum Limited. With forecasting it is possible to optimize the ordering time, lead time, transportation system and related costs as the company ensure their profit through operational activities. Proper forecasting can make their operations smoother. In a broader prospect this study can be a learning curve for the national policy makers. The model can set a base to order optimum quantity of Diesel from the international market and improve the performance of the domestic supply chain system.

Indeed, many documents were found in the literature that focused on making forecasting for petroleum items for different countries. However, no such study was found in regards to Meghna Petroleum Limited of Bangladesh particularly focusing on High Speed Diesel. The current study, probably for the first time, has attempted to identify the demand pattern of HSD and prepare a forecasting model basing on the demand specimen overcoming the facts of Bangladesh. As Meghna Petroleum mainly focused on qualitative model in preparing the forecast the study aimed in preparing a quantitative forecasting model. A quantitative approach in combination with qualitative supervision works appropriately for any time series data. The study also attempted to justify the accuracy and maintain the quality of the forecasting model.

The subsequent part of the paper describes the methodology used in selecting and preparing the forecast. The article also gives the detailed analysis of data to justify the selection of a particular forecasting technique according to the data pattern. The data analysis is followed by the preparation of the forecast and the accuracy test. Moreover, the manuscript reveals the benefits of using forecasting model from financial and supply chain point of view. Finally the paper comes up with a set of recommendations for the organization and researchers to enhance the performance of the forecast in future.

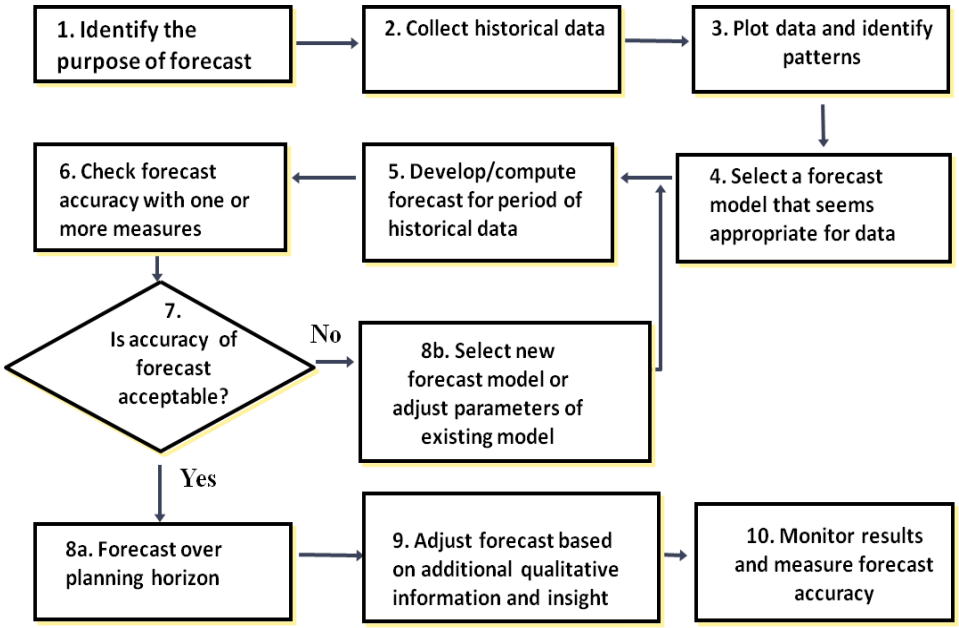
2. Methodology

According to Stevenson (2005, p. 72) there are two general approaches to forecasting. They are qualitative approach and quantitative approach. Qualitative methods consist mainly of subjective inputs, which often defy precise numerical description. Quantitative methods involve the projection of historical data to make the forecast. It usually avoids personal biases that sometimes contaminate qualitative methods. Also the pattern of the data is an important factor in understanding how the time series behaved in the past. If such behavior can be expected to continue in the future, the past pattern can be used as guidance in selecting an appropriate forecasting method. After performing the forecast accuracy and control of the forecast is a vital aspect. It is important to include an indication of the extent to which the forecast might deviate from the value of the variable that actually occurs. This will provide the forecast user with a better perspective on how far off a forecast might be. Stevenson has also mentioned that it is important to monitor forecast errors, during periodic forecasts, to determine if the errors are within reasonable bounds. If they are not, it is necessary to take corrective action.

To prepare an appropriate forecast the study mainly focused on quantitative approach rather than the qualitative approach used by the organization. As historical data is available quantitative method can provide a better accuracy in forecasting model. Basing on that the study collected monthly sales data of HSD from secondary source of Meghna Petroleum Limited. The data was plotted on graph to indentify the underlying pattern of the series and an

appropriate forecasting model was selected to prepare a forecast for coming 12 months. The forecasted data was justified through various methods to ensure the accuracy and control of forecast. The summary of the methodology as follows:

Figure 1: Forecasting process



3. Data Analysis

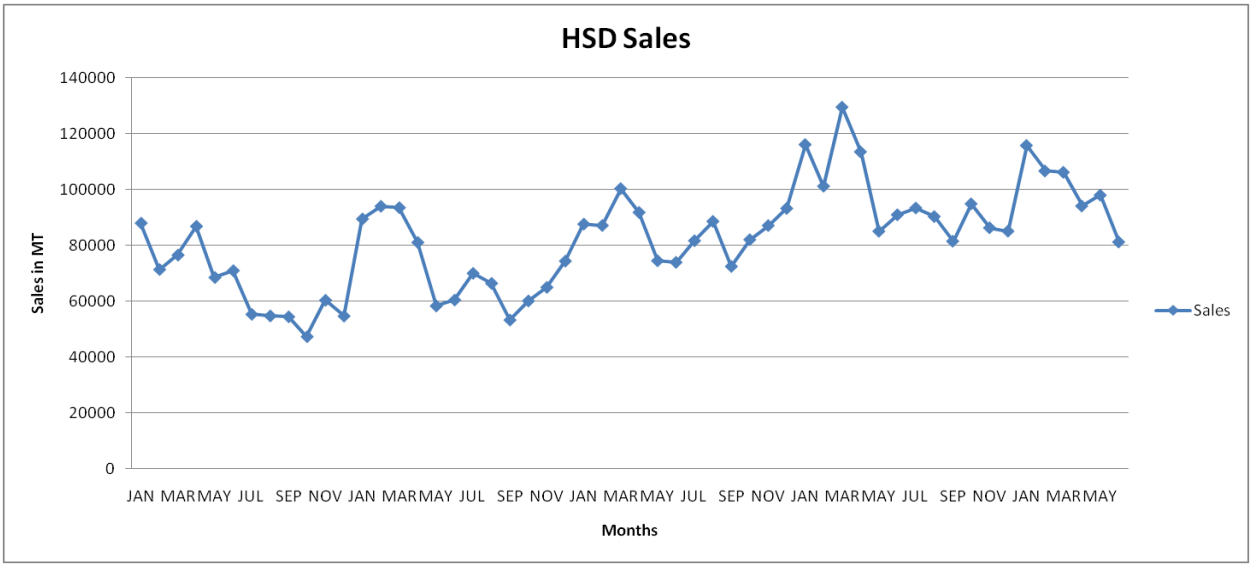
The study has collected secondary sales data of 54 months (From January, 2008 to June, 2012). It has analyzed data pattern from different point of view using the graphical format. It also tried to identify the appropriate forecasting model for the data pattern.

Karim & Hasnat

Table 1: Sales of HSD in Metric Ton (MT)

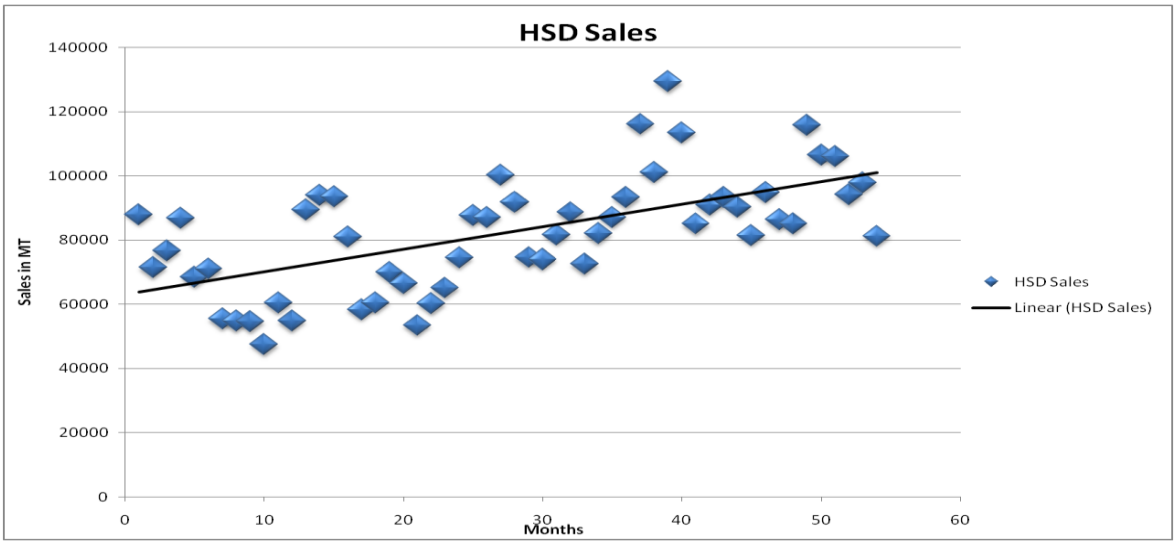
Year	Month	Period	Sales (MT)	Year	Month	Period	Sales (MT)	Year	Month	Period	Sales (MT)
2008	JAN	1	88,019	2010	JAN	25	87,659	2012	JAN	49	115,728
	FEB	2	71,413		FEB	26	87,148		FEB	50	106,615
	MAR	3	76,595		MAR	27	100,322		MAR	51	106,145
	APR	4	86,874		APR	28	91,832		APR	52	94,118
	MAY	5	68,583		MAY	29	74,562		MAY	53	97,977
	JUN	6	71,036		JUN	30	73,993		JUN	54	81,254
	JUL	7	55,415		JUL	31	81,722				
	AUG	8	54,863		AUG	32	88,619				
	SEP	9	54,546		SEP	33	72,539				
	OCT	10	47,452		OCT	34	82,088				
	NOV	11	60,464		NOV	35	87,138				
	DEC	12	54,793		DEC	36	93,254				
2009	JAN	13	89,498	2011	JAN	37	116,069				
	FEB	14	94,002		FEB	38	101,182				
	MAR	15	93,518		MAR	39	129,409				
	APR	16	81,098		APR	40	113,458				
	MAY	17	58,422		MAY	41	85,098				
	JUN	18	60,538		JUN	42	90,964				
	JUL	19	70,080		JUL	43	93,412				
	AUG	20	66,495		AUG	44	90,337				
	SEP	21	53,393		SEP	45	81,533				
	OCT	22	60,221		OCT	46	94,898				
	NOV	23	65,061		NOV	47	86,328				
	DEC	24	74,437		DEC	48	85,126				

Figure 2: HSD sales for four and half years



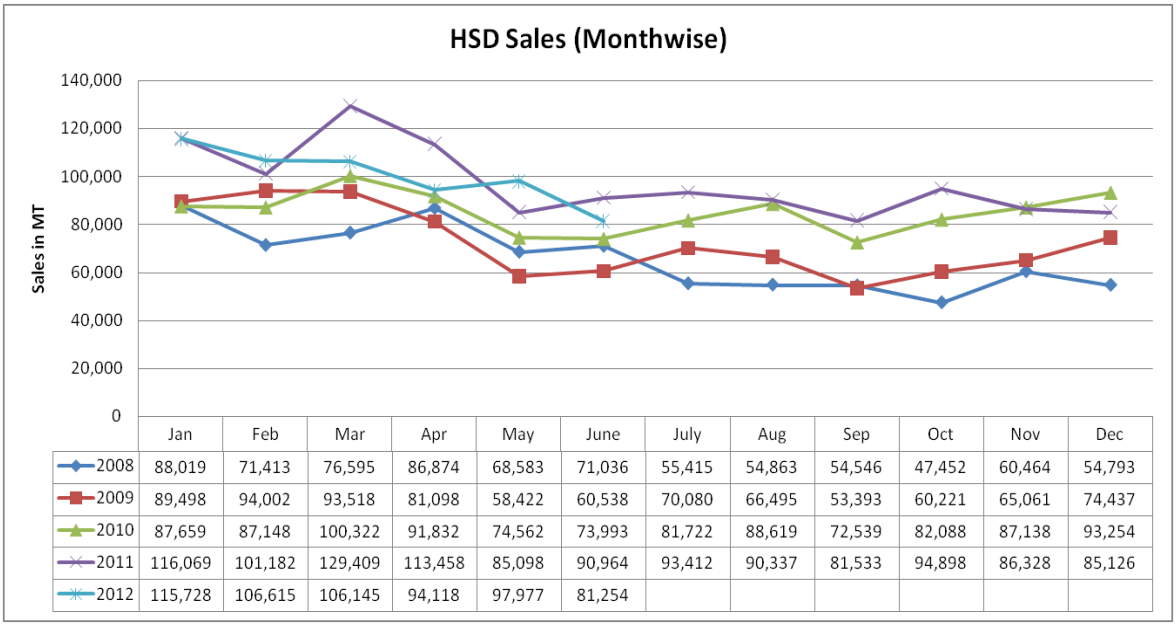
The figure 2 represents the sales of HSD for four and half years in Meghna Petroleum Limited. In the chart Y (vertical) axis represents the sales quantity and the X (Horizontal) axis represents month of all years. From the chart it is visible that the sales of the HSD have slowly increased with some random variations. The demand has followed an upward trend pattern. To be more precise the study has plotted the data in a different layout -

Figure 3: HSD sales for four and half years (Scatter format)



The above scatter format is clearly showing that the data is following a steady linear trend pattern. Most of the data are nearby the trend line. To find the presence of other patterns the study has plotted the data on monthly basis for five years -

Figure 4: HSD sales for four and half years (Month wise)



	Jan	Feb	Mar	Apr	May	June	July	Aug	Sep	Oct	Nov	Dec
2008	88,019	71,413	76,595	86,874	68,583	71,036	55,415	54,863	54,546	47,452	60,464	54,793
2009	89,498	94,002	93,518	81,098	58,422	60,538	70,080	66,495	53,393	60,221	65,061	74,437
2010	87,659	87,148	100,322	91,832	74,562	73,993	81,722	88,619	72,539	82,088	87,138	93,254
2011	116,069	101,182	129,409	113,458	85,098	90,964	93,412	90,337	81,533	94,898	86,328	85,126
2012	115,728	106,615	106,145	94,118	97,977	81,254						

The figure 4 represents the sales of HSD for four and half years on monthly basis. In the chart Y axis represents the sales volume and X axis represents month wise sales of HSD for different years. From January to February the sale has decreased in four cases. From February to March the sale has increased in three cases and remained steady in another two cases. From March to April the sale has decreased in four cases. Also from April to May the sale has decreased in four cases. From May to June the sale has increased in three cases and remained stable in one case. From June to July the sale has increased in three cases out of four cases. From July to August the sale has decreased in three cases. Also from August to September the sale has decreased in three cases and remained stable in one case. From September to October the sale has increased in three cases. From October to November the sale has increased in three cases. Also from November to December the sale has increased in two cases and remained steady in once case. From December to January the sale has increased in three cases. Hence it is clearly visible that the sale is also following a seasonal pattern.

From the analysis the study visualized that each month has a pattern of seasonality and most of the months showed a similar increasing data pattern. Delurgio (1999, p. 175) agreed that the most appropriate method to model trend and seasonality is Classical Decomposition Model. The strong seasonality of series sometimes makes it difficult to measure their trend movements. Thus, measurement of the seasonal variation is an essential step in understanding a time series. In fact, most of the economic measures reported to media by government are seasonally adjusted. It is necessary because the high month to month seasonal variations confound identification of trends. For this particular data pattern, study established forecasting model for HSD demand using classical decomposition model.

Basically there are two types of classical decomposition model. They are Multiplicative Model and Additive Model. The multiplicative model is more prevalent with economic series since most seasonal economic series have seasonal variation which increases with the level of the series. The additive model is appropriate if the magnitude of the seasonal fluctuation does not vary with the level of the series. The determination whether seasonal influences are additive or multiplicative is usually evident from the graph of the data. If the differences of the peaks and troughs get greater as the trend increases, a multiplicative model is used. If the differences between the peaks and troughs stay the same, independent of the level of the series, an additive model is used. From figure 2 it is visible that the differences between the peaks and troughs are not same, they are varying as the trend has increased. From this analysis the study has concluded to use the multiplicative version of classical decomposition model.

4. Forecasting Model

In preparing the forecasting model for HSD the study has constructed the linear trend model in the first step. The linear trend equation as follows:

$$F_t = a + bt$$

Where,

F_t = Forecast for period t
t = Specified number of time periods

a = Value of F_t at t = 0
b = Slope of the line

The coefficients of the line a and b, can be computed from historical data using the following two equations :

Slope, b = $((n*\sum ty)-(\sum t*\sum y))/((n*\sum t^2)-(\sum t)^2)$

Intercept, a = $((\sum y)-(b*\sum t))/n$

The forecast using linear trend as follows:

Table 2: Forecast using linear trend.

Year	Month	Period (t)	Sales (y)	ty	t^2	$F_t = a + bt$
2008	JAN	1	88,019	88,019	1	63,739
	FEB	2	71,413	142,826	4	64,441
	MAR	3	76,595	229,785	9	65,144
	APR	4	86,874	347,496	16	65,847
	MAY	5	68,583	342,915	25	66,549
	JUN	6	71,036	426,216	36	67,252
	JUL	7	55,415	387,905	49	67,954
	AUG	8	54,863	438,904	64	68,657
	SEP	9	54,546	490,914	81	69,360
	OCT	10	47,452	474,520	100	70,062
	NOV	11	60,464	665,104	121	70,765
	DEC	12	54,793	657,516	144	71,468
2009	JAN	13	89,498	1,163,474	169	72,170
	FEB	14	94,002	1,316,028	196	72,873
	MAR	15	93,518	1,402,770	225	73,575
	APR	16	81,098	1,297,568	256	74,278
	MAY	17	58,422	993,174	289	74,981
	JUN	18	60,538	1,089,684	324	75,683
	JUL	19	70,080	1,331,520	361	76,386
	AUG	20	66,495	1,329,900	400	77,089
	SEP	21	53,393	1,121,253	441	77,791
	OCT	22	60,221	1,324,862	484	78,494
	NOV	23	65,061	1,496,403	529	79,196
	DEC	24	74,437	1,786,488	576	79,899
2010	JAN	25	87,659	2,191,475	625	80,602
	FEB	26	87,148	2,265,848	676	81,304
	MAR	27	100,322	2,708,694	729	82,007
	APR	28	91,832	2,571,296	784	82,710
	MAY	29	74,562	2,162,298	841	83,412
	JUN	30	73,993	2,219,790	900	84,115
	JUL	31	81,722	2,533,382	961	84,817
	AUG	32	88,619	2,835,808	1,024	85,520
	SEP	33	72,539	2,393,787	1,089	86,223
	OCT	34	82,088	2,790,992	1,156	86,925
	NOV	35	87,138	3,049,830	1,225	87,628
	DEC	36	93,254	3,357,144	1,296	88,330
2011	JAN	37	116,069	4,294,553	1,369	89,033
	FEB	38	101,182	3,844,916	1,444	89,736
	MAR	39	129,409	5,046,951	1,521	90,438
	APR	40	113,458	4,538,320	1,600	91,141
	MAY	41	85,098	3,489,018	1,681	91,844
	JUN	42	90,964	3,820,488	1,764	92,546
	JUL	43	93,412	4,016,716	1,849	93,249
	AUG	44	90,337	3,974,828	1,936	93,951
	SEP	45	81,533	3,668,985	2,025	94,654
	OCT	46	94,898	4,365,308	2,116	95,357
	NOV	47	86,328	4,057,416	2,209	96,059
	DEC	48	85,126	4,086,048	2,304	96,762
2012	JAN	49	115,728	5,670,672	2,401	97,465
	FEB	50	106,615	5,330,750	2,500	98,167
	MAR	51	106,145	5,413,395	2,601	98,870
	APR	52	94,118	4,894,136	2,704	99,572
	MAY	53	97,977	5,192,781	2,809	100,275
	JUN	54	81,254	4,387,716	2,916	100,978
TOTAL		**1,485**	**4,447,343**	**131,518,585**	**53,955**	
			Forecast			
2012	**JUL**	**55**				**101,680**
	AUG	**56**				**102,383**
	SEP	**57**				**103,086**
	OCT	**58**				**103,788**
	NOV	**59**				**104,491**
	DEC	**60**				**105,193**
2013	**JAN**	**61**				**105,896**
	FEB	**62**				**106,599**
	MAR	**63**				**107,301**
	APR	**64**				**108,004**
	MAY	**65**				**108,707**
	JUN	**66**				**109,409**

Here,

Slope, b	=	702.62	$((n*\sum ty)-(\sum t*\sum y))/((n*\sum t^2)-(\sum t)^2)$
Intercept, a	=	63,036.08	$((\sum y)-(b*\sum t))/n$

Where,

$\sum t$	=	1,485
$\sum y$	=	4,447,343
$\sum ty$	=	131,518,585
$\sum t^2$	=	53,955
n	=	54

In table 2 the model has prepared the linear trend forecast for historical data as well as for next 12 months (From July, 2012 to June, 2013).

In the second step the study has unveiled the seasonal relatives from the historical data. According to Stevenson (2005, pp. 84-85) the seasonal percentages in the multiplicative model are referred to as seasonal relatives. Seasonal relatives are used in two different ways in forecasting. One way is to deseasonalize the data and the other way is to incorporate seasonality in the forecast. This study has used the seasonal relatives for incorporating seasonality in the forecasting model. Incorporating seasonality in a forecast is useful when demand has both trend and seasonal components. It is a commonly used method for representing the trend portion of the time series which involves a centered moving average. Computations and resulting values are the same as those for a moving average.

The number of periods needed in a centered moving average has to be equal to the number of seasons involved. In case of monthly data, a 12 period moving average is used. As the number of periods is even, one additional step is required because the middle of an even set falls between two periods. The additional step requires taking a centered two period moving average of the even numbered centered moving average, which results in averages that line up with data points and helps to determine the seasonal ratios -

Table 3: Seasonal relative percent of centered moving averages

Year	Month	Sales	MA12	MA2	Sales/MA2
2008	JAN	88,019			
	FEB	71,413			
	MAR	76,595			
	APR	86,874			
	MAY	68,583			
	JUN	71,036	65,837.75	65,899.38	1.08
	JUL	55,415	65,961.00	66,902.21	0.83
	AUG	54,863	67,843.42	68,548.54	0.80
	SEP	54,546	69,253.67	69,013.00	0.79
	OCT	47,452	68,772.33	68,348.96	0.69
	NOV	60,464	67,925.58	67,488.17	0.90
	DEC	54,793	67,050.75	67,661.79	0.81
2009	JAN	89,498	68,272.83	68,757.50	1.30
	FEB	94,002	69,242.17	69,194.13	1.36
	MAR	93,518	69,146.08	69,678.13	1.34
	APR	81,098	70,210.17	70,401.71	1.15
	MAY	58,422	70,593.25	71,411.75	0.82
	JUN	60,538	72,230.25	72,153.63	0.84
	JUL	70,080	72,077.00	71,791.42	0.98
	AUG	66,495	71,505.83	71,789.33	0.93
	SEP	53,393	72,072.83	72,520.08	0.74
	OCT	60,221	72,967.33	73,639.83	0.82
	NOV	65,061	74,312.33	74,872.96	0.87
	DEC	74,437	75,433.58	75,918.67	0.98
2010	JAN	87,659	76,403.75	77,325.58	1.13
	FEB	87,148	78,247.42	79,045.17	1.10
	MAR	100,322	79,842.92	80,754.04	1.24
	APR	91,832	81,665.17	82,585.04	1.11
	MAY	74,562	83,504.92	84,288.96	0.88
	JUN	73,993	85,073.00	86,256.75	0.86
	JUL	81,722	87,440.50	88,025.25	0.93
	AUG	88,619	88,610.00	89,821.96	0.99
	SEP	72,539	91,033.92	91,935.00	0.79
	OCT	82,088	92,836.08	93,275.08	0.88
	NOV	87,138	93,714.08	94,421.21	0.92
	DEC	93,254	95,128.33	95,615.42	0.98
2011	JAN	116,069	96,102.50	96,174.08	1.21
	FEB	101,182	96,245.67	96,620.42	1.05
	MAR	129,409	96,995.17	97,528.92	1.33
	APR	113,458	98,062.67	98,028.92	1.16
	MAY	85,098	97,995.17	97,656.50	0.87
	JUN	90,964	97,317.83	97,303.63	0.93
	JUL	93,412	97,289.42	97,515.79	0.96
	AUG	90,337	97,742.17	96,772.83	0.93
	SEP	81,533	95,803.50	94,997.67	0.86
	OCT	94,898	94,191.83	94,728.46	1.00
	NOV	86,328	95,265.08	94,860.50	0.91
	DEC	85,126	94,455.92		
2012	JAN	115,728			
	FEB	106,615			
	MAR	106,145			
	APR	94,118			
	MAY	97,977			
	JUN	81,254			

Table 4: Adjusted seasonal relatives

Year / Month	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2008						1.08	0.83	0.80	0.79	0.69	0.90	0.81
2009	1.30	1.36	1.34	1.15	0.82	0.84	0.98	0.93	0.74	0.82	0.87	0.98
2010	1.13	1.10	1.24	1.11	0.88	0.86	0.93	0.99	0.79	0.88	0.92	0.98
2011	1.21	1.05	1.33	1.16	0.87	0.93	0.96	0.93	0.86	1.00	0.91	
Seasonal Index	**1.21**	**1.17**	**1.30**	**1.14**	**0.86**	**0.93**	**0.92**	**0.91**	**0.79**	**0.85**	**0.90**	**0.92**
Adjusted Seasonal Index	**1.22**	**1.18**	**1.31**	**1.15**	**0.86**	**0.93**	**0.93**	**0.92**	**0.80**	**0.85**	**0.91**	**0.93**

After all the seasonal components are computed, they are averaged to eliminate the error and to isolate the seasonal relatives as shown in table 4. The seasonal relatives have been adjusted so that they equal 12, which is the number of periods per season. According to Delurgio (1999, p. 180) it is required to adjust the seasonal relatives because the average seasonal index should equal 1, and therefore the sum of all seasonal relatives total the number of periods per year. In the above table the sum of the unadjusted seasonal relatives is 11.91. To adjust these to total 12, 12 has been divided by 11.91 and multiplied this factor times each of the unadjusted relatives.

In the third step the study has combined the linear trend and seasonality index using multiplicative method. The method as follows:

$$F_c = F_t \times S_t$$

Where,

F_c = Combined forecast for period t
F_t = Linear trend forecast for period t
S_t = Seasonal relative for period t

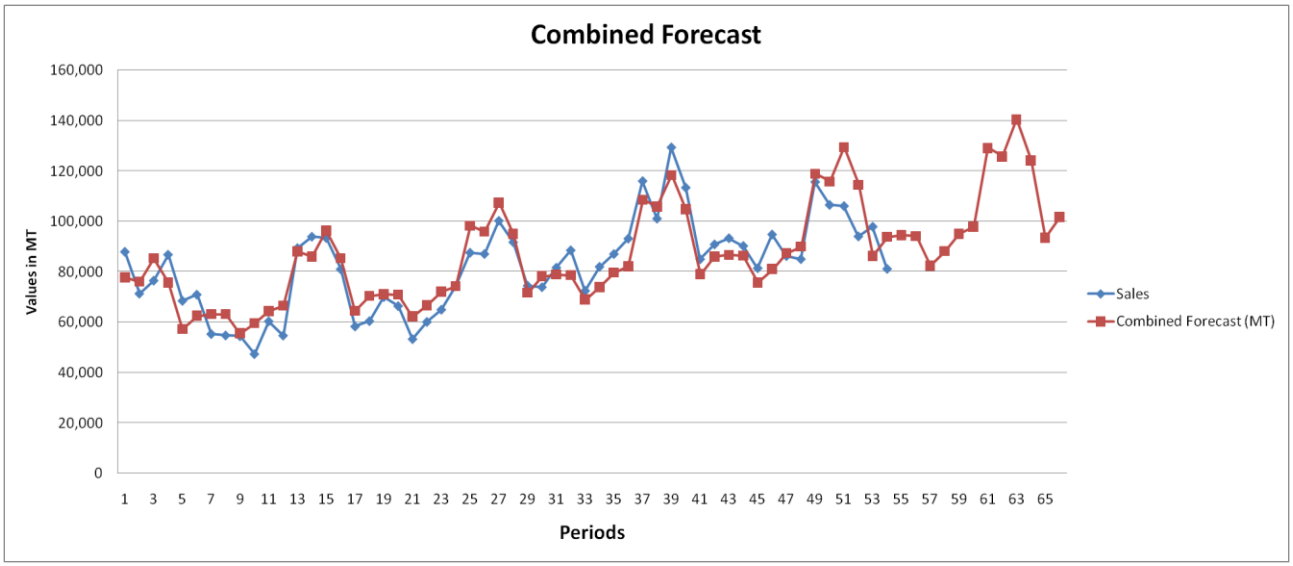
Karim & Hasnat

Table 5: Combined forecast

Year	Month	Period	Sales	Linear Trend	Seasonal Index	Combined Forecast (MT)
2008	JAN	1	88,019	63,739	1.22	77,761
	FEB	2	71,413	64,441	1.18	76,041
	MAR	3	76,595	65,144	1.31	85,339
	APR	4	86,874	65,847	1.15	75,724
	MAY	5	68,583	66,549	0.86	57,232
	JUN	6	71,036	67,252	0.93	62,544
	JUL	7	55,415	67,954	0.93	63,198
	AUG	8	54,863	68,657	0.92	63,164
	SEP	9	54,546	69,360	0.80	55,488
	OCT	10	47,452	70,062	0.85	59,553
	NOV	11	60,464	70,765	0.91	64,396
	DEC	12	54,793	71,468	0.93	66,465
2009	JAN	13	89,498	72,170	1.22	88,048
	FEB	14	94,002	72,873	1.18	85,990
	MAR	15	93,518	73,575	1.31	96,384
	APR	16	81,098	74,278	1.15	85,420
	MAY	17	58,422	74,981	0.86	64,483
	JUN	18	60,538	75,683	0.93	70,385
	JUL	19	70,080	76,386	0.93	71,039
	AUG	20	66,495	77,089	0.92	70,921
	SEP	21	53,393	77,791	0.80	62,233
	OCT	22	60,221	78,494	0.85	66,720
	NOV	23	65,061	79,196	0.91	72,069
	DEC	24	74,437	79,899	0.93	74,306
2010	JAN	25	87,659	80,602	1.22	98,334
	FEB	26	87,148	81,304	1.18	95,939
	MAR	27	100,322	82,007	1.31	107,429
	APR	28	91,832	82,710	1.15	95,116
	MAY	29	74,562	83,412	0.86	71,734
	JUN	30	73,993	84,115	0.93	78,227
	JUL	31	81,722	84,817	0.93	78,880
	AUG	32	88,619	85,520	0.92	78,678
	SEP	33	72,539	86,223	0.80	68,978
	OCT	34	82,088	86,925	0.85	73,886
	NOV	35	87,138	87,628	0.91	79,741
	DEC	36	93,254	88,330	0.93	82,147
2011	JAN	37	116,069	89,033	1.22	108,620
	FEB	38	101,182	89,736	1.18	105,888
	MAR	39	129,409	90,438	1.31	118,474
	APR	40	113,458	91,141	1.15	104,812
	MAY	41	85,098	91,844	0.86	78,986
	JUN	42	90,964	92,546	0.93	86,068
	JUL	43	93,412	93,249	0.93	86,721
	AUG	44	90,337	93,951	0.92	86,435
	SEP	45	81,533	94,654	0.80	75,723
	OCT	46	94,898	95,357	0.85	81,053
	NOV	47	86,328	96,059	0.91	87,414
	DEC	48	85,126	96,762	0.93	89,989
2012	JAN	49	115,728	97,465	1.22	118,907
	FEB	50	106,615	98,167	1.18	115,837
	MAR	51	106,145	98,870	1.31	129,519
	APR	52	94,118	99,572	1.15	114,508
	MAY	53	97,977	100,275	0.86	86,237
	JUN	54	81,254	100,978	0.93	93,909
2012	**JUL**	**55**		**101,680**	**0.93**	**94,563**
	AUG	**56**		**102,383**	**0.92**	**94,192**
	SEP	**57**		**103,086**	**0.80**	**82,468**
	OCT	**58**		**103,788**	**0.85**	**88,220**
	NOV	**59**		**104,491**	**0.91**	**95,087**
	DEC	**60**		**105,193**	**0.93**	**97,830**
2013	**JAN**	**61**		**105,896**	**1.22**	**129,193**
	FEB	**62**		**106,599**	**1.18**	**125,786**
	MAR	**63**		**107,301**	**1.31**	**140,565**
	APR	**64**		**108,004**	**1.15**	**124,205**
	MAY	**65**		**108,707**	**0.86**	**93,488**
	JUN	**66**		**109,409**	**0.93**	**101,751**

Table 5 shows the combined forecast for the historical data and coming 12 months. To visualize the performance of the model the study has plotted the forecasted values along with the actual values of HSD in the following graph -

Figure 5: Combined forecast with actual sales



In figure 5 the blue line represents the actual sales of previous periods and the red line represents the forecast of previous and coming periods for HSD. From the figure it is visible that the combined forecast is adjusting with the actual sales value. The error level seems to be in range. To be more precise about the performance of the forecasting model it is necessary to conduct accuracy test.

5. Accuracy Test

To judge the performance of the forecasting model it is required to perform the accuracy test using one or more measures. The ultimate goal is to minimize the forecast error as the complex nature of most real world variables makes it hard to correctly predict future value of the sales on a regular basis. Consequently it is important to include an indication of the extent to which the forecast might deviate from the value of the sales that actually occurs. Stevenson (2005, p. 93) describes that the commonly used measures for summarizing historical errors are the Mean Absolute Deviation (MAD), Mean Squared Error (MSE) and Mean Absolute Percent Error (MAPE) -

$$\text{MAD} = \Sigma\,|\text{Actual} - \text{Forecast}| \,/\, \text{No. of periods}$$
$$\text{MSE} = \Sigma\,(\text{Actual} - \text{Forecast})^2 \,/\, \text{No. of periods}$$
$$\text{MAPE} = \Sigma\,((|\text{Actual} - \text{Forecast}| \,/\, \text{Actual}) \times 100) \,/\, \text{No. of periods}$$

In this regard it is necessary to add that the study collected actual sales information from Meghna Petroleum Limited after submitting the forecast to the management. The actual sales data of 5 months (From July, 2012 to November, 2012) was collected to judge the accuracy

level of the forecasting model. In the following calculation of accuracy test the study has also included the values.

Table 6: Calculation of MAD, MSE and MAPE

Year	Month	Period	Sales (MT)	Combined Forecast (MT)	Sales - Forecast	|Sales - Forecast|	(Sales - Forecast)²	((|Sales - Forecast| / Sales)×100)
2008	JAN	1	88,019	77,761	10,257.78	10,257.78	105,222,080.92	11.65
	FEB	2	71,413	76,041	-4,627.77	4,627.77	21,416,209.70	6.48
	MAR	3	76,595	85,339	-8,743.57	8,743.57	76,450,071.82	11.42
	APR	4	86,874	75,724	11,150.44	11,150.44	124,332,370.79	12.84
	MAY	5	68,583	57,232	11,350.69	11,350.69	128,838,229.95	16.55
	JUN	6	71,036	62,544	8,491.81	8,491.81	72,110,841.70	11.95
	JUL	7	55,415	63,198	-7,782.63	7,782.63	60,569,310.79	14.04
	AUG	8	54,863	63,164	-8,301.50	8,301.50	68,914,856.07	15.13
	SEP	9	54,546	55,488	-941.75	941.75	886,889.05	1.73
	OCT	10	47,452	59,553	-12,100.96	12,100.96	146,433,265.73	25.50
	NOV	11	60,464	64,396	-3,932.09	3,932.09	15,461,303.52	6.50
	DEC	12	54,793	66,465	-11,671.82	11,671.82	136,231,477.05	21.30
2009	JAN	13	89,498	88,048	1,450.39	1,450.39	2,103,619.58	1.62
	FEB	14	94,002	85,990	8,012.10	8,012.10	64,193,719.31	8.52
	MAR	15	93,518	96,384	-2,865.80	2,865.80	8,212,815.93	3.06
	APR	16	81,098	85,420	-4,321.75	4,321.75	18,677,521.55	5.33
	MAY	17	58,422	64,483	-6,061.37	6,061.37	36,740,239.40	10.38
	JUN	18	60,538	70,385	-9,847.46	9,847.46	96,972,437.07	16.27
	JUL	19	70,080	71,039	-958.90	958.90	919,484.35	1.37
	AUG	20	66,495	70,921	-4,426.45	4,426.45	19,593,470.06	6.66
	SEP	21	53,393	62,233	-8,839.93	8,839.93	78,144,278.02	16.56
	OCT	22	60,221	66,720	-6,498.71	6,498.71	42,233,261.55	10.79
	NOV	23	65,061	72,069	-7,007.73	7,007.73	49,108,218.83	10.77
	DEC	24	74,437	74,306	130.91	130.91	17,136.71	0.18
2010	JAN	25	87,659	98,334	-10,675.01	10,675.01	113,955,827.01	12.18
	FEB	26	87,148	95,939	-8,791.04	8,791.04	77,282,354.30	10.09
	MAR	27	100,322	107,429	-7,107.03	7,107.03	50,509,861.51	7.08
	APR	28	91,832	95,116	-3,283.94	3,283.94	10,784,276.89	3.58
	MAY	29	74,562	71,734	2,827.56	2,827.56	7,995,104.64	3.79
	JUN	30	73,993	78,227	-4,233.73	4,233.73	17,924,445.04	5.72
	JUL	31	81,722	78,880	2,841.83	2,841.83	8,076,019.67	3.48
	AUG	32	88,619	78,678	9,940.59	9,940.59	98,815,426.11	11.22
	SEP	33	72,539	68,978	3,560.90	3,560.90	12,679,990.40	4.91
	OCT	34	82,088	73,886	8,201.54	8,201.54	67,265,205.18	9.99
	NOV	35	87,138	79,741	7,396.64	7,396.64	54,710,210.82	8.49
	DEC	36	93,254	82,147	11,106.64	11,106.64	123,357,420.42	11.91
2011	JAN	37	116,069	108,620	7,448.60	7,448.60	55,481,568.46	6.42
	FEB	38	101,182	105,888	-4,706.17	4,706.17	22,148,082.18	4.65
	MAR	39	129,409	118,474	10,934.74	10,934.74	119,568,605.65	8.45
	APR	40	113,458	104,812	8,645.87	8,645.87	74,750,986.25	7.62
	MAY	41	85,098	78,986	6,112.50	6,112.50	37,362,606.70	7.18
	JUN	42	90,964	86,068	4,896.00	4,896.00	23,970,857.47	5.38
	JUL	43	93,412	86,721	6,690.57	6,690.57	44,763,662.40	7.16
	AUG	44	90,337	86,435	3,901.64	3,901.64	15,222,801.67	4.32
	SEP	45	81,533	75,723	5,809.72	5,809.72	33,752,847.13	7.13
	OCT	46	94,898	81,053	13,844.79	13,844.79	191,678,094.24	14.59
	NOV	47	86,328	87,414	-1,086.00	1,086.00	1,179,405.00	1.26
	DEC	48	85,126	89,989	-4,862.63	4,862.63	23,645,171.54	5.71
2012	JAN	49	115,728	118,907	-3,178.80	3,178.80	10,104,772.02	2.75
	FEB	50	106,615	115,837	-9,222.31	9,222.31	85,051,029.45	8.65
	MAR	51	106,145	129,519	-23,374.48	23,374.48	546,366,542.97	22.02
	APR	52	94,118	114,508	-20,390.33	20,390.33	415,765,442.66	21.66
	MAY	53	97,977	86,237	11,740.43	11,740.43	137,837,703.31	11.98
	JUN	54	81,254	93,909	-12,655.26	12,655.26	160,155,718.16	15.57
	JUL	55	87,443	94,563	-7,119.70	7,119.70	50,690,177.94	8.14
	AUG	56	78,556	94,192	-15,636.31	15,636.31	244,494,286.35	19.90
	SEP	57	81,856	82,468	-612.46	612.46	375,103.95	0.75
	OCT	58	86,405	88,220	-1,814.97	1,814.97	3,294,098.42	2.10
	NOV	59	80,824	95,087	-14,262.64	14,262.64	203,422,996.45	17.65
Total						**438,687.67**	**4,518,221,811.83**	**550.08**
						MAD	**MSE**	**MAPE**
						7,435	**76,580,031**	**9.32**

MAD measures the difference between actual demand and average forecast values providing equal weight to all errors. In the above forecasting model the MAD is 7,435 MT; that means the average absolute deviation from the mean is 7,435 MT.

MSE measures the average of the squares of the errors. The MSE is the second moment (about the origin) of the error, and thus incorporates both the variance of the estimator and its bias. In the model the MSE is 76,580,031 MT.

MAPE provides the measurement of forecast error relative to the actual value. In the forecasting model the MAPE is 9.32%; that means the average absolute percentage of error is 9.32%. From here it can be concluded that the model is having an absolute accuracy level of 90.68% on average.

Another useful tool for monitoring forecast errors is the control chart. In this method errors are plotted on a control chart in the order that they occur. The centerline of the chart represents an error of zero. There are two limits in control chart; named Upper Control Limit (UCL) and Lower Control Limit (LCL). They represent the upper and lower ends of the range of acceptable variation for the errors.

Another commonly used method to monitor forecast error is tracking signal. But Stevenson (2005, p. 96) has claimed control chart as a better approach than the tracking signal. He has mentioned that the main weakness of tracking signal approach is its use of cumulative errors; individual errors can be obscured so that large positive and negative values cancel each other. Conversely, with control chart every error is judged individually. Therefore it can be misleading to rely on a tracking signal approach to monitor errors. In the modern age of technology easy calculation of standard deviation has given the control chart superiority over the tracking signal.

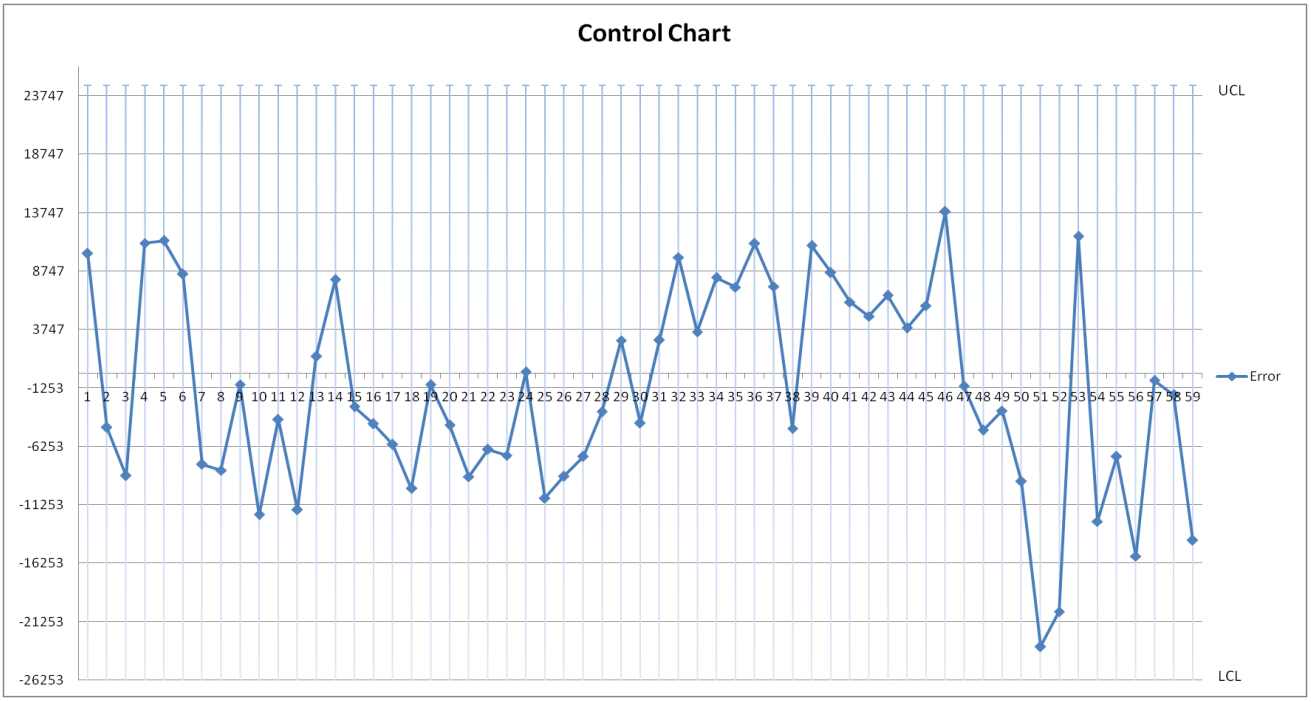
Control chart are based on the assumption that when errors are random, they will be distributed according to a normal distribution around a mean of zero. Hence for a standard deviation of 3 approximately 99.74% of the values can expected to fall within ±3s of zero.

Standard Deviation, s		=	$\sqrt{MSE}$
Upper Control Limit, UCL		=	$0 + z\sqrt{MSE}$
Lower Control Limit, LCL		=	$0 - z\sqrt{MSE}$
Where,	z	=	Standard deviations from the mean

Using the value of MSE from table 4.5 the calculation as follows -

Standard Deviation, s		=	8,751
Upper Control Limit, UCL		=	26,253
Lower Control Limit, LCL		=	26,253
Where,	z	=	3 standard deviation

Figure 6: Control chart.



According to the control chart in figure 6 all the values are within the range. The values are randomly distributed in the chart which represents the stability of the process. From the above discussion it can be concluded that the forecasting model is working suitably.

6. Benefits

As Meghna Petroleum Ltd. makes the profit from the operational activities the performance of the forecasting model is very important for them. Based on trading places (Cerere 2011) a 6% forecast improvement can improve the perfect order by 10% and deliver a 10-15% reduction in inventory. Infusing proper forecasting model into the demand management process can affect many Key Performance Indicators (KPI) closely monitored by management -

Financial KPI's

- Forecasting model can sense and react to upswings in demand of HSD to capture additional revenue and increase profit margins by avoiding costly supply chain inefficiencies stemming from demand uncertainty.

- Forecasting model can help to increase cash flow and achieve higher return on invested capital by reducing inventory levels of products.

As mentioned in fuel prices hiked again (The Daily Star Archive 2013) Bangladesh spent around BDT 8,500 crore in fuel subsidies during 2012-13; contributing BDT 11.77 per liter of HSD. The model can play a vital role in reducing the subsidy in fuel sector provided by the Government of Bangladesh.

Supply Chain KPI's:

- The forecasting model can help Meghna Petrolium Ltd. to improve customer service by delivering the product according to the demand at right time.

- The model can assist to stabilize delivery schedules and avoid emergency changeovers to meet surges in demand.

- The forecast of HSD can reduce transportation costs by avoiding transshipments and expensive emergency shipments; and reduce warehouse costs with lower inventory levels.

7. Recommendations

After analyzing the revealed information from the forecasting model following suggestions are encouraged to enhance the performance:

- It is highly recommended to associate a qualitative method, basing on the experience of the management, with the current model. It will enhance the performance of the forecast model.

- The management should update the periodical values for MAD, MSE, MAPE and control chart to monitor the performance of the forecast model. Any disorder may indicate the required modification in the model.

- With forecast diverging from actual by an average of 9.32%, there is a window of opportunity to improve the forecasting model using more sophisticated method. Further study can be carried out using ARIMA model, basing on extensive survey, to calculate the future demand in the long run.

8. Conclusion

Proper planning is the central part of the management process. Managers will find it difficult to plan effectively if uncertainties cloud the planning horizon. Forecast models help managers by reducing some level of uncertainties, thereby enabling them to develop more momentous plans. With this aim the study prepared the forecasting model for HSD for Meghna Petroleum Ltd. With thorough analysis the study unveiled the data pattern of the time series and decided to use classical decomposition model for forecasting purpose. Using multiplicative version of classical decomposition model the study prepared the forecast for historical data as well as for upcoming one year. The study used MAD, MSE, MAPE and control chart to judge the performance of the model. It can be noted that the MAD and MSE showed evenhanded values to ensure the satisfactory performance of the model. The MAPE indicated an average 9.32% of absolute error. The control chart also responded with all the values within the 3 sigma limit. This may conclude that the forecasting model for HSD is performing adequately.

The study was limited to visual method using graphs to identify the data pattern. Instead of using graphs regression model can be used to confirm the presence of trend and seasonal pattern. The study waited in combining the qualitative method in the forecasting model. Addition of the qualitative method, based on management experience, in future studies will advance the performance of the forecasting. Using the findings of the study further research can be initiated to improve the efficiency of procurement and supply chain management. In future the organization can also produce similar models for other petroleum products. Taking the study as a base Bangladesh Petroleum Corporation can introduce such practice in other fuel distributing companies of Bangladesh. It will assist the organizations to ensure a proper distribution management in the fuel sector. Ultimately Government will be able to reduce the level of subsidy and ensure the security in the energy sector.

Endnotes

Meghna Petroleum Ltd.: The fuel sector of Bangladesh is maintained by Bangladesh Petroleum Corporation (BPC). BPC distributes the HSD all over the country through Meghna Petroleum Ltd., Padma Oil Company Ltd. and Jamuna Oil Company Ltd. Meghna Petroleum Ltd. was setup on December 27, 1977 under the company act 1913 (Later on company Act 1994) as a private limited company. The Company was converted into public limited company from a private limited company on May 29, 2007 and its authorized capital was increased to BDT 4,000 million. The company sales 10 different products to the local market including lubricants. Among all the items HSD contributes 65.34% of total sales for Meghna Petroleum Ltd.

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