Demand Forecasting-using Simulation for SCM Environment

Venkata Reddy. S, V. Sai Rakesh, M. Varun, S. Prakash, D. Naveen

Abstract*: *Supply chain management (SCM) is an emerging field that has commanded attention and support from the industrial community. Forecasting activities are widely performed in different categories of supply chains for predicting important supply chain management (SCM) comparis ons such as demand volume in order management, product quality in manufacturing processes, capacity usage in production management, traffic costs in transportation management and so on. Demand forecast taking inventory into consideration is an critical issue in SCM. The demand is forecasted using SIMULATION and compared with various forecasting models. The paper describes an application of discrete event simulation for forecasting the demand for next few periods, where the previous demand pattern show a purely random variation and increasing trend with random variation. The main objective of the study was to determine the demand of the product for future periods based on past data using simulation technique and compare its efficiency with conventional techniques for the SCM environment. By simulation we can forecast the demand either with the same accuracy or with more accuracy by increasing number of iterations. Mean absolute deviation (MAD) is used as measure of accuracy of various techniques. In this paper, this technique is verified by considering a case study which deals with the demand of tyres over past three years(2002,2003,2004) and forecasting the demand in the present year(2005) and successful results are obtained.

Key words: Supply chain management (SCM), Forecasting, Simulation, Random number, Mean Absolute Deviation.

I. INTRODUCTION

Production network the executives (SCM) is a developing field that has requested consideration and backing from the mechanical network. Production network can be clarified as the chain interfacing every element of the assembling and supply process from crude materials all the way to the finish client. A production network comprises of numerous frameworks, including different assembling, stockpiling, transportation and retail frameworks. Dealing with any of these frameworks includes a progression of complex exchange offs between differentiating business work costs. For instance, to effectively run an assembling activity, the cost must concur with the expenses of stock and crude materials.

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All supervisors wellbeing is to guarantee that the general expense is decreased and works among different frameworks are incorporated through coordination. At the point when the framework isn't composed, that is, every substance in the store network does what is best for that element, it brings about nearby enhancement. Each store network element advancing its own activity without considering the effect on different elements frequently brings about bigger variety of stock and request in the entire production network. To have great coordination, supervisors need to impart in detail, which is frequently a tedious procedure. Also, insufficient correspondence influences material streams and makes long lead times. To take care of this issue and to make correspondence viable, data must be accessible and straightforward utilizing data innovation.

The inventory network has three phases: acquisition, creation and appropriation. These stages likewise include three business elements providers, producers and clients who start and apply endeavors on each comparing stage. Numerous scientists likewise consider wholesalers and retailers as key business elements rather than clients. Whatever production network is characterized as, store network the board (SCM) is only the administration of material and data streams required in the inventory network both in and between offices, for example, merchants, assembling and gathering plants and dispersion focuses.

Determining is one of the most significant exercises for upgrading efficiency and improving quality in the entire authoritative capacity in light of the fact that most estimating outcomes are powerful in settling on administrative choices and assessing execution of the organization. Much of the time, a guaging framework has been built up that can fill in as an indicative device for distinguishing potential mutilations in authoritative exercises.

For instance, anticipating the item surrenders during assembling forms is the start of value improvement exercises and the guaging results are utilized to accurately control the future procedure for delivering better items. This paper is worried about the improvement of an anticipating framework for productively estimating the interest volume of the inventory network.

Types of forecasting:

Short range forecasting:

Estimate made for a period of 0-1 year. This forecast is useful for day-to-day operational planning activities and inventory control.

Medium range forecasting:

Estimate made for a period of 1-2 years. Useful for procuring raw materials especially imported ones.

Long-range forecasting:

Estimate made for a period of 1-5 years.

Useful in taking strategic decisions like major capacity expansion, plant location, product development and design etc.

STeps in forecasting:

There are 5 essential steps in forecasting. They are

- Defining the purpose.
- Collecting and analyzing the data.
- Selecting the appropriate technique.
- Making the forecasts.
- Tracking the forecasts.
- Tracking the forecasts. (means comparing the actual with the forecast and calculation of error.)

Various Techniques Of Forecasting:

Quantitative	Qualitative	Casual Method
Simple average method	NGT method	Cause and effect relationship (Correlation and Regression analysis)
Moving average method	Delphi method	
Weighted moving avg. Method	Sales force estimate	
Simple Exponential smoothing		
Advanced Exponential Smoothing		

Simple average method:

It is a technique for stock valuation or conveyance cost figuring, where regardless of whether tolerating stock products with various unit cost, the normal unit cost is determined by duplicating the aggregate of these unit costs basically by the quantity of accepting.

Moving average method:

A moving average is a technique often used in technical analysis that smoothes price histories by averageing daily prices over a certain period of time. Simple Moving Averages (SMAs) shall take the arithmetic mean of the set of prices in the past number of days, e.g. the preceding 15, 30, 100 or 200 days.

Weighted moving avg. Method:

The Weighted Moving Average puts more weight on recent data and less weight on past data. This is achieved by multiplying the price of each bar by a weighting factor. Owing to its special measure, WMA can obey markets more closely than the related Basic Moving Average.

Exponential smoothing:

Exponential smoothing of time arrangement information relegates exponentially diminishing loads for most current to most established perceptions. As such, the more established the information, the less need ("weight") the information is given; more up to date Knowledge is seen as more important, and more weight is allocated. Easier parameters (smoothing constants) usually denoted by α determine the weights for observations.

Exponential smoothing is usually used to make short term forecasts, as longer-term forecasts using this technique can be quite unreliable.

- Basic (single) exponential smoothing uses a weighted moving average of exponentially diminishing weights.
- Holt's pattern adjusted twofold exponential smoothing is normally progressively dependable for dealing with information that shows patterns, contrasted with the single system.
- Triple exponential smoothing (additionally called the Multiplicative Holt-Winters) is normally progressively dependable for allegorical patterns or information that shows patterns and regularity.

Simple Exponential smoothing:

The **basic formula** is:

$S_t = \alpha y_{t-1} + (1 - \alpha) S_{t-1}$

Where:

- α = smoothing continuity, an opportunity from 0 to 1. As 5-007 is below zero, the smoothing occurs all the more slowly. Following this, the best incentive for 5-007 is the one that results in the smallest mean squared blunder (MSE). There are different ways to do this, but the famous strategy is the Levenberg – Marquardt calculation.
- t = timeframe.

Numerous elective recipes exist. For instance, Roberts (1959) supplanted yt-1 with the present perception, yt. Another formula uses the projection for the previous time and the present time:

$$Ft = Ft-1 + a(At-1 - Ft-1)$$
$$= a*At-1 + (1-a)*Ft-1$$

Where:

- Ft – 1 = estimate for the past period,
- At – 1 = Actual interest for the period,
- a = weight (somewhere in the range of 0 and 1). The more like zero, the littler the weight.

What method to use is usually an unsettled problem, as most exponential smoothing is performed using programming. However, whatever equation you use, you will need to set the underlying perception. It is an informed decision. You could use the normal of the initial scarcely any perceptions, or you could set the second smoothed value equivalent to the first perception incentive to get the first perception.

Advanced Exponential Smoothing:

Exponential smoothing is a time series forecasting tool for univariate data which can be expanded with a systemic pattern or seasonal portion to help the data. It is a effective forecasting tool which can be used as an alternative to the common system family Box-Jenkins ARIMA.

Simulation:

A simulation is the impersonation of the activity of genuine procedure or framework after some time. Regardless of whether done by hand or PC,

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reproduction includes the age of a counterfeit history of a framework, and the perception of that fake history to draw surmisings concerning the working attributes of the genuine framework.

It empowers the investigation of and experimentation with, the inward connections of a perplexing framework, or of a sub framework inside an intricate framework. Changing reproduction inputs and watching the subsequent yields can acquire significant knowledge into which factors are most significant how factors cooperate. Recreation can be utilized as an educational gadget to fortify diagnostic arrangement approachs. Recreation can be utilized to try different things with new structures or polices preceding execution, to get ready for what may occur.

II. SEQUENTIAL STEPS IN SIMULATION STUDY

- Problem Formulation.
- Setting of Objectives and overall project plan.
- Model conceptualization and Data collection.
- Model Translation, its verification and validation.
- Experimental Design.
- Production runs and analysis.
- Documentation and Reporting.
- Implementation.

case study:

Statement of the problem:

Forecasting the demand for the product whose past demand shows pure randomness.

Objectives:

To establish simulation technique for forecasting demand so as to prove that the forecasting error is equivalent to that of a simple average method and can even become less if more number of iterations is carried out.

Methodology applied:

The technique used here involves the selection of random observations with in the simulation model. The principle of this technique is replacement of actual statistical universe by another universe depicted by some accepted likelihood dispersion and afterward testing from this hypothetical populace by methods for irregular number. This procedure includes the age of reproduced measurements (arbitrary factors) that can be clarified in straightforward terms as picking an irregular number and subbing this incentive in standard likelihood thickness capacity to get arbitrary variable or recreated insights. This generation of random numbers is carried out for desired number of runs. More the number of runs, more accurate will be the decision derived by simulation technique.

If the interval (0,1) is divided into n classes, or sub-intervals of equal length, the expected number of observations in each interval is N/n, where N is the total no. of observations.

Data collection:

In this mini project, the actual demand of **tyres** over a period of past three years was collected and also the actual demand for the current period (of six months) was collected for making comparison between the actual and the forecasted demand.

Analysis of Data:

2016	*Jan*	*Feb*	*Mar*	Apr	*May*	*Jun*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
1st fortnight	10	06	08	04	08	06	04	08	12	05	10	08
2nd fortnight	05	05	10	12	07	05	08	10	05	05	12	08
2017	*Jan*	*Feb*	*Mar*	Apr	*May*	*Jun*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	*Dec*
1st fortnight	05	12	05	07	04	10	05	10	10	08	05	04
2nd fortnight	12	10	08	05	12	08	06	04	12	12	06	04
2018	*Jan*	*Feb*	*Mar*	Apr	*May*	*Jun*	*July*	*Aug*	*Sept*	*Oct*	*Nov*	Dec
1st fortnight	05	05	04	05	10	12	04	12	12	06	12	10
2nd fortnight	06	05	04	12	07	05	10	07	05	04	12	08

Application of simulation technique:

Step1: To determine the probability distribution for each random variable that requires analysis.

Step2: To determine cumulative probability distribution corresponding to each probability distribution.

Step3: To assign suitable set of random numbers for representing the value or the range of values of related variables.

Quantity	*Frequency*	*Probability Distribution*	*Cumulative Probability Distribution*	*Range of Random number*
4	10	0.138888889	0.138888889	0-12
5	17	0.236111111	0.375	13-36
6	6	0.083333333	0.458333333	37-44
7	4	0.055555556	0.513888889	45-50
8	10	0.138888889	0.652777778	51-64
10	11	0.152777778	0.805555556	65-79
12	14	0.194444444	1	80-99

Step 4: To conduct the simulation experiment by random number generation. This is repeated until the desired number of simulation runs is generated. The forecasted demand from these runs is then used to calculate the average forecasted demand.

Month	**Period**	***Trial No.1***		***Trial No.2***		***Trial No.3***		***Trial No.4***		***Trial No.5***		***Average***
		RND No.	***Demand***	***RND No.***	***Demand***	***RND No.***	***Demand***	***RND No.***	***Demand***	***RND No.***	***Demand***	
Jan	1	87	12	23	5	29	5	87	12	10	4	8
	2	11	4	11	4	66	10	20	5	14	5	6
Feb	3	88	12	11	4	44	6	25	5	34	5	6
	4	73	10	0	4	66	10	75	10	64	8	8
Mar	5	12	4	78	10	41	6	59	8	28	5	7
	6	47	7	10	4	83	12	20	5	18	5	7
Apr	7	99	12	88	12	27	5	42	6	96	12	9
	8	42	7	90	12	96	12	76	10	48	7	10
May	9	60	8	35	5	58	8	29	5	47	7	7
	10	70	10	19	5	98	12	53	8	34	5	8
Jun	11	49	7	42	6	9	4	58	8	12	4	6
	12	65	10	58	8	49	7	71	10	5	4	8
July	13	82	12	72	10	98	12	36	5	60	8	9
	14	0	4	37	6	18	5	75	10	34	5	6
Aug	15	45	7	70	10	10	12	71	10	92	12	10
	16	39	6	99	12	38	6	72	10	19	5	8
Sept	17	13	5	4	4	18	5	5	4	80	12	6
	18	45	7	0	4	88	12	89	12	0	4	8
Oct	19	36	6	64	8	94	12	22	5	75	10	8
	20	91	12	71	10	18	5	65	10	16	5	8
Nov	21	18	5	44	6	88	12	34	5	31	5	7
	22	77	10	69	10	82	12	59	8	96	12	10
Dec	23	26	5	89	12	26	5	26	5	0	4	6
	24	3	4	2	4	5	4	98	12	8	4	6

Step 5: The average forecasted demand calculated is then used to compare with actual demand for six months (of **2005**) using SIMULATION method and SIMPLE AVERAGE method.

1.) BY SIMULATION METHOD:

	Jan		Feb		Mar		Apr		May		June	
Period	1	2	3	4	5	6	7	8	9	10	11	12
Actual Demand	6	5	5	5	5	5	12	8	6	6	7	4
Forecasted Demand	8	6	6	8	7	7	9	10	7	8	6	8
Absolute Error	2	1	1	3	2	2	3	2	1	2	1	4
Error	-2	-1	-1	-3	-2	-2	3	-2	-1	-2	1	-4
Squared Error	4	1	1	9	4	4	9	4	1	4	1	16
BIAS (Avg. Error) = -1.33333												
Mean Absolute Deviation = 2*												
Squared Error = 4.833333												

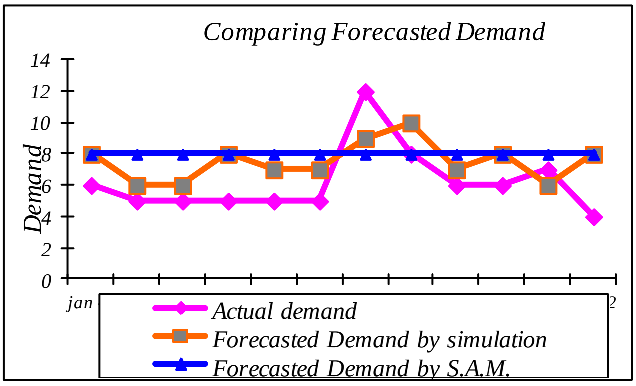
2.) BY SIMPLE AVERAGE METHOD (sam):

Total Demand for 72 Periods = 547													
Average Demand for next periods = (547 /72) = 8													
	Jan		Feb		Mar		Apr		May		June		TOTAL
Period(Fort nightly)	1	2	3	4	5	6	7	8	9	10	11	12	
Actual Demand	6	5	5	5	5	5	12	8	6	6	7	4	74
Forecasted Demand	8	8	8	8	8	8	8	8	8	8	8	8	96
Absolute Error	2	3	3	3	3	3	4	0	2	2	1	4	30
Error	-2	-3	-3	-3	-3	-3	4	0	-2	-2	-1	-4	-22
Squared Error	4	9	9	9	9	9	16	0	4	4	1	16	90
BIAS (Avg. Error) =	-1.8333333												
Mean Absolute Deviation =	2.5*												
Mean Squared Error =	7.5												

III. COMPARISION OF RESULTS

1.) MAD by ***Simulation Method:* 2***

2.) MAD by ***Simple Average Method (SAM):* 2.5***



IV. CONCLUSION

As observed from the above data it is clearly seen that the mean absolute deviation (MAD) is less than constant forecasting method or is almost same for both methods. Therefore simulation can be applied in forecasting a demand with purely a random component or random with increasing trend. Carrying out more number of iterations/runs using computers can considerably reduce the error. The forecasted demand by such method helps the firm in less inventory cost be it of raw material or be it of finished goods.

Thus it can be concluded that for a product (whose demand varies purely on random basis or random with linear trend), the forecasting can be effectively simulated.

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