International Journal of Advance Engineering and Research Development
Scientific Journal of Impact Factor (SJIF): 4.72
Special Issue SIEICON-2017,April -2017
e-ISSN : 2348-4470 p-ISSN : 2348-6406

Evaluation of Different Lot Sizing Techniques in a MRP System

Swati Singh[1]

[1]*Assistant Professor, Mechanical Engineering Department, Sigma Institute of Engineering, Vadodara*
swatismile87@gmail.com

Abstract - *This Paper Consider the evaluation of Lot Sizing Techniques in MRP system. This problem deals with the determination of a Production plan for the end item and its components in order to meet the forecast demand in each period of a planning horizon. The production plan should minimize the sum of Production, setup & Inventory cost. In this paper, the different Lot Sizing Techniques like LFL, EOQ, LUC, LTC, PPB & POQ; which are used to see the effect of holding cost in total cost of Inventory problem. In this paper; we propose the best Techniques in the different situation of MRP system which attempts to find a feasible solution & minimize total cost.*

KEYWORDS: *Material Requirement Planning, Lot Sizing Techniques, Holding cost, Production Planning***.**

I. INTRODUCTION

Over the past two decades the development of productivity of manufacturers has come through the implementation of sophisticated planning and control system. While newer systems such as JIT management have contributed much to our ability effectively to plan and control our processes, it may be argued that the basic net change material requirement planning system. Since then the growth in popularity of MRP based manufacturing logistics has been phenomenal. An experimental factory environment was created on the computer to simulate the performance of lot size adjustment rules researched by previous researchers and modifications suggested for their implementations by the managers.

Material Requirement Planning is a technique for determining the quantity and timing for the acquisition of dependent demand items needed to satisfy master schedule requirements. A material requirements planning (MRP) system, narrowly defined, consists of a set of logically related procedures, decision rules, and records designed to translate a master production schedule into time-phased net requirements, and the planned coverage of such requirements, for each component inventory item needed to implement this schedule (Orlicky, 1975)[1].

Material Requirement Planning provides a framework for handling massive amount of data on the interrelationships between raw materials, components, sub-assemblies and end items. Its hallmark is deriving time phase requirement for components and sub-assemblies from the production plans and their parents. MRP is getting wide acceptance in industry, because in industry, there are several sub-assemblies of complex products, so it generates bill of materials, master production schedule, time phasing and all forecasting demands for all components, sub-components and assemblies through MRP system. Basically MRP is used for material procurement in any industry. MRP is commonly used in industry to determine production schedules in a multi stage manufacturing environment. Production requirements of an end item are translated into known production quantities, purchase quantities and timing of components, based on bill of materials and lead time information.

An MRP system is intended to simultaneously meet three objectives:

1. Ensure materials and products are available for production and delivery to customers.
2. Maintain the lowest possible level of inventory.
3. Plan manufacturing activities, delivery schedules and purchasing activities

1.1 MRP Overview

Before 1960 there was no satisfactory method available for handling the inventory of dependent demand items. A firm's formal inventory system was often patterned after order points and was either misapplied or broken down into a maze of informal methods when it comes to handling dependent demand items. There was no feasible method of keeping accurate records of thousands of inventory items that went into finished products, and so firms relied upon the safety stock of the order point model to keep them out of much scheduling trouble.

During 1960's the computer opened the door to an inventory system that could keep up-to-date records on status of all inventory in stock, this brought a better understanding of production operation and new ways of managing operation through MRP.

In 1970's Joseph Orlicky invented the technique of MRP (material requirement planning) which is a method of planning & controlling inventories in which projected inventory levels are computed from present inventories and from planned transactions affecting inventory levels. These Transactions includes with-drawls & addition of inventories. Such computations are made on the basis of requirement of finished products. Final product requirement for all lower order components can be translated in to purchase orders and shop orders.

1.2 Components of Material Requirement Planning (MRP)

While an MRP system is essentially concern with inventory planning a slight amount of reflection will indicate clearly that more inventories is involved. As such the timing of orders per component is an important aspect. The timing of output of finished products is inherent in all inventory decisions. Therefore the determination of scheduled release of orders for components and schedule of final production plan are concern of an MRP system.

The three principle inputs of MRP System are

1. Master production schedule
2. Bill of materials
3. Inventory record file

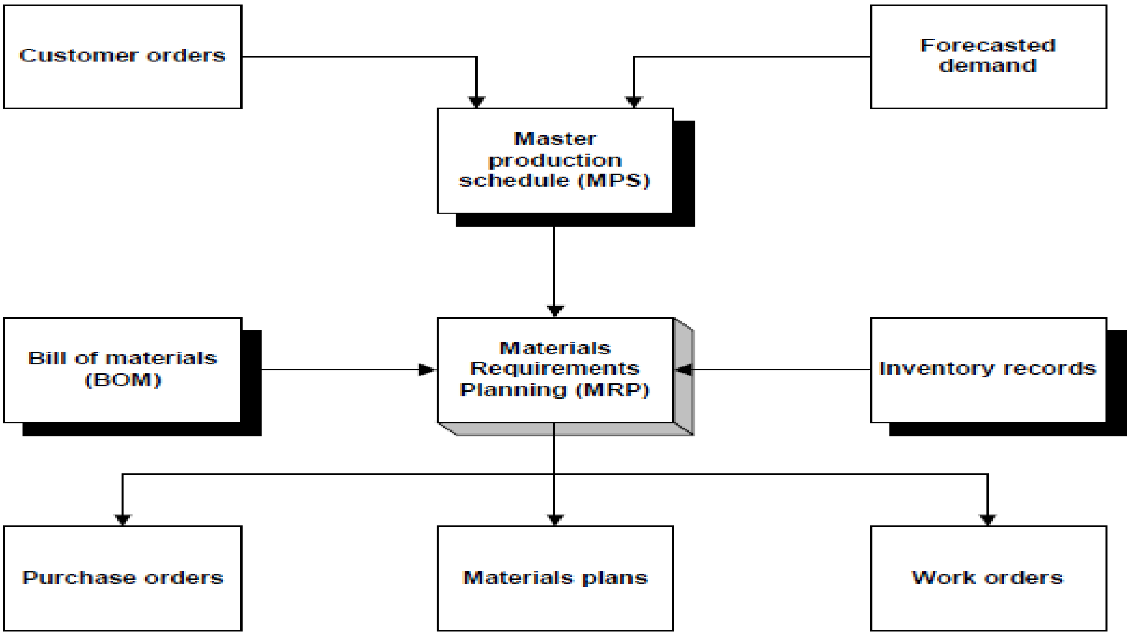

Figure. 1 Material requirement planning (Source: Slack et al. (2001) [2])

II. LITERATURE REVIEW

According to Zhao et al. (1995)[3] Investigation of Impact of Lot sizing rules selection on the selection of the master Production Schedule freezing parameters under probabilistic demand. They included various lot sizing rules. These rules are silver meal (SM) rule, part period balancing (PPB) rule, economic order quantity (EOQ) rule, the periodic order quantity (POQ) rule, and lot for lot (LFL) rule for the dependent components. The performance of lot sizing rules is significantly influenced by the forecasting model used, the cost structure and the product structure. The purpose of this study is to report the research results under deterministic demand and examine the interaction between lot sizing decisions and MPS freezing decisions under deterministic demand. The total study is based on (1) the impact of the lot sizing rules selection on the total cost and schedule instability of multilevel MRP system in a rolling time horizon under deterministic demand; and (2) the impact of lot sizing rule selection on the selection of MPS freezing parameters under deterministic demands.

Ho and Ireland (1998)[4] conducted a simulation experiment to examine the impact of forecasting errors on the scheduling instability in a MRP system. They found that forecasting errors might not cause a higher degree of scheduling instability, which can be mitigated by using an appropriate lot-sizing rule. They suggested that applying EOQ and lot-for-lot (LFL) creates a significantly more nervous MRP system than applying part-period balancing (PPB) and the Silver-

Meal (SM) approach. They also found that the selection of an appropriate lot-sizing rule can be effective in dealing with forecast errors when lead time tends to fluctuate.

The major issue in MRP deals with question: how to decide the order quantity? This is generally called the lot sizing decisions. The lot sizing issue has attracted a significant amount of research, for the incapacitated case, Harris (1915) develops a well- known EOQ demand assumption. Wagner & whitin (1958)[5] introduce a dynamic programming procedure to handle the time varying demand case. Silver & meal (1973)[7] propose a heuristic that seeks to minimize the average cost of carrying and holding. Other popular heuristics are lot for lot (LFL), period order quantity (POQ), Part period algorithm (PPA) (Demattais, 1968), Part period balancing (PPB), least unit cost (LUC), least total cost (LTC), and fixed order quantity (FOQ).

The most common techniques are LFL, FOQ, and FPQ & POQ. This is because the more realistic problems, such as the capacity constraint case have been shown to be NP-hard (Bahl, Ritzman & Gupta 1987)[8]. Hence, MRP system usually opts for simpler sub-optimal techniques.

III. PROBLEM FORMULATION AND OBJECTIVE

3.1 Problem Formulation

Due to detailed literature survey it can be found that MRP has faced several problems like finding the exact lot size with minimum cost, finding the exact time period for planned order release and planned order receipt, integrity of data, exploring the bill of material (BOM) file, finding a correct forecasting demand. Another major problem with MRP systems is the requirement that the user specify how long it will take a factory to make a product from its component parts. Additionally, the system design also assumes that this "lead time" in manufacturing will be the same each time the item is made, without regard to quantity being made, or other items being made simultaneously in the factory.

3.2 Objective of the Study

1. To solve a MRP problem by using a dummy problem.
2. To find out total cost by using different lot sizing techniques and compare these lot sizing technique for a specified dummy problem.

3.3Problem Statement 1

A company produces end item A. all information about end item A is summarized in following table.

Table 1 Master schedule for end item A

Week	1	2	3	4	5	6	7	8	9	10
Gross requirement	35	30	40	0	10	40	30	0	30	55

Table 2 Detail of problem

<table>
<tr><th rowspan="2">Intended BOM</th><th colspan="2">Lowest level codes (LLC)</th><th colspan="2">Inventory Records</th></tr>
<tr><th>Item</th><th>Code</th><th>On-hand</th><th>Lead Time</th></tr>
<tr><td rowspan="9">A
A1
1
a
2
A2
3
4(2)
1
a
b</td><td>A</td><td>0</td><td>35</td><td>1</td></tr>
<tr><td>A1</td><td>1</td><td>40</td><td>1</td></tr>
<tr><td>A2</td><td>1</td><td>15</td><td>2</td></tr>
<tr><td>1</td><td>3</td><td>10</td><td>3</td></tr>
<tr><td>2</td><td>2</td><td>20</td><td>4</td></tr>
<tr><td>3</td><td>2</td><td>15</td><td>1</td></tr>
<tr><td>4</td><td>2</td><td>30</td><td>2</td></tr>
<tr><td>a</td><td>4</td><td>10</td><td>3</td></tr>
<tr><td>b</td><td>3</td><td>10</td><td>3</td></tr>
</table>

IV. PROPOSED METHODOLOGY

4.1 Lot Sizing Techniques

There is various lot sizing techniques which are used for calculation of total cost of any problem, which are described below:

1. **Lot for Lot(LFL) method**
2. **Economic Order Quantity(EOQ) method**
3. **Part Period Balancing(PPB) method**
4. **Period Order Quantity(POQ) method**
5. **Least Unit Cost method**
6. **Least Total Cost method**

1. Lot for Lot (LFL) method

This technique is referred to as discrete ordering that is the simplest and most straight forward of all. It provides period by period coverage of net requirements and the planned order quantity always equals to quantity of net requirements being covered. These order quantities are to be computed whenever the respective net requirement changes. They use of this technique is minimizes inventory carrying cost and it often used for expensive purchase items or for items that have highly discontinuous demand. **(**Aquilano et.al, 1995)[9]

2. Economic Order Quantity (EOQ) method

The economic order quantity (EOQ) policy, although never intended for material requirement planning environment, is one of the most commonly used methods in MRP. EOQ is essentially an accounting formula that determines the point at which the combination of order costs and inventory carrying costs are the least. The result is the most cost effective quantity to order. EOQ formula has shown in equation 4.1. (Taylor et.al, 2007)[10]

EOQ= [2(Annual usage in units) (order cost)/ (annual carrying cost per unit)]$^{1/2}$ ….1.1

$Q = \sqrt{2ds/h}$……………….…………………………………..1.2

Where d= ordering cost, s= set up cost, h= inventory holding cost.

The EOQ model is simple, inexpensive and easy to use decision making tool for minimizing inventory costs. The EOQ is based on an assumption of continuous steady rate demand and it will perform well only where the actual demand approximates this assumption.

3. Part Period Balancing (PPB) method

This method uses the ratio of ordering and carrying cost to derive a part period member and use the number as a criterion to cumulative requirements.
Set the order horizon = the number of periods that most closely matches the total holding cost with the set up cost over that period

4. Period Order Quantity (POQ) method

The period-order-quantity (POQ) model was designed to avoid remnants and give lower costs with lumpy demand. Using the known future demand as represented by the net requirement schedule of a given inventory item, the EOQ is computed through the standard formula to determine the number of orders per year to be placed, the annual demand is divided by EOQ, and the number of planning period when divided by the given ordering interval.
Orders per year = Annual demand / EOQ
Ordering interval= 12/ Number of orders per year

5. Least Unit Cost method

Order the net requirements for the current period, or current plus next, or current plus next two, and so on depending upon which gives the lowest unit costs.

6. Least Total Cost method

It is a dynamic lot sizing method. It is used to calculate order quantity by comparing the carrying cost and setup costs for various lot sizes and then select the lot in which these are most nearly equal.

V. ANALYSIS OF DATA

5.1 Analysis of Lot Sizing Techniques

This analysis based on finding the lot size with minimum cost among the different lot size techniques such as lot-for-lot, EOQ, least unit cost (LUC), least total cost (LTC), periodic order quantity (POQ) and part period balancing (PPB) and for item A in given problem statement.

1. To calculate total cost by using different lot sizing techniques are described below
When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $2
Economic Order Quantity (EOQ) method

Calculation for Economic Order Quantity (EOQ) has given below:-

$$Q = \sqrt{2dCo/h} \quad \text{.......} 1.3$$

$$Q = \sqrt{2\,(27)\,(200)/2} = 74$$

EOQ: - 74

Table 3 MRP calculation using Economic Order Quantity (EOQ) method

Week		1	2	3	4	5	6	7	8	9	10
Gross requirement		35	30	40	0	10	40	30	0	30	55
On hand	35	0	44	4	4	68	28	72	72	42	61
Planned order receipt			74			74		74			74
Planned order release		74			74		74			74	

Ordering cost (Co) = $200, no. of separate setup weeks= 4, holding cost= 2/unit/wk,
Total on hand inventory= 395

Total cost= (ordering cost × no. of set- ups) + (total on hand inventory cost × holding cost)

Total cost = (200×4) + (395) ×2 = (800) + (790) = $1590

Comparison of various lot sizing methods:-

Table 4 Comparison of various lot sizing methods

Lot sizing methods	LFL	EOQ	POQ	PPB	LUC	LTC
Total cost	$1400	$1590	$980	$980	$990	$910

From above comparison of various lot size methods, it is clarify that minimum cost obtained by using least total cost (LTC) is $910.

Comparison of total cost by changing holding cost due to different lot sizing techniques

Table 5 Comparison of total cost by changing holding cost due to different lot sizing techniques

Holding cost	**Total cost**					
	LFL	**EOQ**	**POQ**	**PBB**	**LUC**	**LTC**
$2	$1400	$1590	$980	$980	$990	$910
$2.5	$1400	$1717.5	$1150	$1050	$1087.5	$987.5
$3	$1400	$1505	$1220	$1240	$1185	$1220
$3.5	$1400	$2102.5	$1290	$1270	$1272.5	$1272.5
$4	$1400	$1860	$1360	$1280	$1340	$1340
$4.5	$1400	$1742.5	$1430	$1400	$1407.5	$1407.5

5.1.1 Graphical Representation

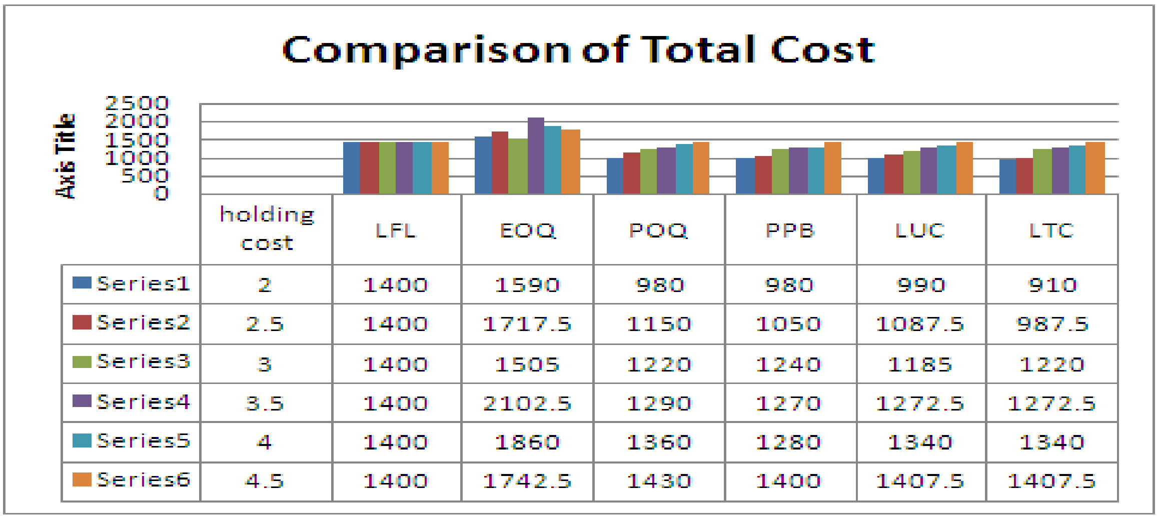

Figure . 2 Graph between holding cost and total cost by different lot sizing techniques

From figure, it has been seen that the graph between the holding cost and total cost by different lot sizing techniques are described above. Here we have easily compare the different lot sizing techniques.

VI. CONCLUSION OF THE STUDY

6.1 Conclusion of the Study

Holding cost	Total cost					
	LFL	**EOQ**	**POQ**	**PBB**	**LUC**	**LTC**
$2	$1400	$1590	$980	$980	$990	$910
$2.5	$1400	$1717.5	$1150	$1050	$1087.5	$987.5
$3	$1400	$1505	$1220	$1240	$1185	$1220
$3.5	$1400	$2102.5	$1290	$1270	$1272.5	$1272.5
$4	$1400	$1860	$1360	$1280	$1340	$1340
$4.5	$1400	$1742.5	$1430	$1400	$1407.5	$1407.5

1. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $2

We have compared 6 lot sizing techniques using a set of widely varying parameters. Each technique can be evaluated for a specific data set that most closely approximates reality by examining the detailed in table results. Each new formula claims better results than the others. Several articles prior to this one have proven that dynamic lot sizes give faculty logic and excessive nervousness to MRP calculations in the many environments. When this is true they should be discarded in favor of more stable and logical methods. In lot sizing rules, in generally LFL and EOQ rules were performed very poorly. The LTC, POQ and PPB rules were performed best in majority in the methods, it ranked first for LTC. The PPB and POQ lot sizing rules generally ranked in upper half of those evaluated. LUC rule was ranking of fourth position in evaluation procedure. The EOQ rule was the poor performance, since the EOQ rule represents the closest equivalent to a just in time lot sizing philosophy, this result poses some interesting questions. It suggests that just in time must result in other benefits yielding significant costs savings, but that these savings are likely to be negated by significantly higher inventory costs. The basic EOQ model and all other popular lot sizing models, treats setup cost as a constant. In practice, however many firms have managed to economically reduce setup costs and lot sizes. Reduced lot sizes means more frequent setup. Thereby moving more rapidly down the learning curve and improving the competitive position of the firm. Strategic decision making is usually oriented toward achieving long term objectives. These objectives generally refer to positioning the firm at some point or points in the future, and may also refer to performance over an extended period of time. Lot sizing can be used as a strategic weapon by intentionally reduction of setup costs. Time variant (dynamic) lot sizing techniques such as LTC and PPB were used by very few companies avoid these techniques because changes in top levels are transmitted down through lower stages, producing system nervousness, or exaggerated response as component levels to small changes at parent levels. At assembly and sub-assembly stages, the popular LFL technique helped maintain stability and minimized the amount material tried up.

2. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $2.5

In lot sizing rules, in generally EOQ rules were performed very poorly. The LTC rules were performed best in majority in the methods; it ranked first for LTC. PBB and LUC lot sizing rules generally ranked in upper half of those evaluated. POQ rule was ranking of fourth position in evaluation procedure. The EOQ rule was the poor performance, since the EOQ rule represents the closest equivalent to a just in time lot sizing philosophy, this result poses some interesting questions. It suggests that just in time must result in other benefits yielding significant costs savings, but that these savings are likely to be negated by significantly higher inventory costs.

3. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $3

In lot sizing rules, in generally EOQ rules were performed very poorly. The LUC rules were performed best in majority in the methods; it ranked first for LUC. POQ and LTC lot sizing rules generally ranked in upper half of those evaluated. PBB rule was ranking of fourth position in evaluation procedure. LFL rule was ranking of fifth position.

4. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $3.5

In lot sizing rules, in generally EOQ rules were performed very poorly. The PPB rules were performed best in majority in the methods; it ranked first for PPB. LUC and LTC lot sizing rules generally ranked in upper half of those evaluated. POQ rule was ranking of fourth position in evaluation procedure. The EOQ rule was the poor performance.

5. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $4

In lot sizing rules, in generally EOQ rules were performed very poorly. The LTC, LUC, POQ and PPB rules were performed best in majority in the methods; it ranked first for PPB. LUC and LTC are in second rank. Both methods have same cost when holding cost has increased with $2 to $4. The POQ lot sizing rules generally ranked in upper half of those evaluated. LFL method has also well because this has also less cost as compared to others. The EOQ rule was the poor performance, since the EOQ rule represents the closest equivalent to a just in time lot sizing philosophy, this result poses some interesting questions.

6. When Ordering cost= $200, no. of separate setup weeks= 7, holding cost= $4.5

In lot sizing rules, in generally EOQ rules were performed very poorly. The LFL and PPB rules were performed best in majority in the methods; it ranked first for LFL and PPB. LUC and LTC lot sizing rules generally ranked in upper half of those evaluated. POQ rule was ranking of fifth position in evaluation procedure. The EOQ rule was the poor performance, since the EOQ rule represents the closest equivalent to a just in time lot sizing philosophy, this result poses some interesting questions. It suggests that just in time must result in other benefits yielding significant costs savings, but that these savings are likely to be negated by significantly higher inventory costs.

It is clear from above when holding cost is $2, and then least total cost method is best, when holding cot has increased from $2 to $2.5, and then least total cost has best method and have lowest cost. When holding cost has increased from $2.5 to $3, then least unit cost has lowest cost and other method have also comparatively less cost. When holding cost has also increased $3 to $3.5, then part period balancing is the best method and when holding cost has increased $3.5 to $4, then part period balancing is the best method. When holding cost has increased $4 to $4.5, then lot for lot and part period balancing has lowest cost and best method. So lot sizing technique method are depends upon the demand fluctuation and type of industry.

REFERENCES

[1] Orlicky, J. “Material Requirements Planning: the new way of life in production and inventory management”, McGraw-Hill, New York, 1975.
[2] Slack, N., S. Chambers and R. Johnston “Operation Management”, Third Edition, Pearson Education Limited, 2001.
[3] Zhao Xiande and Lee T.S. “Freezing the master production schedule for material requirements planning systems under demand uncertainty”, Journal of Operations Management, Volume 11, pp. 185-205, 1995.
[4] Ho, C.J., and T.C. Ireland “Correlating MRP system nervousness with forecast errors”, International Journal of Production Research, Volume 36, Issue 8, pp. 2285-2299, 1998.
[5] Wagner, H.M., and Whitin, T.M. “Dynamic version of economic lot size model.” Management Science, Volume 5, Issue 1, pp. 89-96, 1958.
[6] Melnyk, S. A. and C.H. Piper “Lead-time errors in MRP: the lot-sizing effect”, International Journal of Production Research, Volume 23, pp. 253-264, 1985.
[7] Silver, E.A., and Meal, H.C. “A heuristic for selecting lot size quantities for the case of a deterministic time varying demand rate and discrete opportunities for replenishment”, Production and Inventory Management, Volume 14, Issue 2, pp. 64-77, 1973.
[8] Bahl, C. Harish and Ritzman, P. L. “An empirical investigation of different strategies for material requirement planning”, Journal of Operation Management, Volume 3, Issue 2, pp. 67-77, 1983.
[9] Chase, R.B., and N.J. Aquilano “Production and Operations Management”, Homewood, IL: Irwin, 1995.
[10] Russel & Taylor “Operation Management: Quality and Competitiveness in a Global Environment”, Fifth Edition, Willey India Edition, 2007.