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Multilevel inventory techniques for minimizing cost-a case study

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Abstract

The inventory problems of most of the manufacturing or trading organization are of great concern. The end item has independent demand and all its component and parts have dependent demand. These component and parts of end item are produced at different stages of production process. Thus, manufacturing of these dependent materials is done at multilevel. Depending upon the capacity of production, cost of setup and carrying inventories, the various parts and components are produced or procured at different level. MRP computes these requirements of material as per time schedule. In order to fulfill these demands of materials at multilevel situation, the production or procurement orders are released for economic batch or lot quantities. In the present paper, the order quantity or lot sizing is obtained by minimizing the cost of ordering plus the cost of carrying the item in stock certainly. Apart from that some constraint such as the availability of space and storing the inventory of these multiple items need to be taken into account.

Keywords: Inventory management, MRP, LOT for LOT, carrying costs, changeover costs.

Introduction

Manufacturing inventories consist of raw material and finished components, subassemblies and finished component in stock and in process. In order to establish these manufacturing inventories providing accurate information about the requirement of material, time at which it is required, quantity of material on hand i.e. inventory and work in process and quantity of requirement to be ordered of manufacturing. The computer is used to calculate, share and provide this information. This method of inventory management is called material requirement planning (MRP) (Enss, 2002; Ashayeri *et al*., 2006; Grubbstrom, 2006; Jose *et al*., 2007).

The MRP system is a practical inventory control method development around 1960 to handle large amount of record keeping, material requirement data, inventory status of material and their cost, interlinking the production with procurement of materials, controlling the stock and deliveries. It controls the manufacturing resources and flow of material much more efficiently and accurately. In MRP system lot sizing is required for fulfilling end product demand which is independent. The demand for subassemblies, component parts and raw material stock is derived from planned production level of end products and is dependent on end item demand. Such a multilevel production/inventory situation involves production and procurement of various materials as per bill of material of various final products according to master production schedule. The level O represents the end product and its demand is fixed by customer order and forecasted as per market needs. The single level lot sizing technique would be applied to level-1 .The level O is fixed and level 1 is controlled by some lot sizing rule. The multilevel lot sizing problem is to determine the production of lower level items (level 2, 3 etc.) economically. For deciding this economic policy at more than one level, production selection of lot sizing rule is complicated and decision based on economic criteria alone may be misleading. Lot sizing in MRP system is to calculate the order quantity for production of net unfilled requirements of an item at each level of manufacturing. The order quantity must be such that it will minimize the cost of setup or ordering and cost of carrying the item in stock (Khare & Sadiwala, 1987; Enns, 1999; Enns, 2001; Tang, 2004; Choi & Enns, 2004;

Table 1. Indicated different level for the manufacturing of cc LMV

Level O	LMV				
Level 1	Engine assembly		Tank	Wheel assembly	Frame
Level 2	Motor	Carburetor	-	Hub assembly	Tire

Table 2. Bill of material

Parent Code	Component code	Level code	Description	Component required
	800	O	800 cc LMV	1
800	EA	1	Engine assembly	1
	GT	1	Tank	2
	WA	1	Wheel assembly	1
	F	1	Frame	1
EA	M	2	Motor	1
	C	2	Carburetor	2
WA	HA	2	Hub assembly	1
	T	2	Tire	1

Table 3. Inventory status

Item code	On hand	Safety stock	Lot size	Lead time	Schedule receipt	
					Qty	Weeks
800	500	200	LFL	1	-	-
EA	300	100	500	1	1000	10
GT	600	200	LFL	2	900	10
WA	500	400	500	1	2000	10
F	600	0	2000	3	2000	10
M	800	0	LFL	1	-	-
C	150	100	2000	2	-	-
HA	100	0	LFL	1	2400	11
T	500	500	1000	3	3000,2000	11,12

Table 4. Master production schedule: #800 LMV

Week	10	11	12	13	14	15	16
Qty	0	1000	0	1300	800	1200	1400

Table 5: MRP schedule for #800 LMV.

Item 800cc LMV LT1 lot size: LFL SS:200	Weeks						
	10	11	12	13	14	15	16
Gross requirement	0	1000	0	1300	800	1200	1400
Schedule receipts	-	-	-	-	-	-	-
Available (On hand=500)	300	300	0	0	0	0	0
Net requirements	-	1000	0	1300	800	1200	1400
Planned order receipts	-	1000	0	1300	800	1200	1400
Planned order releases	1000	-	1300	800	1200	1400	-

Table 6 MRP schedule for tanks (start prod on 1000 LMV wk 10 so they will be complete by wk 11)

Item 800cc LMV LT 2 lot size: LFL SS:200	Weeks						
	10	11	12	13	14	15	16
Gross requirement	1000	0	1300	800	1200	1400	0
Schedule receipts	900	-	-	-	-	-	-
Available (On hand=600)	1300	300	300	0	0	0	0
Net requirements	-	-	1000	800	1200	1400	-
Planned order receipts	-	-	1000	800	1200	1400	-
Planned order releases	1000	800	1200	1400	-	-	-

Table 7. MRP schedule for engine frames

Item 800cc LMV LT 3 lot size: 2000 SS:0	Weeks						
	10	11	12	13	14	15	16
Gross requirement	1000	0	1300	800	1200	1400	0
Schedule receipts	2000	-	-	-	-	-	-
Available (On hand=600)	2600	1600	1600	300	1500	300	900
Net requirements	0	0	0	500	0	1100	0
Planned order receipts	-	-	-	2000	0	2000	-
Planned order releases	2000	-	2000	-	-	-	-

Table 8. MRP schedule for engine assemblies

Item 800cc LMV LT 1 Lot Size: 500 SS:100	Weeks						
	10	11	12	13	14	15	16
Gross requirement	1000	0	1300	800	1200	1400	0
Schedule receipts	1000	-	-	-	-	-	-
Available (On hand=300)	1300	200	200	400	100	400	0
Net requirements	-	-	1100	400	1100	1000	0
Planned order receipts	-	-	1500	500	1500	1000	-
Planned order releases	-	1500	500	1500	1000	-	-

Bretthauer *et al.,* 2005).

Analysis of case study

The case study details on light motor vehicle (LMV) manufacturing requirements for 800 cc Model are listed in Table 1, 2 & 3. The company is currently planning production for weeks 10 to 16. Based on existing orders and demand forecasts, the master production schedule is provided in Table 4.

The case study includes the determination of the MRP schedule required to support the master production schedule for the Model 800 LMV in weeks 10-16 (Table 5).

MRP schedule for #800 cc LMV for Weeks 10-16, considering that:

1. Gross Requirements come from the LMV MPS
2. There is an on-hand balance of 500 LMV at the end of week 9
3. There are no scheduled receipts for LMV
4. A lot-for-lot rule is used for ordering LMV
5. Safety stock of 200 LMV is desired
6. Lead time for LMV is one week

MRP schedule for tanks for weeks 10-16, considering that (Table 6):

1. Gross requirements come from LMV planned-order-releases
2. There is an on-hand balance of 600 tanks at the end of week 9
3. There is a scheduled receipt for 900 tanks in week
4. A lot-for-lot rule is used for ordering tanks
5. Safety stock of 200 tanks is desired
6. Lead time for tanks is two weeks

MRP Schedule for frames for weeks 10-16, considering that (Table 7):

1. Gross requirements come from LMV planned-order-releases
2. There is an on-hand balance of 600 frames at the end of week 9
3. There is a scheduled receipt for 2000 frames in week 10
4. The firm uses a lot size (multiple) of 2000 for ordering frames
5. No safety stock of frames is desired
6. Lead time for frames is 3 weeks.

MRP schedule for engine assemblies for weeks 10-16, considering that (Table 8)*:*

1. Gross requirements come from LMV planned-order-releases
2. There is an on-hand balance of 300 engine assemblies at the end of week 9
3. There is a scheduled receipt for 1000 engine assemblies in week 10
4. The firm uses a lot size (multiple) of 500 for ordering engine assemblies
5. Safety stock of 100 engine assemblies is desired
6. Lead time for engine assemblies is 1 week.

A Large number of economic lot sizing methods are available to management, any one or combination of which may be incorporate in an inventory control system. Consider economic order quantity (EOQ), lot-for-lot (LFL) and period order quantity (POQ) all these methods detailed and compared in MRP schedule for minimizing total cost (Table 9).

Table 9. The net requirements for a material from an MRP schedule are

	Week							
Net	1	2	3	4	5	6	7	8
requirement	1000	0	1300	800	1200	1300	0	800

Table 10. Lot-for-Lot method

	Week							
Net	1	2	3	4	5	6	7	8
requirement	1000	0	1300	800	1200	1300	0	800
Beginning inventory	0	0	0	0	0	0	0	0
Production lots	1000	0	1300	800	1200	1300	0	800
Ending inventory	0	0	0	0	0	0	0	0

Table 11. Economic order quantity (EOQ) method

Economic order quantity (EOQ) method	Week							
	1	2	3	4	5	6	7	8
Net requirement	1000	0	1300	800	1200	1300	0	800
Beginning inventory	0	265	265	230	695	0	0	0
Production lots	1265	0	1265	1265	1265	1265	0	1265
Ending inventory	265	265	230	695	760	725	725	1190

Table 12. Period order quantity (POQ) method

	Week							
Net	1	2	3	4	5	6	7	8
requirement	1000	0	1300	800	1200	1300	0	800
Beginning inventory	0	0	0	800	0	1300	0	800
Production lots	1000	0	2100	0	8000	0	800	0
Ending inventory	0	0	800	0	1300	0	800	0

It costs Rs. 400 to change over the machines for this material in the affected work center. It costs 0.40 per unit when one unit of this material must be carried in inventory from one week to the next. Identify the lot-sizing method that results in the least carrying and changeover costs for the 8-week schedule (Table 10).

Carrying Cost = 0(.40) = 0
Changeover Cost = 6(400) = 2,400
Total = 2,400

Economic order quantity (EOQ) method (Table 11)
S = 400.00
D = [(Net Req. for 8 wks)/8 weeks)] (50 weeks/year) = (6400/8) (50) = 40,000
C = (0.40 per week) (50 weeks/year) = 20.00

$$EOQ = \sqrt{2DS/C} = 1265$$

Carrying cost = 4855(.40) = 1,942
Change over cost = 6(400) = 2,400
Total = 4,342

Period order quantity (POQ) method (Table 12):
POQ = (# weeks/year)/ (# orders/year) = 50/ (D/EOQ) = 50/ (40,000/1,265) = 1.58 or 2 weeks Carrying cost = 2900(0.40) = 1,160
Changeover Cost = 4(400) = 1,600
Total = 2,760

Table 13. Cost comparison

Method	Carrying cost	Change over cost	Total cost
LFL	0	2400	2400
EOQ	1942	2400	4342
POQ	1160	1600	2760

Conclusion

We presented results which lead to the determination of the optimal inventory policy and the minimum total cost. Product structure can be any type; each item in the system can have external demands and the cost parameter (carrying cost & changeover cost). In addition, the proposed precise model can help inventory decision maker to obtain solution closer to global optimum. The promising result motivates the need for further research on the inventory problem with LOT for LOT method. Table 13 shows the cost comparison and it is found that in case for LOT for LOT the cost in minimum.

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