Development of Material Requirement Planning in Small Scale Industry:A Case Study

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Abstract-*Materials requirement planning (MRP) is a method to determine what, when, and how much component and material are required to satisfy a production plan of end products over time. An MRP system is a widely used method for production planning and scheduling. It module allows for more efficient and effective use of resources. A MRP system requires a great deal of information and processes in order to perform its complete logic. The aim of this thesis is to propose an inventory management system based on the material requirements planning, the system helps in encouraging the procedure of inventory management and ensures the availability of materials for production, and make sure inventory is on the same line with demand. The software system for the same is made by using WINQSB, necessary calculation for the system to function are done by using it, such as the required quantities for the items of the product, and the dates of orders. The company make 2 types of Hand Wash, Pine Lavender and Lime Lemon, and each comes in 3 sizes 100ml, 250ml and 500ml. Material Requirements Planning system software is designed to fit the plant requirements, the results obtained by the system are the dates of deliveries, the quantities of each item needed for production, the dates of orders and the quantity required for inventory. The system facilitates the process of managing the inventory necessary for production.*

Keywords-MRP, Item Master, Bill of Material, Inventory Schedule

I. INTRODUCTION

Material requirement planning (MRP) is a method or process to decide what, when, as well as how much component and material are required to satisfy a production plan of end products over time. MRP system is a prominent approach to manage the material flow and components on the factory floor. MRP technique is used to explode bills of material, to calculate net material requirements and for production planning. The master production schedule and bill of materials indicates the materials to be demanded, order scheduling, cycle time production and supplier lead times then these all factors jointly determine when orders should be placed. It is a time phased priority-planning technique that calculates material requirements and schedules supply to meet demand across all products and parts in one or more plants and used to optimize the inventory. It controls the system that attempts to keep adequate inventory levels to assure that required materials are available when needed.

An MRP system requires with a great deal of data, information and processes in order to perform its complete logic. The development of the economy and of the trade-markets has framed new conditions in the market place which are characterized by uncertainty and exhaustive competition in the business market.

Without the basic inputs the MRP system cannot function. The demand for end items is scheduled over a number of time periods and recorded on a master production schedule (MPS). The three major inputs of an MRP system are:

a) Master Production Schedule: The master production schedule expresses how much of each item is needed and when it is needed. The MPS is developed from forecasts and firm customer orders for end items, safety stock requirements, and internal orders. MRP takes the master schedule for end items and translates it into individual time-phased component requirements.
b) Product Structure Records: The product structure records, also known as bill of material records (BOM), contain information on every item or assembly required to produce end items. Information on each item, such as part number, description, quantity per assembly, next higher assembly, lead times, and quantity per end item, must be available.
c) Inventory Status Records: The inventory status records contain the status of all items in inventory, including on hand inventory and scheduled receipts. These records must be kept up to date, with each receipt, disbursement, or withdrawal documented to maintain record integrity.
d) The major objective of an MRP system is to simultaneously:
e) Ensure the availability of materials, components, and products for planned production and for customer delivery,
f) Maintain the lowest possible level of inventory,
g) Plan manufacturing activities, delivery schedules, and purchasing activities.

II. LITERATURE SURVEY

Whybark and Williams, (1976) considered material requirement planning problem under uncertainty in 1976. They developed a model to show the way in which MRP systems reveal preference for using either safety stock or safety time, depending on the category of uncertainty to be buffered. According to simulation experiments, when exists timing uncertainty the concept of safety time instead of safety stock is preferable. When quantity uncertainty is involved, higher service levels are achieved by the use of safety stocks. [4]Melnyk and Piper, (1985) investigated the effect of different lot sizing rules on lead-time error. They examined the interaction between lot sizing rules and lead-time estimation methods. They believed that lot size and lead-time are two inter dependent functions. They found that PLT (planned lead time) inflation influences lot size effectiveness and vice-versa. [5]

Lee and Adam (1986) conducted a simulation study to examine two dimensions of forecast error standard deviation and bias. They found that standard deviation is relatively less important in terms of the magnitude of the total cost impact, which includes inventory carrying cost, setup cost and end item shortage cost. Their results suggest that higher forecast error level may not result in higher total cost, which seems to contradict what we intuitively believe. [7]

Mohan and Ritzman (1998) investigated the impact of planned lead-time on MRP system performances. They used four different levels of planned lead-time. At each level, they used different magnitudes of inflation. They concluded that planned lead-time does affect customer service, but it has a lesser effect on WIP than that of lot size. They did not consider the interdependent nature of both lot size and planned lead-time. [8]

Guide and Srivastava (2000) reviewed different buffering techniques used for tackling the uncertainty in MRP systems. Their study report indicates that only a few research efforts have been made in the area of lead-time uncertainty in MRP systems. Most of the research has tackled lead-time uncertainty using the safety lead-time factor and they have all used independent approach for estimating lot-size and planned lead-time. [9]

III. METHODOLOGY

- *Data Collection*

To develop the MRP system, research work was conducted in the industry for 6 weeks. During the work period, related data is collect to justify the result of the developed system. Different factors were observed for Item Master, Bill of material, master production schedule, lead time and inventory. Data collected is fed into WINQSB. In this study, analysis is done on only one hand wash i.e. lavender hand wash.

1. *Item Master:* Item Master contains primary information for each product of part item in MRP system. The item detail file contains details of both products and raw materials.Fig 1 shows data of Item Master for the Lavender hand wash.

No	Item ID	ABC Class	Source Code	Material Type	Unit Measure	Lead Time	Lot Size	LS Multiplier	Scrap %	Annual Demand	Unit Cost	Setup Cost	Holding Annual Cost	Shortage Annual Cost
1	BOTTLE100	B	RCASE	FINISED	Each	3	LFL							M
2	BOTTLE250	B	RCASE	FINISED	Each	3	LFL							M
3	BOTTLE500	B	RCASE	FINISED	Each	3	LFL							M
4	BASE HAND	A	RCASE	RAW	LITRE	2	LFL							M
5	LAVENDER	A	RCASE	RAW	LITRE	4	LFL							M
6	FLIP CAP	C	RCASE	PART	Each	3	LFL							M
7	SCREW CAP	C	RCASE	PART	Each	3	LFL							M
8	LABLE	C	RCASE	NISHED	Each	1	LFL							M

Fig 1 Item master

2. *Bill of Material:* Bill of Material (BOM) gives information about the product structure i.e. part and raw material unit necessary to manufacture on unit of the product of interest. Fig 2 shows the Bill of Material for the Lavender hand wash.

Item ID	Component ID/Usage	Component ID/Usage	Component ID/Usage	Component ID/Usage	Component ID/Usage
BOTTLE100	BASE HAND	LAVENDER	FLIP CAP	SCREW CAP	LABLE
BOTTLE250	BASE HAND	LAVENDER	FLIP CAP	SCREW CAP	LABLE
BOTTLE500	BASE HAND	LAVENDER	FLIP CAP	SCREW CAP	LABLE
BASE HAND					
LAVENDER					
FLIP CAP					
SCREW CAP					
LABLE					

Fig 2 Bill of Material

3. *Master Production Schedule*: Fig 3 shows the purchase requirement of the end products or independent demand parts items. Fig shows the components that are on order from the suppliers, and the date they are due to be delivered.

Item ID	Overdue Requirement	WEEK 1 Requirement	WEEK 2 Requirement	WEEK 3 Requirement	WEEK 4 Requirement	WEEK 5 Requirement	WEEK 6 Requirement
BOTTLE100		2000		1800			18
BOTTLE250				1500		1500	
BOTTLE500		1200		1100	1300	1200	
BASE HAND							
LAVENDER							
FLIP CAP							
SCREW CAP							
LABLE							

Fig 3: Master Production Schedule

4. *Inventory Schedule:* Inventory schedule contains the inventory related information for each product or part item in an MRP system.

Item ID	Safety Stock	On Hand Inventory	Overdue Planned Receipt	WEEK 1 Planned Receipt	WEEK 2 Planned Receipt	WEEK 3 Planned Receipt	WEEK 4 Planned Receipt	WEEK 5 Planned Receipt	WEEK 6 Planned Receipt
BOTTLE100		800		250	300	250			250
BOTTLE250		400			350	250			300
BOTTLE500		300		250		250			
BASE HAND		2000							
LAVENDER		500							
FLIP CAP		1000							
SCREW CAP		1000							
LABLE		2000							

Fig 4: Inventory schedule

IV. RESULT

All the data is fed into WINQSB software and the following results are analyzed. The finished product inventory and forecast is used to calculate finished product inventory cover.

Fig 4 shows the result of BOM generated by WINQSB.

06-24-2017	Item ID	Component ID	Usage	Item Description
1	BOTTLE100		1	
2		BASE HAND WASH	1	
3		LAVENDER ESSENCE	1	
4		FLIP CAP	1	
5		SCREW CAP	1	
6		LABLE	1	
7	BOTTLE250		1	
8		BASE HAND WASH	1	
9		LAVENDER ESSENCE	1	
10		FLIP CAP	1	
11		SCREW CAP	1	
12		LABLE	1	
13	BOTTLE500		1	
14		BASE HAND WASH	1	
15		LAVENDER ESSENCE	1	
16		FLIP CAP	1	
17		SCREW CAP	1	
18		LABLE	1	
19	BASE HAND WASH		1	
20	LAVENDER ESSENCE		1	
21	FLIP CAP		1	
22	SCREW CAP		1	
23	LABLE		1	

Fig 4 BOM result by WINQSB

06-24-2017	Item ID	Overdue	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	Total
1	BOTTLE100	2,200	0	0	1,550	0	0	0	3,750
2	BOTTLE250	500	0	1,500	0	0	0	0	2,000
3	BOTTLE500	1,500	1,300	1,200	0	0	0	0	4,000
4	BASE HAND WASH	6,200	1,550	0	0	0	0	0	7,750
5	LAVENDER ESSENCE	9,250	0	0	0	0	0	0	9,250
6	FLIP CAP	8,750	0	0	0	0	0	0	8,750
7	SCREW CAP	8,750	0	0	0	0	0	0	8,750
8	LABLE	3,500	2,700	1,550	0	0	0	0	7,750

Fig 5 Planned Order Release

Following are the product structure for all the three items i.e. 100 ml lavender hand wash, 250 ml lavender hand wash and 500ml lavender hand wash.

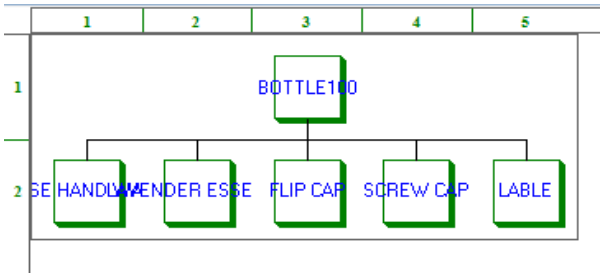

Fig 6: Product Structure for 100 ml hand wash

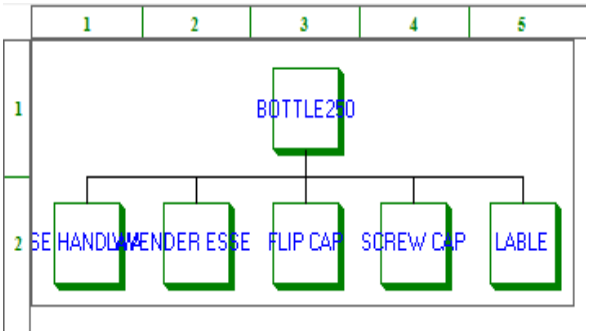

Fig 7: Product Structure for 250 ml hand wash

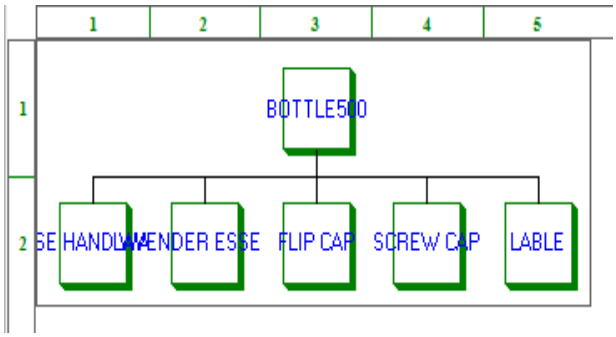

Fig 8: Product Structure for 500 ml hand wash

Fig 9 show the generated MRP result for the lavender hand wash for all the three quantity

06-24-2017	Overdue	WEEK 1	WEEK 2	WEEK 3	WEEK 4	WEEK 5	WEEK 6	Total
Item: BOTTLE100		LT = 3	SS = 0	LS = LFL	UM = Each	ABC = B	Source = PURCASE	Type = FINISED PRODUCT
Gross Requirement	0	2,000	0	1,800	0	0	1,800	5,600
Scheduled Receipt	0	250	300	250	0	0	250	1,050
Projected On Hand	800	0	300	0	0	0	0	
Projected Net Requirement	0	950	0	1,250	0	0	1,550	3,750
Planned Order Receipt	0	950	0	1,250	0	0	1,550	3,750
Planned Order Release	2,200	0	0	1,550	0	0	0	3,750
Item: BOTTLE250		LT = 3	SS = 0	LS = LFL	UM = Each	ABC = B	Source = PURCASE	Type = FINISED PRODUCT
Gross Requirement	0	0	0	1,500	0	1,500	0	3,000
Scheduled Receipt	0	0	350	250	0	0	300	900
Projected On Hand	400	400	750	0	0	0	300	
Projected Net Requirement	0	0	0	500	0	1,500	0	2,000
Planned Order Receipt	0	0	0	500	0	1,500	0	2,000
Planned Order Release	500	0	1,500	0	0	0	0	2,000
Item: BOTTLE500		LT = 3	SS = 0	LS = LFL	UM = Each	ABC = B	Source = PURCASE	Type = FINISED PRODUCT
Gross Requirement	0	1,200	0	1,100	1,300	1,200	0	4,800
Scheduled Receipt	0	250	0	250	0	0	0	500
Projected On Hand	300	0	0	0	0	0	0	
Projected Net Requirement	0	650	0	850	1,300	1,200	0	4,000
Planned Order Receipt	0	650	0	850	1,300	1,200	0	4,000
Planned Order Release	1,500	1,300	1,200	0	0	0	0	4,000
Item: BASE HAND WASH		LT = 2	SS = 0	LS = LFL	UM = LITRE	ABC = A	Source = PURCASE	Type = RAW MATERIAL
Gross Requirement	4,200	1,300	2,700	1,550	0	0	0	9,750
Scheduled Receipt	0	0	0	0	0	0	0	0
Projected On Hand	0	0	0	0	0	0	0	
Projected Net Requirement	2,200	1,300	2,700	1,550	0	0	0	7,750
Planned Order Receipt	2,200	1,300	2,700	1,550	0	0	0	7,750
Planned Order Release	6,200	1,550	0	0	0	0	0	7,750
Item: LAVENDER ESSENCE		LT = 4	SS = 0	LS = LFL	UM = LITRE	ABC = A	Source = PURCASE	Type = RAW MATERIAL
Gross Requirement	4,200	1,300	2,700	1,550	0	0	0	9,750
Scheduled Receipt	0	0	0	0	0	0	0	0

Fig 9: Material Requirement Planning result

V. CONCLUSION & FUTURE WORK

The advancement in technology had lead to the industrial revolution and higher level competition for survival. The industry may be out of the competition and loss the value in the market if they do not secure the level of standard to be as a competitor. Now a days Materials requirement planning is a widely accepted approach for production planning and scheduling. MRP module helps a lot for more efficient and effective use of available resources. This thesis work take into consideration that raw materials used by more than one product, and ration the inventory across the products so as to even out the product inventory cover as much as possible.
Following conclusions are drawn from this thesis work:

i. Successfull development of MRP system will help the management to have better control over the items in the inventory.
ii. The stock of items, contributing maximum to capital investment in the inventory can be kept as low as possible.
iii. The various reports such as Item Master, BOM, Inventory schedule, Product Structure will show the necessary information regarding the status of items which will help in decision making regarding certain parameters.
iv. Inventory Schedule helps to procure materials, which helps to satisfy the customers need by delivering product in right time.
v. By forecasting the demand pattern and developing MRP table, company can plan when to buy, how many to buy, and what to buy to ensure that all the bought items is useful and not to make the storage area narrow.
vi. These results into lower storage cost and adds to company profit.

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