A Contribution in Materials Requirement Planning Techniques

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ABSTRACT

Materials requirement planning (MRP) is a widely used method for production planning and scheduling. MRP module allows for more efficient and effective use of resources.

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. A MRP system requires a great deal of information and processes in order to perform its complete logic.

Planning the menu and calculating the number of servers is equivalent to creating an authorized Master Production Schedule (MPS), while reviewing the recipes to assemble the raw materials is equivalent to checking The Bill of Material (BOM) file for the needed materials, so that MRP checks the inventory records for the materials on hand and those purchasing needs to procure.

In this paper, a computerized operations research techniques was used to model the required factors to optimize the use of MRP problems using a general computer programs named (WINQSB). Inventory control lot sizing was used and modified in such a way that it minimizes the combination of setup cost, holding cost and work-in-process cost. This proposed approach embeds an optimization routine.

Introduction

Materials Requirements Planning (MRP) [1], is a

computerized inventory control & production planning system. It is an information system that uses concept of backward scheduling. MRP is a production control program that improves the production efficiency and service supplied to the customer. It arranges the material needs for the related terms with the production planning made for product inventory information and Bill of Material (BOM) information.

MRP logic [2] is pervasive in manufacturing planning systems for batch production environments. 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 requires a great deal of information and processes in order to perform its complete logic.

There [3] is currently a lack of good prescriptive methods for setting various tactical parameters, such as lot sizes and planned lead times. It is well recognized that these can have a very significant effect on performance. The study of work flow in production systems is often undertaken using discrete-event simulation.

Simulation [3, 4] is especially appropriate where the production environment is stochastic, exhibits non-stationary loading patterns, and relies on complex planning and control systems. These characteristics apply to typical batch production systems using MRP. In particular, the need to model both material and information flow makes the use of simulation attractive and perhaps necessary. Simulation is an experimental approach that can provide little direct guidance as to appropriate settings for MRP tactical parameters. Although extensive experimentation is possible to find good combinations of settings in a very small system, this is not feasible for real world systems. A better

alternative is to discover analytical relationships that provide insight and guidance.

The product [1, 3] due dates are critical to the MRP system since they set the completion dates used to backward schedule production. Not all parts [5, 6] and materials have to be available at the start of production, but they must be available at the stage of production that they are needed. The MRP system checks the BOM file to determine the materials needed, how much, and when.

An overview, Features and Objectives of MRP

Material Requirements Planning (MRP) was developed [1, 2, 7] in the USA in the 1960s. In 1972 the American Production and Inventory Control Society, APICS, launched a high profile MRP education and promotional program called the "MRP crusade". At this time MRP was viewed merely as an order launching system. Two subsequent stages were recorded in the development of MRP [8]. The first came with the realization that in order for the Master Production Schedule to be realistic and maintained, the MRP system should receive feedback from the other operational systems such as capacity planning, shop floor control and purchasing, and this concept was known as Closed Loop MRP (it was first practiced about 1969. Wight [9] proposed an ABCD classification of MRP II implementations, which has become widely used. A "D" class implementation is one in which MRP ideas are only influential in the computer department, whereas an "A" class site will be running the business via MRP II with the MPS being a true forecast of the business's intentions. Today, MRP II is generally implemented using proprietary integrated manufacturing software packages, most frequently on mid-range computers or networked PCs.

A number of studies have provided foundations for exploratory work with MRP systems. Johnson and Silver [10] demonstrated that inventory in queue is an important component of costs in capacity-constrained systems, a fact that most discussions on MRP lot sizing tend to ignore. Authorized master production schedule.

The features of MRP aims to Provide the study team with suitable information to indicate what is required in manufacturing or purchasing in addition to indicate the start and completion dates[6, 11, 2].

The main objective of MRP is to determine the quantity and timing of material requirements [1, 5, 9]. MRP used to determine what to order, how much to order, when to place the order, and when to schedule delivery. It [1, 11, 12] can be used to keep priorities updated and valid, requirements change, customers change order quantities, timing, suppliers deliver late and equipment breaks down.

Production Technology Optimization

The idea [1, 3, 5] of using such technology for production scheduling came from the British parent company. The greatest technical weakness of MRP [13] is that it takes no account of the finiteness of shop floor capacity.

During this time there must have been many systems developed [6] by individuals, mostly for individual companies. There are a number of computerized [15, 16, 17] planning techniques that have been developed to tackle the manufacturing operations management's problem which grouped under the Computer Aided Production management, CAPM. Examples are Manufacturing Resource Planning, MRP II Optimized

Production Technology (OPT), and Finite Capacity Scheduling or Schedule Based MRP.

The objective of MRPII is to make the original plan to meet customer demand happen. This technology allows to test the planned production before it actually happens and then to monitor the actual production against the plan, while Enterprise resource planning (ERP) [4, 5, 18] systems provide a central database for all internal and external members of the supply chain. It allows external customers or suppliers to access in the information system.

Artificial Intelligence, Operations Research and MRP

Artificial Intelligence (AI)[19] is a one of the computer science fields that recognizing information researching the cause-reason relationship, recognizing and development of some comprehension techniques, with a large number of experiments by using computer. It helps [20] to solve problems and provides the operations uses Computer and Intelligence to be more productive and work at optimum.

AI techniques can be applied in the case [21] of being late or finishing early of lead-times in MRP. MRP [22] is a planning process and AI techniques can be used to estimate the process of how to be made. To support the MRP system with Decision - Support systems; Expert systems and Neural Networks techniques was used to provide alternative solutions.

Operations Research (0R) [23, 24] is a scientific approach used for analyzing the structure of the system, solving various

problems occurring in the system, then for making reasonable and desirable decisions. It concerned with optimal decision making in, and modeling of, deterministic and probabilistic systems that originate from real life.

Manufacture Resource planning is a method of simulating reality as close as possible so that the problems associated with the execution of a future plan can be identified and resolved before the time is reached when the plan must be executed. The method encompasses MRP and determines the capacity requirements of the plan by calculation of the time required in work centers, for machining, finishing, subcontract, and inspection labor for each stage of the manufacturing process. Feeding back the problems that would occur if the plan were executed to the planners closes the loop.   To balance the customer demand and production plan, linear programming approach was used to provide an efficient optimum solution [20, 21].

WINQSB Program

WINQSB [25] (Windows application of Quantitative System for Business) is a program that represents an available modified OR computerized software to evaluate and solve the most OR and related problems. Such software building suitable model for each entered related problem. The program builds and develops a model according to the available entered data to reflect the main problem requirements. MRP is one program of such software. It performs material requirements planning and conducts related

analyses for multi-level discrete product and part items. Specific capabilities of this program include :

- Perform full MRP function with inputs including item master, bill of material (BOM), inventory records, and master production schedule (MPS)
- Fully explode the MPS requirements to obtain net requirements, planned orders, and projected inventory for materials and component items .
- Display indented, single-level, and where-used BOM .
- Display graphic product structure .
- Display MRP report in part item, ABC class, sourcing type, or material type .
- Display capacity analysis .
- Display cost analysis .
- Enter problem in spreadsheet format .

Inventory control

     Inventory [24, 26, and 27] is a key component in the logistical behavior of essentially all manufacturing systems. The classical inventory results are core to modern techniques of manufacturing management such as MRP, just-in-time, and time-based competition. Inventory consists of goods and materials used in the production and distribution process such as raw materials, component parts, subassemblies, and finished goods, as well as the various products and supplies required in the production and distribution process.

MRP Inputs

A MRP [22, 25] system requires a great deal of information and processes in order to perform its complete logic. There are three key inputs to the MRP system :

Master production schedule (MPS) file, Bills of materials (BOM) file and Inventory records.

The MPS specifies what end product is to be produced, when it is to be produced, and in what quantity. The sources for updating MPS may be from sales orders, service orders, or sales forecasts. The BOM describes how an end product is made from raw materials, parts, or purchased components. BOM can be shown in multiple-level or single -level format, or in graphic product structure. In multiple-level BOM, the end product is considered as level 0 and its direct components are considered as level 1, and so on. The engineering department is responsible for updating the BOM. The inventory records contain information such as safety stock, on-hand quantities, and scheduled order receipts for each item.

Besides the above three input sources to the MRP, item master is also essential in implementing the materials requirement planning. Item master contains the primary information to define an end product or part item. Typical information in the item master includes :

1. Item ID (or part number): which is used to uniquely identify a product or part item?
2. Item Description: a meaningful description for the item .
3. ABC Class: for classifying the product or part item .

It means classifying inventory according to some measure of importance and allocating control efforts accordingly.

A - Very important items. It represents about 20% of the total materials.

B - Mid. Important items. Represents about 25% of the total materials?

C - Least important items. Represents about 55% of the total materials.

4. Source Code: for specifying the source of a product or part item .

5. Material Type: for specifying the type of a product or part item .

6. Unit Measure: ordering unit for a product or part item .

7. Lead Time: ordering lead time in planning periods for a product or part item .

8. Lot Size: Either lot size code or lot size quantity. Refer to Lot Sizing for more information .

9. LS Multiplier: Multiplier for the lot size methods .

10. Scrap percentage.

11. Annual Demand

12. Unit Cost

13. Setup Cost: ordering or production setup cost .

14. Holding Annual Cost

15. Shortage Annual Cost

MRP Processing

MRP [1, 5, 25] determines the quantities required for each part in each period. The logic is based on the explosion of the end items in the MPS file by using the product structures in the BOM and taking into consideration the inventory records.   Explosion is the process to derive the gross demands level by level. For a

particular period, let G represent the gross requirement from the explosion, and A represent the availability including on hand and scheduled receipts of a particular part item. The net requirement, R, of this part can be calculated by :

$$R = G - A$$

If R is greater than zero, we have the net requirement in this period; otherwise, we have the expected inventory, R, left over for the next period. By shifting the lead time period, the MRP system determines the time for action (i.e., planned order), such as issuing purchase or work orders .

When to Use MRP

This system [20, 25] was used in one of the following cases:
• Dependent and discrete items.
• Complex products
• Job shop production
• Assemble-to-order environments

Requirements of MRP [21, 22, 25]

- Computer and necessary software
- Accurate and up-to-date
  - Master schedules
  - Bills of materials
  - Inventory records
- Integrity of data.
- MRP provides answers for the following questions;What is needed?

How much is needed? When is it needed?

MRP Outputs

The following example will explain how the MRP [25] processing produces the net requirements for each part in each period. From that, much information can be reported :

1. Primary reports: schedule of the planned orders, changes in due dates, inventory status reports, and so on .
2. Secondary reports: performance reports, late order reports, scrap reports, aged inventory reports, and so on .

In this program, the MRP report for each item includes the following information for each planning period :

- Gross Requirement : derived from the parent item
- Schedule Receipt : from inventory records
- Projected On Hand
- Net Requirement
- Planned Order Receipt
- Planned Order Release

Example

The following MRP example [25] illustrates the process of using and implementing the (WinQSB) program to show the data entry menu and most of this program available facility. Fig (1) represents the entrance menu; fig (2) shows the initial input data menu, table (1) shows the input data which is required, fig(3) indicates the report selection menu, while tables (2,3) presents the output reports and the final results, and the menu shown in fig(4)helps in finding the final structure of the designed products.

Figure 1: entrance menu

Figure 2: initial menu
Table 1: first input data menu

Figure 3: reports selection menu

Table 2: output reports menu

Table 3: final result menu

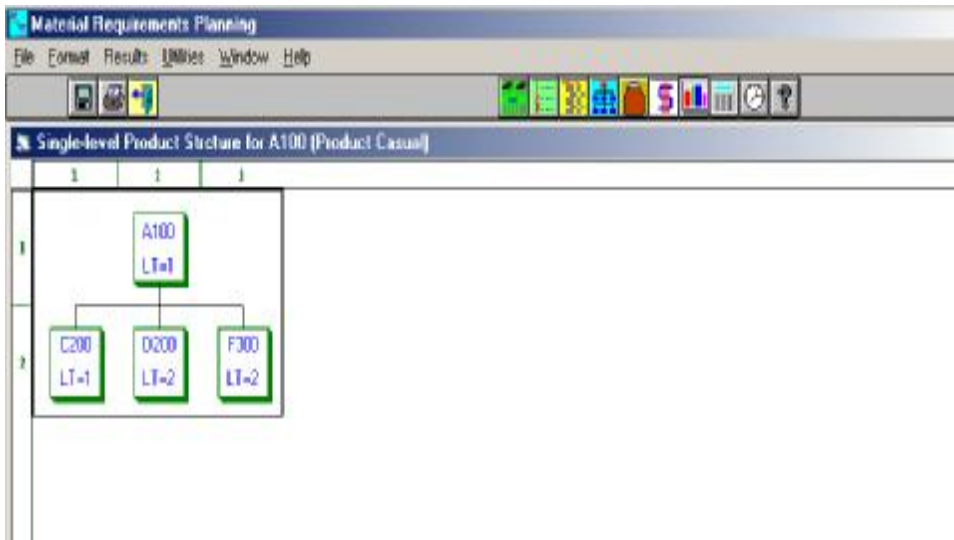| 10-14-2006	Item ID	Total Setup/ Ordering Cost	Total Holding Cost	Total Shortage Cost	Total Unit Cost	Overall Cost
1	A100	2,000	355.77	0	110,625	112,980.77
2	B100	3,500	1,184.62	0	107,625	112,309.62
3	C200	500	461.19	0	69,335	70,296.20
4	D200	300	390.46	0	36,140	36,830.46
5	E200	300	483.75	0	29,046	29,829.75
6	F300	240	292.38	0	69,600	70,132.38
7	G300	320	442.88	0	48,560	49,322.88

Figure 4: final product structure menu

<u>Conclusions:</u>

Material Requirement Planning is an effective method to determine the quantity and timing of material requirements. It will be more effective and useful technique with the use of the available version of WINQSB program.

Each company can easily maintain priorities updated and valid, requirements change, customers change order quantities and / or timing, and suppliers deliver late, unexpected scrap results from manufacturing, and Equipment breaks down.

MRP technique can now be evaluated with out long hand calculations or equations representation. The available program will perform any required calculations internally to give valid useful reports. Such process will be implemented by assigning the entered values through the screen menus to the required variables in the suitable model equations.

MRP helps in planning production to layout the right materials in the suitable place at the required time. MRP programs used to fixes the latest possible time to produce goods

and buy materials. It is one of the available tools in controlling inventory planning, purchase management and production steps.

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إسهام في اساليب تخطيط متطلبات المواد

الدكتور المهندس سعد طالب حسون بحت الجبوري

لبداب عماج

المستخلص

يعد التخطيط لمتطلبات المواد من الطرائق الشائعة في جدولة وتخطيط الإنتاج. تساعد هذه الطريقة في الاستغلال الكفوء والمؤثر للموارد. انها طريقة لحساب ماذا نحتاج ومتى وما هي كمية المكونات والمواد المطلوبة لتحقيق الخطة الإنتاجية للمنتج النهائي ضمن الوقت المحدد. ان هذه المنظومة تتطلب تعاملا كبيرا مع المعلومات والعمليات من اجل تحقيق تتابعها المنطقي المتكامل.

ان التخطيط وحساب عدد المستخدمين يكافئ عملية استحداث برنامج تخطيط الإنتاج المخول، بينما تعد عملية المراجعة لطريقة تجميع المواد الأولية مكافئه لعملية تدقيق ملف جداول الكميات للمواد المطلوبة، لذلك فان هذه المنظومة سوف تدقق سجلات الخزين للمواد المتوفرة ولتلك المواد المطلوب توفيرها.

في هذا البحث تم استخدام اسلوب بحوث عمليات حاسوبي لنمذجة العوامل المطلوبة للوصول الى الاستخدام الأمثل لمشاكل التخطيط لمتطلبات المواد باستخدام البرنامج الجاهز (WinQSB) . كما تم استخدام وتحسين اسلوب السيطرة المخزنية بطريقة تساعد على تقليل كلف الطلبيات، كلف الاحتفاظ بالخزين وكلف الأعمال الإضافية أثناء مراحل العمل المتقدمة. هذه الطريقة المقترحة تضمنت برنامج امثلية.