A Comprehensive Study for Enhancing the Productivity of a Fabrication Industry by using MRP Techniques

Ajit Singh Tomar1, Abhishek Gupta2, M. Tech Student2, Assistant Professor1
Department of Mechanical Engineering
Shri Shankaracharya Institute of Engineering & Technology, Durg, India

Abstract:
Fabrication industry is an essential and sizable sector for industrialized economies. Since it is capital and energy intensive, companies have been putting consistent emphasis on technology advances in the production process to increase productivity and to save energy. Durga industries division takes care of steel fabrication whether it is ducting, structural and piping from the smallest being 300 mm to 40 m for structural & from 300 mm diameter to 5000 mm diameter with latest art of welding technology with stringent quality control at all points stating right from the procurement of raw materials to final product. The objective of this work is to reduce the idle time, cost of materials and by procuring materials in right time and also deliver fabricated finished product to the customer at a given period of time. This paper gives the advantage of Material Requirement Planning (MRP) in ensuring materials on time for service and delivery to various Industries. Forecasted demand gives the input to MRP for the next purchase of materials. It controls the high inventory level and low inventory level of materials by maintaining the need amount in the industry. It plans manufacturing activities, delivery schedules and purchasing activities in fabricated industry. Finally Material Requirement Planning (MRP) reduces the maintenance and carrying cost of industry. It improves the unbroken chain of components for service and delivers fabricated parts on time.

Keywords: Material Requirement Planning, Fabrication, Materials.

1. INTRODUCTION

Material requirements planning (MRP) systems 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. Material Requirements Planning (MRP) is a computer-based production planning and inventory control system. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed. MRP is applicable in situations of multiple items with complex bills of materials. MRP is not useful for job shops or for continuous processes that are tightly linked.

The major objectives of an MRP system are below:
1. Ensure the availability of materials, components, and products for planned production and for customer delivery,
2. Maintain the lowest possible level of inventory,
3. Plan manufacturing activities, delivery schedules, and purchasing activities.

MRP is especially suited to manufacturing settings where the demand of many of the components and subassemblies depend on the demands of items that face external demands. Demand for end items are independent. In contrast, demand for components used to manufacture end items depend on the demands for the end items. The distinctions between independent and dependent demands are important in classifying inventory items and in developing systems to manage items within each demand classification. MRP systems were developed to cope better with dependent demand items. The three major inputs of an MRP system are the master production schedule, the product structure records, and the inventory status records. Without these 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 master production schedule expresses how much of each item is wanted and when it is wanted. 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. 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. 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. MRP will determine from the master production schedule and the product structure records the gross component requirements; the gross component requirements will be reduced by the available
inventory as indicated in the inventory status records. 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. This method is used for a fabrication plant for procuring spare parts to reduce the servicing time of a vehicle. The demand is forecasted for the materials based on actual demand and this gives the expected levels of goods or services. Based on the forecasted demand material requirement planning is done and orders are released to purchase materials and the materials are stocked. The objective of this work is to reduce the idle time and cost of materials and by procuring materials in right time. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required materials are available when needed. MRP is applicable in situations of multiple items with complex bills of materials. MRP is not useful for job shops or for continuous processes that are tightly linked. MRP is especially suited to manufacturing settings where the demand of many of the components and subassemblies depend on the demands of items that face external demands. Demands for end items are independent. In contrast, demand for components used to manufacture end items depend on the demands for the end items. The distinctions between independent and dependent demands are important in classifying inventory items and in developing systems to manage items within each demand classification. MRP systems were developed to cope better with dependent demand items. The three major inputs of an MRP system are the master production schedule, the product structure records, and the inventory status records. Without these basic inputs the MRP system cannot function.

MRP Process:
MRP process goes through the following steps:

1. Establish gross requirements.
2. Determine net requirements by subtracting scheduled receipts and on hand inventory from the gross requirements.
3. Time phase the net requirements.
4. Determined the planned order releases

In Today’s highly competitive market, industries should view customer satisfaction. One of the most important measure of the quality of service, an industry provides is on time delivery. Orders delivered after a promised due date will result in lost customer goodwill and ultimately in lost market share. This is particularly true for small scale industries whose business is based on producing a special product to customer specification rather than on producing standardized Parts to stock. Material Management played an important role in any manufacturing system. Computations to find out the quantity of raw materials to be ordered and the period in which to be ordered require processing of huge amount of data from various manufacturing functions. Here, for efficient functioning of the system, reliable and accurate information are necessary. Almost, all industrial organizations use materials to produce goods and services, which constitute the biggest single element of the cost. For efficient functioning, reliable and accurate information have to be made available to various departments of the industry. This can be made possible only by the use of computer based information. MRP system development in production engineering has been the area of interest in recent years. The MRP system development is carried out for the purpose (a) to know the gross requirement (b) on hand and (c) net requirement (d) planned order of a particular part (item code) in a particular period of time. The Material Resource Planning (MRP) process has become a cornerstone of the manufacturing industry that has been around for many years. In 1921, theoretical calculations were being utilized in the production process. Over the decades, it has been refined, and furthermore with the development of the computer, it has become a robust and complicated tool used in many of the manufacturing industries. MRP has become so engrained in the manufacturing industry that one of the biggest challenges in improving customer service is the fact that not all users understand the complexity of the system.

Due to this complexity, it is difficult to make changes to a process because the total impact may not be known. The dependency of how the consultants set up the forecasting tool becomes an obstacle in the mission of Customer Urgency Focus (CUF). Companies invest so much money into these systems that it is difficult to convince them that change will improve customer service.

FUNCTIONS AND TERMINOLOGY OF MATERIAL REQUIREMENTS PLANNING

MRP is software based production, order planning and control systems used to manage the manufacturing process. MRP requires information concerning independent demand, which comes from the master production schedule (MPS). The MPS contains gross requirements and scheduled receipts (status of outstanding orders). MRP systems use four pieces of information to determine what material should be ordered and when:

a) The Master production and order schedule: The master production schedule, which describes when, each product, is scheduled to be manufactured.

b) Bill of Materials: Bill of materials, which lists exactly the parts or materials required to make each product. Bill of Materials gives information about the product structure, i.e., parts and raw material units necessary to manufacture one unit of the product of interest.
c) Priority planning and control: Production cycle times and material needs at each stage of the production cycle time.

d) Supplier led times.

II. LITRATUTE REVIEW

Hyoun-Gon Lee, Namkyu Park, Han-II Jeong and Jinwoo Park (2009) [1] proposed a grid enabled MRP process in a distributed database environment and demonstrates the performance improvement of the proposed process by a simulation study and divided into five parts. Enterprise resource planning (ERP) software, are used in the production planning for manufacturing enterprises to ensure that appropriate quantities of raw materials and subassemblies are provided at the right time. Vincent A. Mabert, (2007) , This article chronicles many developments and events during the formative years of MRP, highlighting changes in computer technology and contributions by key early proponents of this approach for managing the flow of material on the factory floor. Much of this work was done manually, using pencil and paper, a slide rule or a simple tabulating machine available during the 1930s and 1940s. The approaches normally focused upon single level stocking decisions, even though many companies were dealing with multi-echelon material flow on the factory floor [2]. Karl Inderfurth, (2009) Traditional MRP systems suffer from several weaknesses, one of them being the disregard of uncertainties like those referring to demand and supply quantities. Advanced MRP concepts handle these uncertainties by incorporating safety stocks and scrap allowances into order release calculations. However, they fail to address how these measures of risk protection might interact [3]. Whybark and Williams (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 (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]Karmarkar (Karmarkar et al., 1985) illustrated the impact of lot size on queues. They intuitively found that big lot size causes large queue build up. They also found that initially lot size reduction causes queue reduction but eventually the queue started to build up because of an increased number of setups. They also suggested the conventional objective function modification for finding the optimal lot size. They argued that an investment associated with work-in-process (WIP) is the opportunity cost and lot size models should incorporate the WIP cost in their objective function in order to capture the implicit effect of lot size on lead-time [6]. Lee and Adam (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 (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 (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], Huge (Huge, 1979) found that the waiting time in queue can represent as much as 90 to 95% of the lead time. Hence, lead time is very much determined by how long it takes to obtain the required capacity, in other words, the congestion level of the shop. Therefore, setting optimal planned lead times for MRP is not a simple task. St. John (St. John, 1985) investigated the cost of inflated planned lead times for the multi-product, multi-stage environment, where MRP system was employed. He found that total costs were significantly higher when the planned lead time was set to be long. Therefore, any deviation of the planned lead time from the actual lead time can create undesirable effects [10]. Wilhelm and Som (1998) present an inventory control approach for an assembly system with several types of components. Their model focuses on a single finished product inventory, so the interdependence between inventory levels of different components is once again neglected [11]. Axsiot (2005) considers a multilevel assembly system where operation times are independent random variables. The objective is to choose starting times (release dates) for different operations in order to minimize the sum of the expected holding and backlogging costs. The paper (Loully and Dolgui, 2002) considers the case of the objective function minimizing the sum of average holding and backlogging costs. [12]. Kanet and Sridharan (1998) examined late delivery of raw materials, variations in process leadtimes, interoperation move times and queue waiting times in MRP controlled manufacturing environment. To model such environment, they represented demand by interarrival time rather than defined from the master production schedule [13]. Kumar (1989) studies a single period model (one assembly batch) for a multicompent assembly system with stochastic component lead times and a fixed assembly due date and quantity. The problem is to determine the timing of each component order so that the total cost composed of the component holding and product tardiness costs is minimized [14]. Chauhan et al. (2009), presents an interesting single period model. Their approach considers punctual fixed demand for one finished product. Multiple types of components are needed to assembly this product. The objective is to determine the ordering time for each component such as to minimize the sum of expected holding and backlogging costs [15]. Van Donselaar and Gubbels (2002) compare MRP and line requirements planning (LRP) for planning orders. Their research basically focuses on minimizing the system inventory and system nervousness. They also discuss and propose LRP technique to achieve their goals [16]. Billington et al. (1983) suggest a mathematical programming approach for scheduling capacity constrained MRP systems. They propose a discrete time, mixed integer linear programming formulation. In order to reduce the
number of variables, and thus the problem size, they introduce
the idea of product structure compression [17].

III. PROBLEM IDENTIFICATION

MRP system implementations in manufacturing have often failed to meet expectations. Many explanations have been offered for this failure. One of the major difficulties which hinders the successful operation of MRP systems is the uncertain nature of the manufacturing environment. This uncertainty is due to two major factors, viz. demand and supply. MRP is a tool to deal with these problems:

What items are required? How many are required? When are they required?

A MRP system represents a plan for the production of all end-items over a given planning horizon. It specifies how much of each end-item will be produced in each planning period, so that future component production requirements and materials purchases can be calculated using MRP component. Many sources state that problems associated with MRP systems lie, to some degree, with organizational and behavioral factors. Among the causes cited for MRP system failures are the following:

1) Lack of top management commitment
2) Failure to recognize that MRP is only a software tool
3) Insufficient user training and
4) Lack of technical expertise

IV. METHODOLOGY

In this paper two major objectives of the work. The first objective is to develop a model of a real time MRP production system which represents the operation of an MRP information from the shop floor. The second objective is to study the behavior of such a system in the presence of uncertainties in lead times due to unpredictability in supplier behavior and/or process uncertainty.

MRP process goes through the following steps:
- Establish gross requirements.
- Determine net requirements by subtracting scheduled receipts and on-hand inventory from the gross requirements.
- Time phase the net requirements.
- Determine the planned order releases. Thus, the objective of this work is to gain insight into the workings of an MRP system under real time control in such circumstances.

Based on the forecasted demand material requirement planning is done and orders are released to purchase materials and the materials are stocked. The objective of this work is to reduce the idle time, cost of materials and by procuring materials in right time and also deliver fabricated finished product to the customer at given period of time.

INVENTORY OPTIMIZATION MODEL

Average inventory of the plant was around 65 days as there was no scientific method was followed to maintain optimized inventory level. Huge cost was incurred in keeping such higher inventory. Hence a methodology was to be derived to arrive at an inventory level by accommodating all fluctuations of production volume and transportation lead time. Now Inventory Optimization means maintaining a certain level of inventory that would eliminate the out-of-stock situation and at the same time the cost of carrying inventory is not detrimental to the bottom-line. In simple inventory optimization means balancing demand and supply. Inventory carrying cost for holding an inventory of more than 65 days seems to be very high. It’s very examine issue whether this inventory level is high or low or optimum. Because there is not any scientific and logical method to define how much inventory is to be maintain. Floors beams are frequently ordered fabricated products from various industries.

**DISCUSSION**

V. RESULT AND DISCUSSION

**Approach-constant review process**

Lead Time variation = \( \sigma_l \)

Variation in Quantity due to Lead Time = \( \sigma_q \) \* \( M_s \)

Variance of demand due to lead time = \( M_s \) \* \( \sigma_q \)

Total variance of demand during the lead time = \( M_s \) \* \( \sigma_q \) \* \( \sigma_q \) \* \( \sigma_q \)

Variance of demand during lead time = \( (M_s \) \* \( \sigma_q \) \* \( \sigma_q \) \* \( \sigma_q \)

Standard Deviation of demand during lead time = \( \sqrt{M_s \) \* \( \sigma_q \) \* \( \sigma_q \) \* \( \sigma_q \)}

Safety Stock to be maintained = \( \sqrt{5.86 \times (2.55)^2 + (1.1 \times 189.83)^2} \)

= 463.044

So total 464 number of safety stock has to be kept at Fabrication of floor Beam for various industries & machining of their casted items for constant review process. So total 464 number of safety stock has to be kept at Fabrication of Floor Beam for various industries & machining of their casted items for a periodic review in 3 days of interval. Finally with the help of statistical tool optimized safety stock is calculated. The above calculated inventory level is based on theoretical calculation. If we have to maintain the above safety stock the given below assumptions are taken to be in considered for smooth operations:

1. The Transit lead time is taken as to be 5-6 days.
2. The Production volume is taken as to be 190/Day.
3. Everyday 204 fabricated parts should dispatch from Durga Industries, Hathkhok Bhilai.
4. In ideal situation after every 14 dispatches 1 day will have no dispatches.

http://ijesc.org/
In this work a certain challenges are which expected in order to achieve the optimization project a practical, feasible and workable model.

i. Transit time
ii. Production volume
iii. Availability of the vehicles for transportation
iv. Cost/fabricated parts.

All above dimensions were consult with the higher management authorities and experiments performed by trying few of the above aspects by discussing with different service providers and comparing the price fluctuating in the market.

VI. CONCLUSION

This paper gives the advantage of Material Requirement Planning (MRP) in ensuring materials on time for service and delivery to various Industries. Forecasted demand gives the input to MRP for the next purchase of materials. It controls the high inventory level and low inventory level of materials by maintaining the need amount in the industry. It plans manufacturing activities, delivery schedules and purchasing activities in fabricated industry. Finally Material Requirement Planning (MRP) reduces the maintenance and carrying cost of industry. It improves the unbroken chain of components for service and delivers fabricated parts on time. 464 number of regular safety stock is to be kept at Fabrication of Floor Beam for various industries & machining of their casted items for constant review process. So total 464 number of safety stock has to be kept at Fabrication of Floor Beam for various industries & machining of their casted items for a periodic review in 3 days of interval. Material Requirement Planning is an effective method to determine the quantity and timing of material requirements. 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.

VII. REFERENCES


http://ijesc.org/