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MRP-JIT INTEGRATED PRODUCTION SYSTEM

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Abstract :

A combined MRP(material requirement planning) and JIT(just in time) system can be more effective manufacturing system which utilizes the best attributes of each manufacturing system need to accommodate the best planning features of MRP and the best execution features of JIT to address the changing needs of industry. When MRP and JIT involve in any production system than its balance the all entire production and also minimize their limitation by work together.

1. Introduction:-

In this competitive era every firm/ industries tries to survive in this competitive market. Revolution in industrial engineering always made changes in the production system. In past many firm were using MRP type push system. After that these firm took interest toward pull type production system like JIT. But in present time due to some limitation JIT concept is not appropriate for all type of industries. Many research works accomplish on the concept of MRP and JIT for finding the best solution for industrial problems.

A combined MRP(material requirement planning) and JIT(just in time) system can be more effective manufacturing system which utilizes the best attributes of each manufacturing system need to accommodate the best planning features of MRP and the best execution features of JIT to address the changing needs of industry. When MRP and JIT involve in any production system than its balance the all entire production and also minimize their limitation by work together.

The main theme of MRP- JIT is “getting the right materials to the right place at the right time”. But JIT and MRP work on opposite type.

MRP and JIT each have benefits. The question is, Can they work together successfully and how would one go about combining them? Most major manufacturing firms use MRP. Of the firms using MRP, Many in repetitive manufacturing also use JIT techniques. Although JIT is best suited to repetitive manufacturing, MRP is used in everything from custom job shops to assembly-line production. A challenge arises in integrating the shop-floor improvement approaches of JIT with an MRP-based planning and control system. The MRP/JIT combination creates what might be considered a hybrid manufacturing system.

This hybrid system is commonly found in any assemble-to-order environment. In this environment, raw material can be transformed into common semi-finished products at a point where next downstream operations are controlled by customer orders. Therefore, the production of the earlier upstream stations is controlled by push-type production, while the production of the later downstream stations is controlled by pull-type production. This type of assemble-to-order environment can be found in many electronics manufacturers.

JIT mainly work as pull system where as MRP work as push system. The traditional Material Requirement Planning (MRP) and the recent Manufacturing Resource Planning (MRP II) represent the Push type of production control. On the other hand, JIT is an effective and proven Pull type of production control system.

The difference between Pull type manufacturing systems and Push type manufacturing systems is the difference between producing to order and producing to schedule. In a pull management, upstream activities are geared to match the final assembly needs. When all component parts and materials are pulled through production in an exact correspondence to end-item demands, the theoretical ideal of 'stockless production' is achieved.

The Push type production control will run as per the predetermined Master Production Schedule (MPS). The lead times for all the products and for all their operations are known and are used as a basis for the MPS. Work orders are issued based on this schedule for all the production time-frame in consideration and then flow of production is rigorously followed up to ensure the timely completion.

1.1 Push type production system

Push system it is a conventional system of production. When a job completes its process in a workstation, then it is pushed to the next workstation where it requires further processing or storing. In this system, the job has a job card and the job card is transferred stage by stage according to its sequence.

This system works on MPS and a continuous updating of the central computer database is carried out for each activity completed. As a result,

quick and easy tracking of job progress can be done from any user terminal in the plant.
For absorbing the uncertainties in process and change in demand in any plants/ industries, push system always used work in process inventory.

The push-type system can be described as a top-down planning system because all production quantity decisions are derived from forecasted demand in the master production schedule. The system produces as many parts as previously forecasted. The parts are released to the next station as quickly as possible to avoid starvation at the downstream stations. This characteristic enables the system to reduce delivery lead-time since many semi-finished or finished products are available. Medium to large variation of demand may not cause any confusion because semi finished products are kept at each station. The push-type system is better for planning and controlling production activities. However, it causes high volume of work-in-process (WIP), both in the form of semi-finished and finished products. As a result, the system suffers from high inventory holding cost.

1.1.1 Material Requirement Planning (MRP)

MRP Overview

The earliest mechanism used to manage inventory was the reorder-point/reorder-quantity system. Under the reorder-point system, the depletion in the supply of each inventory item was monitored and a replenishment order was issued whenever the supply dropped to a predetermined quantity – the reorder point (Orlicky, 1975).

Joseph Orlicky (orlicky, 1975), defined MRP as following:
"A material requirements planning (MRP) system, narrowly defined, consists of a set of logically related procedures, decision rules, and records (alternatively, records may be viewed as inputs to the system) 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".

According to Stevenson (Stevenson, 2005), MRP is a "computer-based information system that translates master schedule requirements for end items into time-phased requirements for sub-assemblies, components, and raw materials"

MRP system suffered from two main difficulties. One was the enormous task of setting up schedules, keeping track of large numbers of parts and components, and coping with schedule and order changes. The other was a lack of differentiation between independent demand (end-items or finished goods) and dependent demand (raw materials, subassemblies, components) (Stevenson, 2005).

The main purposes of a basic MRP system are

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

(Chase et al, 2006).

1.1.2 Components of Material Requirement Planning (MRP)

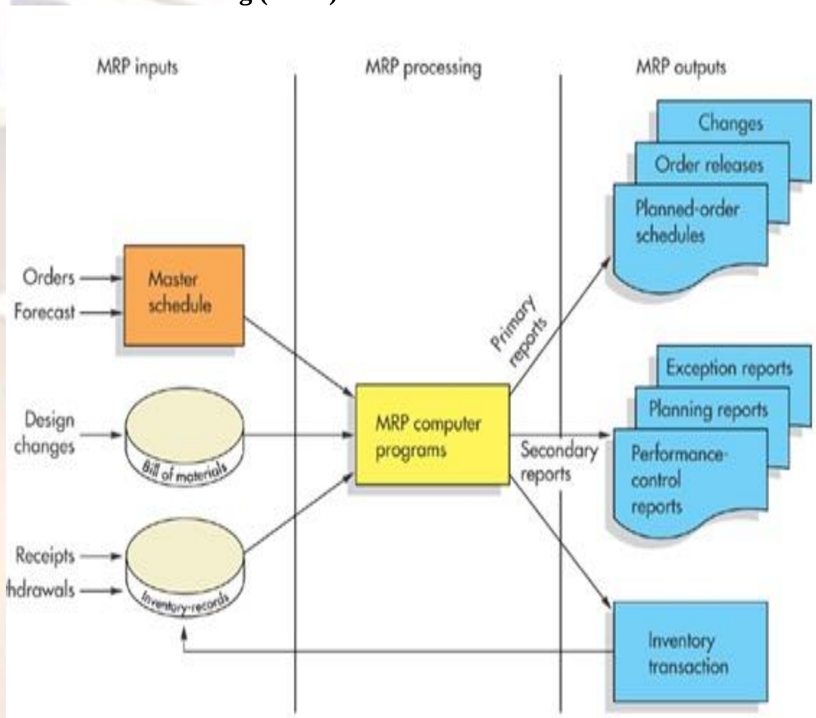

Figure1: basic components of MRP Source: (Stevenson, 2005)

The primary inputs of MRP are a bill of materials, which details the composition of a finished product; a master schedule, which details how much finished product is desired and when; and an inventory records file, which details how much inventory is on hand or on order. The planner processes this information to determine the net requirements for each period of the planning horizon. Outputs from the process include planned-order schedules, order releases, changes, performance-control reports, planning reports, and exception reports (Stevenson, 2005).

MRP inputs

- **Master schedule**

The master schedule is one of three primary inputs in MRP stating which end-items are to be produced, when these are needed, and in what quantities. Normally, the master schedule is formed after disaggregating the aggregate planning which consists of demand for groups of end-items. Based on the customer orders, forecasts, and orders from warehouses to build up seasonal inventories, the demand for each particular end-item within the groups is specified. Following figure shows what a master schedule looks like.

Item: X	1	2	3	4	5	6	7	8
QUANTITY		500					700	

Figure2: Master schedule for end item A

To ensure good master scheduling, the master scheduler (the human being) must

- Include all demands from product sales, warehouse replenishment, spares, and interplant requirements.
- Never lose sight of the aggregate plan.
- Be involved with customer order promising.
- Be visible to all levels of management.
- Objectively trade off manufacturing. Marketing, and engineering conflicts.
- Identify and communicate all problems. (Chase et al, 2006)

➢ Bill of materials

A bill of materials contains a listing of all of the assemblies, subassemblies, parts, and raw materials that are needed to produce one unit of a finished product. A product structure tree is useful in illustrating how the bill of materials is used to determine the quantities of each of the ingredients (requirements) needed to obtain a desired number of end items:

The bill of materials (BOM) file contains the complete product description, listing not only the materials, Parts, and components but also the sequence in which the product is created. This BOM file is one of the three main inputs to the MRP program. (The other two are the master schedule and the inventory records file.)

The BOM file is often called the product structure file or product tree because it shows how a product is put together. It contains the information to identify each item and the quantity used per unit of the item of which it is a part.

Following figure shows the bill of material of end product A. Product A is made of two units of Part B and three units of Part C. Part B is made of one unit of Part D and four units of Part E. Part C is made of two units of Part F, five units of Part G, and four units of Part H.

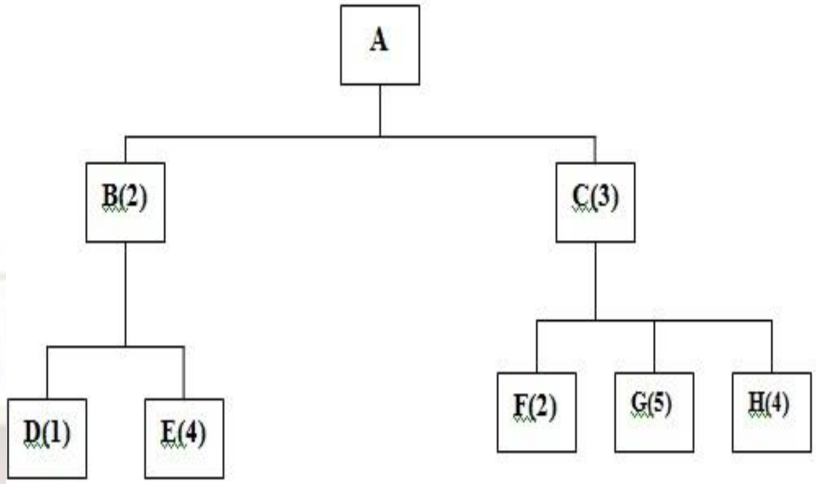

Figure3: Bill of Material (product structure tree) for product A Source: (Chase et al, 2006)

➢ The Inventory Records

Inventory records include information on the status of each item by time period or time buckets. This contains gross requirements, scheduled receipts, and expected amount on hand. It also includes other details for each item, such as supplier, lead time, and lot size policy. Changes due to stock receipts and withdrawals, cancelled orders, and similar events are also recorded in this file (Stevenson, 2005).

MRP Processing

MRP processing takes the end-item requirements specified by the master schedule and "explodes" them into time-phased requirements for assemblies, parts and raw materials using the bill of materials offset by lead times. The determination of the net requirements is the core of MRP processing.

Week number	0	1	2	3	4	5	6	7	8
Item: A									
Gross requirements								(x)	
Schedule receipts								(y)	
Projected on hand								(z)	
Net requirements								(x-z)	
Planned-order receipts								M	
Planned-order releases					M				

Z=Y +INVENTORY

M>= (x -z)

LEAD TIME

Figure4: MRP process chart

Gross requirement: Gross requirements are the total expected demands for an item or raw material during each time period. These quantities are derived from the master production schedule or the planned-order releases of their immediate parents.

Scheduled receipts: Scheduled receipts are open orders (orders that have been placed) and are scheduled to arrive from vendors or elsewhere in the pipeline by the beginning of a period.

Projected on hand: Projected on hand are the expected amounts of inventory that will be on hand at the beginning of each time period: scheduled receipts plus available inventory from last period.

Net requirements: Net requirement are the actual amount needed in each time period. In addition to subtracting projected inventory on hand from gross requirements, net requirements are sometimes adjusted to include safety stock and an allowance for waste.

Planned-order receipts: Planned-order receipts are the quantities expected to be received by the beginning of the period. Under lot-for-lot ordering (lot size = 1), this quantity will equal net requirements. Under lot-size ordering, the order size must be in multiples of the lot size, thus this may exceed net requirements. Any excess is added to available inventory in the next time period.

Planned-order releases: Planned-order releases are the planned amount to order in each time period; equal planned-order receipts offset by lead times. This amount generates gross requirements at the next level in the assembly or production chain. When an order is executed, it is removed from "planned-order releases" and entered under scheduled receipts.

MRP Output

The MRP system has the ability to provide management with a fairly broad range of outputs. These are often classified as primary reports, which are the main reports, and secondary reports, which are optional outputs.

Primary reports

1) Planned orders: indicating the amount and timing of future orders.
2) Order releases: authorizing the execution of planned orders.
3) Changes: Revising planned orders, including changes of due dates or order quantities and cancellations of orders.

Secondary reports

1) Performance-control reports: evaluating the system operation by measuring deviations from plans, including missed deliveries and stock outs, and by providing information that can be used to assess cost performance.
2) Planning reports: including purchase commitments and other data that can be used to assess future material requirements.
3) Exception reports: calling attention to major discrepancies such as late or overdue orders, excessive scrap rates, reporting errors, and requirements for nonexistent parts.

1.1.3 Where MRP can be used?

MRP is most valuable in industries where a number of products are made in batches using the same productive equipment.

The following table shows the examples of different industry types and the expected benefit from MRP. (Chase et al, 2006)

Industry type	Examples	Expected Benefits
Assemble-to-stock	Combines multiple component parts into a finished product, Which is then stocked in inventory to satisfy customer demand. Examples:- watches, tools, appliances	High
Fabricate- to-stock	Items are manufactured by machine rather than assembled from parts. These are standard stock items carried in anticipation of customer demand. Examples:- piston rings, electrical	Low

	switches	
Assemble-to-order	A final assembly is made from standard options that the customer chooses. Examples: - trucks, generators, motors	High
Fabricate-to-order	Items are manufactured by machine to customer order. These are generally industrial orders. Examples:- bearings, gears, fasteners	Low
Manufacture-to-order	Items are fabricated or assembled completely to customer specification, Examples: - turbine generators, Heavy machine tools	High
Process	Includes industries such as foundries, rubber and plastics. Specialty paper, chemicals, paint, drug, food processors.	medium

MRP is most valuable to companies involved in assembly operations and least valuable to those in fabrication. One more point to be noted that MRP does not work well in companies that produce a low number of units annually. Especially for companies producing complex, expensive products requiring advanced research and design, experience has shown that lead times tend to be too long and too uncertain, and the product configuration too complex. Such companies need the control features that network scheduling techniques offer.

1.1.4 Requirements to Apply MRP

MRP is most valuable in industries where a number of products are made in batches using the same productive equipment. It is often referred to as a planning and scheduling technique used for batch production.

In order to implement and operate an effective MRP system, it is necessary to have:

- A computer and the necessary software programs to handle computations and maintain records;
- Accurate and up-to-date master schedules, bills of materials and inventory records; and
- Integrity of file data.

1.2 Pull type production system

The pull-type system drives productions based upon customer demand (as opposed to forecasted demand). This is a simplified control technique, which is designed to respond quickly to the demand changes. In pull-type system downstream of production system pulls the upstream of the production system. When a customer order is placed, it will be fulfilled from the finished product inventory. As soon as the finished product is pulled from this inventory, a signal (or kanban, containers, tags etc) is generated to trigger production of the upstream station in order to replenish the finished product inventory. Similar procedures take place until the first station, where it pulls raw material from the raw material storage. The pull-type system can reduce WIP (work in process) inventory significantly. However, the system may not work well in an environment with medium to large demand variation because there is not enough semi-finished inventory kept. This in turn may result in a significant backorder. In addition, the pull-type system often has longer delivery lead-time than that of the push-type system, thus higher delivery late penalty costs.

The increased responsiveness of this system to the changes in product demand makes it a better choice in certain cases over the Push type of production. In Pull type of production control, MPS is used only as a broad outline of the requirements for resources at the different work centers. The major difference with Push type, as regards the usage of MPS lies in the fact that MPS is used for this broad outlining and not for the individual workstation production rate. The JIT philosophy is the original basis of this system

1.2.1Just in Time (JIT)

JIT Overview

The JIT approach started to be developed at Toyota by Taiichi Ohno, its vice president of manufacturing, and several of his colleagues since 1940s. At that time it was called the Toyota Production System (TPS). Just-In-Time was widely applied in Japan during the 1970's in the automotive and electronics industries. The system gradually evolved and became a success during the 1980s when Toyota created impressively high quality, yet lower priced cars compared to their American rivals.

The Japanese are very sensitive to waste and inefficiency. They regard scrap and rework as waste and excess inventory as an evil because it takes up space and ties up resources. The JIT methods produced high quality, low cost products that permitted the Japanese to obtain world leadership in these markets. The Japanese success prompted many American firms to adopt JIT methods.

In addition JIT also emerged as a means of obtaining the highest levels of usage out of limited resources available. The JIT philosophy aims at reducing the production batch sizes to expose the production problems. Producing goods 'just in time' eliminates the need for buffer stocks. "Making (or buying in case of JIT purchases) right quantity at the right time at the right place" is another way of defining the JIT systems. When compared with the MRP-ll system, which emphasizes on planning to anticipate problems, JIT stresses at execution to identify problems. To achieve low-cost, high quality and on-time production, this system removes stock accumulations between various production stages

Just-In-Time production techniques were pioneered by the Toyota Motor Company and were widely applied in Japan during the 1970's in the automotive and electronics industries. The JIT methods produced high quality, low cost products that permitted the Japanese to obtain world leadership in these markets. The Japanese success prompted many American firms to adopt JIT methods. Major improvements have been reported from these efforts. For example,

Harley Davidson's JIT/TQC efforts from 1981-1986 resulted in a 30 percent productivity improvement, a 60 percent reduction in scrap and rework, and a $ 22 million reduction in work-in process inventory.

At Hewlett Packard's Vancouver Printer division, inventory was reduced by 82 percent, floor space requirements were reduced by 50 percent, and scrap and rework costs were reduced by 30 percent.

Philosophy of Just in Time Manufacturing

the main aims of JIT philosophy is to continuously eliminate waste and improve productivity .The essence of JIT is elimination of waste through elimination of non-value added activities in purchasing, manufacturing, distribution, and manufacturing support activities of the manufacturing process. JIT manufacturing is a demand-pull system where products are produced when orders are received from customers and only in the quantities demanded by the customers.

Just in Time production is defined as a "philosophy that focuses attention on eliminating waste by purchasing or manufacturing just enough of the right items just in time".

It is a Japanese management philosophy applied in manufacturing which involves having the right items of the right quantity in the right place and at the right time.

JIT is a philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity. It encompasses the successful execution of all manufacturing activities required to produce a final product, from engineering to delivery and including all stages of conversion from raw materials onwards.

The first basic principle involved in the JIT production approach is the elimination of waste. In a JIT system, waste is defined as anything associated with the production process that does not add value to the final product. Thus, waste includes quality defects, inventories of all kinds, time spent to move material and time spent setting up machines. If the implications of managing the reduction in waste for the categories mentioned above are analyzed, it becomes obvious why JIT is involved in all aspects of the management of the production process.

The second principle of JIT production involves the management of people. The JIT philosophy assumes that people are capable and willing to take on more responsibility. People will respond to the critical needs of the organization if they have the opportunity and authority for helping to solve production problems. If defective parts are being produced, and individual can stop the production line. Once stopped, everyone working on the line has the responsibility to solve the problem.

1.2.2 Goals of JIT

- Increasing the organization's ability to complete with rival firms and remain competitive over the long run. JIT allows organization to develop an optimal process.
- Increasing the degree of efficiency within the production process. Efficiency will concern itself with achieving greater levels of productivity while minimizing the associated cost of production.
- Reducing the level of wasted materials, time and effort involved in the production process.
- Identifying and responding to consumer needs.

4 Benefits of JIT

There are many advantages for a business to adopt a JIT technique:

- Improvement in the relationship with suppliers
- Multi skilled employees are identified and used
- Reducing the manufacturing and production lot sizes
- Striking at the core of any problems associated with manufacturing processes
- Responsive to the consumer needs
- Eliminating wastages of various kinds such as inventory waste from the Processes, time waste, waste arising out of over production etc.
- Preventing any sort of breakdown by maintaining the equipments during the idle time of machinery and workers
- Less inventory of raw material.
- Improving quality by aiming at zero defects.

1.2.5 Limitations of JIT

- Cultural differences have been cited as possible limitation of JIT. The benefit associated with JIT may be culturally bound and somewhat limited to Japanese environment.
- Loss of individual autonomy is another possible shortcoming of JIT. Reduced cycle time forces the workers to adjust immediately to changes in demand, significantly reducing the idle time of the workers resulting in greater amount of stress and pressure placed upon the workers to perform.
- The success of JIT production depends upon co-operation between employer-employee, daily workstation rotation, training of operators for different kind of jobs and system adaptability to market function etc.
- There is no flexibility-only 'first come first served' principle is applied by manufacturing items in order of releasing kanbans.
- There is no safety stock to offset inaccurate demand forecast.

JIT production is effective only when the daily demands are fairly stable.

2. Literature review:-

The literature review is divided into the following parts. They are

- Review related to MRP
- Review related to JIT
- Review related to integrated MRP- JIT production system

2.1 Review related to MRP-

MRP has been a very popular and widely used in practice, it has attracted many researchers' interests. For example

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.

Two basic sources of uncertainty affect directly an MRP system performance: demand and supply uncertainty. In either of the two scenarios, uncertainty may exist in quantity and/or in timing.

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.

Melnyk and Piper proposed a forecast method for the lead time which is issued from the used methods for random demand:

Planned lead time =
= lead time forecast + safety lead time
= lead time mean + k lead time standard deviation.

Past studies for improving the performance of MRP can be divided into two types; those for improving the part explosion process and those for reducing MRP nervousness. These issues are interrelated, and the MRP nervousness used to be the key problem to be resolved in MRP. Most previous studies attempted to solve this problem by the lot-sizing method. However, the lot-sizing method often needs to be tailored to the specific manufacturing environment involved and there is no guarantee that an optimal solution can be found.

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.

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.

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.

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.

According to Hopp and Spearman (Hopp and Spearman, 2008) MRP is one of the earliest computerized production scheduling approaches. Although it started slowly, MRP got an extensive boost in 1972 because the American Production and Inventory Control Society (APICS) launched its "MRP Crusade" to promote its use.

2.1.1 Major problem of MRP

The general theme of MRP is to receive the right part, in the right quantity, and at the right time. The first major problem of MRP is the need to set planned lead time. Planned lead time represents the amount of time allowed for orders to flow through the production facility. It plays an important role in the phasing principle of MRP, that is, the planned order receipt date is offset by the planned lead time.

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.

The major issue in MRP deals with the question: how to decide the order quantity? This is generally called the lot-sizing decision,

The second major issue of MRP is that it does not produce a workable schedule for the shop-floor. The planned order release and the planned order receipt merely specify the start date and finish date of an order. Hence, MRP cannot determine the exact time period and workstation for processing each operation,

The last major problem of MRP is capacity planning, According to Chase & Aqnilano (Chase & Aquilano, 1995) When MRP is employed to perform capacity requirements planning, it assumes that the resource capacity (machine time) is utilized at the period that a job is released or at the middle period between planned order release and planned order receipt dates

2.1.2 Problems with MRP implementation

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 -** "Part of the blame for the lack of top management commitment may be MRP's image. It sounds like a manufacturing system rather than a business plan.

However, an MRP system is used to plan resources and develop schedules. Also, a well-functioning schedule can use the firm’s assets effectively, thus increasing profits. MRP should be accepted by top management as a planning tool with specific reference to profit results” (Chase & Aquilano,1995).

2) **Failure to recognize that MRP is only a software tool-** that needs to be used correctly to adapt the organization and its processes to exploit the system’s capabilities. “MRP proponents overdid themselves in selling the concept. MRP was presented and perceived as a complete and standalone system to run a firm, rather than as part of the total system” (Chase & Aquilano, 1995)

3) **Insufficient user training and education -** In nearly every study conducted and in many published cases, the lack of training or understanding is considered a major barrier to MRP implementation. Sum and Yang (Sum and Yang, 1993) identified that the lack of MRP expertise, training, and education were major problems facing MRP implementers. There are several published books about user training for Management Information Systems. The need to adapt employees to their MRP systems definitely exists.

4) **Lack of technical expertise -** Not only is there a need to improve user training techniques and general understanding of MRP systems, there is also a definite lack of technical expertise to provide the leadership needed to implement the systems. Not only would the technical experts need to be familiar with the operational needs of daily production, the system integrators would also need to understand how the computer software system can be built to handle the production needs. Increasingly, the advanced
MRP-type systems are seeking to integrate concepts of Just-In-Time (JIT) production into the computer applications system.

Major problem of JIT

JIT production can be viewed in a colloquial fashion as consisting of 'Big JIT' and 'Little JIT' (Chase & Aquilano, 1995) [3]. Big JIT is more of a management philosophy that encompasses every aspect of a firm's production activities. On the other hand, Little JIT is focused on 'Kanban' pull production scheduling and control method. Here Little JIT used as the production and inventory control tools in JIT. The Kanban pull system suggests that production should be triggered by a pull signal from a downstream work center when it has demand for component parts. That is, the downstream work center serves as a customer for its upstream work center. The result is that the upstream work centers will not produce unless there is a demand or 'pull' from its customer (downstream work center). On the other hand, a 'push' system, driven by the upstream workstation, pushes out the parts (that later become work-in process inventory) without regard to the demand of its downstream workstation. The excessive WIP inventory is one of the major disadvantages of push systems.

One of the major requirements for JIT production is a stable environment so as to obtain a level schedule. A JIT production system requires a uniform flow of goods through the system to achieve a good coordination of the different operations and the movement of goods and materials from the supplier to the final output. Therefore, production schedules must be fixed over a time horizon in order for production and purchasing schedules to be established. Once plans are set, they generally are not allowed to change. Therefore, Kanban system is more suitable to companies that produce repetitive products. In fact, the simplicity principle employed in JIT reinforces the level schedule idea. Furthermore, JIT is more of a planning concept rather than a planning and scheduling technique. Hence, it does not generate a formal shop-floor schedule.

2.3 Literature review related to integrated MRP-JIT production system

A number of research works have appeared which discuss the possible integration of MRP-JIT. Nonetheless, most of them are focused on the conceptual level of JIT philosophy and are more concerned with combining rather than integrating MRP and JIT.

Olhager and Ostlund(Olhager and Ostlund, 1990) proposed a three types of push- pull integrated model in relation to

- customer order point,
- bottleneck resources, and
- The product structure.

These approaches were applied to a medium-sized packaging company. The results included cycle time reduction to one week, inventory decrease by 75% and sales turnover increase by 10–15%.

Flapper et al. (Flapper et al. 1991) they present a three-step framework for embedding JIT into an MRP environment. This method will allow JIT to operate within MRP. The benefits include lower costs, shorter lead times, better quality, lower transportation cost, and reductions in floor space. They propose one of the most rigorous frameworks for integrating MRP and JIT. Their three-step framework makes use of MRP's back flushing and phantom features, and allows JIT principles to be utilized to the fullest extent. They suggest that MRP is an ideal mechanism for planning and control propose, while JIT is the best tool for reducing cost and lead times. By taking advantage of the two, one can obtain the best of both worlds. The essence of the proposed framework is to incorporate the pull element of operations scheduling in JIT into MRP. It is generally agreed among researchers that MRP is a push system. However, it is very important to make the distinction between materials (or parts) planning level and operations scheduling levels when we say MRP is a push system.

Hodgson and Wang (Hodgson and Wang, 1991) developed a Markov Decision Process model for HIHS (horizontally integrated hybrid system). The model solved problems using both dynamic programming and simulation for several production strategies, including pure pull, pure push, and integrated ones. They indicated that the pure pull strategy was a group of decentralized controllers without any real-time coordination.

Later, Hodgson and Wang (Hodgson and Wang, 1991) focused on the local goal of each decentralized controller, which was to satisfy the local demand subject to the available local supply, instead of paying attention to the global goal of meeting end-users' demand while saving inventory expenses. They conclude that a superior strategy containing a group of decentralized controllers with a centralized coordinator. Individual controllers had the ability to adjust their inventory situations to meet the local demand. But their material supply was controlled, in part, by the central computer.

Cochran and Kim (Cochran and Kim, 1998) categorize the combination of a push/pull manufacturing system into vertically and horizontally integrated hybrid systems. Vertically integrated hybrid systems consist of two levels, an upper level push-type production ordering system and a lower level pull-type production system. For this type of hybrid system, material requirement planning (MRP) is normally applied for production and operation planning, while just-in-time (JIT) is used for shop floor control and execution. This method enables the production system to keep the inventory low while still reacting fast enough when fluctuation of demand occurs.

Beamon and Bermudo (Beamon and Bermudo, 2000) suggest a hybrid push/pull algorithm to reduce costs of inventory and at the same time, maintain a high level of customer service. The algorithm developed is for a multi-line, multi-stage assembly-type production system.

The push philosophy is applied from the raw material storage until the components complete processing and go to buffer storage at the end of each line. The pull stations start at this buffer storage down to the final packaging stations. Based on their study with computer-generated data, the results are in favor of the hybrid system.

Geraghty and Heavey (Geraghty and Heavey, 2005) defined that "A hybrid production system could be characterized as a production system that combines elements of the two philosophies in order to minimize inventory and unmask flaws in the system, while maintaining the ability of the system to satisfy demand".

Hybrid systems can be classified into two categories: vertically integrated hybrid system (VIHS) or horizontally integrated hybrid system (HIHS).

Cochran and Kaylani (Cochran and Kaylani 2008), propose a horizontally integrated hybrid production system with multiple part types that saves production costs compared to either pure push or pure pull. In their paper, Cochran and Kaylani developed a genetic algorithm (GA) to optimize the hybrid production system by locating points of integration, and determining the optimal values of safety stocks for the push part and number of Kanbans for the pull part.

Problem Formulation:-

The main limitation of MRP is the integrity of the data. If there are any errors in the inputs of MRP then the output will also be incorrect. In case of JIT concept, JIT only works in stable demands. JIT concept does not allow to keep inventory, thus it is not suitable for fluctuate demands.

Both MRP and JIT have benefits, MRP is most suitable for planning and scheduling of the production system while JIT is most suitable for executing and controlling the production system with minimum inventories.

Objective of Study:-

1. To study the material requirement planning (MRP) systems in manufacturing industry.
2. To study the integrated system of MRP-JIT system.

Proposed methodology:-

1. To identifying the best practices related to MRP system in manufacturing industry.
2. To identifying the best practices related to JIT system in manufacturing industry.
3. To explore the possible integrated MRP-JIT system in practice.

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