Comparison of JIT with other Industrial Production Approaches: A Review

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Abstract As competition increases day by day and all the manufacturer wants to produce the product at minimum cost with proper utilization of the resources without any loose cost of inventory. Thus for that different techniques are adopting like reduction inventory, change in production layout, utilizing of resources in most efficient manner. Although such perfect scenarios are unfeasible, there are many methodologies of industrial production planning that can significantly contribute to a more efficient and effective production scheme. This means that managers need to have a deep understanding of production management systems in order to select the one that is more appropriate for their company. In this paper, a critical review of such well-known and widely-used methodologies is presented to support management in their selection of an appropriate one.

***Key-Words**:* - Production management methods; Material Requirements Planning (MRP); Manufacturing Resource Planning (MRPII); Enterprise Resource Planning (ERP); Just in Time (JIT).

1 Introduction

Due to increase in competition and rapidly growing market there is challenge appears in front of the producers to produce the goods at minimum cost with best service during usage. Customers demand for smaller product quantities, which are cheaper, delivered always on-time and personalized to their individual needs. Companies compete to meet these increasingly high expectations by trying to decrease product production and delivery times, and by offering an increasingly wider range of products.

Effective organization and management of the materials, processes and human resources of a company is a prerequisite in today's highly competitive industrial landscape. Methodologies of industrial production management can support today's companies in addressing the aforementioned challenges. Such methodologies typically offer material requirements planning, capacity planning, work scheduling, and demand management. Key goals of these methodologies are to improve planning and scheduling of processes, increase productivity, minimize inventory level, improve responsiveness to changes in demand, improve quality, and lower operation cost. However, the abundance of available alternative methodologies for production management and the wide range of different particularities of the companies make the choice of the appropriate method a complex issue. Choosing the wrong methodology can result in well-planned processes that are not really required for a specific type of company or for a company in a certain context. In addition, such methodologies typically require a change in the culture and practices of the company.

The remaining of the paper described the concise description of each method. Subsequently, the advantages, drawbacks and practical considerations of each approach based on literature and our personal experience with such systems. All these information is summarized into comparison tables that are meant to support managerial system selection and decision-making.

2. Methods Surveyed

Due to space limitations we chose to present only a short description of the most popular approaches. The total number of results returned from Google was used as an index of their popularity. These results were in agreement with our personal past experience derived from discussions with professors in management and administration. Additional details for each method can be found in [1]-[4].

2.1 Just-In-Time

Just-in-time (JIT) is a philosophy that calls for eliminating all sources of waste including unnecessary inventory and scrap in production and it also constitutes a complete solution for the organization, control and continuous improvement of production systems and products' development. JIT was firstly established and publicized in Japan – mainly by the Toyota Motor Corporation. Japan is a country with minimal raw material and problematic warehousing due to limited land availability. By applying JIT systems, Japan achieved the most competitive industry in the entire world both in quantity and quality of products. The philosophy of the JIT methodology is to minimize anything considered waste in order to increase overall productivity. Products not immediately used by the enterprise to yield profit are a waste of time, money and space. The time required to prepare a machine to function is a waste of time and should be limited to minimal. The partial use of materials or the low degree of transformation in goods which have some value is a waste of material, material that costs. Faults occurring during the production are a waste of time, work, energy and materials. The application of the JIT production organization system requires a bottom-up analysis of the entire productive

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process. Having knowledge of the quantity of products that should be disposed in the market, the last stage of the production chain is planned first, followed by the hierarchically precedent until the first stage of raw material. This is achieved by a series of signals, or Kanban (card in Japanese), which tell production when to make the next part. Due to its bottom-up approach the JIT system is classified as a demand-pull system.

2.2 Materials Requirement Planning

MRP is a production planning and inventory control system used to manage manufacturing processes. Most MRP systems are software-based, while it is possible to conduct MRP by hand as well. An MRP system is intended to simultaneously meet three objectives:

- Ensure materials are available for production and products are available for delivery to customers.
- Maintain the lowest possible material and product levels in store.
- Plan manufacturing activities, delivery schedules and purchasing activities.

. If it is properly implemented, it will reduce cash flow and increase profitability. MRP will provide ability to be pro-active rather than re-active in the management for inventory levels and material flow, distribution of machine parts in the various departments, minimize inventory level and adhere to final product delivery dates.

The information required as input to a functional MRP system is the following: a) the *Master Production Schedule (MPS),* which describes quantities and types of products to be produced based on known orders and forecasts, b) the *product structure records* or *Bill of Materials (BOM),* which includes a list of raw materials and how each product is manufactured, and c) the *inventory status records,* which describe the materials available for immediate usage and those on order from suppliers.

The first output of the MRP system is the Recommended Production Schedule, which presents the minimum start and completion dates and quantities required to meet the demands of the MPS for each step of the end-product manufacturing. The second output is the Recommended Purchasing Schedule, which delineates both the dates that the purchased items should be received into the facility and the dates that the purchase orders should be placed in order to match the production schedules. These are only recommended outputs. A trained manager in charge should review them and also take
into account various external factors, such as fluctuation of prices, order delays, and execution of earlier commands that appear to be more important.

2.3 Manufacturing Resource Planning (MRP II)

MRP II is defined as a method for the effective planning of all resources of a manufacturing company. Ideally, it addresses operational planning in units, financial planning, and has a simulation capability to answer "what-if" questions and extension of closed-loop MRP. This is not exclusively a software function, but a marriage of people skills, dedication to data base accuracy, and computer resources. It is a total company management concept for using human resources more productively. Thus MRP II is a computer-based system that can create detail production schedules using real-time data to coordinate the arrival of component materials with machine and labor availability. MRP II is used widely by itself, but also as a module of more extensive enterprise resource planning (ERP) systems.

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As Manufacturing Resource Planning (MRPII) is the evolution of MRP. This evolution from MRP to MRPII was gradual and was mainly inspired by the two basic weaknesses of MRP:

a. MRP uses some priorities, but it does not take into account the restrictions that concern the productive capacity of the company. Thus, it proposes what should be ideally done, and not what the production can really support. MRPII was the first that started taking into account the capacity of the human potential and machines or even of some other limited resource.

b. MRP was a system exclusively used for materials management and inventory control. The MRPII was developed with the aim of taking into account all aspects of the manufacturing process, including materials, finance and human relations.

The technical differences between MRP and MRPII are very small. The most important is that MRPII is a closed-loop system. Thus, the modules of MPRII are self-sufficient and there is feedback of expected or unexpected facts that

allows a continuous retroaction to the data used for planning. The philosophy of MRPII is to support decision-taking by providing simulations of "what-if" scenarios. In this way, fluctuations in forecast data can be taken into account by including simulation of the master production schedule. An MRPII output is a final labor and machine schedule.

2.4 Enterprise Resource Planning

Enterprise resource planning (ERP) systems integrate internal and external management information across an entire organization, embracing finance/accounting, manufacturing, sales and service, customer relationship management, etc. ERP systems automate this activity with an integrated software application. Their purpose is to facilitate the flow of information between all business functions inside the boundaries of the organization and manage the connections to outside stakeholders. ERP systems can run on a variety of computer hardware_and network configurations, typically employing a database as a repository for information.

Enterprise resource planning (ERP) is the natural outgrowth of MRPII [4]. MRPII evolved into ERP when "routings" (i.e. listing of the work centers and operations needed to make a part) became parts of the standard software activity. A steep increase in the sales of ERP systems was observed in the 1990s due to the "Year 2000 Problem". Many companies took this opportunity to replace their legacy information systems with ERP systems. ERP systems are a complete cross-functional and enterprise-wide solution that attempts to cover all functions of an enterprise, such as process design and development, manufacturing, finance and accounting, human resources, marketing, inventory control and strategic management. ERP systems can be viewed as having three levels:*planning*, b) *execution* and, c) *analysis*.

Examples of activities that take place in the planning level are design of the supply chain and the production process, planning of sales and establishment of the annual budget. Accounting management, stock management and human resources are typical components of the execution level. Analysis activities typically include cost analysis, budget analysis and finance tools.

2 Selecting an Appropriate Method

A critical factor that determines the success, and often the viability, of today's companies is the selection and application of suitable methods for the organization and management of production The progress of technologies relating to computers and their application in the context of production scheduling, inventory control, and supplies planning constitutes one of the most important developments in the organization and management of companies.

Nevertheless, this decision is difficult due to the abundance of the available methods and the factors that should be taken into account. A company should pick from the breadth of available methods, the one that is a better fit to its individual characteristics. This situation becomes even more complicated by the fact that a solution for a company is neither the solution for the entire industry nor for the particular sector of industry. The efficient and effective application of the adopted approach requires a detailed examination of the company's environment, taking into account company size, business goals, implementation expenses, effect on existing work practices, degree of customization and shop floor configuration.

An ideal production plan would always satisfy demand, keep the level of employment steady, minimize warehousing costs and use available resources to their utmost. Unfortunately ideal productions schemes are unfeasible. There are always trade-offs involved. Each method of production planning is a compromise between the objective marketing, financing and production goals. For this reason, it is necessary to have a good understanding of the strengths and limitations of the available methods for production management. Following, we present a critical review of such methodologies. The strengths, weaknesses and practical concerns for each method are delineated. The aim is to support managers in both the selection and later application of the method that is more suitable for their company.

3.3 JIT Practical Considerations

The most important advantage of using JIT is waste reduction, which leads to reduction in inventory level and smoother flow of goods. Other advantages include improved working relations between employees, stronger and more reliable working relations with suppliers, higher profits and improved customer satisfaction [14]. In addition, JIT systems rely on manual-card based systems (e.g. Kanban) or inexpensive software. Thus, they are efficient and cost-effective to implement. Furthermore, JIT systems also contribute to the decrease of defect percentage and improvement of product quality. However, the JIT method is not applicable to all types of industries. JIT requires a discrete production and/or assembly environment with a standardized production process. In general, a JIT system can either fail internally or externally. Internally, JIT systems rely on the assumption that employees are highly motivated, perform their best when

entrusted with responsibility, help their co-employees when they fall back, and collaborate smoothly with upper levels of management. Therefore, JIT is often a cultural shock for employees and requires significant changes in existing work practices. Thus, JIT systems add psychological and sociological points of failure, which are hard-to-predict and take into account beforehand. For this reason, JIT systems typically require many years to provide optimum results. Externally, JIT expects suppliers to act as extensions of the company, accept rigid delivery schedules and have their own quality control. If problems appear due to unexpected events in the supplier (e.g. fire) or shortage of materials the system fails. Furthermore, when there is a sudden change in the demand pattern it will take time for a JIT system to react, since there is no central information unit or demand forecasting (as in MRP/MPRII/ ERP). An extended comparison of the MRP family of methods and the JIT system is provided in Table 1

3.1 MRP/MRPII Practical Considerations

Advantage of MRP/MRPII is the possibility for forward looking when planning. These systems are a useful simulator allowing its users to run multiple scenarios with different parameters before taking any decisions. If implemented correctly, MRP/MRPII can provide significant benefits such as improved productivity, improved customer service, better production scheduling and reduced manufacturing costs. Although MRPII cured a lot of weaknesses that the MRP system had, MRP/MRPII systems have accepted serious criticism. One important drawback of these systems is the fact that in both the estimation of needs for materials and the scheduling of production commands, they use empirical means for the years of transit. These years have the tendency to be overestimated for reasons of safety and they lead to excessively premature starting times for production commands, and consequently to excessively increased real transit years, which revise again the estimates of the mean. This results to deficiencies in the reliability of time scheduling and to an under-processing of the intermediary stocks.

Furthermore, these systems assume the production of standard products with well-known structures and routings. The MRP/MPRII model is mainly suitable for production industries with relatively small lots, with products of many assembling stages and with intermediary storage. It is not particularly suitable for other type industries, such as those with continuous processes (process industries) that have restriction of capacity or the manufacturing industries, in which the process of offers' preparation is the most important phase and the work plan is developed with unknown data that become available only later. Petroni [6] is critical of the low implementation success rate of MRPs, especially amongst small and medium enterprises.

Problems are often but not always the result of system functionality. Other factors can also be important, such as the level of management support, degree of functional integration and data accuracy. From our experience, the most important factors for an MRP/MRPII system to be successful are: a) administrative engagement, b) personnel training and c) accuracy of provided data. First, the commitment and engagement of the company's administration plays a critical role in the success of the system. The administration needs to confront the informal and already existing production policies of the company, transfer all her accumulated knowledge to the lower levels of the hierarchy, and be continuously engaged in learning about issues related to MRPs. Next, the training of all personnel in functionalities of MRP/MRPII they will be using is of paramount importance. Often the success of the MRP system is determined by this training process. The objectives of the training should be the acquisition of knowledge around the system and the establishment of a collaborative and friendly environment. Finally, the successful operation of an MRP/MRPII system depends on the precision of the provided data. The lack of precision in the relative files is the main reason for the failure of MRP/MRPII systems to meet the expectations of the enterprises. Most vendors of this type of system recommend at least 99% data integrity for the system to give useful results.

3.2 ERP Practical Considerations

An additional advantage of ERP systems is the increased flexibility they offer, both during their initial implementation and their later functioning. ERP systems are implemented on a module-based architecture, which allows a company to add, remove or reconfigure components on-demand without any loss of data. But even if a company does not find a module that exactly fits its needs in any of the available commercial ERP systems, it can re-write some of the enterprise systems' code or build interfaces with other systems. However, both options add time and cost to the implementation process, and increase the chance for incompatibilities with future official updates. Practitioners should also be familiar with typical points of failure for ERP implementation. Yusuf et al. [7] groups implementation difficulties into three categories: cultural, business and technical. Motwani et al. [8] argue that an evolutionary implementation process supported by management and cultural readiness are of critical importance. Schniederjans and Kim [9] suggest that

success depends on how a company prepares itself for integration.

Most problems of ERP systems appear due to lack of training on both IT personnel and employees using the system, as well as lack of policies to ensure the integrity of the stored data. One other common mistake is to neglect to analyze the company's organization and processes before implementing an ERP system [10]. In such cases, the organization of the company is usually adapted to the ERP system, instead of adapting the ERP system to the existing processes [11]. As a result, processes can also become less efficient than they were prior to the implementation of the ERP system. Ramaswamy [12] argues that data migration is one of the most important activities in determining the success of an ERP implementation, and proposes the following steps for an efficient data migration strategy: a) identify the data to be migrated, b) determine the timing of data migration, c) generate data templates, d) freeze the tools for data migration, e) decide on migration related setups, and f) decide on data archiving.

MRP/MRPII/ERP (push-based)	**JIT (pull-based)**
Very expensive software, difficult/time-consuming to install and implement.	Manual card-based system or inexpensive software, efficient to implement, minimal setup-times and costs.
Fast reactions to demand changes due to centralized data management.	Reaction to demand fluctuations takes more time.
Higher raw material inventories, levels of work-in-progress and holding costs.	Lower raw material inventories, levels of work-in-progress and holding costs.
Defect percentage is higher. Rework is often necessary.	Defect percentage much lower. Almost no reworks.
Variety of suppliers who are often distant and unreliable.	Few suppliers who are near and very reliable.
More discounts and better price opportunities.	Price opportunities are limited.
Short range contracts, few deliveries.	Long range contracts, frequent deliveries.
Small number of setups and larger lot sizes.	Frequent setup changes and smaller lot sizes.
Managers and workers typically have no relationships.	Better relationship and understanding between all levels.
Workforce has limited responsibility, less commitment and specialized knowledge is not required.	Workforce has big responsibility, high commitment and requires continuous training.

Table1. Comparison between JIT and other Techniques

Techniques	**Strengths/Advantages**	**Weakness/Limitations**
MRP/MRPII	• Useful simulator to answer what-if questions • Minimizes work-in-progress in each production station. • Reduces manufacturing costs • Permits monitoring of the production process from purchase order to end product shipment. • Improves production scheduling and planning. • Provides valid, credible priorities that reflect actual, and not implied, needs	• Proposes what should be ideally done, not what can be really achieved based on capacity (*remedied by MRP II*) • Only concerned with materials management. (*remediedby MRP II*) • Requires extremely high accuracy of data (e.g. 99%) • Does not tolerate informal systems/processes that people working together for years typically have. • Assumes production of standard products with well known product structure and routings.
ERP	• Integrated solutions for a wide range of activities of the company. • Better cooperation among departments. • Centralized data management means no synch problems, and less risk of data losing. • Data security features. • Eliminates redundant transactions • Enables better analysis and future planning due to tracking/logging of all activities	• Increased integration can cause problems in accountability and responsibility. • Resistance in collaboration may lead to system failure. • Changing company's processes to fit "best practices" of an ERP may lead to a loss of competitive advantage. • Centralized data management can also mean an increased risk of a security breach • Data migration problems may arise. • Can be complex, expensive, time-consuming to install. • Once a system is established, switching costs are high
JIT	• Affordable software, even for small companies • Reduction in set up times, inventory level and smoother flow of goods. • Increased supplier reliability and quality. • Flexible and efficient workforce due to employees' multiple-skills training. • Better scheduling/work hour consistency. • Better relationships between managers and employees. • Better relationships between managers and employees.	• Requires standardization of materials/ production process. • Risk of delay due to late deliveries, unexpected evens (e.g. natural disaster), and shortage of materials. • Slow respond to change in product design, large demand volume. • Adds a sociological point of failure due to bad relationships between workers and management • Typically requires

	• Improved performance/ throughput of employees to meet deadlines.	years to provide optimum results due to culture change.

Table2. Advantage and disadvantages of different production methods (Source: Emmanouil et al.)

Finally, ERP systems are usually so expensive that only big companies can afford them. In addition, they require time to implement and adapt to the specific workflow of some companies. This time depends on the company size, the extent of customization, the number of installed modules and the customer's contribution to the project. A typical project requires on average 14 months and 150 consultants [13]. A smaller project (e.g. company of less than 100 staff) may be implemented within 3-9 months, whereas a large, multi-site or multi-country implementation may take years.

3. Conclusions

Boom of industries and demands of products at low cost and at adequate quality leads to increase in level of competition. The number of the different variants of products and their complexity has been increased with a rapid rhythm. All these conditions have led to the growth and establishment of computerized systems for planning, management and control of the production Managers need to understand the philosophies of these systems, their strengths and limitations in order to choose what is best for their organizations. All the aforementioned systems surveyed can be both successful or fail under certain conditions. It is neither merely a matter of finding the system that promises greater profit, nor a matter of deciding which system seems to provide a best fit for the type of production operations involved. There are other practical considerations that should be taken into account, such as the effect of the system on the company culture, employees' practices and social relationships, and existing processes.

Table 2 summarizes the results of the critical review conducted in this paper. The table is meant to be used as a quick tool to support managerial system selection decision-making.

In this paper, we have presented a critical review of popular methods of industrial production management. For each system surveyed, a concise description of its philosophy and technical functionalities, along with practical considerations was provided. MRP/MRPII systems require administrative engagement, personnel training and increased accuracy and integrity of data. ERP systems require a careful analysis and alignment of the companies needs to the modules of an EPR system, an evolutionary implementation process supported by management, careful data migration strategies and cultural readiness. JIT systems force psychological and sociological considerations and require reliable suppliers.

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