INTRODUCTION TO JIT: A REVIEW
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Abstract - Just-in Time system has been defined and identified worldwide by many researchers and practitioners for world class manufacturing. This system has been accepted as a systematic approach to achieve competitiveness and excellence in manufacturing by many researchers and practitioners in many countries in last three decades. This system has potential to compete in the present scenario of rapid development and growth of industrialization. This paper presents the spread of JIT movement, concepts, objectives, elements, benefits, implementation and motivation of JIT system.

Keywords :- JIT, Elements, kanban, waste, 5’s

I. INTRODUCTION
The principle of Just in time (JIT) is to eliminate sources of manufacturing waste by getting right quantity of raw materials and producing the right quantity of products in the right place at the right time. The main purpose of this paper is to provide informations to the people who is interesting in knowing JIT.

Just-In-Time is a Japanese manufacturing management method developed in 1970s. It was first adopted by Toyota manufacturing plants by Taiichi Ohno. The main concern at that time was to meet consumer demands. Because of the success of JIT management, Taiichi Ohno was named the Father of JIT (Cheng). After the first introduction of JIT by Toyota, many companies followed up and around mid 1970’s, it gained extended support and widely used by many companies. One motivated reason for developing JIT and some other better production techniques was that after World War II , Japanese people had a very strong incentive to develop a good manufacturing techniques to help them rebuilding the economy. They also had a strong working ethic which was concentrated on work rather than leisure, seeked continuous improvement, life commitment to work, group conscious rather than individualism and achieved common goal. These kind of motivation had driven Japanese economy to succeed (Cheng). Because of the natural constraints and the economy constraints after World War II, Japanese Manufacturers looked for a way to gain the most efficient use of limited resources. They worked on “optimal cost/quality relationship”(Cheng). Before the introduction of JIT, there were a lot of manufacturing defects for the existing system at that time. According to Hirano, this included inventory problem, product defects, risen cost, large lot production and delivery delays. The inventory problems included the unused accumulated inventory that was not only unproductive, but also required a lot of effort in storing and managing them. Other implied problems such as parts storage, equipment breakdowns, and uneven production levels.

2. PHASES FOR IMPLEMENTATION OF JUST IN TIME

According to Hirano, the introductory phases of JIT involves 5 steps.

Step 1: Awareness Revolution
It means giving up old concept of managing and adopting JIT way of thinking. There are 10 principles for improvement:

1. Abolish old tradition concepts.
2. Assume that new method will work.
3. No excuses is accepted.
4. It is not seeking for perfection, absolutely zero-defect process, few defects is acceptable.
5. Correct mistakes immediately.
6. Do not spend money on improvement.
7. Use you brain to solve problem.
8. Repeat to ask yourself 5 times before any decision.
9. Gather information from several people, more is better!
10. Remember that improvement has no limits. (Hirano).

The idea of giving up old concept was especially for the large lot production. The lot production was felt that “having fewer changeover was better”, but it was no longer true. Whereas JIT is a one-piece flow manufacturing. To compare the two, Hirano had this idea. Lot production: “Unneeded goods...In unneeded quantities...At unneeded times...” JIT: ”Needed goods...In needed quantities...At needed times...”

The main point here is to have an awareness of the need of throwing out old system and adopting a new one.

Step 2: 5S’s For Workplace Improvement (Hirano)
This 5S’s should be implemented company-wide and this should be part of a total improvement program.

Seiri - Proper Arrangement means sorting what you have, identifying the needs and throwing out those unnecessary. One example is using red-tags. This is a little red-bordered paper saying what the production is, how many are accumulated and then stick these red tags onto every box of inventory. It enhances the easiness to know the inventory status and can reduce cost.
**Seiton** - Orderliness means making thing in order. Examples include keeping shelves in order, keeping storage areas in order, keeping workplace in order, keeping worktables in order and keeping the office in order.

**Seiso** - Cleanliness means having a clean workplace, equipment, etc.

**Seiketsu** - Cleanup mean maintaining equipment and tools.

**Shitsuke** - Discipline means following the rules and making them a habit.

**Step 3: Flow Manufacturing (Hirano)**

Flow manufacturing means producing one single piece of product at a time but multi-handling which follows the process sequence. There are several main points concerning flow manufacturing:

1. Arrange machines in sequence.
2. U-shaped production line (Cellular Manufacturing)
3. Produce one-piece at a time.
4. Train workers to be multi-skilled.
5. Follow the cycle time.
6. Let the workers standing and walking around while working.
7. Use small and dedicated machines.

The author continued by comparing lot production with flow manufacturing, here is a short summary of comparison:

<table>
<thead>
<tr>
<th>Lot Production</th>
<th>Flow Manufacturing</th>
</tr>
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<tbody>
<tr>
<td>1. Floor layout is job-shop type.</td>
<td>1. Floor layout is U-shaped cell.</td>
</tr>
<tr>
<td>2. Grouping machines of same type together.</td>
<td>2. Different types of machines are type together put together into one cell.</td>
</tr>
<tr>
<td>3. Large lot product.</td>
<td>3. One-single piece at a time.</td>
</tr>
<tr>
<td>4. Machines used are large.</td>
<td>4. Machines used are small.</td>
</tr>
<tr>
<td>5. Inventory is easy to accumulate between processes.</td>
<td>5. Less or even no inventory between processes accumulated.</td>
</tr>
<tr>
<td>7. Workers are sitting while working.</td>
<td>7. Workers are standing while working.</td>
</tr>
<tr>
<td>8. Workers are single-skilled.</td>
<td>8. Workers are multi-skilled.</td>
</tr>
<tr>
<td>9. Inspection at the final stage process</td>
<td>9. Inspection at the end of each process</td>
</tr>
</tbody>
</table>

So, we can see that there was a need to change from large lot production to flow manufacturing.

**Step 4: Standard Operations (Hirano)**

Standard Operation means to produce quality safely and less expensively through efficient rules and methods of arranging people, products and machines.

The basis of standard operations are:

1. Cycle time It means how long it would take to "carry out part all the way through the cell". (Hirano) Following are the equations for calculating cycle time. (Hirano)

\[
\text{Cycle Time} = \frac{\text{Working Hours per day}}{\text{Daily Quantity Required}}
\]

| Daily Quantity Required = Monthly Quantity Needed / Working Days per month |
| Cycle Time = Working Hours per day / Daily Quantity Required |

2. Work sequence
3. Standard stock - on - hand
4. Use operation charts

**Step 5: Multi-Process Handling**

Multi-process handling means one worker is responsible for several processes in a cell. (Hirano)

Some points that should be aware: (Hirano)
- Clearly assign jobs to machines and workers.
- Make a good use of U-shaped cell manufacturing.
- Multi-skilled workers
- Operation should be able to perform multi-machine handling and multi process handling.

**3. ELEMENTS OF JUST IN TIME**

According to Cheng, the basic elements of JIT manufacturing are:

- People Involvement
- Plants
- System

**People Involvement**

Maintaining a good support and agreement from people involved in production. This is not only reduce the time and effort in implementation of JIT, but also minimize the chance of creating implementation problem. (Cheng) The attempt to maximize people’s involvement may carry through the introduction of quality circle and total involvement concept. (Cheng)

Manufacturers can gain support from 4 sources.

1. Stockholders and owners of the company - should maintain a good long-term relationship among them. (Cheng)
2. Labor organization - all labors should be well-informed about the goals of JIT, this is crucial in gaining support from the them. (Cheng)
3. Management support - support from all level of management. The ideas of continuous improvement should spread all over the factory, managers and all shop-floor labor. (Cheng)
4. Government support - government can show their support by extending tax and other financial help.
This can enhance the motivation, and also help in financing the implementation of JIT. (Cheng)

**Plants**

Certain requirements are needed to implement JIT, there are:

**Plant layout** - the plant layout is mainly focus on maximizing working flexibility. It requires the use of “multi-function workers”. (Cheng)

**Demand pull production** - it means to produce when the order is received. This can manage the quantity and time more appropriately. (Cheng)

**Kanban** - a Japanese term for card or tag. Special inventory and process information are written on the card catch mistakes immediately.

**Continuous improvement** - this concept should be adopted by every members in the organization in order to carry out JIT. This is the most important concept of JIT. This can allow an organization to improve its productivity, service, operation and even customer satisfaction in an on-going basis. (Cheng). This helps tying and linking the process more efficiently. (Cheng)

**System**

This refers to the technology and process that combines the different processes and activities together. Two major types are MRP(Material Requirement Planning) and MRP II (Manufacturing Resource Planning). (Cheng) MRP is a computer-based, bottom-up manufacturing approach. This involves two plans, production plan and master production schedule. Production plan involves the management and planning of resources through the available capacity. Master production schedule involves what products to be produced in what time. (Cheng) MRP II is mainly involved the management or planning of financial resources in order to carry out the operation. (Cheng).

**4. GOAL OF JUST IN TIME**

According to Cheng in Just-In-Time Manufacturing – An Introduction, he explains the ideas of Suzuki for the objectives of JIT. There are three main objectives:

A. Increasing the organization’s ability to compete with others and remain competitive over the long run. The competitiveness of the firms is increased by the use of JIT manufacturing process as they can develop a more optimal process for their firms.

B. Increasing efficiency within the production process. Efficiency is obtained through the increase of productivity and decrease of cost.

C. Reducing wasted materials, time and effort. It can help to reduce the costs.

Other short-term and long-term objectives(Cheng) are:

1. Identify and response to consumers needs. Customers’ needs and wants seem to be the major focus for business now, this objective will help the firm on what is demanded from customers, and what is required of production.

2. Optimal quality/cost relationship. The organization should focus on zero-defect production process. Although it seems to be unrealistic, in the long run, it will eliminate a huge amount of resources and effort in inspecting, reworking and the production of defected goods.

3. Reduce unwanted wastes. Wastes that do not add value to the products itself should be eliminated.

4. Develop a reliable relationship between the suppliers. A good and long-term relationship between organization and its suppliers helps to manage a more efficient process in inventory management, material management and delivery system. It will also assure that the supply is stable and available when needed.

5. Plant design for maximizing efficiency. The design of plant is essential in terms of manufacturing efficiency and utility of resources.

6. Adopt the work ethic of Japanese workers for continuous improvement. Commit a long-term continuous improvement throughout the organization. It will help the organization to remain competitive in the long run.

**5. LIMITATION OF JUST IN TIME**

Regardless of the great benefits of JIT, it has its limitation, JIT has the following major limitations:

**Culture Differences**- The organizational cultures vary from firm to firm. There are some cultures that tie to JIT success but it is difficult for an organization to change its cultures within a short time.

**Traditional Approach** The traditional approach in manufacturing is to store up a large amount of inventory in the means of backing up during bad time. Those companies rely on safety stocks may have a problem with the use of JIT.

**Difference in implementation of JIT** Because JIT was originally established in Japanese, it is somehow different for implementing in western countries. The benefits may vary.

**Loss of individual autonomy** This is mainly due to the shorter cycle times which adds pressures and stress on the workers.

Loss of team autonomy This is the result of decreasing buffer inventories which lead to a lower flexibility of the workers to solve problem individually. Loss of method autonomy It means the workers must act some way when problems occur, this does not allow them to have their own method to solve a problem. JIT success is varied from industry to industry Some industries are benefit more from JIT while others do not.

**Resistance to change** JIT involves a change throughout the whole organization, but human nature resists to change. The most common resistance are emotional resistance and rational resistance. Emotional resistance are those psychological feeling which hinder performance such as anxiety. Rational resistance is the deficient of the needed information for the workers to perform the job well. Relationship between
management and employees is important. A mutual trust must be built between management and employees in order to have effective decision making. Employee commitment empowers must commit to JIT, to enhance the quality as their ultimate goal, and to see JIT as a way to compete rather than method used by managers to increase their workload. Production level JIT works best for medium to high range of production volume. Employee skill JIT requires workers to be multi-skilled and flexible to change. Compensation Compensation should be set on time-based wages. This allow the workers to concentrate on building what the customers wants.

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