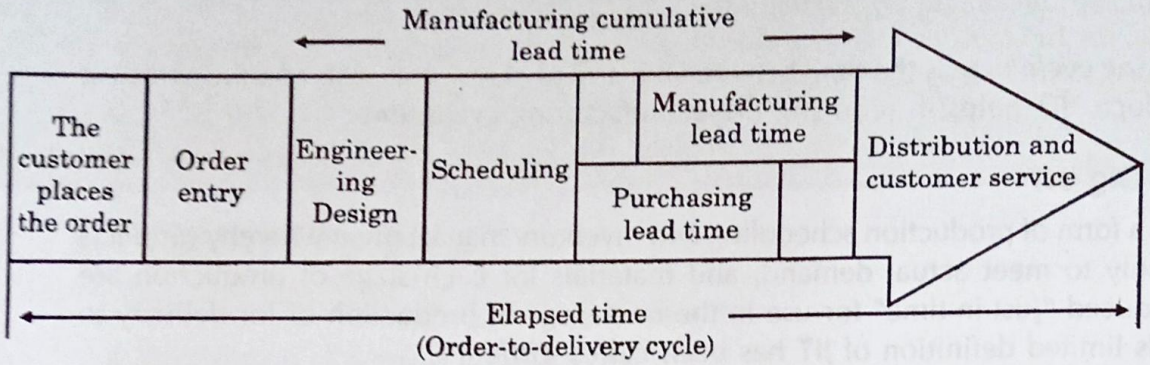

JIT has another major tenet in its philosophy-utilising the full capability of the worker. Workers in the JIT system are charged with the responsibility of producing quality parts just in time to support the next production process. If they cannot meet this responsibility they are required to stop the production process and call for help. In addition to greater responsibility for production, workers are also charged with improving the production process. Through quality teams, suggestion systems and other forms of participation, workers offer improvement to the production processes. Thus, the capabilities of workers are used to a much greater extent in the JIT system than in traditional production approaches.

Objectives of JIT manufacturing : The specific goal of JIT manufacturing is to provide the right quality level at the right place. Customer demand always determines *what is right.* JIT tries to build only what internal and external customers want and when they want it. The more focussed objectives of JIT are:

(i) Produce only the products (goods or services) that customers want.

(ii) Produce products only as quickly as customers want to use them.

(iii) Produce products with perfect quality.

(iv) Produce in the minimum possible lead times.

(v) Produce products with features that customers want and no others.

(vi) Produce with no waste of labour, materials or equipment, designate a purpose for every movement to leave zero idle inventory.

(vii) Produce with methods that reinforce the occupational development of workers.

Relevance of JIT to TQM

The achievement of JIT may sometimes be a spin-off or by product of a company-wide quality improvement (CWQI) programme or it may be one of a number of specific goals in such a programme. Either way, CWQI is fundamental to the achievement of JIT. While JIT may or may not be one of the outcomes of CWQI, JIT cannot reasonably be achieved without it. JIT is one of the goals of CWQI.

Basically, CWQI is a concept well established in Japanese organisations from the bottom to the top. The objective is to form an organisation where everyone at all levels and in all functions can work together and make their company the best in its field of operation.The overview of just-in-time manufacturing indicates that there are many activities which are common to Total Quality Management (TQM) which we have discussed in the earlier chapters.

Overview of JIT manufacturing

JIT manufacturing includes many activities :

(i) **Inventory reduction :** JIT is a system for reducing inventory levels at all stages of production *viz.* raw materials, work-in-progress and finished goods.

(ii) **Quality improvement :** JIT provides a procedure for improving quality both within the firm and outside the firm.

(iii) **Lead time reduction :** With JIT, lead time components such as set-up and move times are significantly reduced.

(iv) **Vendor control/Performance improvement :** JIT gives the buying organisation greater power in buyer-supplier relationship. The firm moves from a situation where multiple suppliers are used to a situation where only one or two suppliers are used for supplying most parts. With fewer suppliers, the buying organisation has more power because it is making larger purchases from each vendor. Also, the buying organisation can now impose higher requirements on each supplier in terms of delivery and quality.

(v) **Continuous Improvement :** In the JIT system, existing problems are corrected and new problems identified in a never-ending approach to operations management.

(vi) **Total Preventive Maintenance :** JIT emphasises preventive maintenance to reduce the risk of equipment break-downs which may cause production hold ups and increase in manufacturing cycle time due to delays.

(vii) **Strategic Gain :** JIT provides the firm's management with a means of developing, implementing and maintaining a sustainable competitive advantage in the market place.

An Ideal Production System and JIT Production

An ideal production system might be described by the following:

(i) Only one type of product is produced.

(ii) Demand for the product is constant at the rate of one unit every 't' units of time.

(iii) Customers purchase the product at the production facility.

(iv) All resources needed to produce the product (materials and labour) are available at the production site.

(v) All materials are without defect and will be delivered exactly when needed and only the amount needed will be provided (every 't' units of time, the materials to make one unit of product are delivered).

(vi) The amount of processing time required to make one unit of the product is "Nt" where N is a positive integer.

(vii) There is no randomness in processing times.

(viii) No defects are produced.

(ix) Machines never wear out or break down.

(x) Employees always show up for work and never make mistakes.

In the ideal production system, there are no raw materials, in-process or final product inventories, except the product actually being processed at the workstations. There is no need for safety stocks of any kind because it is known when demand will occur and there are no unexpected production shortages due to quality defects, machine break-downs or employee absences. Because only one product is made, no time is lost on changing over or setting up machines and no scheduling or coordinating of different products or jobs is necessary. Such a system would be easy to manage.

Unfortunately, in the real life, the situation is not like the ideal production system. Most firms produce a variety of products that share equipment and personnel in their production, demand is not uniform and totally predictable, final products must be transported to spatially dispersed customers, resources must be collected from various locations, deliveries are not always reliable and there are economies of scale in acquisition. The tasks performed in the production process are often lumpy (not totally decomposable) in terms of their processing times, processing times are variable, mistakes are committed, defects occur, machines break-down and employees are absent. Firms normally accommodate these deviations from the ideal environment by changing the design and operation of the system in ways that result in higher cost, lower quality and less timely product delivery than occuring in the ideal system.

The one consistent system of deviation from the ideal production system is excessive inventories, in addition, excessive amounts of materials and products have to be scrapped due to poor quality and due to overproduction in anticipation of demand that does not materialise. Inspite of carrying large inventories and overproducing, firms may still suffer from poor product quality and late deliveries to customers.

The JIT philosophy and JIT system has been successful not simply because it reduces inventories and scrap but, more important, because it recognises that excessive inventories are symptomatic of more fundamental problems. Big JIT philosophy focusses on *eliminating* problems of demand variations, unreliable deliveries of raw materials, processing time variations and excessive set-up times. Reduction of inventories is then a natural consequence of the improvements in the production system.

CHARACTERISTICS OF JUST-IN-TIME SYSTEM

Employee-involvement and inventory reductions are essential to JIT.

JIT systems focus on reducing inefficiency and unproductive time in the production process to improve continuously the process and quality of the product or service. *Employee involvement and inventory reductions* are essential to JIT operations. The salient characteristics of JIT are:

(i) pull method of material flow
(ii) constantly high quality
(iii) small lot sizes
(iv) uniform workstation loads
(v) standardised components and work methods
(vi) close supplier ties
(vii) flexible workforce
(viii) line flow strategy
(ix) automated production and
(x) preventive maintenance.

The above characteristics are discussed in the following paragraphs.

In a pull system, customer demand activates production of the item.

***(i)* Pull Method of Materials Flow :** In the pull method, the customer demand activates production of the item. The concept behind JIT is that of a pull system, which is a system that pulls a unit to where it is needed just as it is needed. A pull system uses signals to request production and delivery from stations upstream to the station that has production capacity available. The "pull" concept is used both within the immediate production process and with suppliers. By pulling material through the system in very small lots just as it is needed, the cushion of inventory that hides problems is removed,

problems become evident and a continuous improvement is emphasised. Removing the cushion of inventory also reduces both investments in inventory and manufacturing cycle time.

(ii) **Consistent High Quality :** JIT systems seek to eliminate scrap and rework in order to achieve a uniform flow of materials. Efficient JIT operations require conformance to product or service specifications and implementation of behavioural and statistical methods of TQM. JIT systems control *quality at the source*, with workers acting as their own quality inspector.

Management must realise the enormous responsibility this method places on the workers and must prepare them for the same. In one division of General Motors (GM), when JIT was implemented in 1985, management authorised its workers to stop the production line by pulling a cord if quality problems arose at their stations – a practice the Japanese call *"andon"*. GM also eliminated production line inspectors and cut the number of supervisors by half. Later, the *"andon"* system was modified to include a yellow warning cord so that workers can call for help without stopping the line.

(iii) **Small Lot Sizes :** Rather than building up a cushion of inventory, users of JIT system maintain inventory with lot sizes that are as small as possible. The benefits of lot sizes are:

JIT systems maintain inventory with lot sizes as small as possible.

(a) Reduction of *cycle* inventory (work-in-process inventory). The average cycle inventory equals one-half the lot size. Reducing lot size reduces the cycle inventory which in turn reduces the time and space involved in manufacturing and holding inventory.

(b) Small lot sizes help reduce lead times. A decline in lead time in turn reduces WIP inventory because the total processing time at each workstation is greater for larger lots than for small lots. Also, a large lot has to wait longer to be processed at the next workstation while that workstation finishes working on another large lot. In addition, if any defective items are discovered, large lots cause longer delay because the entire lot must be inspected to find all the items that need rework.

(c) Small lots help achieve a uniform operating system workload. Large lots consume large chunks of processing time on workstations and therefore complicate scheduling. Small lots can be processed more effectively, enabling utilisation of capacities more efficiently.

However, the disadvantage of small lot sizes is increase in the frequency of set-ups. For operations having sizeable set-up times, small lots may result in waste of employee and equipment time due to repetitive set-up. Hence, in JIT production, the operations must reduce the set-up time to realise the benefit of small-lot production.

(iv) **Uniform Workstation Loads :** The JIT system works best if the daily load on individual workstations is relatively uniform. Uniform loads can be achieved by assembling the same type and number of products each day, thus creating a uniform daily demand at all work stations. Capacity planning which recognises capacity constraints at critical workstations and line balancing are used to develop the monthly master production schedule.

(v) **Standardised Components and Work Methods :** The standardisation of components called *part commonality* or *modularity* increases repeatability. *For example,* a firm producing 10 products from 1000 different components could redesign its products so that they consist of only 100 different components with longer daily requirements. Because the requirement per component increases, so does repeatability, that is, each worker performs a standardised task or work method more often each day. Productivity tends to increase because with increased repetition, workers learn to do the task more efficiently.

Standardisation of components and work methods in JIT production systems aid in achieving high productivity and low inventory.

Standardisation of components and work methods aid in achieving the high productivity, low inventory objectives of JIT systems.

Close relationships with suppliers enable JIT systems to operate with very low levels of inventory.

(vi) **Close Supplier Ties :** Because JIT systems operate with very low levels of inventory, close relationships with suppliers are necessary. Stock shipments must be frequent, have short lead times, arrive on schedule and be of high quality. A supplier may have to deliver goods to a factory as often as several times per day. Purchasing managers focus on reducing the number of suppliers, using local suppliers and improving supplier relations.

Manufacturers using JIT systems generally utilise local suppliers. Firms that have no suppliers close by must rely on a finely tuned supplier delivery system. Geographic proximity of suppliers enable the firms to reduce the need for safety stocks.

Firms implementing JIT systems reduce the number of their suppliers considerably. This approach puts a lot of pressure on these suppliers to deliver high quality components on time. JIT users extend their contracts with their suppliers and give them firm advance order information. In addition, they include their suppliers in the early phases of product design to avoid problems after production has begun. They also work with their suppliers' vendors to achieve JIT inventory flows throughout the entire supply chain.

Users of JIT system also find that a cooperative orientation with suppliers is essential. The JIT philosophy looks for ways to improve efficiency and reduce inventories throughout the supply chain. Close cooperation between firms and their suppliers can be a win-win situation for every one. Better communication of component requirements enables more efficient inventory planning and delivery scheduling by suppliers, thereby improving profit margins of suppliers. Customers can then negotiate lower component prices. Suppliers also should be included in the design of new products so that inefficient component designs can be avoided before production begins. Suppliers should be considered as partners in a venture wherein both parties have an interest in maintaining a long term profitable relationship.

Flexible workforce comprises workers having multiskills trained to perform more than one job or task.

(vii) **Flexible Workforce :** Workers in flexible work force can be trained to perform more than one job. When the skill levels required to perform most tasks are low, a high degree of flexibility in the workforce can be achieved with little training. In situations requiring higher skill levels, shifting workers to other jobs may require extensive, costly training. Flexibility can be very beneficial : workers can be shifted among workstations to help relieve bottle-necks as they arise without resolving to inventory buffers – an important aspect of the uniform flow of JIT systems. Multi-skilled workers may do the job of those who are on vacation or who are absent due to sickness.

(viii) **Line Flow Strategy :** A line flow strategy can reduce frequency of set-ups. If volumes of specific products are large enough (mass production), groups of machines and workers can be organised into a product lay-out to eliminate set-ups entirely. If volume is insufficient to keep a line of similar products busy, *group technology* can be used to design small production lines that manufacture, in volume, families of components with common attributes. Change over from a component in one product family to the next component in the same family are minimal.

(ix) **Automated Production :** Automation plays a big role in JIT systems and is a key to low cost production. Money freed up because of JIT inventory reductions can be invested in automation to reduce costs. The benefits, of course are greater profits, greater market share or both. However, automation should be planned carefully.

(x) **Preventive Maintenance :** Because JIT emphasises finely tuned flows of materials and little buffer inventory between workstations, unplanned machine down time can be

disruptive. Preventive maintenance can reduce the frequency and duration of machine down time. Maintenance is done on a schedule (frequency) that balances the cost of the preventive maintenance program against the risks and costs of machine failure.

Total preventive/productive maintenance concept makes workers responsible for routinely maintaining their own equipment and to develop employee pride in keeping their machines in top condition. This is however restricted for simple maintenance tasks such as lubrication, cleaning and minor adjustment of the machines. Maintenance of high-tech machines need trained specialists.

JIT Manufacturing Versus JIT Purchasing

Just-in-time manufacturing is an organisation-wide quest to produce output within the minimum possible lead time and at the lowest possible total cost by continuously identifying and eliminating all forms of waste and variance. ***Just-in-Time purchasing*** has the same pull type approach used in JIT manufacturing (or JIT production) applied to purchasing shipments of parts from suppliers. The essentials of JIT purchasing are :

JIT manufacturing: An organisation-wide approach to produce output with in the minimum possible lead time and at the lowest possible total cost by continuously identifying and eliminating all forms of waste and variance.

(i) ***Supplier development*** and ***supplier relation*** undergo fundamental changes. The supplier and customer have co-operative *relationship* which is also known as *subcontractor network* and suppliers are referred to as co-*producers*. Sensitive information, assistance in reducing costs and improving quality and even financing are often shared by customers and suppliers.

(ii) Purchasing departments develop *long term relationships* with few suppliers rather than a short term relationship with many suppliers.

(iii) Although price is important, delivery schedules, product quality and mutual trust and co-operation become the primary basis for the selection of suppliers.

(iv) Suppliers are encouraged to extend JIT methods to their own suppliers.

(v) Suppliers are ordinarily located near the buying firm's factory or clustered together at some distance which will keep the lead times shorter and more reliable.

(vi) Shipments are delivered directly to the customer's production line usually through transportation vehicles owned by suppliers.

JIT purchasing: Same pull type approach used in JIT manufacturing applied to purchasing shipments of parts and components from suppliers.

(vii) Parts are delivered in small, standard size containers with a minimum of paperwork and in exact quantities.

(viii) Delivered material is of near-perfect quality.

Pre-requisites for JIT Manufacturing

JIT production drastically reduces WIP inventories throughout the production system and thereby reduces the manufacturing lead times. The result is a smooth, uninterrupted flow of small lots of products throughout production. Most successful JIT applications have been in repetitive manufacturing operations where batches of standard products are produced at high speeds and high volumes with materials moving in a continuous flow.

Before implementing the JIT system, certain changes to the factory and the way it is managed must occur before the benefits of JIT can be realised. These changes are:

(i) Stabilise production schedules.

(ii) Make the factories focussed.

(iii) Increase production characteristics of manufacturing work centres.

(iv) Improve product quality.

(v) Cross-train workers so that they are multi-skilled and competent in several jobs.

(vi) Reduce equipment break downs through preventive maintenance.

(vii) Develop long-term supplier relationships that avoid interruptions in material flows.

Elements of a JIT Manufacturing System

The JIT manufacturing system has six major components or elements.

The important elements or components of a JIT manufacturing system are:

(i) Eliminating waste

(ii) Enforced problem solving

(iii) Continuous improvement

(iv) Involvement of people

(v) Total quality management and

(vi) Parallel processing.

The elements of JIT mentioned above are discussed in the following paragraphs.

(i) Eliminating waste : Eliminating waste of all kinds is the deep-seated technology behind JIT. *Waste* is any activity or action that adversely affects the value equation for the customer. Waste is a negative to be avoided or eliminated. Rather than increasing or enhancing value, waste reduces value. *For example,* if a company wants to compete on quality, flexibility and performance, then anything that reduces quality, decreases flexibility or adversely affects performance is a waste.

Managers must view waste, like value, from a customer's perspective. As an example, consider inventory, items that a firm keeps in stock, from raw materials to products currently in production (work-in-process) and completed products (finished goods) held in stock before selling. In general, operations managers view inventory as waste because of the following reasons :

(i) Inventory hides problem with the transformation process by allowing it to draw on stocks to avoid disruptions instead of correcting the cause of the problem.

(ii) Inventory consumes corporate resources such as storage space, money to pay for it, people to count and manage it.

(iii) Inventory increases lead times because more inventory means that more work is in the system at any time, which means that it takes longer for any item to go from start to finish. Reducing the waste of inventory should result in shorter lead times, higher quality through improvements in the process and lower costs and this should equate to higher value.

There are seven categories of waste in production that shoule be eliminated.

Categories of Waste : Shigeo Shingo, a JIT authority at Toyota, identified *seven wastes* in production that should be eliminated. They are listed in *Box 24.3.*

Japanese perspective of waste states: "waste is anything other than the minimum amount of equipment, materials, parts, space and worker's time which are absolutely necessary to add value to the product."

Box 24.4 gives examples of waste.