Chapter 3*

Just in Time Supply Chain

This chapter will discuss the definition of Just in Time Supply Chain (JSC) and its important attributes encountered in the literature review. Due to JIT implementation system of supply chain develops many complications which are discussed with the help of general system theory.

3.1. Just in Time Supply chain

Recent trend is to strengthen Supply chain Management by improving procurement of raw materials, manufacturing process, distribution process of finished goods and improving information flow. The contribution of Mistry (2005) in this field has been taken into accounts. The author has emphasized compression of lead time, removal of all non-value adding activities, maintaining low level of inventory and utilizing the entire human resources in optimized way. Following definition can be cited of JIT supply chain.

“A just-in-time supply Chain Management (JSCM)” manages the supplier, manufacturer and distributors in philosophy of reducing the inventories, removing the wastes, improving the quality, speeding up the flow of material and information, building up long term relationships and after all establishing the cooperative working cultures”.

Forty six attributes and fourteen performance factors of JIT Supply Chain are recognised in the literature. With the help of experts, five dimensions of attributes and factors of performance of JIT supply chain are proposed here. The brief discussion of relevant attributes and Performance factors under suitable dimensions are done below.

3.2. Dimensions of JIT supply chain

Supply chain management is integration of procurement, manufacturing and distribution process to get the seamless flow of material and information. Following five dimensions of JIT supply chain can be laid down.

1. Procurement process
2. Manufacturing process
3. Distribution Process
4. Information sharing
5. Human involvement

3.2.1 Procurement process

Purchasing of raw material from the vendor by the manufacturer has been termed as procurement process in this thesis. In JIT Supply chain it is desired that the supply of the raw material by the supplier/ vendors should be flexible, frequent, certified, as per quality demanded and economical. (Goyal and Deshmukh 1992; Garg et al.1999; Joe et al. 2012). The following are brief discussion of attributes under this dimension.

i. Supplier Selection: supplier selection for JIT manufacturer is mandatory. Only those suppliers are given contract/ order of supply, which are well aware of JIT philosophy and is willing to practice at his level.Wu and Pheng, (2006) and Joe et.al, (2012) are reporting that to supply the raw material and other services firms seek the good and responsive vendors who can meet the supply requirement as and when required. For finding the suitable vendor auditing of his supplying capacity, quality, prices and timeliness are to be carried out.

ii. Supplier evaluation: Garg et al. (1999) states that each supplier is to be evaluated for his quality standard, timeliness and preparedness to supply the material at any time. While doing evaluation, the experts scrutinise vendor’s capacity, history and technological supports too.

iii. Fewer suppliers: Researchers support few suppliers in JIT manufacturing. With few suppliers, manufacturer is able to control, maintain long term relationship and extends the technical supports.

iv. Supplier Training: Once the supplier or vendor is selected the firm gives the technological support in terms of training. The manufacturer involves supplier to learn how to maintain the quality and standard of the firm with supply of right material in time. Zhuang (1994); Wu and Pheng, (2006) describe training and support to the suppliers which are to be extended by firm to meet the required standard of the supplied material enhances the quality assurance programme.

v. Long term contract: generally long term contract provides better relationship between supplier and receiver. This would give benefits of cost, quality and
timeliness. Expected fare practices by supplier will depend upon long term practices and well coordination between buyer and suppliers (Hong and Hayya, 1992).

vi. Mutual trust and cooperation: Seongje et.al. (2008) explains that the firm and supplier must have faith in each other and should share the informative material readily. The mutual trust will be based upon long term contract between buyer and supplier of the raw materials.

vii. Supplier’s participations: Joe et.al, (2012) suggests that Supplier of the firm must actively participate in technological development with the firm for the improvement of raw material supply. This act will improve the product design, requirement of the manufacturer, difficulties and opportunity in supplying.

viii. Small lot production: Garg, (1999), describes JIT procurement is management’s decision to maintain a smaller inventory by regularly purchasing goods in smaller lot size. He stresses that in manufacturing firm there is a continuous requirement of raw material as its input. By small lot sizing inventory level can be reduced at low levels Pamela, (2012) and Emerson et al.(2009) reported that the low level inventory at all time in form of raw materials will lower the other inventories of semi-finished and finished products.

ix. Short lead time: Mistry (2005) have mentioned about the supply of the material at the shortest possible time to avoid delay in manufacturing process.

x. Flexible supply: Fararhani and Elahipanah (2008) have reported a very urgent requirement to have flexible supply of raw material in order to meet varying production requirement. The flexibility is in terms of time and quantity.

xi. Quality at the source: The quality of raw material if good at source itself, the further processing on it takes lesser time, efforts and investment.

xii. Frequent supply: Emel et al. (2013) suggest that Supply of the material in JIT system is exactly as per requirement of the production process on daily basis, as carrying the minimum inventory even tending to zero. This requires frequent shipping of raw material in small lot. In recent years, researchers have extensively studied small lot sizing as a means of implementing successful JIT purchasing, with the buyer–supplier coordination. However there is a chance of possible higher delivery costs and loss of discount rates, because implementation of frequent deliveries in
small lots requires firms to reduce the number of suppliers even to a single supplier (Nassimbeni, 1995).

**xiii. Reduced paper work:** Paper work is drastically reduced due to use of electronic media. The buying and forwarding of demand is conveyed through use of internet. E-biding, e-tendering etc. are helping in procurement process of raw materials.

**xiv. Supplier certification:** The supply of raw material is preferably demanded by certified firms. For example firms seek ISO, ISI, and other quality certificates for better marketing which give them competitive advantages.

### 3.2.2. Manufacturing process

Earlier finished goods were stored and were supplied to the market whenever demands were raised. Iwase and Ohno, (2011); Fredendall and Hill, (2012) have reported the overall result of JIT manufacturing extremely appreciable. Kang, et.al. 1994; Christensen, et.al,(2005) indicated the advantages of JIT in reducing set up time, scraps generation, rework/ reprocess, ideal manpower and overall inventory. Along with reduction in inventory JIT also worked as catalyst of continuous improvement programme in manufacturing processes as a regular routine and was termed as Kizen (Brox and Fader, 1997). The important manufacturing attributes of JSC encountered in Literature survey are briefly discussed.

**i. Produce some product each day:** Vokura and Lumuns (2000) have mentioned that some fixed quantity of the product should be manufactured every day to avoid the inconvenience when some changes in demand are forwarded from distributors within short notice to the manufacturer. The minimum quantity of production on every day is also required to ascertain the good functioning of machinery.

**ii. Quick equipment change over:** Kumar et al. (2002) suggested that tool changing time is period during which new set up is prepared for other work. This is very critical because till that time production and the working force remain stand still. In this period, inventory and other associated investment add no value in supply chain process. For JIT production low tool setting up time is highly appreciated.
iii. **Standard work:** The Toyota Production System organizes all jobs around human motion and creates an efficient production sequence without any "Muda" (waste). Work organized in such a way is called standardized work. It consists of three elements: Takt-Time, Working Sequence and Standard In-Process Stock.

iv. **Produce to replenishment:** Brox and Fader, (2002) suggest that JIT also allow to produce some product every day to replenish the product kept in shelves, so that old stock may be replenished at marginal profits even in case the product selling in market has come on halt.

v. **Waste elimination:** Non-value added activities are termed as waste. It is also called Muda. There are seven types of Muda: (Overproduction, waiting, conveyance, processing, inventory, motion and correction). JIT philosophy always supports the nil waste occurring due to any reason.

vi. **Visual control:** Go and see the problem. It is the belief that practical experience is valued over theoretical knowledge. Visualization is very important to understand the real problem. JIT encourages the top management and other supervisors to visualise the process for better control and not by mere remote control.

vii. **Pull production system:** It refers to the manufacturing and conveyance of only “what is needed, when it is needed, and in what amount needed.” It is based upon order to build. It was also felt that production should be demand driven. The practices in turn reduced ideal inventories of finished/ semi-finished goods at all levels of supply chain.

viii. **Total productive maintenance:** For smooth running of machines, a concept of total productive maintenance (TPM) is scheduled in the firm. This includes, scheduled preventive maintenance, overhauling and time to time machine replacement programs. Operators are actively responsible for the maintenance of their machines.

ix. **Kaizen events:** Kaizen means continuous improvement in terms of quality practices, time compression, innovations and maintenance programme. Kaizen events can be as short as four hours or as long as five days depending on the improvement opportunity that is being addressed.
x. **Quality product**: Quality of product is what it was expected from it to do. The customer always expects better quality of a product. If his expectation is met, the product gains the customer value. However quality practices required technological supports, good infrastructures, clear policies of top managements, skilled man power and after all good financial supports.

xi. **Group Technology (GT)**: For speedy manufacturing process use of group technology is used in which similar processes are done on a group of machines at one place/floor area? Thus there is ample saving of time of travel of material from one work bench to another.

xii. **Team-Based Problem Solving**: In case of problem in processing line, workers are assembled together and remove the snags in joint efforts. This makes the workers self-dependent and conversant of all types of snags in the line.

xiii. **Point-of-Use Material Storage**: It is always advisable to store the working material right to the workers approach in order to avoid the walking and bringing the material for processing. For this, provision is done to store the material nearer to the workers coming from store or other work bench.

### 3.2.3. Distribution Process

Distribution Process is to positioning of warehouses and distribution of the finished goods. The finished goods are positioned (warehoused) at the convenient place so that retailers/ customers’ demands are met at the earliest. The main attributes of the Distribution process of JSC encountered in literature are discussed in brief.

i. **Quick response**: JIT supply chain is based on the quick responses to the customers as well as to the manufacturers in terms of getting the right material at the shortest possible time. Literature indicates that only quick and reliable delivery of finished product cannot be sufficient in distribution process but quick responses after sale in case of guarantee and warrantee is also to be included. Park, et.al. 2010; Chan and Zuang, (2011) reported that caring of customer after sale of product is also a responsibility of manufacture and distributors and should be responded at the earliest.
ii. **Cross docking:** Cross docking is a practice in logistics of unloading materials from an incoming semi-trailer truck or railroad car and loading these materials directly into outbound trucks, trailers, or rail cars, with little or no storage in between. This may be done to change type of conveyance, to sort material intended for different destinations, or to combine material from different origins into transport vehicles (or containers) with the same, or similar destination. Kreng and Wang (2005); Nassimheni, (1995) have reported cross docking as shortening the transportation time, elimination of warehousing and accelerating the distribution process faster.

iii. **Integrated logistics/distribution:** Distribution process becomes smooth if logistics facility is integrated with after sale supports, transportation fleet, arrangement of warehouses etc. The integrated logistics reduced the total time taken in meeting the customer’s expectations.

iv. **Third-Party Logistics (3PL):** A third-party logistics provider (abbreviated 3PL, or sometimes TPL) is a firm that provides service to its customers of outsourced (or "third party") logistics services for part, or all of their supply chain management functions. Third party logistics providers typically specialize in integrated operation, warehousing and transportation services that can be scaled and customized to customers' needs based on market conditions and the demands and delivery service requirements for their products and materials.

v. **Reliable transportation:** Quick, efficient and cost competitive transportation is key attribute to meet JIT distribution process. Qiang, et.al. al. (2010); Olhager and Prajogo, (2012) add quick, safe, reliable delivery on reasonable cost has prompted web retailers giant to play a very important role in distribution process of finished goods.

vi. **Quality packing:** The transportation of finished goods is the next requirement in order to provide the product at the place of demands. But before that the finished products require a protective cover in order to save those items from the damage in the transit. Hence standards packaging of product is an urgent need to produce the product as it was out from the factory.
vii. **Warehousing**: Warehousing is positioning of storage site for the shipped material or before shipping after goods out from the firm. It is very strategically issue in the supply chain so that goods in and out become easy. Zimmer (2002); Wang, et.al. (2004) have reported in their studies that finished goods produced at manufacturing firms are to be positioned (warehoused) at a convenient place. It enhances the delivery speed against demanded goods from the wholesalers, retailers as well as customers.

viii. **Quick delivery**: The demand raised by the customer is to be supplied with the right quantity as soon as possible. However for quick delivery there is an urgent requirement of efficient transportation system, which includes speedy fleets of vehicles, infrastructural supports like roads, railway tracks, safe airways and water ways (Steele, 2000).

ix. **Vendor Managed Inventory (VMI)**: It is a concept in which buyer of a product provides certain information to a vendor /supplier of the product and the supplier takes full responsibility for maintaining an agreed inventory usually at buyer’s consumption locations. This is used fully to avoid a product unintentionally out of stock and reduces inventory in supply chain. It is kind of shared risk in which in some cases if the inventory does not sell, the vendor will repurchase the product from buyer. In other cases, the product will be in possession of retailer but is not owned by retailers, meaning that retailer simply houses of the product. VMI relieves the burden of selling of product by wholesalers or retailers.

x. **Freight consolidation**: It is a summing of all part loads in a vehicle based on similarity of material, destination, timing etc. This is done to reduce the transportation cost and waiting timing of material to be conveyed. In various literatures it is also termed as composite transportation management for JIT distribution system.

### 3.2.4. Information sharing

The foundation of the information-sharing studies within the Supply Chain domain started early of seventies. Luftman, (1998) recognise the information technology (IT) and Management information System (MIS) with business strategy and acts as a major inhibitor to organisational success. Soosay et al. (2008) and Tan, (2007) have mentioned in Supply Chain literature that information sharing is a potential tool in enhancing the overall performance of the system. The following information sharing attributes encountered in Literature are discussed briefly.
i. **Linked supply chain nodes:** The various nodes of supply chains are vendors of the raw materials, distributor's network, service centres and customer supports. These nodes are to be well connected through proper information networking.

**ii. Effective communication:** Accurate and sufficient data is to be shared at each supply chain nodes. Miemczyk et al. (2012); Liao and Chang (2010), also have reported sharing of information hourly, daily, weekly and monthly basis among all the stakeholders for updated information of material in SC. They stressed upon Sufficient, Accurate, timely, unbiased information sharing.

**iii. Electronic Data interchange:** By sharing information in supply chain number of benefits are sought in literature. The mode of information sharing is transferring of soft data to the relevant stakeholder in a supply chain.

**iv. Synchronised supply and demand:** With the use of latest technology and supports of IT the forecast of the demand can be synchronised with the supply of finished products. This avoids the bullwhip effects generally happens due to safe demand forwarded by each supply chain nodes i.e. demanding more than required to keep reserve as buffer stock at each supply chain nodes. In sum the quantity becomes too huge.

### 3.2.5. Human involvement

For success of JIT various researchers had shown that human factors are very potential tool to get a change in the organisation either at worker level or at management level. Hence its prime duties of firm’s owners to keep their staff contended therefore internal customer’s satisfaction and morale of staffs is very high. An organisation without human involvement even cannot be thought up. JIT being a quality improvement concept it solely depends upon the cooperation, mutual trust, dedication, cross training etc. The researchers pleaded that, JIT is a culture in which intimate involvement of staff and their efforts to improve organisation. Banerjee, et al. (2007) has reported the human involvements at various levels in a supply chain like; in decision making, in operation and in administration. The following human related attributes are encountered in the literature review.

**i. Cross trained workers:** Multi-functional workers are assets for the firm. If one worker is trained in such a way that he performs several functions when and where
required, it increases the performance of the firm. Literature suggests in providing special incentives to those cross trained workers for better motivation and result.

**ii. Dedicated staff:** Duty first and self-motivated workers are assets of the firm. These staffs take interest and feel proud to discharge their duties. JIT implementation becomes practicable only when there is strong sense of dedication in various processes.

**iii. Workers empowering:** Workers of the firms at all levels must be included in decision making once firm advances to take a vital decision. The most obvious ways of demonstrating management support to the workers are the provisions of resources and finance assistance for any mishaps (Storey et al., 2005).

**iv. Strong top managerial team:** According to Fawcett et al. (2006), top management support, broad-based functional support, channel support, and infrastructure/governance support are needed to achieve the highest levels of supply chain success. Top management support can also be demonstrated by participation of top management in employees’ daily operations and decision-making processes. Gerbing et al. (1994) suggest that management participation has two dimensions – involvement and influence. Winter and Knemeyer, (2013) reported that generally decision making is a priority task of top level of management whereas JIT argues to involve staffs positioned at all levels. This will increase in tackling the problem even at the lowest level and can avert major break down at the later stages. Committed top management is responsible to brings changes in organisation like empowering of their staffs (Iwase and Ohino, 2011), trusting on them (Wang et al 2004), participation of staffs in policy making (Chandra, 2000), employee retention attitudes (Fawcett et al. 2006) and high administrative supports (Farahani and Elahipanah, 2008).

**v. Cultur change:** In JIT environment, required work culture is in terms of; trust, loyalty, responsibility, development, motivation, authority, long term relationship and respect for human being. It is critical for a firm to make conscious and deliberate efforts to change the work culture for successful implementation of JIT. These changes in work culture require top management commitment, involvement and leadership, worker participation in decision making and massive education and training to the people concerned. Generally, cultural factors are biased against above
said rapid and massive changes because people prefer an existing inequity to known improvement.

3.3. Important Performance parameters of JSC

Important factors affecting performance of Supply chain can be classified in five dimensions.

- Supplier’s performance
- Manufacture’s performance
- Distributor’s performance
- Performance of information sharing
- Business performance

3.3.1. Supplier’s performance

Supplier’s performance depends upon the flexibility, timeliness, responsiveness and longevity in supplying of raw materials. The cooperative attitudes of supplier will improve production and distribution process in a supply chain.

i. Flexibility: JIT manufacturer demands the supply of raw material as demand raised by the distributors/retailers/customers for manufacturing the product in desired quantity/number. The demand of raw material may vary in terms of quantity and time of supply. The minimum deviation from the quantity and timings against demand raised by manufacture is higher flexibility.

ii. Longevity: with longevity, it is understood that relationship between supplier and manufacturer stands good for longer period. This is important to a manufacturer in order to be comfortable in meeting the production schedules. Long term relationship helps supplier in getting technical and other supports from the manufacturers and manufacture gets discount from supplier.

iii. Quality: The high level of quality of supply of raw materials always helps in producing the quality products on later stage. A supplier performance is dependent of the quality of raw material he supplies for longer period at reasonable rate.
3.3.2. Manufacturer’s performance

Literature indicates number of parameters affecting the performance of Manufacturer. The most important attributes encountered in various research articles are set up time reduction, reduction of total time taken in processing of material till it transforms into finished goods and minimisation of rework/scrap. Therefore three important manufacture’s performance parameters are discussed below.

i. Reduced cycle time: The intention of a manufacture is to achieve time compression of processing the material. The more comfortably he meets the time reduction target the better performance he achieves however there is limitation of time reduction.

ii. Reduced inventories level: The prime purpose of JIT is to reduce all types of inventories like semi-finished, finished and assembled. The low level of inventory in manufacturing process saves cost, manpower and handling of materials. This trend helps the manufacturer not to accept excess of inventory of raw materials from the supplier simultaneously never stocks up finished product at his ends. Therefore overall performance of JIT supply chain improves highly.

iii. Reduced scrap: Rework is wastage of material, energy, man power, time and money. The use of suitable machines and manpower prevents scrap. A manufactures performance is recognised by the nil/low level of scrap/rework carried out in his firm.

iv. Quality product: Quality production is indication of better performance of manufacturer.

3.3.3. Distributor’s performance

Distribution process includes warehousing, transportation and after sale supports. A distributor’s performance is adjudged by way he performs in maintaining the warehouses, transportation facility and after sale support system. Three important attributes of performance of distributor are discussed here.

i. Efficient warehousing: Locating the ware housing centrally in order to facilitate the retailers/wholesalers/customers to have frequent access of the warehouses for supply of goods. The management of proper retrieval and stacking facility, use of suitable material handling equipment and trained work forces make warehousing efficient; consequently there is improvement in the JIT supply chain.
ii. **Efficient Responsiveness:** Responsiveness can be defined as the ability to adjust plant’s output in order to satisfy short-term demand changes. The after sale supports or taking care of demand of customised customer is also considered under responsiveness. The quick solutions of customer’s query gives lot of product values. The efficient resolution of queries is a parameter to gauge the distributor’s performance.

iii. **Delivery Speed:** The expectation of customer to get the product on promised delivery time is increasing. The delivery of product can only be done when there is availability of safe and quick transportation system. The distributor’s performance highly depends upon all those aspects.

3.3.4. **Performance of information sharing**

In modern business information technology has changed all barriers of communication. The effective communication is urgently required to all supply chain partners. What is level of inventory, next lot size, demand of raw material, where about the consignment etc. are to be known by all stakeholders of supply chain. Hence for good performance by an organisation it must be well equipped and conversant of methods of information sharing. Two important parameters recognised through literature are discussed here.

i. **Data sharing frequency:** It is mentioned earlier about supply chain nodes connectivity with information networking. The sufficient and accurate data sharing is required at definite time intervals. The more frequent data sharing takes place the better performing the information system.

ii. **Data accuracy:** The communication between the SC partners should be unambiguous. The information should be reliable otherwise mistrust will lead to the loss of the business. The use of latest technology helps in transferring the accurate and sufficient data.

3.3.5. **Business performance**

Business performance is generally acknowledged by return on investment, asset turnover and market share of product. Therefore three important aspect of performance encountered in literature have been discussed here.
i. **Return on Investment (ROI):** Return on investment is profit divided by the investment done by a firm. The performance of JIT supply chain will largely depend upon the return on investment as more the ROI better the performance of JIT supply chain.

ii. **Market shares:** Each product gains some market share in business environment. The more market share informs better business performance of the product. Market shares give the indication of demands of the product percentage of the similar products available in the market.

iii. **Asset Turn Over (ATO):** Due to profits margin firm’s assets also increases. The assets consist of shares value, total value of lands, brands, fixed deposits etc. Handsome ATO gives solidity to the firms. The business performance can well be recognised by analysing the ATO of the firm.

3.4. **Benefits of JIT supply chain**

Various benefits are reported in literature due to its successful implementation in the manufacturing firms. The closer approach to JIT situation, the more responsive a firm feels to its customers and the less capital have been tied up in raw materials and finished goods inventory (Elimam & Dodin, 2013). The less the firm spend to store and carry inventory, the less obsolescence have to be written off, and the better optimization of firms transportation and logistics operations (Danese et al. 2013).

Ultimately, this all translates into saving of huge company real money. The JIT system is aimed at improving profits, and return on investment through cost reductions, inventory reductions, and quality improvements (Farahani et.al.2008). These benefits explain the wide acceptance of JIT in industry. The following are some benefits of a JIT system stated by researchers (Deshmukh, &Kaul, 1997, 1999; Dangayach, et al. 2003, Farahani et al. 2008; Kumar, 2004).

- Reduce space requirements.
- Reduce inventory investment in purchased parts, raw materials, work in process and finished goods.
- Reduce manufacturing lead times.
- Increase the productivity of direct labour employees,
- Indirect support employees and clerical staff.
• Increase equipment utilization.
• Reduce paperwork and require only simple planning systems.
• Set valid priorities for production scheduling.
• Encourage participation by the work force.
• Increase product quality.
• Close supplier/customer relations
• Reduced overall cost in long run.
• Better responses in total supply chain
• Increased rate of information sharing
• Competitive advantage
• Globally accepted process

3.5. Challenges in front of JIT supply chain

Mishra et al. (2013) has reported that due to implementation of JIT in supply chain the complexity of the supply chain activities increased many folds. To explain the various challenges he has used four General System Theory (GST) and adopted from work of Yourdon (1989) and caddy (2007).

*Principle 1: The larger the system, the more resources are required to support it, with the increase being non-linear rather than linear.*

*Principle 2: The larger the system, the more resources are required to support it, with the increase being non-linear rather than linear.*

*Principle 3: Systems often contain other systems or are themselves components of larger systems.*

*Principle 4: Systems grow over time, both in terms of size as well as structural complexity.*

These four general system theories will explain the natural challenges in-front of JIT Supply Chain
**Principle 1:** The larger the system, the more resources are required to support it, with the increase being non-linear rather than linear.

In JIT environment supply chain becomes more responsible by use of latest technology which needs more specialization in IT networking and support at the competitive cost. Some times smaller firms are unable to spend sufficiently and often forbid the firms to adopt the JIT philosophy. However there are few limitations of JIT philosophy; like market uncertainty, supply break down, workers strikes, transportation facility, government rules and regional constrains which too increase challenges to the new development. It is found that there is an environment of uncertainty in the decision making on the issues of nil inventory, continuous reduction of cycle time and nil wastage.

An intermediary compromise is done to maintain certain level of concept (Christensen, 2005). Simatupang and Sridharan (2002) reported that increased logistics complexity is associated with poor performance of the firm. It is also suggested that if there is a greater degree of integration and a higher level of formality start existing in the system which restrict the changes, such as meeting new customer demands, compiling with new government regulation, or reacting to new industry entrants, adoptability of the JIT practices in the supply chain is likely to be less adoptive as the principles or philosophy behind the business becomes complex.

**Principle 2:** The larger the system, the more resources are required to support it, with the increase being non-linear rather than linear.

JIT supply chain requires a high level of integration and commitment of the working and managerial force (Garg & Deshmukh, 1999). Monden (1993) explains the JIT production systems require both input stock in the form of parts and output stock in the form of products at each stage. To maintain these systems pull-production control mechanism throughout the system is exercised. Just-in-Time (JIT) production systems have been created based on the main objective of reducing cost by eliminating waste during the production process.

The system is to be supported with high technological in puts like automation, flexibility, use of IT, freight consolidation, cross docking etc. for in time delivery of the products. Kim, (2003) says that increases in the support system for JIT
implemented supply chain are non-linear and required lot of planning with utmost accuracy. The net-work of suppliers, producers, distributors and customers become too large once the supply chain becomes global. JIT suggest using the latest technology to reduce the time and overall cost. Use of flexibility, automation, group technology, ISO certification etc. requires heavy support system like availability of the technology, efficient transportations, skilled man power etc. In recent years, the collaboration among partners within the supply chain and e-supply chain has been widely accepted (Garg et al., 1994). The transportation and its impact on the entire supply chain are very important. It is also found that developing countries lacks in efficient transportation, so JIT implementation is a big challenges to these countries (Maiga, 2009). It is seen that once the supply chain becomes more responsive the supporting facts behind the responsiveness also becomes very vital and getting extension of even smallest activities. In doing so smaller activities are becoming larger and larger of the supply system requiring greater supports and attentions an urgent need otherwise it would be a great loss as outcome. Therefore support system required for the larger system is many times enhanced and thus it is non-linear. Therefore to support JIT supply chain requires nonlinear supporting infrastructures in form of spending, manpower and technologically.

**Principle 3:** Systems often contain other systems or are themselves components of larger systems.

Supply chain consists of a large number of interacting but un-integrated members. Its main focuses are on material, information and cash flows from vendors to customers or vice-versa. A key feature of present day business is the idea that it is supply chains that compete, not companies (Christopher and Towill, 2001), and the success or failure of supply chains is ultimately determined in the marketplace by the end consumer. Getting the right product, at the right time is the JIT assisted activities. The issue of the supply chain is dealt in dividing the different activities alike; production, purchasing and distribution in sub groups of batch, mass, customized and these again into sub groups of types of process and so on. Fig 3.1 shows the full supply system closed network.
The JIT applied activities make these subgroup activities more responsive. It has been discussed that a supply chain is made up by multiple actors, multiple flows of items, information and finances and these again subdivided at the minimum level to execute the working. For an example take JIT production system in which many number of sub producer, assemblers, quality checkers, calibration, maintenance etc. exist, further work related to mechanical nature, electronic, electrical, computer related sub group is thought up. Similarly JIT procurement is an integrated effort of vendor management, suppliers training and technical supports, quality assurance of received material, etc. (Kaynak H. & Pagan, 2003,). JIT logistics is combined efforts of transportation, packaging, distributions, responses to the customers etc. None functioning or partial functioning of any section will dampen the JIT concept in the supply chain. All stakeholders in the business want to be always in win-win positions, therefore supply
chain process contains no. of sub processes and these sub processes are also divided into different processes, so due to heavy integration chances of one non performing element will dampen the JIT supply chain Management.

**Principle 4:** *Systems grow over time, both in terms of size as well as structural complexity.*

Chan & Zhang (2011) discusses for big collaboration of the various partners participating in the supply chain as the chain expand. As per Yourdon (1989) information system has started with a small equipment and support system but as time passed the bigness of the information system can now be imagined, how vast it has taken a shape. Similarly supply chain in JIT environment has expanded; as new norms, techniques, philosophy and perception of people (Customers) changes as the time passes.

Further as the business grows in size the activities getting inflated. More collaboration of groups and activities are seen which requires more cooperation and mutual trust among the stakeholders. The growth of system is seen at multi levels and is an unavoidable phenomenon. JIT has risen from a mere tactical to a more strategic level in supply chain (Farahani, & Elahipanah, 2009). By managing the supply chain in JIT Environment Dell computers, Vishal Mega mart, Flipcharts etc. have risen within the short time with a small investment to such a big venture. The supply chains of these firms in due course of time have become complex due to highly interdependent processes. Various new departments have come up as stretch of supply chain enhanced beyond the boundary of one firm. These firms are integrating various processes to support the smooth flow of material increasing the complexity. Hence it can be said that Systems grow over time, both in terms of size as well as structural complexity.

In view of above pursuits several challenges are reported in literatures in front of developing nations. The literature shows that the poor supply and demand conditions and the unstable economic environments are the main obstacles in JIT application especially in developing countries. Balakrishnan (1996) has mentioned following challenges in front of JIT Supply Chains.
• High costs of imported technology,
• Training, maintenance and the quality systems,
• Low costs of labour
• Cultural values based on both high power distance and uncertainty avoidance.
• In developing countries industrial firms are contended with highly ineffective freight transportation system which is poor in quality and often obsolete, consequently industries in this region operate under handicap relative to their competitors in advanced industrialized countries.
• Financial challenges as high investment required at initial stage.
• High uncertainty due to strikes, breakdown and political willingness.

Summary

Just in Time Supply chain is management of procurement, manufacturing and distribution process with the aim of waste elimination, maintenance of low level of inventory, fast information sharing and to be highly responsive towards customers. Forty six attributes of Just in Time Supply chain encountered in the literature survey has been classified in five dimensions and each attribute is discussed briefly. The factors affecting performance of Just in Time Supply chain has been extracted from literature and briefly discussed. Important benefits of JIT supply chain are listed and challenges in implementation are discussed in reference of General system theory.

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