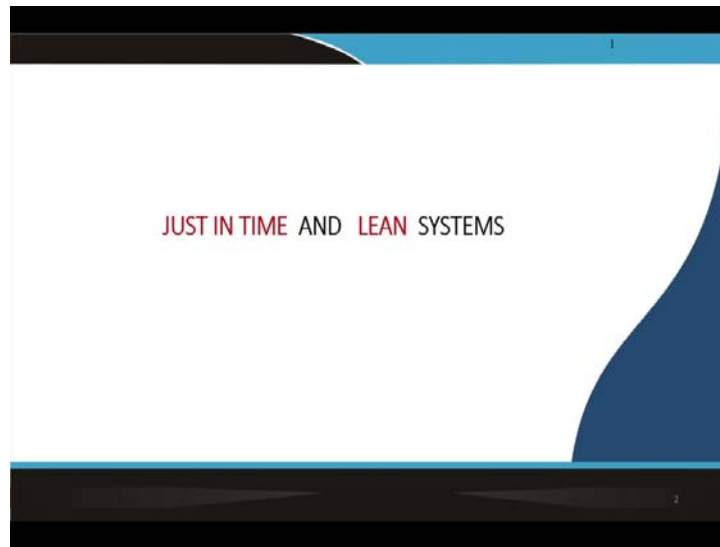


**Management Information System
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**Week - 04
Supply Chain Management
Lecture – 17
SCM – Part - 2**

Hello and welcome back to the second part of Supply Chain Management. See last time in part 1 we introduced what is supply chain management and what are the involvement and which are the areas where it is applied and you also understood the basic concept of how supply chain management works - the entire the chain right from the vendor, the supplier to the organization to the manufacturing enterprise. And finally, to a customer. This entire spread is what is being covered under what we are calling Supply Chain Management and then we also discussed impacts like what is a bullwhip effect and how things can go wrong and how can inventory level go very high. So, these are the risks the fundamental risk of a supply chain management or an improper supply chain management is that neither you can have very high inventory which is a loss which is waste nor you can have a low inventory. So, that is also a danger because then your production can come at a halt.

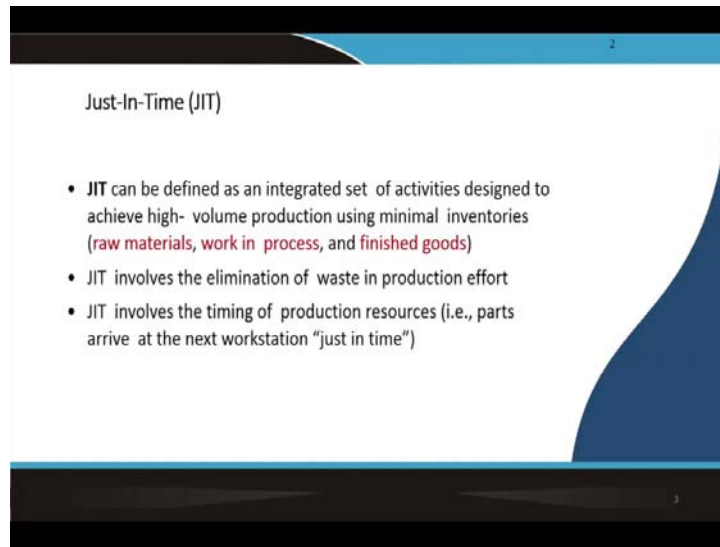
So, here we will discuss some new concepts of supply chain management , may not be very new, but very novel concepts , which have been in practice for quite a few years and they are still very prominent and very effective in optimizing supply chain management solutions. These are very actively followed by many industries primarily automobile industries.



Just in Time which is also known as a Toyota Process System (TPS) or Toyota Manufacturing System, it has various names because it was discovered at the Toyota manufacturing plant in Japan and then from there we will discuss something called Lean Systems which is again an extension of Six-sigma methodology.

So, you must have heard about Six-sigma as a quality system which results in very low error, that is, almost a zero defect system. Six-sigma was classically again you know designed and developed at a manufacturing unit (Motorola Corporation – by Bill Smith in 1986. GE extended the use of this to all their manufacturing operations in 1995). But this was again extended to various other service sector and it is called Lean Sigma Basically it is a lean system so, we will discuss more about that as we move.

Six Sigma is a method that provides organizations tools to improve the capability of their business processes. This increase in performance and decrease in process variation helps lead to defect reduction and improvement in profits, employee morale, and quality of products or services.



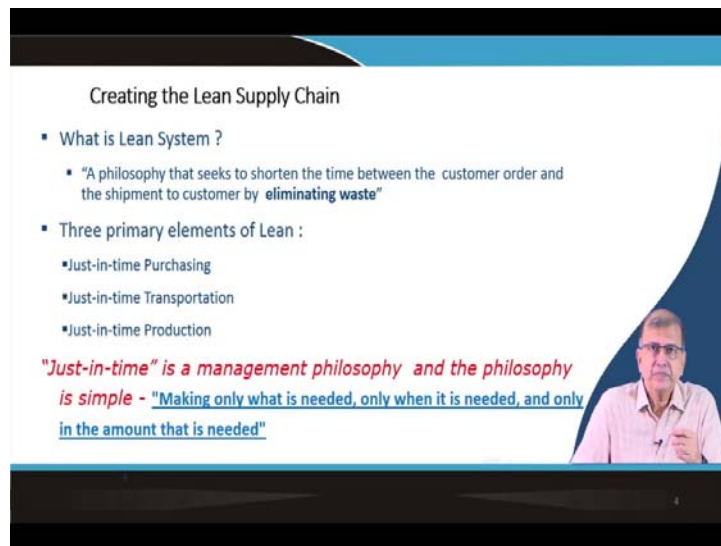
So, just in time (JIT)- how it is known as is that famous acronym can be defined as an integrated set of activities designed to achieve high - volume production using minimal inventory. So, the point here is a how to minimize the inventory because we have been talking about that inventory is money blocked. Having more inventory, you might get a feel good factor that, I will not run short of my material and my production will move etcetera, however, it is directly holding up your money. So, your working capital gets blocked and that is when you have to take more working capital loan from banks and you pay lot of interest. So, that is the interest cost and it is a major cost element in the overall cost of manufacturing. That interest cost goes into your product cost.

So, that is why the whole thing started with how to minimize the cost. So, that is the whole essence of JIT for all inventories including raw material, work in progress and finished goods. These are various classification of inventories. Raw material which is the starting material, which you receive from supplier, then work in progress is the semi-finished product which is in your shop-floor of your factory.

So, you are processing goods and it is moving from machine to machine, stage to stage. So, it is known as work in progress or work in process (WIP) and that is also a part of inventory because till the time it moves out as a finished goods and reaches your customer and you can create an invoice and get paid, it is still money blocked for you. And finished goods of course, if it is lying unsold at your stores or at your warehouse is again money blocked, because you are not getting cash.

So, JIT involves the elimination of waste in production efforts. The whole thing again as I will telling you is elimination of waste in production effort and JIT involves a timing of production resources that is – required parts arrive at the work station “just in time”. It is the very name which means you get the inventory supplied only when you need it not may be 1 day before, not 2 day before, not 1 week before, not 1 month before.

If I need the material in my today’s morning shift production, the material will arrive at 6’O clock, the vendor will supply me the material at 5’O clock in the morning or at worst case it can come in the previous day evening shift. So, it should have minimum stay in my factory premises. It will just come and I will consume it. So, that is the whole essence of ‘just in time’. So, the name itself of the process explains the how it works.



Creating the Lean Supply Chain

- What is Lean System ?
 - "A philosophy that seeks to shorten the time between the customer order and the shipment to customer by **eliminating waste**"
- Three primary elements of Lean :
 - Just-in-time Purchasing
 - Just-in-time Transportation
 - Just-in-time Production

"Just-in-time" is a management philosophy and the philosophy is simple - "Making only what is needed, only when it is needed, and only in the amount that is needed"

[Video inset of a man speaking]

Creating the lean supply chain:- When we say what is a lean system, “it is a philosophy that seeks to shorten the time between customer order and shipment to customer by eliminating process waste”. Here you are mostly talking about process waste. Can I make it more efficient, is it a roundabout process? It is going from one place to another place is the route short or is it long or is there some diversion in between, may be some other department is in between and it has to go round that. So, these are all adding to your wastage as the process is taking more time.

So, can I make it more efficient? It starts with shop floor layout? The layout is very important as my material should move logically in a sequence and it should move in the shortest possible of time. There should not be delays because any delay is causing more

time to produce and so it increases the cost. So, that is where we discuss lean, where we try to eliminate all process waste. By Lean, we are making the entire process more and more efficient.

Three primary elements of lean; - just in time Purchasing, just in time Transportation, just in time Production. So, just in time purchasing means we place the order and that vendor comes and supplies a material just in time. I do not want it to be supplied one week before as it would be lying unused in my store and is thus a waste. I want to eliminate that by following just in time purchasing.

Just in time transportation again transportation bottleneck should be removed so, it should be moving at the shortest possible time. It includes both inside the factory which I was discussing in the factory layout and also when it is finished it should go out immediately to the customer.

It should not wait in my godown, store or warehouse. Why should it wait, because waiting stock is a waste because I am not getting my money till the time it gets delivered to the customers? So, I should ensure that it should get delivered to the customer in the shortest possible time; fastest possible time.

Just in time production was the productivity part of it. Inside the factory also we should have to cut out all the waste due to unnecessary operations. All that is seen by industrial engineers another shop floor process engineers, they look into it and see to it that how my process can be improved, there can be bottlenecks. Like one particular center one particular machine the capacity does not match with the say capacity of the machine previous to that and that machine is producing at a faster rate, but this machine cannot produce at that same rate.

So, what is happening? Before this machine, material is getting piled up so that is called a bottleneck. So, conventionally, we have heard about bottleneck so, bottleneck is a constriction where because of that constriction caused by low productivity of the machine or whatever reason may be, material movement slows down.

So, my production time will increase and that will increase my cost. So, then I should focus on that particular center or that machine or the work center the location and see how can I improve its productivity, may be run it in two shifts, may be change the

operator or machine, may be if there is too much of manual operation and try to automate that by making some investment. Investments are always justified by the return, the benefit what I can get by removing this bottleneck, by increasing my overall productivity. So, I can move things faster I can produce more etcetera.

So, just in time is a management strategy. However, it has gone up to the level that it is considered as a philosophy and the philosophy is very simple. "Making only what is needed, only when it is needed and only the quantity that is needed." So, it is a simple philosophy- make only what is required do not make anything extra and make only when it is required.

So, do not make it earlier and hold on to it as you might feel that you are safe. The customer wants a material may be on 30th of July, but I will finish it by 20th of July. So, that I am ensured that as soon as he wants it, he will get it, but what happens to those 10 days when my inventory is locked up.

So, again the quantity what is needed and when it is needed and what item is needed are the three important components of this simple philosophy. But may be the philosophy is simple, but converting that into an actual practice in a shop floor needs lot of training, lot of discipline and lot of knowledge amongst everybody I mean it starts with the workman level, the entire shop floor team will have to be educated and trained in JIT philosophy and then it goes up to the highest management level. So, it is really a completely bottoms up approach right from the workman level to the top management level everybody has to be trained in this philosophy. So, the implementation and execution is not as simple as the basic philosophy is.

So, you have to keep that in mind that if you want to implement JIT philosophy in your factory it takes lot of effort, it takes lot of training, it takes lot of studies and it takes lot of discipline from everybody. So, it cannot be done very easily that we will go and just start because it is a simple philosophy. It is not so simple to execute.

The Toyota Production System

- Based on two philosophies:
 - Elimination of waste
 - Respect for people

Taiichi Ohno and Eiji Toyoda, Japanese industrial engineers, developed the system between 1948 and 1975. Originally called Just-in-time production, it builds on the approach created by the founder of Toyota, Sakichi Toyoda, his son Kiichiro Toyoda, and the engineer Taiichi Ohno

Just-in-time (JIT) manufacturing, also known as just-in-time production or the Toyota Production System (TPS), is a methodology aimed primarily at reducing times within the production system as well as response times from suppliers and to customers. Its origin and development was mainly in Japan, largely in the 1960s and 1970s and particularly at Toyota.

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It is also known as it started off as the Toyota Production system. It is based on two philosophies ‘elimination of waste’ which we were talking and ‘respect for people’. So, that is very important when you say respect for people because it is always people driven. It is all process orientation and only people can make it successful. So, you need trained knowledgeable people. Any untrained person cannot really solve it.

It was developed by one Taiichi Ohno and Eiji Toyoda, two Japanese industrial engineers. They developed the system between 1948 to 1975. That is the history of the process originally called just in time production. It builds on the approach created by the founder of Toyota, Sakichi Toyoda, who was the main promoter for this. I mean he drove the whole thing and these are the two engineers who developed the system, but it was driven by and sponsored and owned by Sakichi Toyoda, one of the founder owners of Toyota Motor Company.

So, he saw lot of value in this and he then he insisted on his engineers to do it for him and then his son Kiichiro Toyoda and the engineer Taiichi Ohno were involved in developing this famous system which is now being used worldwide.

So, just in time manufacturing, also known as just in time production or the Toyota production system is a methodology aimed primarily at reducing times when the production system as well as response times from suppliers and to customers. It’s origin and development was mainly in Japan largely in 1960s and 1970s and particularly at Toyota.



Waste in Operations

1. Waste from overproduction
2. Waste of waiting time
3. Transportation waste
4. Inventory waste
5. Processing waste
6. Waste of idle workforce
7. Waste from product defects
8. Waste of movement

Now what are the wastes in operations? The waste in operations are waste from overproduction, wastes of waiting time, transportation waste any delay in transportation or inefficient transportation if your truck has to be filled up with 8 ton of material you are filling up half the truck that is the waste.

Inventory waste: Inventory you have been talking about how inventory waste is it is like unused. So it is a waste if and when it lies unused. When your processing takes more time than what is required, is a waste.

So, you create waste by generating defective parts or scrap. So, that is a waste which happens during processing because you might have made some mistakes in your machining or whatever and something goes wrong, like, the dimension goes wrong. So, the material has to be scrapped and also processing waste includes bottlenecks or a faulty layout causing unnecessary movement of the material.

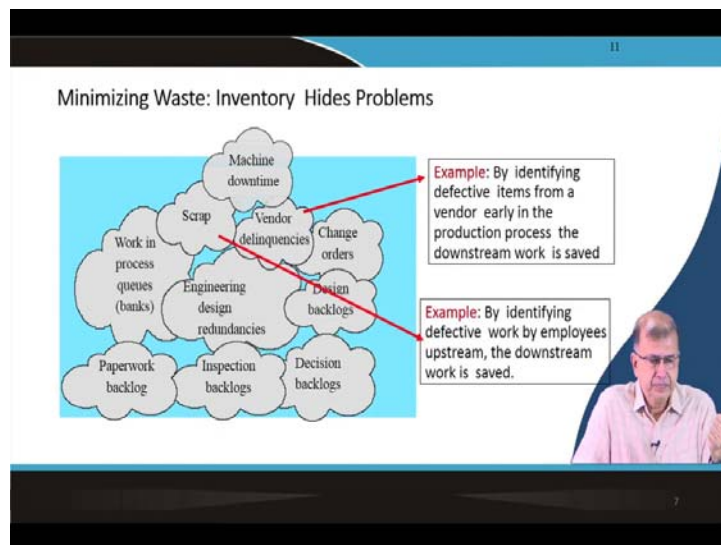
Wastes of idle workforce. If some workforce is sitting idle that is a waste because his time is valuable as he has to be productive for 8 hours or whatever is the rule. But if he is sitting idle and not working, that means, it is a waste.

Waste from product defects which we have talked as a part of the processing waste if you have the defective product at the end of the day, quality control comes and checks and finds that whatever you are produced is not up to the specification and it has to be scrapped then the whole thing is a waste. So, the entire cost you have borne from

material to processing time to labor cost to power, energy whatever has gone into making that product is a loss for the organization.

Waste of movement. Why there should be unnecessary movement. So, material from A center has to go to B, B goes to station C; it should go again in a proper way systematic ways such that no time is wasted.

So, these are the main types of wastes in operation, about 8 types we have defined here and I mean you can understand very easily as these are all from our day to day life. We understand basic things like, over production, waiting time, transportation, inventory, processing, waste of idle person sitting, product defect and of course, waste of movement.



Minimizing waste: the inventory hides problem. - Inventory is actually hiding your problem. So, you must look at it; why is the inventory lying there. So, as a shop floor man if you see some inventory lying at any shop floor you should question the people, why is it lying there, why is that not moved, because that is the fundamental thing if it is lying there means nothing is happening no operation is happening so, it is a waste and you are losing money.

So, for example, by identifying defective work by employees upstream the downstream work is saved. So, the earlier you detect scrap, defects etcetera, your loss is reduced Because if in the first stage itself there was some mistake but it was overlooked by the workman, who does not notice that intentionally or unintentionally whatever the reason

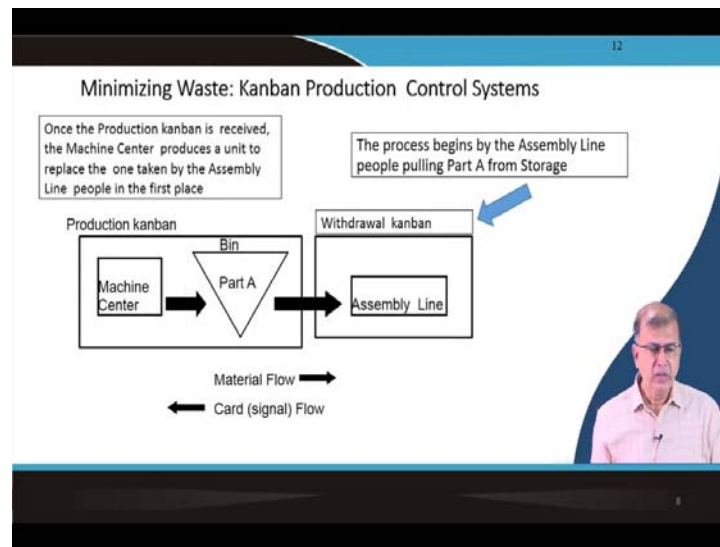
and it moves to stage 2, 3, 4 etcetera to the final stage and somewhere finally, it gets detected that oh there was a mistake and the whole thing needs to be scrapped. But if you had scrapped it earlier, all these time the machines utilization, productivity, capacity utilization, power, labor could have been saved. So, earlier you detect a scrap or defect lesser is the loss. It is called – “Shift Left” strategy. In other words, start finding defects as early as possible catch them right at the source, right at the beginning and do not keep them pending. If you find it later means you have also incurred more losses.

Vendor delinquencies: - Identifying defective items from a vendor early in the production process means downstream work is saved. Now when a vendor brings in material if I can find out the quality of the vendor defects earlier, then my production line does not get impacted. For example, again if you take companies like Maruti and Tata Motors etcetera, the automobile companies, lot of material is supplied by vendors. They (Maruti, Tata Motors) have their own quality people sitting at the vendor’s place and monitoring the quality there.

So, what happens is when the material moves out from the vendor, the Maruti person is sitting there and does a quality check and ensures that whatever goes out of the vendor’s premises is of the right quality.

So, that when it comes as a JIT supply, suppose at morning shift 6’O clock starts at 6’O clock the material comes at 6’O clock, the shop floor person knows that these have been tested by my people my own people quality people at the vendor’s premises. So, I can I do not doubt them I do not have to doubt them, they will be and I can confidently take them into my production schedule.

So, see what happens that you get it just in time because you get it right at time 6’O clock. So, it is minimum stay at your premises company and it is quality checked by your people. So, not only by the vendor’s person, but your people also supervising that and ensuring that only the right material comes to delivered at the Maruti shop floor. So, this is how the whole thing works.



Minimizing waste: - It is known by another name - Kanban production control system. Kanban is an inventory control system used in just-in-time manufacturing. It was developed by Taiichi Ohno, an industrial engineer at Toyota, and takes its name from the colored cards that track production and order new shipments of parts or materials as they run out. When a production Kanban is received the machine center produces a unit to replace the one taken by the assembly line people. In an automobile industry you know the final stage is the car assembly line where all the components come in and the car is assembled. The body, the engine, gear box, etcetera and it moves in a chain. So, they fix the wheels, then fix the gear box and the whole body moves to every station and something gets added to the car body.

Now many of the components, which were produced at in-house, shop floor is pulled by the assembly line. So, once it comes in, the machine operator, starts making another batch. This is known as the Pull system and we will discuss it again. So, the assembly line pulls the parts from each of those machine centers and when it pulls, the machine centers then pulls raw material from other or previous stage etcetera and thus at every stage of the shop floor, the manufacturing goes on by the pull method.

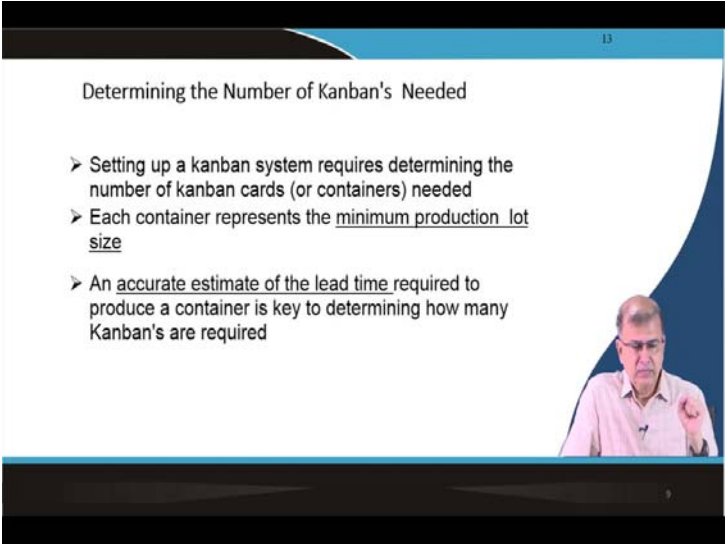
Everybody is pulling so, there is no push. So, there is no question of accumulation because I will pull only as much quantity as I need in my assembly line. So, it starts with the assembly line. This is the withdrawal Kanban. Kanban starts and there is a bin containing a fixed batch quantity of part A near the machine center. So, bin is a

temporary storage where the material comes in from the machine center and it gets pulled into the assembly line.

So, as soon as this bin becomes empty, then only machine center will produce another batch quantity of part A and put it into the bin. So, although these things are very difficult, how to time it, because if the bin is empty and the machine center is taking long time to produce, then the assembly line will become idle because the bin is empty for half an hour, 1 hour whatever time. So, for that duration of that time the assembly line production stops which is not right. So, that is not JIT or that is not Kanban.

So, there is a card which is nothing, but it is a signal; it is a message. So, as soon as a bin becomes empty there is a message to the machine center that fill it up. So, machine center suppose that bin capacity is may be 50 units and assembly line has drawn 50. So, immediately information will go to machine center to supply 50 units. So, they will again fill up this bin with 50 and similarly, it goes back this machine center will then again ask for material from the others previous stages.

So, the process begins at the assembly line by people pulling part A, from storage bin. So, that is how the pull system work. Assembly line is the starting point and they first pull things for their assembly and then the chain moves it goes back like that.



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Determining the Number of Kanban's Needed

- Setting up a kanban system requires determining the number of kanban cards (or containers) needed
- Each container represents the minimum production lot size
- An accurate estimate of the lead time required to produce a container is key to determining how many Kanban's are required

A small video inset in the bottom right corner shows a man with glasses and a light-colored shirt speaking.

Determining the number of Kanban that is needed: - Setting up a Kanban system requires determining the number of Kanban cards or containers that would be needed for that shift. Each container represents a minimum production lot size. An accurate estimate of the lead time required to produce a container lot size of materials, is key to determining how many such Kanban's will be required. See the previous diagram if you go back , you can see the capacity of the assembly line for assembling those component say part A suppose it is 50 per hour. So, 50 cards you know can get fitted with that component per hour. Now the capacity of the machine center is say also 50 and it can produce 50 components per hour. So, then it is fine so, and you need 1 bin. So, 50 it is producing every hour and 50 is getting consumed every hour.

So, there is no accumulation, but suppose your machining center capacity was more it can produce 100 per hour, but the assembly line can consume only 50 per hour. Then the machine center will not produce to it is full capacity. So, it will produce only 50 because if it produces to it is full capacity which is 100 per hour, there will be an accumulation and you will need instead of 1 bin you will need 2 bins to store 100 because capacity of each bin is 50 units.

Now, what can happen in future, suppose Maruti's car demand goes up and they have a parallel assembly line and they want to produce more car because the demand has gone up. Then they know that if the requirement is doubled from 50 to 100 I do not have any problem because my machine center can produce 100 per hour.

So, instead of 1 bin I will now arrange for 2 bins. So, they will fill up 100 qty, 50 in each and 50 will be taken up by assembly line 1 and the other 50 will go to assembly line 2. So, this is how these basic thing about Kanban was developed.

So, as I said the implementation is not so easy. You have to take the manufacturing lead time; you have to consider how long time the machine center takes to produce the material this is just one machine center we are talking about. This component may be manufactured in several machine centers. So, for each of these machines you have to similarly work out what is the capacity, what is the manufacturing lead time etcetera, before we can design or plan how many Bins will be required. So, lot of studies and estimation and calculation goes behind to finally, set up this entire thing and how it moves so that is why I said implementation is not easy.



Managing the inventory investments:- Inventory is an investments so, how do you manage that. There are basically 3 components I would say - Volume, Value and Velocity. So, what is volume? Volume pertains to the amount of physical inventory the firm owns at any given time across the supply chain. Volume pertains to the amount of physical inventory. So, we have been always talking to reduce inventory. So, first we need to know what the quantity is, that is, volume.

The key question is, how much and what types of inventory do we own? I need to know as a management person that what type and how much I have in my stock. What are the key measures, the value or amount, or weight, quantity and numbers and weight? And, what are the activities which affect the volume requirement. How I can manage this volume better if I have improved forecasting techniques.

So, I know how much quantity of material I actually need for my say next 1 week, 2 weeks, 3 weeks of production. Then I can order accordingly. So, that I have exactly that quantity of material required. If my forecasting went wrong or if I do not have such forecasting tools like I have in ERP etcetera, I will probably use that bullwhip effect - say customer wants so much may be I will add some buffer as something might go wrong and we know from our knowledge of this Bullwhip effect how the inventory keeps on increasing.

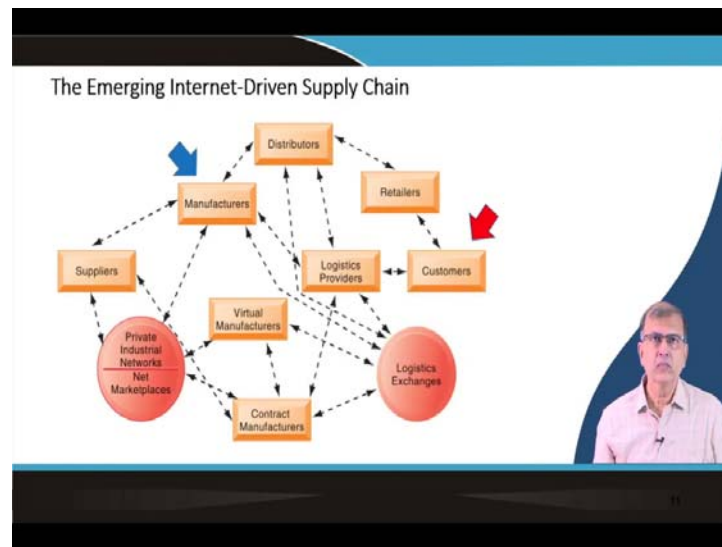
In forecasting technique, there is something called a 'supplier provided consignment' type of inventory. There are many situations where the supplier stores my inventory. He does not supply till the time I am telling him to supply. One example of this is in airports, where the oil companies like Indian Oil Corporation etcetera are stocking fuel for the aircrafts. Now that is a vendor managed inventory because the inventory cost is borne by Indian oil corporation and the storage tanks , pipelines etc. are all managed by IOCL /HP etc. The airline companies like Indigo or Spice or Air India, will pay only when their aircraft gets filled up with the fuel.

So, that cost is borne by Indian oil. Indian oil has moved its storage to the airport because that is where it is required and till the time it is pumped in to the actual aircraft, they cannot bill or cannot raise an invoice. So, that is known as the supplier provided consignment inventory. This is also an example of JIT as the fuel is given to the aircraft when it is required. The airline companies do not have to pay for the fuel till it is delivered to the aircraft.

Value pertains to the unit cost and the total value of the inventory. End of the day, although volume is important, but still it is the value of the inventory which matters to the organization.

When you simplify a product or you standardize a product, we can have lesser number of types of material or raw material. So, that is very useful as I can save lot of money because due to standardization, the same component can go into by various models for example, I have many models of car, but I use the same tyre size. I can share the component. By this way I can optimize my quantity of tyres to be stored and that is saving for me.

Velocity pertains to how quickly raw material or WIP become finished goods that is accepted and paid by customer. So, the thing is we have been talking so long is about velocity ,that is, how can I move it faster then what I am doing and so that I can get my payment earlier. So, if I move it faster I get my payment from my customer earlier.



In the emerging internet driven supply chain what is happening today.

Companies are global like a company say selling clothes, shirts, trousers in Europe is sourcing it's material from say Bangladesh, India, Indonesia, Philippines, Malaysia etcetera.

So, the vendors and suppliers are spread out all over South East Asia wherever, but the final manufacturer/seller may be somewhere else. For Nike .assembling is done at US or China or some other country and then it is sold to customers everywhere.

It is a networked world and for everybody there are many suppliers, manufacturing units, customer's etcetera, but they are all in a network so you do not really see like a straight line of suppliers supplying to one factory and one factory producing and then going to the customer. So, it is not like such simple like the automobile industry example I was giving. So, in various industries it is all becoming a very networked world and it is all internet driven supply chain.



Business value of supply chain management system: Match supply to demand, Reduce inventory levels, Improve delivery service, Speed product time to market, Use assets more effectively. Here we have explained talked about most of the things except ‘speed product time to market’ talks about any new product which I develop and how first can I send it to the market.

Like when Nike is developing a new shoe, sports shoe, special shoe, they work with the vendors, and vendors are developed because everything has to be developed by the vendors, all new components which Nike will assemble, test and supply. But how soon I can take it to the market because of the development time if I take more time then I am actually losing money and also losing my ‘first-movers ‘advantage over my competitors.

I want to develop a product and bring it out to the market as soon as possible and that is where supply chain management plays a big role because you have to develop vendors who can supply the new material up to your new design. Because it is a new design it is a new concept so, the vendors have to be trained.

Now, that you have changed your design and these are new design, vendors have to again retool, recheck their machines, maybe have to buy new machines, their production line etcetera, which takes, money and time. So, everybody has to change their systems and all that takes time. So, how soon can I do that change, so that I can develop my new product and send it to the market. So, that is all about ‘speed product time to market’ and it comes in supply chain management in a big way.

Supply chain management costs can be 75 percent of the operating cost. So, it is a big amount. So, that is why it is so important and helps in revenue generation and cost reduction.



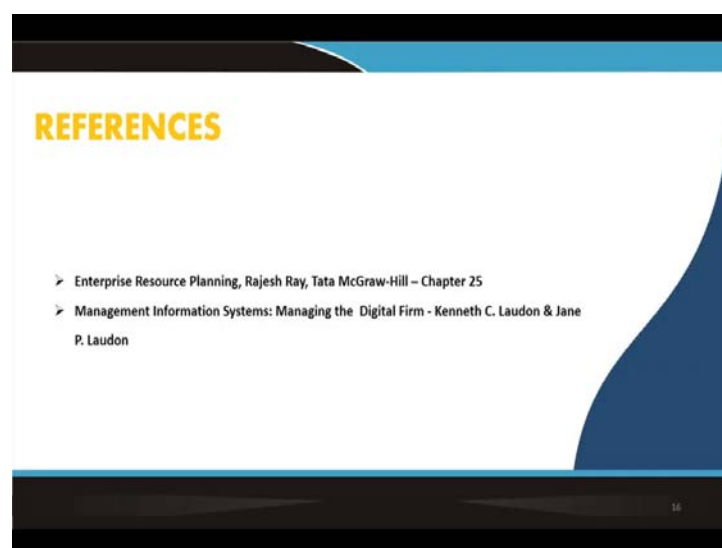
Challenges and new technologies: we are coming in a big way traceability, regulatory compliance, quality of food supply, counterfeit and cost. So, cost is everywhere, but other components are becoming important in supply chain: - you can trace your products where it is coming from, what is the origin, whether it is genuine or not, especially in food items, medicines, drug industries etcetera, supply chain traceability is very important and very crucial thing because we need to know whether the products are genuine or not.

So, that is also a part of regulatory compliance like you must have seen USFDA the food and drug association, they come to India and visit the factories which are supplying them medicines etcetera to check quality. It is very important for the manufacturers keep a detailed record of the entire supply history of what all have gone in every process, where it was manufactured, what sort of quality check was done etcetera. So, that any audit can find out whether things were done properly or not.



Technology and innovations in supply chain are coming in with lot of modern technology like ERP, which of course is there, then we have big data, robotics, IOT, cloud computing, and drones etcetera. Drones are being used to supply material. You must have seen since like Amazon is using drones to deliver material.

So, these are all again getting in to the supply chain domain, these technologies which of course, are applied in many places, but even supply chain is using lot of these things. Another new concept called block chain has come up. You can read about these in the the internet, you will find plenty of documentation how interesting things are happening in this domain of supply chain management.



Thank you very much. So, I will request you to do some reading in the internet to find out more because too many things are happening in this field ,specially with new technology.

Thank you.