Toyota Production System
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Lecture – 36
KANBAN Approach

Welcome friends, so now we are moving into the final week of this course of Toyota production system. This is the eighth week the final week of this course and so far we have already mastered the various concepts of Toyota production system and we have discussed in detail about various principles, the 4 P models of Toyota production system and we extended this discussion in past few classes for lean manufacturing for agile manufacturing for flexible system manufacturing and sustainable manufacturing.

And in the last week we also started discussions about some specific issues like we focused on benchmarking that is a particular tool for achieving excellence. Then we also started focused on lead time that what is the significance of lead time and how can we reduce the lead time. What are the different types of techniques, strategies for reducing the lead time? Because in pull-based manufacturing it is quite possible that lead time may increase because you are not anticipating the customer requirement and you are producing things in response of customer order.

And therefore it is always a challenge that how to reduce lead time for your customers and for that purpose we discussed in our last session value stream mapping that by having the value stream mapping we can identify that what are the things which are valuable for my customer and what are the things which are non-valuable or you can say waste and we discussed 2 examples.

One, the example of oil change where from traditional approach where oil changing was taking around 8 hours of time we reduced it. The ideal condition became of just 10 minutes so it is really a magical value that from 8 hours we reduced the time of oil change just to 10 minutes. The other example of stamping, welding and assembling in that the total lead time was 23 and 1/2 days and by using the concept of value stream mapping.

We reduce that 23.5 days to 4.5 days the reduction of 19 days. Again, it looks like a magical surprising value to us but all these things are possible. If you have the right understanding then in pull-based manufacturing also you can provide products to customer within no time and therefore the customer satisfaction will also be high and at the same time you will be able to save lot of costs because of low inventory.

When you have push system in your manufacturing you create lot of inventory at each stage. So that inventory is minimized by having the system of value stream mapping by having the waste minimization. We were discussing in that particular pull-based system in our previous session when we were discussing the value stream mapping another very interesting concept SIPOC we could not complete that.

So in this particular session we are going to discuss about Kanban systems which are very important for the visual displays in my manufacturing system. Because in Toyota production system also we discussed the importance of visual displays. So Kanban is one type of visual displays. So we will focus on those visual aspects also.

But before we go to Kanban we will like to discuss in the beginning of this session for some time about that SIPOC concept that how because we are doing the value addition and we also discuss that we need to see value from the customers eye. Customers point of view is very important in deciding the value. Now the SIPOC is actually a very useful tool.

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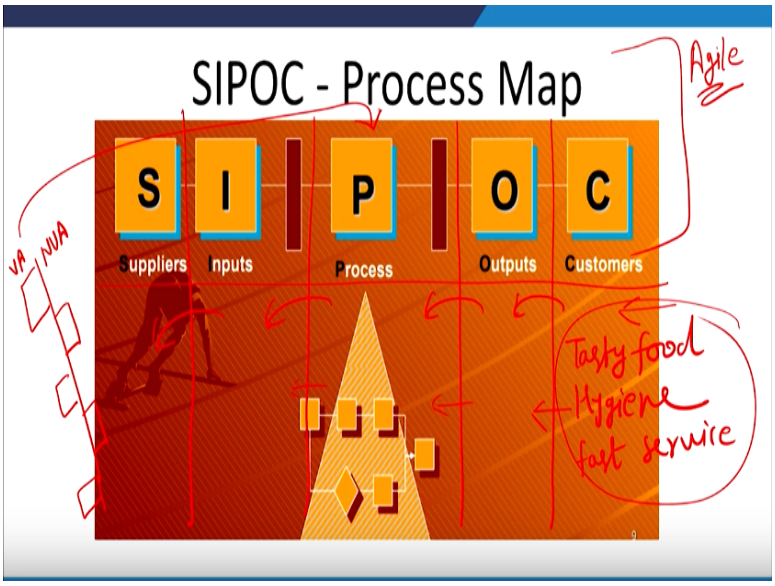

Where you create actually multiple columns S for supplier, I for input P for process, O for output and C for customer. Now here we start from customer side to supplier side, what customer is requiring? Let us say you are going to a restaurant so as a customer in the restaurant what is your requirement? Your requirement is tasty food, your requirement is hygiene, your requirement is fast service. So these are your requirement as a customer.

Now in this SIPOC process map we will try to convert these customer requirements from stage to stage that if customer requires these things, what type of output I should create. So when a customer requires tasty food it means I should be able to provide variety of food I should be able to change the contents of spices, I should be able to change the content of oil, I should be able to content of how much heat I should give.

So that as per the taste of the customer I should be able to provide food. Customer requires hygiene, so I need to have that kind of cleanliness in my restaurant not only in the dining area but also in the kitchen area also. So that is the kind of output I am supposed to produce for meeting these requirements of the customer. Now for having that particular type of food where I can have modularity, where I can produce the food as per the requirement of the customer, what type of internal processes I need to have.

So that I do not means produce only some standard type of food items. So variety of food is possible though what should be my internal processes so that that variety can be produced or so that the food taste can be customized as per the customer requirement. So I need to have some kind of processes and let us say if I am talking of hygiene. So for hygiene I need to have a process that in a days time at least 4 time I am going to clean my floors.

So that I can maintain a high level of hygiene and I am going to use a particular type of disinfectant which is healthy which is not creating any kind of odour, bad odour and therefore that is the part of my process. Then for getting that disinfectant or getting the cloths for wiping the floors what type of inputs are required and then who are going to be my supplier who can give me those products as per my requirement.

I require this much quantity each month, each week and at a competitive price. So you started from this hygiene issue which is required by the customer and because of this requirement of the customer we are moving up to the supplier that how we have to develop a system of value. The customer is looking at the value of hygiene and we have designed the entire system that how are we going to provide that value to the customer.

So you are actually starting point from the customer so it is also supporting your concept of agile manufacturing that what customer is expecting. Customer expects product but customer expects value in the product, customer expects product but what type of value you are providing in that product, that is more important. Whether the value is of quality, whether the value is of low price, whether the value is faster delivery, whether the value is better functionality.

So these are the different types of values which a customer may expect and accordingly your SIPOC model will help you that how different stages, what is the role of supplier, what type of inputs are required, what type of internal processing you will do, what type of output you will create. So that the values which customer is expecting you are able to deliver. So that is a very interesting thing that how customers input can create this your model.

And it is to be used in conjunction with your value stream mapping because it decides what is value and accordingly yesterday we discussed this particular thing that in our value stream mapping we have this type of visual display where these are value added activities and these are non-value added activities. So these value added activities are related to your process part because these value added activities will be in line with the values which are customer expecting.

So therefore this SIPOC diagram can very well we discussed in line with your how to reduce the lead time and with respect to your value stream mapping. So we need to understand the totality, the integration between all these things which we are discussing. So all these things support each other and we should be able to use these things in a holistic manner for better use of these tools and techniques.

And these are various symbols which we use whenever we prepare the value stream mapping wherever we prepare that diagram. So these type of symbols we used like.

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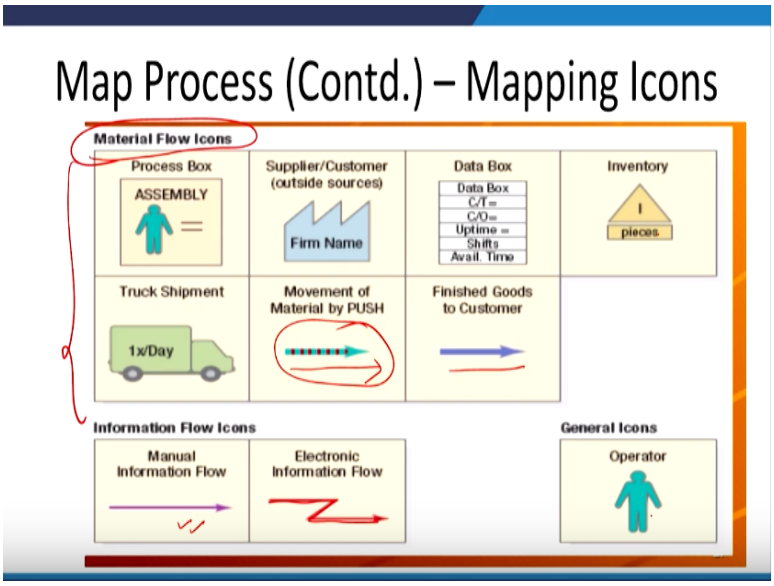

This is the process symbol that some processes happening, this is the symbol for representing an organization which may be the customer or which may be the supplier outside sources so that is being represented by this kind of a zigzag factory thing. This is the databox, we discussed that value stream mapping is used not only for product but also for information. So you have lot of information box at each step.

And this kind of information that what is the cycle time, what is the cycle change overtime, uptime, how much shift is available, what is the total available time at that particular step, so all these are the information which are to be written at each step. This symbol I is for inventory that you have the inventory of how many pieces, so that inventory and below that you write the number of pieces that how much inventory you have.

And then this is the symbol of shipment that you are getting product from one place to another place. This is movement of material by push. Now this is you are pushing the material from one stage to another stage. And this is this blue line indicates that finished goods to the customer. So this is the WIP movement and this is the movement of finished goods that final products are moving to the customer side.

Then these symbols are used for the information flow. All these symbols are for material flow. These 2 types of symbols are for information flow. Earlier only this pink symbol was used, this was indicating the manual information flow. The MIS earlier used to be the manual MIS, but nowadays we use this type of zigzag symbol also which represents the electronic information flow. So lot of MIS activities are moving towards digitization.

So you have organization wise and information network and lot of information flows almost the entire information flow has moved from this manual system to the electronic system. So it is now very common to have this kind of symbols in your value stream mapping. And this is a symbol of representing operator so this human is being represented.

So if this human has this equal to sign, it represents some kind of process and if it is only human without this equal to sign that means, it is only some operators is standing here. So these are the common symbols which we use in our value stream mapping diagram. How to prepare the diagram that we have already discussed. The other important concept which we need to discuss in this continuation that is the concept of Takt time.

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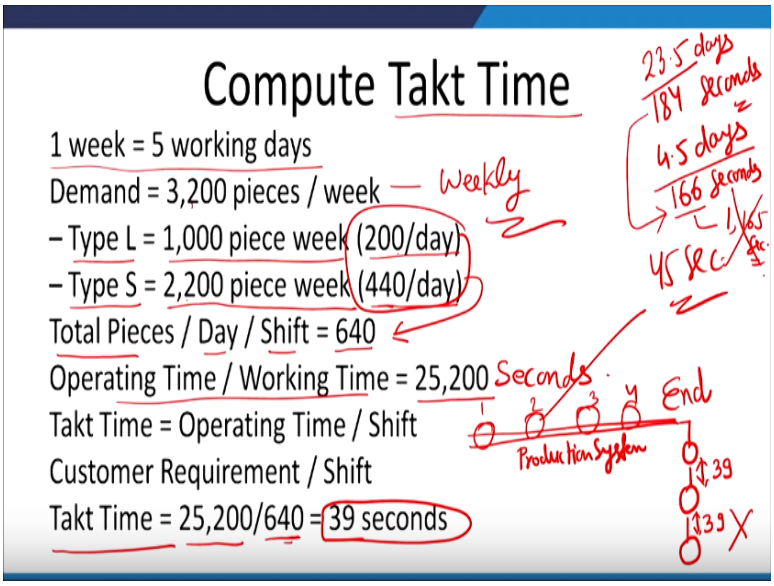

Now what is this Takt time? it is important to understand for this present discussion which we are going to have about the Kanban and also for our value stream mapping also for our lead time discussions. Now this example will give you an idea what is the meaning of Takt time. Now in 1 week we assume there are 5 working days. So there are 6,7 depending upon organization to organization.

And there are 2 types of products which are being made by the organization, type L products and type S products. And weekly demand of these products are 1,000 pieces and 2,200 pieces respectively. So 1,000 pieces means 200 pieces per day and 440 pieces per day. So that 1,000 + 2,200 that makes 3,200 pieces per week. So that is the weekly requirement. So since you have 5 working days, so total pieces per day per shift that is required are 640,200 L type and 440 S type.

So per day we require 640 pieces. Now, how much operating time available to you. Operating time or the working time available to you is 25,200 seconds. That is the per day operating time available to you. So operating time is 25,200 so the Takt time is 25,200 seconds, the total time available to you and in that total time you have to make 640 pieces. So 39 seconds is the Takt time.

So after every 39 seconds, the meaning of Takt time is that after every 39 seconds we require 1 output from our manufacturing system. So let us say you just consider this is my production

system and from here outputs are coming, these outputs are coming from this end of the manufacturing system. So the gap between these 2 outputs is 39 seconds. After each 39 second there has to come a new output.

So in a full day if after every 39 seconds, we are getting a new output. Then in a shift of a 25,200 second a full day, we will be able to get 640 pieces and then only we will be able to fulfil the demand. If you are not able to maintain this Takt time of 39 seconds, if you are taking 40 seconds for making a product therefore you will not be able to achieve that output of 640 pieces per day and therefore you will not be able to fulfil the complete demand.

And if you reduce the Takt time if 39 if you are making it 35 seconds, so you will produce more and that will create inventory. So therefore the meaning of Takt time is very important that what should be the rate of output, what should be the rate of output that is being decided by the Takt time. So depending upon how much time are available to you and how much output you want you decide your Takt time.

And accordingly all these stages if you go to class of operation management in that this particular concept becomes very important in assembly line balancing. So when we are balancing the assembly line, it is required that each workstation should take exactly 39 seconds or less than that. Then only you are able to produce after an interval of 39 seconds. If in this, if these are 1,2,3,4,4 processes which are involve.

Like if one of the process is taking 45 seconds. So if 1 process is taking 45 seconds, you cannot achieve this 39 seconds objective of Takt time because 1 process itself is taking 45 seconds. So to achieve the Takt time whatever Takt time you have all processes involved, all activities involved in making the product should take less than Takt time, otherwise that Takt time cannot be achieved.

So all these 1,2,3,4 should take maybe 30 seconds,34 seconds,35 seconds or up to 39 seconds then you can achieve this Takt time of 39. If it is any process is taking more than that you cannot achieve Takt time of 39 seconds. So sometime it is required that 1 or 2 operation may take more

time. So then there is a role of industrial engineer how to split those processes into different processes so that you can maintain this desire Takt time.

If you combine if you remember in our previous class discussion there was a situation where the total time total lead time was 23.5 and in that 23.5 days only 184 second was value added activities. And when we improved it we may need 4.5 days and the value added activities were 166 seconds so this we discussed in our previous session. And when we reduced 184 to 166,what we did that we combined various processes so only 2 processes were there.

One process was taking was 1 second and another process was taking 165 seconds. Now if in this particular case our Takt time should be 100 second so this combination is wrong then if one of the process is taking 165 second you cannot get the Takt time of 100 second. So that is the significance of Takt time that on one side we are trying to reduce the lead time, we are trying to combine the processes so that you can excuse the time taken by your activities.

But on the other side you also need to keep in mind your Takt time that you cannot combine various processes then your Takt time cannot be achieved. So that is the significance of this discussion of Takt time in your value stream mapping and the lead time. Now this is 1 part of todays discussion. Now we move to the next part of the discussion that is about the Kanban system.

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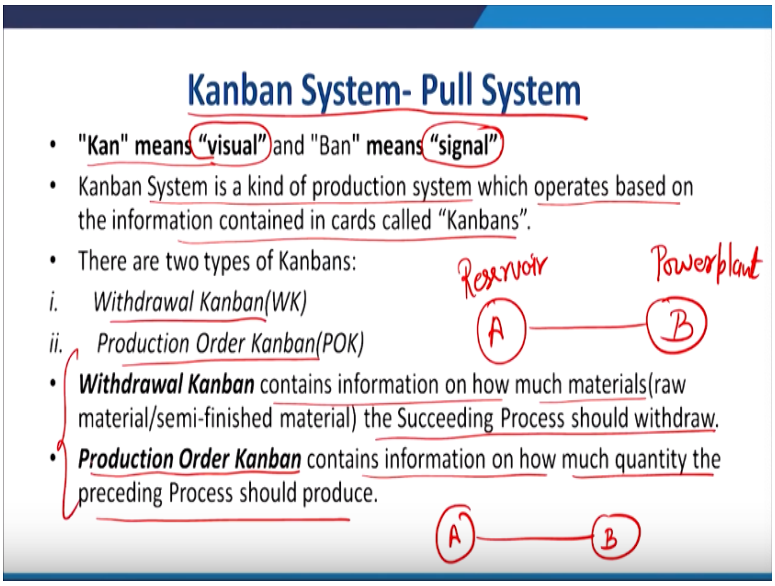

Now Kanban, we already introduced when we were discussing the principles of Toyota production system. In that discussion we said that we need to install various visual displays and visual displays are very effective in monitoring your day to day performance. We discuss the example of traffic signals that how without any word just by different colours of light ,you are able to understand what is the meaning of these signals.

So that is the power of visual system. So Kanban is that type of visual system in the organization. And the meaning of Kanban is also visual. Kan is visual and Ban is signal. So you are creating a kind of visual signal and this is very much useful rather you can say a pull-based manufacturing is not possible without this kind of signalling arrangement. You need to have this kind of signalling arrangement, then only pull-based system is whenever there is a green light at the next stage, then it means that products are required by this stage.

If there is no green light or red light, it means products are not required. So by putting these kind of green signals that maybe the LED lights, that may be a card, that may be a flag so it can be of any variety. But that signal is necessarily whether the product has to move to that stage or not to move to that stage. And since now everything has become very integrated. So the application of Kanban is much easier.

Now go further in this discussion of Kanban, Kanban system is a kind of production system which operates based on the information contained in cards which are known as Kanban. So the originally in Kanban, we used to have cards and those cards used to contain some kind of information and based on that information the product has to flow. So information was there and Kanban cards.

And then on the basis of that the previous stages used to take decisions. There are 2 types of Kanban systems which are available. One is Withdrawal Kanban and another is Production Order Kanban. Now what is this Withdrawal Kanban? Withdrawal Kanban contains information on how much material that material can be the raw material, the WIP it can be any kind of material.

How much material the succeeding process should withdraw. So from stage A and this is a stage B, so the withdrawal Kanban will tell you that how much material stage B can withdraw from stage A. So this is a type of a system available and accordingly how much you can withdraw from stage A, so that is that information is available. So you can have this kind of system like your hydropower plants where reservoir is there.

And now in that reservoir you have stocked water and for producing electricity you need to flow the water through the turbines. Now, here we use this withdrawal Kanban where you regularly have this much information that how much water level is available and how much you can withdraw for producing the electricity. So that is a very appropriate example I will say for the Withdrawal Kanban.

That the stage A is like reservoir and stage B is your power plant. So power plant needs water for producing the power, but depending upon how much water is available in reservoir. You use this withdrawal Kanban to inform this to power plant that you can withdraw this much of water for producing the electricity. So that is 1 type of Kanban. The second is production order Kanban. It contains information on how much quantity the preceding process should produce.

Now another example again A and B 2 stages are there. Now there is a requirement raised by B and according to that requirement stage A will produce that much of parts. So here stage A does

not have any kind of inventory available. Any kind of inventory is not available at stage A but stage A will produce depending upon the signal raised by B, that in that Kanban how much quantities are required by B will be available and accordingly stage A will produce.

So there are 2 distinct type of Kanban systems. One is Withdrawal Kanban and another is Production Order Kanban. In withdrawal, you already have inventory at A and depending upon the size of inventory, you will tell other stage that how much you can withdraw from here. And in the second, you have no inventory at A or you have some maybe raw material, spare parts etc. B will give you the order that how much is required and accordingly A will produce for fulfilling the needs of B.

So that is a very important differentiation between 2 types of Kanban systems. Now this diagram gives you an idea that how this Kanban systems are working. So this is Production Order Kanban system.

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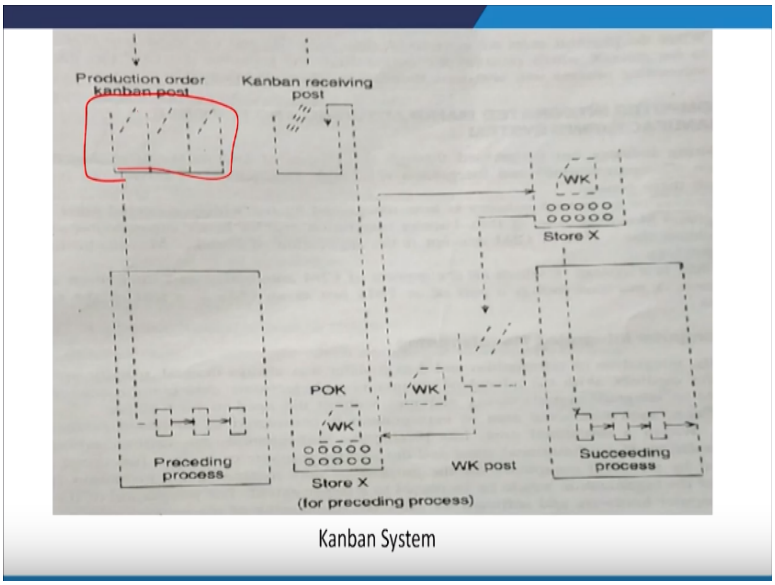

So on the basis of this Production Order Kanban system, you are giving the order to the preceding processes that how much to produce and as orders are there accordingly you will produce this much. So this is the inventory level which are being shown in this Kanban and based on this inventory level, you will produce the product. So this is simply the diagrammatical representation of our Production Order Kanban system.

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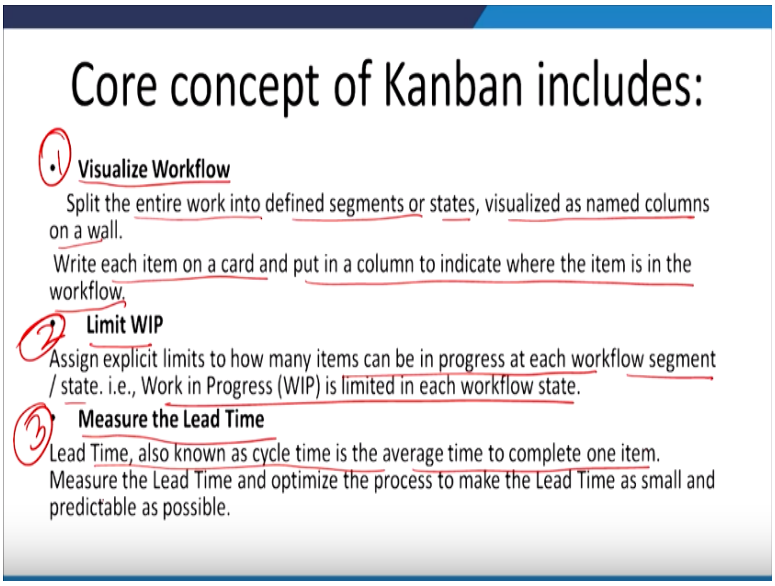

Now when we are talking of Kanban system, what are the important concepts which govern the decisions which govern our calculations of the Kanban. So some important concepts we will like to discuss. One important concept that is visual workflow Kanban is a visual signal. So it helps you already in our Toyota production system, we have discussed that we need to maintain a proper workflow.

The continuous workflow is very important and that continuous workflow can be maintained by this kind of visual signalling. So the visual workflow is one important concept. So split the entire work into defined segments or states, visualized as named columns on a wall. So like on a hall you have various pillars, so for each pillar you give a different name, same thing like in a process from start to finish various intermediate activities may be there.

So you try to split your entire process into various intermediate activities. So it requires some kind of your own creativity, imagination that how well you are able to split the entire process into various activities. Write each item on a card and put in a column to indicate where the item is in the workflow. So then you will write all those processes on piece of card and then you will identify where that particular card is in the entire process.

The second important concept is limit in the work in process, assign explicit limit to how many items can be in progress at each workflow segment or state that means work in process is limited in each workflow state. You should create the limit of work in process that this particular stage cannot have more than 3 units. This particular stage cannot have more than 5 units. This stage cannot have more than 1 unit.

And as you reach to the finish side, the WIP should reduce. The concept says that you can have more WIP in the beginning when you are at the raw material side, can we have more WIP. But as you are adding more and more value and finally you are reaching towards that finish side your WIP should reduce. So that is and how it should reduce what should be the maximum level, that is another very important aspect of designing a good Kanban system.

And third is measure the lead time. Already we have discussed about the lead time, that the time between giving the order and receiving the supplies. So that total time is known as lead time. So lead time that is also known as the cycle time is the average time to complete 1 item. Measure the lead time and optimize the process to make the lead time as small as predictable as possible. So you need to work towards reducing the lead time because lot of non-value adding activities are there in the total lead time.

And we have discussed and seen also that may be up to 90% of the time is wasted in non-value added activities. So you have to be very careful that the how you optimize your lead time and through proper use of Kanban system, we can work on optimizing the lead time. So with this we are actually coming to close of this session. In our next session, we will discuss more about Kanban systems and we will also discuss about some calculations related to Kanban system. So with this, thank you very much.