Toyota Production System
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Lecture – 37
KANBAN Calculation-1

Welcome friends, So we were discussing in our last session about Kanban systems. Kanban, which we understood are the visual signals for the production system. We discussed that, two types of Kanbans are possible, the withdrawn Kanban and the production order of Kanban. In withdrawal Kanban, you already have a quantity available at the preceding station and it gives you a signal that how much can be withdrawn from this stage to the next stage.

And we discussed the example of hydro power plants that a reservoir of stage A and the power plant is stage B. So how much water can be withdrawn by power plant for producing electricity for that purpose at stage A that is your reservoir, we will use withdrawal Kanban. On the other side you have a production order Kanban where the stage B gives you the requirement that what is my requirement and accordingly stage A will produce the products. Like if we extend the example of power plant, so here if I go

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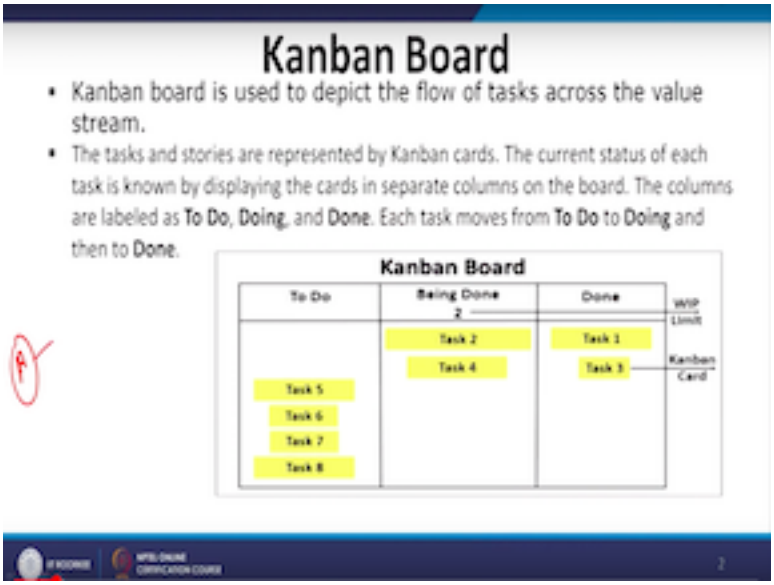

Like stage A, stage B, stage C, now at stage A which is reservoir, stage B is power plant and stage C is the grid, now you have a withdrawal Kanban at stage A and production order Kanban

at stage C. So how much is the requirement at the grid, how much electricity is required at the grid. So for that purpose grid will give you a signal that this much electricity is required, so you produce this much electricity.

So based on production order Kanban power plant will produce that much electricity for which need has come from the grid. Now power plant will produce only that much for which reservoir can give permission to withdraw the amount of water. So reservoir will have the withdrawal Kanban. So in one single system from A to B to C where hydropower is being produced for the grid, we have seen that how withdrawal Kanban and production order Kanban is used simultaneously.

So those things which are having the inventory and how much they are allowing to be withdrawn, they use this withdrawal Kanban and those who are requiring something. So how much is their requirement they use production order Kanban. So this is what we have discussed in our previous session. We also discussed some important you can say issues, characteristics related to Kanban that, we need to work on visual flow.

We need to work on lead time and these are important things which are essential for making Kanban a success. Without Kanban, you cannot achieve the objective of a single piece flow system. So Kanban is very important for achieving your concepts of Toyota production system. Now, going into the deep discussions on Kanban, we need to have some more important issues. One is Kanban board.

The Kanban Board we have a diagram for that here. And in this diagram you see there are three columns. So Kanban board is used to depict the flow of tasks across the value stream. So we have already discussed in our previous week about value stream mapping. So the concept of value stream mapping that how flow of activities are taking place on that value stream. First, that example, if you recall, the first activity was stamping, the second activity was welding, third activity was assembling.

So these are the value adding activities, in between, lot of waiting a lot of you can say transportation, movement were there. So all those were non-value-added activities. Only three value adding activities were there, one was a stamping, the second was welding and third was assembly. So it is used to depict the flow of tasks across the value stream. Now the task and the stories are represented by Kanban cards.

So Kanban cards are here, in our last session we discussed the current status of each task is known by displaying the cards in separate columns on the board. So these are the separate column on the board, the columns are labelled like To Do, being the things which are being going on and things which have been done. So these are the three important thing which we are mentioning on these cards. Each task moves from to do, to doing and then to done.

So as this card moves to so your task is going to move from here to here and from here to here, those things which are yet to do. These are the part of first column those processes which are currently happening are the part of second column and those things which are done, which have happened, the part of third column. Now you also see that in this particular Kanban card, the diagram which we have also, if you remember in the previous session in the important issues related to Kanban, we used to have a WIP limit.

That WIP limit here is given as two, that at any point of time there should not be more than two items in your production process. So that is the WIP limit, and this is a good example to understand the flow of material in automobile workshop in a garage. So if a car is there for repair, so you need to take only two cars at a time for the repair purpose and then what are the different activities to be done.

You note in the beginning of that, and then you decide the flow and the use will take the car to the first working station and then you will say that what all things you are doing at this moment you are checking the oil level, you are checking the alignment of wheels, that is two activities which are happening. When it goes to the next stage, so all those things which were being done at that time, will move to done and some new activities will come under being done and that will be deleted from the to do column.

So that is how this flow will take place and this Kanban card will decide, will finally give you an idea that you have completed all to do things and everything has come on the downside. So this will actually also help you in a type of checklist that all the activities have been completed. Sometime it is possible, particularly because we are talking of flexible systems nowadays. It is possible as many things are not arranged in sequence.

We are moving away from product based manufacturing. So when we are moving away from product based manufacturing where activities are linked in a proper sequence. So when things are arranged in proper sequence Kanban may not have that kind of importance because that is less likely to miss any particular process because everything is arranged in a particular order.

But thing like in a tool room environment, in a flexible manufacturing system, where you are looking more and more customization and organizations are developed on the basis of cellular manufacturing. It is quite possible that you may miss one or two important value added process and therefore this Kanban card becomes a very good checklist that whether you have completed all the tasks or not completed all the task.

So that is about the Kanban board or you can say Kanban card, this is nowadays possible on a computer screens also. So manual Kanban cards may not be that much required. Nowadays. You can have the electronic Kanban cards also. So now what are the important characteristics of Kanban? Let us see some of those important characteristics.

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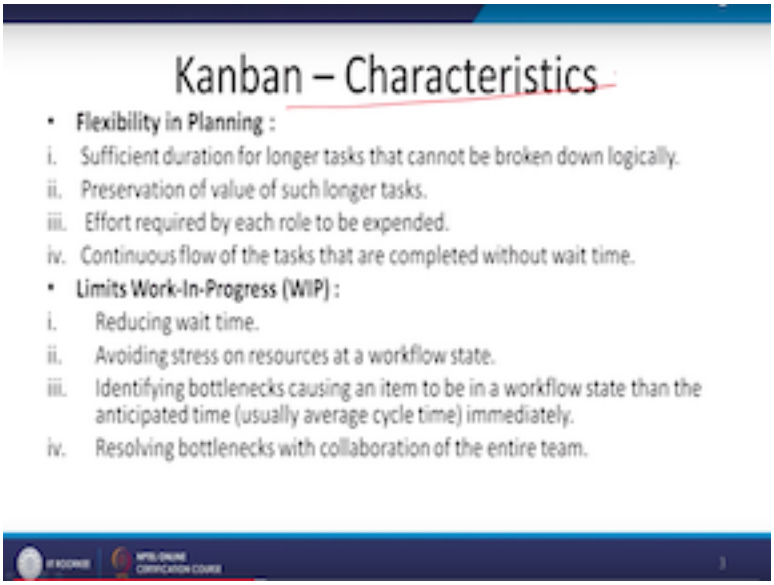

We already have discussed some of them in our previous sessions, but a quick recap will be very useful. Now it provides flexibility in planning and as I just told you, when we have a product based manufacturing system, Kanban will have limited applicability. Because in that the flexibility is not required or rather you can say it other way around also that product based systems have very limited flexibility.

When you have process-based systems, when you have a general purpose machines, then you want to use that flexibility for your advantage, then you want to use that generic manufacturing system for your competitiveness. And Kanban can be a very useful tool in properly executing that flexibility. You have flexibility, but at the same time you need some kind of check and balances whether you are properly using that flexibility or not.

So Kanban is one such tool which can help you in properly using the flexibility. So that is one very important, you can say advantage of Kanban that how flexibility can be used, that is possible with Kanban. How it is thing sufficient duration for longer tasks that cannot be broken down logically. It helps you in preservation of value of such longer tasks if we are required by each role to be expended and continuous flow of the tasks that are completed without waiting time.

So these are the different characteristics of flexibility which a Kanban can help you in achieving. The second important thing, the second important, you can say characteristic is a limited work in process. In our just concluded example of Kanban board, we saw that we had a limited WIP that is two numbers, that was limited WIP. Now because of limited WIP, you achieved the advantage of reduced waiting time.

If large WIP is there so obviously everywhere queue formation will take place. So you will have almost no queue or very small queue. So that is the reduced waiting time, avoiding stress on resources at a workflow state. So since a queue is not there and it is really simple to understand whenever queue is there, it creates additional stress on the system. Whether you are a workman or you are a manager or you are a repair shop person.

So whenever there is a queue, a sense of urgency will come and when sense of urgency will come, you will be under stress and therefore chances of mistake may increase. So that a stress will not be there because of limited WIP. Identifying bottle necks causing an item to be in a workflow state then the anticipated time immediately. So this will help you the limited workflow in actually predicting when the output will be ready.

So this is going to help you generate more certainty more on time delivery because of limited WIP, and because there is a limited stress the system is not under stress. Therefore you can resolve bottlenecks if there is a long queue of items waiting to be processed, so you will not be in a position to take some corrective actions but only limited one or two items are there, then you may stop the line.

And therefore, when we were discussing the principles of Toyota production system, we said that in a TPS each worker is empowered to stop the line, which is not possible in a mass manufacturing system where lot of questions will be raised. Why, Who stopped the line?. But limited WIP facilitate you to get that kind of strength that whenever there is a lacuna wherever there is a shortcoming, you can stop the line and do a away with the bottleneck.

You can improve the bottle neck, so that system becomes a more efficient. So WIP is limited and obviously a lot of advantages are associated with that limited WIP.

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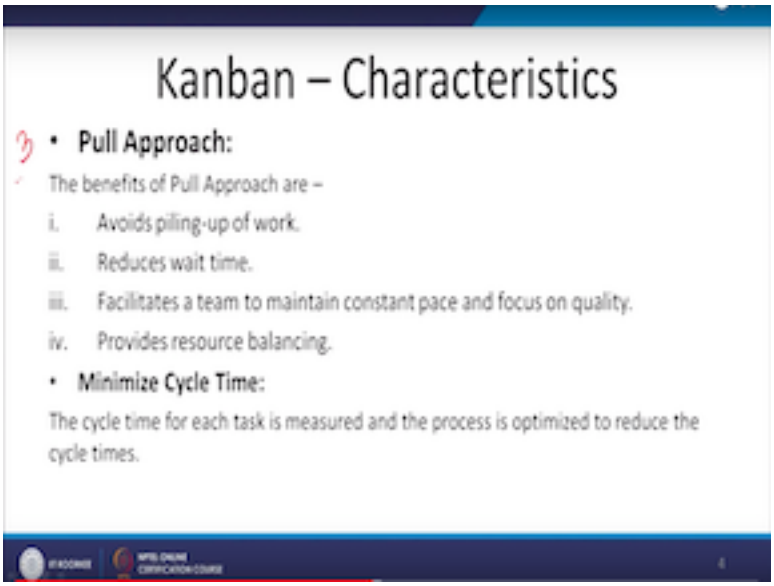

Then another important characteristic of Kanban becomes is the Pull Approach or you can say that whenever we talk of Pull approach, Kanban becomes an essential element of that pull approach. Without Kanban Pull approach is not possible. And we already know since in this course from the very first lecture, we have discussed it so many times that it avoids piling up of work.

So less inventory reduces waiting time, it facilitates a team to maintain constant pace and focus on quality, it provides a resource balancing. So all these are the advantages of Pull based manufacturing, so because Kanban is facilitating the pull based approach, so all those benefits will automatically come. If you have Kanban in your organization, then it also helps you in minimizing the cycle time.

Your cycle time will be reduced, the cycle time for each task is measured and process is optimized to reduce the entire cycle times When you have the Kanban, so you are able to reduce the waiting time and when there is no waiting time, your time is used only in the value added activity and therefore the entire cycle time is reduced. We have discussed various examples in this course where we saw that our maximum time is wasted in non-value-added activities.

Waiting, transportation are the two biggest you can say, consumer of your entire time. So by this you will be able to reduce your waiting time or you will be able to reduce the time of transportation and that will help you in tremendously reducing your entire cycle time so your CD will also get reduced or become optimized. Then another important characteristic of Kanban is the continuous delivery.

You will be able to deliver with a regular flow because the objective of pull based system is to achieve some kind of continuity in our output. We are not that way creating output in a lot and then stock it and sell it for a period of time. Then again go for a lot manufacturing. So we are against lot manufacturing, we are against batch manufacturing, we are against mass manufacturing.

We are in favour of in this particular concept of continuous manufacturing that it may be a very low rated output, but it has to have some kind of continuity. So that the continuous delivery is another important characteristic of Kanban system.

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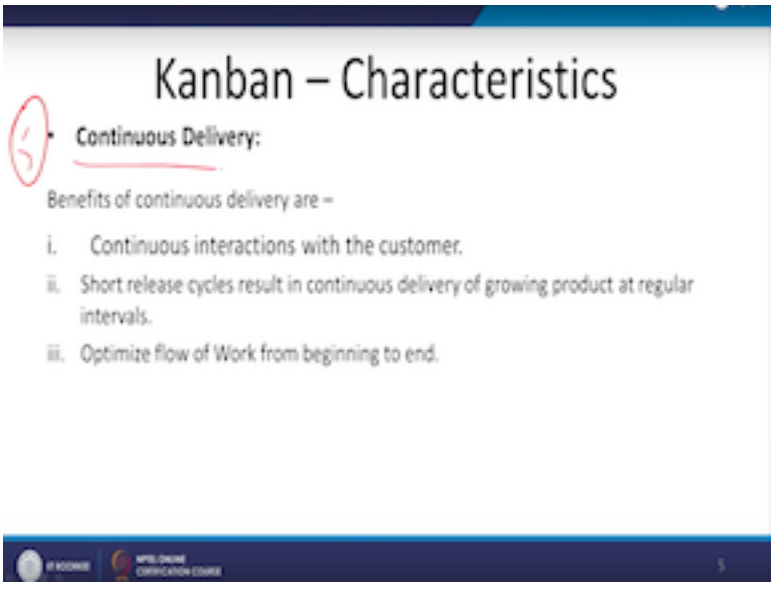

Based on the need of the customer, you will continuously produce and benefit of continuous delivery are continuous interaction with the customer. Since you are producing all the time, whenever a customer requirement is there, so you are always remaining actually up to date with

the customer requirement. If you stock items in anticipation and suppose in the meantime, customer expectations change, so all that inventory which you have piled up will become useless because that is based on previous customer requirements.

But because you are following the concept of continuous delivery and daily customer requirements may change. So you will be able to adjust your system, your product with the changing needs of the customer. So that is one big advantage. Many times we do not discuss this in our operation management classes, but this is one very important advantage of continuous delivery.

Short release cycles result into continuous delivery of growing product at regular intervals. So you develop a short release cycle which helps you in continuous delivery and that is the essence of this particular aspect of continuous delivery systems in the Kanban and it also optimize flow of work from beginning to end. You from start to end so many intermediate activities are there, with the help of Kanban, you actually optimize each one of them, each one of them that, because of visual display information available on all those visual displays.

You actually are able to optimize all intermediary steps from beginning to end. So these are related to continuous delivery characteristics of Kanban. Then Kanban we as already understood is a visual signal.

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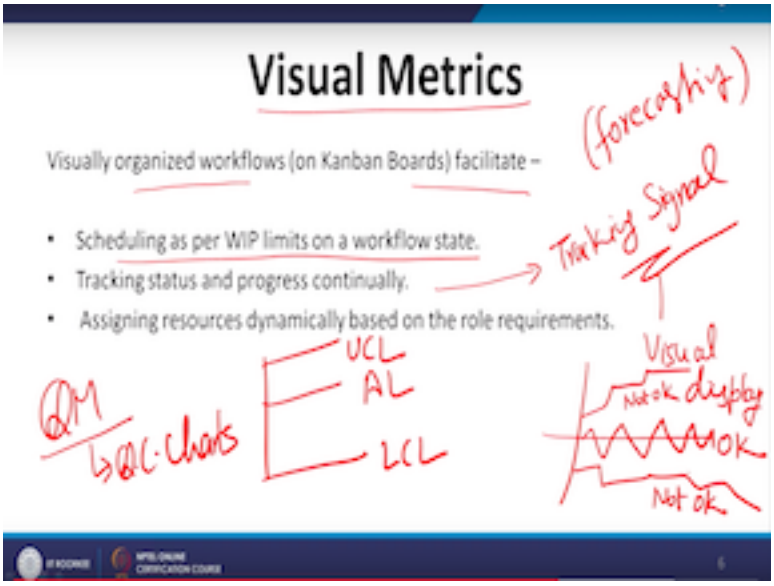

So visual metrics play a very important role in success of Kanban. So visually organized workflows facilitate scheduling as per WIP limits on a workflow state. So you know that like in our Kanban card we discussed in this session the WIP limit is two. So at any point WIP should not cross that limit of two and that if visually displayed, you will always be careful that my system has only two units in the WIP.

That is actually becoming a kind of benchmark, a kind of you can say upper limit for sure during activities also. So based on your WIP limits, so you can schedule your various machining activities or the loading on the machines. Then tracking the status and progress continually so you can track the continuous progress. You remember there are two, three things like whenever we do the forecasting we use a concept known as tracking signal.

Now in that tracking signal, the idea is only this whether you are, and this is why we are discussing this tracking signal right now because it is also a visual display. When we are talking of quality management, this tracking signal comes from the discussion of forecasting when we are talking of quality management. So we use QC charts, where we are making upper control limit, lower control limit and average line.

So all these things are actually deep visual display of your information. And with the help of visual display your understanding becomes much faster, much impactful. That is the idea. So

whether you are having the tracking signal, you can just by seeing the tracking signal. So like I am just plotting a tracking signal whether it is moving like this way you will say okay this is the appropriate tracking signal.

But if tracking signal is moving this way, you say not okay. If tracking signal is going this way, you will say not okay. Because these tracking signals without even knowing the just values just by seeing their shapes, you can interpret that the tracking signal has some kind of biasness or there is no biasness. If tracking signal is random you say it is okay, but whether it is a positive biasness or a negative biasness, biasness means you are not having the appropriate forecasting.

Similarly, in case of quality control charts, if your charts are having, let us say it is a P chart. So if you are plotting the values of P on this QC chart and if these values are random, you are happy that okay the system is performing well, but if these values are not random, if these values are showing some type of trend or if values are random but they are consistently coming either beyond the UCL or beyond LCL, that again, it is a matter of concern that why it is happening and then you need to go that question of five-whys.

So it is a very useful tool for tracking the performance of your system. Then assigning resources dynamically based on the role requirements. So how different systems, different activities, tasks that require resources. So that is also possible dynamically that today, this resource this activity requires more resource. Tomorrow this may not require more resource, some other activity. So you do not have the permanent assignment of resources to a particular activity.

You can change the availability of the resources depending upon the need. So, that dynamic shifting of resources is also possible. And with the IT in our organizations, this has become a good enabler for this dynamic resource allocation. So that is also possible by visual displays. So like this is simply an example,

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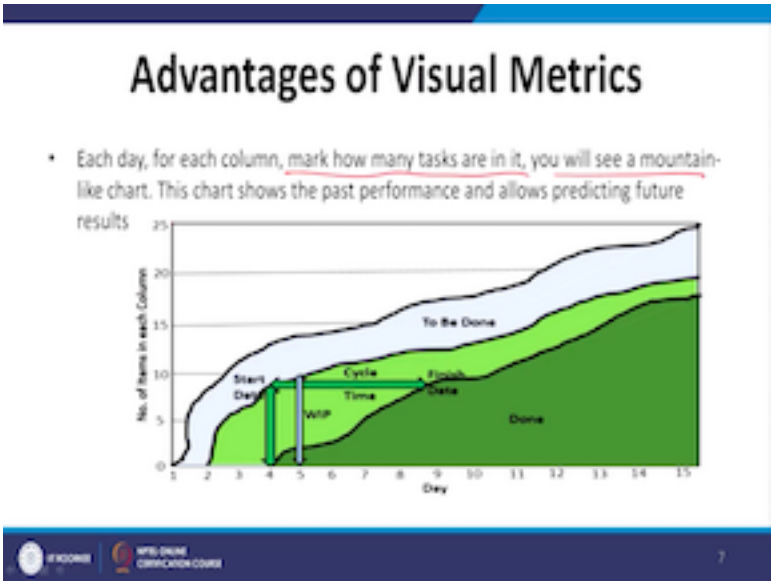

Where you will see that how you can have advantage of visual metrics. So each day for each column you can mark how many tasks are in it. You will see a mountain like chart. So like this you can see a mountain like chart that how from this a lower point you are going to the top points. So it is like a mountain chart and this chart shows the past performance and allows predicting future results.

So you can see that how your this is into if you remember the Kanban card, we have components in that to be done then, what is being done and then done. Those things which we have already done, so like you have a number of items in each column, how many items are there in a particular column at a particular time. So depending upon how many days are there.

So you had it starting like this, that initially these many things are there and you are moving and therefore you will see that your time and, there has to be a proper balance between the done to be done and the being things which we are happening and with the help of this visual display, you understand that how these different activities are consuming my time. So like in this you have the items, how many items are there and here how many daytime is there.

So if activities are taking more time, so that gives you an opportunity to actually excuse those times. So this is like a tracking signal and QC chart. So this is also a type of visual, you can say a symbol that gives you one particular thing. Like here, this activity is starting and here this

activity is finishing. So this much time it is taking for this much duration. This activity is the part of ongoing being done.

So it is starting on fourth day, it is finishing on almost ninth day. So five day time it is taking and how can we reduce this five day time. So over a period of time it becomes a tool of improvement also. So that is the benefit of visual metrics in this particular case. Now for doing the calculations related to Kanban, so that is also a very important thing that how many Kanbans are required and how much item you need to produce or how much you can withdraw depending upon type of Kanban. So you have a very simple four step process

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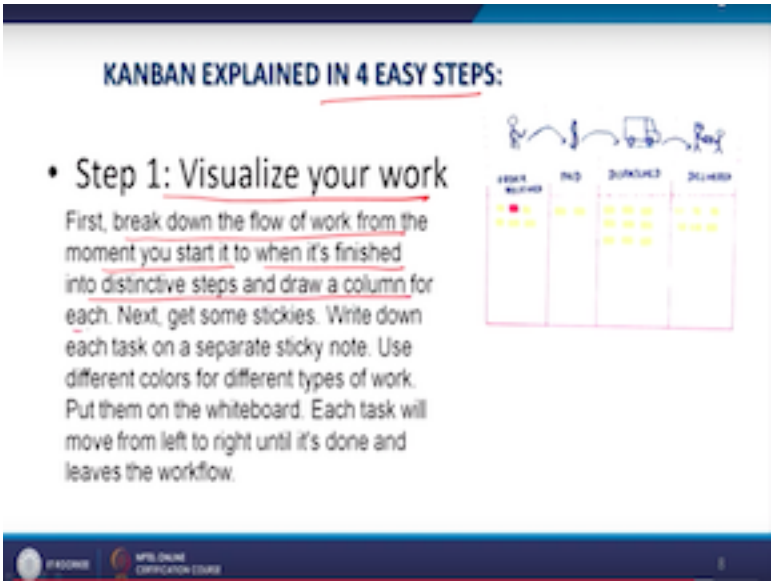

And that we will like to discuss in this particular part, that the first is you have to visualize your worker. So first, you need to see this kind of a flow diagram that what are the various stages, what are the various steps involved in your work. So that is the first part is break down the flow of work from the moment you start it to when it is finished into distinct steps and draw a column for each.

So like here in this particular case we have four stages, order received, the payment received and you are dispatching and finally it is being delivered to the customer. So these are the four stages and that we have identified, and for each activity you have drawn columns. Now what next get

some stickies. Write down each task on a separate sticky note. Use different colours for different types of work.

Put them on the white board each task will move from left to right until it is done and leave the workflow. So like here we are putting various stickies. You see these are various stickies and these stickies will move like we are right now talking of order received. So you are writing on this particular sticky that this is order received and we will see that how this sticky will move from one stage to another stage till it leaves this system.

That means the completion of task, and through that we will see that how many Kanbans are required to maintain a continuous flow. We are right now keeping three and three, six here, two stickies here. Then nine stickies in the dispatch and six stickies in the delivered area. So how does the stickies have come and what are the significance of these stickies. That is important thing so that we will discuss that the calculation part of these stickies and how many Kanbans are required to maintain proper flow in this system.

That is actually the calculation and we will see that calculation part in our next session. So we stop this session here itself, and we will continue with this calculation part with the help of some examples in our next session. Thank you very much.