Simulation of Business Systems
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Lecture - 17
Simulation with ARENA: Use of Decision node

Hello everyone. I am Dr. Suman Samanta and I welcome you to the Core Simulation of Business System and Applied Approach and today we will be discussing about Simulation with ARENA. Today we will show how the various nodes of the ARENA can be used to develop various models.

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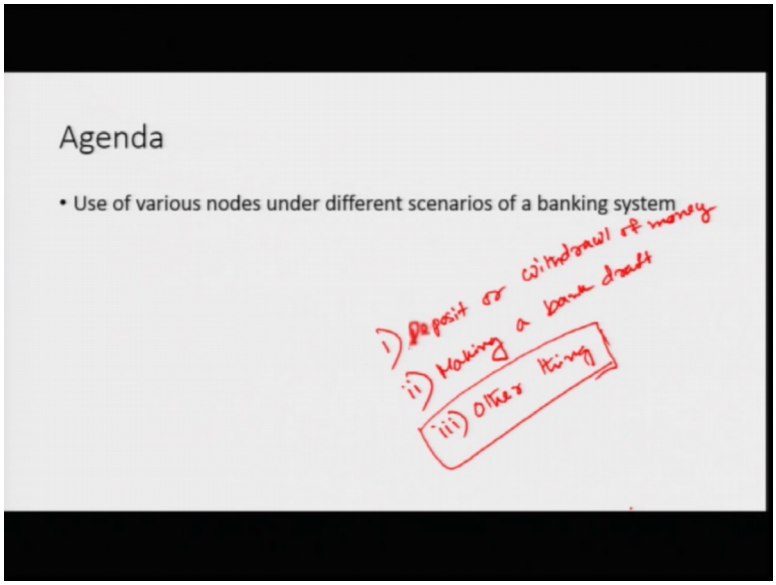

So, today we have only one point agenda that is how we use various nodes under different scenario of a banking system. So, the thing is that there are you might have seen when Professor Philip have shown you the ARENA inter GUI, you have seen there are, that means several nodes are available, but today we will show that how these nodes can be used to develop various scenarios. We will use a simple banking system here and we will develop various cases and we will show that how those nodes can be used on those various cases.

So, first of all we would like to define, we like to discuss about a banking system in brief and then, we will show, we will discuss various cases and then, we will develop the

ARENA models of those cases. We will take here that a customer when enters into a bank can have only 3 things to do. Number 1 is deposit or tubular withdrawal of money, second is making a bank draft and third is other things that includes he may have some discussion with the bank how to open their bank account and any other thing. So, we will put all these things to this category, other things.

So, as you know [FL]. So, in this banking system we basically considered 3 major things that a customer will be doing, then one more thing is that this is basically what we are trying to do is that we are developing a model simulation model from a real life situation. We are not developing something which we are going to establish or anything like that. We will at the end of each case we will discuss some managerial aspects of the run, so that we can try to find out whether how the system is going there is requirement of some extra window or there is requirement of removal of an window something like that.

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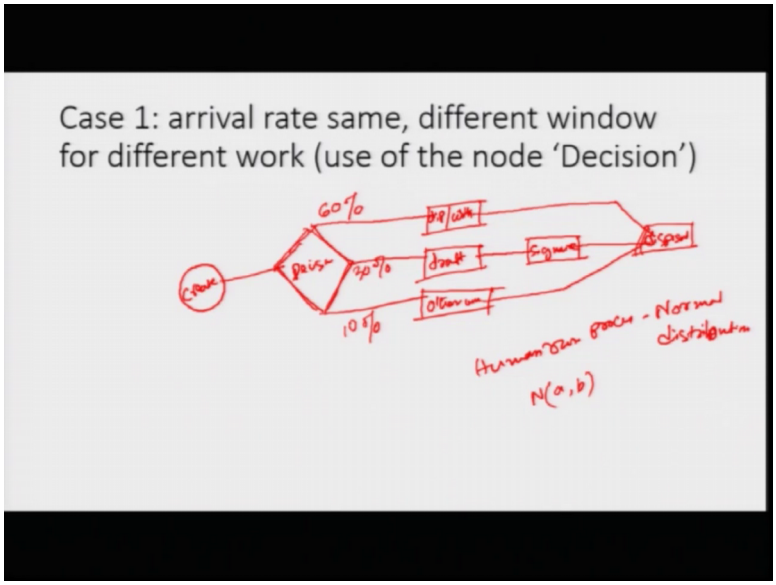

We start with case 1, where a customer arrives at bank and we are basically counting the arrival rate as same and then, the customer depending upon their requirements they go to a window and there is a separate window for different different operations that a customer needs. So, when we draw a process flow of this bank system, we start with the create node. The create node signifies that the customer have arrived at the bank door, then once it arrives, it decides where he wants to go. So, he will require a decision node as we have said that for this case, we have a separate window for separate operations.

So, we already have discussed that they have mainly 3 operations available in this bank. So, we have similarly 3 kinds of flows will be coming from here; one process, first process, second process and third process. So, this one is deposit and withdrawal window, this is draft making window, demand draft making window and the third one is other work window. So, once if you have ever went to a bank to make a demand draft, you can see that once the draft is made in the window, it goes to the manager for signature.

So, for making a demand draft there has another process left that is signature with the manager. Once this signature is, manager has been signed the draft, the draft is developed by. However, for the other cases it will directly go to the I mean a customer directly leaves the system, node is developed based upon the past history and you can in this case we will I mean estimate that there are maybe 60 percent of the customers will be opting for deposition and withdrawal, there may be 30 percent of customers who will be opting for draft and making demand draft. And, there will be other remaining 10 percent of the customers will be developing the other services of the branch.

So, this process is mainly when we saw a system which is run mainly by the human, then there is some set of rules that if you can go through the simulation modeling and any standard simulation modeling book, you can find that there are several consideration that we take when we estimate with the processing time for various processes. Say for example, if the process is mainly run by humans, then we will use normal distribution human run process. So, in this case all these process will be considered as normal distribution. All these process times follows a normal distribution of something mean and standard deviation.

So, now we have developed this process flow, we will go to the ARENA simulation software and we will try to develop this model in ARENA and we will run it. And, we will try to see the managerial aspects of it like how this process is actually working whether we need to include some other window or we need to exclude some other window these kind of things.

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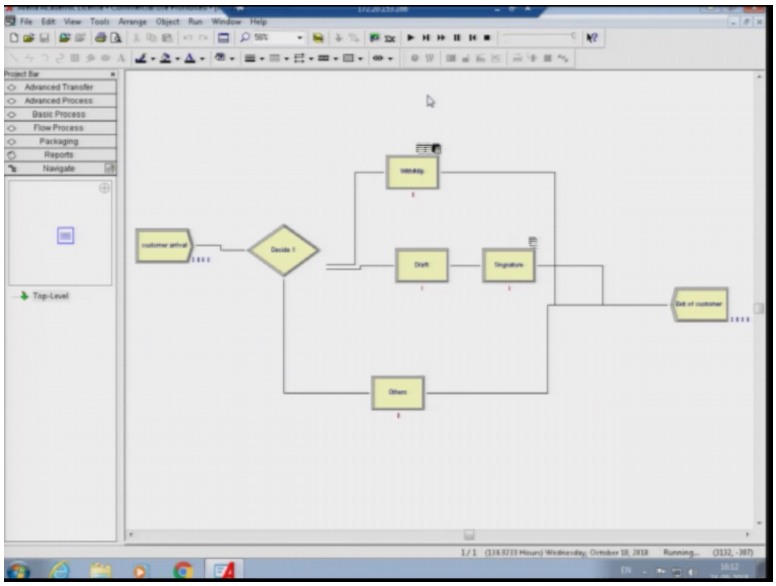

As I said in previously, we will start with create node. Create node basically signifies when this customer arrives at the bank, then we will have a decision node that is that will be signified by this decide, we will come to how we will put the values on this, I will come to that later, then we will have 3 processes. One is deposition and withdrawal, second is making a demand draft and third one is other processes that must be deleted first and then, with demand draft there is another additional process and finally, once all these things happens, the customer leaves the system, ok.

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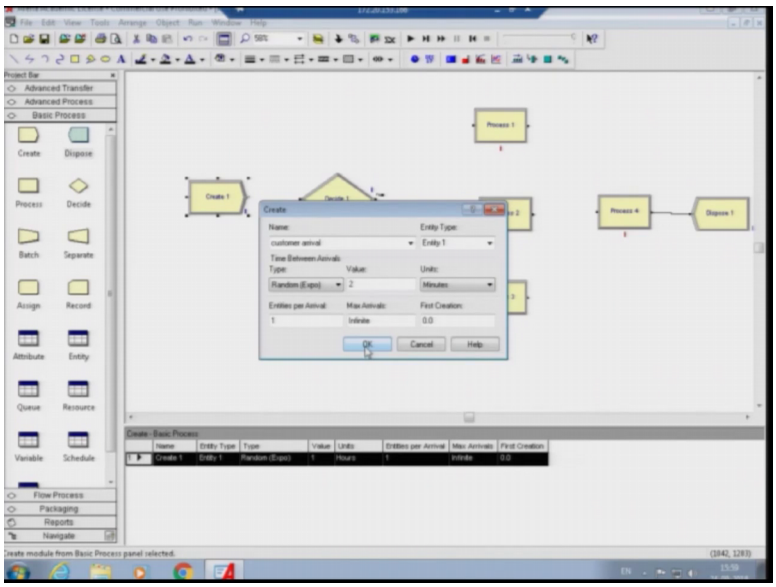

So, as we see in the create node, we can rewrite it as customer arrival. So, another important thing is that when we have a human arrival in a system, we normally used it, use exponential distribution. When in a process industry, we go for various processes I mean go through various processes; milling, drilling and other things and then, we normally use this constant thing constant I mean this constant arrival. That is because we already have inventory for that, but for human we normally use this random exponential distribution.

Now, say for example, for this case for this particular bank we have two arrivals per minute having different I mean 1 arrival per 2 minutes. Having if you see this there is entities per arrival is 1 and every 2 minutes there is 1 entity per arrival that is the I mean of the random distribution random exponential distribution. So, that is all about the create node.

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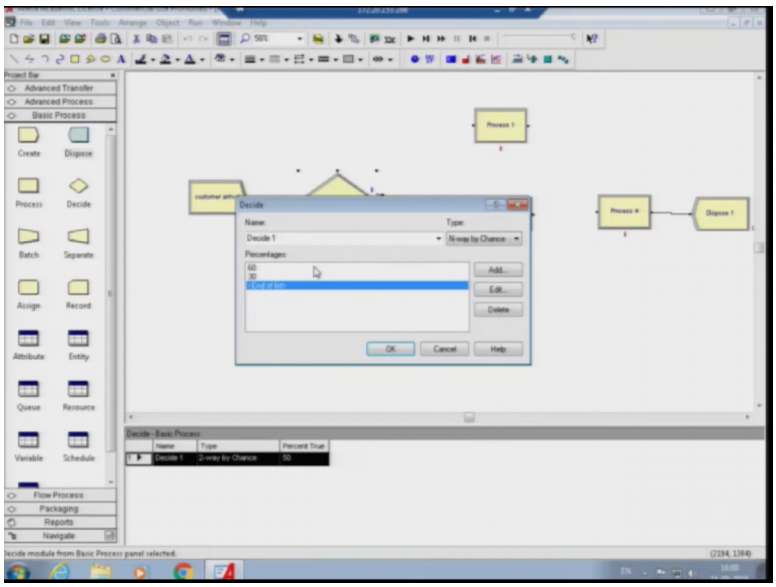

Then, we will have decide node as we have already said that there are 3 kind of processes. So, we need to have 3 decisions. So, as we can see as you can click on this type, see there are several choices two way by chance two way by condition n way by chance and n way condition. We will come to these condition cases later on since we have more than two chances. So, we will use two way by chance.

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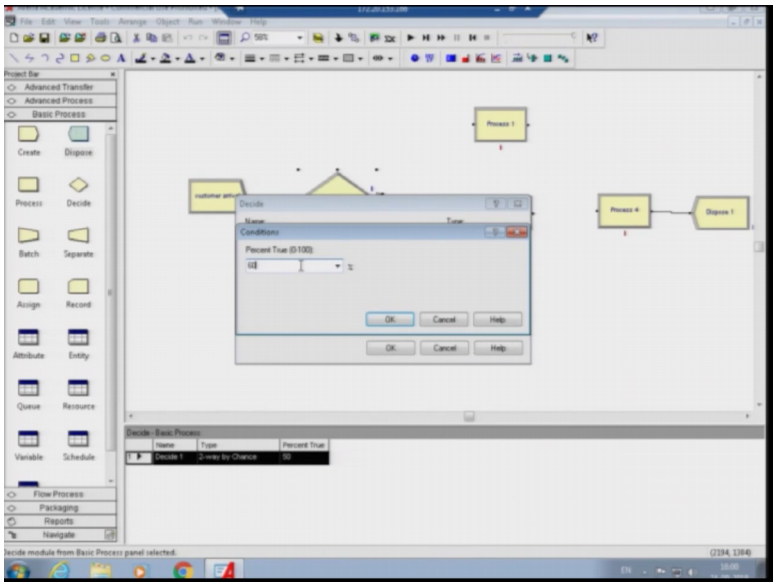

So, in the first case we have we said that there will be 60 percent of the cases where customer will opt for withdrawal and deposit of the money. So, first case is 60 percent, second is 30 percent where people will be opting for making demand draft and when we use 3 decisions, 3 kind of customers, then we need to define two things, two percentages and third percent will be automatically taken by the default case as you can see here there has two already dots are available. So, as you can see there are very small two dots in this. We have to connect these processes with these two dots. I will show you how to connect them. So, you can see that whenever you bring this plus sign, when you have this dot, you will see this green square. So, you have to touch there first and then, you have to close it here.

Similarly, similar thing you have to do for the second that is 30 percent case. I mean that is for the people who are making the demand draft, you have to bring this, you have to bring this green circle near the second dot and then, touch it and then, you have to touch the third process and for the third case where I mean once 60 percent, 30 percent has been done, no remaining 10 percent case that is basically default end case that you have to touch here and then, you have to put it here like this. Similarly this thing has not been joined it. So, I am joining this.

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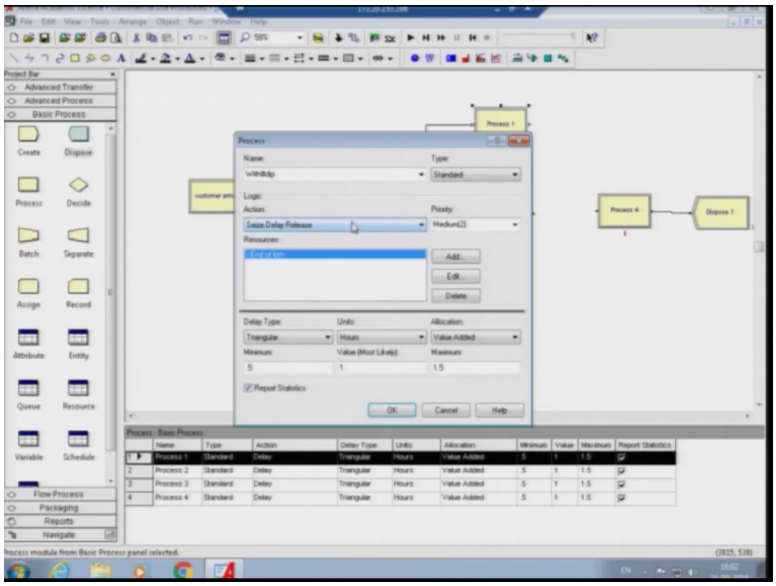

So, as we said the first process is basically the withdrawal or deposition of money. So, we will name this as withdrawal dip. So, similar to the cases that has been discussed by Professor Philip, we will use seized delay release in this case also.

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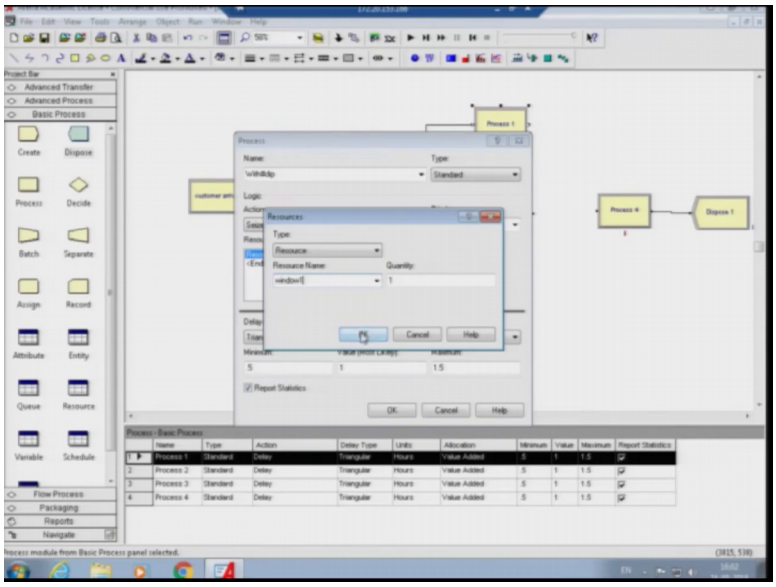

We will add one resource that is window and we call it as say for example window 1 and we have one quantity only. So, we put it like this. So, this is basically withdraw deposition window.

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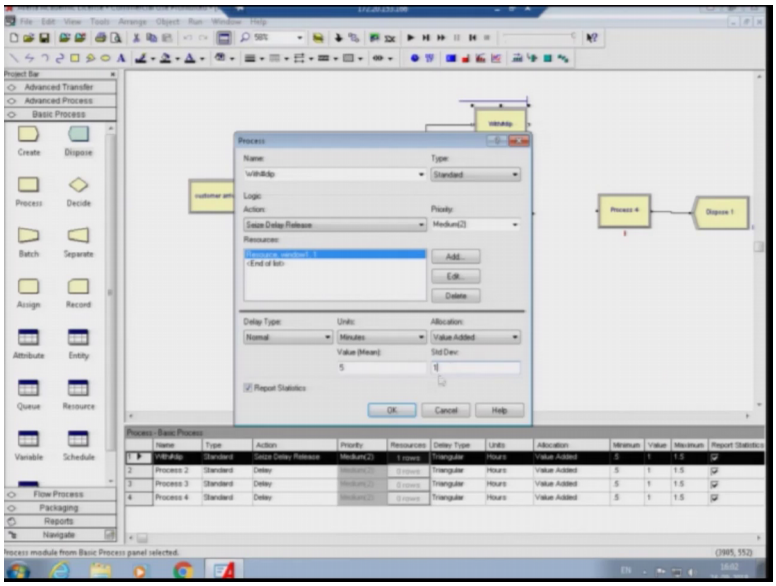

Then, the second process is basically the draft making, demand draft making will call is draft it was an we forgot to give this time window here. So, as I said earlier we will use normal distribution here. We will use minutes for the time. So, say for example we have given the time taken to avail this service is basically with vary with mean 5 minutes and standard deviation 1 minute. So, similarly for the process 2 also we will do, we will name the process as draft. We will use seize delay release, we will add a resource whose name is say window 2. Similarly here also we will use normal distribution so, for as this process takes around 3 minute of time with a standard deviation of 0.5 minute.

So, similarly third process we will rename it as others. We will use that seize delay release again. We will make the resource name as window 3. Again we will use here normal distribution. Minutes may be this one takes maybe 10 minutes with a standard deviation of 2 minutes because in the other case we are basically covering a large number of various, then people may have lot of querie. To resolve these queries, it may take some time.

Similarly for the process 4 also, we will make this as rename this process as signature. We will again use seize delay release process seize release and we will make the, rename the resource name as a manager since the manager needs to sign these drafts and we will use a normal distribution say for example and it as a minute and say the manager

requires 10 minutes time with a standard deviation of 2 minutes to sign the document. So, we have not.

So, as you see if the customer needs to do only money withdrawal or other things, so they do not need to meet the manager and directly go to the exit. This disposal is basically I am trying to make it in such a way it is visible disposal means exit of customer. Now, we are we are in a position to run this simulation model and look into the system how systems are working.

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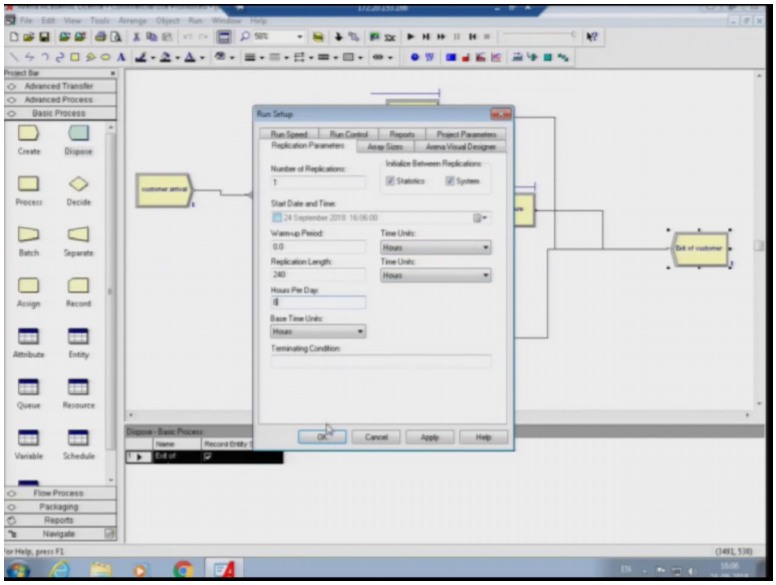

So, we will make the setup correct. So, replication length we are taking as say for example for a month. So, 240 hours 8 hours per month per day. Now, I am ready to run this system and let us run it and then, checkout check how system is working. I will make the speed little bit higher, so that we can reach to the result earlier. So, that is the end of this run and we have already got the result.

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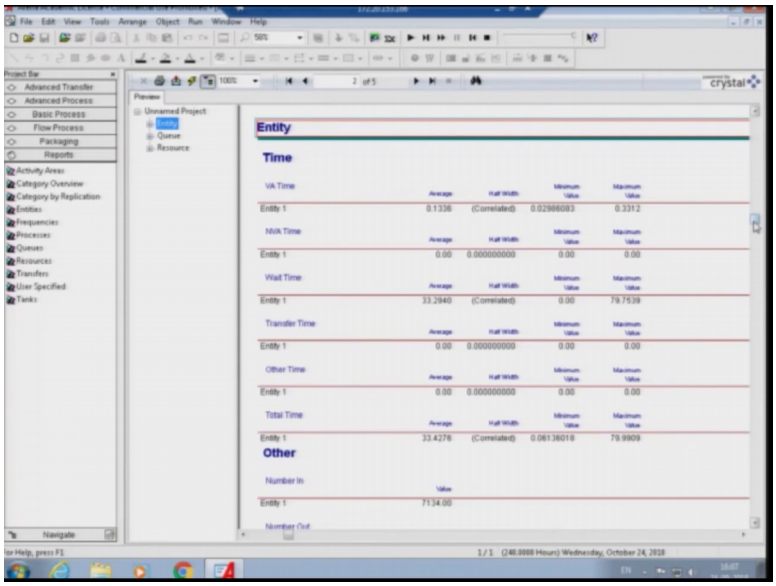

So, when you see the result, you can see that the total number of customers served is 5084, then you can see a few most important things that is total number of entity that came is basically 7134, where as the number of output is basically 5084.

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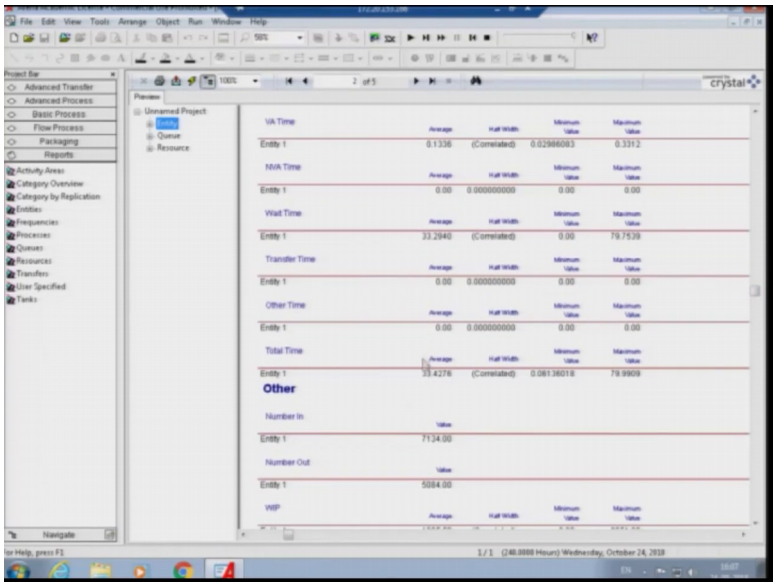

So, there is huge number of gap between the people that came in and people came out. So, there definitely have some issue with the bank, banking system because all the people that came to the system could not be served. So, there might have been requirement of inclusion of inclusion of a window or something like that, inclusion of

resource something like that. We will we will show; see that in the queue itself and we will see that in the resource phase as well.

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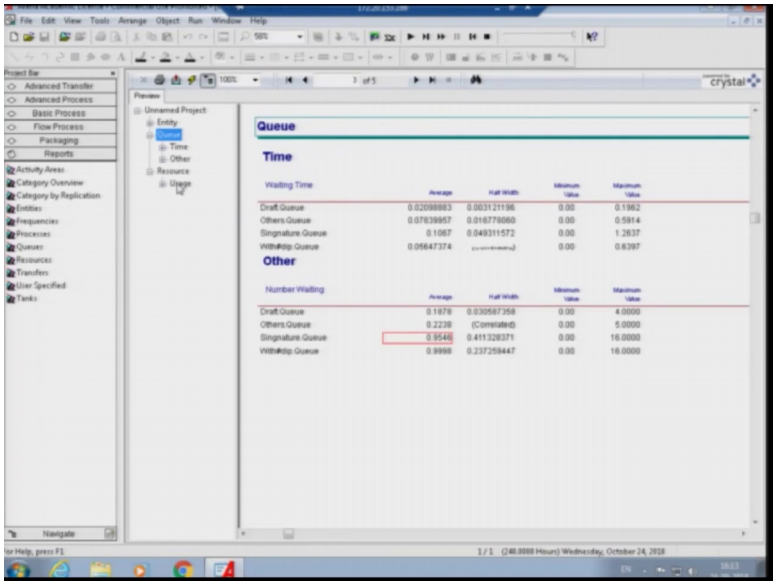

So, as we can see that the draft queue is basically performing well with a very less number of average queue per queue number whereas, you can see the other queue is also looking, performing preferably good way. Whereas, the signature queue have an average queue length of 39.5 minutes and withdraw deposal also have a queue length of 39 point, sorry have a queue length of 39.5 number of people whereas, with maximum number of length of queue as 79.7 that is near about 80.

Similarly, for the withdraw deposition queue length we can see that the average number of queue is basically 39 around 39 and maximum of queue length is around for 76. So, there is definitely some issue with this signature queue and withdrawal queue. Similarly you can see number of waiting in the queues. Also here in signature queue, you can see around 355 people are waiting on an average with the maximum number of waiting is 717. Similarly withdrawal and deposition queue we can see 677 number of people are waiting on an average, average 1332 is the maximum number of people waited at some point of time.

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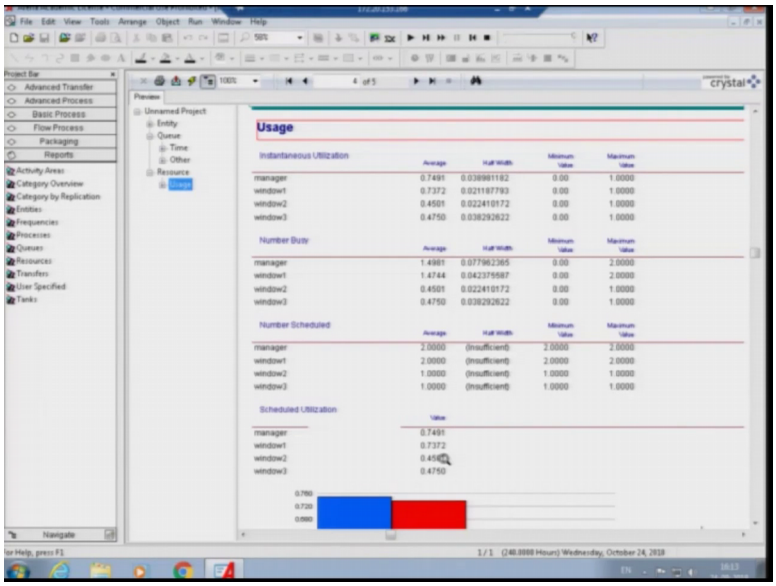

So, when we see the resource, this shows much clearer view that you can see here the manager and window 1 having the highest utilization of resources. See for example here with the window 1 is basically is completely weared out with one utilization number. That means, almost all the time it has been busy till it could not produce, it could not serve all the people. Similarly manager also is busy with this from 0.991 means it is basically over near about 1 and it is only this much less is because the managers work immediately did not start. It starts after the first process has completed his work.

So, seeing this we can decide that there is definitely some issue with the window 1 and window 1 is not been capable to cope with the customers requirements. So, as we can see here also there has around 1332 number of customers which were unserved and still in the queue about the period 1 which we run and similarly in the signature also, there are 716 people who are not processed. So, to cope up this situation what we will do is that we will add resource to this withdraw and withdrawal deposition window that is we are trying to make another window for this withdrawal deposition counter and for signature, we can put another signatory authority.

For that we can suggest to the bank authority that we can put I mean first of all let us try to see if we include this one resource to these two processes and then, try to find out how the system is behaving and after that we can suggest that these things can be done. So, we will go to the resource block and we will add that, add one more resource to this

window. Say for example, see there is resource block, you can see there is window, then type of the capacity fix capacity, then there is a capacity block on which we will put two instead of one. Similarly for the manager also we will put two instead of one. Now, we have 2 windows for this withdrawal deposition work. One window for this draft, one window for the others and one and two window for the making the signature in the draft.

Now, with this we will run the model again with the previous similar see when we add one resource to one process, that we mean that the mean and standard deviation of the process remains the same. Only we are adding one more window for this particular process. So, again we will run the model and we will check how the system is behaving with the added new window. So, we have end of the run.

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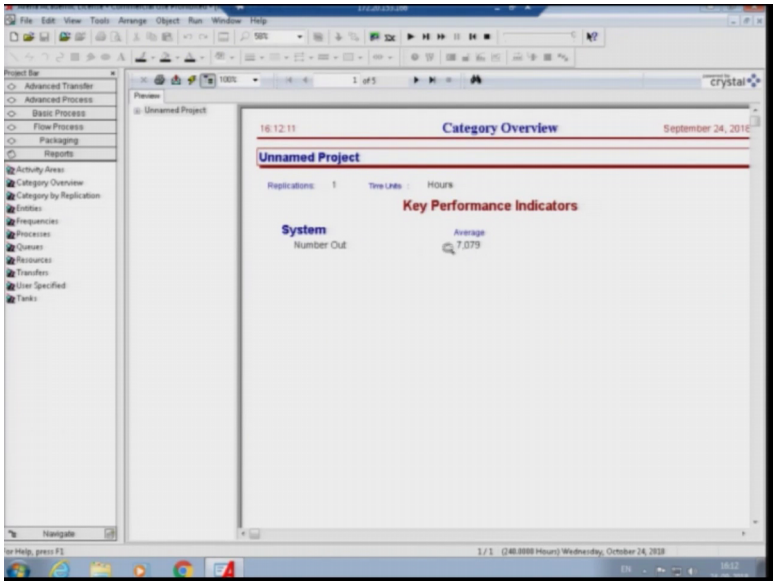

So, as we can see now the total number of out is 7079.

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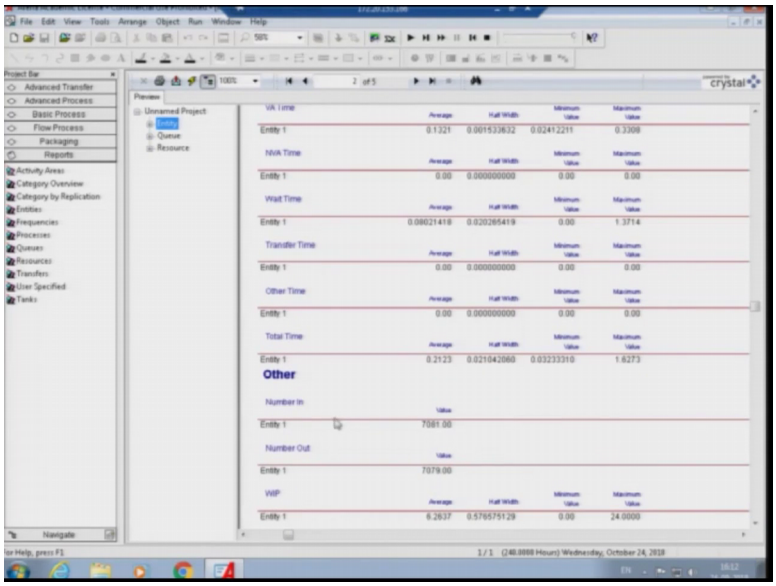

As we can see here the total entity in is 7081 and 70 out is 7079. So, we have done pretty well with adding these two resources to the system while [FL] satisfying the customers requirements. Now, when you see that queue you can see that the waiting time has been reduced significantly for the withdrawal. So, it has been reduced significantly for the withdrawal deposition queue and signature queue.

Similarly, number of people waiting in the queue also have been reduced significantly for these 2 queues. Similarly when you see the utilization of the resources, then also you can see there are significant improvement in all these cases. So, in this way we can do this analysis of this and we can try to find out whether we can add a resource or not, we can remove a resource or not. These kind of things we can do. So, this is end of the first case. So, we will go to the second case where as we have already said that we will not change variety of the customer. We have only 3 kind of customers.

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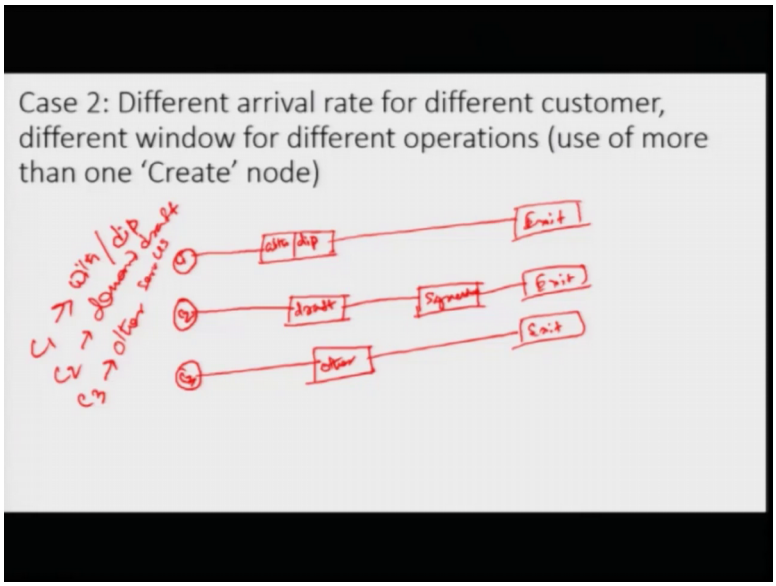

So, for the second case, what we are considering is that we have different arrival rate for this one that is we are not saying that we are not dividing the customers after they arrive. We know that arrival rate of different customers and this case also the windows which serves the different kind of customers are different. So, that is what we are doing in this case is that we are using different, create mode for different type of customers on the same simulation model. Similar to previous case, we will also try to draw the process here first and then, we will go to the simulation model.

So, as we see that we have 3 kind of customers. So, we have 3 create nodes here say C1 C2 C3. C1 is for withdrawal deposition, C2 is for demand draft and C3 is for other services. So, similar to previous one, here also we have different window for different processes that is withdrawal and deposit is draft making that is other as we have said the draft making process have another, draft making system is another process let in beginning with signature. Then, finally we can make the exit node as individually different or it can be made the same and putting them in the same exit window also replicable.

So, since we have different create more nodes for different processes, different time in customers, so we have to we need to redefine I mean we need to add the different I mean arrival rate for different, this create nodes as well. So, let us go to the ARENA and we show how we can incorporate this model into the arena, ok. So, we need to save the

previous model. First let us save it somewhere around. Are you saving, ok? I will close it, save as. Now, we will take another open new file and then, will try to develop the model that we have just saying about.

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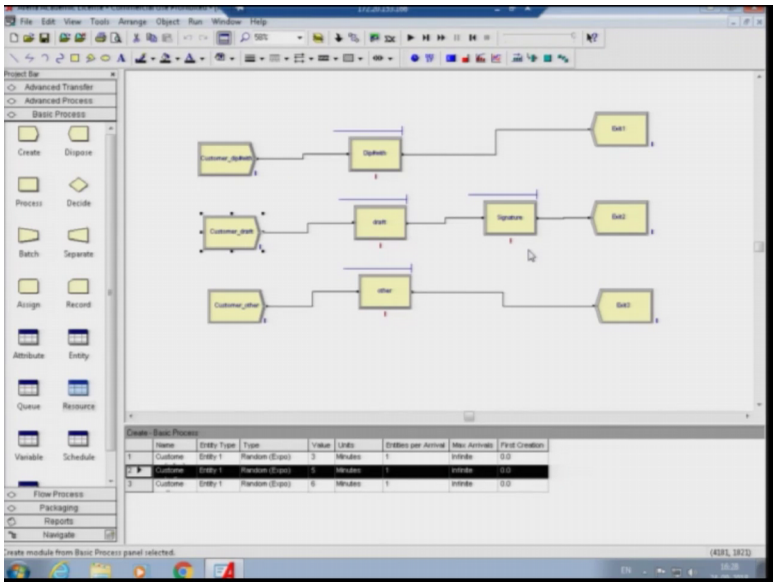

So, as I said earlier we will have to make 3, create nodes. Similarly, in correspondence to each create node. There is at least one process and since you for the draft making process system, we require another additional process. So, I will put it there. So, we will here put 3 separate disposal nodes. However, if we put one only disposal node and they connect all these 3 to the 1 disposal node that also can be varied model and that also can be done. So, we are joining this which similar to the previous one.

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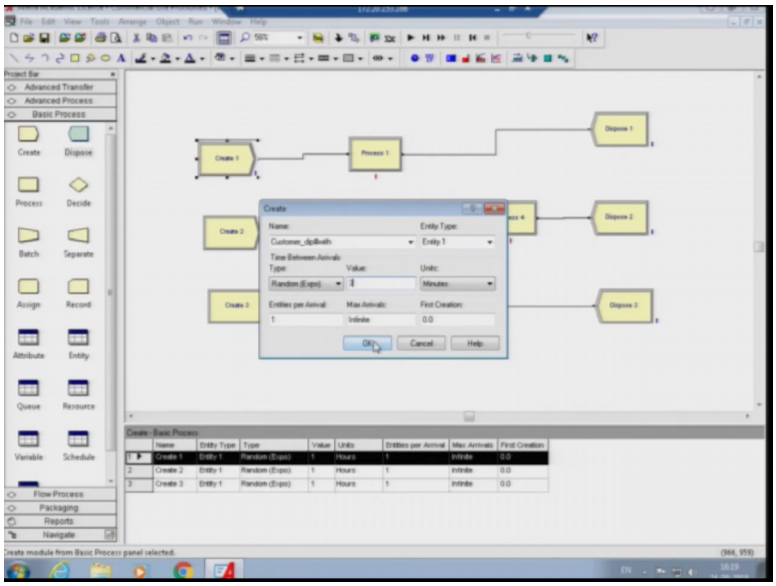

We will put values to this. All these nodes first of all is create node. Create node 1 is basically the customer who comes to deposit or withdrawal of money. Now, similarly we will use random exponential distribution say for example, the value of this random exponential distribution is say every 3 minutes, 1 customer come for depositing and withdraw. Similar to this is basically customer draft. So, for example, in every 5 minutes, 1 customer comes for making a draft.

So, third one is customer which viables other operations. So, say for example, here also we will put say for example every 6 minutes, 1 customer arrives for making the draft.

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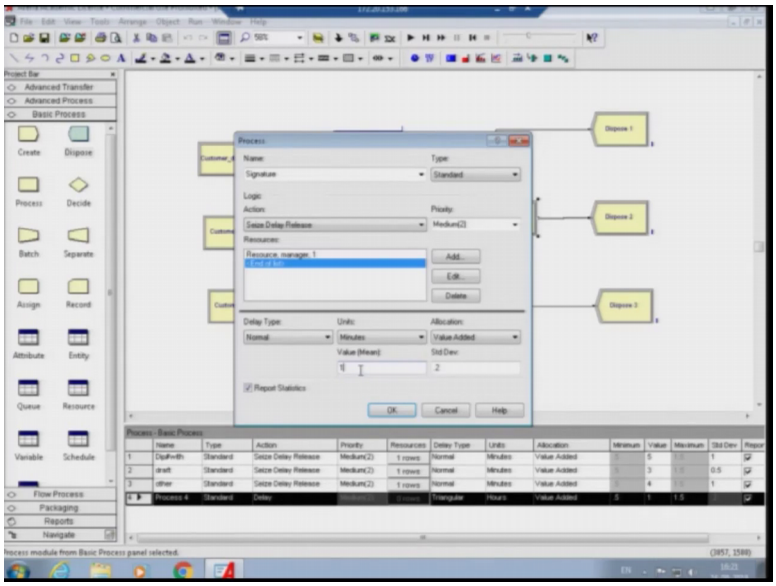

Similarly, we will rename the processes is this process is deposition, withdrawal of money processes. Similarly previous one here also we will use see it as a delay release.

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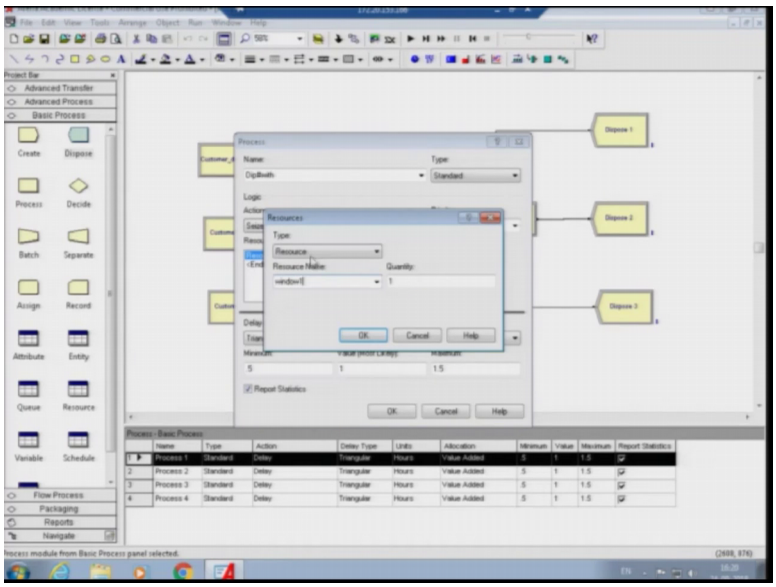

We will add resource name window 1. We will use normal distribution with 5 as 5 minutes as a mean as an division of 1 and we will here also we will make demand draft. This will release, we will put the process name as window resource name. As window 1 window 2, sorry release normal distribution here also with a mean of say 3 minutes and it is a division of 0.5 minutes only.

Process 3 also will rename it as other. This will release, we will put it as window 3 with normal distribution. We keep the value as 4 minute within the division of 1 minute. Similarly, here also we will put the process name is signature. This is delay release. Manager will do this process. We will put manager as the resource name. So, again we will put that as 10 minutes with 2 minutes of standard deviation.

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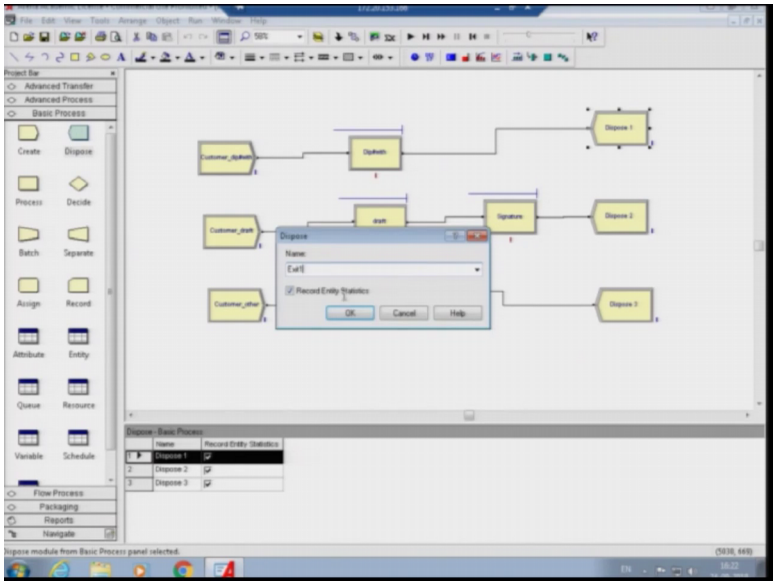

So, here for example, we can keep this name as a exit 1 exit 2 and exit 3. Now, we will run this project again, ok.

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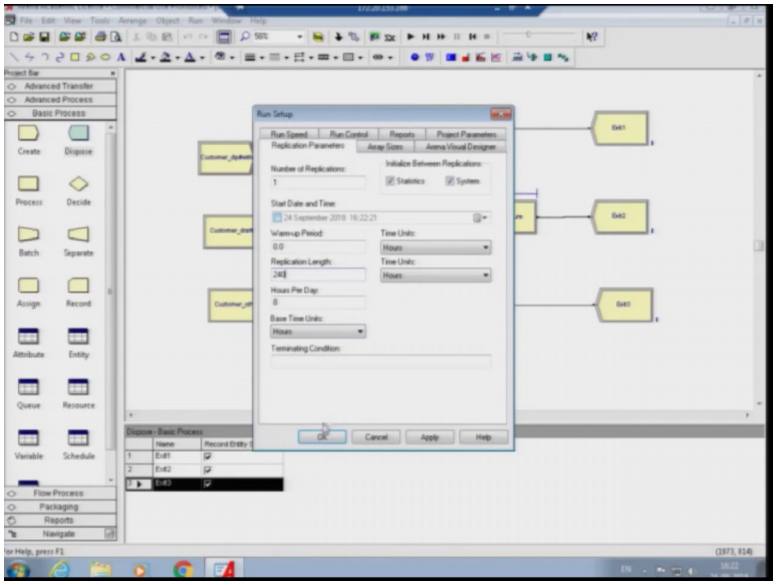

Before running we need to always check this window that is run setup, otherwise if you do not check this and it will go for infinite run and we can never get the result. So, every time we develop a new model, you need to check this window run setup first. So, similar to previous one also, also we will do run for 1 month 8 hours per day 240 hour total run. So, we will run it again. We make it first to reach the result has arrived.

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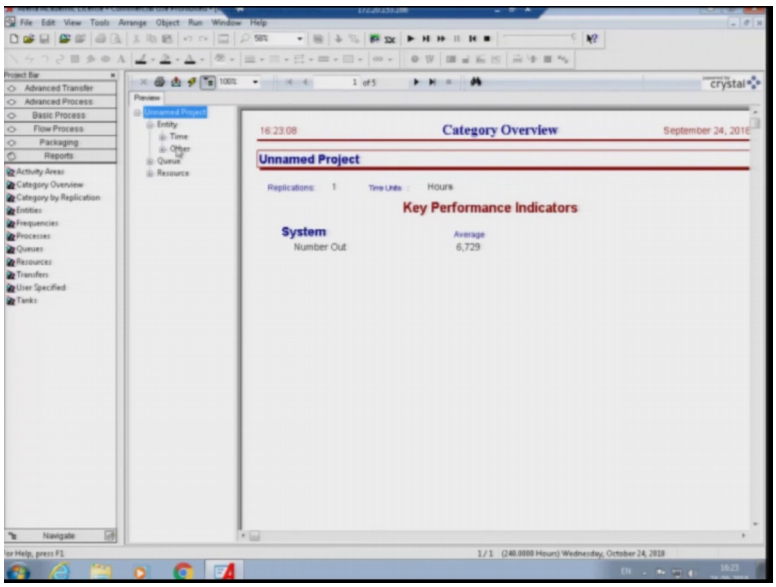

So, we can see total number out is 6729.

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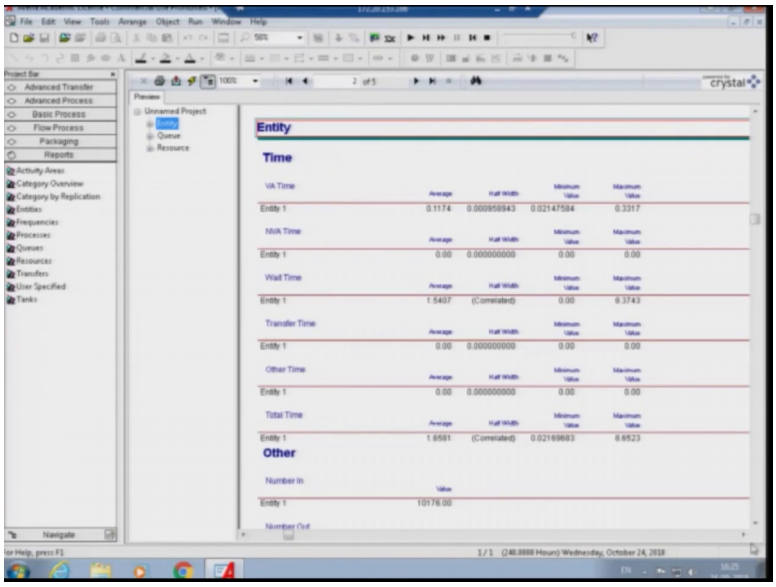

We can see here also there is entity number 1.

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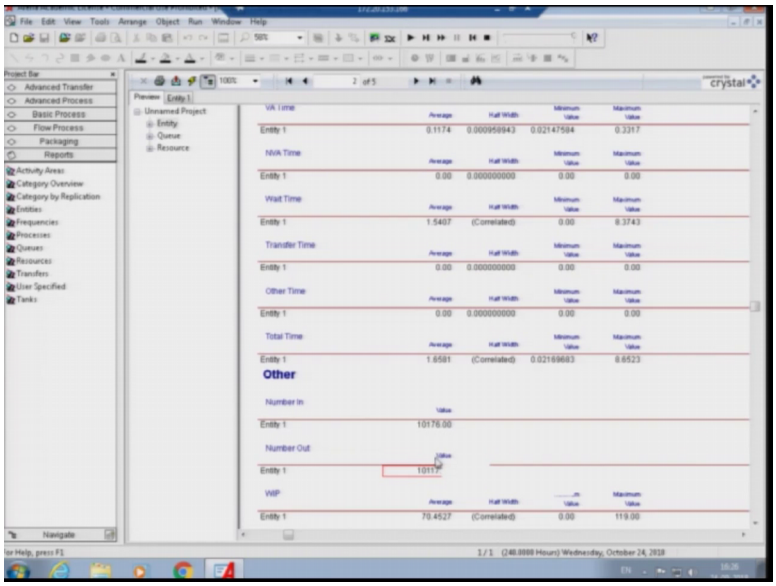

I mean number of entity in is 9919. Number of entity out is 6729. So, they definitely have some issue with the system which restricts these many number of people to get served. This can be found out by two things.

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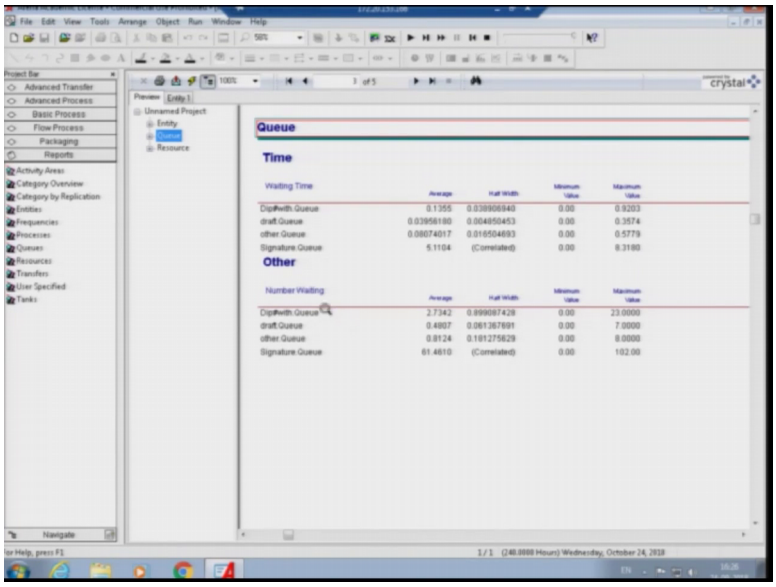

Number 1 is queue. When you see the queue there, again you can see that deposition and withdraw counter is basically have always have an average value of queue length as 48.2476 with a maximum value of 93. Similarly, the signature case I mean the manager also have a queue length of average queue length of 59.1700 and maximum value of 117.

Similarly with the on the number of waiting you can see this number of waiting window, you can see that there has an average number of people waiting for getting served, in the window 1 is around 937.726 with the maximum value of 1845. Similarly for the signature queue as well you can see the average value of people waiting in there is 684.43 and maximum value of with an maximum value 1343.00.

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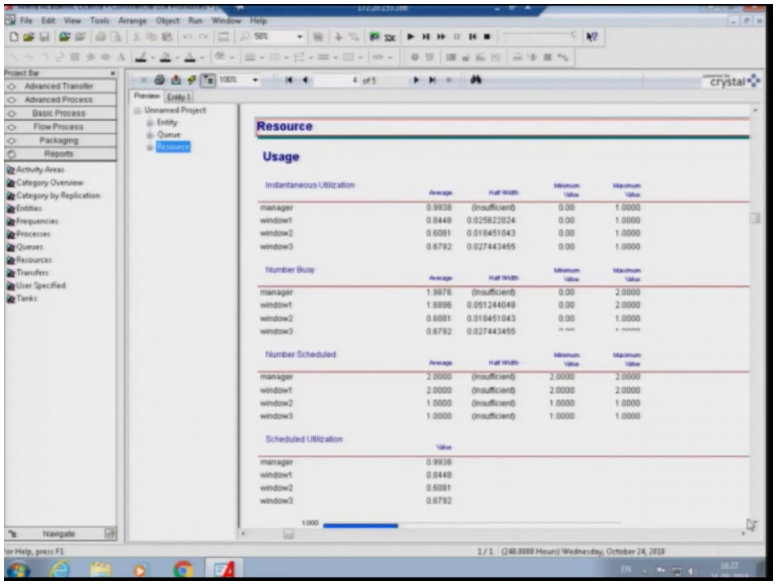

So, when you see the resource utilization case, you can see very similar result has been sited as we have shown in the last case also as the window 1 and manager is having very [FL] high and now, values of the resource utilization. So, similar to previous one, we can also do add resources to reach to processes and you can do the way we have done it. In the similar previous case, you can add one resource into these two places and we will run it again.

We have done it right [FL] ok, take it. Now, when you see the result that the number of out has been increase significantly, so similarly you can see there is a rarely very less difference between numbers on number of people who went into the service and number people who got serviced. So, though there number is very much nearer, but there has some issue with these because you can see there is around 70 people 60 people are not served in the system. So, we will see these by analyzing two things that is number of queues and number of resources. So, when you see the queue, queue window you can see

that the signature has always been found with queues with average number of 5 and maximum value of 8.

Similarly, number people waiting in the queue also where is very high for the signature as we can see there is around 61 people are waiting in the queue to get their draft signatured with a maximum value of 102. When you see them is the resource utilization here also you can find that the manager is having very high utilization value with 0.9938. Others have predominantly good utilization values not like that much significant. So, here we can conclude that the two managers, I mean two signatory authorities are not even capable of doing all the signatures. As you can see here also there are around 51 customers who are not getting, not been served in the signature who are still in the queue after the completion of this run.

So, to add that, that can be a managerial decision whether they want to add another queue and another I mean whether they want to add another manager or they want to go with this thing. Because model may we have some differences in with the real life system because we already have decided, we have already have said that we are using random extensional distribution with honorable for 5 for 5 minutes, there may be some, there may be in real life cases that this is not exactly the same thing. So, also the number of unsatisfied I mean undelivered customer is very low. So, manager can, the management can take decisions upon whether they want to add another individual authority or not. So, that is all about these first 2 cases. We will discuss about other cases in the next lecture.