Logistics & Supply Chain Management

Professor Vikas Thakur

Department of Humanities & Social Sciences

Indian Institute of Technology, Kharagpur

Lecture 28 : Supply Chain Models and Modelling Systems

Hello dear friends, welcome back to NPTEL online course on Logistics and Supply Chain Management. I am Dr. Vikas Thakur, Assistant Professor, Department of Humanities and Social Sciences, IIT, Kharagpur. So, now today we will talk about Supply Chain Models and Modeling System. We will see what are the different options we have when we will define the overall layout for the supply chain. And, then we will you know model all those scenarios and we will see what are the results of the simulation if we will go with one particular type of model and then how we can adjust all those parameters.

So, that we can come up with the desired output whatever is the requirement by the customer either customer is may be more. cost focused or maybe a customer wants responsive kind of delivery so those parameters we will see right so this modeling system will help us to you know model all those requirements of the customers will also consider the constraints from the supply chain side right whatever the capabilities of our supply chain we will also consider that all the stakeholders will take into picture and then we will see this is what maximum we can do using that particular approach right So, this is how we will proceed for this, we will just introduce about the supply chain modeling, what are different components we will consider when we will go for the modeling process and then we will talk about some supply chain models and obviously, we will talk about the future in this modeling system and we will end up with some cases. So, supply chain modeling designing and analyzing a supply chain to identify potential improvements. So, that means it is a kind of design of experiment approach where we will see you know we will try different types of inputs and in different quantities this is how you initially how you are learning the cooking process same way right.

So, sometimes you are adding some ingredient may be in more quantity. So, then you will suddenly after analyzing the output tasting that food you will realize I need to reduce the quantity of that particular ingredient or may be I need to increase that. So, in that way we can simulate different scenarios just to we will find out what are the outputs whether the outputs are efficient the way we want that system should behave. So, we can compare with the whatever you know pre assumptions we have about that model. So,

either we can talk about the offline model static or we can go for online model this is known as offline model.

this is known as online model. Offline means we will take care of the present scenario and we will model the factors likewise right. We will consider all the situations whatever is right now we will record the data on that and on that basis we will run our model and we will say this is going to be the output if we will go with this approach right. Dynamic model is a kind of model which continuously fields data inside the system and then we is there any changes in the environment that also we can reflect on that. So, it is a kind of we know we call it online system as well and then we can go for the Monte Carlo simulation models where we can talk about different scenarios and those scenarios if will go by one way what will be the output and if will go by other way what will be the output and chances of happening that particular thing we can figure out all those things right.

so talking about either local supply chain or global supply chain right so we have you know so many different stakeholders we have so many different processes different activities so many different products we are handling through the same supply chain right if raw material is there that is different product finished good is different product after returning back that packaging is another different product right or may be after the end of life we are handling another kind of product which requires all together another set of activities to perform that right and in that way so many different organizations are involved so like we have raw material suppliers we have manufacturers we have co manufacturers we have distributors we have warehousing partners and then end mile delivery partners are also there so all those things we can model in this system right. So, any miscalculation will you know you will land up with the in the scenario where you will be facing more risk, uncertainties will be there because you could not figure out the you know dynamic environment in that way and then interruptions to your smooth supplies and then obviously, when you are you know reacting here and there you are trying to somehow manage the things your cost will be higher on that side because you are not you know standardizing the process. So, that will lead to extra cost. So, then after you know replicating all the scenarios within your model or in different models you can pick the most suitable supply chain model that depends upon whether that most suitable supply chain model for one may be it is cost efficient and for other may be it is responsive kind of model which is you know responding so quickly to customer requirements that you are changing those things. So, depending upon the different choices we can then come up with the final model either your supply chain now is cost efficient or you are lying toward the responsive side right so these two ends are there either you can be cost efficient or you can be responsive but yes we as supply chain you know managers or whatever organizations are working we are not purely saying that we

are only cost efficient we will not take care of any kind of input which is coming may be in terms of quality may be in terms of quantity may be in terms of variety you are putting to us so that we will not say right so yes somewhere we will find out the mixture this particular product requires most may be cost efficient supply chain will somewhere set the parameter here, may be this requires a kind of emergency services, healthcare services, we can set up our parameters somewhere here.

So, obviously the ultimate purpose is to reduce the cost, increase the efficiency and customer satisfaction within that particular target area where we are saying that either we are responsive or we are cost efficient. so when you need to model these different supply chain scenarios obviously you need to define what are the components right how those components will change here and there so that the final outcome will change so let's talk about from the very beginning point like procurement so now procurement again different decision different scenarios are there we have multiple vendors or we have single vendors right and then how many components we are outsourcing right so that means procurement then how many lots in one month you are procuring then what is the lot size right this lot size will help you to negotiate on your price as well right so these all parameters are there when you will consider the model you will consider all these inputs because if you will increase the lot size this is what walmart is doing always feeding very large orders to their suppliers so that they can negotiate on the your price right so and then they can maintain that minimum quality level as well because this procurement now your raw material suppliers they need not to go so quickly for change over because if you are buying product in small small lots maybe then from one lot they are preparing for 50,000 items then they are changing over to next lot maybe for 30,000 they will prepare then 35,000 but instead of that maybe if you are uniformly you are doing that you are producing one item 75 k units and then you are changing over for the next model right. So, then in that way your suppliers will also be in that way efficient and you can further reduce the pricing. So, this is again one important component which you can consider. Second manufacturing.

where the manufacturing is happening right what are the different locations are you going to provide the different are you going to serve the different market from different locations or may be one centralized facility manufacturing hub will be there and then you will be circulating throughout the Indian market that can be the another scenario that depends upon the initial investment cost of setting up any manufacturing unit right. Then how much of one particular model you will if you are having 4, 5 different production lines. So, this is producing A and B model here we are producing C, D and E model. So, when you will go for change over right. So, that optimal level you can decide that if I will run this particular production line for 10 hours continuously that much is going to be the

productivity because whenever we are going for change over in the process initial time we are taking to set up you know to standardize that and then we can produce some rejection as well so those factors we will consider third is warehouse now we have two different scenario one is we are putting this warehouse very near to the customer or may be markets These are end markets are there and warehouse is very near.

So quickly you can respond to the customer. So that means you can reduce this distance outbound logistics distance to the customer to the market and then quickly you can respond. If this warehouse is a kind of centralized facility which is far away from your main markets maybe the distance is higher in that case. So then obviously if you are serving to market one or market 4 so then that much distance you are covering right because why you are doing that because you do not want to set up so many different warehouses at different locations if instead of you know going for 1, 2, 3 different warehouses to serve these 10 markets you are may be keeping inventory at 3 different locations but when I am having centralized warehouse I am keeping inventory here only and serving all 10 markets from the centralized location in that way we can minimize the inventory cost but you need to take care about the transportation cost because then from central facility every time the order is coming from the different market you are moving to that particular location. So, in that way may be economies of scale you also cannot utilize fully, you cannot fully utilize the container vehicle capacity as well right.

Transportation as this is related to this structure only, I told you we talk about compare the inbound logistics cost with the outbound logistics cost. So your outbound logistic cost is always higher. That means you want your warehouse should be very, very near to your end market. Because this distance if you are covering maybe 100 kilometer and if this is 5 kilometer, so outbound logistic cost is higher. We discussed in another session why this outbound logistic cost is higher, right? and if you are following this particular model for every market you are may be covering a distance of 35 kilometer, 40 kilometer, 30 kilometer, 25 kilometer so that means outbound logistics distance is now increasing right so in that way so this is if you will take example if you are buying furniture from amazon flipkart so they are disassembling that furniture and that it is reaching to your doorstep and again you are assembling that So, this is one way because when you will you know buy the raw material or you will disassemble the product it is easy to carry that product from one end to other end.

The other example may be if you are carrying may be these cars in one container may be 8 or 10 maximum car you can ship if that size is little small of the car right. but if you are carrying the raw material component you just imagine within 10 containers how much raw material you can transport. So, that means, if your factory is near to the end market

then that outbound logistics cost can be increased. reduced but yes then again other challenges are also there when you are moving near to market so that means you cannot operate with one facility for many markets you need to come up with many manufacturing units right so that way it will increase that cost so somewhere in your modeling system you need to put all these parameters and for a particular product you are depending upon the nature of the product size of the product how frequently you are shipping demand from the market how quickly you are changing that product all those parameters will consider in that model and will come with the best fit model which will tell you about all these parameters eight components how you can set where you should develop your warehouses where you should you know set your manufacturing unit which kind of transportation mode you should use now this is the next parameter fourth one is transportation we talk about different modes of transportation either through road, through rail, through air, through ship right, but yes all those parameters are there that if you will go by ship the least cost method may be and sustainability also will take care. If we will go by road it is taking more time, if we will go by air it is very you know speed delivery, but yes in that way your cost is increasing right.

So, all those factors also you will consider availability of the infrastructure you can use ship only when the infrastructure is there right. You can use air facility only when that infrastructure is there, but for specific products may be you can go for that kind of infrastructure. So, fifth one is inventory already we discussed we are maintaining three different types of inventory either raw material or semi finished good or finished goods and some rejected also we are maintaining the inventory in the hope that we will repair these products and again we will resell in the secondary market or in the same market or somewhere recycling remanufacturing can be ensured. So, now if you are again we will take that scenario only when we are keeping our warehouse very near to the your markets. So, that means now you are going with the multiple warehouses for one for may be this market these 10 markets you are serving by warehouse 1, we have warehouse 2 which is again serving may be another 20 markets we have warehouse 3 which is again serving may be another 20 25 markets right so that means if we are moving very near to customer we have multiple warehouses so that means that will increase the cost of keeping the inventory because every warehouse you will keep the inventory that is why online platform when we are going so now because they are opting for zero inventory model it's not inventory led model where earlier they were taking the inventory from the you know manufacturers from the sellers and they were storing in their warehouses and whenever amazon is receiving the order they were processing that order but now what is happening they are not keeping inventory in that way minimizing the inventory cost and directly channelizing the product from the seller to the So, then you can save the inventory cost.

So, these factors we will consider because obviously when you will model these factors you will ensure that you are not stock out and also you are not keeping excess inventory with you. that these two points you need to keep in mind right then information technology this is a kind of your component which will affect your all the players all the activities in that supply chain network so you need quick relevant information transparency should be there where is the material right now right, how much quantity coming, how much quantity may be units damaged during transportation, during handling, how many are finally consumed in the production floor, how many finally consumed in the end market, consumed by the customer. So, then this information technology what type of system you are implementing to ensure the quick information sharing system. then again customer service is another point what type of expectations from the customer coming in terms of the quality level they are expecting in terms of the quantity in terms of the frequency how frequently they are buying in terms of the variety they are going they are looking for in terms of the innovation in the product they are looking for in terms of the delivery they are looking for right either they are looking for doorstep delivery or they are looking for some pickup locations or they want to feel the product and then they want to purchase that product right so and this is not only the end then customer expectation in terms of returns how you will manage those returns right or in terms of if end of life of that product, how you are recycling, reusing, remanufacturing that product. The final component is a distribution, how you are ensuring the distribution network, either the last mile delivery, then last mile delivery, then how you will combine, consolidate multiple orders from the same location.

or maybe sometimes what is happening when you are not so efficient with your information then the same amazon if you are placed two three different orders so maybe the delivery person different delivery person they are making multiple visits to your doorstep instead of consolidating into one order and then that cost can be reduced but you have experienced that as a customer that from amazon morning to evening you are receiving sometimes multiple deliveries So, why cannot they consolidate all the orders and then deliver at one time right, but there may be then you know challenges with that may be customer want some products before 10 o clock in the morning related to may be breakfast or kind of things right grocery products or some products may be anywhere during that day you can transport or deliver right. So, then you need to manage means you need to model those factors in your ah this modeling ah analysis right so already i talked about all these components in detail so significance of supply chain modeling first is you need to this is the ultimate aim we need to minimize the cost but maximizing the services right so how efficiently we can ensure the flow of those three basic components material is one information is another one how efficiently we can ensure the flow of finance right planning and controlling of the flow of these resources. We need to plan

supply chain modeling. Now, once you worked with all those eight components, now you have developed the matrix for all those eight components, now you will go for modeling that. you will put all those constraints, these are the capacity limitations, these are the requirements from the customer, this is the capacity of our, capability of our supply chain, then you will go for that modeling.

And then again I was talking about experimentation and scenario analysis, where you will come up with different simulation models, different scenarios you will simulate. And then depending upon different scenarios, what is the output? Either you are cost-efficient or responsive, how you are, you know, making the trade-off between cost-efficient and responsiveness. And types of model you can pick linear programming where we are defining the linear relationship, that is the basic assumption of linear programming. We are defining the linear relationship between the all those independent variables, right? So whatever we are, you know, modeling in that particular model. and we go for simulation where we are depicting different scenarios queuing model what is the you know this also we are considering how many orders are in queue what is the queue length idle waiting time so right processing time all that we will consider in queuing model statistical model different statistical model either you talk about you know stochastic model you talk about non probabilistic model deterministic models right so those models we can work with in operation research we have seen all those models like when we talked about transportation management this we will discuss in our this lecture always right so that is part of your supply chain management transportation then assignment models we talk about simplex method we talk about the project management using you know different probabilistic models like critical path method and program evolution and review techniques.

So, those all are different types of modeling techniques kind of methods which we can use to optimize our processes. So, selecting the right model depending upon your requirements you will pick the right model in the end. So, these are different types of model we will just quickly go through. what are these different types of model and in that way which model is a you know best fit for a particular kind of industry if you talk about continuous type of model this is a kind of model where continuously your product is flowing through the supply chain not only product product information and your your money right your finance these three are continuously flowing When you can ensure the continuous flow of these resources? Obviously, when you are having fixed kind of demand and fixed supply. You are pretty sure about your forecasting process, your demand function and your supply function.

So, in that way it should be a continuous kind of model. So, material should flow

continuously from the supplier to customer. but what should be the objective ok first we will take the examples for this continuous kind of model already we talked about so many all the industries related to you know commodity kind of product you talk about grocery item usually continuous kind of model we can go for right or may be FMCG products many products we can use continuous kind of model. Steel industry continuously we are producing, sugar industry, salt industry these are the best example because as per the population we can fix this is going to be the demand and we can go for that right. So, this is these are some of the examples now when you are saying you are sure with the demand and supply.

So, obviously, the ultimate objective should be you should be very very efficient right. So, because otherwise what is there to compete the first thing is how efficiently how with the minimum cost you are providing that product or services right. So, that should be the ultimate objective of your continuous kind of production system other characteristics just in time we can implement because we are sure about the demand and supply so we can just get the supplies continuously feed those supplies to the production lines and right we in that way we can reduce the inventory and inventory cost as well and waste also can be eliminated because now that waste which was we were generating earlier from the inventory while handling managing updating the inventory we were damaging the products In the inventory only sometime product were going obsolete. So, that waste we can reduce. So, it is kind of smooth flow, one piece flow kind of production system.

It is coming from one end leaving the other end. So, that is there. Advantages, all those advantages we can minimize the cost, we can be more efficient in that way, productivity will be improved. Disadvantages. basic disadvantage of continuous system is less flexible because we are not considering the dynamism of the environment because it is a continuous model and any disruption major disruption will interrupt the supply sometimes will interrupt the demand sometimes right so that is the basic disadvantage if we will talk about the amazon they usually focus on this where a type of model where they are continuously you know sourcing the product from the sellers and delivering the products at the minimum cost right so you can see this model is suitable for those business already i talked about the examples where you have stable demand and supply you can see this is the standard shipping where you were having you are placing the order but your fulfillment center is far away then they are using some usb services to transport that product and finally here you are where you were getting the product right now the concept is same day delivery when you are very your fulfillment center is very near to your customer that is what i discussed in the initial slides right but then if you are near to the customer you are adding more responsiveness right but in that way cost efficiency will not be there because so many locations will be there you need to serve all those

locations you are maintaining inventory at all those locations so inventory cost will get high but outbound logistics you will reduce right and in that way somewhere you can manage in that model which you want type of product and then your customer is ready to take same day delivery then you know we cannot separate these two things at two different centers why to make multiple stoppage right.

So, then it is ultimately adding to the cost. So, why do not we do this in one station and then crowd sourcing means local courier partners we can pick who are frequently delivering here and there and we can collaborate with them and finally, within same day delivery or one hour delivery you can go for. second is fast model obviously this is obviously the speed is the main parameter of this and where you need quick delivery and timely response and zara is the best example where they are not only quickly delivering the product but they are replenishing the new inventories with the old inventory right So we have discussed one case where the new trends whatever new fashion they are coming with the average of that industry is 6 to 7 weeks but Zara is almost every other week they are changing the trends they are coming up with the new products right so .This fast model is best fit for those product which is having very limited life cycle right if you are talking about entertainment industry if today any movie or web series is launched it should be distributed fully wherever you want to distribute right it should not happen that now today you are launching it somewhere in the north then you are going to south eastern part west this cannot happen right so . These kind of products which got very limited shelf life you need to distribute using your fast model right so and seasonal products also because those products may be for four or five months season so within that time you need to ensure the raw material acquisition, production and final consumption as well within those 4-5 months right.

then we talk about efficient supply chain model so this is again we can extend the first model which was your continuous flow model we can relate it with that because here also we we ah target a type of supply chain model which is you know which can minimize the cost right this is the only thing we are adding here efficiency right so when you are sure about the demand you are sure about the supply only thing you the fight is how efficiently you can deliver the product to the end customer from the suppliers right so that is that should be the priority so you can see Here we keep priority on efficient inventory management and getting the most out of production workers and equipment. So, that the productivity can be improved with minimum outputs you can get the maximum output. With minimum inputs you will get the maximum output. This is how you can increase the productivity.

So, this is efficient model. Obviously the challenges are there to the efficient model

because you cannot change the cost of the raw material and commodities whatever you are using and then capacity constants are also there. May be 24 hours into 7 you are running your plant even then you cannot manufacture more than 50 lakh units. so then how you can you know deal with that capacity constraint shall we come up with the new machine or new plant then again can we utilize that full capacity of the new machine and some other challenges labor shortage delays are there so highly competitive sectors are the reasons why we need where you know almost products are similar kind of thing features you are providing. So, it becomes very very important that you provide efficiently with minimum cost that can become your one USP with the minimum cost you are providing the products to the customer. So, Zara we can go this is the best example is suiting for different cases you see when we have very short lead time this is the only lead time.

right if you'll see lead time is on y axis so we should source from the local market like Spain Portugal or Morocco right so that it can be shipped quickly right so items with high fashion components means which you are changing very frequently you need to ship immediately you have limited lead time items with reasonable lead time you can go for offshoring but nearby offshoring because that much time is not there may be compared to this it is little higher but still we need to go for minimum maybe distance whatever we can you know manage up to that point and we can be those location can be some way cost efficient location or maybe some extra advantage we are getting out of that location in terms of technology in terms of skills we are getting in terms of the cost those can be there right .If we are having that much lead time little higher lead time so then we can go for low cost country like china india where we can get the cheap labor where we can get the cheap you know resources right all those resources and we are producing some you know raw material silk also there and then we have when more time all the time and then you can go for highly standardized kind of you know items. and you can go anywhere in the world wherever you are finding the best locations in terms of quality, cost, availability of raw material, availability of man power, skills, technology whatever is required. So, then you can permanently you can source those product to those countries. So, this is the best example you can understand agile model.

Next is where you are responsive to you know quickly adapt the changes in the market so nike is doing it beautifully any changes are coming or recommendation are coming from the customer they are quickly amending the product right so agile model works on how quickly you are responding to the customer any changes in the scenario how that can happen when you your communication and collaboration network is very strong that any change is here you are you know you are sharing immediately with your supply chain stakeholders right. So, you can see. agile kind of supply chain is required when you are dealing with those kind of products which we are you are not sure about the demand

where everyday renovation innovation is happening with the product or process right so in that way the four characteristics are you need to align your process virtual integration with all the stakeholders and all the activities throughout the network a network waste should be there and market sensitivity you need to sense the market trends and then you can come up with that plan right so this can be only i told you agile model is only possible when you are jointly managing with your suppliers so how supplier can manage the inventory at some point of time right it's not only the manufacturer responsibility and then if you are changing the product design process design accordingly your suppliers need to supply the material custom configured model where we are providing the customizing services right supply chain according to the specific customer needs so this is the best example always we talk about dell where you go to dell showroom you tell your specifications in terms of processor you want in terms of ram rom capacity storage speed processing speed you want which generation so you know processor you want all those requirements you can give and then through their you know customer configured model they will provide you that product right and how they are doing that it combines agile and continuous flow methodology right so they are buying all the raw material components from the various part of the world usually from the asian countries and then they are as per the configuration you are giving they are assembling the product and providing you so this is direct kind of supply chain flexible model again kind of agile model flexibility where you are dealing with the you know varying customer demands anytime you need to change you that should be incorporated throughout your supply chain so part segmentation precise talking algorithms and flexible planning are some of the main components when you are talking about the flexible model So, you cannot go for huge pile of inventory and then you are consuming slowly in the market. May be tomorrow scenario will be different and then you require another set of raw material, another set of inventory. So, then how you will ensure the consumption of the inventory already you acquired.

So, that flexible model does not work for those kind of items. it's kind of you know you need to turn it on turn it off kind of thing and Hewell Packard is the best example for this kind of flexible model where they are you know sensing the market conditions and recording the customer preferences so frequently and providing the flexible supply chain solutions right. another is your virtual supply chain model right which is you can consider the future supply chain model as well where we are taking the help of cloud computing and data analysis so ai iot system will be part of this the only purpose here is we have the greater visibility and communication the things i was talking about to be more efficient quick agile flexible what you need you need to share information quickly and procter and gamble they are doing this they are sharing the information quickly and managing the minimum inventories right in that way because only when product is required they are shipping that product right so best practices for supply chain modeling you need to

understand the business needs already we talked about different products required different types of supply chain if you are talking about steel industry continuous flow efficient supply chain if you are talking about health care emergency supply chain you need to go with an agile and flexible supply chain disaster management that's a entertainment kind of supply chain you need that you know quick supply chain speedy supply chain right choose appropriate approach so you need to pick the modeling method approach how you will model those factors whatever you have figured out right and validate with the accurate data so it is not only once you pick the model it will be forever. you need to validate the established model again and again right and you need to test all those scenarios what if that happens right what if it will go the other way we thought may be in this way and it does some other factors came into picture we did not model those factors and now you know playing very important part right. So, then we can consider different models obviously, we can involve the stakeholders whatever model if you are going for agile kind of model you need to you know take the views from your stakeholders whether they are ready for that kind of flexible agile quick model or not.

regularly you need to update and refine that model already I talked about document assumptions see whenever you are developing any model there are limitations like we talked about linear programming and then we said that the independent variables are having linear relationship if you are talking about simplex method where we are or transportation method where we are talking about the linear relationship so if those assumptions you are forgetting when you are implementing then your model will be then it will be a disaster right so you need to train and educate the people how they can use the best model and those best model can be tracked against the set of performance measures you have already defined obviously we have some challenges because complex relationships different stakeholders, different activities, it is very difficult to configure all those activities in one model. But still we are trying to cope up with that and defined those eight components so that we can include parameters from all those things. Because these kind of models work only with the data. you need data to validate right you need data to develop those models right so then how accurately you are getting timely information you are getting so that also big challenge multiple objectives because multiple organization so one organization may be competing on responsiveness other organization is competing on cost efficiency so then multiple organization multiple objectives so that can be another challenge dynamic environment this because dynamic modeling is required where everyday situation is changing you need to change your model as well integration issues are there because multi tech supply chains are there and various stakeholders are there so then sometimes those conflicts can be there whether we want cost efficient we want responsiveness we want to manage inventory we are the customer we should keep inventory centralized so those issues can be you know sometimes making decisions can be little difficult .Resource constraints always we are

working with the limited resources in terms of all the resources time money machine method material whatever we are using scenario complexity because these days we have multi-clone networks and omni-channel distribution multi-clone network where we are providing the distribution multiple distribution points from the distributor and or supplier and to the customer omni-channel distribution where the customer can come from the multiple channels right like you can book air ticket through goibibo everywhere through make my trip through exigo through your irctc through the indigo website or Vistara whatever airlines you are picking So, that scenario complexity is there risk management obviously, because you are working in the dynamic environment and that any change either in all those pastoral dimension political, ethical, legal, technological, social all those environmental any change in that environment will disrupt your supply chain and how quickly you will manage that change and how efficiently you will manage that will help you change management.

this is the future of modeling supply chain control towers now this is the combination of machine learning artificial intelligence iot because now we were talking about eight components and we have seen under manufacturing so many components can be there So, many model we are manufacturing within those production lines, on one assembly we are making multiple models, then we are keeping the inventory for each model, each component, packaging, distributing, so many different parameters. How you will keep the track of all those parameters? Then we need these cloud waste solutions. supply chain control towers which will take care of every parameter you need information related to warehousing whatever parameters you will say we will see in the next session what are the different you know parameters when we will talk about you know transportation facility inventory so all those parameters you just say and supply chain control tower will track those parameters will give you the data now you feed that data in your model and you will get the output right so if you will travel from here to the other point so how much cost will be there how much lead time is required when the end time delivery will happen and all those things you can figure out so this is a small video on this the smart solution will just go through this video so you can just see that this supply chain control towers when because when we are talking about different types of mathematical modeling we will go for we need data for all those parameters whatever you have set for transportation right per unit shipment cost right per unit manufacturing cost warehouse capital capacity utilization different parameters we are recording so this supply chain control tower will help you to record all those parameters and then you can you know develop your best fit model which model is best for your type of product right so quickly we will go through the case studies first is case study is about intel who is the largest manufacturer of computer chips the problem here i am highlighting how they they became more efficient right earlier they were producing chips and that chip were costing

around 100 dollars right. So, they were spending almost 5.5 dollars per chip for transportation supply chain cost right.

but now because they are coming up with the new chips and it is a low cost atom chip so which cost around 20 dollar so if it is costing 20 dollars and the shipment supply chain cost is still 5.5 that is big question so then what can be done so they analyzed all the scenario and they came up with the discussion this that inventory is something which we can you know finally reduce the cost but why before inventory they worked with you know ah ah packaging they scaled down the level of the packaging required for that so that high value to weight ratio can be maintained packaging material can be reduced already they did that right but still the cost was around 5.5 dollar per chip right .They already worked with the distribution cost and they know that now further it cannot be reduced so only thing is we can reduce the inventory and there we can save that cost right so . But to reduce the inventory the basic problem was nine week order cycle if today you will place the order after nine weeks you will get the order so that means minimum nine to ten weeks inventory you will keep that so.

First point while in reducing the inventory cost how we can bring this cycle time down maybe somewhere two to three weeks so then we will maintain inventory only per two to three weeks so then they thought that okay we'll go for make to order once we will get the order only then we will make that right this is one approach they opted for and then they instead of you know cutting the chip assembly test window from five day schedule to y weekly two day schedule right so three days they cut there and then they analyzed very frequently and minutely their sales and operation planning right so how their you know sales is happening that throughput rate how the end sale is happening in the market right accordingly they plan the production and then they asked their vendors you keep the inventory we do not want to keep the inventory so this is how they worked on these two three parameters and then you can see they reduced four dollar per unit for that atom chip which is costing them twenty and you can just imagine the saving they have done just working on the inventory but minimizing the inventory again have some challenges right so if you are minimizing the inventory that means the production schedules are very very tight schedules means small orders you are producing so we already know that if you are producing in small orders production cost will be higher because economy is of scale then transportation if you are shipping small orders full capacity may not be utilized then again economies of scale right will be in question but yes then that is why we have this mathematical modeling system we will keep our data feed our data and we will get the best result because you cannot count on fingers this is best in this case this is better in this case this is so that we cannot do that so let us feed all the data in that system and we can go for that another quickly case of pharmaceutical industry and you know that

pharmaceutical industry you know everyday scenario where acquisitions are happening and divestment studies are happening everyday so this is one organization which is expanding by you know benching with other organization and keeping out their known core businesses and that known core business is one of is your distribution network and then they suddenly realized this is going very inefficient and fragmented way we need to organize this how we can reduce cost enhance customer services and establish a reusable modeling tool which can automatically model the scenario and will give you the best option so we are doing fairly well with the manufacturing as that is our core business activity but we need to work on the distribution network right so they used mixed integer linear programming problem where they've model all those factors which were required required like manufacturing sites how many sites where the location they will decide distribution centers again location how many required demand from which reason demand is coming what are the demand pattern aggregated product groups right so they included all those products and then they included the global as well as your local business levels right so then they model that and you can see the result indicated significant improvement and ten percent reduction in the overall cost and in next day delivery they ensured in ninety five percent of the products right just working on their distribution network how they can model using mixed integer your linear programming model right where they fed all this data and then they reduce the overall cost. So, despite this because obviously when we are talking about you know linear programming and all that getting data from different sources different stakeholders and then you know then you are so frequently recommending the changes . We are always we are as a human being we are you know first we are resisting to the change so that is one challenge and other challenges in terms of how you will take care of the data coming from different stakeholders different activities right so then you have to make the trade-off right so decision makers to under understand trade-offs and make informed decisions you can make informed decision when you have that information which is you can easily record through your supply chain towers right. So, we can here we can conclude that modeling system will help you to simulate all the different scenarios what can be different outputs what are the possibility of getting the success or failure and how the environment will behave all the environmental factors you can model into that right. So, this is particular thing, but then you need to feed regular data.

it's not one time fixed model regularly you need to feed the data from where you can get that data already we talked about your supply chain tower solution control tower where you know the virtual world is there for all the physical items you have right so anywhere you are depleting inventory it can record quickly right anywhere you are damaging the product it can be quickly replenished you can be shared throughout the network any customer complaint is coming because of any defect can be quickly shared with the manufacturing process right. So, with this we will end this that this modeling system will

help you to improve the efficiency as well as the responsiveness of the overall supply chain. So, these are the references for further reading. So, that is all. Thank you very much.