Logistics & Supply Chain Management

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Lecture 45 : Demand Forecasting

Hello dear friends. Welcome back to NPTEL online course on Logistics and Supply Chain Management. So in the last session, we discussed about locating the facility. So where we should locate the facility so that we can be somewhere, cost optimization can also be ensured and somewhere the responsiveness, quick delivery of the product can also be ensured. so once you have decided the location the very next step should come the forecasting the demand because once you will predict the demand only then you can design the capacity of that location right how large how big you need to design so this session will discuss about the demand forecasting right what are the factors we need to consider What are the challenges for demand forecasting? What different types of demand forecasting techniques we have? We'll discuss some qualitative techniques, we'll discuss some quantitative technique as well, right? So this is some related data, latest data by World Bank on Indian, you know, how Indian economy is behaving since last two, three years, right? So if you can see, instead of you know the global economy the global markets they are facing challenges but still India somehow managed the growth rate right and you can see financial year 2022 and 2023 at 7.2% right so India's growth rate was the second highest among G20 countries and almost twice the average for emerging market economies right so this resilience was underpinned by robust domestic demand which is quite obvious we have used customer potential whatever we are producing we can you know consume within the country right so that kind of market is there and strong public infrastructure investment private investment is also coming and then if you see bank credit growth rate has also increased to 15.

8 percent from 23 24 to 13.3 percent right so from last year 13.3 percent so if you talk about India's GDP so that is also predicted somewhere more than 6% right so if you talk about manufacturing sector is tremendous growth we are seeing services sector again matured at that maybe we are somewhere struggling with the agriculture sector right so because of maybe the growth rate is not that high what we were expecting right if you talk about the expenditure approach method so GDP growth in the third quarter was aided by a strong uptake in private investment spending which I was talking about that private investment is also increasing and 10.6% year over year we have seen the growth which is not small right so talking about the private consumption improved to 3.

5% and this again coming back to India's resilient domestic demand which is you know not only a opportunity for the local players but also then the global players now they are thinking of investing within India and the kind of the business environment now we are providing here in India with the you know one point tech structure and all those liberal policies are there so kind of red carpet welcome is there for all the foreign investors so you can see the growth is also coming in that way right so let us come back to some production and supply chain perspective if you see gross value added is growing at six point five percent year over year so that means that is showing the growth in manufacturing which is again you can see and construction activities are also increasing at nine point five percent then you can see services sector somewhere seven to eight percent we have seen agriculture which i was talking about rate is not that high, but the main point here is that gap between GDP and GVA what gross value adding we can see it is not only one year problem year over year we have seen that there is GDP is higher than the gross value added. so now this reason what is the basic reason so very clear indication that demand is high right but there is gap between the demand and supply we are not able to produce all the things we need here that's why we are going for importing right so if you talk about food industry only so food industry if agriculture growth is contracting at 0.8% you just imagine so where from where we will you know produce that much so that gap is obvious supply gap is obvious right so that's why we need to predict our demand in a proper way so that all the facilities can be you know made ready to whatever future challenges will come right so demand forecasting is the process of understanding and predicting the customer demand right and why we are doing that when you obviously how we are meeting the demand through that long supply chain in that we need to manage our suppliers also we need to place the replenishment orders with them right whatever demand is accordingly they will supply the material accordingly we will store the material in the storage house accordingly we will design our manufacturing capacity accordingly we will design our distribution network so that means all depends upon only demand forecasting having said that, that means we need to define the demand function very clearly that means demand function on which the demand is depending may be the economic condition, may be the price of the product, may be the price of the competitive product, may be the inflation rate, may be the so many other factors Price of the complementary goods, so many other factors can be there. So, you need to configure this demand function very carefully for your industry, for your product or services whatever you are selling. so once you have done that only then we can ensure that this is not happening not we are producing over excess production is not there and we are also not stock out right in the market so obviously this is not one step we have one comprehensive structure how we can predict the demand right so what are the factors we will just go through what are the factors which are affecting the demand seasonality which is very obvious now the summer season is going on right everywhere there is demand for ACs water coolers for fans all those things are going on right so that is

seasonal but what about after 3-4 months then there will be winter season right so then how you need to predict it very accurately because the industry I was talking about may be when there is off season during winters you can still you know pile up your inventory and whenever the season will come you can consume that inventory right that is one way but again if it is a kind of perishable item how you will maintain the inventory so seasonality plays very important role and suddenly if peak demand is there can you go for expanding your capacity like anything to meet that peak demand and then after 3 months what you will do with those extra capacity, those extra resources, manpower, machines, whatever plant you have expanded simply you cannot fire the people you have hired now for your peak demand and then after 2 months you cannot do that right then competition this also plays important role while shaping your demand function suddenly some player are losing may be market share because of their brand image like what happened with nokia, nokia was leader once in a time in indian market and you can see because of their after sales services people were relying in nokia right but then the issues happened with battery and then you see now where is nokia so if that situation happened with nokia that becomes opportunity for other players so then either your demand can go down or skyrocket that is obvious if xeo is coming with so many different offers obviously demand for other hatch voda phone cellular network all that has gone down so then they collaborated to fight still they could not right so competition is also important factor geography so geography from where the demand is coming where are your customers and where are your manufacturers right so let's say if I am talking about some hilly area and you are promoting your low floor car whether it will work in hilly area low floor car no obviously so then you know that ,that is specific for some particular reason if you talk about the cosmetic industry the cream they are selling right so hilly area weather conditions are different here in Kharagpur or Calcutta weather conditions are different so the demand will be you know if we are using all those stuff right so that geographical location also you need to consider economy so you might have seen during recession there is usually fall down in the economic activities during 2008 recession also we have seen during this covid pandemic we have also seen that demand for automobile industry demand for all those luxury product have gone down right but the demand for low price product like basic things right people started buying like anything like your grocery item so demand is increasing for those item price will shoot up like anything but luxury items price may fall but even then you are not interested because you are not getting enough income you want to survive so for survival you need those minimum things right for whom maybe those things for getting those things you are paying extra now types of goods like I talked about the perishable goods you need to predict in that way but if you are talking about let's say how many people will recharge your you know go for your data services you know that how many people are using your network interconnection so those many fixed kind of demand even if you talk about the automobile industry once the product is matured you know this is going to be the demand right and you know when

you are going to be you know going to phase out that product and you are coming up with the new model and then you are shifting in a proper way right so that transition is planned transition but what about the perishable items so that you need to predict properly Advantages of demand forecasting, obviously you can plan your inventory in that way so that you are not maintaining extra inventory, that extra carrying cost you can prevent, holding cost you can prevent.

and the extra effort required to maintain the inventory and then you don't want to be stock out so for that you need to predict your demand accurately cost reduction when you can reduce inventory obviously you can reduce the cost as well not only inventory cost but the production cost but the transportation cost extra you are producing extra you are transporting extra you are distributing to your retailer and then your retailer is struggling to consume that in the market because there is no demand customer satisfaction so once you predict the demand accurately you can be easily available in the market with your product and services and you can satisfy the customer and in that way you can maintain loyal customers production planning you can go as per your demand right and resource allocation that may be next two three months peak season is there i can prepare for that with extra resources right or maybe right now i can plan inventory little bit and then i can meet the demand so whatever way you want to work and different strategies are for different kind of industries. marketing and promotion now you need you know that the demand for particular product right so you know which product you need to campaign more and which you can restrict with the campaign if you are phasing out any product no demand is coming after your heavily investment in the marketing things but even then you are struggling with you know arranging that so then you should you know you can plan that marketing budget as well Financial planning, how much you need to invest into raw material, how much you need to invest into capacity planning, production, warehouses, distribution, so that planning you can do. Risk mitigation, if you are doing the forecasting thing regularly, if any fluctuation is coming in the market, that you can spend. assess in advance and then you can mitigate that risk right strategic decision making how much i need to make another strategic decision where i need to locate the warehouse center if that demand is coming high demand is coming from kharagpur let us set up one distribution center in kharagpur right so and new product development market expansion capacity expansion all that will depend upon obviously you will go for capacity expansion when you are sensing that your demand function is increasing when you are getting that input supply chain optimization you can do based on that once you are sure about the future then you can optimize and seasonal planning any peak season scale up scale down you can do and if you are doing the demand forecasting in a proper way you have that information and you are taking informed decision obviously will provide you the competitive edge over the other players. What are the challenges of demand forecasting? how we are predicting the demand future based on information so

that means always you need information data to process to find out the future demand right so if you are lacking with the data or sometimes we are lacking with the resources to get that much data then we are facing difficulty to predict the accurate demand and because how we are predicting the demand because we are what we are doing in forecasting we are taking the historical data we are trying to extrapolate the trend for future we can see that how it will impact if the demand is behaving somewhere like this so we can see it is growing so we can extrapolate that this will grow like this only at this rate or may be like this it will come down depending upon whatever factors you are considering right limited visibility into future always you cannot predict the future accurately so some risk is always there and in forecasting risk is always there right so technological change will come and you never know that this technology will be outdated whatever you are doing right now and you need to change to the new technology and you have build up all the inventory production you are doing so much inventories with the retailers with the warehouses how you will consume if better technology product is available in the market we will go for the outdated product inaccurate demand models if you are not predicting which model is required for predicting the demand that also you need to pick carefully right so we have qualitative quantitative models we will see how that will help you to you know accurately predict the demand poor forecasting process see this forecasting process is depending upon collecting data so in during collection also whether you are touching all the data points or you are collecting few samples then that process you can just imagine how if you are collecting only 500 samples or if you are collecting 5000 or 50000 right so there will be difference between the results when you are compiling the results insufficient resources collecting 50,000 data points you need those resources you need technology you need to invest whether we have efficient those many resources or not and sometimes the factors like pestle analysis we are doing political, economical, social, legal, ethical, technological that all those external factors you cannot predict right so if any change is there so that will change type of forecast demand forecasting passive demand forecasting is a kind of where you are not considering the dynamic environment and whatever is the demand in the last year you are thinking that similar kind of demand will be there so you are using though for this kind of model passive demand forecasting where steady demand is there Active demand forecasting for any startups or new companies coming with new products, new ventures, new you know R and D you are doing with the old product.

So, then you need to predict accurately, you need to consider the active environment, dynamic environment and then that is active demand forecasting means quickly you need to update your forecasting. Short-term demand, depending upon the time, maybe that short term you are saying that somewhere less than 1 year whatever you are predicting, 1 year to 2 years may be the medium term forecasting or more than 2 years again can be your long term forecasting. But that again depends on short-term, medium-term, and

long-term depends upon the nature of the industry we discussed earlier as well if you are talking about the entertainment industry launching a web series or movie today, you are launching tomorrow maybe It is gone if you have seen once no one is going unless it is you know that level, so that means for that one or two days or initial one or two weeks are critical as short term planning median term may be after that how you launch on a different platform Long term, there is no long-term term if you are talking about the fashion industry, so short term, you need to predict accurately so that you can plan just in time when it is required so day-to-day routine activity you can expect and long-term demand forecasting so over next maybe 5 years how you think if you need to expand the plant capacity whether you have that land available with you so that you can expand So, the overall blueprint may be for 10 years, 20 years targeting your vision statement and how you look yourself after 20 years, so macro and micro level, micro level within that industry, how other players are competing, how your product is competing with the different products available in the market all those factors related to product complementary products right the prices of the raw material all those things you will consider macro like i talked about the peston analysis always political economic social technological ethical legal all those factors you will consider in macroeconomics so talking about demand forecasting techniques we have qualitative techniques as well we have quantitative techniques so quickly we will go through each technique and we will see first is Delphi method so different steps are there but I will in nutshell I will tell you Delphi method is we have group of 10 to 15 experts right they all are sitting around round table and then we are giving them one questionnaire or common agenda to discuss right so we are asking to record their inputs they are recording their inputs we are collecting those inputs we are compiling those inputs and then again we are circulating inputs of all the Experts among themselves right so after that is going through that compiled report now, they will come to know ok, we missed these points, and someone else maybe they have mentioned those points, so then they will start thinking that we will do this exercise again we will compile again we will circulate until the consensus is done. This is the complete Delphi method so you can just go through step by step-by-step selection of expert 10 to 50 experts as I told you the expert in that industry where if you talk about the automobile industry 10 to 50 experts in the automobile industry 2-wheeler industry or 4 wheeler industry whatever you are going to predict they will sit together then questionnaire design what are the points you will include in the questionnaire on which you are seeking the input right those quantitative qualitative questions close ended questions can be there open ended questions can be there as i mentioned first round of questionnaire you will provide your independent inputs but then because once you are providing your independent input you are not biased with other inputs what others are thinking so first i want to record your independent opinion on that then we will take the feedback analysis from each one we will summarize that and subsequent rounds will happen where i will circulate the inputs coming from all fifty experts to all the fifty

experts And then again we will do this exercise and we will final report will prepare where all points are now 50 experts have given their points, all points will circulate then they will come with the common agenda that this is going to be the forecast for the next 6 months, next 5 years, next 10 years in that particular industry. Then this is another method of sales force composite forecast usually this is what we do when we are dealing with those products which we are consuming through the retail industry so either you talk about the FMCG products, or you talk about other food industries or even not only food construction industry also right where you are talking about moving cement or steel rods or bricks whatever required in the end market so again here what we are doing we have sales this is also known as pooled sales force composite method why pooled salesforce composite method because region-wise we have defined that this region particular markets 10 market this person salesperson is looking after maybe he is visiting those retailers 10 markets maybe you have 20-25 retailers he is managing data for all those retailers how much daily inventory they are depleting how much inventory they are depleting of the competitors what is the market demand how it is going to behave they are interacting with the retailer getting the fresh inputs directly from the customers as well so right now that 10 market information he will be sharing may be at the next level district level so this is may be region small region is there then district level I am collecting from may be 50 these sellers are there in one district then that district different district one state we will be compiling the data from one state we will be compiling data for one country from one country we will compile data for one continent so this is how if you are my MNC this is how you will compile data pooled sales force map So data collection again step wise you will see where you can collect the data obviously with the retailers, choose forecasting method how you will predict, how you will compile the report, how you will generate the initial forecast and then collaborative input as I told you region wise then district wise will be compiled, then state wise will be compiled, then country wise will be compiled and in the end we will find out one figure for that particular product in India how much demand is going to be.

Right? So another is expert knowledge. here what we are doing expert we are conducting interviews with the expert and we have listed question and we are giving them either close ended question or open ended questions or different discussion points this is also known as focused group discussion or delphi method can also be included here or brainstorming sessions can also be included here and then we will ask them their opinion perspective right on the prediction of That particular industry right so how it is going to it is if it is talking about whether any technological development will be there or not for the next 5 years so how they are experts in that field they can tell us that this technological you know advancement is going to happen and we need to move in this way so this is another method survey method like this can be routed through your sales force or maybe special survey team can be there who will be defining the objective of the survey

obviously, in this case, we are predicting demand so we will be interested in knowing the demand of the product for the whole industry for our product right then we will design the questionnaire and multiple choice questions like i talked about Likert scale questionnaire ranking all those open ended questions can be there and then you will select the samples like different markets consumers you will go customers you will interact with and then you will collect the survey. So, then again you will analyze that survey report, you will interpret those results, you will tabulate results, you will come up with the diagrams that how it is going to be. So, again, we can predict demand by using the survey method. So either you can take an online survey like Monkey Surveys Google or you can telephonically you can collect the information via a face-to-face survey also when you are interacting directly with the customer usually when we launch new products we are going for face-to-face interaction, or you can send some emails, and then you can collect the information this I talked about the interview or focused group discussion where you are you know interacting with the experts And getting that expertise ah information from them now let us talk about some of the quantitative methods so quantitative methods mean now we will record the ah inputs in terms of quantities or we will see historical data we will try to figure out the, you know, pattern in the historical data let us say if this is how the historical data is moving so i can say this is a kind of product which is where demand is cyclic means there is cycle so peak season is there then off season is there then again peak season or may be the demand is like this if it is like this so i can see it is increasing like this right so This is how I can draw this.

I need data points and quantitative data so that I can exploit the trend if I have up to the data I have so I can see after it is going to be like this so I can predict the future right so the first method is moving average where we are considering ah latest data sometimes we are providing the weightage also to latest months data and then we are finding out what is going to be the demand for the next month we have three methods for is first is simple moving average second is weighted moving average third one is exponential moving average right simple moving average let us ah talk about with the some example only see i am having data for january month february month march month let us take 3 months moving average. So, what I will do I will sum up these 3 150 plus 160 plus 170 divided by 3. This is will be this will be the average will be the demand for March month. Let us now take for April if I want to calculate for April I will take the last 3 months February March April. If I will calculate May I will take now I will not take February I will take March April so latest three months i will consider so you can see for march it is there for april it is there for may june july you can find out latest but here what we are doing we are giving equal weightage to last three months that should not be because in some cases if the latest month data is showing some fluctuation in the demand either in the positive side or negative side and then we are giving equal weightage to all the months then we can predict it wrong so that we need how we can tap that exponential moving average

where we are giving weightage The basic purpose of this is that we are we need only one month's data earlier we were calculating three months of data right and then we can capture those fluctuations as well so the unique feature is it incorporates all past data points because we are calculating the exponential moving factor right from all the past point and then we need only one-month data to predict it and if it is non-linear if it is not moving like this right if it is moving like this so that also we can configure with this so how we can predict the demand for particular month t so we need to find out the a smoothing factor which is alpha and we can find out alpha by 2 divided by n plus 1 n is number of months we were considering so earlier we were considering 3 so if you are taking 3 months you can take 3 if you are taking 5 you can take 5 so 1 minus alpha into your last month predicted demand so let's take here example so if you are taking 3 so obviously we can calculate the exponential smoothing factor So, 2 divided by 3 plus 1 it will be 0.

5 and then the alpha will be 0.5 for this alpha will be 0.5 and if we are calculating for March month. So, then for March month it will be 0.5 multiplied by 170 plus 1 minus 0.

5. multiplied by last month predicted demand let's say predicted here is 155 so it will be 155 this is how you can calculate so you can see for February month you need demand actual demand for February month and January month last month predicted demand and you can see this is for each month you can calculate and this is three months exponential moving average Right now, next is the weighted moving average in this case, what will we do I was talking about giving the highest priority to the last month, so if I am calculating for March maybe I will give 0.5 weightage and 50 per cent weightage to March data maybe I will give 0.3 per cent weightage to February month data, and I will give weightage to 0.2 to January data so how I will do 150 multiplied by 0.2 plus 160 multiplied by 0.

3 plus 170 multiplied by 0.5. This will be demand for March month. So, now you can see here different scale has been used 1, 2, 3, 4 right that also you can use 4 means latest month you have given highest weightage. This also you can use where I have given highest weightage to March month.

Now you can find out when I will calculate for April highest weightage will be given to the latest month right. This is how you can find out. The next is trend projection. So trend projection obviously we will find out, we will plot all the data points, historical data and then we will find out the best fit line, right. So that linear or simple linear regression, multiple linear regression or polynomial regression we can use for that.

So we will see how we can fit that data. See, this is like, let us say this is x independent variable; this y is a dependent variable I am having like these data points. So, I will draw the best-fit line Maybe this is the best-fit line, which is touching and passing all the points nearby. We are drawing that line which is having a minimum distance from the data points it can be in the negative direction as well, which will reflect that your demand is decreasing as this x factor is increasing this is a positive relationship between this is the relationship can be like this also The relationship can be exponential also, right so this trend, we need to find out if I can predict this line up to this point I can extrapolate for next month this is going to be the demand for next month this is going to be the demand I can predict for those points, but i can predict only up to the maximum scale we have considered right So, linear this is how we can predict linear where this is your y-intercept, this is your slope of the regression line. y-intercept means where this line will touch, this A point is your y-intercept and slope of this line is this angle.

right. So, in detail, simple linear regression. If you can go, then maybe you will find out how we are driving this equation of y-intercept plus m means this slope b into your independent variable, which is there x here this independent variable and the dependent variable is y where here it is written dependent variable is y. So, this m we can calculate this is slope right and the what is the significance of this slope is per unit change in this independent variable how much it is going to effect the dependent variable if it is value is 0.55. that means per unit change in independent variable will affect 0.

55 times dependent variable so this is exponential trend model you can use this also where we are using exponential function again we are using a e raise to power b where b is your growth rate and a is your initial value we can use polynomial equation as well where straight line will not be there and you can find out polynomial equation I will just give you one example of simple linear regression where you can see this is how we can calculate see, this is the simple this is regression equation like I told you, this is dependent variable demand this is independent variable, this is your slope, this is your bientercept how we can calculate the bientercept b naught is equal to y bar minus b1 x bar, b1 how we can calculate the slope? This is how we can calculate the slope. We have x values, we have y values, right. let's say this is one question I just want to predict we are launching different TV ads and we are how many units of car we are selling so these data points are there we want to draw this line so what should be the slope of this line right so this is number of ads independent variable and your car sold depending upon number of ads buy So, we can calculate b1 from here, you can calculate x bar, you can calculate y bar, this you can find out and then you can find out b0 as well. So, just you put the value here b1, b0, any x value you put 3, it will give you the number of cars sold.

So, this you can extrapolate, same equation you can use regression line, this is known as simple linear regression.

So, for more details maybe research methodology course you can see where we are using this trend how we are drawing the best fit line and then we are talking about the error as well. There is error component as well which I have not included because that is statistic part. So, maybe in detail you can refer to regression line. so this is all about the quantitative methods right so these are references you can refer thank you very much