ISB CTO

Week 13: Impact of Data Strategy and Analytics

Video 1: Retail Analytics: Introduction

So, we have seen now, we have understood the different drivers of supply chain. We have also seen examples where data has been used in a different way to improve the efficiency of the supply chain. So, with this understanding, now we will move more towards how organisations have done or changed their structure, business structure to collect more data and also how they have applied it to different drivers of the supply chain. At this point, we are very clear on what is the supply chain, what is the value chain, where the data comes from. But there have been companies who have fundamentally changed their business process to collect more data.

One of the classic examples of that has been Amazon. Now, Amazon traditionally have relied heavily on data for their supply chain. But more in the later part or more recent past, they have been very aggressive about that. So, one of the classic examples have been in March of 2015, they introduced something called Amazon Dash. Now, I want you to go and watch this video on Amazon Dash and also on Dash Wand. These are the two things they introduced one after other and how this has helped them in collecting data.

So, I want you to watch this video but also discuss how do you think these things help from the perspective of collecting data that can change or improve the whole supply chain analytics. Now, one thing to keep in mind is that all of these things improve customer convenience, and that is one of the big reasons companies go for this kind of thing. But I want you to understand is that this is not the only reason and there are lot of hidden and fundamental reasons behind that.

Video 2: Application of Retail Analytics Data

So, now you have seen this videos and you have discussed what is in there. So, let us try to summarise what happened here. Through this Dash and Dash Wand, they try to get into inside the head of the consumer. See till now, the supply chain analytics in general has relied on data from point of sales, which is the scanner data, where customers go and make some purchase either in the physical world or in the e-commerce world, it does not matter. But you have made some transactions and whenever you made the transaction, the data is collected. And mostly those data come in the form of numbers, and we analyse those numbers, and we make decisions. And that is how the traditional supply chain analytics has been built.

What is changing now? And changing very rapidly is that rather than just knowing what customers did, if I can know why they did what they did and also go deeper into the whole thinking process, the whole flow chart, then I can deliver better to this customer. I can improve the whole value chain using that and I can improve both efficiency and responsiveness using that data. So, one of the thing that Amazon Dash did for them was, see the customers are keeping all these buttons on their app. Now what buttons could customer keep? Not just what they have bought in the past but what they want to

buy in the future. Now, I am trying to get into their head about what they want into the future. Take a simple example that if I buy lot of stuff for my kids but my kids went to college. Now, that has been a challenge for organisations to know or understand from the point of sales data. But now here, I can see if they have deleted this button then I know something has changed.

Now, Amazon has used data for many things in the supply chain. They are now doing this anticipatory delivery where they can deliver item before you even order and they can try to see whether you like it and if you like it, you can keep it or if you do not like it, you do not keep it. But that gives them lot of power and lever to manage their supply chain, manage their inventory or even do upselling. So, for all the purposes this works great. Now, this does not stop here because no this is just one part of collecting data. In fact, Amazon Dash was discontinued by Amazon in August of 2019. Now why did they discontinue it? They discontinued it because they wanted to move most of their focus on the customer. They wanted to move all of their customers into Alexa shopping. Now Alexa shopping has been a big push for Amazon in recent time and you know even though Amazon has done some layoffs in Alexa unit, it is mostly because of the push on the too much push on that. But that does not mean that Alexa is not important.

Now, I want you to watch this another video on how shopping with Alexa works, which Amazon has posted. Now, one thing you would have noticed in this video is that, of course again convenience is very important. But another thing that you notice in this video is that when the lady tried to order a product, the Alexa gives only one option. And it gives that option either based on your past order, which says that just reorder this item, or looking at the history holistically and then look at some other data and then try to decide what to what to propose to you. But because of the convenience and because of the mode of communication, you can't get a whole list of items like you get in your app or in your web page. So, you get one item. Now, which item would Amazon offer to the customers? Yes, of course the one that you are going to like most, because if I do not do that, then you will stop using the service. But most of the time or many times, the customers don't have just one thing as number one. They will have a list of things. Those are their top choices. Now, within that list, within those choices, they can always pick the one which works best for them. Now, Amazon gets not only much better data, they get to exploit that data to influence both the consumer behaviour on what they buy but also the seller behaviour on what they should be selling. So, that is fantastic. And this we are looking at the whole supply chain, whole value chain, which can be changed by the collection and analysis of this kind of data. And this is where supply chains are moving right now.

Supply chains are moving towards making them with getting inside the head of the consumers and move all the supply chains around that. But that requires the newer way of collecting data and analysing data. And this I think opens up the great future for all kind of supply chain across industry. And you know, we are not thinking just the industry like manufacturing, retail, we are talking all kind of industry. You can think of healthcare industry or any other service industry. They all have very similar problems we are facing right now. And this kind of solutions can take them in very different direction. So, another solution that Amazon has offered along with all these things is Amazon Key. Now

Amazon Key is an interesting application. In Amazon Key, Amazon says that see, you can buy a camera which you install in your house, and you give me access to that camera as well as access to your house. And I can do, I can solve all your business, all your world's problems. For example, the packets will not be lying outside the house. You want to get immediate cleaning; somebody will come and clean your house. So, lot of ancillary services come with that. They can even put the packet in your trunk, in your garage and all these places.

As a customer, one can also see in real time when the delivery is happening. But Amazon also have access to those video. Now, of course Amazon has to be very careful on how they utilise these videos and how they use it. But it will be foolish to think that these videos will not be used for optimising their supply chain. So, that is, now we are getting into the value of dealing with videos, images, that is very different from numbers that we have dealt with earlier. But that is where the future lie. Now building on that, this whole example of Amazon Key looking at this, this was already fantastic. Walmart now told that we will come with a solution where I will come and put grocery not just inside your house but wherever you want. I can put it in your kitchen. I can put it in your refrigerator.

Now these kind of services, which is in-home service offered by Walmart now. So, Walmart is doing that this in-home service where they can put it wherever you want them to put. They can put in garage; they can put in your refrigerator. Now, that is taking the supply chain and the data collection to a different level. Now as a customer, you are allowing third party to look at what is inside your fridge. It is a very different thing. It is very convenient solution actually if you really think about it. In fresh fruit market, one of the challenge has been the things go bad, even if they deliver inside your house or in the garage or trunk they may go bad. So, the fresh food delivery, this is a fantastic option. But now you are giving access to not only your house, you are allowing them to come inside your house and you allow them to get into your fridge. Now even though it may look outrageous, I can tell you that we are going to see a lot more solutions like this because customers are liking it.

It is very convenient, and it is great for the firms like Walmart and Amazon to collect a new set of data and think of analytics or improving supply chain from very different lens. So, we all need to think from as a business manager, as an IT manager. We need to think about how to collect such kind of data and how to create business value around it as well as create value for the firm in terms of improved services and that will improve the whole value chain and unless we look at this, we will be left behind with blind spots and we do not want to do that.

Another fantastic example is Amazon Go. This is another video I would ask you to watch because this will really tell us some very different story. Now, when you see in this video how this whole system works is fantastic. So, here you can look at your customers, how they are behaving, how they are going, how they are navigating in this store because you know exactly where they went, how they went, which path they took, how they interacted. They first took the item, put it back. Which part of shelf they looked at because you can track the eyeball movement and think the quality of this data. It's hard

to analyse all this data because this is all videos and all but the way our AI, machine learning, deep learning, neural net is moving in these things we can do lot of things. So, data is the key here. You are able to get this data, you can apply this. So, even though Amazon Go was first started in December 2016, only for the employees, in 2018 they opened their first store for general public in Seattle. And then they have opened several other stores around the country.

Now, one of the challenges with these stores is that these are very technology heavy, so you cannot open very large stores. So, you are limited by the size and that has been one of the challenges. So, Amazon tried to open several stores, but they started getting lot of problems. They had to open smaller stores even in the suburban areas. Now in the suburban areas it is a problem. People like to go to larger stores, so they had some failures in that. But this technology itself is fantastic. So, what Amazon has done now they call it walk out technology where you can just take things and walk out and started implementing this technology or selling this technology to other players. One very good example is that they have started putting it on airports. So now, one of the first applications, they started with Hudson on Dallas Fort Worth Airport. At DFW Airport, they created this small store of Hudson where this technology is used. People can just go in, put their credit card to enter and they can just walk out. This is great.

Now, let us think about what are the other places where this can be utilised. So, we see that the obvious thing will be where people are in rush and people still want to purchase. So, airport was one of the examples I talk about. Similarly, railway station, bus stop and so on. But even places like stadium where people go to watch sports and they are always in rush. So, another applications and these collaborations are going on right now that this walk out technology is being experimented at stadiums and they create the temporary go store or walkout technology stores where people can do; these are these kind of things will change the collection of data, analysis of data and supply chain efficiency.

So, future is very interesting as long as we are aware of it and we are able to change our mindset based on that. See, these are not technology or simply technology. This is about the cultural shift we have to think about. We have to think that how we can change organisations, how we can change the thinking process of people, stakeholders and we can change culture of the company. Unless we do that, these things will not work. We will not see the fruits of supply chain analytics. So, this is very important to think from the broader perspective rather than just looking at technology perspective.

Also, we need to be careful with supply chain. Supply chains have always been or even value chain has always been defined in many different ways. And the reason has been that not two supply chains are alike. And that reminds me of interesting story that several blind men were asked to touch an elephant and define how the elephant looks like. Now what they did different blind men took look at touched the different parts of elephant, some touched the trunk, some looked the tail, and everybody defined it, whatever they touched. Now many supply chains operate like that, that is, they are supply chain managers. They touch different parts of supply chain, optimise it very well, but they do not look at the full supply chain. So, how can we create that perspective?

And not only that, then how to make it a partnership with your supply chain, other players in the supply chain?

See we call it supply chain partners, not supply chain competitors, but many supply chains have treated them like competitors and that has been the problem. So, how to look at the whole supply chain as a one thing and use analytics to improve it and how to work with different players as the partner. I think that is the biggest thing that we need to consider and improve upon it. So, and how much to define? Should we only care about our Tier 1 suppliers who are the supplier who directly supply it to us, or should we care about our suppliers of suppliers which are Tier 2 suppliers?

Similarly on the customer side, do I need to worry about only my immediate customer, or do I need to worry about the end customer who is buying the product? Unless we start making it broad, we will not make our supply chain successful. I will give you one example. You know Toyota initially was looking at their own supply chain part, the Tier 1 suppliers and they always felt initially was that you know if Tier 1 suppliers are doing good, I am fine. They need to bother about their suppliers. Why do I need to bother about that right? But they realise that does not work because what if there is a disruption for the supplier's supplier. Your supplier is not going to supply to you. You may charge penalty on whatever you want but it may hurt your business big time. So, how to create that view of that you need to broaden your scope in the supply chain without losing the focus is a critical point.

Video 3: Managing Supply Chain Drivers

Now we have different supply chain drivers. We have talked earlier. And those supply chain drivers are transportation, we have inventory, we have facilities and the information is another driver which ties everything together. Now we all have to understand that even if I talk about one of the drivers, I cannot ignore other drivers. If I do that, then I will not get the full supply chain. So, I will talk about one of the drivers and I will try to see how I can bring other driver in the analytics framework without even talking about that.

Now in the transportation, the biggest cost has been logistic cost. And logistic cost makes a big chunk of the percentage of country GDP. In U.S., it is around 8%. On the other hand, in country like India, it's little more than 13%. And if you see countries like Europe which is around 9%, South America is around 11%. So, this is all going to different chunk, but where does the cost go? If you think of a country like India, the big chunk of cost goes in fuel, price for the gas because this is where the fuel has always been the key chunk of the optimisation piece and how to reduce that. But, if you think of the U.S., some of the biggest part of the cost goes into drivers, and driver shortage is a huge problem.

During the COVID pandemic, Walmart even decided that they will pay some of their drivers up to $110,000. That badly they needed all these drivers to reduce all their supply chain cost and improve resiliency. UK even had a special visa category for drivers. If you are ready to drive a truck, you get immediate visa, come to the country and paid well. So, that shows that we need to use data differently in different scenario.

In some countries, the cost on the supply chain analytics or the focus on supply chain analytics may be on reducing the fuel cost, whereas somewhere else, it could be on the driver cost. That's why we have seen lot of push in countries like India towards electric vehicles, whereas if we think about countries like U.S., there is lot of discussion around autonomous or driverless vehicles.

In one of the interviews with NBC I have been talking about that how this different players, and almost every player in the U.S. is moving towards, they are changing their fleet to electric vehicles. And we are seeing the similar thing in other countries like India and China. And actually, those vehicles come with the special capabilities to collect more data. So, we are going to now see more data, but we are also trying to make our supply chains more efficient, and analytics is playing an important role on how you move towards electrification. But if you really think carefully, dig deeper into where the cost is really going.

On one side, country like India having very high cost for logistic—around 13% or more on GDP. On the other hand, we have countries like U.S., where the logistic cost is around 8%. It's a combination of things. U.S. is not into manufacturing. So, the items they are transporting is very different. So, that's the one part of the cost that they have an advantage. They are more into e-commerce items, food and beverages. Not like cement, coal and those kind of things. Now that is the reality. So, the countries can't do much on that, But that is not it. Another piece is on infrastructure. Now, every country like China, India, they have pushed lot of money on infrastructure lately. But that is still behind some of the countries like the U.S. So, if you think of the busiest port in India or in the U.S., they will be taking load of 20% of the total load across all the ports. But if you think in India, the busiest port could be handling almost half of the total traffic. Now, that creates lot of supply chain issues.

First of all, that creates congestion and lot of supply chain inefficiency. Now, how we can remove that? That's where we need not just the infrastructural development, we also need a lot of data. Because the loss of transparency at the ports have been one of the big reasons why we see lot of supply chain inefficiency. I was working with one of the largest aluminium suppliers who built parts for a lot of auto companies, and they were based in India. And one of our biggest challenge was that how much time it takes for part to come from port to the plant, and it could vary a lot. And that was impacting the whole supply chain efficiency even though we did very fancy algorithms and all.

So, one of the company which I sit in the board of one of my former student is called Insightzz, which is a great company also to look at on many of the supply chain and manufacturing-based solutions. We basically started looking at how we can create more transparency and visibility on this port. Now that is the place where, if we are able to do that, we can cut lot of cost and we can improve efficiency, and we can make a dent on this 13% to possibly 8%, 9% or even 10%, that is a big chunk of the cost. Another thing that in supply chain analytics is very important to understand is, the role of third-party logistics company.

Now what is a third-party logistics company? These are the company who takes care of the logistics of an organisation, and they will be a one-point contact. For example, I

want to deliver my item from point A to point B, but it needs to take road route, it need to take railways, it need to take waterways. And whenever this happens, in several countries, right now this is managed in very disorganised way. For example, in India, this is done by this individual players. Now what these third-party logistic companies do, they try to put it together for you and they will take care of everything. They will provide you real time update and they will tell you that when your path will reach. You can see everything along the path as well as you don't have to deal with more than one person. Now having such kind of system improves the supply chain efficiency, improves the data collection process and improves the whole analytics. Now just to give you a perspective that in the U.S., almost 60% of logistic is done by third-party logistics company. And you compare that with countries like Japan and Europe, they are in the similar range or even some of them higher range. But when you come to country like India, it's less than 20%. And that is where I think the biggest scope for supply chain analytics comes into the picture.

How we can think about right data to create this kind of logistic companies. So, I work with some of the third-party logistic companies very closely, like there's a company NFI in Philadelphia and then Tucker Worldwide, for which we have even written a case which is on Harvard Business Publishing. We have carefully looked at the role of data, role of information and how they work.

So, I think there are lot of low hanging fruits in countries like India, where this problem can be looked through from the lens of creating new businesses as well as utilising data that can totally change the perspective of supply chain. And I hope that we get there because then, we can make a huge dent on not only the supply chain cost but also a huge dent on the issue of having the items not available. And this will improve the supply chain resiliency worldwide. Because these players, when I say that U.S., China, India, Japan, they are playing a very important role in global supply chain right now.

So, any improvement in any of these places will help others. And the big chunk of this challenge comes from the fact that supply chains don't work like, we don't use the just one mode of transportation in most of the supply chains. For most of the movement, we need to use different modes, like water, railway, trucks. So, how can we create this kind of system of third-party logistic, where we can streamline and use data to make the process smoother? And that will be the best thing in the domain of supply chain analytics. The most value will come, how we can have an exchange of information between different modes to facilitate transfer and provide a one view to the customers. So, I think this is one of the thing that I really want to, I cannot emphasise enough, that we need to look at carefully and you know, this is all about analytics.

Video 4: Transportation Network Design Options

Now the next issue comes is transportation network. Now transportation network when we talk about, it involves lot of different kinds of optimisation in it. Like I want to design a network, I have to look at how do I transfer item from point A to point B. Now in order to transfer item from point A to point B, I can send it directly, I can send a truck goes from A to B or I can put it at the intermediate site. So, how do I make that decision? Very interesting problem and that is where we use lot of analytics, we use lot of data

and optimise. Another question is that if I send it through an intermediate site whether I will keep the item there or it will just serve as a transfer point. And if I only use this warehouses as a transfer point they are called cross-docking station. So, cross-docking locations are the locations or cross-docking stations are the stations where you use a site, but they are not doing, they are not adding any value other than just keep as a space where we can bring the item and move it to different places, but you don't plan to store it there. And cross-dockings are very popular and sometimes cross-dockings can also be there because to avoid some tax and tariff that is also possible. But all of those things how to design we use lot of analytics there. And then the piece comes that how we should deliver, how should decide my route. That is another part, and the concept of milk run is very important that I will get into.

Let us first try to understand what is the trade-off and between sending it direct or sending it through another channel and what kind of data we can use. So, one problem we have seen in the past in all these thing is that we try to use the transportation method, which minimises my transportation cost; that has been a traditional method of selecting transportation mode but that has been shown to create problems. So, all these companies like Amazon and Walmart, they started looking at this problem very differently. So, they told, see when I realised that my supply chain cost is not just transportation cost, I have to take more holistic view of that. Now how do I decide on that holistic view that we have to go back the drivers of supply chain. Now supply chain drivers are key drivers are facilities, transportation, we have inventory and information.

Now when I am deciding on the transportation, I also need to look at what will be my inventory cost. That should help me in deciding what will be my transportation cost. We cannot just look at inventory cost separately. And when we think about inventory cost, you know, inventory cost has to be decided based on how much I am keeping in my stock, how much is in transit and on top of that, how much is safety I need to keep. First of all, why do we even need to keep safety stock? Safety stock we need to keep just because I do not have perfect information. That is where, again, data comes into play. If I know the perfect demand, I know the perfect supply, then I only need to keep items such that I can keep delivery. I don't need to keep on top of that, safety stock.

Safety stocks are always something that is not needed to deliver my demand if everything goes perfectly, but we keep it because we need to make sure that we can deal with disruptions like COVID. COVID is of course extreme disruption, but there are many places where we will do. Actually, during COVID, one of the companies that did very well in their supply chain was 3M and they were selected as supplier of the year by some organisations. And where they've made real value was that right before COVID, they were implementing a system, which was taking data from many different sources and they were already in the process of implementing all the system, although they expedited it when COVID came. Now they had a very good view of different supply chain partners, different demand in different thing and that way, they reduce their safety stock, which was always very hard to keep during COVID and that made them the supply chain thing. Now that is a good lesson for other supply chain companies like toilet paper supply chain where there is not much visibility in the system how we can

create and they could use this data to optimise the whole supply chain, not just one part.

So, when we are optimising transportation, we also have to look at our inventory cost. And in the inventory cost, we always see something called cycle stock. Cycle stock is essentially the stock that we keep to meet demand if everything goes perfectly and I don't have to get into the safety stock, so we need to look at that. And cycle stock is calculated usually using a very popular supply chain model which is called economic order quantity model or EOQ model. And what EOQ model simply does is that you receive your order and then replenish that order. Once that is done, then you get a new order. Of course, you have to order little bit in advance to get it on time, but you get your order, finish it off, get a new order, finish it off and get on. And one of the assumptions of the economic order quantity model is that the demand is linear, which means that you linearly replenish your item. Now if you think carefully, I start, let us say with my order size Q, Q is my lot size. I started this with Q, and I make it to 0. Again, I go to Q, again I make it to zero. If I keep doing that, then on average I store Q by 2 items, and that Q by 2 is called cycle stock or average inventory. So, now I have looked at the inventory cost, but I also have to look at how much inventory is in transit, how much safety stock I am keeping. So, when I am deciding my cost of transportation, I have to look at all of these cost and then decide the transportation mode and that is a supply chain view.

Now also there is another driver facility I did not go into; I did not go into that just because facility sometimes is a higher level decision. But you can include that as well to make the decision. And once we do that, then sometimes I can pick a transportation mode that in itself may be expensive, but it may reduce my total supply chain cost. And many companies make their decisions like that when all this Coca-Cola or Walmart when they decided to use more and more of their own trucks, it was all based on this kind of data and analysing what is the best mode for me that's where many companies moved.

Now, one interesting example was that in 2019, Amazon started considering that they move their one-day and two-day delivery in the US to their own fleet rather than using companies like UPS and FedEx. Now this is very interesting. Amazon is not a company who can manage the local delivery on their own. This is not their core competence. They were never built around that. But the reason was that their data clearly told that if they move to that, then they will reduce their supply chain cost, both in terms of the combination of inventory cost as well as transportation cost. Amazon is becoming the largest logistic company now in the US. What it means is that if they don't move for some of the delivery on their own, they are giving too much business to the third-party player.

So, we have to look at this data carefully and also you have to look at the capability. Don't think that when Amazon moved to their own delivery, they didn't have problems. Actually, they had a lot of problems. They created their own mapping because they wanted to make sure they have a better understanding than just relying on Google map and it also be the strategic reason they don't want to rely on Google map and give them

all their data. So, they created their own mapping which led to lot of issues. And now they are mapping many other countries actually. They are in the process of mapping countries by hiring people because they want to have their own mapping system. Because in the future if their data tells us that see, look at the supply chain view and you should use your own logistic, they want to be ready for that. Again, how we can use data to impact all our business design, that is what the view we need to take and here we are taking a supply chain view to do that.

Video 5: Transportation Network Aggregation and Consolidation

When we decide about transportation, I need to decide that do I deliver to each of the places separately or maybe I can aggregate. I can go to three places at the same time, and I can put all of them in the same truck. That is called physical or geographical aggregation, where you aggregate your demand of different physical locations and put them together. Another kind of very commonly used aggregation using data is called temporal aggregation, where I aggregate my demand overtime. So, rather than sending demand every day, I aggregate the demand of a week and I send it together. Now both of these, physical aggregation and temporal aggregation requires lot of analytics because I need to first understand where the aggregation need to be done and second how it needs to be done. So, it uses both data analytics as well as decision analytics. And just to give you a perspective, in the data analytics we are using lot of regression models for that.

Now we have gone into lot of machine learning based solution which can look at non-linear models and then we use lot of mixed integer programs, non-linear programming. These kind of solutions we are using to solve these problems. But everything is built on data. We work with one of the food delivery company very closely in Philadelphia, which was started by the alumni of Temple University, and I dealt with lot of their capacity planning and then inventory consolidation. We collected all their demand data, all their delivery data and based on that we could do a lot of aggregation in terms of how to deliver the food. You just send one box at a time or more than one. And any delivery company has to solve those kind of problems right now, all the consolidation problem. That's why all this delivery companies across the world, food delivery company or item delivery company, they are running after collecting all the data and understanding what to consolidate together, what route to take and all. And we have lot of nice algorithms around that that can be used. But data is the key. Data is the new oil in supply chain that takes care of all of those things. So, if I decide to go from point-to-point is very easy. Those are called direct shipment network, where I decide to connect each supplier with each buyer. But in the milk run, what we do that we try to combine some of them together.

So, for example supplier A want to deliver to buyer A, buyer B and buyer C, I can do that in same delivery. I don't have to take three different delivery. I can take them in same delivery, and I can deliver to three places. At the same time, I can take items from three different supplier and delivered to one buyer. And this process, both of these are referred to as milk runs and where does the name milk run come from because that milk person takes milk and go and deliver at different location. That's a physical or

geographical aggregation. And then comes the storage part; should I use a distribution centre or send the item directly? That again depends on your data. So, let's say that you have lot of demand close to some distribution centre, then what you would need to do is that you want to move the items to those distribution centre and then you can let customers pull from those distribution centre. So, it really depends on how and where your data tells us to put.

And Amazon during COVID started buying lots and lots of these small stores which were closing at that time and now they are using as their distribution centre because they want to be very close to their customers. They have collected data and they found out that more and more people in this area want to have a distribution centre, so that they can deliver very fast to them. In fact, Philadelphia had a big protest that Amazon is bringing lot of this distribution centre to residential areas and these truck drivers are driving in very high speed, kids are around. So, you have to ask the people that do they really want fast delivery. If they don't, then actually it's a very bad decision for Amazon anyway and they should be taking it out. But this involves lot of calculation, and analysis on how it need to be done.

So, another type of distribution centre is where you don't store the item and just use it for sorting facilities, like cross-docking. When we call it cross-docking, like FedEx does it a lot, they do not store the item, but they will bring all the items together and they do lot of sorting as well as moving to different places. So, that also need to be optimised. So, you can have shipping via milk run, where you have a milk run on the supplier side or the buyer side or both and you can also have a distribution centre with or without storage. And all of that optimisation required data on the demand, on the supply and the cost of maintaining these warehouses. And then then we do all the math around it. Math part is not that difficult. We have very good tool to do that. But collecting the data and having that mindset is the key. And another piece that is extremely critical here is that these decisions should be made to minimise the supply chain cost, not just the cost of transportation. If we have that, I think we are in good shape.

Video 6: Role of IT in Transportation

IT can assist in identifying the optimal routes, optimal fleet utilisation or collecting the data through GPS and you can find many such examples like that. In practice, we try to align our transportation strategy with competitive strategy. We need to look at both in-house and outsource transportation. You need to use technology to improve transportation performance. You need to design your flexibility into the transportation network and so on. And I will talk about two specific examples where we have utilised this concept. One is that we worked with one of the countries in South America. I cannot say the name of the company, but they have a central bank and they wanted to manage their whole currency supply chain.

I have written a paper on that you can always find from my website. It is called Managing Logistics and Regional Bank Notes Supply chain. But the interesting and fun part here was that in Mexico, they first have a central bank which gives the new note to the local bank which goes to customer, and they also bring the unfit note back to the central bank. But they interestingly employ decoy trucks. Decoy trucks are the trucks which are

sent along with the cash trucks, but the robbers don't know that which one has cash, which one has police. So, in the optimisation, we had to collect data on first, how many decoy trucks is needed in which area. So, look at the past robbery data, we had to estimate that. Then we had to identify that based on how many trucks are needed. We look at the demand data, then find the optimal routes for each of these trucks, and also how to determine the capacity of this cash truck is very interesting. In Mexico, you do it by total face value of the cash. Even though truck has capacity, you cannot fill it with more than certain face value. In US, it is by physical space, by the way. In UK, they do not use decoy trucks, they use ink now. If their AI system tells them that some robbery might be happening, it throws ink on all the notes, so they go waste. We have done a similar application for US coin supply chain and again, I have a paper on that that can be easily found There we look at the coin supply chain for Federal Reserve in the US. You will see that the whole structure is very different. When the structure is different, I have to redo it. Again, I have to collect all the data and I have to identify the network and find the optimal route.

So, for all of these applications, you have to first get all the data, take the supply chain view of minimising the supply chain cost and then identify the structure and then optimise each of them. If we keep this view and create our systems like that, we can make big progress in our supply chain optimisation and supply chain efficiency. And I think this should be our goal and how we can use new technology to both collect data and find optimal solution. So, both data analytics and decision analytics are important in this case.