

ISB CTO

Week 14: Digital Supply Chains

Video 1: The Bullwhip Effect

So, another important driver of supply chain is inventory. And inventory is always one of the biggest cause in supply chain, and we have to understand how to optimise it. And actually, most of the developments in the recent past have been going on around how to improve our cost of or how to reduce our cost of inventory. So, one of the concept that got lot of attention in supply chain inventory part is called bullwhip effect. Now, bullwhip effect was voted one of the most important development in supply chain analytics in last 50 years.

So, what really it is? Where does the name come from and what does it indicate? So, bullwhip effect talks about supply chain coordination. Now in supply chain when we talk about, they are always with different partners. We have suppliers, we have wholesalers, we have retailers. Now, all these are generally different entities and different companies. So, what would companies like to do? They will maximise their own profit. We all want to make most money, and that has been the flow or process of supply chains for very long time. But in late 90s, one Professor from Stanford, Professor Howley, who is a very good friend; just retired. He actually came up with this whole idea of bullwhip effect. So, what he told that, no, supply chains should not work like this. Supply chains should look at total cost of supply chain and each partner should try to minimise that. Now, that is a very different approach, that I am not maximising my own profit, but I am trying to maximise the surplus of mine plus other part in the supply chain. So, the question is that why. The simple answer is that if the whole supply chain makes \$20 more than earlier, then we can share the benefit. That is where the supply chain coordination part comes into picture. But if we don't do that, then somebody will lose money. Now, how can we make that happen? In order to make that happen, we have to coordinate with each other. If we cannot coordinate with each other, it will never happen. But many supply chains around the world, this coordination does not happen across supply chain partners, and the reason is very simple.

For example, in the Boeing 787 Dreamliner example, Boeing could not share lot of information with their suppliers because they were worried that this information could be leaked to their competitors. That is a serious thing. If we think of the retail world, like any of these grocery stores, drug stores, they are very scared and share any information with any supply chain partners because they think it can lead to the other partner. For example, the same monitor company supplies to both Dell and HP. Now, if they are supplying to both Dell and HP, and Dell shares all their data with them, they can share this information knowingly or unknowingly with HP. So, many places this does not happen because of strategic reason. Another thing that happens is that sometimes they don't even have capabilities to do that. And what I mean by that, that they don't have IT systems which can make this happen, that also create problem. So, what really happens if they do not share information. If they don't share information, then the figure you see on your screen is called bullwhip effect.

So, let us try to understand what is going on here. So, the first thing is, the customer demand at retailer. And we see that customer demand at retailer has a little bit fluctuation, not too much and which is very common across many products. The example of toilet paper, very stable product, diaper, very stable demand at the retailer level. All the beverages like beer, coke; beer did not go down much during pandemic or any other time. People drink beer whether they are happy, they are sad, in the recession and happiness. So, the demand of their many product at the retailer level is quite stable. But retailers not always share this data with wholesalers because they do not want to give their demand data to wholesaler. So, what do they share? They just place their orders to wholesalers. And, when you place the order to the wholesaler, you see that there are more fluctuations than what it was at the retailer level.

Similarly, when wholesalers place the order to manufacturers, they have more fluctuation. And when manufacturers place the order to supplier, they have more fluctuation. This effect was termed as bullwhip effect. Because the bullwhip what you see and when you have seen people using bullwhip or if you have used it, the fluctuation changes across the bullwhip when it is used. So, few things here. Now the graph clearly shows that the fluctuation is increasing and there is a shift that fluctuation moves to the right as we go upstream in the supply chain from retailer to supplier. And the peak of the fluctuation also increases. So, why is the problem? Now what if the retailer rather than sharing, just placing their order, they have shared their demand information with the wholesalers. And wholesalers did the same thing, they shared this demand with the manufacturers, and manufacturers shared this demand with the supplier. Then all the graphs will look exactly the same, and our supply chain will be lot more efficient. We will save lot of money on safety stock, and then we can decide to share this information with each other. So, that was the whole idea of bullwhip effect. So, how we can do that and how we can use data for that, that is the question here. So, bullwhip effect essentially it not only increases the cost, it also reduces responsiveness because you cannot respond to your customer fast. And this happens mainly because of the lack of coordination. There are some other things that happen that I will talk but main is the lack of coordination.

So, how can I improve the lack of coordination and how I can fix other things? Now in addition to the lack of coordination, another thing that causes this bullwhip effect is the lead time. If the lead time is zero, then I don't have to order in advance and I don't have to worry about uncertainty. So, Howley basically came with this whole idea that first all organisations need to collect data on their bullwhip effect, across supply chain. So, they need to have some understanding and that I want to understand at least for the experiment purpose, and it can be done by a third-party. They don't have to share with each other. That's where a lot of consulting companies can help. They can take all this data with all the proper NDAs and all, and then find out what is the bullwhip effect in the supply chain. Then, once we quantify and we tell them that see this much money the whole supply chain is losing, then figure out how we can make this happen without even sharing all the data. So, there is a whole list of way to do. You have to first quantify, but then this cannot be done just as the technology solution. This requires lot of commitment and coordination. So, get top management commitment, revert resources

to the coordination and then focus on how to communicate with each other, try to achieve this coordination in the whole supply chain. And then I have to share this data in the real time. So, I have to use technology, and I will talk about some examples of that, how companies have been what technology we are talking here. But the big piece is that if let us say supply chain cost reduced by \$100, how would I distribute the benefits? It has to be distributed equitably, not equally. So, the difference between equitable and equal is that equal talks about I give equal amount to everybody, but equitable says that they get in proportion. So, for example if there are two people, I want to make them equal, I will give them same size ladder to plug fruits from a tree. But if I want to make them equitable then I will give a shorter ladder to the taller person and the longer ladder to the shorter person. So, that's the whole idea of equitability.

Video 2: Supply Chain Coordination

Now, there is a lot of research and analysis on that now on how to do the supply chain coordination, including lot of my research is on that. We have worked with several companies on how to make that happen. So, we can make that happen, but before that we have to collect all the data, identify it and see how we can use technology to share information. Now, that is where the challenge comes. And always keep in mind, the whole idea is around safety inventory. So, if you have high variability, you have more safety inventory that increases the cost of supply chain.

So, let me talk about some of the examples how companies have really solved this problem. One of the classic example is that when Procter & Gamble realised that the demand for diapers was very variable at manufacturing end. And they were very concerned that diaper demand, how can it be variable? It should be as stable as possible. We almost know how many diapers would be used. So, Procter & Gamble went to Walmart and told that see, I am really worried that why demand is so variable. So, Walmart has been a very bold company on sharing their data by the way. And one of the reason is that they are very powerful. So, they think that by sharing data they cannot lose much, and they trust their partners as well. So, we need that kind of vision as well, and collecting this and sharing this data. So, Walmart told, the demand for diapers at our end is quite stable actually. People buy from their store at very stable rate. At your end, when it reaches, it becomes very variable. That is a bullwhip effect. Exactly. So, they were one of the early companies who identified bullwhip effect or one of the early supply chains to identify the bullwhip effect. And then, Walmart told Procter and Gamble, see, in almost real time, I will give you point of sales data that who is buying diapers from which store. So, what they really did? They removed the bullwhip effect in the whole chain. The same data is going from retailer to manufacturer, same fluctuation, and they reduced the cost drastically. And that became the starting point for many supply chains.

Now, Walmart has repeated this thing with many other suppliers like Coke, Pepsi. They even told to some of these players that, see you can do this, and you can also manage the inventory. So, you basically look at my data, what I am selling, for your product, only for your product, not for others product, and you decide when to replenish the product in the shelf. You manage the shelf. And by doing that, they have completely removed

the bullwhip effect. That requires lot of data collection, lot of coordination. But we have seen that all the good supply chains who have survived the heat of all the disruptions, they are the ones who have been proactive in using analytics for the purpose of removing bullwhip effect. I recommend each company should really think, and this applies to both traditional companies as well as service industry. Everywhere, you can think of call centres. Call centres are classic supply chain example, where customers are calling, you are serving their customers, that is a processing time and lot of information that goes as resources or input. They are supply chains. So, you have to think of the global view of supply chain, rather than just thinking about supply chain as nuts and bolts. And all the principles we talk here can be applied to very traditional supply chain, like making cars to very intangible supply chain, where we cannot see even a single item. And then you just see the service, like education, teaching, the total service supply chain. So, bullwhip effect is everywhere, and we have to identify and so on.

Another thing that companies have done very nicely to reduce the safety stock and the bullwhip effect is reduce the lead time. Now, lead time is a very interesting thing, because whenever you have a lead time, that is where the uncertainty comes, because I have not got my item and I have not seen my demand yet. So, I have to place my order, because lead time is the time between you place the order and receive the item. So, I have not got my order and what do I do with that? So, one very interesting example, I'll give you, that happened in recent times is that for spare parts. And that's where the supply chain view also comes into the picture, and analytics. So, for the spare parts, there are many parts. The demand for each of the parts is very variable. So, till now how our supply chains used to do is, take lot of data and try to see which will come. But still, it will have lot of variation, so it becomes little challenging for companies. So, they told that the problem is coming because there are many parts and identifying demand for each part is very difficult. So, why don't I reduce the lead time, so that whenever the demand comes, I can produce and make the lead time zero.

Now, how can I make lead time zero? By 3D printing some of the products. So, lot of spare part companies are now aggressively moving to 3D printing. So, even though cost of 3D printing is higher, it is reducing the supply chain cost. Now, combining the supply chain cost with manufacturing cost is the next mantra. That's what we all should be doing now and use data to make that happen. And you can find lot of interesting examples on this spare part industry, which is happening, which is currently happening. And I think that is outstanding, how it can change the whole supply chain cost, and that is the core of supply chain analytics.

Video 3: Postponement Strategy

Remember, you have to first look at the different drivers of supply chain and minimise the cost. Then, you have to work with your partners to minimise the total supply chain cost. Now, you not only look at these drivers, also look at the manufacturing process and reduce the total cost. Now, in order for that to happen, another very good method is called postponement. So, you see this figure on your screen, the supply chain flow without postponement. So, there are four arrows here. So, I have four different parts

that I am selling. For each of the parts, I have a total different manufacturing process. I start from start to end, and so I have to estimate the demand for each of them separately. If I estimate demand for each of them separately, I have a lot of lot of uncertainty in that. And when I have more uncertainty, I will have lot of safety stock, which will increase my supply chain cost. So, why don't I change my process? Why don't I change my process to say that until in the bottom figure, until the bold line, this process is same for all four of them. So, this part of the process is exactly the same for all four products.

Now, to think of an example, so think of HP is creating, HP is selling many printers. So, let us say there are four type of printers. Rather than having four printers created separately, what if I create up to certain point the exactly same thing. Then, when the demand comes, I make some small changes and create four different printers. And HP did it quite aggressively. What they did even that some of their class of printers, if they have like one printer with the features of copying, scanning, printing, one with only scanning and printing, one is only printing, they will actually produce the highest class of printer with all the features, which is the bold line part. So, I aggregated the demand for all different types of printers in that class, and I just produce one. And when the demand for a particular feature comes, I will just switch off some of the features. So, see, the manufacturing cost will go up, but the supply chain cost goes down so much that it has worked wonders for them. And this has helped them in taking over some of the earlier players like Xerox and all. They reduced their supply chain cost so much that they did very well.

Another company which did it quite nicely, Asian Paints. Asian Paints again has a spare part problem. They have many different paints. So rather than creating the final paint and having lot of safety stock and have bullwhip effect, they combine the demand for many of them and they will ready some parts from where you can easily create the paints.

And Zara recently, which is the retail clothing company, did very similar thing in their manufacturing thing. So, this is called commonality across products and postponement. Because I am postponing the final product until very close to when customer pulls from them. So, you have to create commonality and have a postponement. See, this is where goes into the toilet paper example. If toilet papers manufacturing had this substitutability, then life would have been so much easier for everybody during the COVID. We would not be having toilet papers going out of shelves. And then, I talked to some of the CEOs of the company and they basically same problem in every place. So, now we are looking at different perspective. We are trying to switch all these problems. But this commonality and postponement is not unique only to traditional supply chains. In service supply chain, actually it is even more important. How can I combine processes to create more streamline, because in service supply chain, we even have more variability across processes and more safety stock.

So, McDonald's did the same thing. They tried to see that how you can produce each sandwich in exactly same way whether you are buying it in Seattle or whether you are buying in a coast in Florida. Exactly same process. And also, across different kind of

sandwiches, they combine the process. So, they create a lot of commonality and postponement. So, service supply chain, think about how you can create commonality. I want everybody to reflect on this.

Take your industry, take your company and think about how you can do that. If you are able to do that, I can guarantee this itself is worth spending your time on supply chain analytics. This is a gold mine for companies, and we have done many implementation in both traditional and service supply chains using this concept. Very simple idea: you have to look at your data though. You basically make the changes when you are close to your customer. That is exactly what you are trying to do.

I will tell you one interesting example that is happening as ongoing in the industry right now, is called concept of store-in-store. So, I will tell you what is the concept of store-in-store. Store-in-store is a concept, where these retailers are telling the suppliers that, rather than I placing order for you, why don't you manage the part of my store. So, they rent the store space to their suppliers, like Best Buy. Best Buy is one of the companies who have survived all the tides, with Amazon going up. But they have rented lot of space to different suppliers. Companies like Macy's. What Macy's has done; they have created lot of store-in-store for lot of their suppliers. And many such retailers are doing right now. It is happening everywhere in the US, in India, and this whole idea is to remove the bullwhip effect from the process. Because now, I am sharing. They see all data, they manage the inventory, and that is what we really need to think about. How we can do it? Again, we need data, we need coordination, we need to understand bullwhip effect. And analytics is helping in many ways, because this IT is helping us in doing coordination, in tracking inventory, which gives us lot of data, transparency and the value chain, which we talk about, it should be tightly linked to all the accuracy of the inventory information.

Video 4: Supply Chain Optimisation: Example

And I will talk about one interesting application that we did. So, we work with a vendor-built hospital in Tennessee, Nashville. One of the problem with them, their most expensive resource is operating room, because that's where lot of money goes in, and also very critical because would you want to utilise this most effectively because lot of people are waiting for the operating room. So, the question was that when to bring the patient to the holding room, which was before the operating room, so that as soon as the operating room becomes empty, we move the patient there. Now if you bring the patient too late in the holding room, then operating room will be empty. If you bring them too early, that was a complication from medical side. You know, you can't start preparing the patients too early.

Now think about the variability in the process in the operating room. That is one of the highest variability process. I can't go and tell surgeons that you have to reduce the variability in the time. So, what to do? The obvious thing will be can I reduce the variability of the process, like what we did in the postponement and other places. But you know surgeons, I cannot go say that you have to do all the surgery in two hours. So, that is out of question and out of options. So, first thing we did was that all the operation rooms, they were believed to be working, they had 39 of them. And they were

managing their patients separately. So, we told that why don't we create a control desk which is centralised, which basically takes care of which patient will go to which operation room. So, basically, we did aggregation, and when we did aggregation, it is similar idea as what I showed you earlier, it reduces your variance and it reduces our safety stock, which is the time buffer they needed to keep, and it improves the efficiency.

Second thing is about variability. Now, I cannot tell surgeons to reduce the surgery or reduce the variability in the surgery time. But what if I have better knowledge of how much more time it is going to take that can reduce my safety stock and that can improve my efficiency. So, we created an app and gave it to somebody who is in the operation room but not directly working. Always operating room, we were told that as a one or two person who are observers, but they are not actively involved in the surgery. So, we gave this app to the person, and there was something called anticipated out time that they keep updating. And they give us this information in the real time, and we use this information for planning of when to bring the patient to the waiting room. And using this, the centralised decision-making resulted in three-minute reduction in average holding room length of stay and then this app did 10-minute reduction.

So, you can see, and this is big. We reduced the blood loss; we improved the efficiency of operating using the simple concept of supply chain analysis. So, do not think that you need to make cars to apply these things. It is everywhere. Actually, service supply chain has the most opportunity for supply chain analytics because with their variability is high and we have lot of data being collected. So, please keep this vision in mind and we all will do good.

Video 5: Optimisation of Facilities

Now, we have talked about inventory, we talked about transportation, but we also have facilities. Now, facilities is something where lot of supply chain analytics started happening early, because facility talk about where to put your warehouses and so on. But still, it requires a lot of data, a lot of optimisation in there and you also need to look at what kind of service you want to provide to your consumers. And one of the big thing that comes there is like all this e-commerce company you say they are struggling with two-day delivery, one-day delivery, t hour delivery, 30-minute delivery. Now, some of them are even doing 10-minute delivery. So, we really need to understand that how it really works.

So, if you see this graph on your screen, here the X-axis is number of facilities, and Y-axis is response time. Now, what our data has shown, that when the number of facilities increase, your response time first gets a big dip, and then we see the slow decrease. It is very much like when you open a new highway lane. So, let us say you have one lane, which always gets congested with accident and all. If I make it two lanes, then I will see a big advantage on that. My response time will reduce significantly, or congestion will reduce. But, if I make from two to three, the advantage will not be the same. Same thing happens here; initially it is a reduction, but we need to have a supply chain view. We need to look at the cost, not just of the response time or one cost, we have to look at all of them.

So, there was an interesting study done on e-commerce delivery in US. And we told that, if you want to have three-day delivery and based on average e-commerce data, it required five distribution centres across the country, for this player for which this study was done. So, they needed five distribution centres across the country to provide threeday delivery in almost the whole country. But, when they moved from three-day to next day delivery, this five became 13 distribution centres. See, exponential increase, same as the graph I showed you. And when you move from next day delivery to same day delivery, then it became 26. So, that is exactly what the graph shows, that it is exponential growth in the number of facility or initially the advantage is a lot but later on the advantage is not big, so you need to have lot more. So, that creates a problem. That's why we need to have very granular data to do all this facility location.

But the graph here on the screen you see, this is very interesting. Now here, when you increase the number of facility, your inventory cost first increases a lot. Because if I go from one facility to the other, almost I have to double my inventory. Because in both places, I have to keep the total inventory because I cannot say that this place I will keep this, this place I will keep this because I have only two. So, initially it increases a lot, but later on when I have lot of warehouses then I can do optimisation based on my data for a certain distribution centre, that is what Amazon does. So, Amazon takes the data for the local location, and they decide that what inventory or what assortment will go in that distribution centre. So, that is why the cost starts flattening. It does not increase. If you look at transportation cost, that is always more complicated, because you have to have a in traffic to facilities and out traffic from facilities. So, initially I have increased facility, I reduce my transportation cost because now I can go to the local ones. But if I have too many, then I see the sudden growth in that. So, now you have to look at the inventory cost and transportation cost. There is a facility cost, which first linearly increases, but if I have too many of them, then I have to go to prime areas, that is where the facility cost, see there is little bit of a jump when the facilities are too high. When I put all of them together along with the labour cost, labour cost usually follow the piecewise function model, where that there is a linear increase for some time because if you have more labour it will increase but then there are jumps because, then you move to the next price bracket or next salary bracket. So, it is a piecewise linear function we have but we have to have a supply chain view. So, I have to look at the total cost combining all of them. And that usually have a shape of it goes down with the facilities, then it goes up. So, when I optimise my total facility, I have to look at the point which is good for me, but we do not always go for lowest cost here. I also have to see what kind of service I want to provide to my customer.

So, here in this graph, you will see that the service level also keeps increasing with facilities, but it tapers down. So, you have to find a good balance of your cost and service level that gives you the most benefit. So, I take all this data, do this graph and then I look at together with what I can provide. That depends on what your customer wants and also what competitors are providing. So, you do not want to provide too high level of service or too low.

Now, I will give you one example of Dell. Dell, you know, interestingly at one point of time, they started giving customers the option that you can choose the colour of different

part of the laptop. The keyboard may have different colour, bottom may have different colour, top may have different colour. And they realised that, when they give this level of service, their inventory cost went up because then, it is a reverse of postponement. You have to estimate the demand for each of them, but customers maybe did not care about it. So, you give very high level of service, customers do not care. Then, it is not optimal for you. So, they tried back on that, and they decided to do that. So, another thing, Dell had a very good supply chain system, and they essentially were asking all their suppliers to keep items in Austin, where their assembly line was and then they will pull the item whenever it is needed for their purpose. Very good, you know, just in time. But at some point, they started focusing more on their own cost, rather than the supply chain cost. So, not sharing information, giving over estimate of the demand, that blew up their supply chain cost. So, all this coordination and looking at the supply chain view is extremely important. And then, when we go to all the regions where we should have facilities that also depends on factors like, what is the tax in the area.

See, there is an interesting thing in supply chain, which is related to accounting, it is called transfer pricing. So, in transfer pricing, essentially, if one unit of Apple buys item from another unit of Apple, then they have to pay money to them. And the money should be paid based on where this value was created to value for this for which you are paying. But where customers will pay the most value? Where the corporate tax is the lowest. So, nobody wants to show the value in the US because US has one of the highest corporate tax rate. So, they will do in places like Dubai where you don't have to pay lot of taxes and that changes supply chain structure. Now, for those kind of problems, they are regulations like arms-length transaction. Now, how do you create the market price. Apple had another very interesting thing that Apple had lot of items which is unique to Apple and that deliberately they have done that. So, you cannot create the market price for that, and they can play around with the taxes. They are well known to play around with the loopholes. Not cheating, play around with the loopholes.

Video 6: The Future of Supply Chain and Value Chain

We will now focus on little bit future of supply chain, and where we are going from this point. What we need to be careful about, what we need to think. One of the technology that has a huge value to fill lot of pain points in the world of supply chain, is block chain. Blockchain is getting implemented in many supply chains now. But blockchain, many time people think about it will increase transparency, it will reduce fraud, but it has lot more implications for supply chain analytics.

So, for example, Walmart in 2019, they gave an ultimatum to their lettuce and spinach suppliers to join blockchain. Very similar to what they have done with RFID implementation in early 2000, where they mandated their supply chain partners to implement RFID, and they worked with the whole supply chain—farmers. They worked with the logistic firms, all the business partners, and they partnered with IBM to make this implemented. And IBM has a Food Trust blockchain, where they have partnered with other companies. And using that, now, they are trying to put this lettuce and spinach supply chain on blockchain. Now think carefully here. First thing is that, why lettuce and spinach? Because that leads to lot of E. coli and food contamination. Whenever it

happens, tracing back to the source is very difficult. It takes lot of time. We recall lot of stuff, we waste lot of time, lot of money and lot of health issues. Now, with the blockchain, it will be lot more efficient and do it on almost real time. So, that is one part.

Second, it will generate lot of data that can improve our supply chain analytics. So, transparency and efficiency comes.

Third piece is that they can provide newer type of service to customers if they want. Customer can go and scan item, and they can see all the images, videos, process that happen in the whole supply chain. There's a potential of that happening, and we should not look at from the perspective of technology. We should look from the perspective of pain point solving and the future potential. It is used lot in pharmacy supply chain. Almost all of those pharmacy companies are looking at that because it can reduce fraud. It is even used in the supply chain of payments.

Bajaj's Electric is using for making the payments through blockchain. Meat traceability: Walmart did it even before all these things with lettuce and spinach. In China, they did it for sales of pork. That's another place. Cold chain monitoring: that's another place where blockchain is very important. So, some of the large pharmaceutical companies, when they sell critical drugs, the customers get a critical drug, it says that it has to be stored at this temperature and this humidity. But how do the patients know that during the supply chain it was always kept at that temperature and humidity? Now, you will think that in the supply chain, well, if something happens, somebody will report; does not always happen. So, lot of this large pharmaceutical company, for critical drugs like cancer drug, which requires special treatment, they are already putting them on blockchain. And these readings can not only be just be stored, if anything deviates, they create a trigger using smart contract, which is part of the blockchain. And either it can be discarded or changed the due date. And think about the data it is creating. So, we have to think of supply chain from the perspective of where it is really creating value. The real value is coming wherever we can eliminate demand and supply mismatch. And that's what lot of these two-sided platforms have done over time. They have essentially removed the demand-supply mismatch.

For example, think of Amazon and Netflix. So, what did Amazon and Netflix really do? Netflix saw there was lot of demand-supply mismatch on what people want. See, Netflix really made their value or disruption, not just by having an online model, that was part of it, not just having a subscription model, that was part of it. The bigger thing was that they created new demand for small budget movie, by looking at their data. So, they looked at the data and realised that people have interest in that, and they started changing, recommending these movies in their recommender system, again, using lots of analytics. And then, companies like Blockbuster did not understand how to deal with it. It became very difficult for them to deal with the situation, and they went bankrupt. Because they neither have that skill. They neither have data nor the keen skill for analytics. Amazon, they did the same thing. They both created long-tail economies, which means that there are many products which have very small demand. But there are many such products, like low budget movies. There are many of them. They are very low demand. If I can collect the data, and I can see who is interested in what, which

one of these many products, then I can offer it. That's the beauty of supply chain analytics. So, these companies have really made this happen. Actually, if Netflix had not done this disruption, most likely we will not see the web series, which is so popular right now, even the content is now created based on the data, forget about just the recommendation.

So, we all need to think about how in our industry we can make this happen. We have to look at the bottleneck in our industry, where is the supply-demand mismatch and how we can use supply chain analytics to bridge that gap. Amazon has done this; Netflix has done this. They are not the only companies. Uber has done it. There was a mismatch in supply demand. People wanted taxi, no supply. Airbnb, classic example. There are many hotels in downtown, but no in suburban area. But the companies like Microsoft, they were in suburbs of Seattle. You needed place and they flourished. Fresh Direct, which has led to many grocery delivery companies now. Khan Academy: very good example where Khan Academy essentially created the gap between demand supply in the academic world. So, you have to look at the bottleneck in your industry and find out all this industry-wide efficiency. Use the data and see how you can use technology to bridge this gap. Using all the supply chain analytics, you can even have a two-sided platform. But this is always a complex problem. If you create a platform, both sides have to come. Like in Airbnb, if there are no guests, there will be no host, there is no host, there is no gap. So, you have to think carefully on that.

And, I have worked very closely on this whole supply chain analytics with a company called Insightzz, and if you go look at some of the videos on the website we have posted, some videos are fantastic. So, I think that if we all keep that perspective we can make big difference.

Companies like Amazon have used this data to different layer. If you think of their 30-minute delivery, you know how it works? In 30-minute delivery, in their warehouse, they just don't store the items at one place, like one type of item is not at one place, they mix the item. Now, their system knows where the item is. But they use the data to see which items customer order more often from this warehouse or this distribution centre, and they put items together. So, the assortment is based on what kind of items are ordered together, and that reduced their delivery time drastically. They have also used lot of robots now. There are more robots than human. They opened the largest warehouse recently in Delaware. Now it has been some time, but this was the largest one. They are also using lot of vision-based system to improve their delivery system. That is one side of it.

Other side is lot of drones type thing for delivery. That is also changing the whole supply chain in analytics. So, we have to see that Amazon came with this idea very early on, but now we are seeing that lot of delivery companies are using. Domino's started delivering their pizza in Houston using these drones. Autonomous vehicles, they just go and deliver, you open and get your item. And these kind of things will change supply chain analytics very differently.

Another thing. Lot of data is being collected by eyeball tracking and those kind of things and think about how you can collect those data and use it in a responsible manner. That

is another thing very important in supply chain analytics, that we collect lot of data, but we have to think about how we can maintain privacy. How we can maintain regulations. Even sometimes, you may be legal, but you have to be ethical. Whole thing basically, if we keep our holistic view in mind, I think we all can make a big difference, not just from the perspective of supply chain but also from the perspective of changing society, improving society. We need to change our data collection process, analysis process, mindset and think about the bigger picture, not silos.