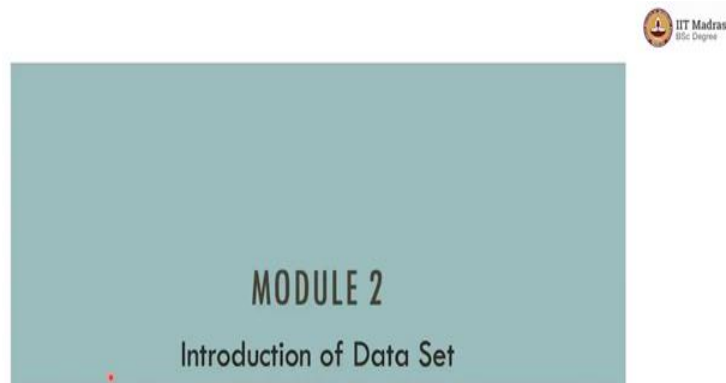**Business Data Management**
**Professor G. Venkatesh, Dr. Milind Gandhe, Mr. Siva Kumar Padmanabhan**
**Indian Institute of Technology, Madras**
**Introduction to the dataset - sales, production and inventory**

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Professor Milind Gandhe: So, maybe it is a good time now to start looking, Siva, now that you have given us this broad overview, maybe a good idea to start looking at a dataset.

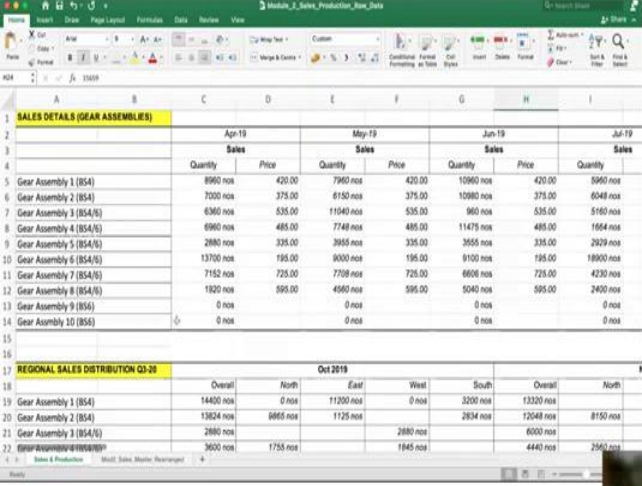Professor Siva Kumar Padmanabhan: Exactly, fantastic.

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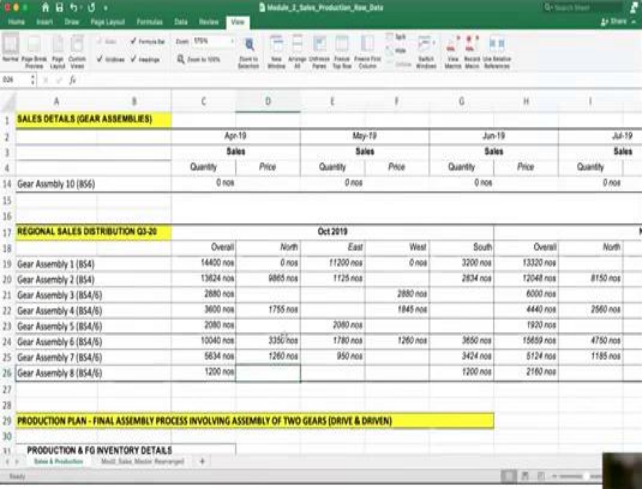Professor Milind Gandhe: GV, we will have Siva walk us through the data?

Professor Milind Gandhe: I will open the Excel.

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Professor Siva Kumar Padmanabhan: Perhaps we can start, as I said, we are going to go from the customer backwards, sales backwards in the value chain of the company. First thing we look at is the sales information. This is basically how much of the product was sold and at what price was it sold and, during each month. All this data, most of this data is available for the entire 24 months, so from April 2019 all the way to March 2021 to show all the different impacts that

happened the BS4 to BS6 transition, the impact of COVID, the recovery from COVID, and so on, so forth.

What you see in the sales data is, as I said, the 10-year assemblies, which are the finished products that ACE is selling. And for each of those year assemblies, you will see the sales for each month. For example, what you are seeing right now is the April 2019. It shows a total sale of that gear assembly, the numbers up to 8960 units of that finished product was sold, and the price at which it was sold 420 rupees that was the price that it was sold at and so on. You will see from May 2019, June 2019, quantity, and price for all the months, the 24 months. That is the first dataset that you will see.

And when you see this dataset, I think you will see the impacts that we talked about in the sales, you will see that the products number one to the BS4 parts, you will see that there the sales of those products. One of the things that I want you to analyze is what happens to the sales of those BS4 products as the transition to BS6 happens on April 1, 2020. That is the first question. And then you will see that the parts number 3 to 8 they are applicable for both BS4 and BS6, so that means that gear sales are not going to stop just because of BS4 or 6. But can you see some seasonal pattern in the year? That is my second question.

Seasonal pattern means at some point in the year the sales is high and then another point in the year was sales is low because we have 2 years. We can start to see potentially some seasonal patterns. My second question is, are there any seasonal patterns you see in the sales data? And then the last set of products is the BS6 products, which initially you will see 0, because BS6 is not kick in till the April 1st, 2020, and then you will start to see their sales. The question on that point is how, what is the pattern of sales of these BS6 products? Did they, when did they start selling and why did they start selling at that point, when you did see their sales start? That is the third question.

The fourth question is what is the impact of COVID on the sales of these products? As production actually and sales slowed down after the pandemic struck in March 2020, what kind of impact are we seeing from the pandemic through the next several months as a first wave hit and then we see that what kind of impact do you see in the sales of these products? That is another question I have. And I also want to find out some things like what are the products that are giving me the highest sales quantity and what are the products that are giving me the highest

sales value. Value means revenue, which means not only that if you multiply the quantity and the price and that is when you get the sales value.

Which products gave me the best sales value that I should pay more attention to, because I obviously want to pay a lot of attention to products that giving me a lot of revenue. I want to make sure that there is no shortage of those products and so on. Those are other questions I have on that first table. What is the product that is giving me the maximum revenue, what are the products that are giving me the minimum revenue, which means I might rethink whether it is worth selling those products in the next coming years? Those are some questions I have on that first table you see.

Professor Milind Gandhe: Next table seems to be more from a regional perspective, I see. Maybe you can help us understand this table.

Professor Siva Kumar Padmanabhan: Yes, absolutely. What we then say is because ACE gears sells in all four regions of the country, and automobile clusters are there as you know in multiple parts, so around the best like the Mumbai, Pune, especially, you have a cluster of manufacturers and in the south, of course, Chennai is the Detroit of India. There is a lot of manufacturing activity, also east and north where significant activity happens for companies such as Tata Motors and Mahindra and so on.

The regional sales distribution is given for just three months and is given only for the 8 products in this case, this because, of course, the products 9 and 10 were not selling in that particular three months we looked at October 2019, November 2019, and December 2019. This is called the Q3 of the financial year '20.

For each of the three months, you will see for the eight products that were selling at that time. You will see the overall sales, but you also see in which region how many units of that product sold. You will see north, east, west, and south. If you take gear assembly 1, for example, in October 2019, it sold 14,400 units. And most of the sales came from east and south, so 11,200 units in the east, and 3200 from south. There were no sales north and west for that unit. That could be because that assembly is used by a particular manufacturer who only has factories in east and south that could be the reason for that.

And similarly, you will see for all the eight gears what is the regional sales for each of the 4 regions. That is what is there in this table. And in terms of questions around this table, I want to understand which regions are most important to me, where is that I am getting the maximum sales quantity, but also the maximum sales revenue. Now, you must look at both tables to figure out the revenue side of it. That is one part I want to find out.

And then I also want to find out, is there, I could, for example, I could give specific focus to some regions by appointing a regional sales agent. What these regional sales agents do, is they are stationed or located in that region in one of the cities and they are make sure that, they will make sure that the customers in that region get regular with it, their feedback is incorporated, the schedules are clarified and so on, then the agents can help improve customer relationship and also improve the sales.

If I want to appoint a few agents, then which region should I appoint these agents in and then how many agents should I appoint in each region? If I want to appoint an agent in such a way that it is somewhat related to the amount of revenue I am making from that region. Every region in which I am making more than certain number of products are sold or revenues gathered, I want to appoint those agents and I have a fixed budget for how many agents I can appoint, then how should I appoint those agents? Which region should I appoint more, and which region should I appoint less? That is another question that I would like to have.

And then I would also like to see are there some products that are clustered in some region, some products are only in certain region, some products are only in certain other region, is there a pattern like that? Those are some of the questions that I have from a regional perspective.

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Professor Milind Gandhe: Then the next table seems to be, I have, let me unfreeze this, and now let us look at this table. Okay.

Professor Siva Kumar Padmanabhan: Now, this one is about production. So, we talked earlier in the case study how, based on how much you are selling, you want to start producing enough so that you do not miss any sales. You have enough product to sell depending on the customer demand.

If the customer is demanding 10,000 then if I have only 9000, I am going to lose the 1000 of sales. Basically, I do not want to do that. I want to make enough so that I can satisfy all the demand that is there. But I do not want to make too much because if I make too much, then that product will lie idle as inventory, either with me or in the regional distribution center or somewhere. That is also not good.

Another thing that is important from a production planning perspective is you do not want production to go up and down as much as the variation in sales. Sales may suddenly peak in one month and drop in another month, because there are many factors. Like for example, if there is a strike, a labor unrest in a car manufacturer's factory and as you all follow the headlines, Toyota had such a major unrest in 2019, for example, that they had to shut down the factory for several months.

Then what happens is, suddenly your demand from your customers going to drop in one month or it could be a new model that is getting launched by that manufacturer, and initial months you have very high demand, because customers are just trying to get their hands on the product as quickly as they can. A recent example is Mahindra where they introduced the new Thar, the Thar SUV and the demand is so much that even if they produce for one whole year, they cannot catch up to the waiting list. Those types of things happen when the demand is fluctuating a lot.

But you cannot flex your production, you do not want to change your production so rapidly, because then you mean, then it means that number of labors will be idle for some time, and suddenly they will be overworked, and we would not have enough labor. What do you want as a production that is smoother? It should be responsive to demand, but just not be as much jacked, going up and down rapidly, like the demand. You must have a production plan that is smoother and follows the sales plan.

What you see in this table is for all of the 10 assemblies that we make, you will see the thing called beginning inventory, which means at the start of the month, how many of those products were already in my store, finished goods store or in my warehouse, and then you see how much was actually produced that month, then you will see the ending inventory, which is at the end of the month how much products do they have on hand, at the end of the month.

For every single one of those months, from April '19 to March '21, you will see the beginning inventory of the gear assembly 1, for example. You will see how much of gear assembly 1 was produced that month. And then you will see how much of the inventory still line with me at the end of the month. And I think as you can logically imagine the ending inventory, the inventory that I have at the end of the month will be equal to how much did I have at the beginning, how much did I make, and then how much did I sell.

Logically, you can put those three things together to find what is the ending inventory. And so similarly, you will have that data for all the 24 months for all the 10 products. So, that is what you see in this table. One thing you will see is that production does vary. So, if we look at gear assembly 1, we produce 7000 in April, we increased to 9000 in May, and then we kept 9000 for some months, and probably then we start decreasing or increasing depending on the customer demand. You see that 10,000 in September and so on. There is a pattern to this.

But if you see the same gear assembly 1 in the previous table, if you see the sales, if I can go back to the first table on the top, you see the sales of gear assembly 1 it was 8960, then it fell to 7960, then it suddenly increased to 10,960 and then 5960 and so on. You see that there is a lot of ups and downs in the sales of the product. But production is also going up and down. But it is not going as rapidly up and down.

And this is the job of the, what we call that the sales and operations planning that we saw on that chart earlier that says, how is my sales going to behave, and therefore, how is my production should look for each month. The sales and operation planning and the market production scheduling, which is the next step we saw. These two activities will make sure that we produce the right amount and that we produce it in a smooth way and not so up and down as much as the sales.

Professor G. Venkatesh: Siva just for my understanding, I mean, do I understand that each gear assembly is manufactured by a different machine and has different, as people associated with that manufacturing, because the reason I am asking that question is that we are trying to smooth each row and we are not taking the total and smoothening the total right?

Professor Siva Kumar Padmanabhan: Yes. That is an excellent question. We should also be smoothing the overall production. So, that is also what NPS tries to look at, like what is the resources available. So, to your question, it is all shared. It is not dedicated lines. You will see later in the production scheduling part of the case study that the same hobbing machine is used to make two gears in different ways. Yes, it is all shared. And the goal is, like you said, to smooth not only one product, but to smooth the entire system.

Professor G. Venkatesh: Okay.

Professor Milind Gandhe: Two observations I had Siva. First is, this table that you have shown us seems very similar to the ledger that we were seeing in the e-commerce case, because there what we saw was that opening stock plus incoming goods minus sales was equal to closing stock. And it seems to me, at least at first glance, that you are looking at something similar here.

Professor G. Venkatesh: Except that I would, the only thing is that their incoming can be anything. Variation incoming is not a problem there. But here it must be smooth, because for whatever we discussed just now, production needs to be smoother. You cannot just have variability in production.

Professor Milind Gandhe: The second sort of thing that immediately strikes me is that if production is smooth and sales are sort of variable, and the amount that I have in my warehouse will keep changing constantly actually. It will have big shift, big swings and that would be another challenge perhaps for the warehouse manager to manage.

Professor Siva Kumar Padmanabhan: Yes, absolutely, Milind. That is very true. And that is the role the inventory plays slightly. Inventory is both bad and good or good and bad. The bad aspect of inventory is, if you have a lot of inventory, then it is idle products, it is locked up capital, it is not actually being used in the, further in the value chain. But the good part of inventory is that it helps you to do the smoothing. It makes sure that your sales do, your production does not exactly match your sales, because you can dip into the inventory when you need more and if you are producing more you can add to the inventory.

But as you said rightly the inventory is a very important thing to manage the store, the space that is required and the security that is required to manage the inventory, the warehousing, and sometimes some production, like we know in the case of vaccines, now cold storage is required, not in this room this kind of product, but those things are all part of the inventory management is do you have the right storage, do you have the right conditions, ambient conditions for storage, do we have enough security and control over the inventory. So, that is very important.

So, one of the questions that therefore I will have in this is how do you manage inventory from a warehouse manager perspective? How much is the maximum and the minimum? And therefore, what kind of percentage variation I am having in that inventory over the 24 months? So, how big a space should I take, like or should I, what is the level of variation that you see in the inventory is an important question in this exercise.

Professor Milind Gandhe: Siva you have given us the inventory data as well. And to me at first glance it seems very similar to the production plan. What is the difference between the two? Maybe you can explain this table and tell us what is the difference from the production?

Professor Siva Kumar Padmanabhan: Yes. So, the first table we just saw was the, is called the production plan for the finished product. If you think back on that slide, we saw there is two stages in this production. First, we must take the blanks and we must make the gears. And then we must assemble the gears together and test and pack and ship it. These are the two stages.

What you see in this table, here on the screen is the finished product assembly production plan. So, that means I must make 7000 assemblies in April 2019. That is what you see there. But to make 7000 assemblies, I need to have the two components available to make the assembly. So, what you see in the below table is the plan for the first stage, which is how do I make the two gears and how much do I make each month so that I can then create assembly in the second stage.

What you see here is the gears 2-A, 2-B, 3-A, 3-B and so on, so these are the gears required to make the assemblies 2, 3, 4, 5, and 6. So, we are showing the 6 just for the sake of managing the amount of data. For each of those assemblies there are two gears that are required. And what is the production plan for those two gears? So, this is how we go level by level.

We start with how much should we produce for finished product; how much should we produce at each of the sub-assemblies and how much should we produce of each of those parts and so on. What you see here is the production plan for the individual gears themselves because the hobbing and broaching are the two steps required to make the individual gear. And then the assembly is the next stage where we put the gears together, test it and aligned it in packed little chip.

Professor Milind Gandhe: That, then my natural question is, what is, what was the term that you used the bluff material?

Professor Siva Kumar Padmanabhan: Yes, here we are seeing the bill of material in action.

Professor Milind Gandhe: And that should be a little bit of comfort for us with perhaps because then from a purchasing perspective I can smooth out the purchases because the same blank is being used into products.

Professor Siva Kumar Padmanabhan: Absolutely, absolutely. Even if you have, let us say, more demand for 3-A but at the same month you have less demand for 4-A that means you do not have to change your purchasing of blank 011 because there will be more use in one place and less use at another place. So, the more we have common components, the more you can smooth your production and make the product structure less complex. And this is the reason that automotive manufacturers go for platforms, the strategy of platforms.

If you look at many cars, they can be built on the same platform. So, for example, right now the Volkswagen Group is launching a platform called MQB A0 IN in India. And on top of this single platform which uses common components in the chassis and common engines, they can make a SUVs, they can make compact sedans, they can make midsize sedans, they can make hatchbacks so all of these and the strategy behind that is exactly this, you have fewer components, you have fewer of assemblies on which you can build multiple different types of products.

Professor Milind Gandhe: Very, very interesting. Siva all the other Excel sheets have the same data, right? There is no other raw data.

Professor Siva Kumar Padmanabhan: Yes. There is one more aspect. So, here we are seeing the scheduled production of finished product, sales of finished product, then regional sales, then we saw the production of finished products, then we saw the production of the gears themselves and then there is the aspect of scheduling which is shift by shift how much do I need to make in the hobbing machine and in the broaching machine. That is the data you have not probably seeing it and then there is also data on purchasing.

Professor Milind Gandhe: Okay.