Business Analysis for Engineers
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Lecture-21
Inventory Management

Last class, we familiarise ourselves with, the economic order quantity, which gives some insights, on what should be the actual level of inventory, that needs to be maintained. And, how inventory as a cost is with very critical, when we actually understand the concepts of budgeting. And, to that extent, how a proper inventory planning model, would help in reducing the associated cost. So that, the actual cost, is in line with the budgeted cost. As a result of which, the variance is zero, or as much as possible, the variance could be minimised.

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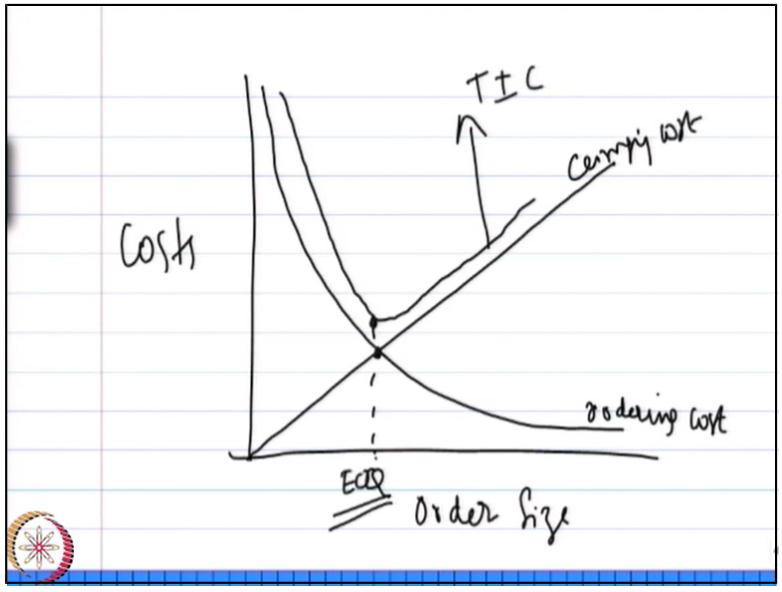

The graphical illustration of the model, that we saw last class, related two variables. That is the, inventory order size, and the costs associated with the ordering. And, we saw that, there are two types of costs, that are associated, when it comes to inventory. One is the ordering cost itself, which decreases, as the order size increases. And, the other one is the carrying cost of the inventory. So, if you look at the relationship, we saw, the ordering cost, and how it behaves with order size. And, the carrying cost, and how it behaves with the order size.

And, we found that, at this point of intersection, is where we find the total inventory cost, which is the carrying cost + the ordering cost, is minimum. Which means, we found that, if this is a representation of the total inventory cost. Let us say, this is total inventory cost. This is minimum at this point. And, the order size, that corresponds to that point, where the total inventory cost is minimum, is what we saw is the, economic order quantity.

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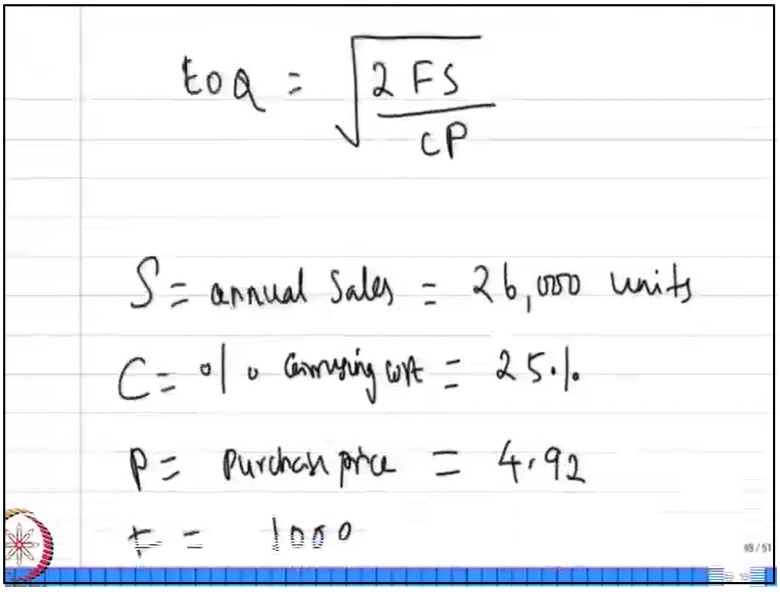

And, we related the economic order quantity, with the formula, which is two times FS by CP, where EOQ is the economic order quantity. And, F is the fixed cost of ordering, placing and receiving the inventory. S is the annual sales. C is the annual carrying cost, which was in our example represent as a, percentage of the average inventory value. And, P is the purchase price, that the firm pays, per unit of the inventory. So, this is how, the economic order quantity was related, to these four variables.

Now, before we proceed further, I would like to understand this model, with the help of an illustrative example, that broadly covers various special cases. And then, we will understand, how there are different concepts, that are associated with the economic order quantity. For example, we made an assumption that, we are basically trying to plan our inventory on a very pragmatic approach, either based on historical experiences of handling inventory.

As a result of which, we know that, this is the carrying cost, this is the ordering cost. And, the

annual sales, is this much. So, the average expected inventory, is this much. And, we found this relationship, based on which, we found the economic order quantity. Now, using the same formula, with some numerical examples, let us just try to understand, with a few more additional concepts. Let us say that, the situation is not as simple as, the formula suggests.

Let us say, as an entity, I need to also have something called a safety stock. Safety stock, to meet sudden requirements, a surge in demand. Or, let us say that, inventory is not just easily available, that I place and order now, and then immediately I get it tomorrow. Let us say, there is also a lead time, for me to get the inventory, from the time that I order. Now, if these two are the additional dimensions, that need to be factored.

Now, how will that change the inventory planning, or how will that change the order quantity. That, we will understand, by taking an example. And, I will use a numerical example, so that the numbers, give you a better understanding. Now, let us say, S, which is the annual sales, is around 26,000. Let us say, we are talking about, textile unit. So, I am selling around 26,000 shirts, let us say. So, the annul sales is 26,000 units.

Now, C, as I told you, it is a percentage carrying cost, which is expressed as a percentage of the inventory value. And, let us say, that is 25%. Now, P is the purchase price of one unit of the inventory. Let us say, it is 4.92 Rupees, per unit of inventory. And, let us say, the fixed ordering cost is 1000. So, for every order that we need to place, the fixed ordering cost is 1000. Now, these are the numerical examples. Now, let us begin with the fundamental equation that, economic order quantity is square root of 2 FS by CP.

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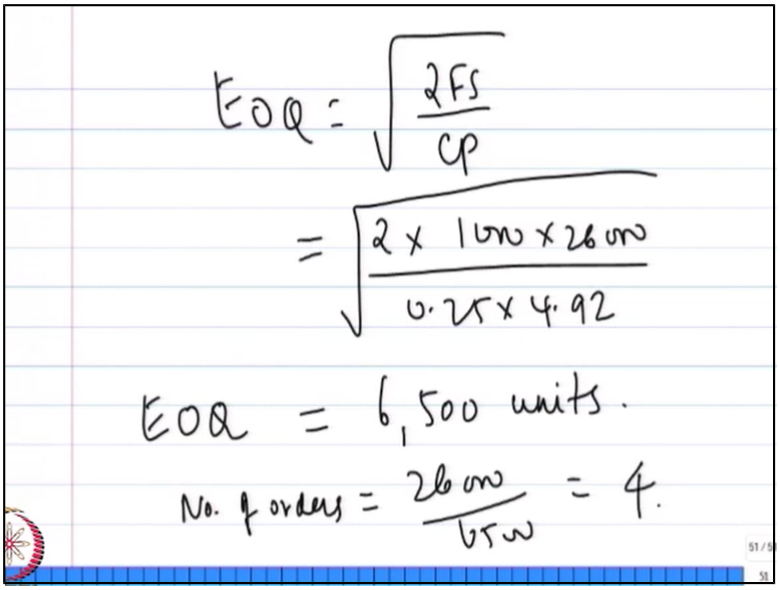

Now, the question is first, let us calculate the economic order quantity, for this entity, whose annual sales is so much, the ordering cost is so much, the carrying cost is so much, and the purchase price is 4.92. Fitting it, into this formula, 26,000 was the annual sales, 25% times 4.92. So, the economic order quantity is 6500 units. So, it means, for an annual sale of 26,000 shirts, that we assume, that this entity is going to make, and with an economic order quantity of 6500, the next data that we can arrive is, the total number of times, that we have to place an order, during this period.

And, assuming that, each of the order is equally sized. Then, the number of orders that we are going to place in one year will be, 26,000 by 6500, which is very simple, 4. This is one data point. I am just trying to present you, various data points. So that, let us see how, we can get more information, using this simple formula. And, how a different circumstance, using the same formula, how we would plan our inventory in a different way. So, we know now that, we will be placing 4 orders, in a given particular year.

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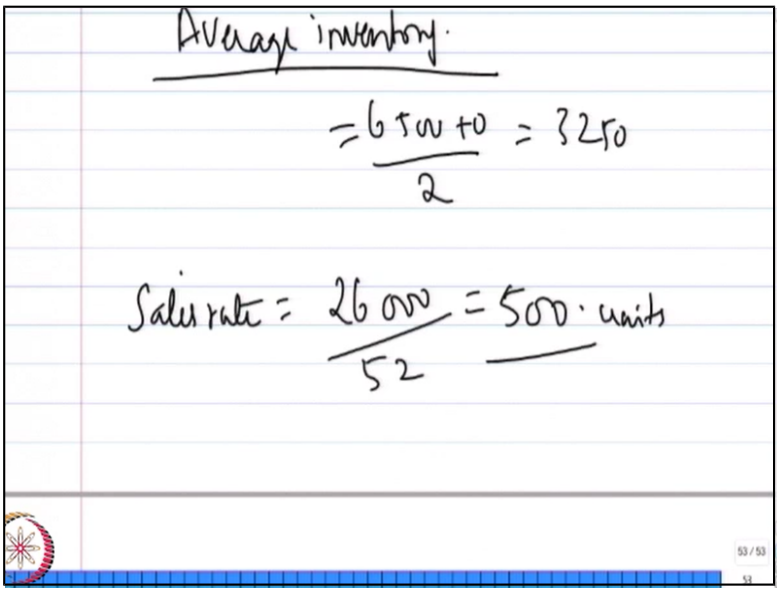

Now, let us next go to average inventory. What is average inventory? We are assuming that, the inventory consumption is uniform. Which means, the average inventory, at any point of time between two successive order points, is the opening inventory + closing inventory divided by 2. In this case, at every time, that we order. And, every time, we receive an order. So, let us say, at the time we receive the order, in this case, 6500 units are there. And then, it is uniformly used. After which, it reaches zero. And then, we order again. Again, we get 6500 units.

Now, the average inventory in this case would hence be, just 6500 divided by 2. Why because, it is 6500 + 0 divided by 2. Now, this assumption holds good. Because, we are assuming that the inventory is consumed, at a uniform rate. Now, let us say, the sales is also uniform. Which means, if I need to calculate the sales rate, then for year which has 52 weeks, I would be selling around, 500 units every year. This is another data point. Now, we know that the purchase price of an inventory is 4.92. And, the average inventory is 3250.

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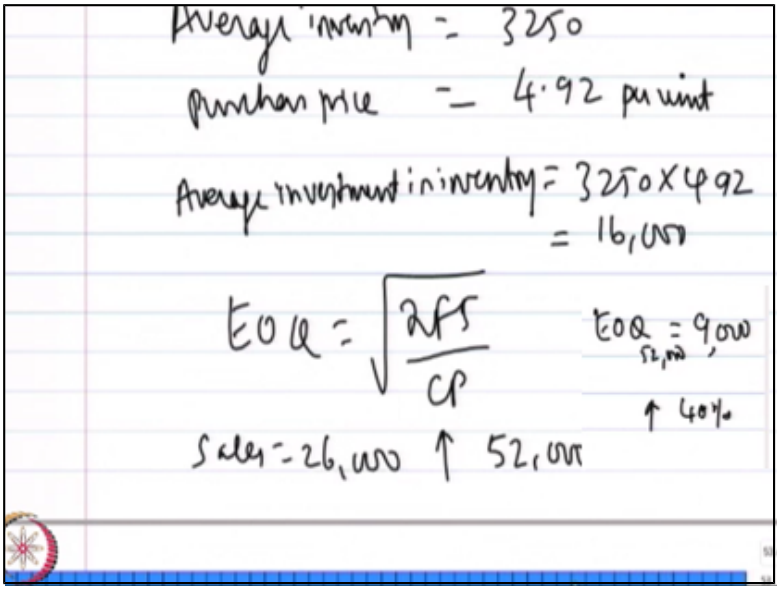

Average inventory is 3250. Purchase price is 4.92 per unit. Now, let us bring in a little bit of working capital. Remember, when we dealt with accounting, I was telling you that, there is something called working capital, which needs to meet the immediate requirements of financing, not long-term, but more short term. In this case, this is a classic example for a working capital requirement. Which means, I need around 3250 units of inventory. And, when the purchase price is 4.92.

It means, that the average investment, that I have to make in purchasing inventory, is 3250 into 4.92. So, the average investment in inventory, will be 3250 times 4.92, which is 16,000 Rupees. So, let us say, this working capital requirement, I am financing it through a bank loan. So, suppose I am doing a working capital requirement analysis. I need to forecast, what would be the working capital requirement. This, gives me an understanding, that the average requirement is 16,000.

Or, it could be as high as 32,000. The 3250 is the average inventory. But actually, the peak inventory is 6500. As a result of which, the working capital requirement will also vary, from the highest possible 32,000, which is 6500 into 4.92, to as low as zero. Which means, I do not need any working capital. So, if the question is, what is the average working capital requirement, it is average inventory times, the purchase price.

And then, based on that, we would come to an understanding that, this is the average working capital requirement. And then, the cost of financing that working capital, is also calculated. That is again, a different subject matter by itself. But, this is just to give you a data point, that with average inventory, I can also calculate my average working capital. Or, in this case, the average investment that is required in inventory, which is 16,000. Now, you should also notice, one more relationship.

The EOQ, is square root of 2FS by CP. So, we will understand that, with a given increase in sales, will result in a less than proportionate increase in inventory. It is because, the relationship between the EOQ and sales, is not directly linear. But, it is a square root relationship. Which means, let us say the, sales which is 26,000 now, increases to 52,000. Let us say, there is 100% increase in sales. Now, the sales increased by 100%.

And, since this is a square root relationship, you will understand that, the economic order quantity, will not increase by the same 100%. But, definitely will increase. But, the increase is less proportionate than 100%. Which would be, if you calculate the EOQ at this sales level, the EOQ at 52000 will be, somewhere around 9000, which is close to another 40%, let us say. 40% increase in EOQ. So, 100% increase in sales, results in a 40% increase in the economic order quantity.

And, also the average inventory, that is also required, will rise by the same percentage. Now, you will understand, when I was talking about the need for maintaining economies of scale. Now, this example suggests that, the economies of scale, when it comes to holding inventories, makes a lot of sense. Because, the relationship between the economic order quantity and sales, since it is not linear, but through a square root. It means that, the economies of scale will help, in reducing the total inventory cost.

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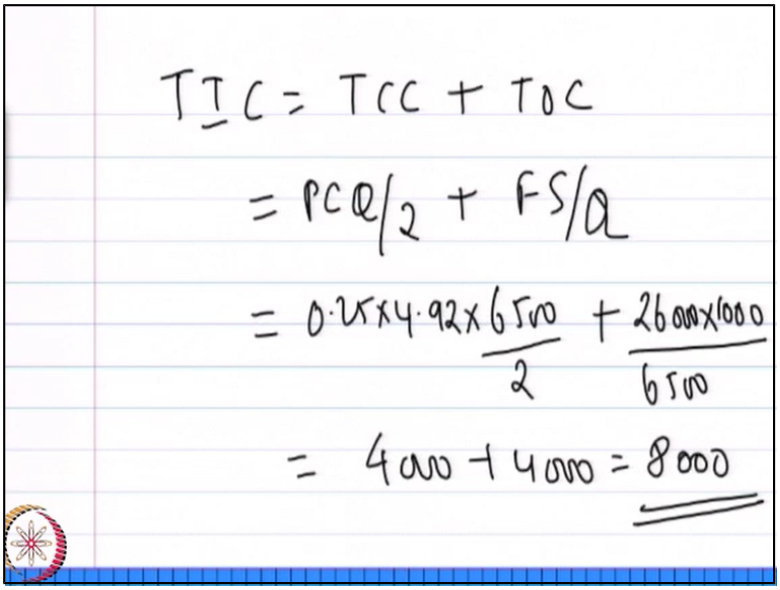

Now, let us just split this, total inventory cost, as we saw in the previous class. We know that, it is a sum of, the total carrying cost + the total ordering cost. And, for the same example, we are expressing the total carrying cost, in the total ordering cost, based on the data that we have, and substituting the value, at economic order quantities. So, Q is 6500 + 26,000 in to 1000 divided by 6500. Now, notice here, that the total inventory cost, at the economic order quantity is 8000.

Now, this 8000 could be, 2000 + 6000, or 3000 + 5000, or 4000 + 4000. But, it is necessarily 4000+4000, in this case. Because, Q here, is the economic order quantity. And, this is no rocket science. Add economic order quantity. Because, our total carrying cost is equal to the, total ordering cost. This 8000, has to be necessarily be split into, 4000 and 4000 each, for ordering and carrying cost. And, this is true in all examples, where the total ordering cost, and the total carrying cost, will be equal, at the economic order quantity. And, that is what, I just illustrated, in this example.

Now, in reality, things are not as simple as, this example suggests. I told you in one example that, suppose, I order an inventory. And, it is going to take 2 weeks for me, to get the inventory. So, after I make in order, let us assume that, I have to wait for 2 weeks. Then, as somebody, who has to plan the inventory, to ensure that the inventory is available just at the time, that it is required, we need to have some trigger points. The moment, the inventory level falls to a certain level, there is a trigger, and hence we order the inventory.

So, that should be something called an, inventory ordering point. Now, this is what, a lot of people, who do the inventory planning, will set, based on their requirements. Now, let us say, in this case, since I told you, it is a 2 week lead time that is required, for inventory to arrive. Which means, this 6500 order quantity, that I expect, will take 2 weeks, for it to arrive. Which means, we need to set this trigger, 2 weeks before, the inventory drops to zero. That is the point. Now, graphically, we can represent this.

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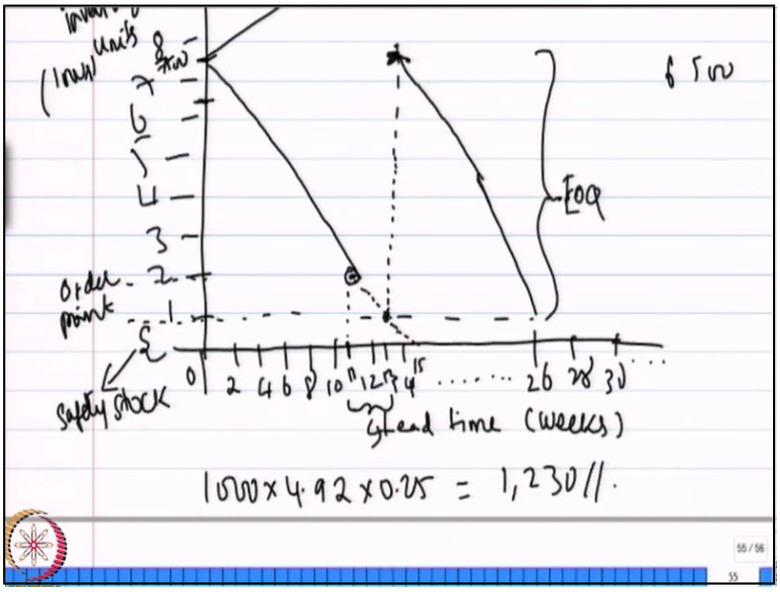

Now, let us say, this is the lead time. And, we will denote them in weeks. And, let us say, this is the inventory units. So, we begin with, 0, 2 weeks, 4 weeks, 6, 8, 10, 12, 14, and so on. 26, 28, 30, and so on. And, let us retain the same example, that we used before. Which means, let us say, this is 1000, 2000, 3000, 4000. This inventory, is in thousands. 5, 6, 7, 8. Now, in this example, we are assuming that, the sales rate is uniform, the inventory consumption is uniform.

Which means, 500 units is been sold every week. And, the 6500 economic order quantity, which is ordered 4 times a year, is used uniformly. Which means, 6500, over a 13-week period is consumed, at a uniform rate, of 6500 divided by 13. That will be, the number of inventory units, that is consumed every week. Now, if that assumption is made, let us see, how the behaviour of inventory with lead time, gives us an understanding of, when we should order the inventory.

Now, in this case, I have told you that, it requires 2 weeks' time, for the inventory to be delivered, from the time that it is ordered. And, since the average sales rate is uniform. Which means, 500 units is been sold every year. So, every week, 500 units are being sold. So, what will be the order point. Now, the order point is, in this case, because, it requires 2 weeks for the inventory to arrive. And, in addition, I am just giving an extra dimension.

And, let us say that, that is not also the only condition. There is also another condition that, I also need to maintain a safety stock, of 1000 units of inventory, or 2 weeks of inventory. Which means, that not only should I have to order 2 weeks in advance, but also order in such a way that, it also ensures that there is a minimum, safety stock of 1000 units, that can be used, when there is a likely even, where there is a surge in the demand. In this case, we are saying that, we are going to sell 500 units every week.

But, let us assume that, there is a likelihood, that the sales rate is twice this amount. So, 1000 units each week. And, I want to set the safety stock to be 1000. In that case, instead of 6500 being the economic order quantity, my maximum inventory that I will be holding, is not 6500, but it will be 6500 + a safety stock of 1000. So, the maximum inventory, that I will be holding now will be, 7500. And, given that, the average sales rate is uniform.

This is a 11th week, 13th week. My order point here now is, the moment the inventory levels touches to 2000. When will that happen? It happens here. I will have to order. Because, it takes 2 weeks for me to, this is the lead time. This 2 week is my lead time. On this week access, it takes 2 weeks for me to get my 1000 units of inventory. So, what will happen at the 13th week? This will go down. And, I also internally set a condition that, I have to have a minimum stock of 1000.

Now, are we meeting this condition? Yes. The order point was, when the inventory level dropped to 2000, I placed an order. While the sales went, the regular sales was 1000. And, after 2 weeks, it is here. And, by the time, whatever I ordered during the 11th week, I would have received. And suppose, there was a surge in the demand, I would have met this demand, because of my safety stock level. Then, it would have later come down to zero, at the 15th week.

This is in the event, that there is a surge in the demand. Assuming that, there is no surge in the demand, and that the safety stock is not utilised, then at the end of the 13th week, my inventory once again reaches to 7500. And, that keeps going, 26th week. So, this relationship continues for every quarter. Since, the number of orders, that we make in a year is 4, in this case. So, you will find that, this will be my economic order quantity. This is 7500, 1000, 6500. This is my safety stock.

So, I am just presenting everything in this graph, so that, this is better understood, instead of taking an example, and working it up. So, this will be the economic order quantity. Now, what I have done in this graph is, just trying to mix both the parameters, that I have internally set. One is that, I need to have a safety stock of 1000 units of saleable inventory, at any point of time. And, that also the information is that, it takes 2 weeks for me to get my inventory, whenever I need to order that.

Which means, every time I order an EOQ, it takes 2 weeks. And then, this example, our EOQ was 6500. And, we knew that, we are going to order 4 times. Which means, at the end of the 13th week, we place an order. And, we know that, it takes 2 weeks. So, what do I do? When do I order 6500 units? At the end of the 11th week, of every quarter. So, I place an order. And, in this case, I am ordering it, when the inventory level is at 2000. Because, I know that, I need to maintain a safety stock of 1000. And, that the incremental 1000, is for the, to take care of the lead time.

So, that is the additional dimension, that I have given. So, this graph represents, how decisions are taking, when it comes to inventory planning level, to set the trigger points, for us to order the inventory. To ensure that, it not only meets the criteria of, the economic order quantity being available just at the time, that I require it. So that, we do not have to carry excess inventory, nor have to incur additional costs for not having inventory. Because, at times, when you do not have inventory, when you actually need it, you also end up buying inventory at, extra price, extra cost.

Remember, when we did this in the material variance analysis, at times we also pay more for the raw material inventory, as a result of which, we end up having an unfavourable variance. So, two things. One, we also need to ensure, that we have the optimum inventory. And secondly, suppose

we anticipate at times there is a good possibility, that there will be a surge in demand, and that we will have to meet the demand through safety stock, we should also have some safety stock. But, safety stock is also additional cost.

So, the question is, whether the benefit of incurring that additional cost of holding safety stock, whether that will be outweighed by the incremental sales is something that, we have to satisfy ourselves. If we feel that, holding safety stock is going to be beneficial, then we will incur the additional cost of holding the safety stock. In this case, the increase in the average inventory causes, an increase in the average inventory carrying cost, because of the safety stock. In this case, the safety stock is 1000.

We know that, the inventory value is 4.92, and, the carrying cost is 25% of the purchase price. So, this will be the additional cost, that we will have to incur, for holding the safety stock. So, this 1230 will be the additional cost, that we will be incurring, in addition to holding the economic order quantity. Now, if the incremental sales out ways its benefit, then there is some sense in holding the extra stock.

Now, this illustrative model, that gives you an understanding of, what is the economic order quantity. And, also from the timing perspective, when should we order this economic order quantity. This is important for us to know, from the perspective of understanding how, we can reduce the total inventory costs. Remember, when in the last class, we were talking about the cash conversion cycle. Three important parameters emerged. One is the collection period.

The other is the payment deferral period. And, the other is the inventory conversion period. While, the collection period, which has got something to do with the accounts receivable, that can be shortened, by employing good or better practices, that ensures faster collection. There is something called, accounts receivable management. We can reduce the collection period. Likewise, the deferral period as much as possible we would try to elongate, by better negotiation terms with the vendor.

But, one thing is the inventory conversion period, which can also be shortened, either by having

better processes about which, accounting does not play a major role, or the management accounting does not play a major role. But, it can be the inventory conversion period, when it is converted into cost, can be reduced, if we have better inventory planning in place. Which means, there should be a scientific approach, that ensures, that we are holding only the right level of inventory, as a result of which, the cost of holding that inventory is minimised.

And, it is with that understanding, that we studied this economic order quantity model. And, this will give you, a very clear understanding on, how much is the optimum inventory that we need to hold. As a result of which, the cost of holding such inventory is minimised. And, if the cost of holding such inventory is minimised, in the overall scheme of budgeting, we are trying to as much as possible, achieve the total cost, very much within the budgeted estimates.

Otherwise, what will happen is, the actual cost would be more, than the budget. As a result of which, we get unfavourable variances. It is only with that perspective, I thought, I should just give you this, introductory concept on economic order quantity. Now, what we have done, in the first part, when I began this course, I said that, I will be handling the 3C's of business analysis. One was the Code. The other was the Conduct. And, the other was the Climate.

Code, Conduct, and Climate. Now, as we draw close, to finishing the first C, which is the Code. I would like to begin the next class by giving, by working out a comprehensive case, that covers the fundamentals of accounting, and also tries to give you an understanding on, how to prepare a balance sheet income statement. And, as we work, we will also understand some nuances of certain concepts, when it actually comes into real-time application. And then, with that, I will be finishing the first C.

After which, we will enter into the, other two c’s, which is the Climate, and the Conduct. There, I will be talking about, strategy, economy. How to understand, the economic principles, theory of demand and supply. How do companies, come out with strategies. These are things, that I will be talking into the, when I talk about the other two c’s, which namely the Conduct, and the Climate. Next class, I will be giving inputs. We will be working out, a problem on the fundamentals of accounting, that we have gathered so far.

So, what we will be doing is, we will go through a series of transactions. And, these are, I will pick a real case study example, so that you will understand, how these accounting concepts are employed, for real-time purposes. How certain principles of accounting, if interpreted in different ways result in, different ways of recording these transactions, and communicating it in a different way.

So this, we will understand, when we actually work, a real-time case. So, next class, I will be coming with a case study, which I will start working out myself, so that, we will have a better understanding. And, that in my opinion will form, the comprehensive summary for, these first twenty sessions on accounting, both financial accounting and management accounting. So, next class, we will begin working, a small case study. Thank you.