Decision Making With Spreadsheet
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Lecture-02
Models of Cost, Revenue, Profit and Breakeven Analysis

Welcome students to the course on Decision making with the Spreadsheet. Today is the second lecture. In this lecture, I will explain the relationship between cost, revenue, profit, and breakeven analysis, as well as some guidelines for making good spreadsheet models.

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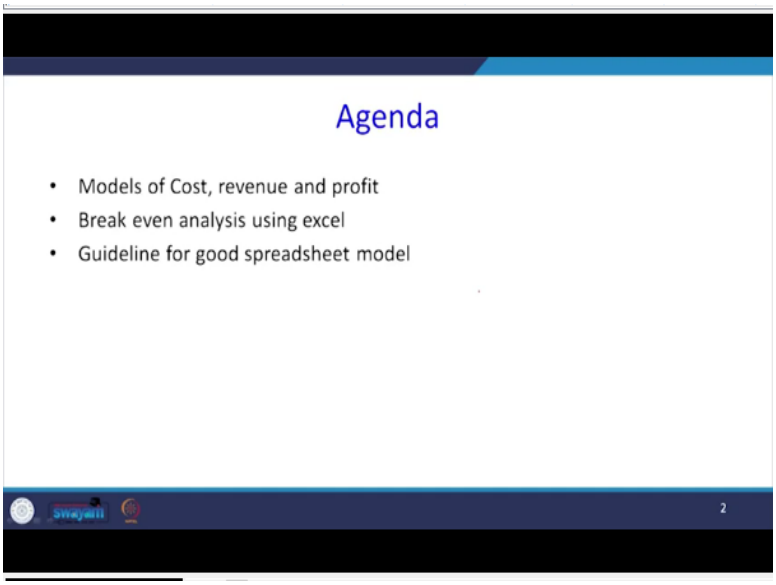
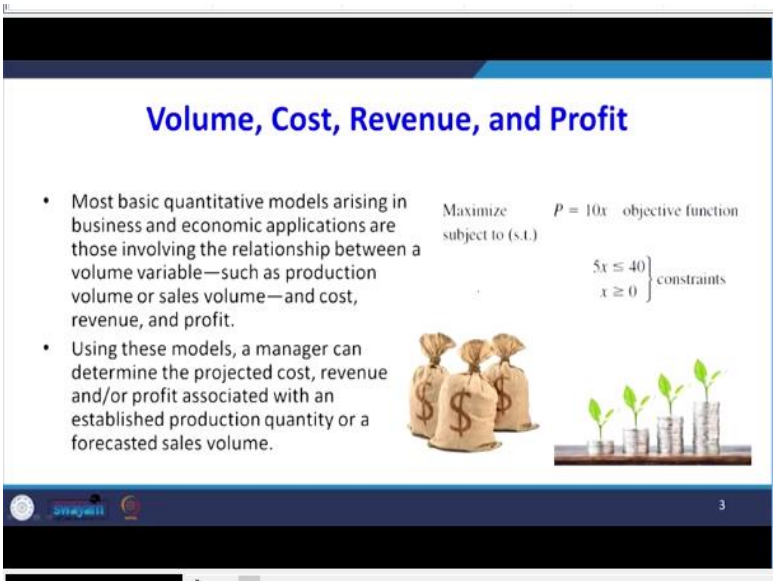
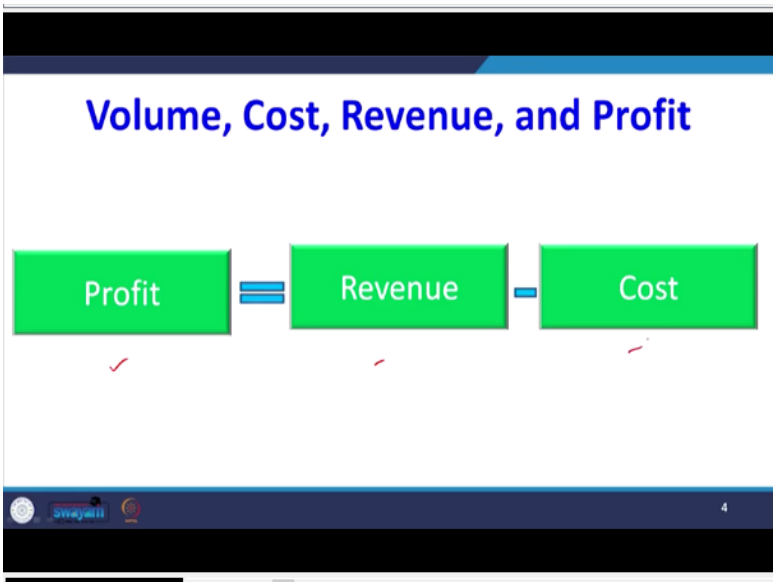


The agenda for this lecture is the relationship between cost, revenue, and profit, and breakeven analysis using Excel and guidelines for making a good spreadsheet models. You may ask, what is the importance of studying or knowing about cost, revenue, and profit? Most of the linear programming models either maximize the profit or minimize the cost. So, it is better to understand the relationship between profit and cost; that is what we are going to see in this lecture.

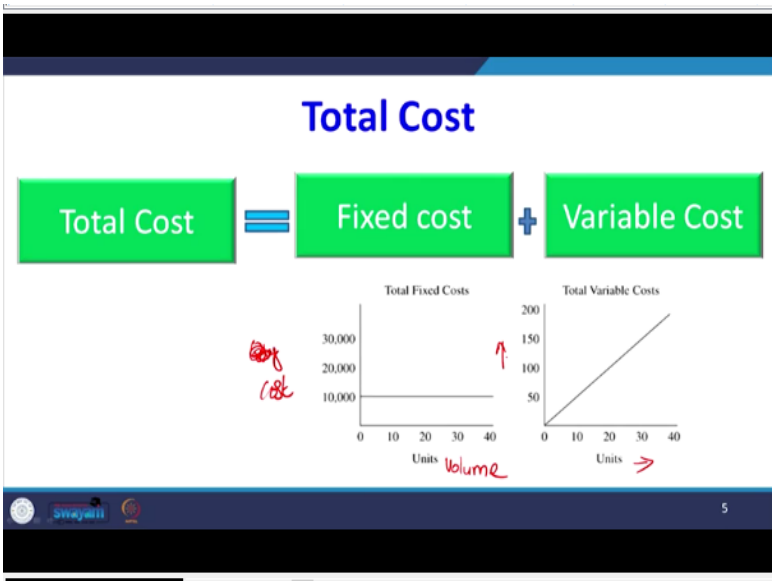


Most basic quantitative models arising in business and economic applications are those that involve the relationship between volume variables. Here, the meaning of volume is a number of quantities, such as production volume or sales volume. When you look at the right-hand side, this was the previous example, which I explained in my first lecture, that you see maximizing the profit =10x.

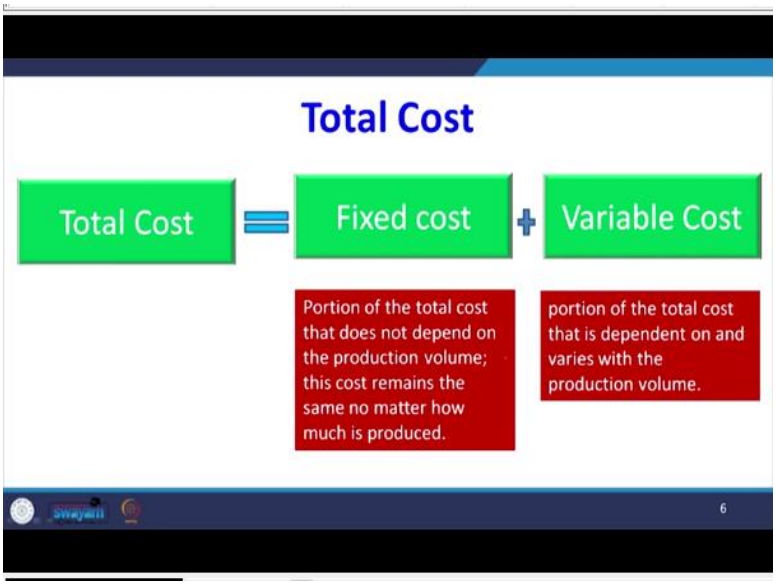
The objective function needs to be maximized; sometimes, there may be an objective function that has to be minimized. So, in this lecture, I will explain the relationship between cost and profit. If you know the relationship between profit, volume, and cost, your manager can determine the projected cost, revenue, and or profit associated with established production quantity or a forecasted sales volume.



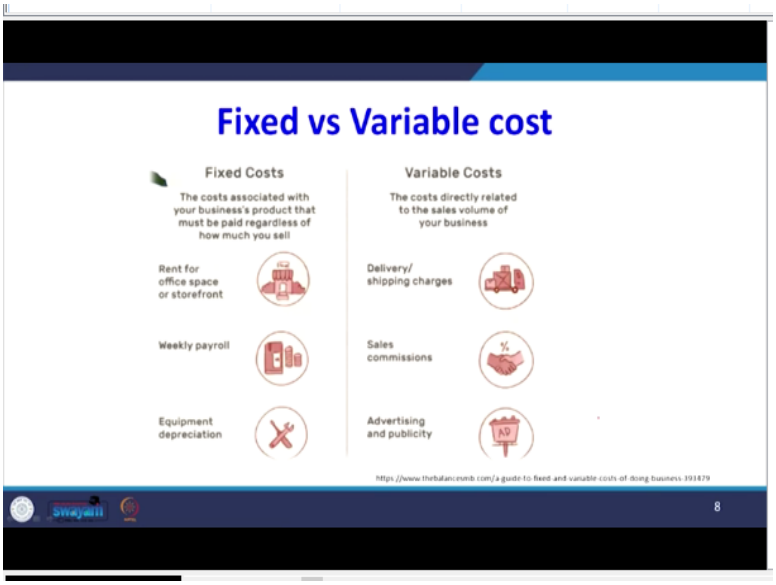
This picture says you see when you say profit is equal to revenue minus cost.



When you see the cost, the cost can be classified into 2 categories: fixed cost and variable cost. What is the fixed cost? In the x-axis unit, in the y-axis quantity. You see, even though the volume increases, the cost is fixed, for example, 10,000 dollars. So, this is an example of fixed cost. What is the variable cost? The cost varies with the number of quantities produced; when the number of quantities increases, your cost also increases. So, this is an example of variable cost.

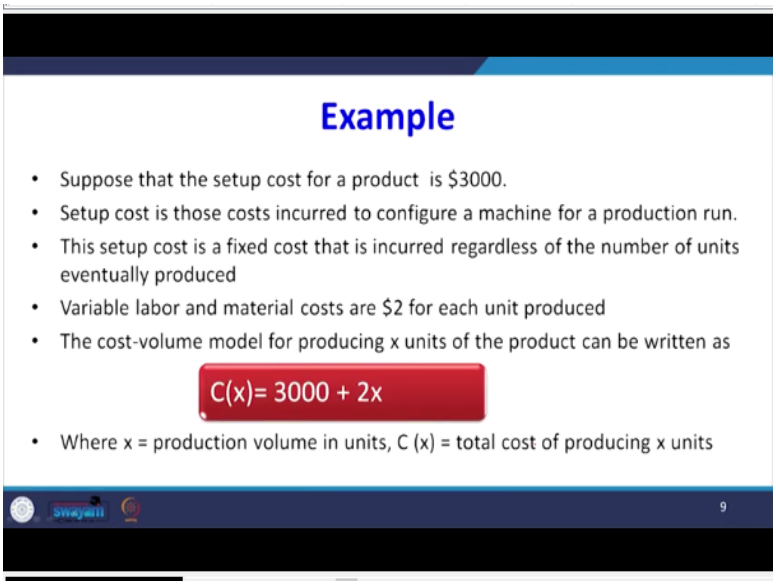


What is the fixed cost? Your portion of the total cost does not depend on the production volume. This cost remains the same no matter how much it is produced. So, the cost is independent of a number of quantities produced. That is called fixed cost. But, when you go back to the variable cost, the portion of the total cost that is dependent on and varies with the production volume, the cost is directly proportional to the number of units produced that cost is called variable cost.



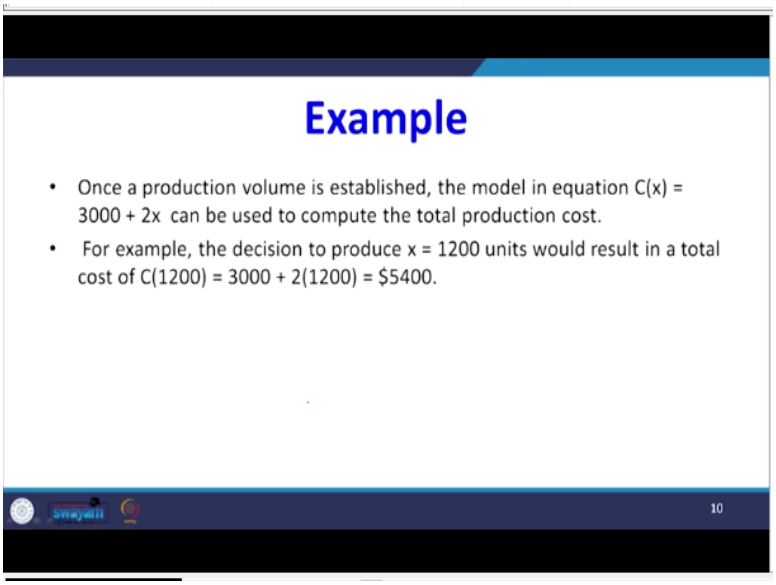
Some of the examples are fixed and variable costs. See fixed cost, the rent for office space or storefront that has nothing to do with a number of units produced. That is an example of your fixed cost. Weekly payroll that is independent of quantity produced. That is your fixed cost. Equipment depreciation is independent of whether you use the machine or not. There should be some cost for its decision. That is called fixed cost.

The right-hand sides are given some examples of variable costs. Delivery and shipping charges: when the quantity increases, the delivery charges will be higher, shipping charges will be higher, and sales commissions when the number of products sold is more, there will be more commission. Then, the amount to spend on advertising and publicity is another example of variable cost.

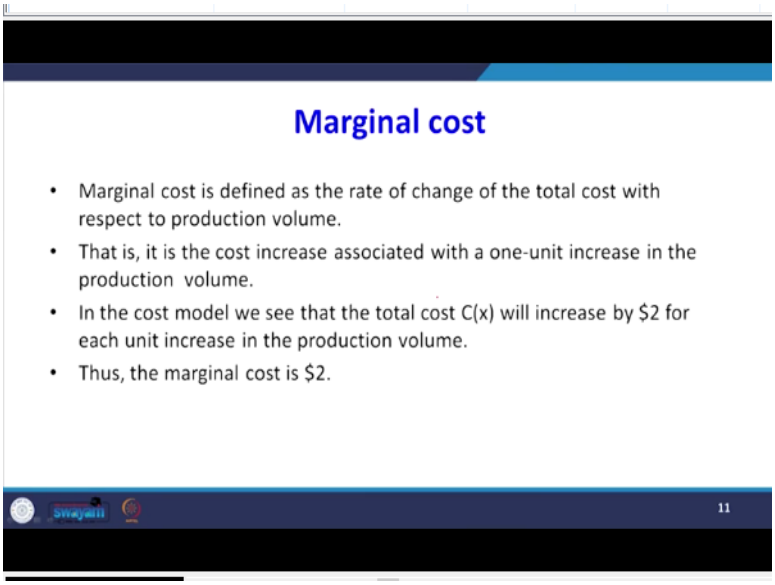


Suppose that the setup cost for your production is 3,000 dollars. Setup costs are those costs incurred to configure your machine for your production run. This setup cost is a fixed cost that is incurred regardless of the number of units eventually produced. Variable labor and material costs are 2 dollars for each unit produced. So, the cost volume model for producing x units of the product can be written as C(x) = 3000 + 2x.

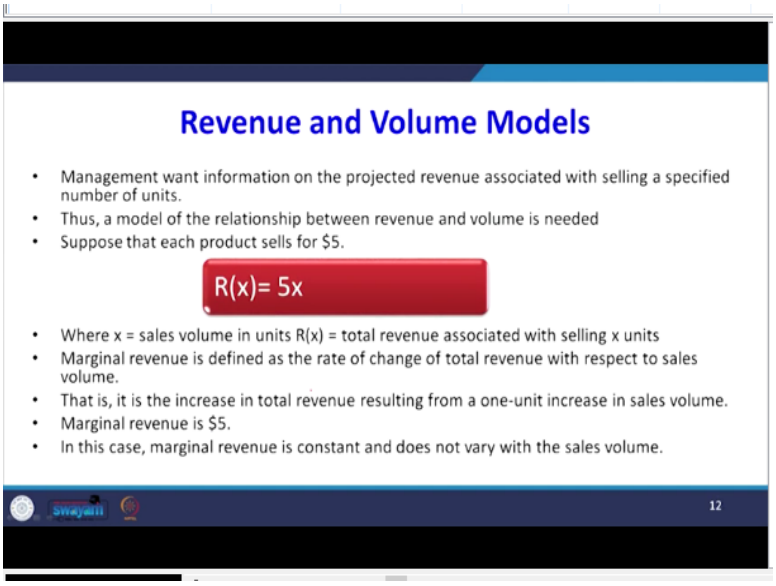
Here, 3000 is your fixed cost, the 2x is called your variable cost, the x is the production volume in units, and the C(x) is the total cost for producing x units. When you look at this equation, when x increases, the total cost of production will increase. But this 3,000 dollars is independent of a number of units produced.



Once your production volume is established, the model in equation C(x)= 3000 + 2x can be used to compute the total production cost. For example, the decision to produce x = 1200 units would result in a total cost of C(1200) = 3000 + 2 (1200). It is 5,400 dollar.

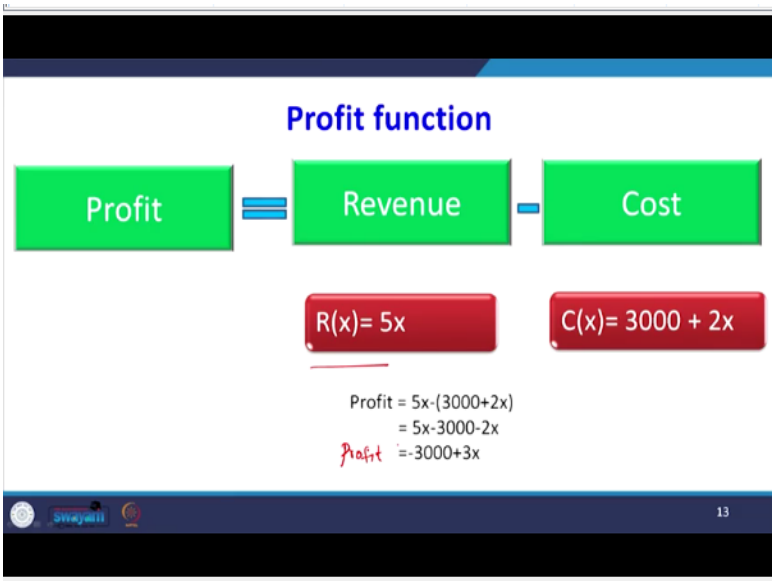


Then another concept is called marginal cost. Marginal cost is defined as the rate of change of total cost with respect to production volume. That is, it is the cost increase associated with your one-unit increase in the production volume. In the cost model, we see that the total cost C(x) will increase by 2 dollars for each unit increase in the production volume. So, here, the marginal cost is 2 dollars. That is how much the cost is increased by each unit of production. So, that cost is called your marginal cost.

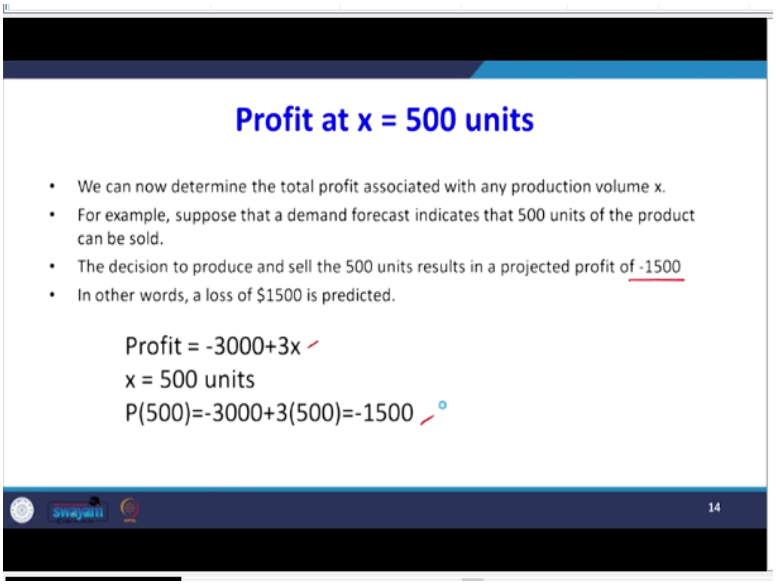


Now, we will go to the second topic, which is called revenue; how are revenue and volumes connected? Management wants information on the projected revenue associated with selling a specified number of units. Suppose I am selling x units; I want to know the revenue associated with the units. Thus, a model of the relationship between revenue and volume is needed. Suppose that each product sells for 5 dollars. So, these 5 dollars are called the marginal revenue.

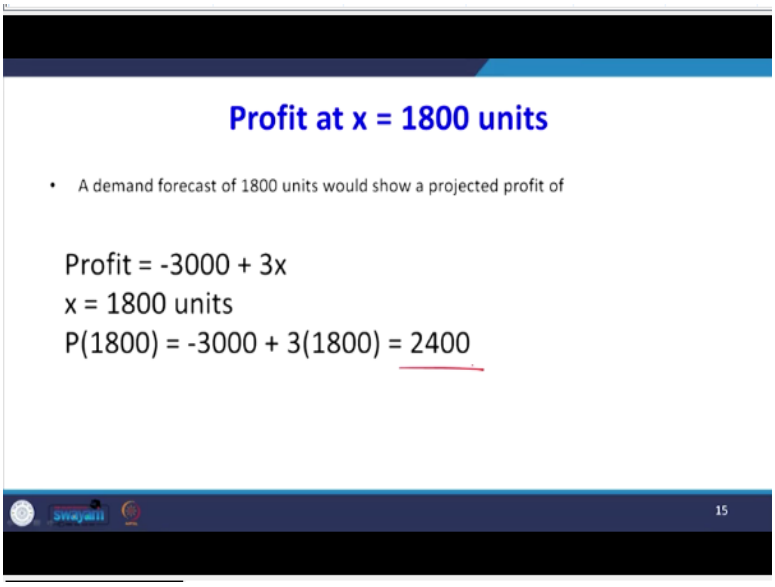
So, this can be written as R(x) = 5x, where x is sales volume in units, and R(x) is total revenue associated with selling x units. So, marginal revenue is defined as the rate of change of total revenue with respect to sales volume. That is, it is the increase in total revenue resulting from one unit increase in sales volume. So, in our problem, the marginal revenue is 5 dollars. What is the meaning of these 5 dollars? If one unit is sold, the revenue is 5 dollars. In this case, the marginal revenue is constant and does not vary with the sales volume.



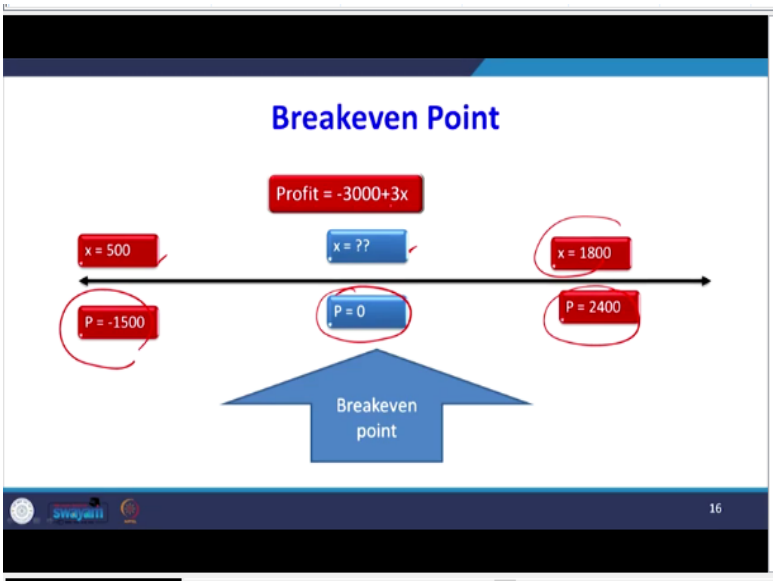
We have already seen what the profit is. Profit = revenue - cost. Just know you have seen what the revenue function R(x) = 5x, then C(x) = 3000 + 2x. So, when you subtract this revenue minus cost, then 5x – (3000 + 2x). So, 5x - 3000 - 2x, so, -3000 + 3x. So, this is your profit function (-3000 + 3x). So, what we have seen, we have studied separately the cost function, and we have studied what is the revenue function; when you subtract revenue minus cost, you are getting the expression for your profit.



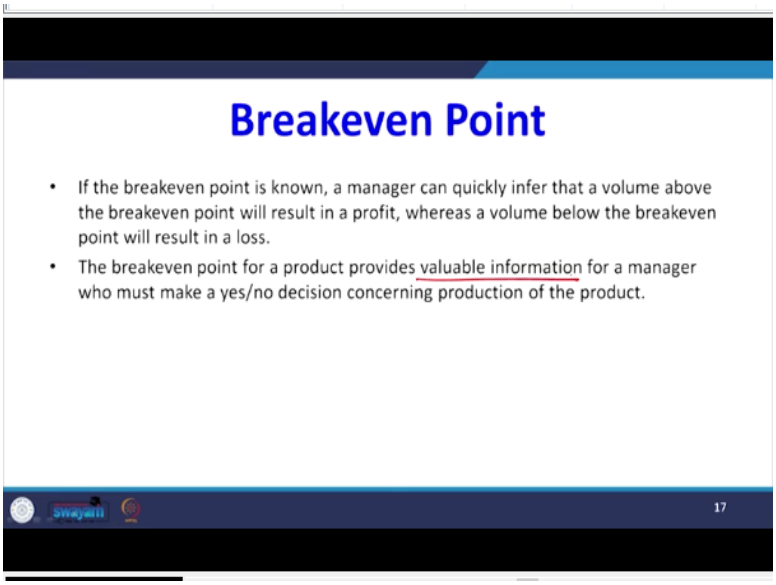
We can now determine the total profit associated with any production volume x because we have no profit function. For example, suppose that a demand forecast indicates that 500 product units can be sold. So, the decision to produce and sell 500 units resulted in a projected profit of -1,500 dollars. In other words, a loss of 1,500 dollars is predicted. How did we get this? We got the profit function in that you substitute x = 500 units. So, P(500) = -3000 + 3 *500. So, we are getting -1,500 dollars is the negative.



So, it is a loss suppose, if you are selling 1800 units, what will happen to our profit function? So, instead of x, you have to substitute 1800 in the profit function; when you substitute 1800, you are getting -3000 + 3*1800, you are getting 2,400 dollars. You see, previously, we got a negative profit. Now, we are getting a positive profit.

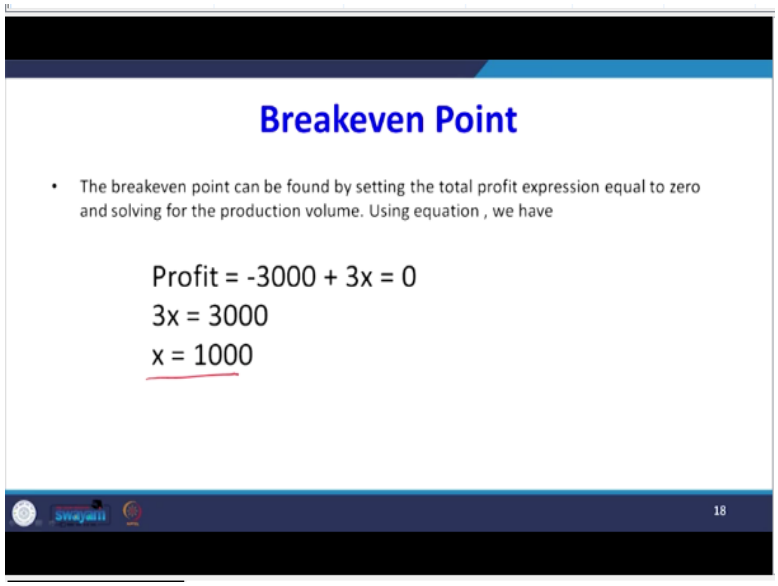


When x = 500, your profit is negative. When x = 1800, your profit is 2400. As a manager, I wanted to know, suppose if I want to know 0 profit, how much unit should I produce? So, answering this question is nothing but your break-even point analysis. So, what is the break-even analysis? When the profit is equal to 0, how many units do I need to produce? So, that situation or that point is called our breakeven point. So, what we are going to do in this function is -3000 + 3x, we are going to get a profit equal to 0, then we are going to find the value of x.

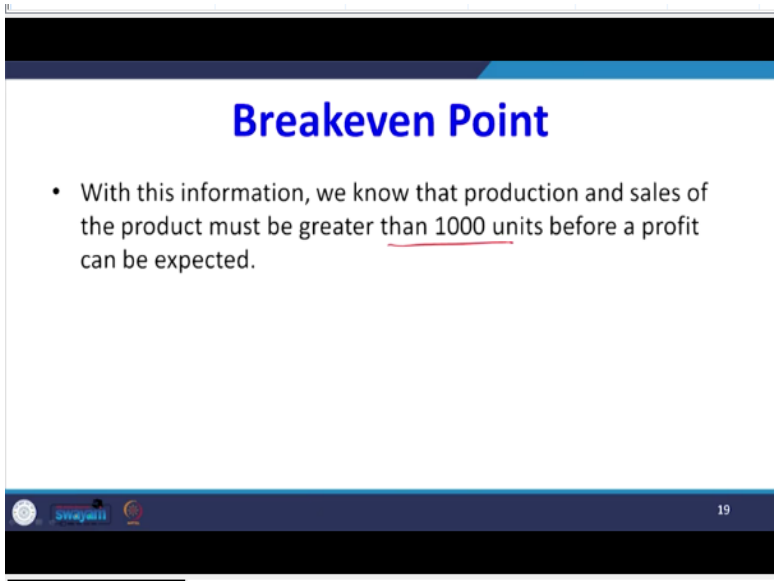


So, if the breakeven point is known, a manager can quickly infer that the volume above the breakeven point will result in your profit, whereas a volume below the breakeven point will result in your loss. So, the breakeven point for a product provides valuable information for your manager, who must make a yes or no decision concerning the production of the product. So, the breakeven point will tell you whether that quantity will yield you profit. So, the

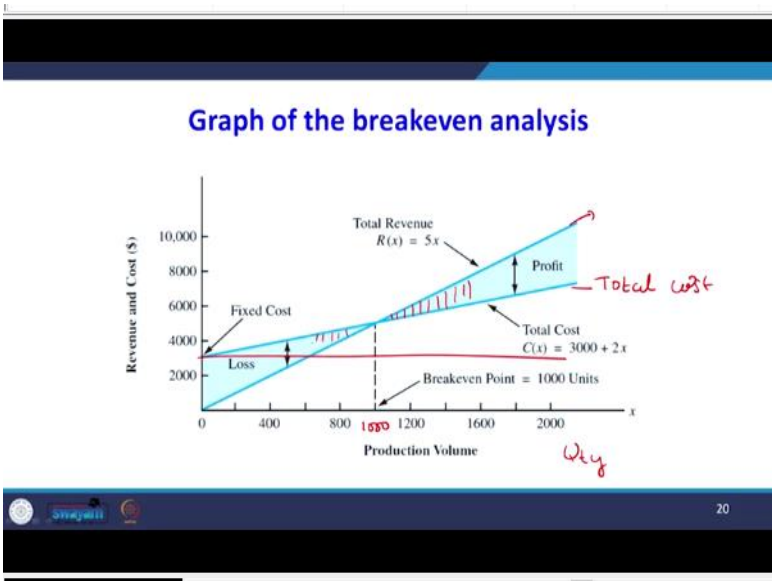
breakeven point is where there is no profit situation. So, when the profit function is 0, the corresponding quantity is called your breakeven quantity.



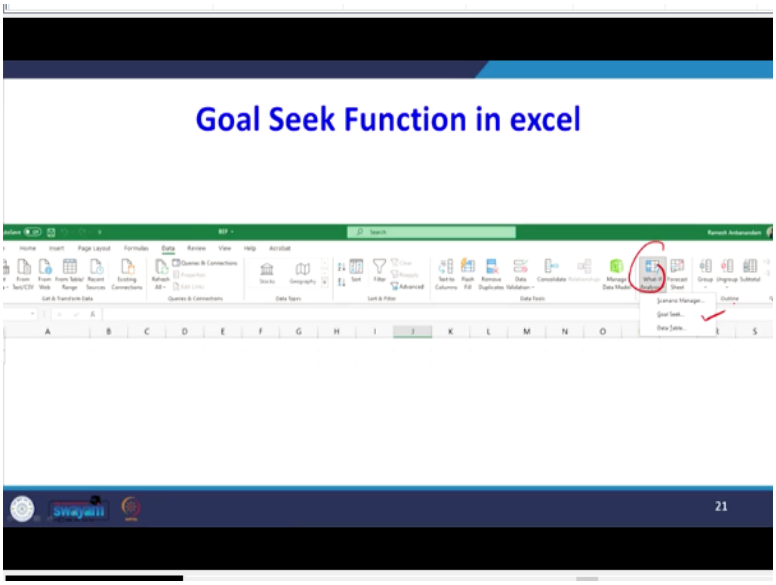
Now, I will explain how to find out the breakeven quantity. So, the breakeven point can be found by setting the total profit expression equal to 0 and solving the production volume. Using the equation, we have a profit equal to -3000 + 3x; using the equation means our profit function. So, when you simplify this, 3x = 3000. So, x = 1000 units. So, if you produce this many quantities, you will get 0 profit. So, after 1000 units, it will start to earn a profit.



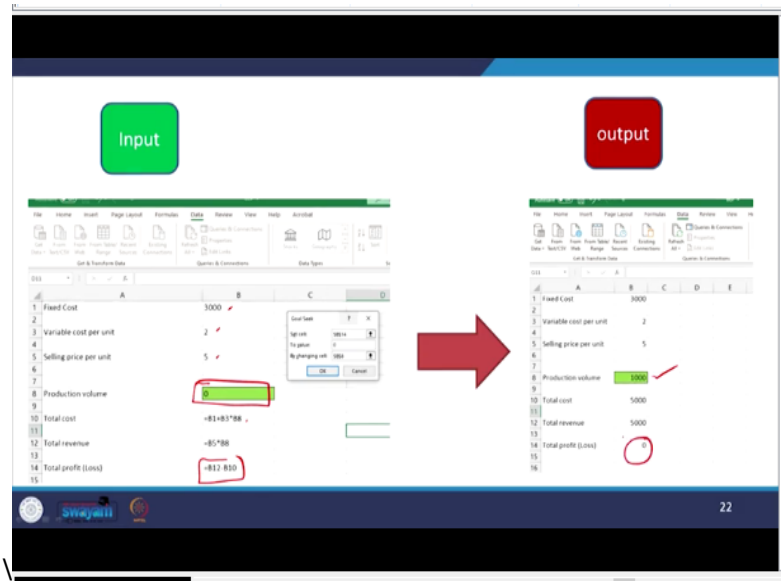
With this information, we know that the production and sales of your product must be greater than 1000 units before a profit can be expected.



When you look at this picture, on the x-axis, the quantity is a production volume; on the y-axis, revenue, and cost are in terms of dollars. So, here, this line shows your revenue function, and this line shows your cost function. What is the fixed cost? Fixed costs will be like this. So, this line is your total cost; this is your total revenue. So, subtracting total revenue from total cost will get a profit function. If you equate that profit function to 0, you will be getting this word 1000 units; this point is called your breakeven point. So, what we understand is that beyond these 1000 units, you will start making a profit; below these 1000 units, you will be incurring a loss.

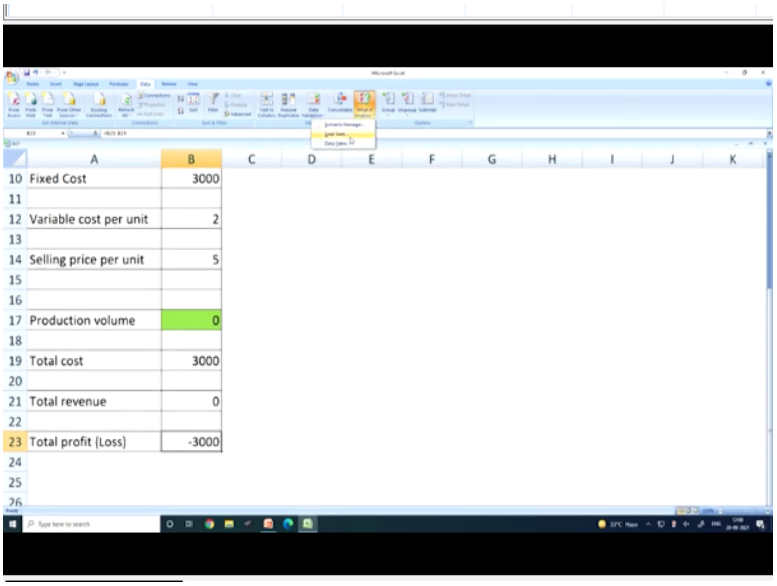


This breakeven analysis can be done with the help of Excel; there is a function called goal seek. So, where do we get this goal-seek function? You have to go to data; there will be a what-if analysis; when you click on this what-if analysis, sees the second option is called the goal seek.



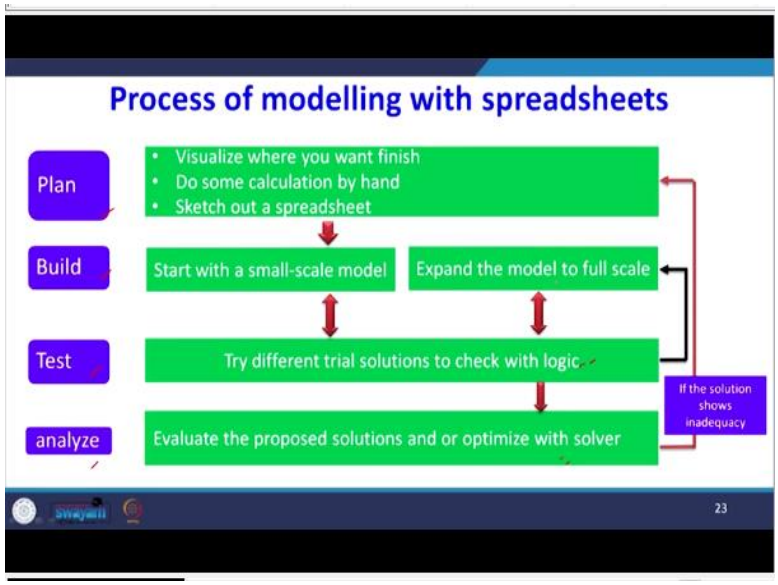
In the Excel model, the left-hand side has given the inputs; what is the input fixer cost I have entered? Variable cost is centered, and the selling price per unit is given. Then, the production volume is the place where we need to get the answer. So, what is the total cost? Total cost is fixed cost plus variable cost. What is the fixed cost? B1 + variable cost 2 is the value that we are going to get in B8. That is your total cost.

What is the total revenue? That is B5, the x quantity where you go to B8. So, what is the total profit or loss? So, total revenue B12 - B10. So, when you click data, you will get a goal seek function. Here, the set cell is we are to make this cell B14, the value which you have to set to 0. The changing cell is where we need to get the answer. So, when you press ok till you get the answer. So, the 1000 unit is your breakeven unit. So, that is the point at which you will get a 0 profit.



Dear students, I will now explain how to use Excel to do a breakeven analysis. I have entered the data fixed cost, variable cost per unit, selling price per unit, and production volume. This is cell B17, where I need to get the answer. So, then I have explained the total cost function. The total cost function is 3000 + 2x, and the total revenue, total revenue is 5*x. So, what is the total profit function? Here, we have written total revenue minus total cost, which is B21 - B19.

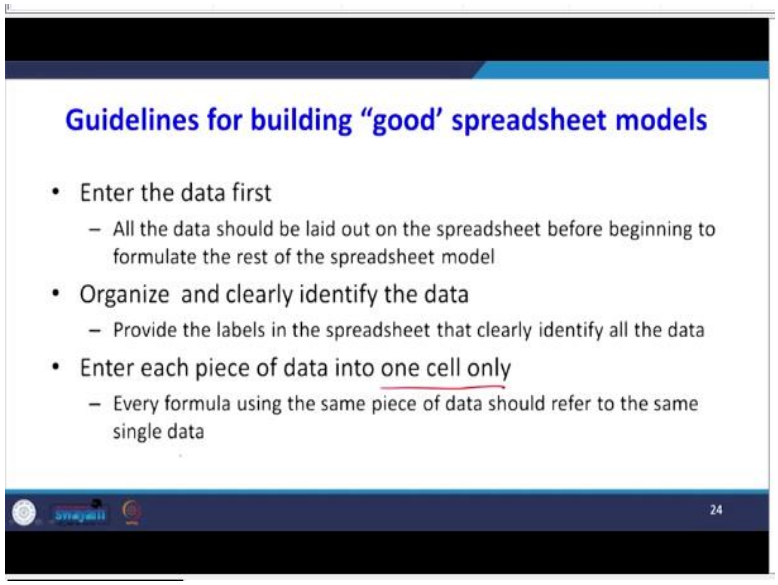
Now, you have to go to the data cell, then there is an option called what-if analysis; go for goal seek. Set the cell. For the set cell, you have to select your profit cell, and the value should be 0. The changing cell is where we need to get the answer is B17. And you press ok. We are getting 1000. So, this 1000 is your breakeven quantity. At this point, the profit is 0. Beyond 1000 units, you will make money. Below 1000 units, you will incur a loss.



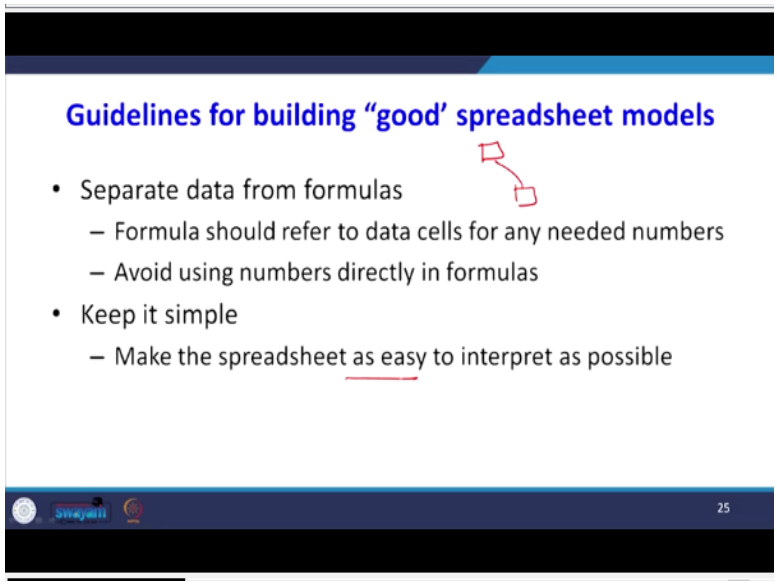
Now, I will explain the modeling process using the spreadsheet. There are 4 stages: plan, build, test, and analyze. In the planning stage, what do you have to do? You must visualize where you want to finish. That is the first step. Then, you must do some calculations by hand so that you will be confident whether the logic is correct or not. Then you have to sketch out the spreadsheet where they should be input, where they should be output, and so on. The second stage is to build the model. Start with the small-scale model. Then, the third stage, the testing stage, tries different trial solutions to check the logic.

That is a testing stage. Then analyze and evaluate the proposed solution or the optimized value with the solver. If the solution shows inadequacy, again, you should go to the planning stage. In the testing stage, in the evaluation stage, testing stage, or in the analyzing stage, if

there is any problem again, you the testing stage, and in the analyzing stage, if it is getting the right answer, then you can go for expanding the model to your full scale. These are the process of modeling with spreadsheets.

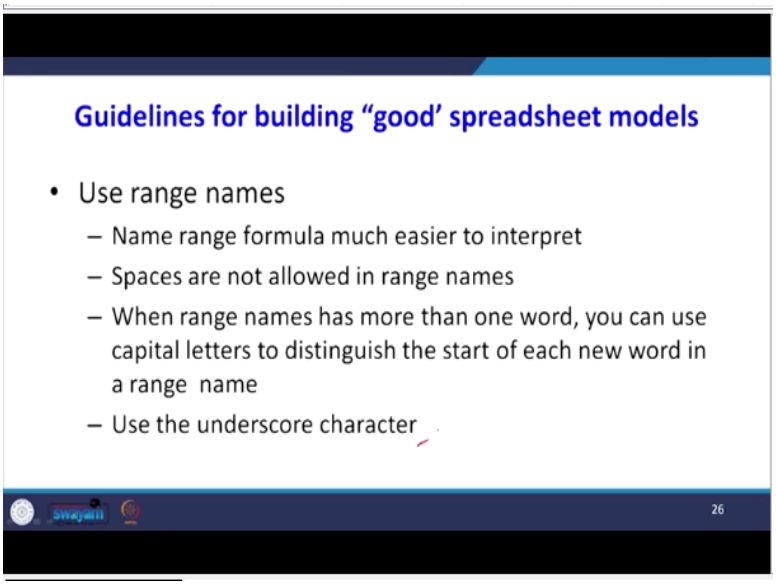


Now, we will explain some of the guidelines for building a good spreadsheet model. What is the first one? Enter the data first; all the data should be laid out on the spreadsheet before beginning to formulate the rest of the spreadsheet model. There should not be confusion about where the data is and where the model is. The second tip says to organize and clearly identify the data. Here is the meaning of this one is you must provide the labels in the spreadsheet that clearly identify all the data. Next, enter each piece of data into one cell only. Every formula using the same piece of data should refer to the same single data.



Then, separate data from formulas. The formula should refer to data cells for any needed numbers. Every time the formula should refer to the data you have entered, the formula you

have entered every time this formula should refer to the data cell. Avoid using numbers directly in formulas. Suppose you are writing some formulas, and you do not write the exact value on the formulas. Always refer to the data set. In the next stage, if you want to modify the value of the data, the formula will be updated automatically, so keep it simple. Make the spreadsheet as easy to interpret as possible.

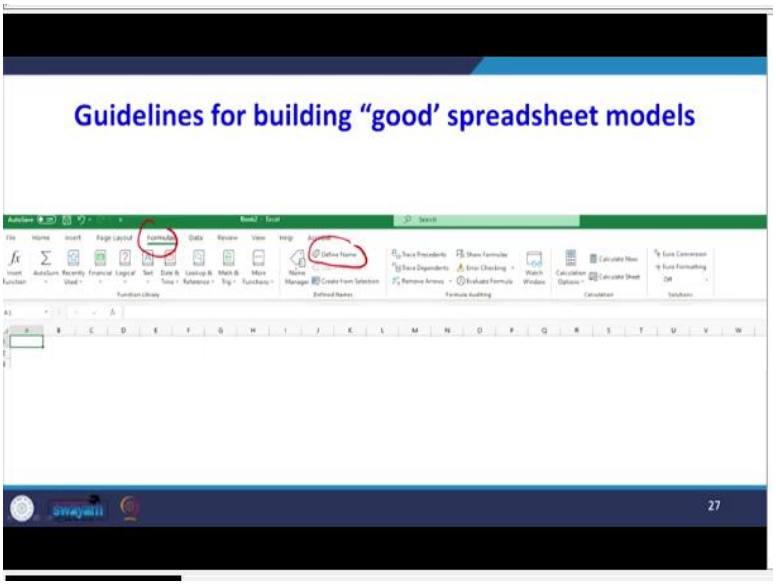


Use range names; name range formulas are much easier to interpret. When you are making the range, when you are giving a name for the range, space is not allowed in range names; when range names have more than one word, you can use capital letters to distinguish the start of each new word in a range name. Use underscore characters. Dear students, I will now explain how to give the name of the range of cells. I have entered the say, for example, marks.

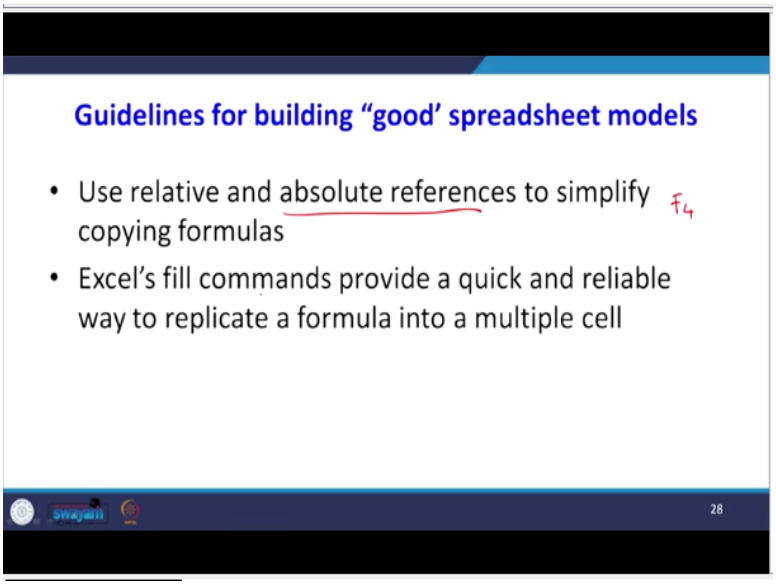
So, I want to give you a name for this range of cells. So, go to define the name. I am writing mark 1, see when you select this, you see that this will be looking at this on the left-hand side. It is under the name box it is coming mark 1. Suppose I have given weightage, for example, 0.25, 0.3, 0.2. For example, 0.5. For this cell, I need to give some other names, select define name, weight 1, and press ok.

Suppose I want to use an Excel function equal to the sum product; I need to find the weighted sum product. Instead of selecting a cell, I can simply type mark 1, weight 1. Now you can see the advantage of this by naming the range of cells. Instead of selecting the cell, it can give the name marks 1 and comma weight 1, and you will get 85.55. This is the sum product. Look

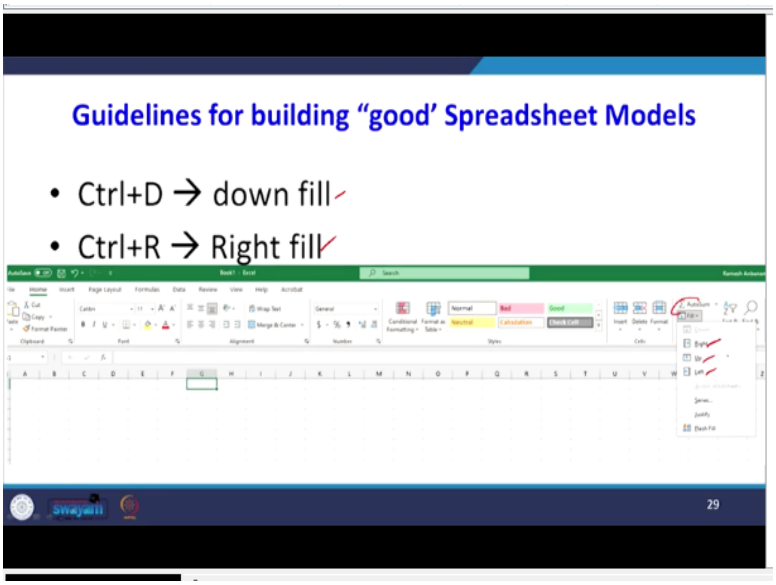
inside the bracket. It is a mark 1, weight 1. So, when you give the range of names to a particular cell, it is easy to call that cell easily if you are using the Excel formula.



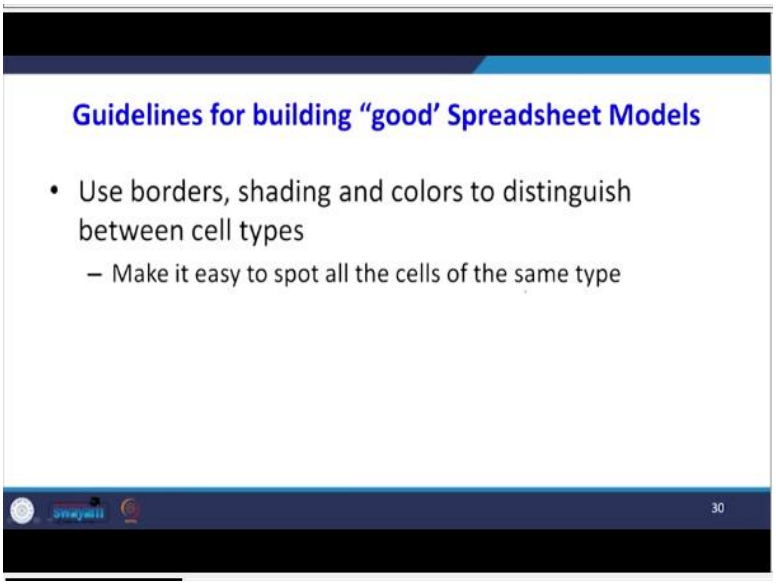
I have explained when you go to formula cells; there is an option called define the name; here, you can give the names, and there is a name manager if you want to modify it. When you click this; we can change or edit the name of the range.



Use relative and absolute references to simplify copying the formulas. For this, if you want to make an absolute reference in Excel, if you press F4 there will be a dollar symbol that will appear, and then that will become an absolute reference. The Excel fill command provides a quick and reliable way to replicate a formula into multiple cells. After selecting that bottom right corner, if you double-click all the formulas will be filled.



This is the formula for filling; suppose you select that particular cell drag it then press control D., it is a down fill shortcut formula for down fill; you select the cell, then you select your number, then select that cell on the right-hand side, then you press control R the right side cells will be filled. You look at it. There is a fill option here, and we can go for right fill, up fill, and left to fill. So, this will simplify your task.



Then, use borders, shading, and colors to distinguish between cell types. For example, which is the objective function cell, which is the changing cell, you can give a different color so that it is easy to recognize, making it easy to spot all the cells of the same type. Dear students, in this lecture, we have seen the relationship between cost, revenue, and profit. Why this is important?

In every linear programming problem, one always has to maximize the profit, or we have to minimize the cost. It is important to know how the cost and profit elements are calculated. Then, I explained what is the breakeven analysis and how to arrive at that breakeven point using Excel. After that, I have explained some guidelines for making a good spreadsheet model. In the next class, we will talk about a very important portion of this course, which is formulating an LP problem. Thank you very much.