**MINERAL ECONOMICS AND BUSINESS**

**Prof. Bibhuti Bhusan Mandal**

**Department of Mining Engineering**

**IIT Kharagpur**

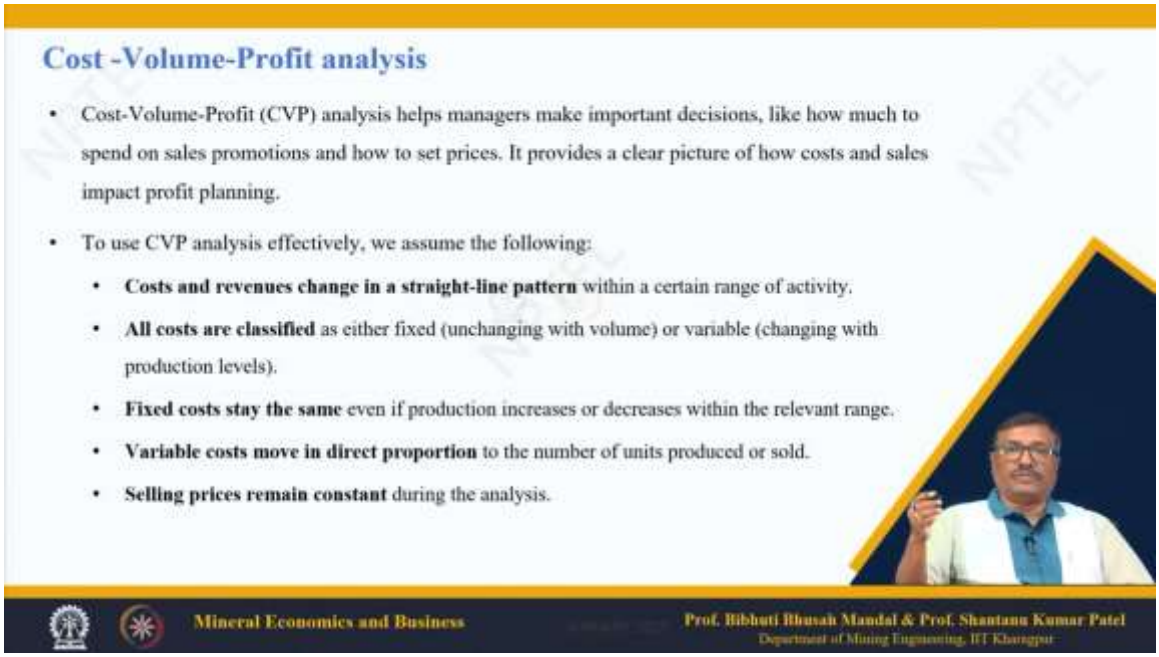
**Week 9**

**Lecture 42 : Cost Volume Profit analysis - I**

Hello viewers, once again welcome to this lecture series and the course on Mineral Economics and Business. In today's lecture, we will be talking about the cost volume profit analysis part 1. In this, we will be discussing the following concept, the basic idea about the cost volume profit analysis. examples of the linear cost volume profit analysis how it is done and there will be certain numericals related to this analysis and specially the break even chart which is a key concept in the cost volume profit analysis. Let us go ahead.


Now, the cost volume profit analysis just try to understand that you have a mine, you have a production unit, you need to know the relationship between the output and your income means the revenue. How much you are producing and how much you need to produce to make a breakeven and when you are crossing that breakeven point, when you

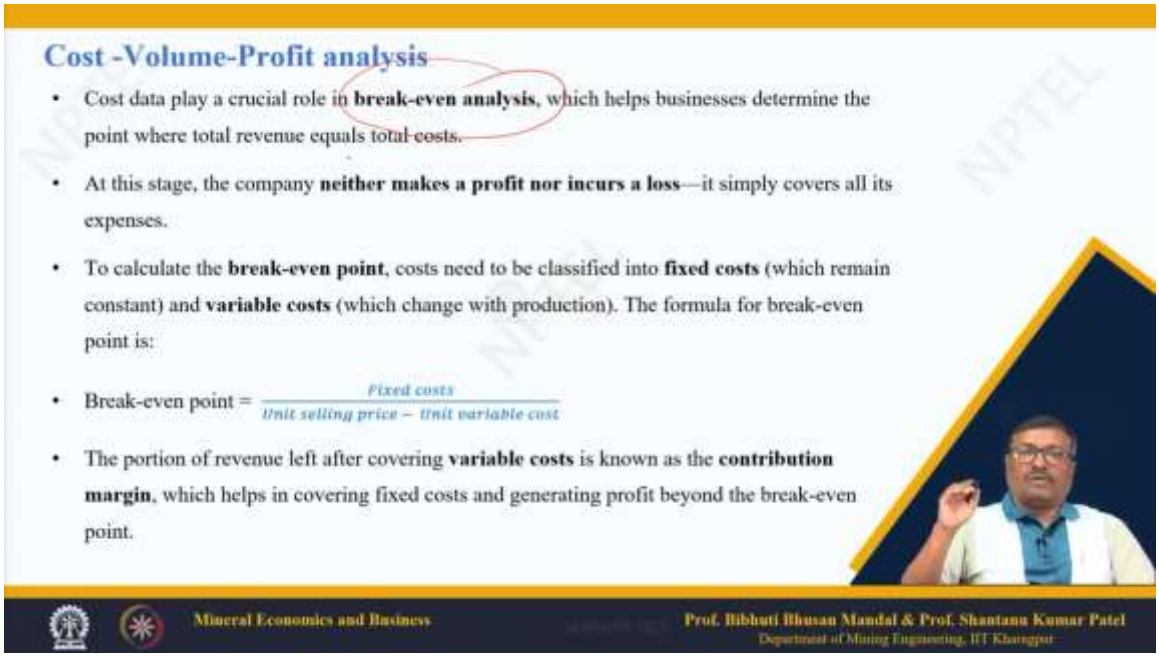
are not making any profit or any loss, how much margin or profit margin you will make. The minimum requirement for the the ah where the ah the profit and ah loss ah we are we are not considering neither profit nor loss that means, we are exactly matching our cost that particular point is also called the break even point. That means, beyond that we if we produce then we will be making profit below that it will be less I mean it will be loss case of loss.




So, in terms of mining also we can understand that for running the business making profit how much we are supposed to produce because if more you produce the variable cost will be going high you have fixed cost. So, if you have some assumption in the beginning to understand all this. that this variable costs are linearly varying with the production and if the sales revenue per unit, then you can do the cost volume profit analysis easily. This is applicable to most of the business in different form. But the basic idea is that it this helps the managers to make important decisions, what kind of decisions like how much to spend on sales promotions or how to set prices, so that the expenditure is well known.

This provides a clear picture of how the cost and set impact the profit planning. To use the cost volume profit analysis effectively we assume the following. First thing the cost and revenue changes in a straight line pattern in this particular lecture we will have all linear relations with a certain within a certain range of activity up to a certain range it is

all linear. Now, the all cost are classified as either fixed or variable no other nothing no grey area here.



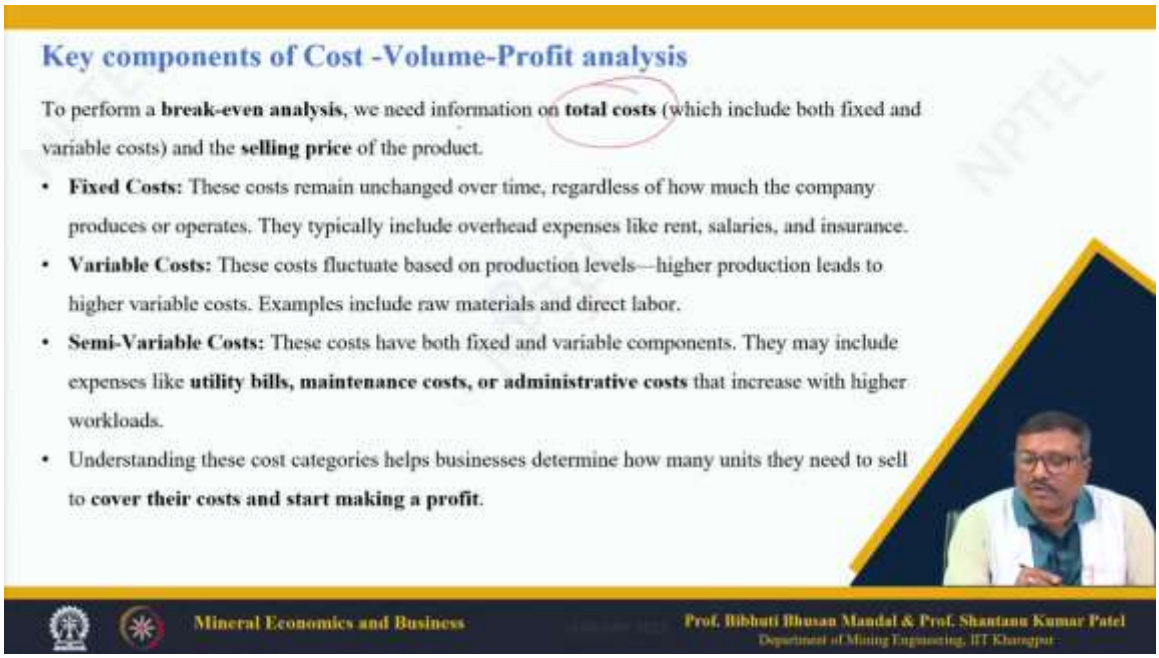

The if there is a cost I can either load in the fixed or I can load in the variable cost. Fixed cost will ah stay the same that means, even if you are changing drastically the assumption is that this is not going to impact the fixed cost then this calculation will not hold true. Now, in variable cost there that will move in direct proportion to the number of units produced and sold not only or sold rather produced and sold they are directly proportional. The selling price will remain constant. If it varies then this calculation in the beginning will not hold true.

If this variation can be incorporated later on, but to understand the cost volume property analysis the break even point or chart, we need to first assume all these things. So, the cost data plays a crucial role in the break-even analysis. You need to know the cost as we have discussed in the earlier lecture about the cost, their cost centers, the job wise, unit wise cost, all these these figures will be very much required. This will help the business determine a point where the revenue equals the total cost. That means, the total cost that is involved equals to our earning.

So, at that point we make neither profit nor we incur any loss. So, it simply covers our expenses that is all. So, to calculate the the breakeven point, the cost need to be classified into fixed cost that means, which remain constant and variable cost which change ah with the production volume. Now, the formula for breakeven point is:

$$Break\text{-}even\ point = \frac{Fixed\ costs}{Unit\ selling\ price - Unit\ variable\ cost}$$

The portion of the revenue left after covering the variable cost is known as the contribution margin. So, that means, the portion of the revenue which is covering the variable cost if that is covered then what is remaining? The fixed cost the fixed cost. So, the portion of the revenue left after the covering of the variable cost which is now known as contribution margin for example, this will help in covering the fixed cost and generating profit beyond the breakeven point which we will explain with the graphics.



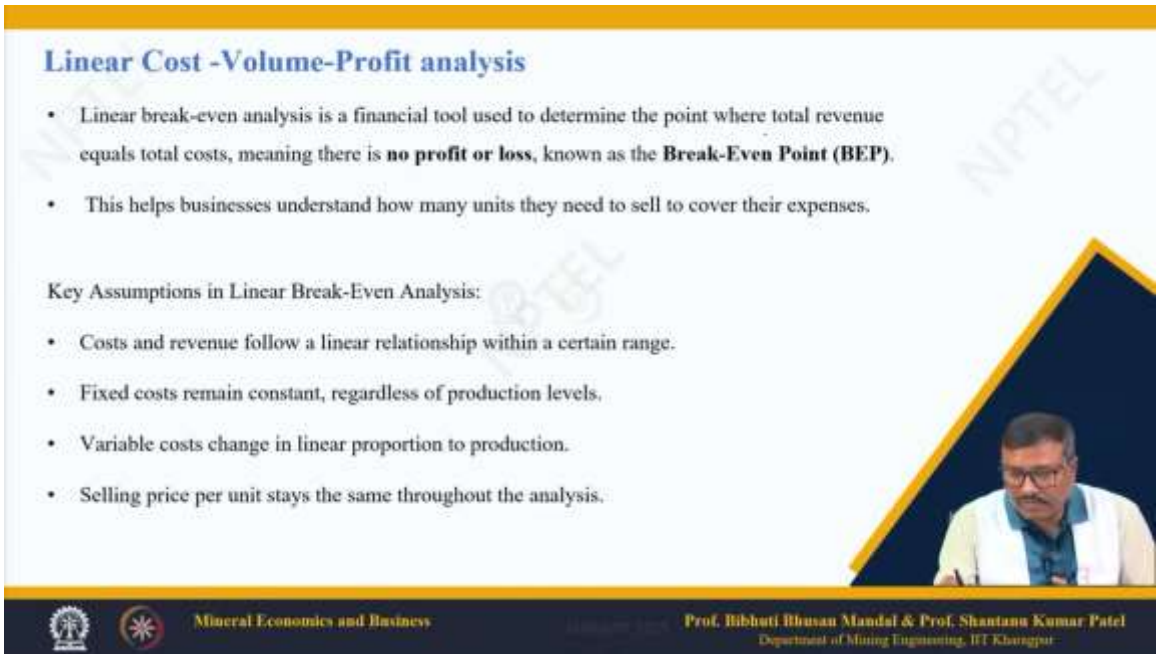

the what are the key components of a cost volume profit analysis. To perform a breakeven analysis you need to information need all the information regarding the total cost which include the fixed and variable cost. And of course, the the the selling price of the product the selling price of the product. So, the fixed cost unchanged over time regardless of how much the company is producing.

They typically include the overhead expenses that are fixed, like the rent, the salaries, and the insurance, which are fixed costs. And then the variable costs will fluctuate; these

costs will fluctuate based on the production levels. Higher production leads to higher variable costs. And examples are, the raw materials required to produce any item.

If you increase production, you will require more raw materials. If you are producing less, you will definitely need fewer raw materials. And of course, the direct labor can vary depending on when it is contractual. So, the variable costs can also be controlled by varying the number of laborers you are deploying for the purpose of production.

There are some semi-variable costs. These costs have both fixed and variable components. So, they may include expenses like utility bills, maintenance costs, and administrative costs. These will increase with higher workload, but initially, they will remain constant. When you just open the office or the factory, it will incur certain costs that you cannot change.




But if you start running the machines and begin operating, then you will see that this is directly varying with the production or production volume. Understanding these cost categories helps the business determine how many units we need to sell to cover their costs and start making a profit. So, we need to understand that volume and that amount of production where we break even, meaning no profit and no loss, and if we cross that, we start making a profit. In the linear cost-volume-profit analysis, this is nothing but a financial tool—an important financial tool used to determine the point where total revenue equals total cost.

meaning there will be no profit or loss, known as the break-even point or BEP break-even point. This helps businesses understand how many units they need to sell to cover their expenses. Now, the key assumptions in linear break-even analysis—again, I will repeat before I show you the chart. The cost and revenue follow a linear relationship within a certain range; after that, it will be non-linear, which is not covered in this particular lecture. The fixed cost will remain constant regardless of the production level, whether you are reducing or increasing it.


Now, the variable cost will change linearly depending on the production—that means, directly proportional to the number of units produced, say, for example—and the sale price per unit stays the same throughout the period of analysis. Applications include identifying the minimum sales volume to avoid losses, meaning you must know where you are making a profit. So, below that, we will be making losses, so we will avoid that. Assessing pricing strategies and profitability means determining what price we should set, considering all our expenses and also our competitors, to ensure we make a profit and maintain profitability over a certain range. So, supporting—it helps in supporting financial decisions related to new products and investments also in the beginning.

So, this will identify also the minimum sales volume required to avoid losses as I said earlier and it assists in pricing strategies and cost management, it helps assess the

financial feasibility of the new products. So, these are the benefits. This we have understood from the application. These are the benefits that we get from the application of the linear cost volume profit analysis. For example, now we will try to analyze these things.

We consider the following for linear cost volume profit analysis:

FC = Total fixed cost

Q = Quantity produced and sold

VC = Unit variable cost

P = Profit

S = Unit selling price

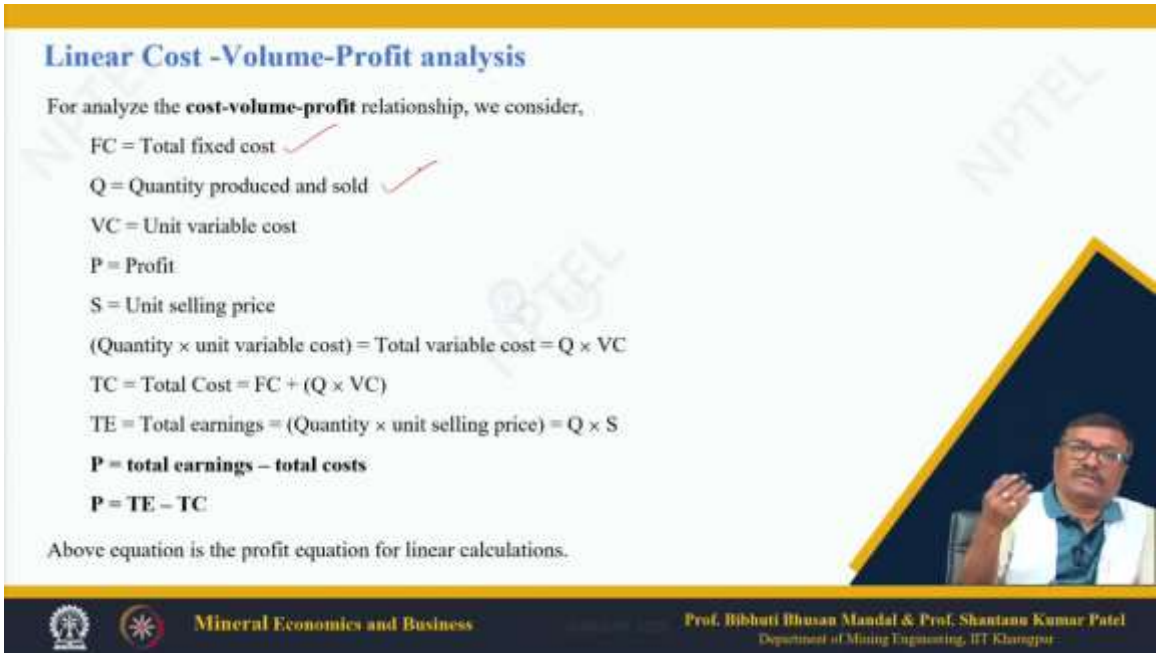
(Quantity × unit variable cost) = Total variable cost = Q × VC

TC = Total Cost = FC + (Q × VC)

TE = Total earnings = (Quantity × unit selling price) = Q × S

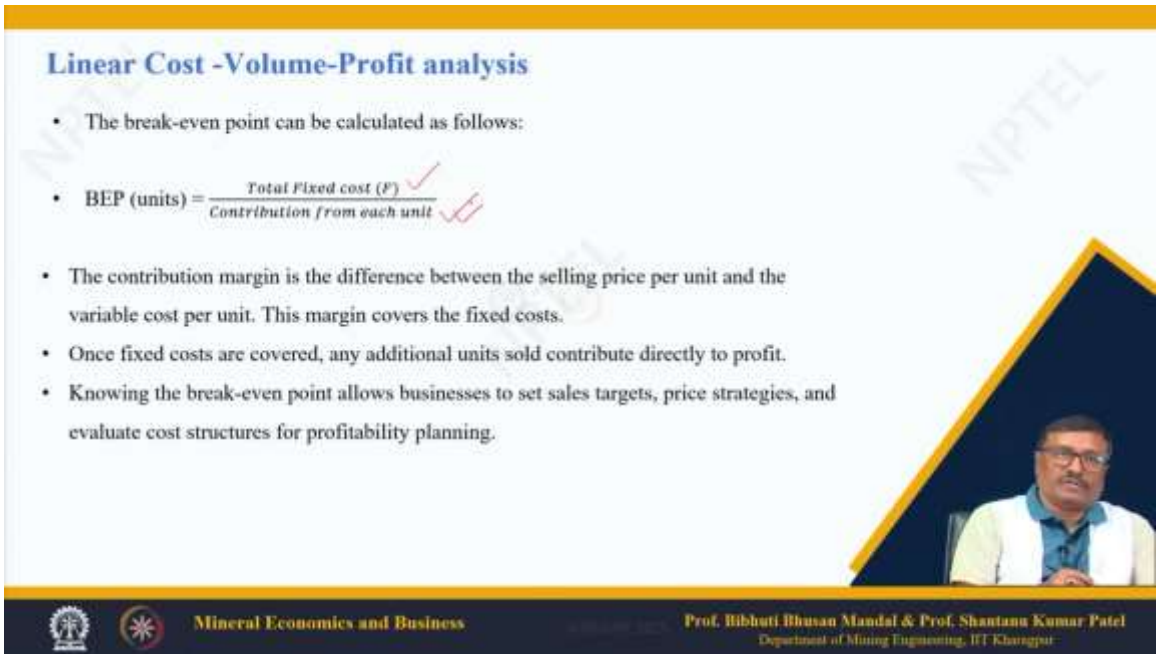
**P = total earnings – total costs**

**P = TE – TC**



The break-even point can be calculated as follows:

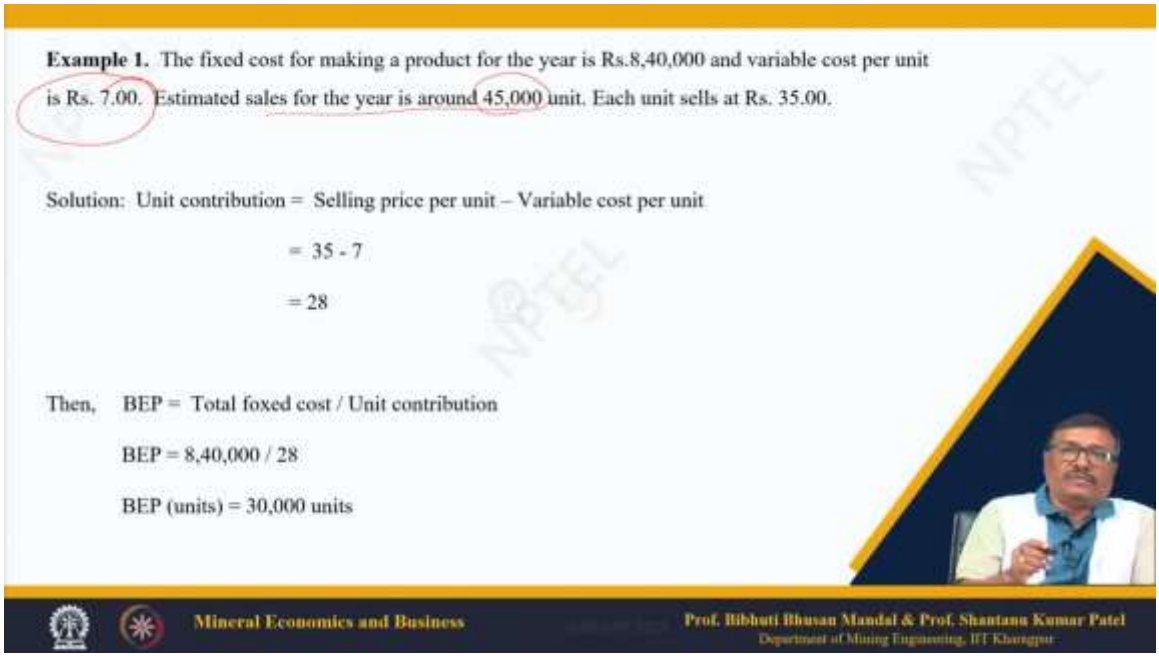
$$\text{BEP (units)} = \frac{Total\ Fixed\ cost\ (F)}{Contribution\ from\ each\ unit}$$




So, the contribution margin is the difference between the selling price per unit and the variable cost per unit—this difference. So, the selling price per unit minus the variable cost per unit is called the contribution from each unit. This margin will cover our fixed cost. To reach the break-even point first. So, once the fixed costs are covered, any additional units sold will contribute directly to the profit.

That means the first job is to offset the total fixed cost. Now, we have the idea of the contribution from each unit, which is nothing but the sales revenue, or rather the cost or the selling price per unit. Minus the variable cost per unit. Selling price per unit minus the variable cost per unit will give us the contribution from each unit.

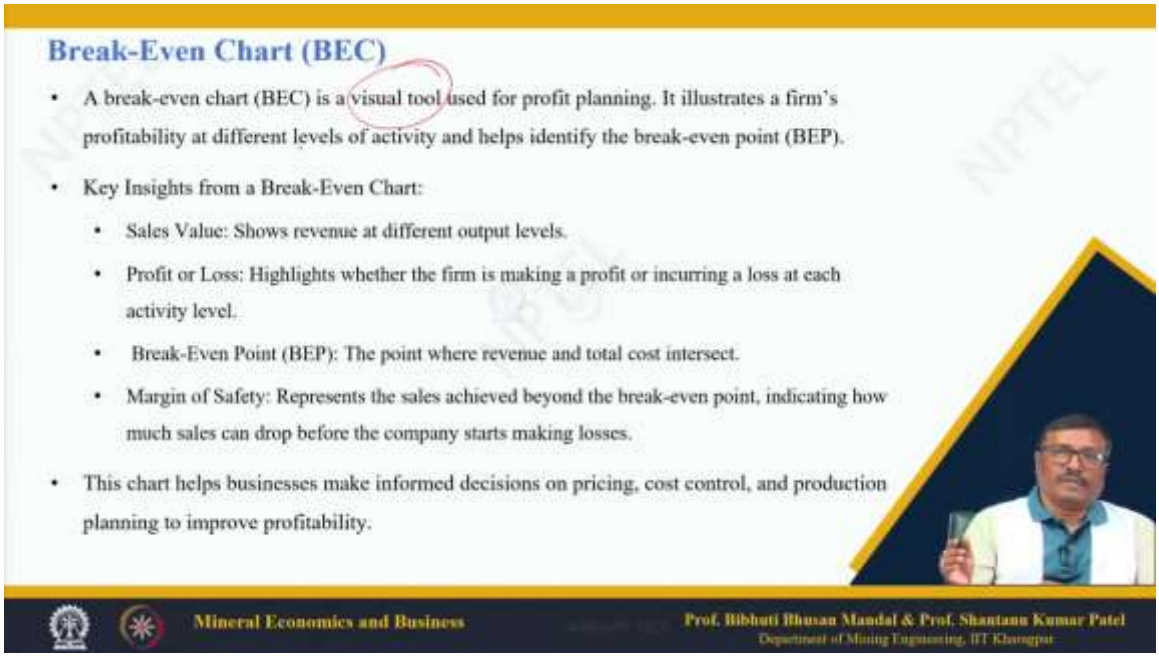
So, knowing the breakeven point allows businesses to set sales targets, pricing strategies, and evaluate the cost structure for profitability planning. Here, by doing this, we know that if you produce this much, then we reach the breakeven unit, which is the breakeven volume. Which satisfies this particular condition in this formula. So, what is happening? We get the number of units to be produced for achieving the breakeven point. Beyond that, whatever we produce will give us profit. For example, the fixed cost for making a product for the year is, say, 8,40,000. For a year, we have a fixed cost of 8,40,000.




And the variable cost per unit is, for example, rupees 7. Now, the estimated sales for the year are 45,000 units, and each unit will sell at rupees 35. So, the variable cost is rupees 7, for example, and the unit selling price per unit is 35 rupees. So, what is the unit contribution? The sale price per unit minus the variable cost per unit comes to rupees 28.

Now, we have to divide the total fixed cost divided by the unit contribution which is 28. So, the break even point is total fixed cost divided by the unit contribution that means, 28 that gives us the break even points equals to the 8,40,000 which is the fixed cost divided by 28. So, we need to 30,000 units and sell in the market to reach the break even point. Remember that our capacity is to produce 45,000 unit we can produce and we can say estimated sales.

So, the break even is already reached when you have produced 30,000 unit. So, if you are producing then you will see that the fixed cost is already covered, but we are now making profits because there is a difference between the sale price and the and the variable cost per unit that means, the unit contribution. To illustrate this, we have something called a breakeven chart or BEC, this is a visual used for-profit planning.

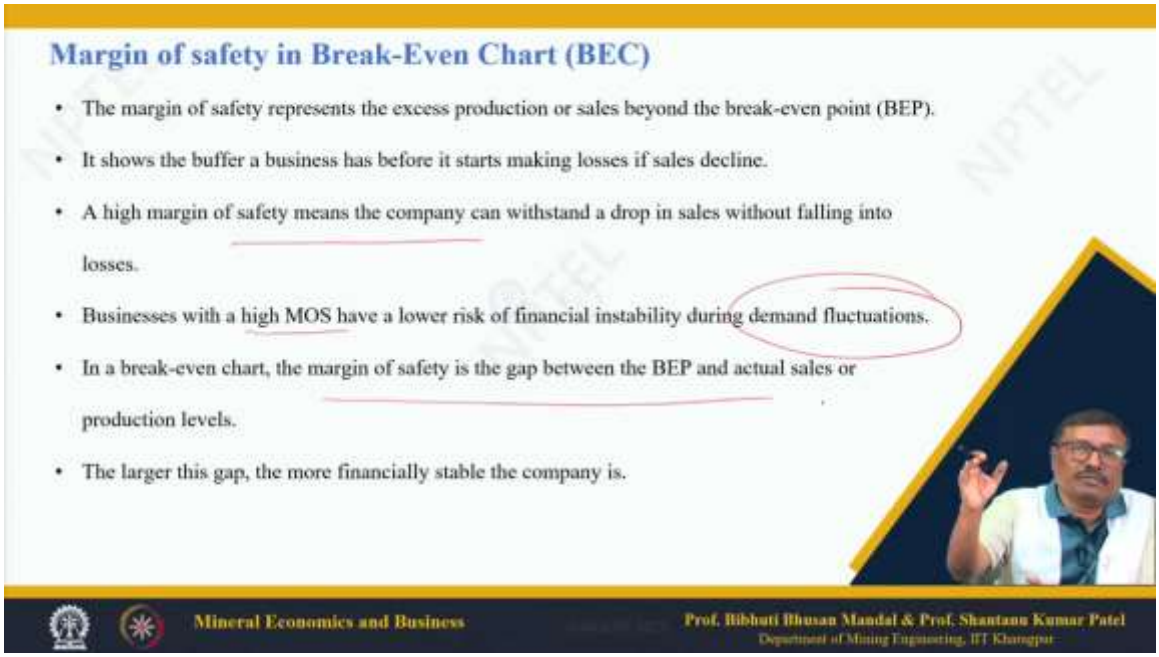



You will see that in many project report this break-even chart is used. This illustrates a firm's profitability at different levels of activity and it helps to identify the break-even point first and then the profit margins depending on different levels of production volume beyond break-even point. So, this shows there are certain important things in the breakeven chart rather the essential part that it shows the sell value, shows revenue at different in output levels, the curve or the straight line here. Profit and loss it highlights whether the firm is making a profit or incurring a loss at each activity level. break even point where the total revenue equals to the total cost.

They intersect the both the lines and there is a margin of safety, this represents the achieved beyond the breakeven point. This indicates how much sales can drop before the company starts making losses. That means, you need to know that margin of safety and and if if that margin of safety erodes that means, then we reach a point of breakeven point, then we go below and start making losses. This chart will help us help the business to make informed decisions on pricing, cost control and production planning to improve overall profitability.

The margin of safety represents the excess production or sales beyond the breakeven point. We will see soon ah ah the margin of safety. It shows that ah there is a buffer that business has before it starts making losses if sales decline. A high margin of safety also

means the company can withstand a drop in sales without falling into losses. So, businesses who are having high MOS have a lower risk of financial instability during demand fluctuation.

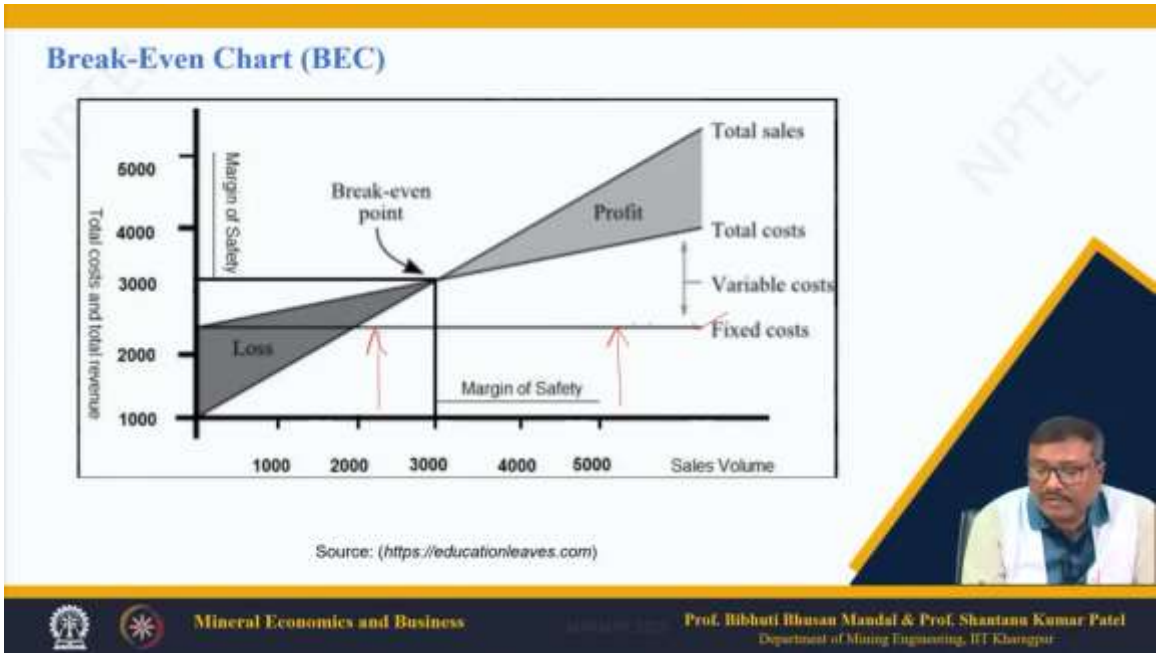



And in a breakeven chart the margin of safety is the gap is the gap between the breakeven point and the actual sales or production level. So, that margin you have margin of safety that means, you are maintaining ah level beyond the breakeven point and ensuring your profitability. The larger this gap, more financially stable the company is. We will come back to this once again once we see the chart. Now this is the breakeven chart that we are talking about.

Now, the fixed cost, for example, is this one—the fixed cost. This is parallel to the x-axis; it does not vary. The assumption is that this does not vary with the volume of production. So, we make this parallel to the x-axis; this is the fixed cost, and we also have the variable cost. The variable cost, you see, is coming from here to this—this is the total cost, and this is our total sales.

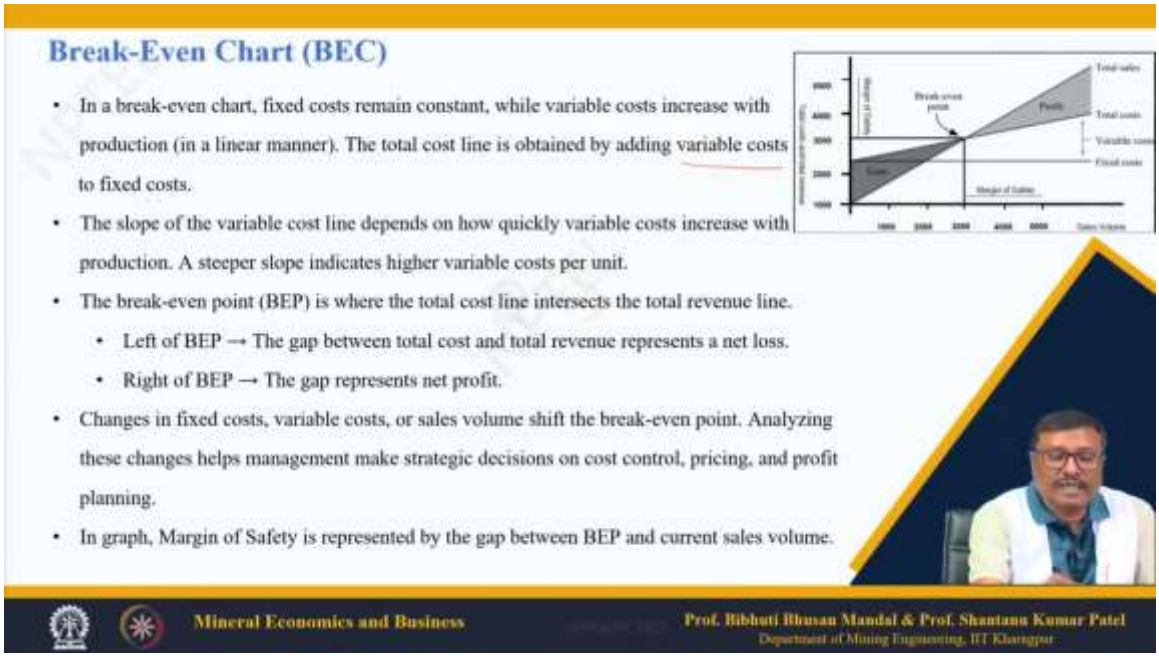
So, the variable cost is added to the fixed cost, and we get the total cost. So, the total cost is composed of two things. One is the fixed cost, and the other is the variable cost. Now, the total sales is this one—this is the sales revenue. So, when you are not selling

anything, then you have the sales revenue at 0, and then it is directly proportional to the sales unit, and we plot this total sales here.




So, what do you see here? You see that there is a difference at this point between the total cost and the total sales—you make a profit here. So, this is the total cost line (Tc), and this is the Te—this is the total earnings line, and this is the total cost line (Tc). It is crossing at a point when the total cost equals the total earnings, or rather, the total earnings equal the total cost, and that is what we call the break-even point—this is the break-even point. Now, for understanding this thing once again, the first thing is that we know what this fixed cost is, and also we can calculate the variable cost since we know the rate of variable cost per unit.

So, if you are producing 0, no unit then your variable cost component will be 0. but the total cost component will be fixed cost, fixed cost plus variable cost which is 0, this is equal to the fixed cost. That is why we start from here, when we produce number of unit produced will be 0, still there will be a fixed cost and once you start producing then the total cost  it goes like this. This is the cumulative cost, fixed cost plus the variable cost. Now, this is representing the variable cost part.



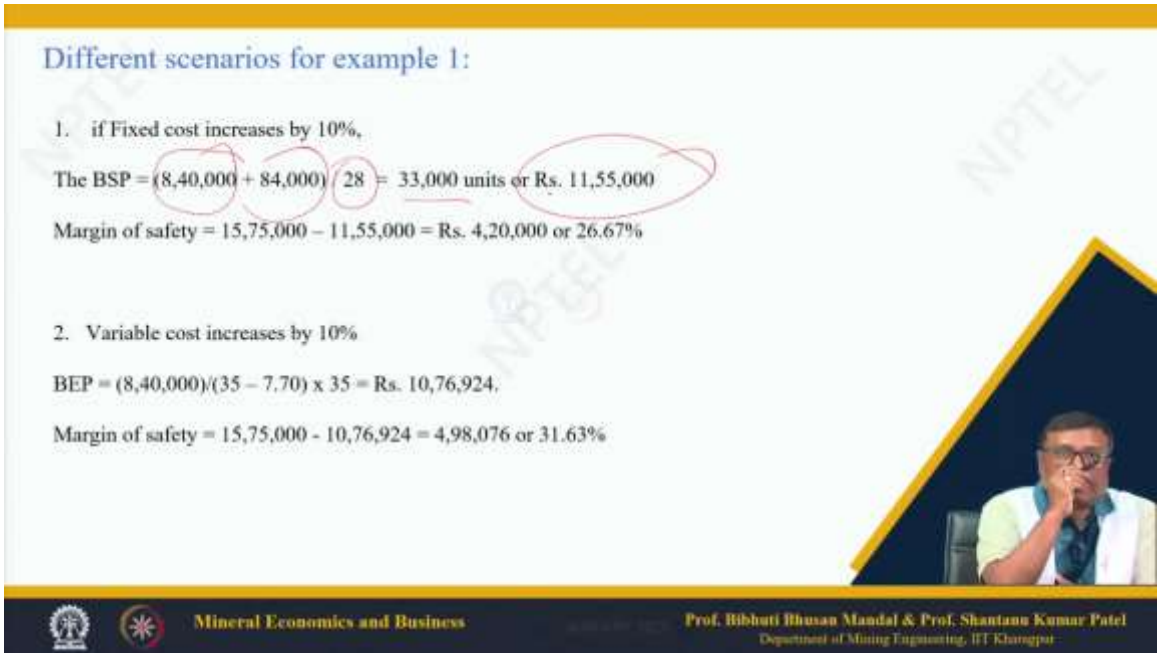

So, total cost is fixed cost plus the variable cost and this is giving you the total earnings, total earnings from the sales. This is the point where we have the break even. So, the margin of safety will be beyond this breakeven point both sides means in terms of sales volume also in terms of earning total cost and total earning both side also you can express this margin of safety. The more the margin of safety if you are here more the margin of safety if the demand falls or if you have some problem still you will be continuing to make profit unless you fall here and start making losses going below the break even point.

So, more the margin of that is why it is called the margin of safety if it is more you are more stable as a company you are more stable. In a breakeven chart the fixed cost remain constant while variable cost increase with production as I have explained in a linear manner. The total cost line is obtained by adding as I said fixed cost and the variable cost. And, the slope of the variable cost line depends on how quickly the variable cost increase with the production. A steeper slope indicates higher variable cost per unit that means, it is highly varying.

The breakeven point is reached where the total cost line intersects the total revenue line, as we have seen here. This is where the total earnings (TE) equal the total cost expenses (TCE). The breakeven point is where the total cost line intersects the total revenue line,

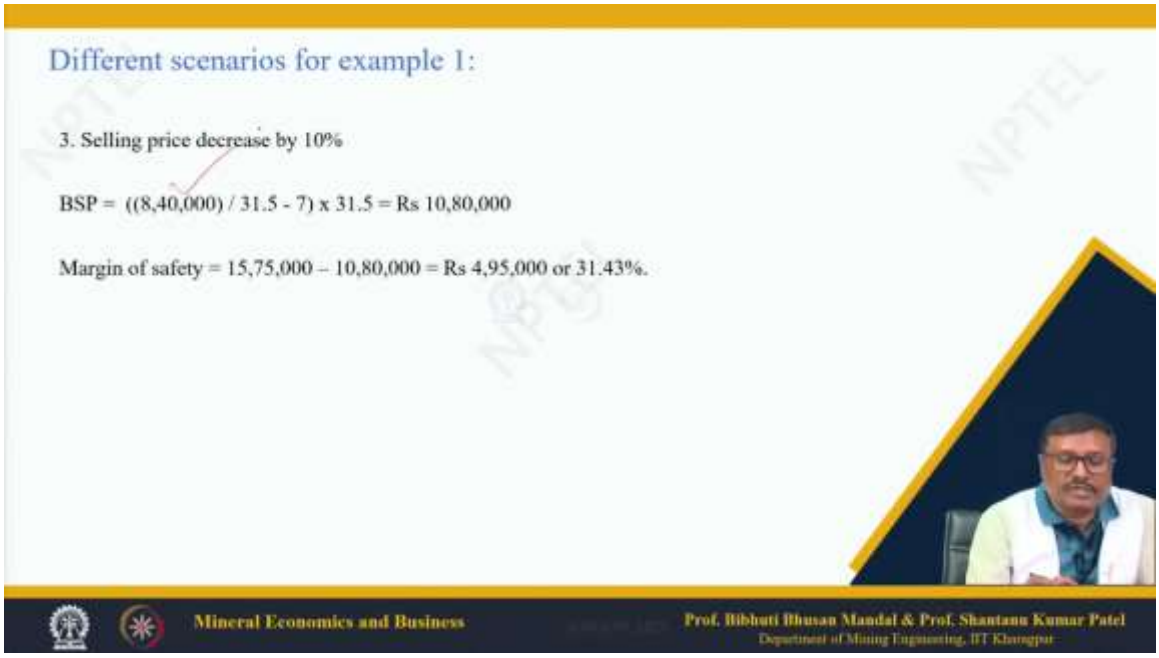
making them equal. Left of the BEP, the gap between the total cost and the total revenue represents the net loss on the left side—this part is the loss zone—and on the right side, the gap represents net profit.

So, changes in fixed cost, variable cost, or sales volume shift the breakeven point. Since figures like fixed cost, variable cost, or sales volume change, this will shift the breakeven point on both sides. So, in the graph, the margin of safety is represented by the gap between the BEP and the current sales volume. If the current sales volume is here, then this will be the margin of safety. This is the margin of safety.




Now, we can perform some sensitivity analysis. As we said, if the fixed cost changes by 10 percent for the year, what happens? The fixed cost of 8,40,000 increases by another 84,000—a 10 percent increase. So, divided by the contribution margin of 28, it becomes 33,000 units, or now it is 11,55,000 in total. Now, the margin of safety is this minus the previous one.

So, this is becoming 26.67 percent is our your margin of safety MOS, it drops a percentage. Now, if the variable cost is increased by say 10 percent. then what happens we are keeping the other things constant. So, the 8,40,000 is remaining constant, then this is the variable cost is increasing Then we have we are multiplying by the rupees 35 as the ah sale.




So, now we are getting the margin of safety at 31.63 percent. So, if the variable cost is increased by say 10 percent this will be the effect this will be the effect. Now the selling price for example, falls by 10 percent falls by 10 percent. In that case what happens that the your 8,40,000 that fixed cost will remain same and the sale price which was previously 35 has become 31.5. cost minus the your unit variable cost minus 7 and we multiply by 31.5 which is now the sale price, new sale price.

So, we get this amount, this amount is changing. So, margin of safety now changes to this minus 10,80,000. this is now becoming 31.43 percent. That means, we can check if the sale price decreases by 10 percent what will be the effect, if the fixed cost changes what will be the effect, if the variable cost changes then what will be the effect. By doing this we can understand how sensitive this our breakeven or profit equation is to the changes that can occur either to fixed cost or variable cost or the sales volume or the sales revenue per unit.

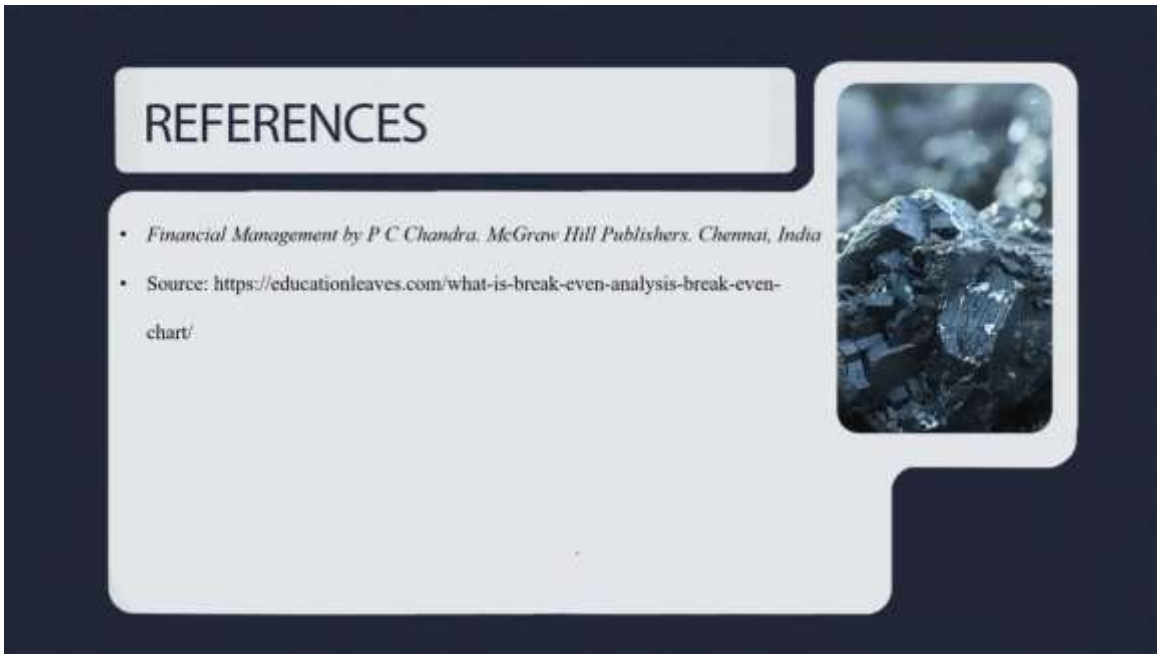
So, the limitations are the assumptions of linearity itself is a limitation because the total cost and the total revenue behave in a linear fashion, which may not be true in a real-world scenario. So, the variable cost could increase due to bulk purchasing or operational inefficiencies, or say, selling prices may vary with demand or discounts. Sometimes, what happens if there is a huge sale? Then you may offer a discount, in which case the

selling price will not remain constant. So, the assumption of linearity depending on any volume of production and sales is not practical, and fixed costs are not always fixed. This assumes that, in our case, the fixed cost will remain unchanged across all production levels.


In reality, costs like facility expansion, equipment upgrades may occur due to scaling of production. Secondly, no focus on mixed costs. Semi-variable costs, like maintenance costs with fixed and variable elements, are not well addressed in linear models. So, we need to go for a more practical, realistic break-even analysis, where this variability—which is practical—should be included, and we can find a more realistic projection of the break-even point, margin of safety, and conduct a more realistic break-even analysis. Single-product focus simplifies the calculation by assuming only one product.

So, here we are not mixing up the analytical part; we are not making it complicated—we are using a simple product focus. And relevant range assumptions. So, break-even analysis is valid within a specific range, beyond which it may not remain linear, as we have understood by this time. We have also excluded the time value of money here—it does not account for these things. Now, lack of strategic context also provides only quantitative insights without considering strategic goals like market share growth or customer retention, which are more complicated.


This is a more or less simplistic model to help you understand how it occurs. Then we can add more complicated things to make it more realistic, and in that case, the analysis will be more complicated, as we can easily understand.




Definitely, we need revisions and changes in this, and we may have to modify our linear models into non-linear models, which we will do in the next lecture. To understand it

better, you can read these two books: Financial Management by P.C. Chandra, which is a very popular book, and also certain websites like The Education Lives Here, where you can learn about break-even analysis in a better way. So, with this, we come to the end of this particular lecture dealing with linear break-even analysis and cost-volume-profit analysis.

In the next lecture, we will cover non-linear break-even analysis, which is more realistic and practical. Thank you.