Decision Making With Spreadsheet
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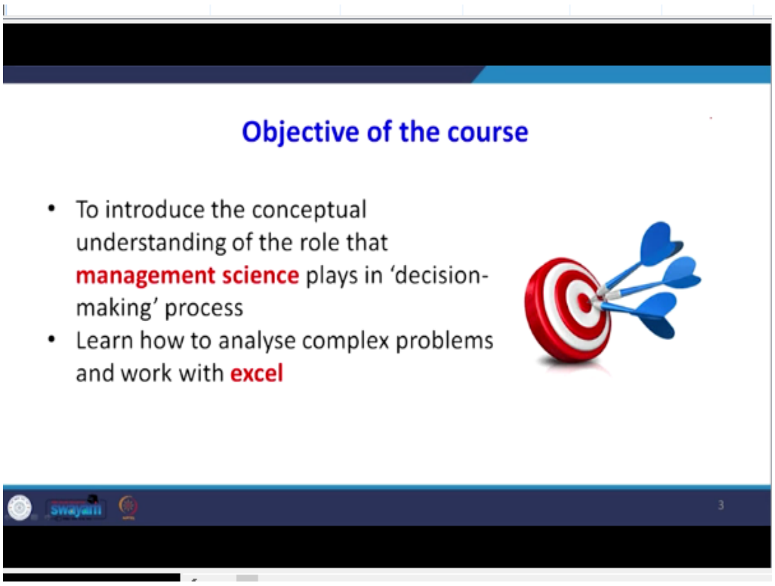
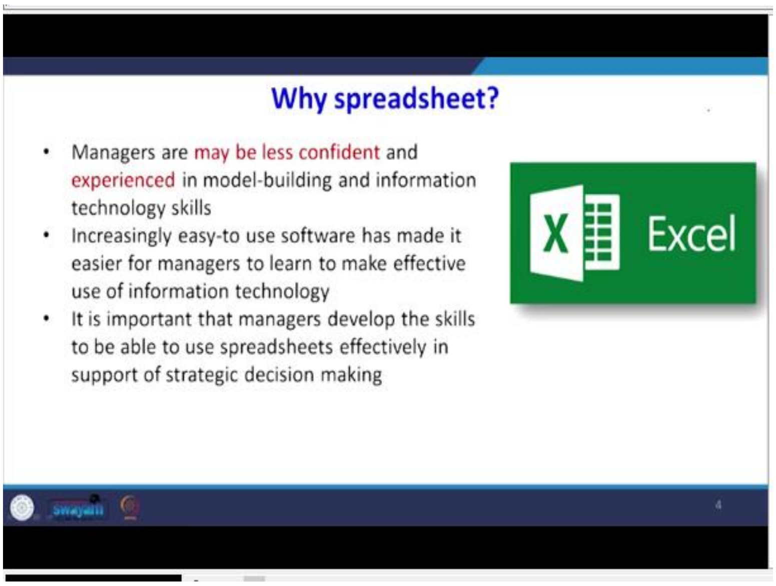
Lecture-01
Introduction

Welcome students to the course *Decision Making with the Spreadsheet*. Why decision making is important for business?

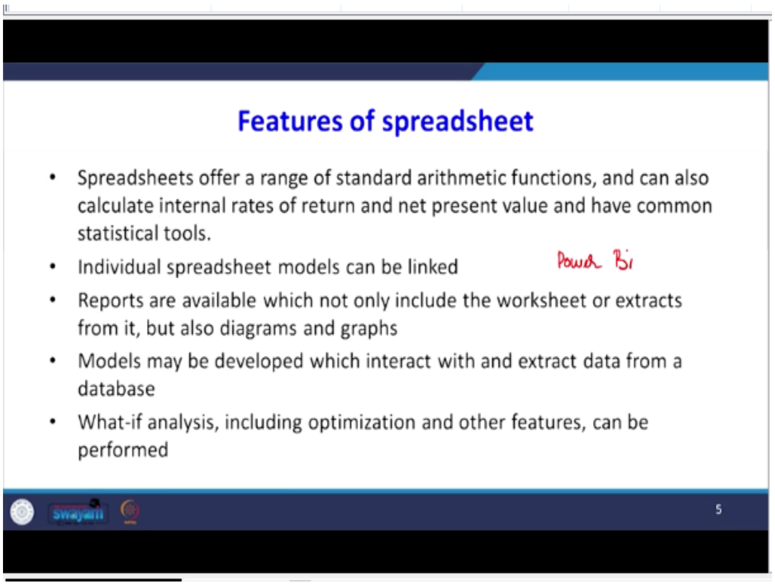
Leaders need to be good decision-makers; leaders learn to understand the difference between what is rational and what feels right. Good decisions save your time and money. When decisions are made, employees gain confidence, and stronger professional development becomes possible. Like this, there are so many events that affect our decisions. So, the purpose of the title of this course is *Decision Making with the Spreadsheet*.



The objective of this course is to introduce the conceptual understanding of the role of management science in the decision-making process. Here is what we have planned for this course. Yes, we are going to make the decisions with the help of management science, and you will learn how to analyze complex problems and work with Excel. You may ask why the spreadsheet is used for decision-making.



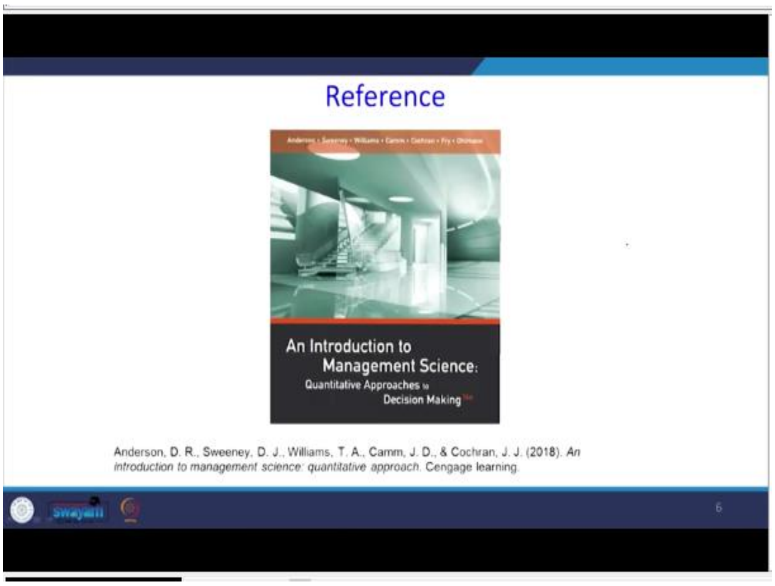
Managers may be less confident and less experienced in model-building and information technology skills. Increasingly easy-to-use software has made it easier for managers to learn to use information technology effectively. It is important that managers develop the skills to use spreadsheets effectively in support of strategic decision-making. That is why I will teach in this course how to use Excel spreadsheets to make decisions.



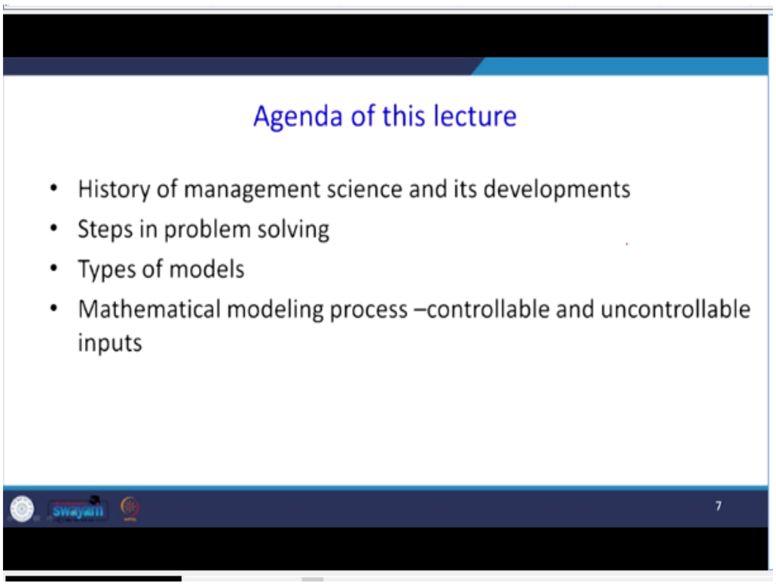
Why a spreadsheet? What are the features of the spreadsheet? A spreadsheet offers a range of standard arithmetic functions and can also calculate the internal rate of return and net present value and have common statistical tools. Another advantage of using spreadsheets is that individual spreadsheet models can be linked with Microsoft. There is software called Power BI. For example, the software Power BI will help you to link various spreadsheets.

Obviously, the data may be collected at different points in time and in different places. The data may be collected in the form of a spreadsheet. So, if you want to make a decision by considering all the spreadsheets, it is possible to link them. Reports are available, which include not only the worksheet and extracts from it but also diagrams and graphs. Models may be developed to interact with and extract data from your database.

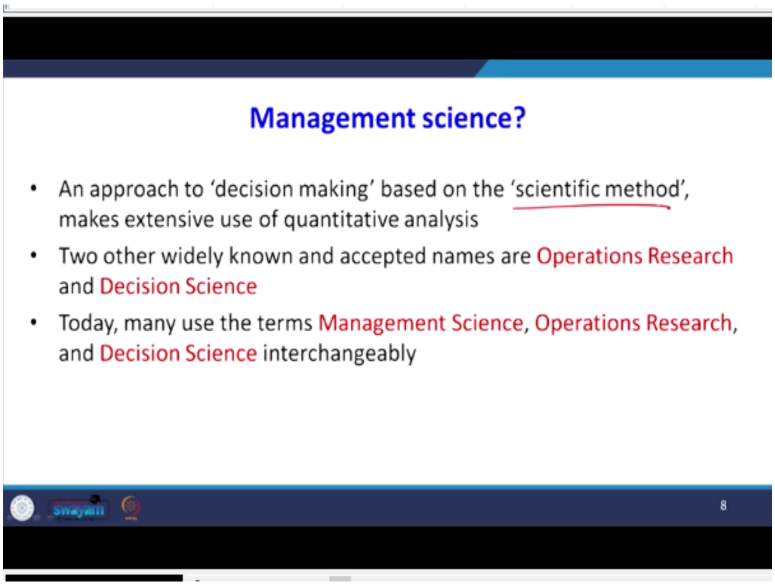
Excel can also be used to import data from the database. Excel also helps you make various diagrams and graphs, making it easy to interpret the result. Another advantage of using a spreadsheet is that we can do a what-if analysis, called a sensitivity analysis, which we will cover in detail in the coming lectures. We can do optimization, and other features can be performed with the help of a spreadsheet.



The reference book, which I am going to follow the title of the book, is the introduction to management science and quantitative approaches to decision making by Anderson et al.



What is the agenda for this lecture? I am going to explain the history of management science and its development. After that, I will explain the steps in problem-solving, and then I will explain the types of models because we will focus specifically on mathematical models. I will explain how to form a mathematical model and how to get a solution out of those mathematical models. Because when we say any models, there will be some inputs, I will classify those inputs into 2 categories: controllable and uncontrollable. That is the agenda for this lecture. What is management science?



It is an approach to decision-making based on the scientific method; it uses extensive use of quantitative analysis, two other widely known and accepted names for the management sciences, operations research, and decision science. Today, many use terms management science, operations research, and decision science interchangeably. Some books carry the title of management science. Some books carry the title as operations research and some books as decision science.

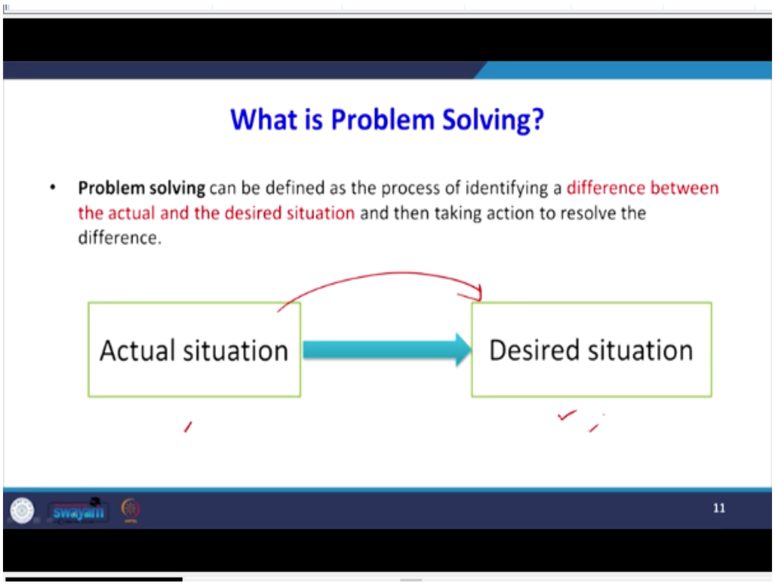
When you look at the history of management science or operations research, the concept of scientific management in 1911 was given by FW Taylor. He was the first person who talked about the importance of decision-making. He has suggested various ways to increase productivity and efficiency. After that, during World War II, from the year 1939 to 1945, because the resources are very scarce, a group of teams are formed to know how to utilize the resources optimizely.

How do we optimize resources? To address this challenge, teams were formed specifically for resource optimization. These teams included engineers, management scientists, and behavioral scientists. Cross-functional teams were created because the problem needed to be understood from multiple perspectives. After World War II, significant methodological developments occurred in management science. In 1947, Professor George Dantzig introduced the simplex method, a groundbreaking approach for solving linear programming problems in management science.

This development paved the way for significant advancements, especially with the advent of computers and the availability of software at lower costs and higher speeds. The field of operations research and management greatly benefited from these technological advancements. In this class, we will also use Excel solver to solve linear programming problems, which will assist you in making more informed and effective decisions.

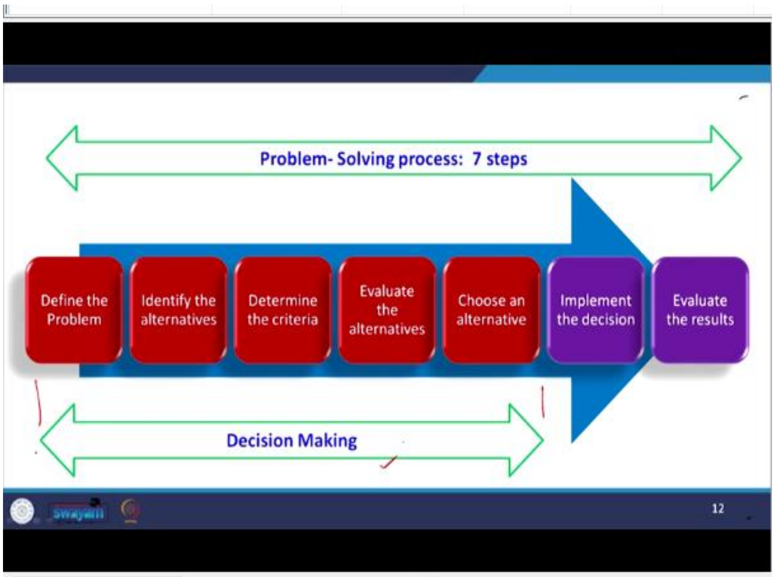
Another significant development is the explosive growth of data. With the internet's availability and the proliferation of mobile phones and social networks, collecting data is no longer a challenge. A vast amount of data is freely available.

The real challenge for management scientists and decision-makers is figuring out how to effectively use this data to make meaningful decisions. That is precisely what we will focus on in this class.

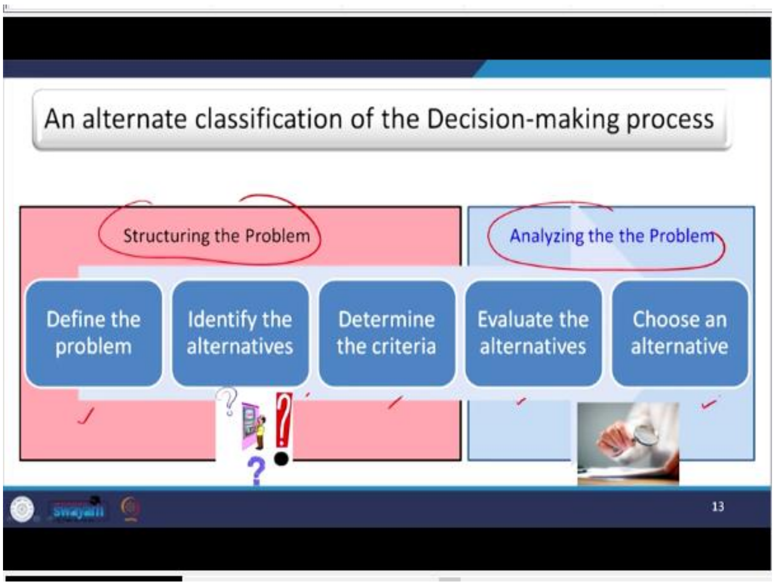


Then what is problem-solving? Problem-solving can be defined as the process of identifying the difference between the actual and the desired situation and then taking action to resolve the differences. Look at the left-hand side. There is an actual situation, and the right-hand side is the desired situation. There is a difference between actual and desired situations.

In this course, we aim to address the gap between the current situation (the actual state) and the desired situation (the ideal state). Our goal is to identify and implement ways to reduce this difference effectively. This process of bridging the gap between the actual and desired situations is what we call problem-solving.

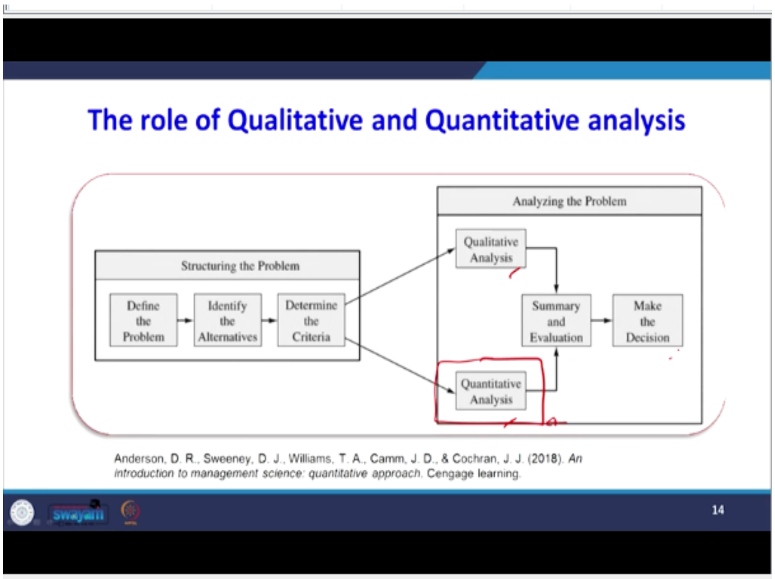


We have seen what is the problem solving in our previous slides. Now, we will see what the steps are for problem-solving. There are 7 steps. Define the problem, identify the alternatives, determine the criteria, evaluate the alternative, choose an alternative, implement the decision, and evaluate the result. Out of these 7 steps, the first 5 steps that are right from defining the problem to choosing an alternative is called decision-making. You will see that problem-solving and decision-making are highly related.



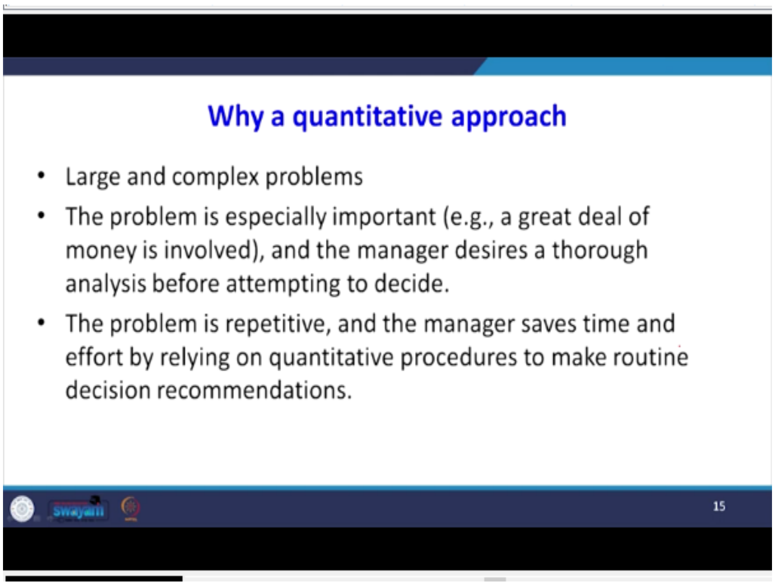
Now, we will see another alternate classification of the decision-making process in detail. See, we can have 2 classifications; one is structuring the problem, and the second one is analyzing the problem of the 5 steps. Again, I have classified some of the first two and three steps for structuring the problem and the remaining 2 steps for analyzing the problem. What is the meaning of structuring the problem, defining the problem, identifying the alternatives, and determining criteria? That is called structuring the problem.

Our focus in this course will also be on how to structure the problem. Once the problem is correctly structured, we will analyze the problem; for analysis, we are going to use Excel. So, in analyzing the problem, there are 2 stages: evaluate the alternatives and then choose the alternative.



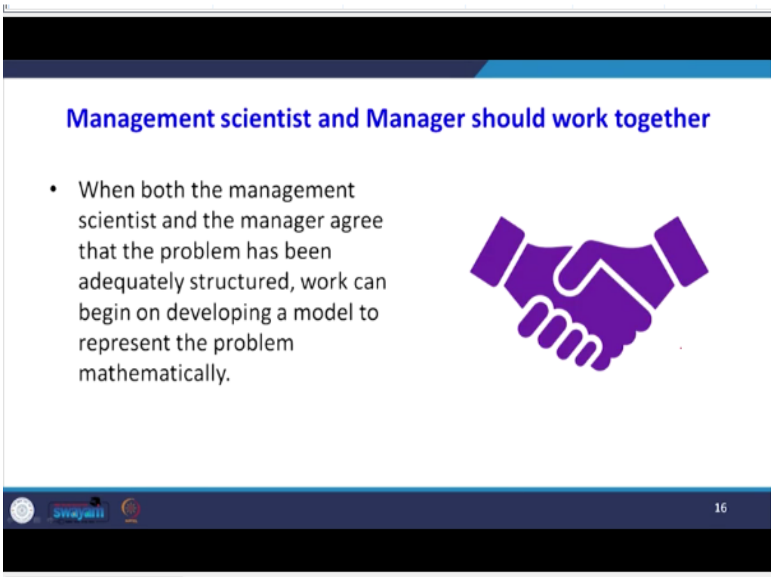
In the decision-making process, let us see the role of qualitative and quantitative analysis. We have seen the structure of the problem. The problem can be analyzed using qualitative and quantitative tools. If you are using qualitative tools, that is called qualitative analysis; if you are using quantitative tools, that is called quantitative analysis. In this class, we'll spend most of the time using quantitative analysis.

Qualitative analysis is equally important because many factors cannot be quantified when making the best decisions. Even though we use quantitative techniques for strategic decisions, the results often need to be complemented by qualitative analysis. In many cases, strategic decisions rely heavily on qualitative insights, followed by a summary, evaluation, and, ultimately, the decision-making process. I'm emphasizing that when analyzing a problem, we should leverage qualitative and quantitative tools to achieve well-rounded and effective solutions.



In this course, the focus is on the quantitative approach. You may wonder why a quantitative approach is necessary. When a problem is large and complex, adopting a quantitative approach becomes essential. This is especially true for problems involving significant financial implications. In such cases, managers seek a thorough and systematic analysis before making decisions. This is where the concept of quantitative analysis comes into play—helping to avoid costly mistakes and ensuring better decision-making.

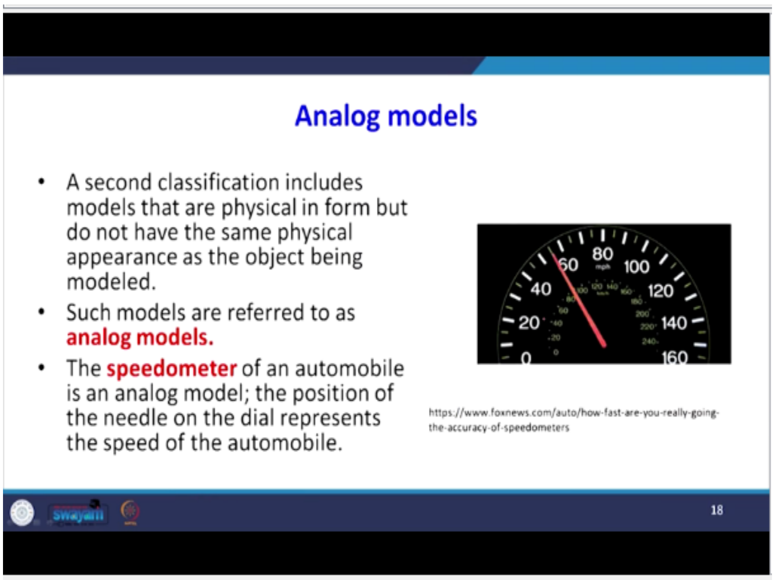
Another situation where we can use a quantitative approach is if the problem is repetitive and the manager saves time and effort by relying on quantitative procedures to make routine recommendations.



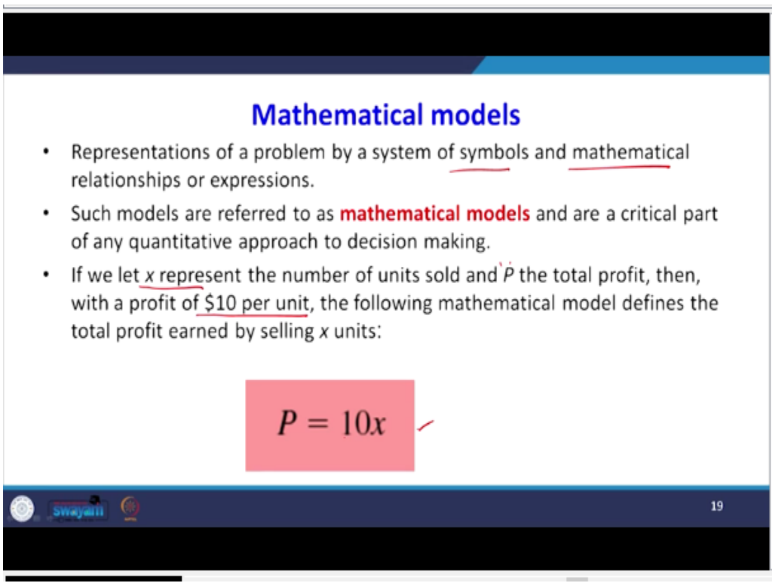
Another important point is that while using quantitative techniques, the management scientist and the manager should collaborate closely. What this means is that the manager, as the end user, must be involved throughout the process. As a management scientist, you may propose solutions, but it is crucial to ensure that, at every stage of the problem-solving process, you gain the manager’s trust and confidence. This is important because the manager is the one who will ultimately implement your recommendations and use the decisions you propose.

When both the management scientist and the manager agree that the problem has been adequately structured, work can begin on developing a model to represent the problem mathematically. So, here you need to have the confidence of your managers. Obviously, you, as a management scientist, should work together before solving the problem.

Then let us look at various models. The first model is the iconic model. For example, on the left-hand side, there is an airplane is there. So, we can have a model airplane model. So, by looking at the study by looking at the models, we can see what are the design characteristics of the actual models? For example, there is another bottom, and there is an example of a toy truck. So, the toy truck is a replica of your actual truck. What is the purpose of this model, because the model can be used for further analysis? This is a prototype of your actual product.

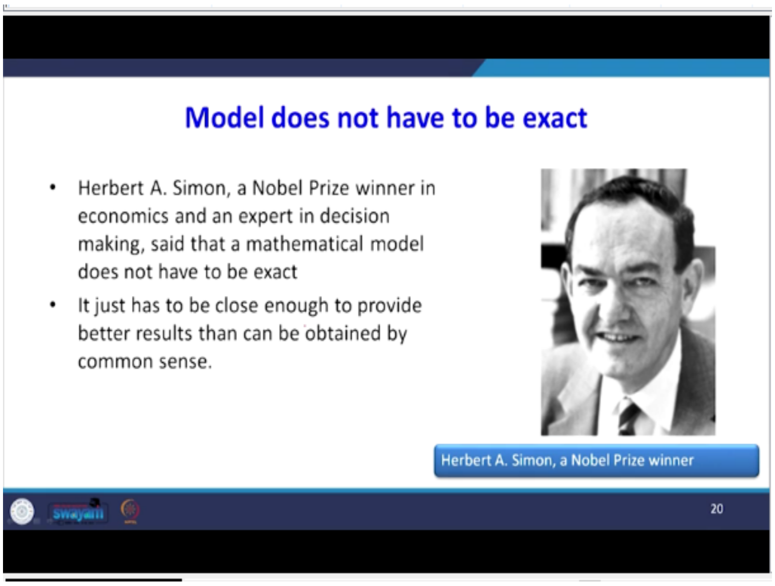


The next type of model is the analog model. It includes models that are physically informed but do not have the same physical appearance as the object being modeled. Such models are referred to as analog models. One example is the speedometer. The speedometer of an automobile is an analog model; the position of the needle on the dial represents the automobile's speed. This is an example of an analog model.

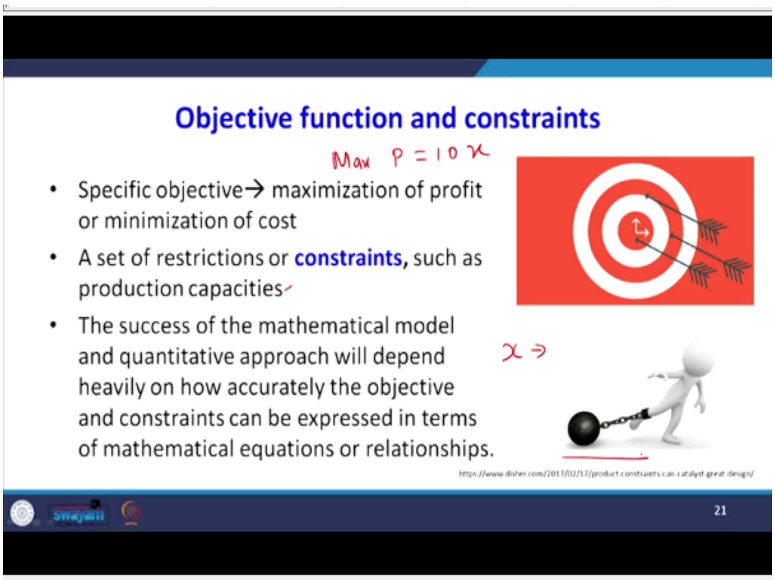


But in this course, we are going to use mathematical models. What is a mathematical model? Representation of your problem by a system of symbols and mathematical relationships are expressions. Such models are referred to as mathematical models and are a critical part of any quantitative approach to decision-making. For example, what is mathematical model?

For example, if we let x represent the number of units sold and P represents the total profit, then with a profit of 10 dollars per unit, the following mathematical model defines the total profit earned by selling x units. So, P = 10x an example of your mathematical model. Here, P is the profit; x is the number of units sold, and 10 represents the profit per unit, which is 10 dollars. So, this is a simple example of your mathematical model.

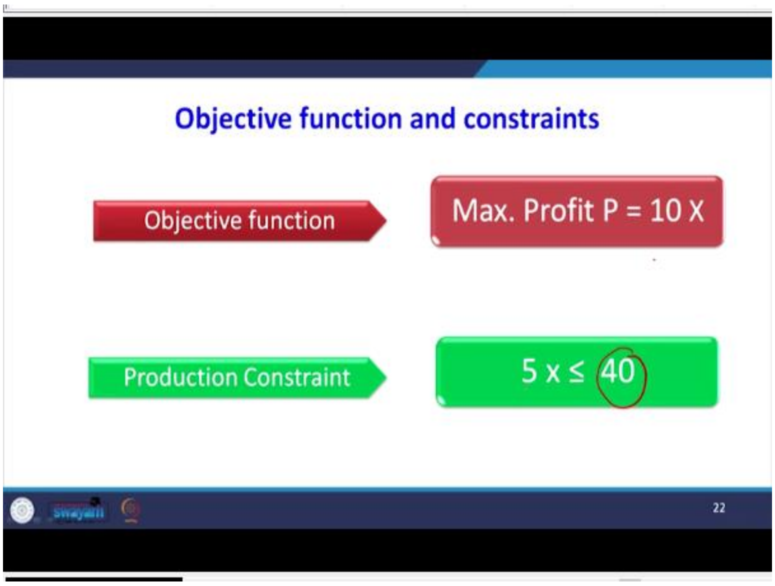


Herbert A Simon, a Nobel Prize winner in economics and an expert in decision making said that a mathematical model does not have to be exact. It just has to be close enough to provide better results than can be obtained by common sense. Obviously, when we look for your mathematical models, you need not provide the exact solution that is not required, but it should be close to the better result, but it has to provide the better result.

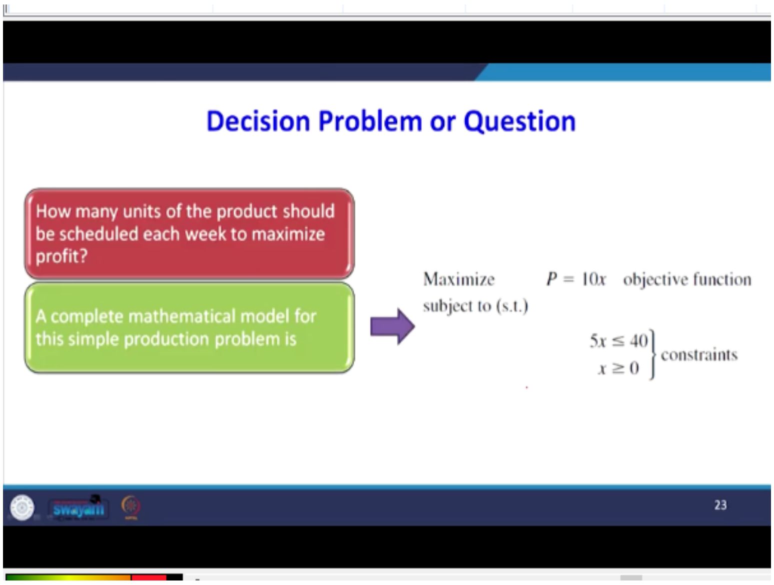


In the mathematical model, I will introduce certain terms. One is the objective function, and the other one is the constraint. There will be a specific objective; that objective may be maximization of profit or minimization of cost. So, in the previous case, when I say P = 10x, I must maximize my profit. So, here, maximization is our objective. A set of restrictions or constraints, such as production capacities, may exist because you cannot keep producing x.

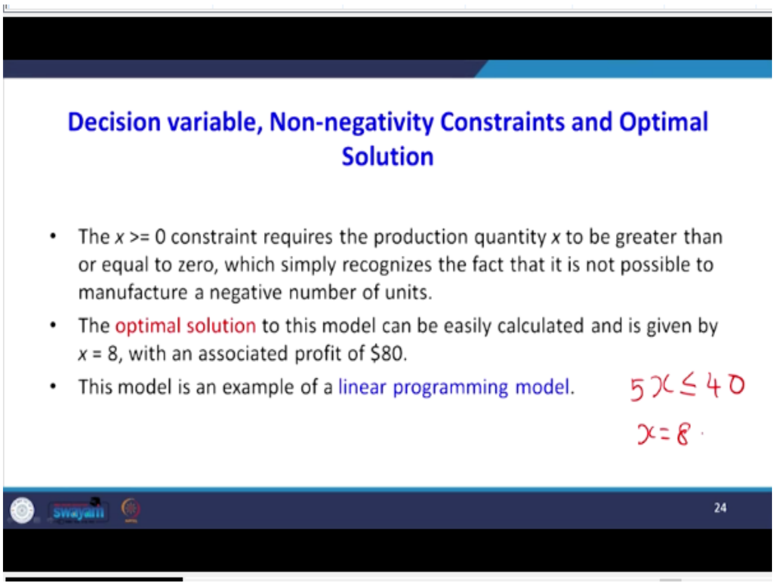
This success of a mathematical model and quantitative approach will depend heavily on how accurately the objective and constraint can be expressed in terms of mathematical equations and relationships. So, we have seen the objective function and the constraint. Constraint is the restriction. For example, x you cannot produce infinitely. The x may require some time; there may be available capacity and times, and the x must be produced only with the available times. So, that kind of restriction is called a constraint.



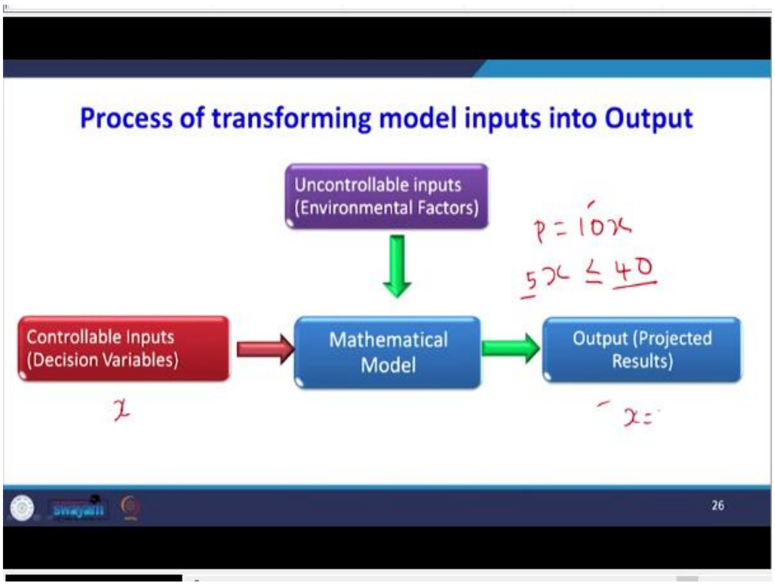
Do you see what I have shown you? The maximize profit P that is 10x is called the objective function. You see the maximum available time is 40 hours. Each unit takes 5 hours. So, 5 in the x should not exceed your 40 hours. Here, x represents the number of products. The 5 represents the time taken for making one product. So, the second one is called your product constraint.



The decision problem or question the manager is willing to ask is how many units of product should be scheduled each week to maximize the profit. The complete mathematical model for this simple production problem is to maximize P = 10x. This is called your objective function, subjected to 5x <= to 40, and x >= 0, which is called the constraint. The second one is called nonnegativity constraint; the first one is called capacity constraint.

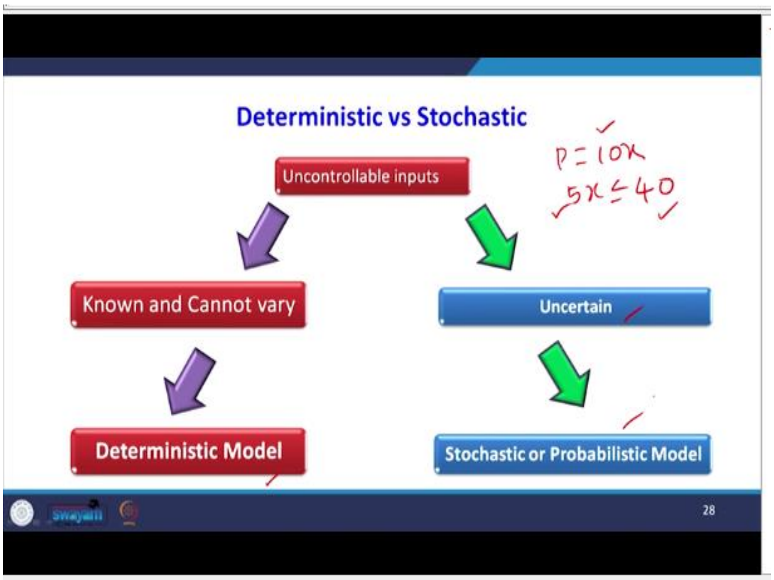


X >= 0 constraint requires the production quantity x to be greater than or equal to 0, which simply recognizes the fact that it is not possible to manufacture a negative number of units. The next term which I want to introduce here is the optimal solution. The optimal solution to this model, which I have shown in the previous slide, can be easily calculated and is given by x = 8 because we have seen 5x <= 40, which is our constraint. So, the value of x will be 8, this model is an example of linear programming, how I got x =40/5.

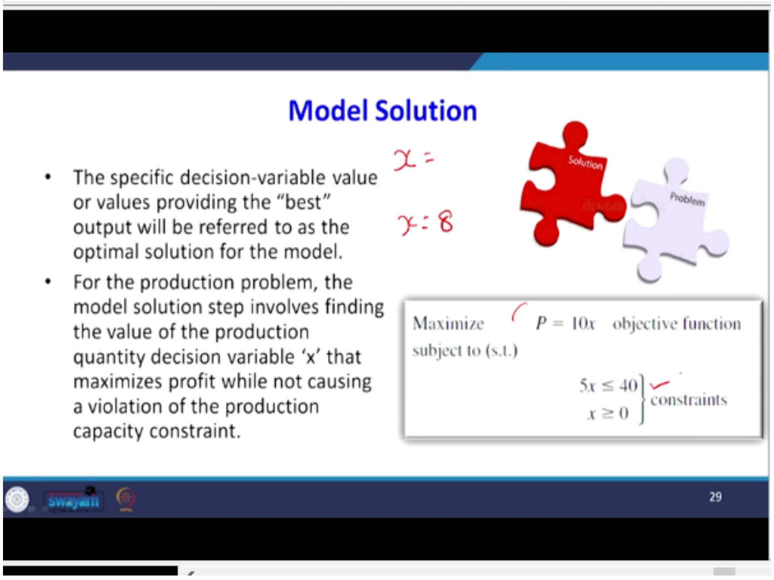


The process of transforming model input into output. I have discussed the classification of input: one is controllable input, and another one is uncontrollable input when I say P = 10x and 5x <= 40. For example, this 10 unit profit is the uncontrollable input. This 5 time taken to manufacture one product is uncontrollable input. This 40 total available time is your uncontrollable input.

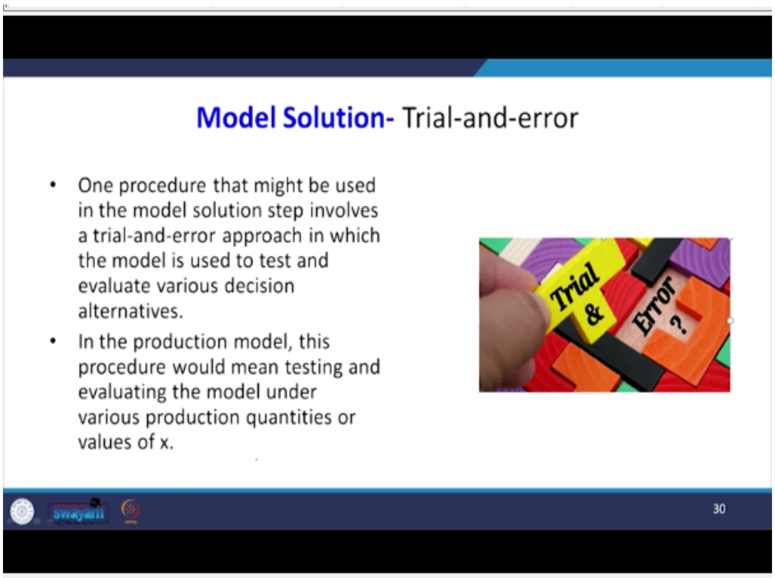
Then what is the controllable input x, and how many units need to be produced, that is your controllable input? So, when the model has controllable and uncontrollable inputs, you can get the output projected result, which is the value of your x.



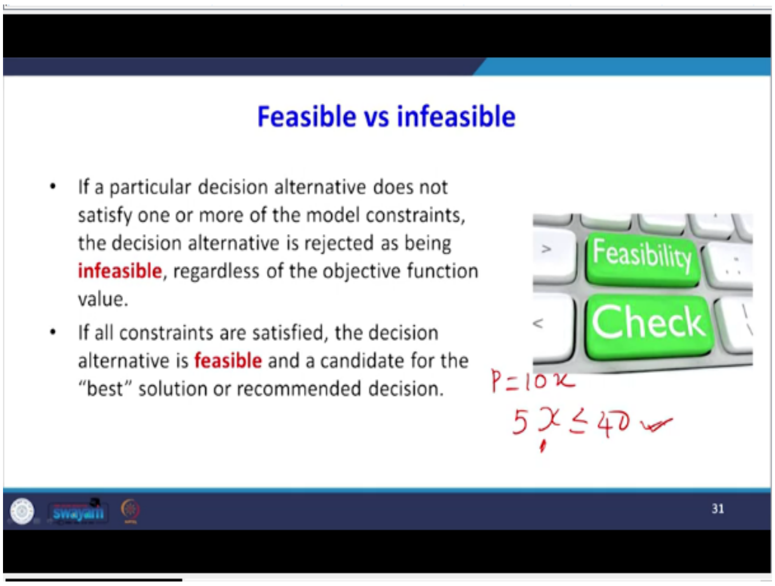
Next, we will be discussing deterministic and stochastic models. We have seen uncontrollable inputs. What are the uncontrollable inputs? P = 10x, 5x <= 40, the 10, 5, 40 this is uncontrollable input. If it is known and cannot vary, that model is called a deterministic model. If the 10, for example, 5 and 40, is uncertain and can vary, then that type of model is called stochastic or probabilistic models.



Next, we will come to the solution. The specific decision variable value in our previous problem we have seen is x; the value of this x is called the decision is called a solution. The specific decision variable value or value providing the best output will be referred to as the optimal solution for the model. We have seen x = 8 as our optimal solution to the model. For the production problem, the model solution steps involve finding the value of production quantity decision variable x that maximizes profit while not causing your violation of production constraint; that solution is called your optimal solution. What is the optimal solution? The value that maximizes your objective function and that does not violate your constraint. So, that solution is called your optimal solution.

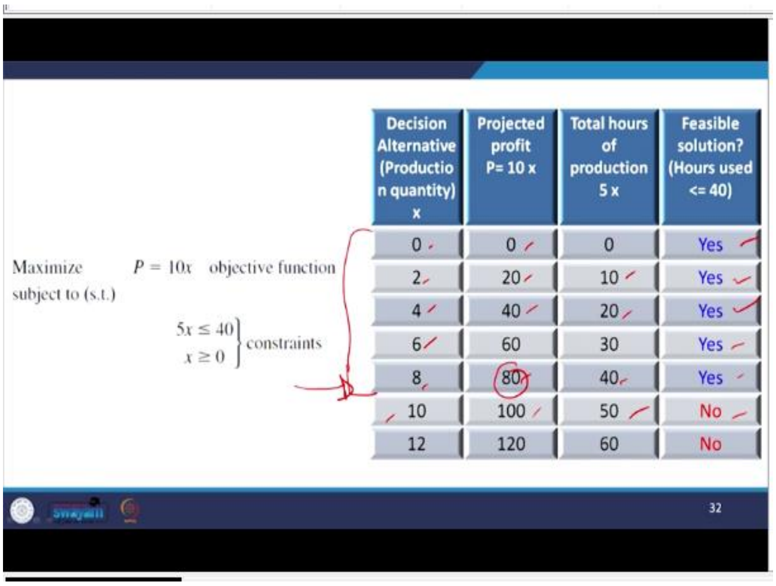


How to get that optimal solution? Getting the easiest way is trial and error. One procedure that might be used in the model solution step involves a trial-and-error approach in which the model is used to test and evaluate various decision alternatives. In the decision models, this procedure would mean testing and evaluating the model under various production quantities value of x. So, in the next slide, I will show you how to do the trial-and-error method.



When we say the solution is feasible or infeasible, if your particular decision alternatives do not satisfy one or more of the model constraints, the decision alternatives are rejected and infeasible regardless of the objective function value. If all constraints are satisfied, the decision alternative is feasible and a candidate for the best solution or recommended decision. So, we have seen in our problem 5x <= 40 and P = 10x. So, we can supply any value for x.

For example, I can substitute the value x = 0, 1, 2, 3 if it satisfies the constraint. So, that solution is called a feasible solution. Your feasible solution, which maximizes your objective function, is called your optimal solution. Your solution that violates your constraint is called our infeasible solution, which you have seen as a feasible and optimal solution. What is the feasible solution? A solution that satisfies the constraint is called a feasible solution; a solution that maximizes the objective function is called your optimal solution.


Maximize $P = 10x$ objective function
subject to (s.t.)

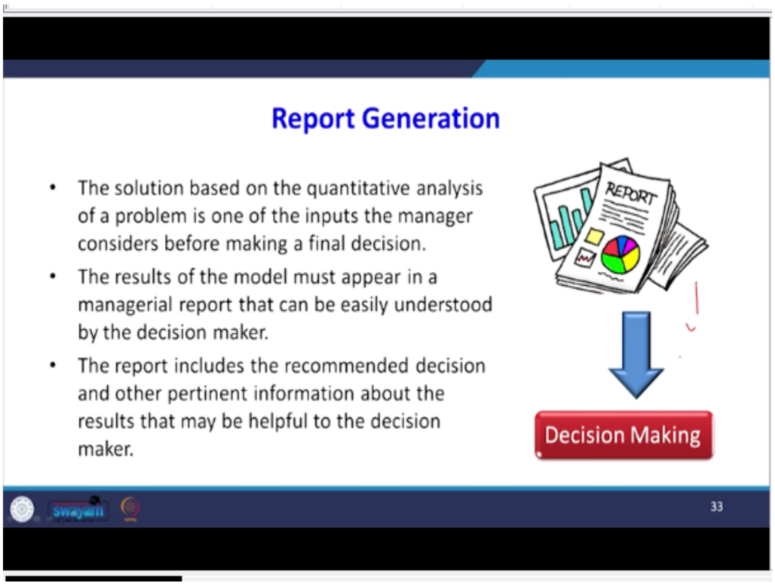
$$\left.\begin{array}{r} 5x \le 40 \\ x \ge 0 \end{array}\right\} \text{constraints}$$

Decision Alternative (Production quantity) x	Projected profit P= 10 x	Total hours of production 5 x	Feasible solution? (Hours used <= 40)
0	0	0	Yes
2	20	10	Yes
4	40	20	Yes
6	60	30	Yes
8	80	40	Yes
10	100	50	No
12	120	60	No

In this slide, I have given an example of trial-and-error methods. P = 10x, 5x less than or equal to 40 x greater than or equal to 0, it is a constraint. So, here I go to substitute the value of x randomly. When I substitute x = 0, the profit will be 0, and the total hours of production that is 5x, which is 5*0, is 0; it is less than or equal to 40. Yes, it is a feasible solution. Similarly, I can substitute to 2.

So, when you substitute 2, 20 total hours of production will be consumed. Still, it is less than 40, so it is a feasible solution. If I substitute x = 4 the projected profit will be 40 hours of production. It is a feasible solution; if it is 6, again, it is a feasible solution; if you substitute 8, it will be 80. This is a feasible solution.

If I substitute x = 10, what is happening? My profit is 100 (10*10). But you see that it is 50, which violates our constraint. So, up to this, whatever solution x = 0, 2, 4, 6, 8 is a feasible solution, this value of x = 8, which maximizes our P is 80; this is our optimal solution.



The final step is reporting degeneration. The solution based on the quantitative analysis of your problem is one of the inputs to the manager before making your final decision. The result of the model must appear in a managerial report that can be easily understood by the decision-maker. When you provide the solution, you should provide the solution in such a way that the manager can understand.

The report includes the recommended decision and other pertinent information about the result that may be helpful to the decision makers; if you want to provide any other pertinent information about that result, that also has to be given because the report will be used for your decision making. So, dear students, in our first lecture, I explained the history of management science and its development.

Then, I explained the importance of spreadsheets for decision-making and the steps in problem-solving. Then, I have explained the different types of models. There are 3 types of models: iconic model, analog model, and mathematical model. I have explained what controllable and uncontrollable input are in mathematical models. Then, I explained the objective function and constraint.

In the solutions, I have explained the feasible and infeasible solutions. I have taken one problem that was solved using the trial-and-error method. In that solution, I explained what was feasible and what our optimal solution was. Thank you very much.