Quantitative Methods for Business

0676-202

Dr. Mohamed Sadok Cherif

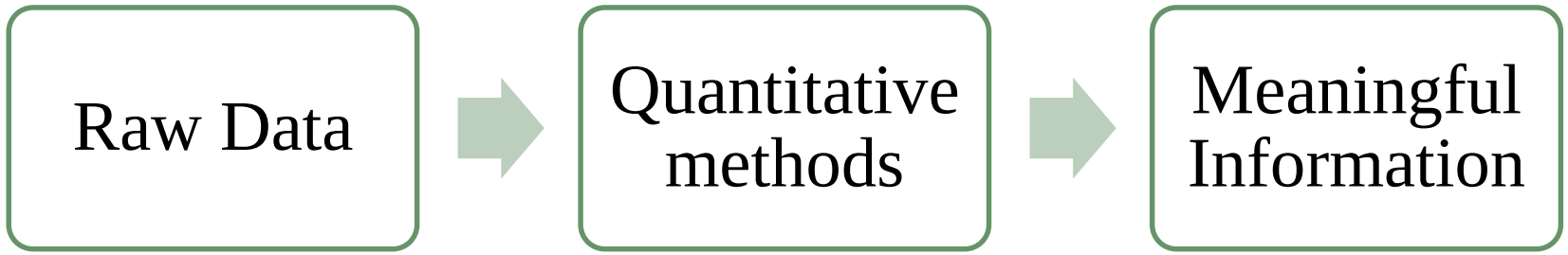
College of Business Administration

CHAPTER 1

Introduction to Operations Research

What is Quantitative Analysis?

- Quantitative analysis is a **scientific approach** to managerial decision making. It seeks to **understand behavior** using mathematical and statistical modeling, measurement and research by assigning numerical values to variables.
- Quantitative analysis models are used widely by real organizations to solve real problems



Examples of Quantitative Analysis

Examples of quantitative analysis tools include:

- Cost-benefit analysis
- Break-even analysis
- Feasibility studies
- Project scheduling
- Indexes
- Statistical analysis
- Forecasting methods

A cost-benefit analysis is the process of comparing the projected or estimated costs and benefits (or opportunities) associated with a project decision to determine whether it makes sense from a business perspective.

Project scheduling is a process that allows you to create a schedule that you can use to keep track of tasks and deadlines within a project.

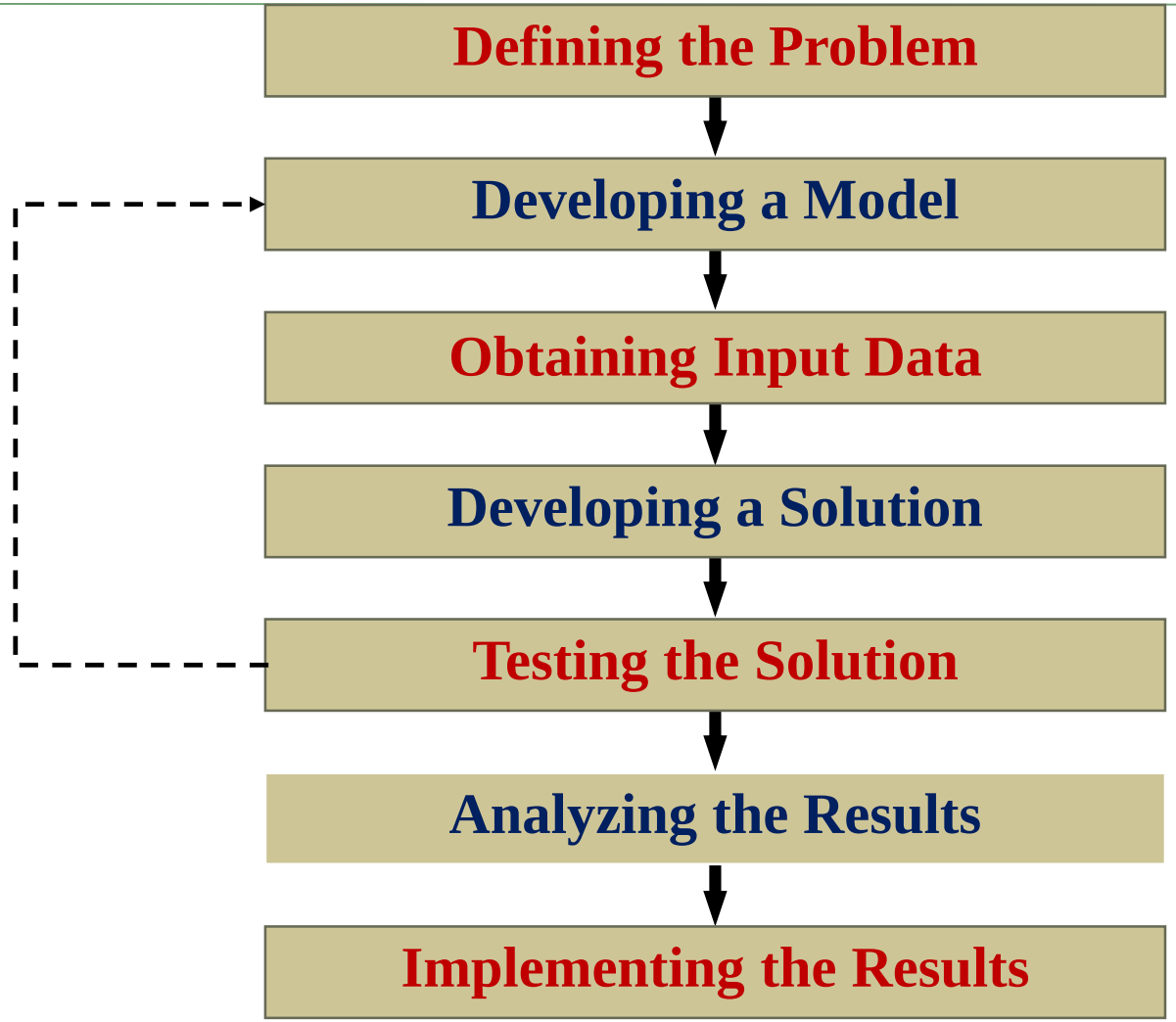
Forecasting is a technique that uses historical data as inputs to make informed estimates that are predictive in determining the direction of future trends.

Cont.

Many large companies with complex business processes have used quantitative analysis for years to help executives and managers make good strategic and operational decisions.

- Taco Bell saved over $150 million using forecasting and scheduling quantitative analysis models
- NBC television increased revenues by over $200 million by using quantitative analysis to develop better sales plans
- Continental Airlines saved over $40 million using quantitative analysis models to quickly recover from weather delays

The Quantitative Analysis Approach



(I) Defining the Problem

- Need to develop **a clear and concise statement** that gives direction and meaning to the following steps.
- This may be the **most important and difficult step**.
- It is crucial to go beyond symptoms and identify true causes.
- It may necessary to develop specific and **measurable objectives** when the problem is difficult to quantify.

(II) Developing a Model

- The **model is a mathematical representation of a situation.**
- A mathematical model is a **set of mathematical relationships** which are stated in equations and inequalities. In addition, it seek to maximize or minimize some objective function subject to constraints
- Models generally contain **variables** and **parameters**
  - **Variables** are generally called decision variables (controllable inputs) and are unknown
  - **Parameters** (uncontrollable inputs) are known numbers that are a part of the problem

Cont.

Advantages of Mathematical Modeling

1. Models can accurately represent reality
2. Models can help a decision maker formulate problems
3. Models can give us insight and information
4. Models can save time and money in decision making and problem solving
5. A model may be the only way to solve large or complex problems in a timely fashion
6. A model can be used to communicate problems and solutions to others

Cont.

- Mathematical models that **do not involve risk** are called ***deterministic*** models. We know all the values used in the model with complete certainty.
- Mathematical models that **involve risk, chance, or uncertainty** are called ***probabilistic*** models. Values used in the model are estimates based on probabilities.

Cont.

A variety of software packages are available for solving mathematical models:

- **Spreadsheet packages such as Microsoft Excel**
- The Management Scientist (MS)
- Quantitative System for Business (QSB)
- LINDO, LINGO
- Decision Science (DS)
- Matrix laboratory (MATLAB)

(III) Obtaining Input Data

- Input data must be accurate.
- Data may come from a variety of sources such as company reports, company documents, interviews, on-site direct measurement, historical data or statistical sampling.

(IV) Developing a Solution

The **values of the decision variables** that provide the **mathematically-best output** are referred to as the optimal solution for the model.

Common techniques are:

- **Solving equations**.
- **Trial and error** – trying various methods and picking the best result.
- **Using an algorithm** – a series of repeating steps to reach a solution.

(V) Testing the Solution

- Both input data and the model should be **tested for validation** before analysis and implementation.
- The **sensitivity analysis** is the common way to validate the solutions. Sensitivity analysis determines how much the results of the analysis will change if the model or input data changes.

If the sensitivity analysis generates accurate and valid solutions:

- use the model on the full-scale problem.

If inaccuracies or potential shortcomings inherent in the model are identified, take corrective action such as:

- collection of more-accurate input data
- modification of the developed model

(VI) Analyzing the Results

Determine the implications of the solution

- Applying results often requires change in an organization.
- The impact of actions or changes needs to be studied and understood before implementation.

(VII) Implementing the Results

- Implementation incorporates the solution into the company.
- Implementation can be very difficult, people can resist changes.
- It must be monitored by some experts to determine if modifications are needed.

What is Operations Research?

We can include different quantitative methods under a comprehensive title of **Operations Research (OR).** Definitions of OR:

Definition 1: It is an Act of winning wars without actually fighting.

Definition 2: It is the application of scientific methods, techniques and tools to problems involving the operations of systems so as to provide those in control of the operations with optimum solutions to the problems.

Definition 3: It is a quantitative approach to decision making based on the scientific method of problem solving.

Cont.

Operations Research is **the scientific approach to execute decision making**, which consists of:

- **The art of mathematical modelling of complex situations.**
- **The science of the development of solution techniques used to solve these models.**
- **The ability to effectively communicate the results to the decision maker.**

Terminology

- The British/Europeans refer to “**Operational Research**", the Americans to “**Operations Research**" - but both are often shortened to just "OR".
- Another term used for this field is “**Management Science**" ("MS"). In U.S. OR and MS are combined together to form "OR/MS" or "ORMS".
- Yet other terms sometimes used are “**Industrial Engineering**" ("IE") and “**Decision Science**" ("DS").

History of OR

- Early work in operational research was carried out by individuals such as **Charles Babbage** in 1840.
- Modern operational research originated at the Bawdsey Research Station in the UK in 1937.
- The modern field of operational research arose during World War II in 1939.
- After World War II, Military Operational Research in U.K. became Operational Analysis (OA) within the U.K. Ministry of Defence with expanded techniques and graving awareness.

The OR techniques

- Linear Programming
- Transhipment Models
- Network Models
- Computer Simulation
- Markov Models
- Dynamic Programming
- Assignment Models
- Waiting Line Models
- Multiple Criteria Decision Making
- Game Theory

Thank you