Managerial Decision Modeling 
with Spreadsheets

Chapter 1
Introduction to Managerial
Decision Modeling

Learning Objectives
• Define decision model and describe its importance.
• Understand two types of decision models: deterministic and probabilistic models.
• Understand steps involved in developing decision models in practice.
• Understand use of spreadsheets in developing decision models.
• Discuss possible problems in developing decision models.

1.1 Introduction
• Decision models can be used to:
  – Solve complex problems.
  – Provide analytical framework for evaluating modern business problems.
  – Provide techniques applicable in many areas -
    • Accounting, Economics, and Finance
    • Logistics, Management, and Marketing
    • Production, Operations, and Transportation
• Decision models subject to limitations.
1.2 What Is Decision Modeling?

- A scientific approach to decision-making.
- Also referred to as
  - quantitative analysis.
  - management science or
  - operations research.

Types of Problem Information

- Quantitative data - numeric values that indicate how much or how many.
  - Rate of return.
  - Financial ratios.
  - Cash flows.
- Qualitative data - labels or names used to identify an attribute -
  - Pending state or federal legislation.
  - New technological breakthrough.

Role of Spreadsheets in Decision Modeling

- Computers are an integral part of decision making.
- Spreadsheet packages -
  - Are capable of handling management decision modeling techniques.
  - Have built-in functions and procedures, such as -
    - Goal Seek.
    - Data Table.
    - Chart Wizard.
### Types of Decision Models

![Decision Models Diagram](image)

- **Deterministic Models**
  - Deterministic models assume -
    - Complete certainty.
    - All information needed is available with fixed and known values.
  - Most commonly used deterministic modeling technique is **Linear Programming**.
  - Chapters 2 through 6 deal with these models.

### Excel Add-In Software Used in this Book

<table>
<thead>
<tr>
<th>EXCEL ADD-IN</th>
<th>USED IN</th>
<th>TOPIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premium Solver for Excel (commercial version of the free add-in that is included with Microsoft Excel)</td>
<td>Chapters 2-7</td>
<td>Linear programming, Network Flow, Integer programming, Goal programming, Nonlinear programming, and Project Management</td>
</tr>
<tr>
<td>Two Plan</td>
<td>Chapter 8</td>
<td>Decision theory</td>
</tr>
<tr>
<td>Crystal Ball 2000</td>
<td>Chapter 10</td>
<td>Simulation</td>
</tr>
<tr>
<td>Excel Modules (custom software provided with this textbook)</td>
<td>Chapters 9, 11, and 12</td>
<td>Queuing Models, Forecasting Models, and Inventory Control Models</td>
</tr>
</tbody>
</table>
**Probabilistic Models**

- Probabilistic models are also called stochastic models.
- Probabilistic models -
  - assume some of data is not known with certainty.
  - take into account information will be known after decision is made.
- Some of these models will be discussed in chapters 7 through 12.

### 1.3 Steps Involved in Decision Modeling

1. **Formulation.**
   - Defining the problem.
     - Develop clear and concise problem statement.
   - Developing a model.
     - Select and develop a decision model.
     - Select appropriate problem variables.
     - Develop relevant mathematical relation for consideration and evaluation.

2. **Solution.**

3. **Interpretation.**

### Step 1: Formulation

- Defining the problem.
  - Develop clear and concise problem statement.
- Developing a model.
  - Select and develop a decision model.
  - Select appropriate problem variables.
  - Develop relevant mathematical relation for consideration and evaluation.
Step 1: Formulation (Continued)

• Acquiring input data.
  – Collect accurate data for use in model.
  – Possible data sources are:
    • Official company reports.
    • Accounting, operating, and financial information.
    • Views, and opinions from knowledgeable individuals.

Step 2: Solution

• Developing a solution involves:
  – Manipulating model to arrive at best (optimal) solution.
  – Solution of set of mathematical expressions.
  – Alternative trial and error iterations.
  – Complete enumeration of all possibilities or utilization of an algorithm.
    • Series of steps repeated until best solution is attained.

Step 2: Solution (Continued)

• Testing a solution involves:
  – Prior to implementation of model solution, testing solution.
  – Testing of solution is accomplished by examining and evaluating:
    • Data utilized in model and
    • On model itself.
Step 3: Interpretation

- Interpretation and What-if Analysis.
  1. Analyzing the results and sensitivity analysis.
     1. Vary data input values and examine differences in various optimal solutions.
     2. Make changes in model parameters and examine differences in various optimal solutions.

Step 3: Interpretation (Continued)

- Implementing the results.
  - Optimal solution must be implemented carefully.
  - Solution implementation usually requires making changes within the organization.
  - Recommendations often require changes in data, data handling, resource mixes, systems, procedures, policies, and personnel.
  - Managers and others may resist recommended solutions.

1.4 Example: Spreadsheet Model: Tax Computation

- The Miller’s 2003 income tax problem:
  - Save 5% of total income in tax-deductible retirement account ($4,000 maximum).
  - No income received from dividends or capital gains.
  - Entitled to personal exemption of $3,200 each.
    - (2x$3,200 = $6,400)
  - Standard deduction = $10,000.
  - No other deductions from income are anticipated.
  - Tax brackets for 2003:
    - 10% up to $14,600, 15% $14,601-$59,400
    - 25% between $59,401 and $119,500.
### Tax Brackets

<table>
<thead>
<tr>
<th>Taxable Income</th>
<th>Percent of Taxable Income</th>
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</thead>
<tbody>
<tr>
<td>up to $14,600</td>
<td>10%</td>
</tr>
<tr>
<td>$14,601 to $59,400</td>
<td>15%</td>
</tr>
<tr>
<td>$59,401 to $119,950</td>
<td>25%</td>
</tr>
</tbody>
</table>

### Example: Spreadsheet Model - Tax Computation

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income</td>
<td>Total income up to $14,600, taxable income up to $119,950</td>
</tr>
<tr>
<td>Exemptions</td>
<td>Personal exemptions, standard deduction</td>
</tr>
<tr>
<td>Tax rates</td>
<td>10%, 15%, 25%, 28%, 33%, 35%, 39.6%</td>
</tr>
<tr>
<td>Taxable income</td>
<td>Maximum of $119,950, minimum of 0% of total income</td>
</tr>
</tbody>
</table>

The Miller's tax computation:

1. Income: $42,000
2. Exemptions: $24,000
3. Taxable income: $42,000 - $24,000 = $18,000
4. Tax: $18,000 * 10% = $1,800
5. Total tax: $1,800
6. Estimated tax per quarter: $1,800 / 4 = $450

The Miller's should pay $450 in taxes each quarter.
Bill's company, *Pritchett's Precious Time Pieces*, buys, sells, and repairs old clocks and clock parts. Bill sells rebuilt springs for unit price $10. Fixed cost of equipment to build springs is $1,000. Variable cost per unit is $5 for spring material.

**Problem (Continued)**

- **In General:** Profit = Total Revenue - Total Cost
  
  Profit = Revenue - Fixed Cost - Variable Cost

  Where:
  
  \[ \text{Revenue} = \text{Sales price ($/unit)} \times \text{Number (units)} \]
  
  \[ \text{Variable Cost} = \text{Variable cost ($/unit)} \times \text{Number (units)} \]
  
  \[ \text{Fixed Cost} = \text{$ necessary to invest in facilities (buildings, equipment, processes, etc.) = constant dollar value.} \]

- **In Our Example:**
  
  Profit = $10X - $1,000 - $5X

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**The Break Even Point (BEP)**

- **Profit** = Total Revenue - Total Cost

- **Set Profit equal to zero.**

  \[ 0 = (\text{Selling price per unit}) \times (\text{Number of units}) - \text{Fixed cost} - (\text{Variable cost per unit}) \times (\text{Number of units}) \]

- **Mathematically rewritten as:**

  \[ \text{Number of units (BEP)} = \frac{\text{Fixed Cost}}{[\text{Selling price per unit - Variable cost per unit}] } \]

- **For Bill Pritchett's example, compute BEP as:**

  \[ \frac{\$1,000}{[\$10 - \$5]} = 200 \text{ springs.} \]
**The Break Even Point (BEP) (Continued)**

- Breakeven point (BEP) in dollars can be computed:

  \[
  \text{BEP}_\$ = \text{Fixed cost} + \text{Variable cost per unit} \times \text{BEP}
  \]

- For Bill Pritchett's example, compute \( \text{BEP}_\$ \):

  \[
  \$1,000 + \$5 \times 200 = \$2,000
  \]

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**Formulating the Decision Model**

**Using Goal Seek to Find the Breakeven Point**

- Use of Goal Seek to find the BEP.
1.6 Possible Problems in Developing Decision Models

- Defining Problem.
- Conflicting Viewpoints.
- Impact on Other Departments.
- Beginning Assumptions.
- Solution Outdated.
- Developing a Model.
- Fitting Textbook Models.
- Understanding Model.

1.6 Possible Problems in Developing Decision Models

- Acquiring Input Data.
- Using Accounting Data.
- Validity of Data.
- Developing a Solution.
- Only One Answer is Limiting.
- Testing Solution.
- Analyzing Results.

1.7. Implementation – Not Just The Final Step

- Decision models assist decision maker by providing scientific method, model, and process which is defensible and reliable.
- Overcome sole reliance upon intuition, hunches, and experience.
- A Swedish study found -
  - 40% of projects suggested by decision analysts were ever implemented.
  - 70% of modeling projects initiated by users, and 98% of projects suggested by top managers, were implemented.
Summary

Decision Models and Modeling -
• Scientific approach to decision making in practice faced by managers.
• Decision models classified into two categories:
  – Deterministic models.
  – Probabilistic models.
• Approach includes three primary steps:
  – Formulation.
  – Solution.
  – Implementation.

Summary (Continued)

Decision Models and Modeling -
• Potential problems to consider:
  – Conflicting viewpoints.
  – Model impacts on other departments.
  – Outdated solutions.
  – Understanding model.
  – Acquisition of good input data.
  – Hard-to-understand mathematics.
  – Solution testing.
  – Results analysis.

Summary (Continued)

Decision Models and Modeling -
• Potential problems to consider:
  – Lack of commitment to approach.
  – Resistance to change.