

Chapter 1

Introduction to Management Science

- Learning Objectives and Introduction
- The Nature of Management Science
- Break-Even Analysis
- The Impact of Management Science

Learning Objectives

- Define the term Management Science (MS)
- Describe the nature of Management Science
- Explain what a mathematical model is
- Use a mathematical model to perform break-even analysis
- Use a spreadsheet model to perform break-even analysis
- Identify the kinds of annual savings that MS studies can sometimes provide

Introduction

- Gain an appreciation for the relevance and power of MS
- Learn and recognize when MS can be fruitfully applied
- Learn how to apply the major techniques of MS to analyze a variety of managerial problems
- Develop an understanding of how to interpret the results of a MS study

The nature of Management Science

- It does involve *Management* and *Science* or *the Science of Management*
- *Definition:* MS is the ***discipline*** that attempts to ***aid managerial decision making*** by applying a ***scientific approach*** to managerial problems that involve ***quantitative factors***.

Management Science is a Discipline (1)

- MS is a whole body of knowledge and techniques that are based on a scientific foundation

Management Science Development

When it appears?

- The Scientific Management revolution of the early 1900's, initiated by Frederic W. Taylor, provided the foundation for the use of quantitative method in Management

But,

- Modern management science research is generally considered to have originated during the World War II (WW II) period

What led to the growth and use of MS after the (WW II) ?

- Continued research resulted in numerous methodological developments:
Simplex by Dantzig 1947
- The aid of computers (explosion in computing power)

Traditional Name

The traditional name (widely used today outside of business schools) is **Operation Research (OR)** because the teams of scientists in WW II were doing *research* on how to manage military *operations*

MS Aids Managerial Decision Making (2)

- MS study only provides an analysis and recommendations, based on the quantitative factors involved in the problems

MS Uses a Scientific Approach (3)

- MS is based strongly on some scientific field (mathematics and computer science)
- When conducting a study, all management science team will follow these steps:
 1. Define the problem and gather data (manager, IT group)
 2. Formulate a mathematical model to represent the problem (perhaps in a spreadsheet format)
 3. Develop a computer-based procedure for deriving solution to the problem from the model
 4. Test the model and refine it as needed (reasonable solution)
 5. Apply the model to analyze the problem and develop recommendations for management (develop a decision support system if model applied repeatedly)
 6. Help to implement the team's recommendations that are adopted by management

Management Considers Quantitative Factors (4)

- Production quantities
- Revenues
- Costs
- Amount available of needed resources
- ...

Thus MS provides a uniquely powerful way of analyzing such managerial problems

An Illustration of the Management Science Approach: Break-Even Point Analysis

- The Special Products Company produces expensive and unusual gifts.
- The latest new-product proposal is a limited edition grandfather clock.
- Data:
 - If they go ahead with this product, a *fixed cost* of \$50,000 is incurred.
 - The *variable cost* is \$400 per clock produced.
 - Each clock sold would generate \$900 in revenue.
 - A sales forecast will be obtained.

Question: Should they produce the clocks, and if so, how many?

Fixed and Variable cost

- A cost that remains the same regardless of the production volume is referred to as a *fixed cost*
- A cost that varies with the production volume is called a *variable cost*

Special Products Break-Even Analysis

- Example:
 - Limited edition grandfather clock
 - Introduce or not
 - If so, how many to be produce
 - Objective: maximize the profit
 - Fixed cost: Setup cost = \$50,000
 - Variable cost: Production cost = \$400 (marginal cost)
 - Revenue = \$900

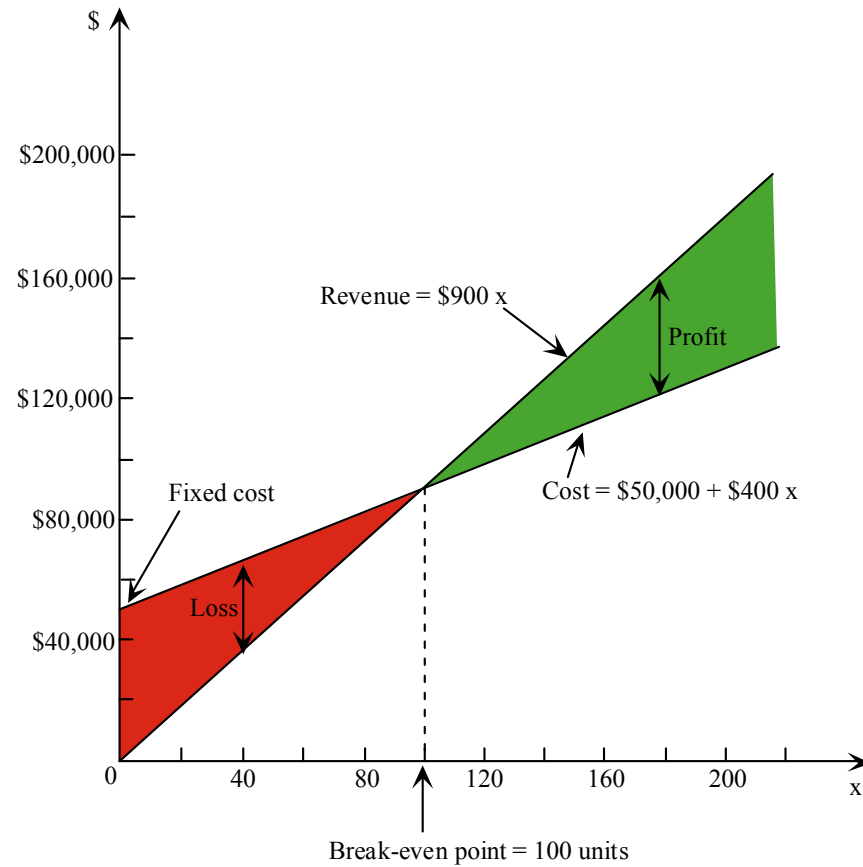
Expressing the Problem Mathematically

- Decision to be made: Number of grandfather clocks to produce that maximizes the company profit
 - Represent this quantity by an algebraic variable denoted Q
 - Q = Number of grandfather clocks to produce
 - Q is the decision variable
- Expressing the objective of the model
 - If $Q = 0$, no cost is incurred
 - If $Q > 0$
 - Total cost = Fixed Cost + Variable Cost = $\$50,000 + \$400 Q$
 - Total Revenue = $\$900 Q$
 - The total profit = Total Revenue - Total cost (if $Q \geq 0$)
 - Profit = $-\$50,000 + \$500 Q$ (if $Q > 0$)
 - Profit = 0 (if $Q = 0$)

Analysis of the Problem

- A small value of Q means a loss (profit <0)
- Sufficiently large value of Q generate a profit >0
 - Profit = -\$40,000 if $Q = 20$
 - Profit = \$50,000 if $Q = 200$

Analysis of the Problem



A complete mathematical model for the problem

- **Constraints:** a constraint in a mathematical model is an equality or equation that expresses some restrictions on the values that can be assigned to the decision variables
- **Parameter:** the constants in the mathematical model are referred to as the parameters of the model
- **Objective function:** the Objective function for a mathematical model is a mathematical expression that gives the measure of performance for the problem in terms of the decision variables

A complete mathematical model for the problem

- s = Sales forecast of the number of grandfather clocks that can be sold
- Q = Number of grandfather clocks to produce
- The complete mathematical model for this problem is to find the value of Q so as to:

$$\text{Maximize Profit} = \begin{cases} 0 & \text{if } Q = 0 \\ -\$50,000 + \$500 Q & \text{if } Q > 0 \end{cases}$$

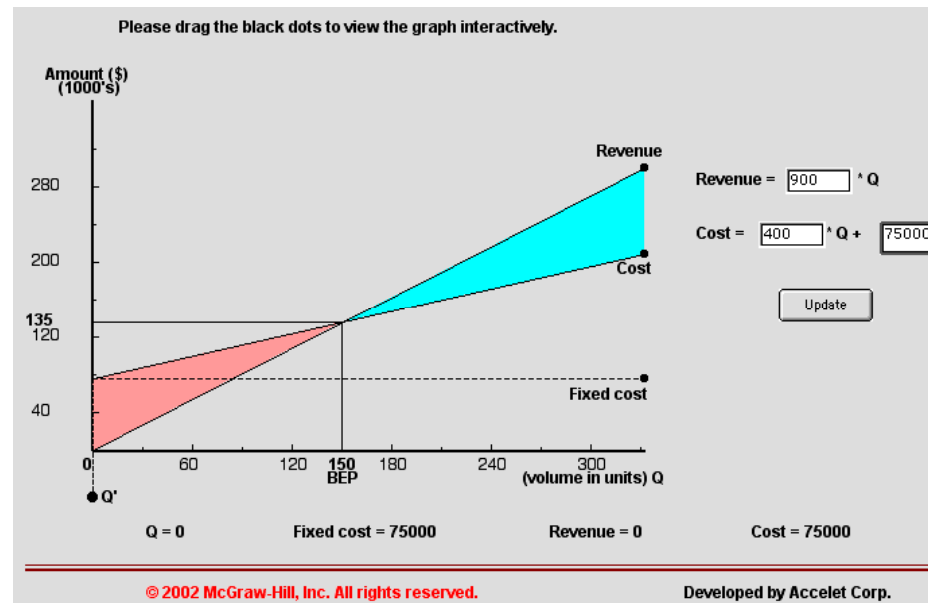
subject to $Q \leq s$

$$Q \geq 0$$

Sensitivity Analysis of the Mathematical Model

- Since estimate can be wrong, sensitivity analysis is used to check the effect on the recommendations of the model if the estimates turn out to be wrong

Management Science Interactive Modules



- Sensitivity analysis can be performed using the Break-Even module in the Interactive Management Science Modules (available on your MS Courseware CD packaged with the text).
 - Here we see the impact of changing the fixed cost to \$75,000.

Special Products Co. Spreadsheet

	B	C	D	E	F
3		Data			Results
4	Unit Revenue	\$900		Total Revenue	\$270,000
5	Fixed Cost	\$50,000		Total Fixed Cost	\$50,000
6	Marginal Cost	\$400		Total Variable Cost	\$120,000
7	Sales Forecast	300		Profit (Loss)	\$100,000
8					
9	Production Quantity	300			

Range Name	Cell
FixedCost	C5
MarginalCost	C6
ProductionQuantity	C9
Profit	F7
SalesForecast	C7
TotalFixedCost	F5
TotalRevenue	F4
TotalVariableCost	F6
UnitRevenue	C4

	E	F
3		Results
4	Total Revenue	=UnitRevenue*MIN(SalesForecast,ProductionQuantity)
5	Total Fixed Cost	=IF(ProductionQuantity>0,FixedCost,0)
6	Total Variable Cost	=MarginalCost*ProductionQuantity
7	Profit (Loss)	=TotalRevenue-(TotalFixedCost+TotalVariableCost)

Special Products Co. Spreadsheet

	B	C	D	E	F
3		Data			Results
4	Unit Revenue	\$900		Total Revenue	\$270,000
5	Fixed Cost	\$50,000		Total Fixed Cost	\$50,000
6	Marginal Cost	\$400		Total Variable Cost	\$120,000
7	Sales Forecast	300		Profit (Loss)	\$100,000
8					
9	Production Quantity	300		Break-Even Point	100

	E	F
3		Results
4	Total Revenue	=UnitRevenue*MIN(SalesForecast,ProductionQuantity)
5	Total Fixed Cost	=IF(ProductionQuantity>0,FixedCost,0)
6	Total Variable Cost	=MarginalCost*ProductionQuantity
7	Profit (Loss)	=TotalRevenue-(TotalFixedCost+TotalVariableCost)
8		
9	Break-Even Point	=FixedCost/(UnitRevenue-MarginalCost)

Range Name	Cell
BreakEvenPoint	F9
FixedCost	C5
MarginalCost	C6
ProductionQuantity	C9
Profit	F7
SalesForecast	C7
TotalFixedCost	F5
TotalRevenue	F4
TotalVariableCost	F6
UnitRevenue	C4

The Impact of Management Science

- See the text book pages: 13,14, 15 and 16