Lecture 1
Introduction to Management Science

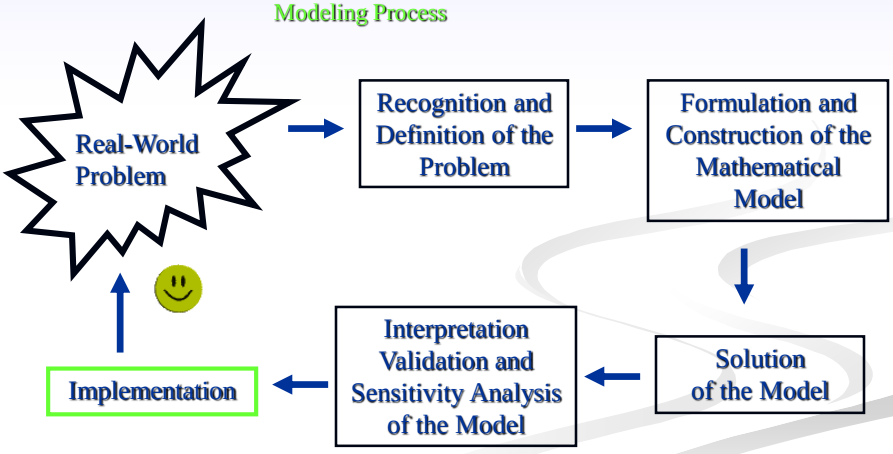
What is Management Science?

- Application of SCIENTIFIC METHOD
- Study of LARGE & COMPLEX SYSTEMS
- Analysis of MANAGERIAL PROBLEMS
- Finding OPTIMAL SOLUTION

- Use of MATHEMATICAL MODELS
- Use of COMPUTERS & SPECIAL SW

What is Management Science -2

Modeling Process



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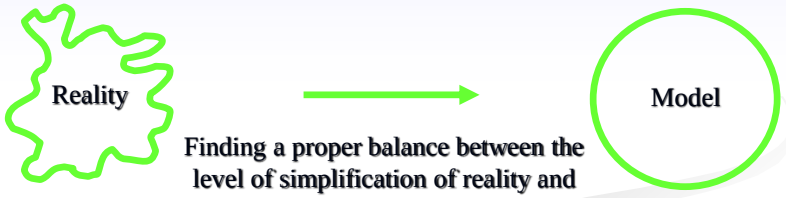
What is Management Science -3

Mathematical Model



Finding a proper balance between the level of simplification of reality and good representation of reality.

Model

- Deterministic
- Probabilistic

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What is Management Science -4

Solution

- **Feasible**
- **Optimal**
- **Infeasible**

Model Interpretation

Model Validation

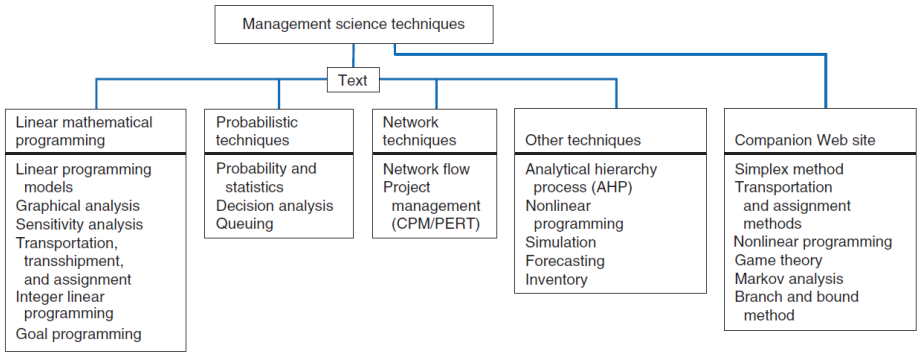
Sensitivity Analysis

Implementation

Business Usage of Management Science

- **Some application areas:**
  - Project Planning
  - Capital Budgeting
  - Inventory Analysis
  - Production Planning
  - Scheduling

Management Science Techniques



Management Science -Techniques

- **Linear Programming**
  - *linear objective function – min/max*
  - *linear constraints*
- **Integer LP, Binary LP, Mixed Integer LP**
- **Nonlinear Programming**
  - *nonlinear objective function and/or*
  - *nonlinear constraints*

Management Science- Techniques

- Distribution Models
  - *special type of LP problems (special structure of model)*
  - *transportation problem*
  - *assignment problem*

Management Science- Techniques

- Multiple Criteria Decision Making
  - *multiple criteria*
  - *compromise*
  - *limited/unlimited number of alternatives*
  - *goal programming*

Management Science- Techniques

- Network Models
  - *network – nodes, arcs*
  - *evaluated network*
  - *minimal distance, maximal flow etc.*
- Project Management
  - *planning, scheduling & controlling projects*
  - *CPM, PERT*

What is Management Science- Techniques

- Inventory Models
  - *how much to order?*
  - *when to order?*
  - *deterministic/probabilistic models*
- Waiting Line Models (Queuing Models)
  - *servers, customers*
  - *goal – optimal number of servers*
  - *analytical approach, computer simulation*

What is Management Science- Techniques

- **Computer Simulation**
  - *computer experiments with models*
  - *complex systems*
- **Games Theory**
  - *2 or more decision makers*
  - *possible strategies*

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How do we construct mathematical models?

Business Problem:

- Business firm makes and sells a steel product, determine the number of units to produce to make the most profit, given the limited amount of steel available.

Information and Data:

- Product costs $5 to produce
- Product sells for $20
- Product requires 4 pounds of steel to make
- Firm has 100 pounds of steel

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How do we construct mathematical models? ...Contd.

Variables: x = # units to produce (decision variable)

Z = total profit (in $)

Model: Z = \$20x - \$5x (objective function)

4x = 100 lb of steel (resource constraint)

Parameters: \$20, \$5, 4 lbs, 100 lbs (known values)

Formal Specification of Model:

maximize Z = \$20x - \$5x

subject to 4x = 100

How do we construct mathematical models? ...Contd.

Model Solution:

Solve the constraint equation:

$$4x = 100$$
$$(4x)/4 = (100)/4$$
$$x = 25 \text{ units}$$

Substitute this value into the profit function:

$$Z = \$20x - \$5x$$
$$= (20)(25) - (5)(25)$$
$$= \$375$$

(Produce 25 units, to yield a profit of \$375)

Model Building: Break-Even Analysis

- Used to determine the number of units of a product to sell or produce that will equate total revenue with total cost.
- The volume at which total revenue equals total cost is called the break-even point.
- Profit at break-even point is zero.

Model Components

- **Fixed Cost (c_f)** - costs that remain constant regardless of number of units produced.
- **Variable Cost (c_v)** - unit production cost of product.
- **Volume (v)** – the number of units produced or sold
- **Total variable cost (vc_v)** - function of volume (v) and unit variable cost.

Model Building: Break-Even Analysis -2

Model Components

- **Total Cost (TC)** - total fixed cost plus total variable cost.

$$TC = c_f + vc_v$$

- **Profit (Z)** - difference between total revenue vp (p = unit price) and total cost, i.e. $Z = vp - c_f - vc_v$

Computing the Break-Even Point

The break-even point is that volume at which total revenue equals total cost and profit is zero:

$$vp - c_f - vc_v = 0$$

$$v(p - c_v) = c_f$$

The break-even point

$$v = \frac{c_f}{p - c_v}$$

Model Building: Break-Even Analysis-Example

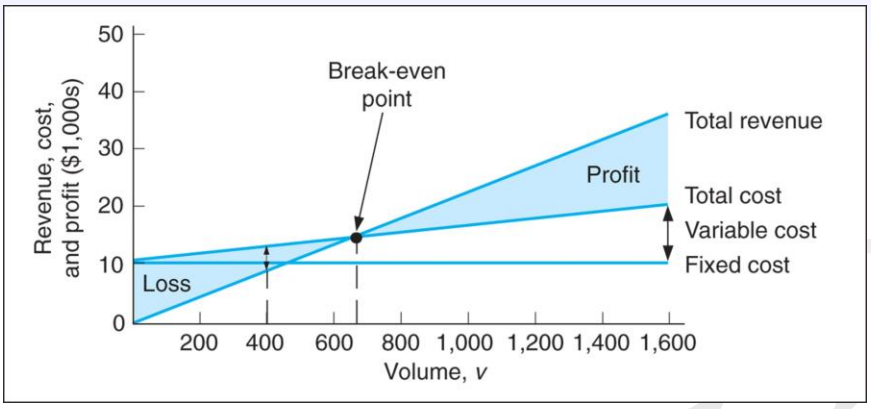
Western Clothing Company

Fixed Costs: c_f = \$10000
Variable Costs: c_v = \$8 per pair
Price : p = \$23 per pair

The Break-Even Point is:

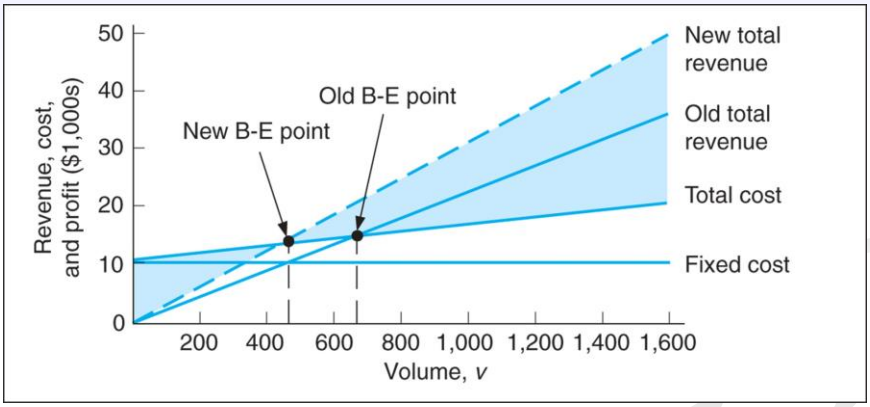
v = (10,000)/(23 -8)
= 666.7 pairs of jeans

Model Building: Break-Even Analysis-Graphical Representation



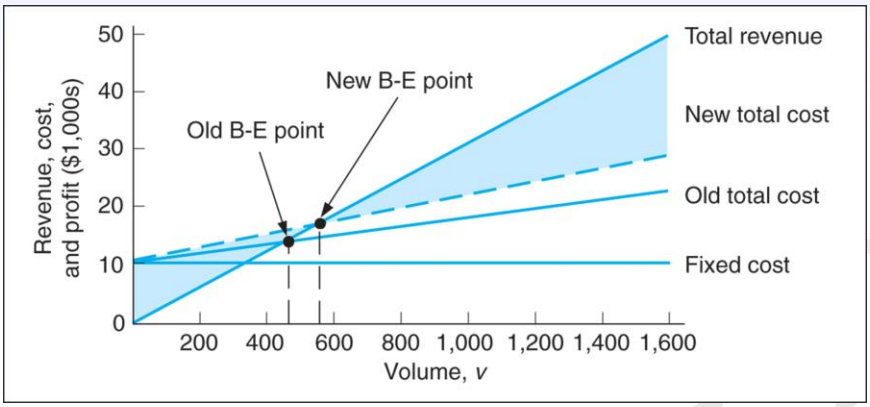
Break-even model

Model Building: Break-Even Analysis- Price Increase



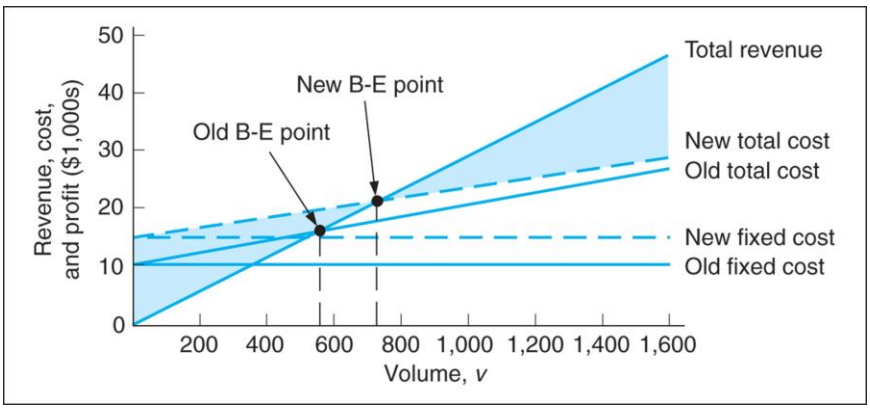
Break-even model with an increase in price

Model Building: Break-Even Analysis- Variable Cost Increase



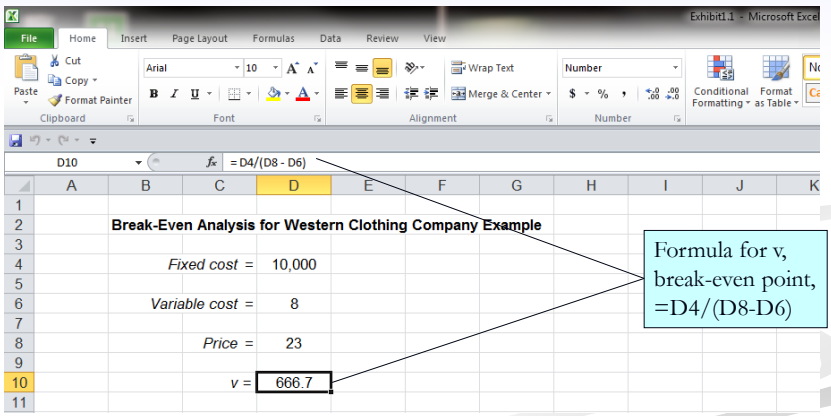
Break-even model with an increase in variable cost

Model Building: Break-Even Analysis- Fixed Cost Increase



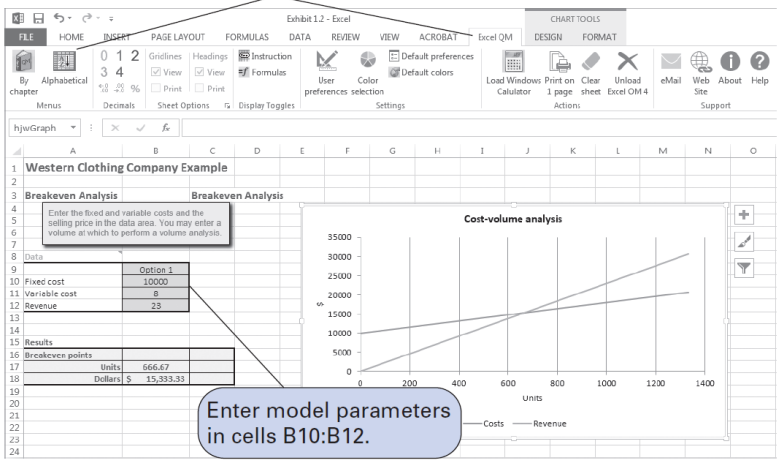
Break-even model with a change in fixed cost

Break-Even Analysis: Excel Solution (1 of 4)

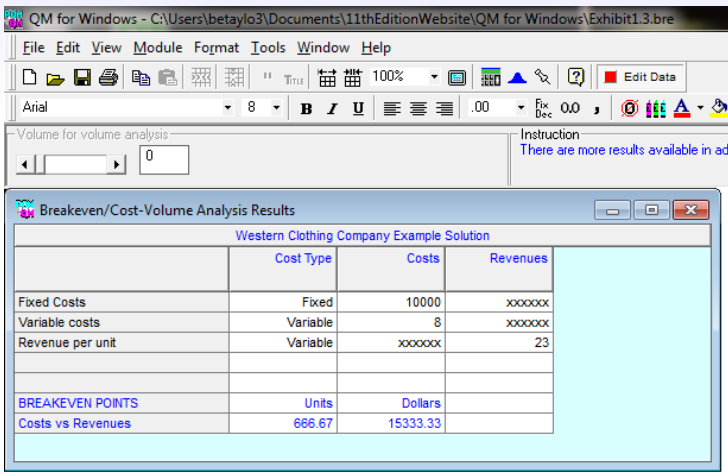


Break-Even Analysis: Excel QM Solution (2 of 4)

Click on "Excel QM," then on Alphabetical" list of models and select "Breakeven Analysis"

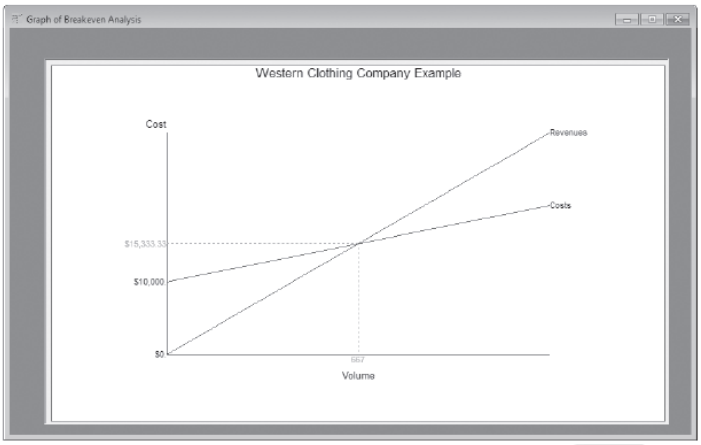


Break-Even Analysis: Excel QM Solution (3 of 4)



Western Clothing Company in QM

Break-Even Analysis: QM Solution (4 of 4)



QM break-even graph for Western Clothing Company