

Strategic Capacity Planning for Products and Services

Chapter 5

Introduction

Capacity refers to an upper limit or ceiling on the load that an operating unit can handle.

the number of physical units produced

the number of services performed

The goal of **strategic capacity planning** is to achieve a match between the long-term supply capabilities of an organization and the predicted level of long-term demand.

Capacity Decisions are Strategic

1. Capacity decisions have a real **impact on the ability of the organization** to meet future demands for products and services.
2. Capacity decisions **affect operating costs**.
3. Capacity is usually a **major determinant of initial cost**. Typically, the greater the capacity of a productive unit, the greater its cost.
4. Capacity decisions often involve **long-term commitment of resources** and the fact that, once they are implemented, those decisions may be difficult or impossible to modify without incurring major costs.
5. Capacity decisions can **affect competitiveness**.
6. Capacity affects the **ease of management**.
7. **Globalization** has increased the importance and the complexity of capacity decisions.
8. Because capacity decisions often **involve substantial financial and other resources**, it is necessary to plan for them far in advance.

Defining and Measuring Capacity

Design capacity: The maximum output rate or service capacity an operation, process, or facility is designed for.

Effective capacity: Design capacity minus allowances such as personal time, maintenance, and scrap.

Business	Inputs	Outputs
Auto manufacturing	Labor hours, machine hours	Number of cars per shift
Steel mill	Furnace size	Tons of steel per day
Oil refinery	Refinery size	Gallons of fuel per day
Farming	Number of acres, number of cows	Bushels of grain per acre per year, gallons of milk per day
Restaurant	Number of tables, seating capacity	Number of meals served per day
Theater	Number of seats	Number of tickets sold per performance
Retail sales	Square feet of floor space	Revenue generated per day

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}$$

Given the following information, compute the efficiency and the utilization of the vehicle repair department:

Design capacity = 50 trucks per day

Effective capacity = 40 trucks per day

Actual output = 36 trucks per day

$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}} = \frac{36 \text{ trucks per day}}{40 \text{ trucks per day}} = 90\%$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}} = \frac{36 \text{ trucks per day}}{50 \text{ trucks per day}} = 72\%$$

Determinants of Effective Capacity

Facilities

- Design
- Location
- Layout
- Environment

Product/service

- Design
- Product or service mix

Process

- Quantity capabilities
- Quality capabilities

Human factors

- Job content
- Job design
- Training and experience
- Motivation
- Compensation
- Learning rates
- Absenteeism and labor turnover

Policy

Operational

- Scheduling
- Materials management
- Quality assurance
- Maintenance policies
- Equipment breakdowns

Supply chain

External factors

- Product standards
- Safety regulations
- Unions
- Pollution control standards

Strategy Formulation

Assumptions and Predictions

the growth rate and variability of **demand**,
the **costs** of building and operating facilities of various sizes,
the rate and direction of **technological innovation**,
the likely **behavior of competitors**,
availability of capital and other inputs.

Key decisions of capacity planning relate to:

The amount of capacity needed.
The timing of changes.
The need to maintain balance throughout the system.
The extent of flexibility of facilities and the workforce.

Capacity cushion is an amount of capacity in excess of expected demand when there is some uncertainty about demand.

Capacity cushion = 100% – Utilization

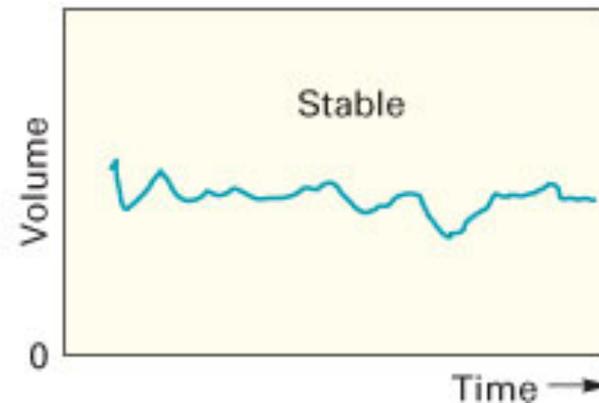
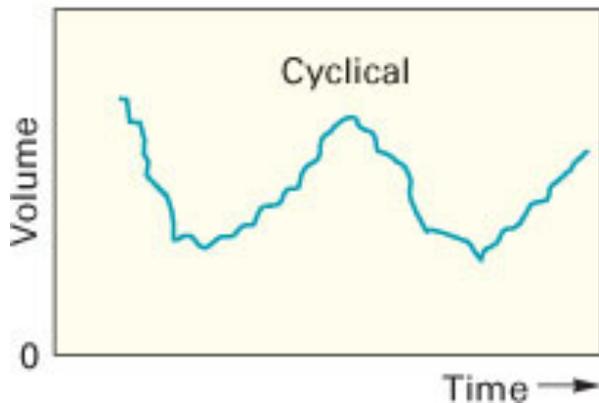
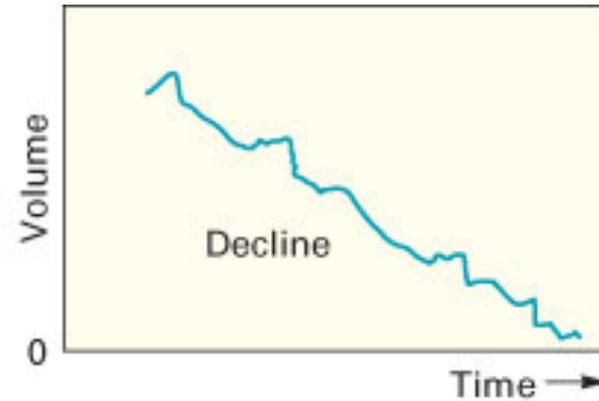
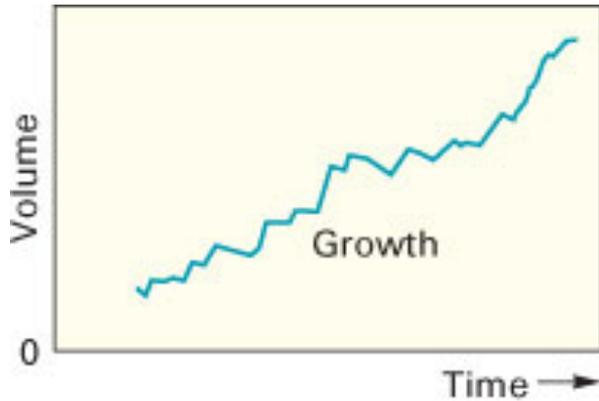
Steps in the Capacity Planning Process

1. Estimate future capacity requirements.
2. Evaluate existing capacity and facilities and identify gaps.
3. Identify alternatives for meeting requirements.
4. Conduct financial analyses of each alternative.
5. Assess key qualitative issues for each alternative.
6. Select the alternative to pursue that will be best in the long term.
7. Implement the selected alternative.
8. Monitor results.

Capacity planning can be difficult at times due to the complex influence of market forces and technology.

Forecasting Capacity Requirements

Long-term capacity needs require forecasting demand over a time horizon and then converting those forecasts into capacity requirements.



Short-term capacity needs are less concerned with cycles or trends than with seasonal variations and other variations from average.

Period	Items
Year	Beer sales, toy sales, airline traffic, clothing, vacations, tourism, power usage, gasoline consumption, sports and recreation, education
Month	Welfare and social security checks, bank transactions
Week	Retail sales, restaurant meals, automobile traffic, automotive rentals, hotel registrations
Day	Telephone calls, power usage, automobile traffic, public transportation, classroom utilization, retail sales, restaurant meals

Calculating Processing Requirements

A department works one 8-hour shift, 250 days a year, and has these figures for usage of a machine that is currently being considered:

Product	Annual Demand	Standard Processing Time per Unit (Hr)	Processing Time Needed (Hr)
1	400	5.0	2,000
2	300	8.0	2,400
3	700	2.0	<u>1,400</u>
			5,800

annual capacity of $8 \times 250 = 2,000$ hours per year

$$\frac{5,800 \text{ hours}}{2,000 \text{ hours/machine}} = 2.90 \text{ machines}$$

The Challenges of Planning Service Capacity

Important factors in planning service capacity:

the need to be near customers,
the inability to store services,
the degree of volatility of demand.

Location

Timing of demand

Speed of delivery or customer waiting time

Demand Management Strategies

Pricing

Promotions

Discounts

Make or Buy?

Available capacity. If an organization has available the equipment, necessary skills, and *time*, it often makes sense to produce an item or perform a service in-house.

Expertise. If a firm lacks the expertise to do a job satisfactorily, buying might be a reasonable alternative.

Quality considerations. Firms that specialize can usually offer higher quality than an organization can attain itself. Conversely, unique quality requirements or the desire to closely monitor quality may cause an organization to perform a job itself.

The nature of demand. When demand for an item is high and steady, the organization is often better off doing the work itself. However, wide fluctuations in demand or small orders are usually better handled by specialists who are able to combine orders from multiple sources, which results in higher volume and tends to offset individual buyer fluctuations.

Cost. Cost savings might come from the item itself or from transportation cost savings. If there are fixed costs associated with making an item that cannot be reallocated if the service or product is outsourced, that has to be recognized in the analysis. Conversely, outsourcing may help a firm avoid incurring fixed costs.

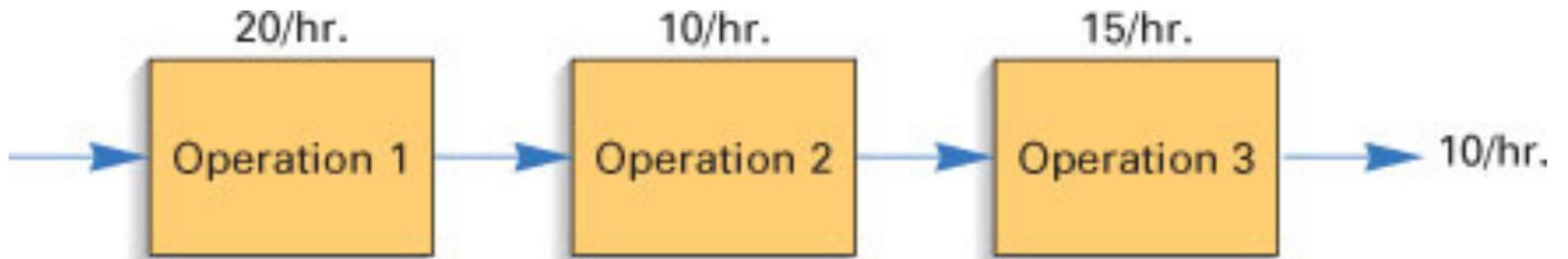
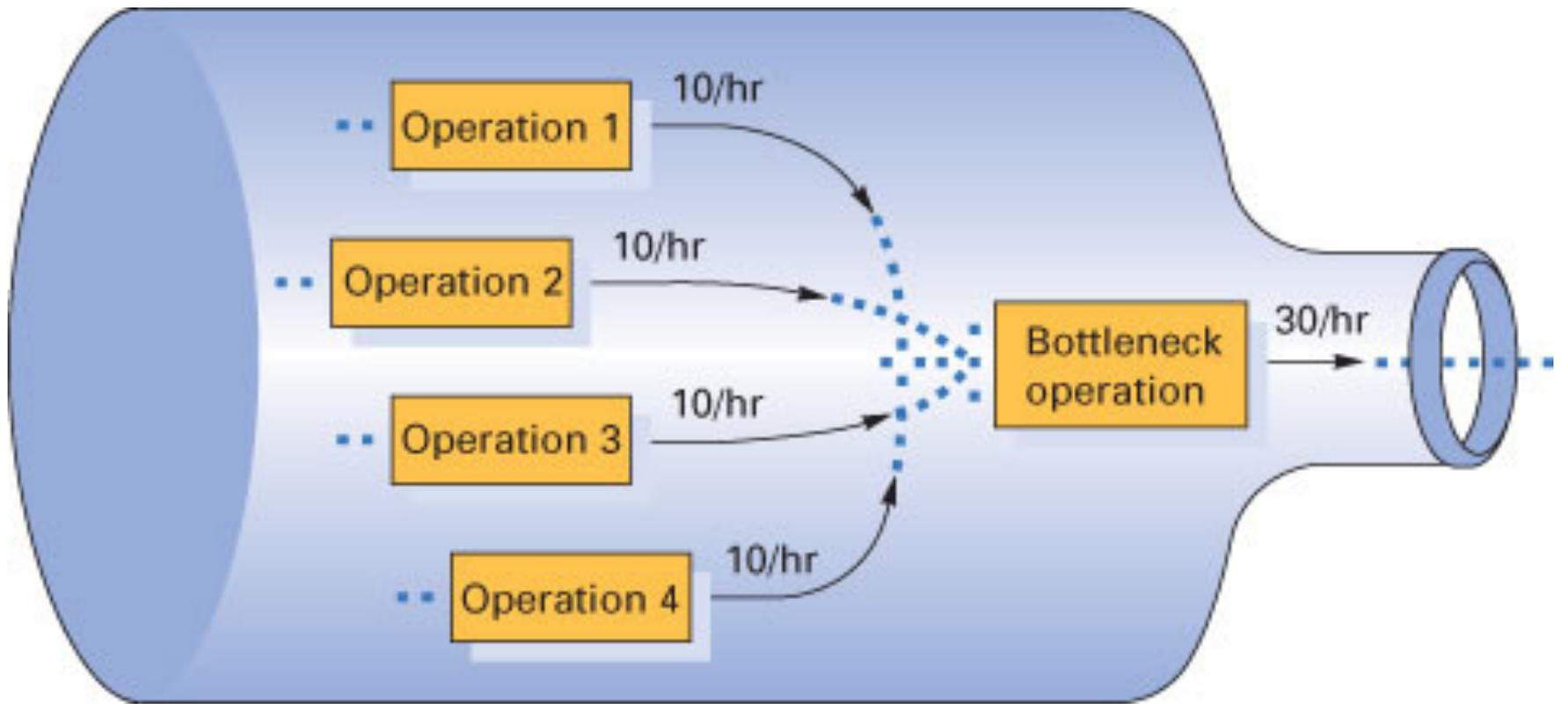
Risk. Outsourcing may involve certain risks. One is loss of control over operations. Another is the need to disclose proprietary information.

Developing Capacity Alternatives

Design flexibility into systems. The long-term nature of many capacity decisions and the risks inherent in long-term forecasts suggest potential benefits from designing flexible systems.

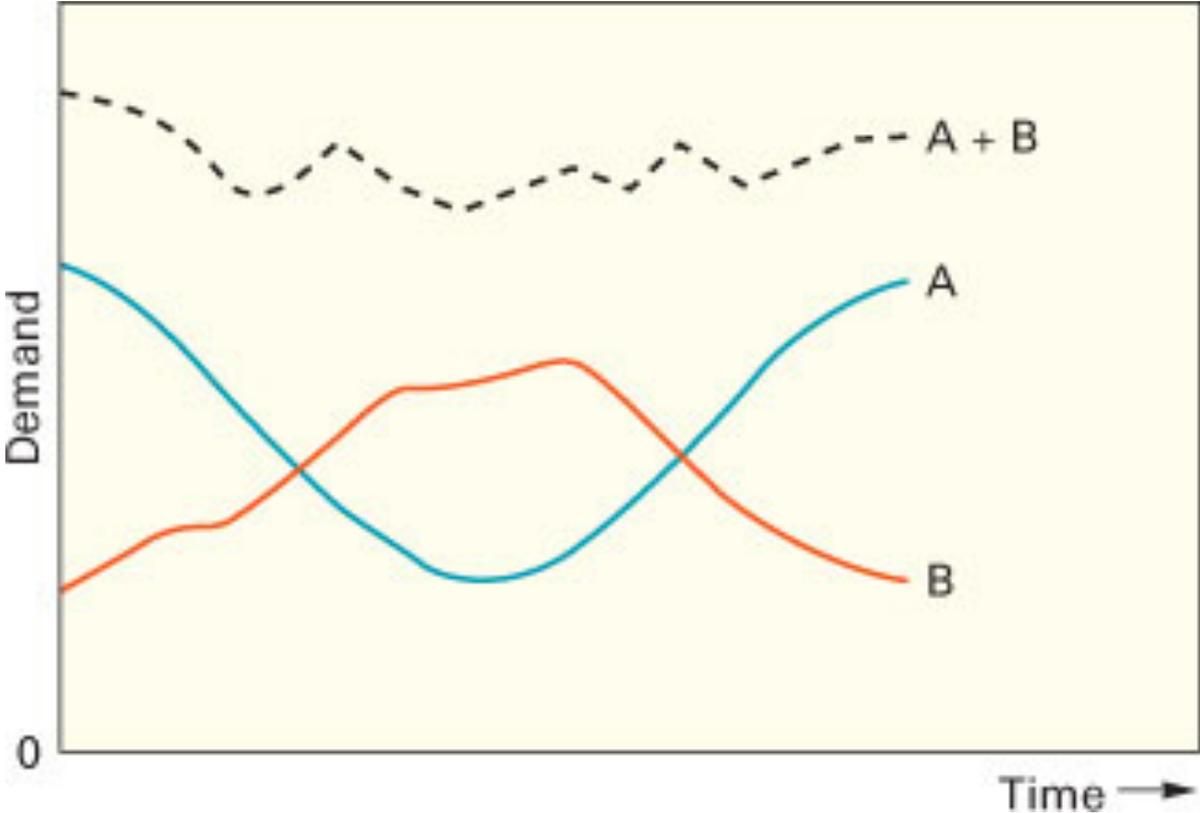
Take stage of life cycle into account. Capacity requirements are often closely linked to the stage of the life cycle that a product or service is in.

Take a “big-picture” (i.e., systems) approach to capacity changes. When developing capacity alternatives, it is important to consider how parts of the system interrelate.

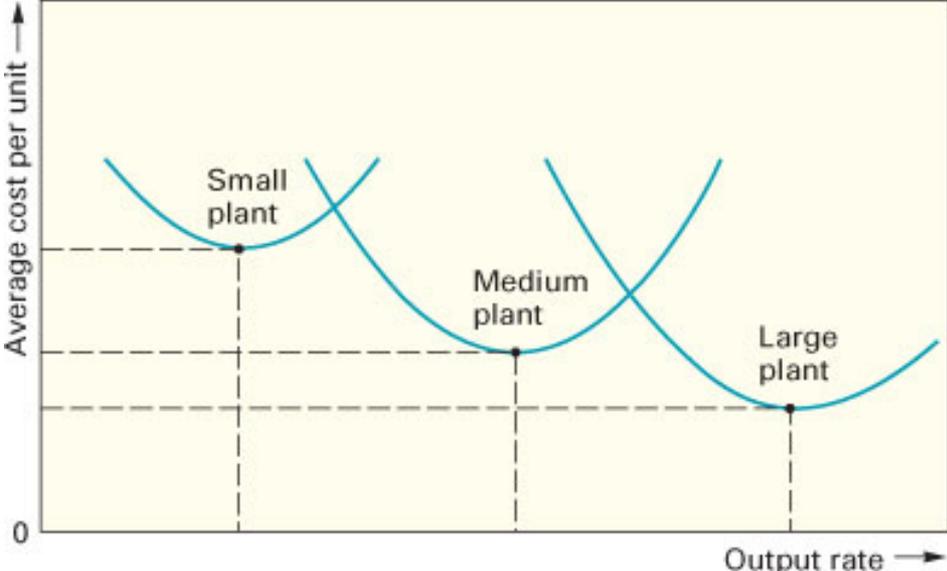
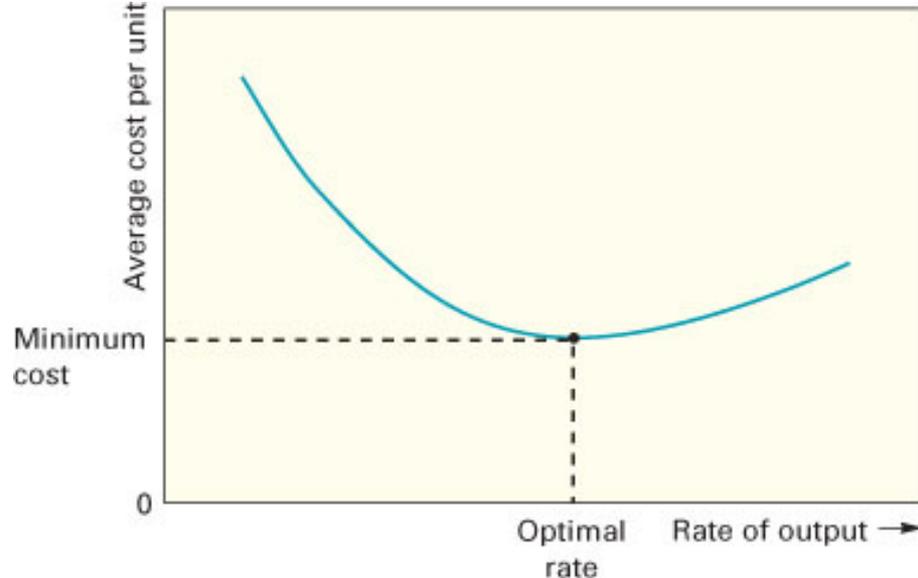


Prepare to deal with capacity “chunks.” Capacity increases are often acquired in fairly large chunks rather than smooth increments, making it difficult to achieve a match between desired capacity and feasible capacity.

Attempt to smooth out capacity requirements. Unevenness in capacity requirements also can create certain problems.



Identify the optimal operating level. Production units typically have an ideal or optimal level of operation in terms of unit cost of output.



Choose a strategy if expansion is involved. Consider whether incremental expansion or single step is more appropriate.

Evaluating Alternatives

Cost-Volume Analysis

FC = Fixed cost

VC = Total variable cost

v = Variable cost per unit

TC = Total cost

TR = Total revenue

R = Revenue per unit

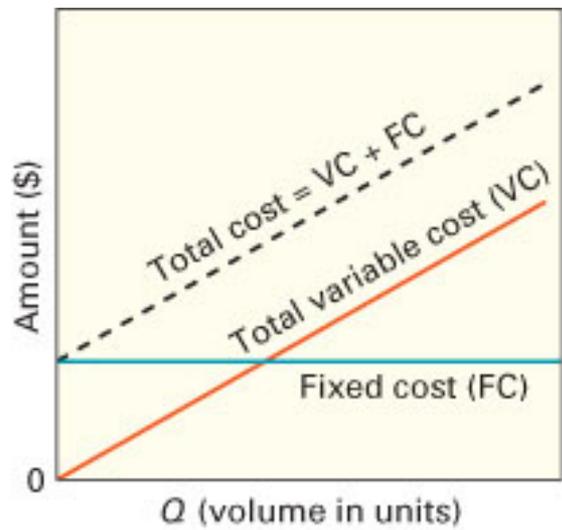
Q = Quantity or volume of output

Q_{BEP} = Break-even quantity

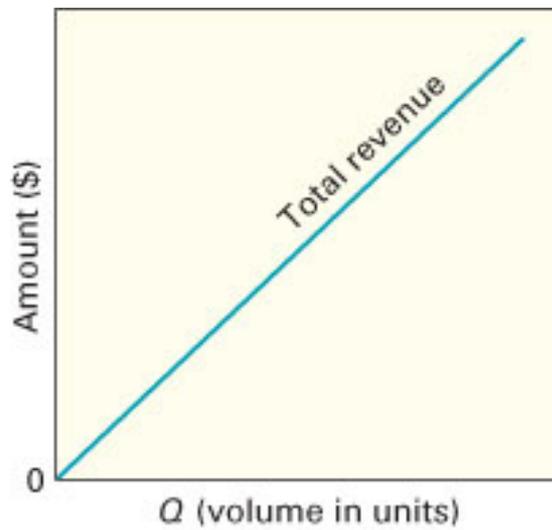
P = Profit

$$TC = FC + VC$$

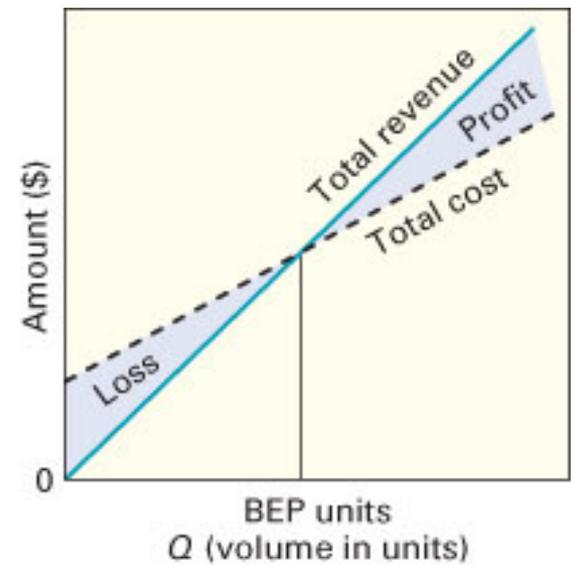
$$VC = Q \times v$$



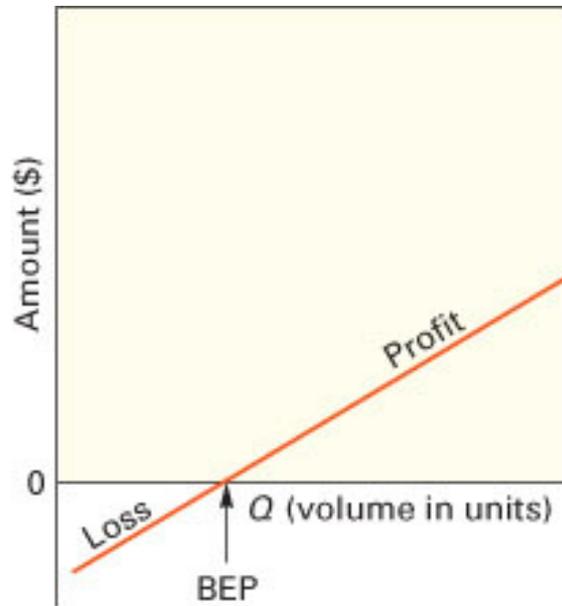
A. Fixed, variable, and total costs



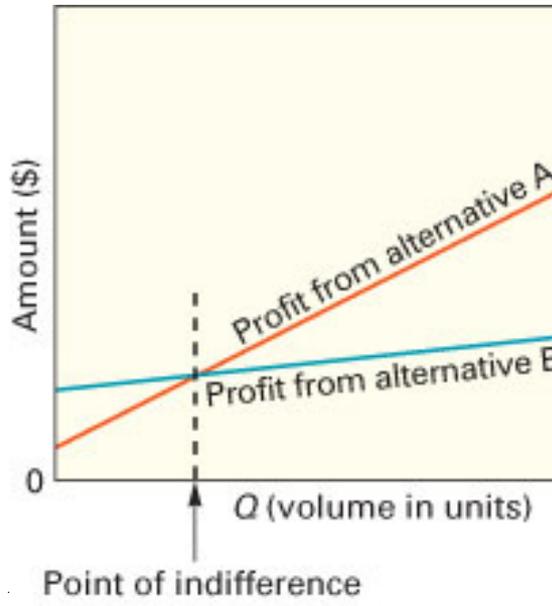
B. Total revenue increases linearly with output



C. Profit = TR - TC



D. Profit versus loss



E. Point of indifference for two alternatives

$$TR = R \times Q$$

$$P = TR - TC = R \times Q - (FC + v \times Q)$$

$$P = Q(R - v) - FC$$

$$Q = (P + FC) / (R - v)$$

$$Q_{\text{BEP}} = FC / (R - v)$$

Example

The owner of Old-Fashioned Berry Pies, S. Simon, is contemplating adding a new line of pies, which will require leasing new equipment for a monthly payment of \$6,000. Variable costs would be \$2.00 per pie, and pies would retail for \$7.00 each.

1. How many pies must be sold in order to break even?
2. What would the profit (loss) be if 1,000 pies are made and sold in a month?
3. How many pies must be sold to realize a profit of \$4,000?
4. If 2,000 can be sold, and a profit target is \$5,000, what price should be charged per pie?

FC = \$6,000, VC = \$2 per pie, Rev = \$7 per pie

$$Q_{\text{BEP}} = \frac{\text{FC}}{\text{Rev} - \text{VC}} = \frac{\$6,000}{\$7 - \$2} = 1,200 \text{ pies/month}$$

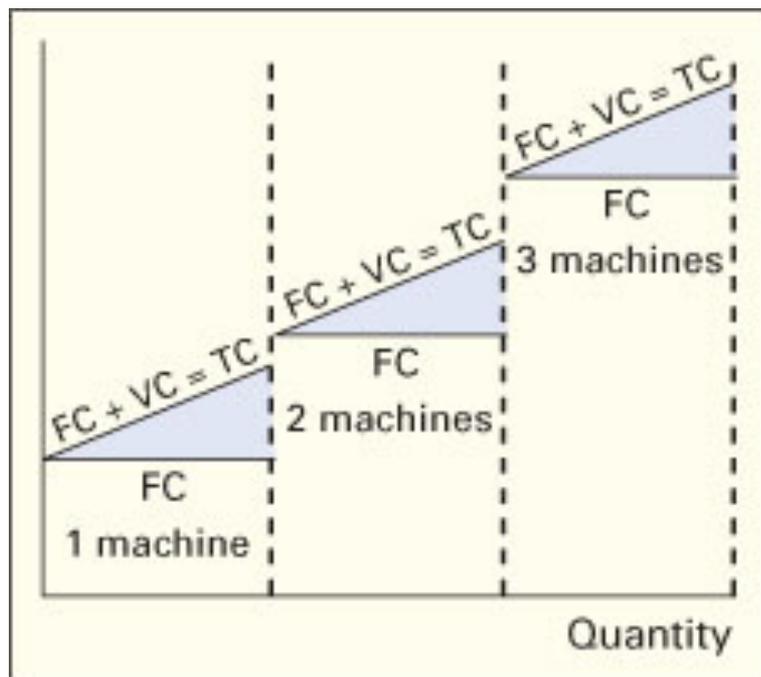
$$Q = 1,000, P = Q(R - v) - \text{FC} = 1,000(\$7 - \$2) - \$6,000 = -\$1,000$$

$$Q = \frac{\$4,000 + \$6,000}{\$7 - \$2} = 2,000 \text{ pies}$$

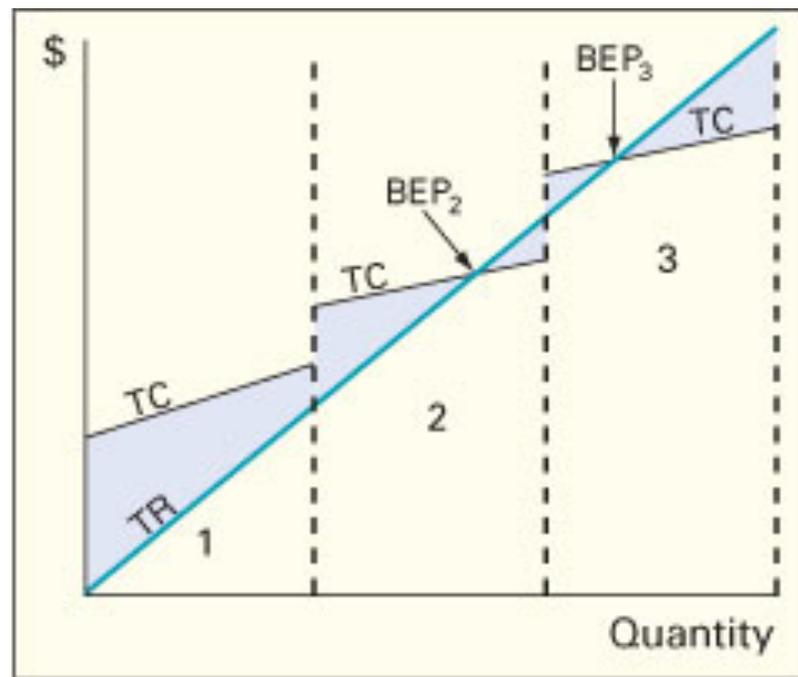
$$\text{Profit} = Q(R - v) - \text{FC}$$

$$\$5,000 = 2,000(R - \$2) - \$6,000$$

$$R = \$7.50$$



A. Step fixed costs and variable costs



B. Multiple break-even points

Example

A manager has the option of purchasing one, two, or three machines. Fixed costs and potential volumes are as follows:

Number of Machines	Total Annual Fixed Costs	Corresponding Range of Output
1	\$ 9,600	0 to 300
2	15,000	301 to 600
3	20,000	601 to 900

1. Variable cost is \$10 per unit, and revenue is \$40 per unit.
2. Determine the break-even point for each range.
3. If projected annual demand is between 580 and 660 units, how many machines should the manager purchase?

$$Q_{\text{BEP}} = \frac{\$9,600}{\$40/\text{unit} - \$10/\text{unit}} = 320 \text{ units [not in range, so there is no BEP]}$$

$$Q_{\text{BEP}} = \frac{\$15,000}{\$40/\text{unit} - \$10/\text{unit}} = 500 \text{ units}$$

$$Q_{\text{BEP}} = \frac{\$20,000}{\$40/\text{unit} - \$10/\text{unit}} = 666.67 \text{ units}$$

Comparing the projected range of demand to the two ranges for which a break-even point occurs, you can see that the break-even point is 500, which is in the range 301 to 600. This means that even if demand is at the low end of the range, it would be above the break-even point and thus yield a profit. That is not true of range 601 to 900. At the top end of projected demand, the volume would still be less than the break-even point for that range, so there would be no profit. Hence, the manager should choose two machines.

Financial Analysis

Cash flow refers to the difference between the cash received from sales (of goods or services) and other sources (e.g., sale of old equipment) and the cash outflow for labor, materials, overhead, and taxes.

Simulation

expresses in current value the sum of all future cash flows of an investment proposal.

Payback is a crude but widely used method that focuses on the length of time it will take for an investment to return its original cost.

The **present value (PV)** method summarizes the initial cost of an investment, its estimated annual cash flows, and any expected salvage value in a single value called the *equivalent current value*, taking into account the time value of money.

The **internal rate of return (IRR)** summarizes the initial cost, expected annual cash flows, and estimated future salvage value of an investment proposal in an *equivalent interest rate*.

Decision Theory

Waiting-Line Analysis

Simulation