Capacity Planning
For Products and Services

- Capacity is the upper limit or ceiling on the load that an operating unit can handle.
- The basic questions in capacity handling are:
  - What kind of capacity is needed?
  - How much is needed?
  - When is it needed?
Importance of Capacity Decisions

1. Impacts ability to meet future demands
2. Affects operating costs
3. Major determinant of initial costs
4. Involves long-term commitment
5. Affects competitiveness
6. Affects ease of management
7. Globalization adds complexity
8. Impacts long range planning

Capacity

- Design capacity
  - 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
- Actual output
  - rate of output actually achieved—cannot exceed effective capacity.

Efficiency and Utilization

\[
\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}}
\]

\[
\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}}
\]

Both measures expressed as percentages
5-7 Capacity Planning

- Actual output = 36 units/day
- Efficiency = 90%
- Design capacity = 50 trucks/day
- Effective capacity = 40 trucks/day
- Utilization = 72%

**Efficiency/Utilization Example**

Design capacity = 50 trucks/day
Effective capacity = 40 trucks/day
Actual output = 36 units/day

\[
\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}} \times 100\% = \frac{36 \text{ units/day}}{40 \text{ units/day}} \times 100\% = 90\%
\]

\[
\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}} \times 100\% = \frac{36 \text{ units/day}}{50 \text{ units/day}} \times 100\% = 72\%
\]

**Determinants of Effective Capacity**

- Facilities
- Product and service factors
- Process factors
- Human factors
- Operational factors
- Supply chain factors
- External factors

**Strategy Formulation**

- Capacity strategy for long-term demand
- Demand patterns
- Growth rate and variability
- Facilities
  - Cost of building and operating
  - Technological changes
  - Rate and direction of technology changes
- Behavior of competitors
- Availability of capital and other inputs
Key Decisions of Capacity Planning

1. Amount of capacity needed
2. Timing of changes
3. Need to maintain balance
4. Extent of flexibility of facilities

Capacity cushion – extra demand intended to offset uncertainty

Steps for Capacity Planning

1. Estimate future capacity requirements
2. Evaluate existing capacity
3. Identify alternatives
4. Conduct financial analysis
5. Assess key qualitative issues
6. Select one alternative
7. Implement alternative chosen
8. Monitor results

Make or Buy

1. Available capacity
2. Expertise
3. Quality considerations
4. Nature of demand
5. Cost
6. Risk
1. Design flexibility into systems
2. Take stage of life cycle into account
3. Take a “big picture” approach to capacity changes
4. Prepare to deal with capacity “chunks”
5. Attempt to smooth out capacity requirements
6. Identify the optimal operating level

Economies of Scale

- Economies of scale
  - If the output rate is less than the optimal level, increasing output rate results in decreasing average unit costs
- Diseconomies of scale
  - If the output rate is more than the optimal level, increasing the output rate results in increasing average unit costs

Figure 5.3
Production units have an optimal rate of output for minimal cost.

Minimum average cost per unit
Minimum cost
Rate of output →
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Evaluating Alternatives

Minimum cost & optimal operating rate are functions of size of production unit.

![Graph showing average cost per unit vs. output rate for small, medium, and large plants.]

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- Need to be near customers
- Capacity and location are closely tied
- Inability to store services
- Capacity must be matched with timing of demand
- Degree of volatility of demand
- Peak demand periods

Planning Service Capacity

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Cost-Volume Relationships

Amount ($) vs. Volume in units

- Total cost = VC + FC
- Total variable cost (VC)
- Fixed cost (FC)

![Graph showing cost-volume relationships.]
Cost-Volume Relationships

Figure 5.5b

Cost-Volume Relationships

Figure 5.5c

Break-Even Problem with Step Fixed Costs

Figure 5.6a

Step fixed costs and variable costs.
**5-22 Capacity Planning**

**Break-Even Problem with Step Fixed Costs**

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Figure 5.6b

### Multiple break-even points

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1. One product is involved
2. Everything produced can be sold
3. Variable cost per unit is the same regardless of volume
4. Fixed costs do not change with volume
5. Revenue per unit constant with volume
6. Revenue per unit exceeds variable cost per unit

**Assumptions of Cost-Volume Analysis**

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**Financial Analysis**

- Cash Flow - the difference between cash received from sales and other sources, and cash outflow for labor, material, overhead, and taxes.
- Present Value - the sum, in current value, of all future cash flows of an investment proposal.
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