Outline

- ☑ *Global Company Profile: Anheuser-Busch*
- ☑ *The Planning Process*
- ☑ *The Nature Of Aggregate Planning*
- ☑ *Aggregate Planning Strategies*
  - ☑ *Capacity Options*
  - ☑ *Demand Options*
  - ☑ *Mixing Options to Develop a Plan*

Outline – Continued

- ☑ *Methods For Aggregate Planning*
  - ☑ *Graphical and Charting Methods*
  - ☑ *Mathematical Approaches to Planning*
  - ☑ *Comparison of Aggregate Planning Methods*

Outline – Continued

- ☑ *Aggregate Planning In Services*
  - ☑ *Restaurants*
  - ☑ *Hospital*
  - ☑ *National Chains of Small Service Firms*
  - ☑ *Miscellaneous Services*
  - ☑ *Airline Industry*
- ☑ *Yield Management*

Learning Objectives

When you complete this chapter, you should be able to:

Identify or Define:

- ☑ ***Aggregate planning***
- ☑ ***Tactical scheduling***
- ☑ ***Graphic technique for aggregate planning***
- ☑ ***Mathematical techniques for aggregate planning***

Learning Objectives

When you complete this chapter, you should be able to:

Describe or Explain:

- ☑ ***How to do aggregate planning***
- ☑ ***How service firms develop aggregate plans***

Anheuser-Busch

- ☑ *Anheuser-Busch produces nearly 40% of the beer consumed in the U.S.*
- ☑ *Matches fluctuating demand by brand to plant, labor, and inventory capacity to achieve high facility utilization*
- ☑ *High facility utilization requires*
  - ☑ *Meticulous cleaning between batches*
  - ☑ *Effective maintenance*
  - ☑ *Efficient employees*
  - ☑ *Efficient facility scheduling*

Aggregate Planning

Determine the quantity and timing of production for the immediate future

- ☑ *Objective is to minimize cost over the planning period by adjusting*
  - ☑ *Production rates*
  - ☑ *Labor levels*
  - ☑ *Inventory levels*
  - ☑ *Overtime work*
  - ☑ *Subcontracting*
  - ☑ *Other controllable variables*

Aggregate Planning

Required for aggregate planning

- ☑ ***A logical overall unit for measuring sales and output***
- ☑ ***A forecast of demand for intermediate planning period in these aggregate units***
- ☑ ***A method for determining costs***
- ☑ ***A model that combines forecasts and costs so that scheduling decisions can be made for the planning period***

The Planning Process

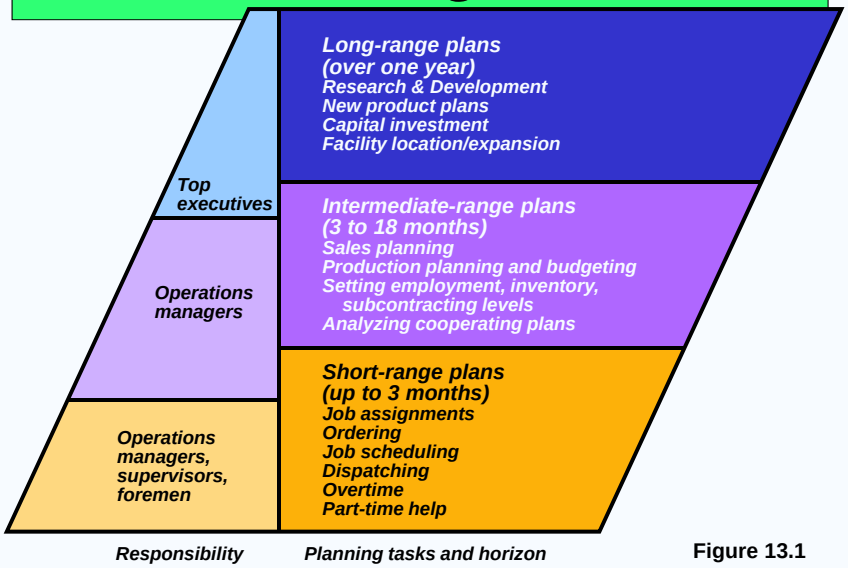


Figure 13.1

Aggregate Planning

Quarter 1		
Jan	Feb	Mar
150,000	120,000	110,000

Quarter 2		
Apr	May	Jun
100,000	130,000	150,000

Quarter 3		
Jul	Aug	Sep
180,000	150,000	140,000

Aggregate Planning

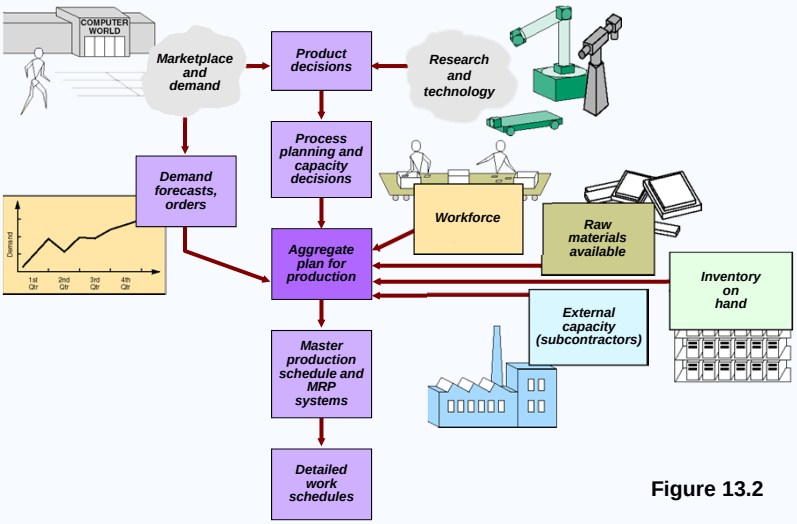


Figure 13.2

Aggregate Planning

- ☑ *Combines appropriate resources into general terms*
- ☑ *Part of a larger production planning system*
- ☑ *Disaggregation breaks the plan down into greater detail*
- ☑ *Disaggregation results in a master production schedule*

Aggregate Planning Strategies

1. *Use inventories to absorb changes in demand*
2. *Accommodate changes by varying workforce size*
3. *Use part-timers, overtime, or idle time to absorb changes*
4. *Use subcontractors and maintain a stable workforce*
5. *Change prices or other factors to influence demand*

Capacity Options

- ☑ Changing inventory levels
  - ☑ Increase inventory in low demand periods to meet high demand in the future
  - ☑ Increases costs associated with storage, insurance, handling, obsolescence, and capital investment
  - ☑ Shortages can mean lost sales due to long lead times and poor customer service

Capacity Options

- ☑ Varying workforce size by hiring or layoffs
  - ☑ Match production rate to demand
  - ☑ Training and separation costs for hiring and laying off workers
  - ☑ New workers may have lower productivity
  - ☑ Laying off workers may lower morale and productivity

Capacity Options

- ☑ *Varying production rate through overtime or idle time*
  - ☑ *Allows constant workforce*
  - ☑ *May be difficult to meet large increases in demand*
  - ☑ *Overtime can be costly and may drive down productivity*
  - ☑ *Absorbing idle time may be difficult*

Capacity Options

- ☑ *Subcontracting*
  - ☑ *Temporary measure during periods of peak demand*
  - ☑ *May be costly*
  - ☑ *Assuring quality and timely delivery may be difficult*
  - ☑ *Exposes your customers to a possible competitor*

Capacity Options

- ☑ *Using part-time workers*
  - ☑ *Useful for filling unskilled or low skilled positions, especially in services*

Demand Options

- ☑ *Influencing demand*
  - ☑ *Use advertising or promotion to increase demand in low periods*
  - ☑ *Attempt to shift demand to slow periods*
  - ☑ *May not be sufficient to balance demand and capacity*

Demand Options

- ☑ Back ordering during high-demand periods
  - ☑ Requires customers to wait for an order without loss of goodwill or the order
  - ☑ Most effective when there are few if any substitutes for the product or service
  - ☑ Often results in lost sales

Demand Options

- ☑ Counterseasonal product and service mixing
  - ☑ Develop a product mix of counterseasonal items
  - ☑ May lead to products or services outside the company's areas of expertise

Aggregate Planning Options

Option	Advantages	Disadvantages	Some Comments
Changing inventory levels	Changes in human resources are gradual or none; no abrupt production changes	Inventory holding cost may increase. Shortages may result in lost sales.	Applies mainly to production, not service, operations
Varying workforce size by hiring or layoffs	Avoids the costs of other alternatives	Hiring, layoff, and training costs may be significant	Used where size of labor pool is large

Table 13.1

Aggregate Planning Options

Option	Advantages	Disadvantages	Some Comments
Varying production rates through overtime or idle time	Matches seasonal fluctuations without hiring/ training costs	Overtime premiums; tired workers; may not meet demand	Allows flexibility within the aggregate plan
Sub-contracting	Permits flexibility and smoothing of the firm's output	Loss of quality control; reduced profits; loss of future business	Applies mainly in production settings

Table 13.1

Aggregate Planning Options

Option	Advantages	Disadvantages	Some Comments
Using part-time workers	Is less costly and more flexible than full-time workers	High turnover/ training costs; quality suffers; scheduling difficult	Good for unskilled jobs in areas with large temporary labor pools
Influencing demand	Tries to use excess capacity. Discounts draw new customers.	Uncertainty in demand. Hard to match demand to supply exactly.	Creates marketing ideas. Overbooking used in some businesses.

Table 13.1

Aggregate Planning Options

Option	Advantages	Disadvantages	Some Comments
Back ordering during high-demand periods	May avoid overtime. Keeps capacity constant.	Customer must be willing to wait, but goodwill is lost.	Allows flexibility within the aggregate plan
Counter-seasonal product and service mixing	Fully utilizes resources; allows stable workforce	May require skills or equipment outside the firm's areas of expertise	Risky finding products or services with opposite demand patterns

Table 13.1

Methods for Aggregate Planning

- ☑ A mixed strategy may be the best way to achieve minimum costs
- ☑ There are many possible mixed strategies
- ☑ Finding the optimal plan is not always possible

Mixing Options to Develop a Plan

- ☑ Chase strategy
  - ☑ Match output rates to demand forecast for each period
  - ☑ Vary workforce levels or vary production rate
  - ☑ Favored by many service organizations

Mixing Options to Develop a Plan

- ☑ Level strategy
  - ☑ Daily production is uniform
  - ☑ Use inventory or idle time as buffer
  - ☑ Stable production leads to better quality and productivity
- ☑ Some combination of capacity options, a mixed strategy, might be the best solution

Graphical and Charting Methods

- ☑ Popular techniques
- ☑ Easy to understand and use
- ☑ Trial-and-error approaches that do not guarantee an optimal solution
- ☑ Require only limited computations

Graphical and Charting Methods

1. Determine the demand for each period
2. Determine the capacity for regular time, overtime, and subcontracting each period
3. Find labor costs, hiring and layoff costs, and inventory holding costs
4. Consider company policy on workers and stock levels
5. Develop alternative plans and examine their total costs

Planning Example 1

Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Table 13.2

$$\text{Average requirement} = \frac{\text{Total expected demand}}{\text{Number of production days}}$$

$$= \frac{6,200}{124} = 50 \text{ units per day}$$

Planning Example 1

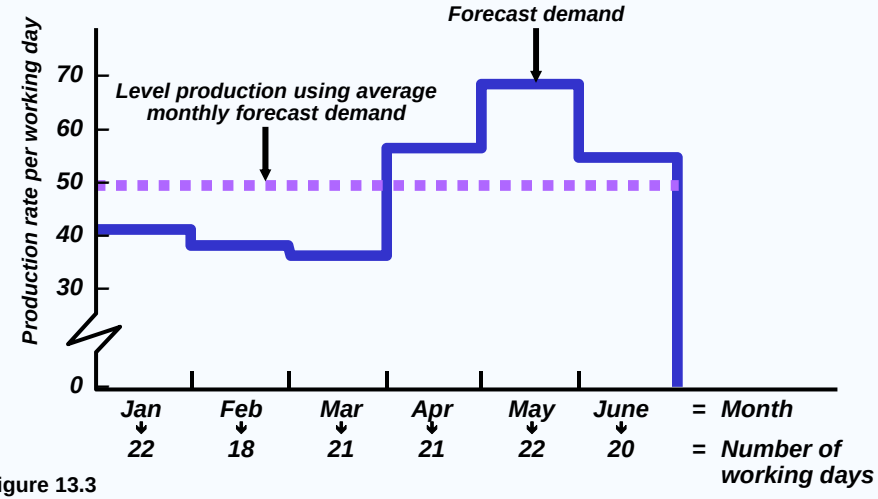


Figure 13.3

Planning Example 1

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$10 per unit
Average pay rate	$ 5 per hour ($40 per day)
Overtime pay rate	$ 7 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Planning Example 1

Month	Production at 50 Units per Day	Demand Forecast	Monthly Inventory Change	Ending Inventory
Jan	1,100	900	+200	200
Feb	900	700	+200	400
Mar	1,050	800	+250	650
Apr	1,050	1,200	-150	500
May	1,100	1,500	-400	100
June	1,000	1,100	-100	0
				1,850

Total units of inventory carried over from one month to the next = 1,850 *units*

Workforce required to produce 50 *units per day* = 10 *workers*

Planning Example 1

Costs		Calculations
Inventory carrying	$9,250	(= 1,850 *units carried x* $5 *per unit*)
Regular-time labor	49,600	(= 10 *workers x* $40 *per day x* 124 *days*)
Other costs (overtime, hiring, layoffs, subcontracting)	0	
Total cost	$58,850	

Total units of inventory carried over from one month to the next = 1,850 *units*

Workforce required to produce 50 *units per day* = 10 *workers*

Planning Example 1

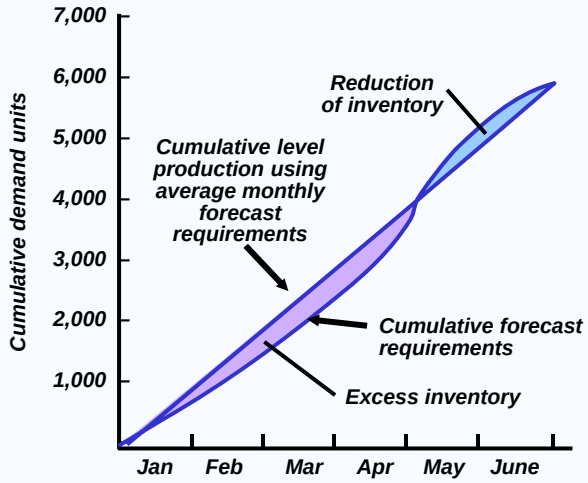


Figure 13.4

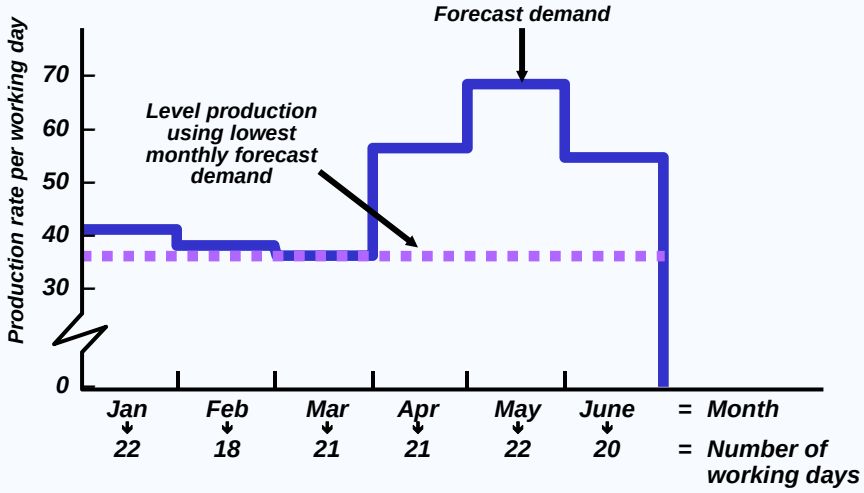
Planning Example 2

Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Table 13.2

Minimum requirement* = 38 *units per day

Planning Example 2



Planning Example 2

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$10 per unit
Average pay rate	$ 5 per hour ($40 per day)
Overtime pay rate	$ 7 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Planning Example 2

In-house production = 38 *units per day*
x 124 *days*
= 4,712 *units*

Subcontract units = 6,200 - 4,712
= 1,488 *units*

(layoffs)

Table 13.3

Planning Example 2

In-house production = 38 *units per day*
x 124 *days*
= 4,712 *units*

Costs		*Calculations*
Regular-time labor	$37,696	(= 7.6 *workers* x $40 *per day* x 124 *days*)
Subcontracting	14,880	(= 1,488 *units* x $10 *per unit*)
Total cost	$52,576	

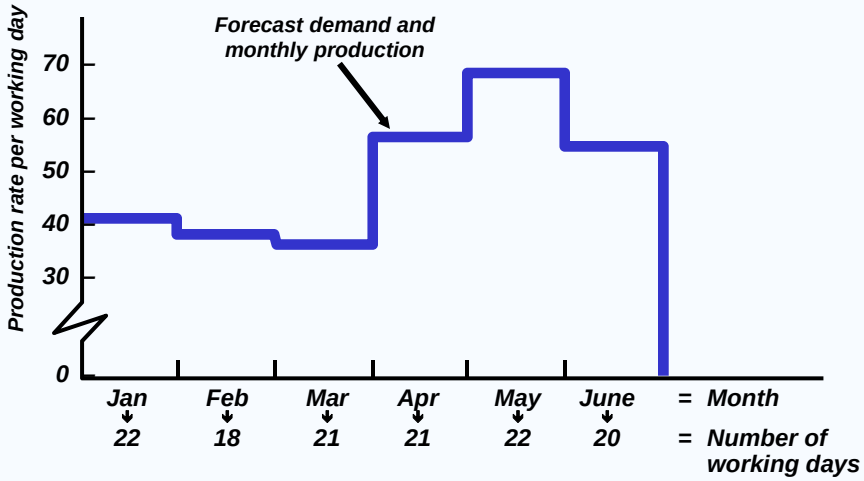
Planning Example 3

Month	Expected Demand	Production Days	Demand Per Day (computed)
Jan	900	22	41
Feb	700	18	39
Mar	800	21	38
Apr	1,200	21	57
May	1,500	22	68
June	1,100	20	55
	6,200	124	

Table 13.2

Production = Expected Demand

Planning Example 3



Planning Example 3

Cost Information	
Inventory carrying cost	$ 5 per unit per month
Subcontracting cost per unit	$10 per unit
Average pay rate	$ 5 per hour ($40 per day)
Overtime pay rate	$ 7 per hour (above 8 hours per day)
Labor-hours to produce a unit	1.6 hours per unit
Cost of increasing daily production rate (hiring and training)	$300 per unit
Cost of decreasing daily production rate (layoffs)	$600 per unit

Table 13.3

Planning Example 3

Month	Forecast (units)	Daily Prod Rate	Basic Production Cost (demand x 1.6 hrs/unit x $5/hr)	Extra Cost of Increasing Production (hiring cost)	Extra Cost of Decreasing Production (layoff cost)	Total Cost
Jan	900	41	$ 7,200	—	—	$ 7,200
Feb	700	39	5,600	—	$1,200 (= 2 x $600)	6,800
Mar	800	38	6,400	—	$600 (= 1 x $600)	7,000
Apr	1,200	57	9,600	$5,700 (= 19 x $300)	—	15,300
May	1,500	68	12,000	$3,300 (= 11 x $300)	—	15,300
June	1,100	55	8,800	—	$7,800 (= 13 x $600)	16,600
			$49,600	$9,000	$9,600	$68,200

Comparison of Three Plans

Cost	Plan 1	Plan 2	Plan 3
Inventory carrying	$ 9,250	$ 0	$ 0
Regular labor	49,600	37,696	49,600
Overtime labor	0	0	0
Hiring	0	0	9,000
Layoffs	0	0	9,600
Subcontracting	0	0	0
Total cost	$58,850	$52,576	$68,200

Plan 2 is the lowest cost option

Table 13.5

Mathematical Approaches

- ☑ *Useful for generating strategies*
  - ☑ *Transportation Method of Linear Programming*
    - ☑ *Produces an optimal plan*
  - ☑ *Management Coefficients Model*
    - ☑ *Model built around manager's experience and performance*
  - ☑ *Other Models*
    - ☑ *Linear Decision Rule*
    - ☑ *Simulation*

Transportation Method

	Sales Period		
	Mar	Apr	May
Demand	800	1,000	750
Capacity:			
Regular	700	700	700
Overtime	50	50	50
Subcontracting	150	150	130
Beginning inventory	100	tires	

Costs	
Regular time	$40 per tire
Overtime	$50 per tire
Subcontracting	$70 per tire
Carrying	$ 2 per tire

Table 13.6

Transportation Example

Important points

1. Carrying costs are $2/tire/month. If goods are made in one period and held over to the next, holding costs are incurred
2. Supply must equal demand, so a dummy column called “unused capacity” is added
3. Because back ordering is not viable in this example, cells that might be used to satisfy earlier demand are not available

Transportation Example

Important points

4. Quantities in each column designate the levels of inventory needed to meet demand requirements
5. In general, production should be allocated to the lowest cost cell available without exceeding unused capacity in the row or demand in the column

Transp Examp

SUPPLY FROM		DEMAND FOR: Period 1 (Mar.)	Period 2 (Apr.)	Period 3 (May)	Unused Capacity (dummy)	TOTAL CAPACITY AVAILABLE (supply)
Beginning inventory		0 100	2	4	0	100
Period 1	Regular time	40 700	42	44	0	700
	Overtime	50	52 50	54	0	50
	Subcontract	70	72 150	74	0	150
Period 2	Regular time	×	40 700	42	0	700
	Overtime	×	50 50	52	0	50
	Subcontract	×	70 50	72	0 100	150
Period 3	Regular time	×	×	40 700	0	700
	Overtime	×	×	50 50	0	50
	Subcontract	×	×	70	0 130	130
TOTAL DEMAND		800	1,000	750	230	2,780

Table 13.7

Management Coefficients Model

- ☑ Builds a model based on manager's experience and performance
- ☑ A regression model is constructed to define the relationships between decision variables
- ☑ Objective is to remove inconsistencies in decision making

Other Models

Linear Decision Rule

- ☑ Minimizes costs using quadratic cost curves
- ☑ Operates over a particular time period

Simulation

- ☑ Uses a search procedure to try different combinations of variables
- ☑ Develops feasible but not necessarily optimal solutions

Summary of Aggregate Planning Methods

Techniques	Solution Approaches	Important Aspects
Graphical/charting methods	Trial and error	Simple to understand and easy to use. Many solutions; one chosen may not be optimal.
Transportation method of linear programming	Optimization	LP software available; permits sensitivity analysis and new constraints; linear functions may not be realistic
Management coefficients model	Heuristic	Simple, easy to implement; tries to mimic manager's decision process; uses regression

Table 13.8

Aggregate Planning in Services

Controlling the cost of labor is critical

1. Close scheduling of labor-hours to assure quick response to customer demand
2. Some form of on-call labor resource
3. Flexibility of individual worker skills
4. Individual worker flexibility in rate of output or hours

Five Service Scenarios

- ☑ Restaurants
  - ☑ Smoothing the production process
  - ☑ Determining the workforce size
- ☑ Hospitals
  - ☑ Responding to patient demand

Five Service Scenarios

- ☑ National chains of small service firms
  - ☑ Planning done at national level and at local level
- ☑ Miscellaneous services
  - ☑ Plan human resource requirements
  - ☑ Manage demand

Law Firm Example

(1) Category of Legal Business	(2) Best Case (hours)	(3) Likely Case (hours)	(4) Worst Case (hours)	(5) Maximum Demand in People	(6) Number of Qualified Personnel
Trial work	1,800	1,500	1,200	3.6	4
Legal research	4,500	4,000	3,500	9.0	32
Corporate law	8,000	7,000	6,500	16.0	15
Real estate law	1,700	1,500	1,300	3.4	6
Criminal law	3,500	3,000	2,500	7.0	12
Total hours	19,500	17,000	15,000		
Lawyers needed	39	34	30		

Table 13.9

Five Service Scenarios

- ☑ *Airline industry*
  - ☑ *Extremely complex planning problem*
  - ☑ *Involves number of flights, number of passengers, air and ground personnel*
  - ☑ *Resources spread through the entire system*

Yield Management

Allocating resources to customers at prices that will maximize yield or revenue

1. ***Service or product can be sold in advance of consumption***
2. ***Demand fluctuates***
3. ***Capacity is relatively fixed***
4. ***Demand can be segmented***
5. ***Variable costs are low and fixed costs are high***

Yield Management Example

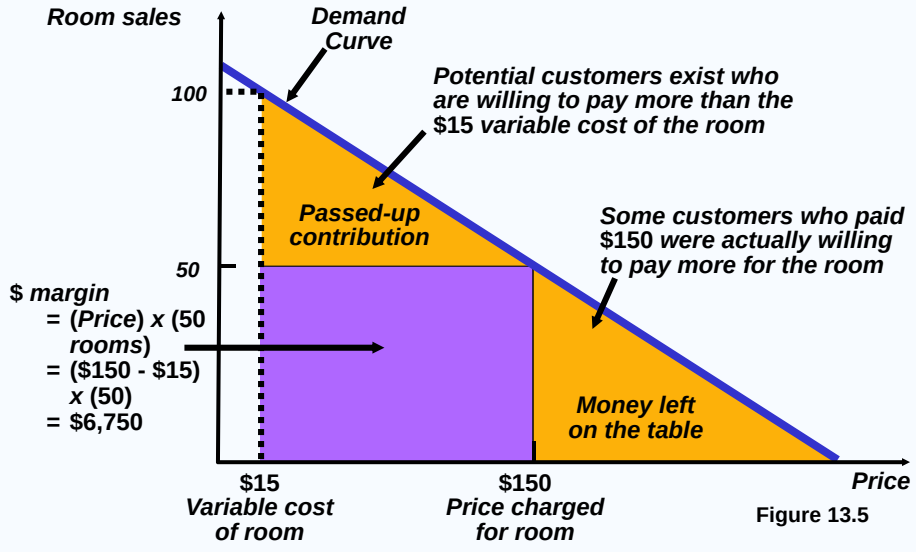


Figure 13.5

Yield Management Example

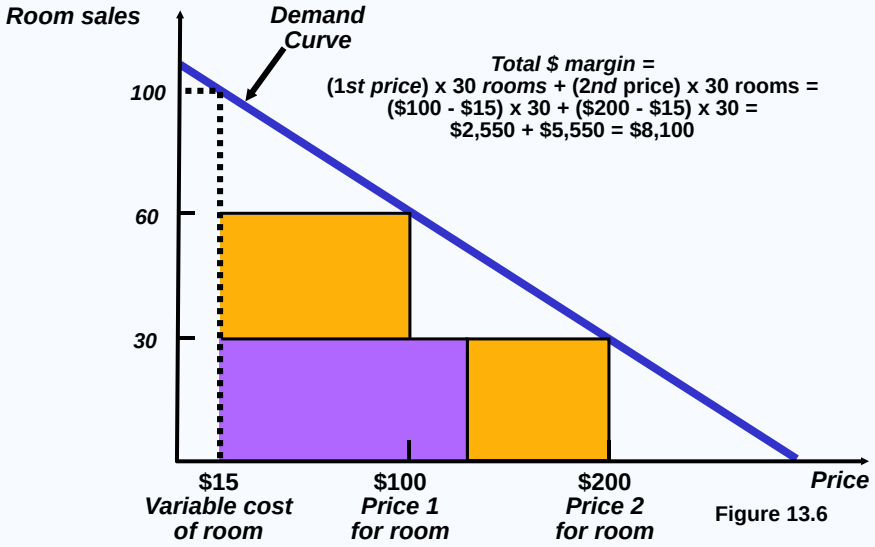


Figure 13.6

Yield Management Matrix

Duration of use	Price: Tend to be fixed	Price: Tend to be variable
Predictable	**Quadrant 1:** Movies, Stadiums/arenas, Convention centers, Hotel meeting space	**Quadrant 2:** Hotels, Airlines, Rental cars, Cruise lines
Unpredictable	**Quadrant 3:** Restaurants, Golf courses, Internet service providers	**Quadrant 4:** Continuing care hospitals

Figure 13.7

Making Yield Management Work

1. Multiple pricing structures must be feasible and appear logical to the customer
2. Forecasts of the use and duration of use
3. Changes in demand