Chapter 5
Strategic Capacity Planning

- Capacity Planning Concepts
- Determining Capacity Requirements
- Service Capacity and Service Quality

Case: Disneyland Paris

- 預估每天的遊客約3至6萬人
- 如何規劃自用車與巴士停車位？
- 如何規劃旅館房間數目？
- 如何規劃旅館的餐廳座位數？

What is Capacity?

Capacity: the upper limit on the rate of output
(amount of output over a period of time)

Measurement of capacity

	Inputs	Outputs
汽車生產線	運轉時數	每日生產輛數
菓園	種植面積	每年蔬果產量
醫院	床位	每月住院人數
百貨公司	實際營業面積	每月營業金額

if an organization has many different products or services, …
frequent changes in the mix of output… use a measure of capacity that refers to availability of inputs.

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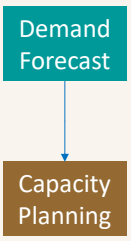
I. Strategic Capacity Planning

Achieve a match between the long term supply capabilities and the predicted level of long term demand.



Key questions in capacity planning:

- What kind of capacity is needed?
- How much is needed?
- When is it needed?

焚化爐、大學數目、發電容量
landfills

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Different Definition of Capacity

- Design capacity (max. capacity)

  maximum output rate or service capacity an operation, process, or facility is designed for

- Effective capacity 應可達到的產能

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

- Actual output

  rate of output actually achieved—may or may not exceed effective capacity

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Determinants of Effective Capacity

A. Facilities 設施
1. Design
2. Location
3. Layout
4. Environment

B. Product/service 產品設計
1. Design
2. Product or service mix

C. Process 製程能力
1. Quantity capabilities
2. Quality capabilities

D. Human factors 人員因素
1. Job content
2. Job design
3. Training and experience
4. Motivation
5. Compensation
6. Learning rates
7. Absenteeism and labor turnover

E. Policy

F. Operational 現場管理
1. Scheduling
2. Materials management
3. Quality assurance
4. Maintenance policies
5. Equipment breakdowns

G. Supply chain

H. External factors 政府或工會
1. Product standards
2. Safety regulations
3. Unions
4. Pollution control standards

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$$\text{Efficiency} = \frac{\text{Actual output}}{\text{Effective capacity}} \times 100\%$$

$$\text{Utilization} = \frac{\text{Actual output}}{\text{Design capacity}} \times 100\%$$

Overall **E**quipment **E**ffectiveness = 稼働率 × 產能效率 × 良率

=實際使用時間/全部可用時間× 產能效率 × 良率

企業的營運目的是賺取利潤，不是提高設備使用率

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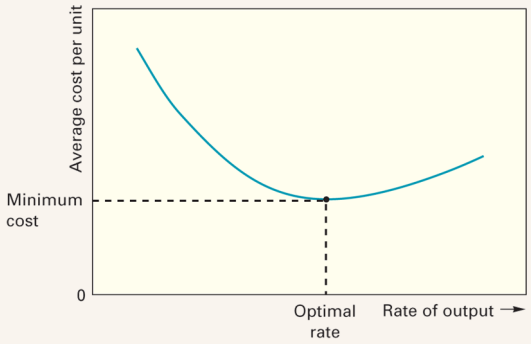
Optimal Operating Level

製程設計時規劃的產能水準，依此運作的單位生產成本最低

Best Operating Level ≤ Effective Capacity < Max. Capacity



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II. Steps for Capacity Planning

1. Forecast 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

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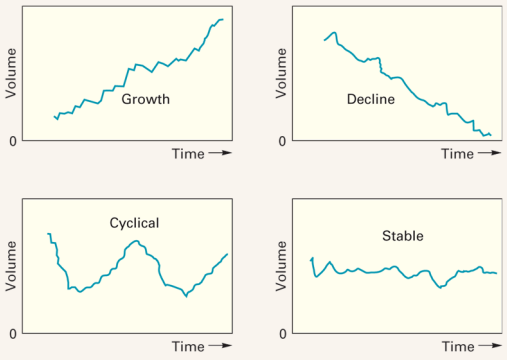
Forecast Future Capacity Requirements



(1) how long the trend might persist.

(2) the slope of the trend.

(1) the approximate length of the cycles

(2) the amplitude of the cycles

capacity cushion

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Calculating Capacity Requirement

Product	Demand	Std. Proc. Time	Proc. Time Needed
1	400	5.0	2,000
2	300	8.0	2,400
3	700	2.0	1,400

1. Forecast long term demand for individual products
2. Calculate equipment and labor requirements
3. Project and allocate resources over the planning period

year	1	2	3	4	5
forecast	135	185	245	297	348
% of capacity	30	41	54	66	77
machine	0.9	1.23	1.62	1.98	2.31

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公共場所男女廁1:5

中國時報 2006/04/27

戲院散場時，婦女常在廁所前大排長龍，非常不方便。內政部昨天通過《建築技術規則》新規定，新設電影院、戲院、車站、航空站、學校等人潮多的公共場所，男女馬桶數比例從原本一比二提高到一比五，以改善長期對女性不友善的環境空間。

新規定中，衛生設備需求模式分為「**同時使用類型**」和「**分散使用類型**」兩大類。前者指一下子湧現大量如廁需求的場所，包括戲院、電影院、歌廳、車站、航空站等，男女大便器數量比例必須一比五；後者如辦公廳、工廠、宿舍等，男女大便器比至少一比三。

「一比五」的比例原則主要參考台灣衛浴協會實務調查，女性如廁時間約是男性的兩倍，男女大便器比例應一比五才適當，因此營建署朝此方向規畫。

In-House or Outsourcing? Make or Buy

Outsourcing: obtain a good or service from an external provider

1. Available capacity 缺乏產能
2. Expertise 缺乏技術
3. Quality considerations 品質不如別人
4. Nature of demand 需求不確定
5. Cost 成本高於別人
6. Risk

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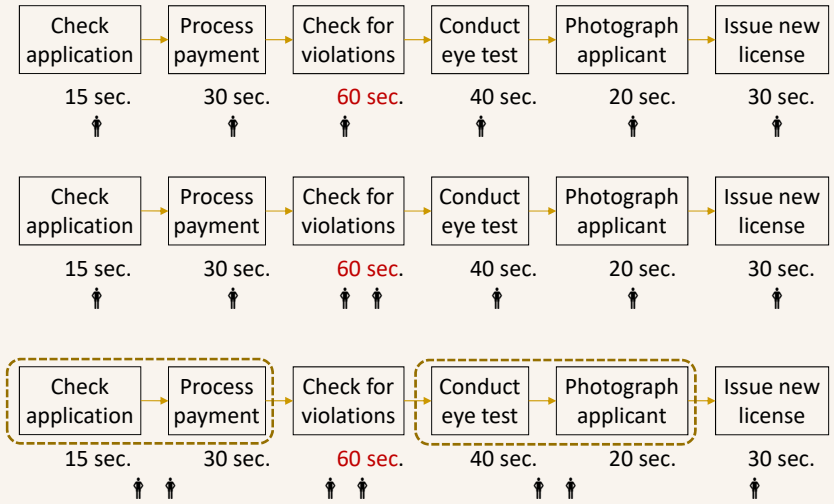
Take a "Big Picture" Approach



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Economy of Scale

規模與產量增加，可分散固定開銷，因而降低單位成本

$$\text{Unit Cost} = \frac{\text{Fixed Cost}}{\text{Total Production}} + \text{Unit Variable Cost}$$

Diseconomies of Scale

- 當規模過大時，可能因管理不易或內部作業過於複雜，使單位成本不降反升。
- 當市場需求不及設計產能時，可能被迫降價以消化庫存，或讓產能閒置而造成單位成本上升。

daewoo

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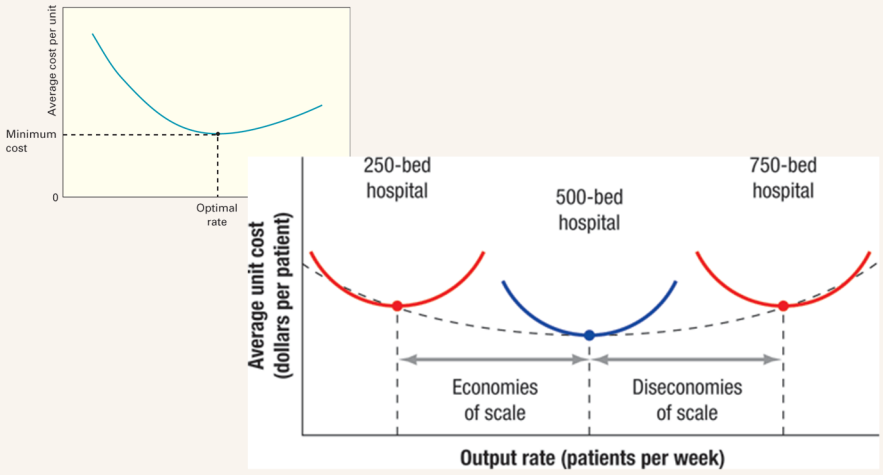
Economies and Diseconomies of Scale



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Bigger is Better in South Korea

大宇曾是南韓五大財團之一，崛起迅速，被稱為大宇神話，但解體速度之快也讓人驚嘆。大宇集團由金宇中創辦于1967年，他從業務員起家到自己設廠出口紡織品。當美國準備對紡織品進口設限時，配額將依據企業過去表現而定，金宇中立刻收購同業，低價搶單，結果大宇獨得南韓配額的近40%。

60年代，南韓政府為刺激經濟起飛，補貼銀行以零利率借貸給企業。在市場占有率至上的觀念下，企業高額負債來擴大規模、搶占市場。這創造了南韓的工業奇蹟，也使家族控制的財閥(chaebol)主宰了南韓經濟。大宇在十幾年內由5名員工擴張到總資產高達650億美元，擁有600多家公司，遍及汽車、電子、通訊、機械、化纖、造船、貿易等產業，員工人數超過二十五萬人，金宇中形容自己**到哪裡都聞得到錢的味道**。

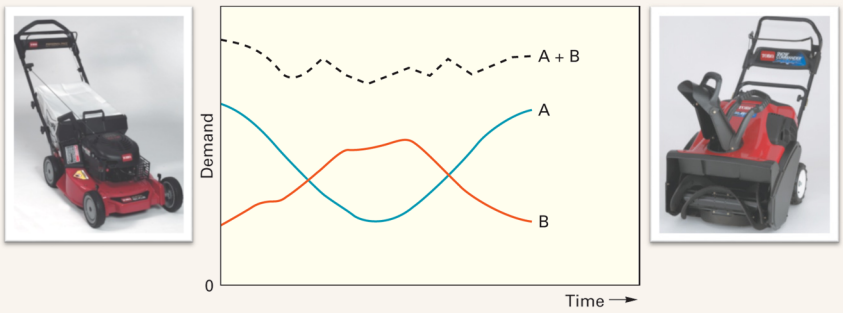
The Collapse of Daewoo

90年代末期爆發亞洲金融危機，南韓政府為了保護幣值與出口，耗盡外匯存底。當大財閥Hanbo Steel爆發嚴重虧損時，政府自顧不暇，銀行也緊縮信用以自保，一半以上的財閥無力還債。大宇沒有設法削減成本，反而低價收購陷入困境的企業，甚至發行公司債以籌措資金進行擴充。

大宇的崩潰不僅是因為政府政策錯誤，更重要的是由於金融危機爆發，使其經營條件惡化，從經濟溫床中培養出來的大宇難以承受市場的巨大風浪，銷售額和利潤均不能達到預期目標，政府也無力再繼續給予財務支持。2000年11月，大宇汽車的最大工廠停止運作，它每年能夠生產50萬輛汽車，實際產量只有一半。長期受到債務困擾的大宇正式宣告破產，總負債超過800億美金。

Smooth Out Capacity Requirements

unevenness in demand ⇒ inventory or lost sales



Identify products or services that have complementary demand patterns.

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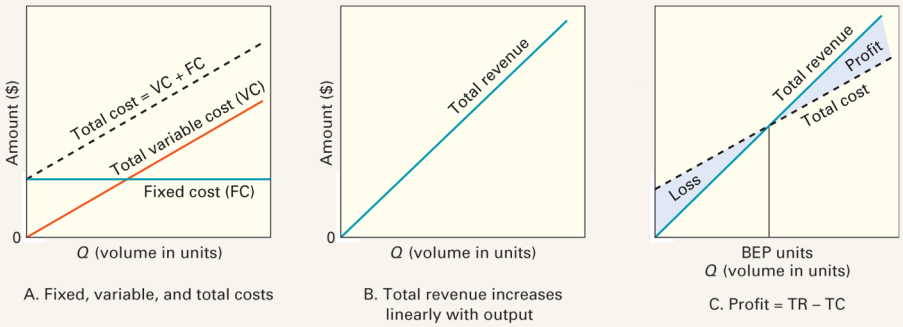
Cost-Volume Analysis (Break-Even Analysis)

Profit = Revenue –Cost = 總銷量Q × 單價R – (固定成本FC + 變動成本VC)

$$P = 0 \Rightarrow Q \times R = (FC + VC) = (FC + Q \times v) \Rightarrow Q = \frac{FC}{R - v}$$



A. Fixed, variable, and total costs

B. Total revenue increases linearly with output

C. Profit = TR – TC

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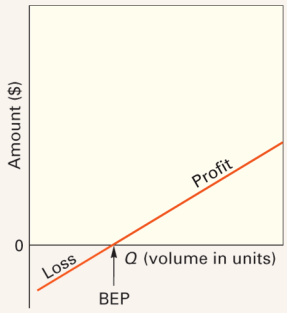
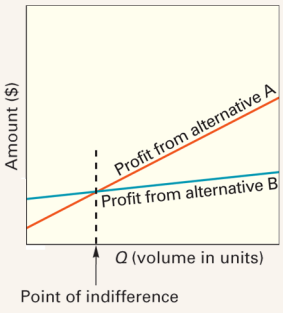
Evaluating Alternatives

$P_A = P_B \Rightarrow Q \times R - (FC_A + Q \times v_A) = Q \times R - (FC_B + Q \times v_B)$

$\Rightarrow FC_A + Q \times v_A = FC_B + Q \times v_B \Rightarrow Q = \dfrac{FC_B - FC_A}{v_A - v_B}$ point of indifference



D. Profit versus loss



E. Point of indifference for two alternatives

Financial Analysis

- Consider time value of money
- Present value=150,000, annual interest rate=5%
- Payback period=5 years
- Annual net cash flow=
  =PMT(5%,5,150000,0)
  =$34646

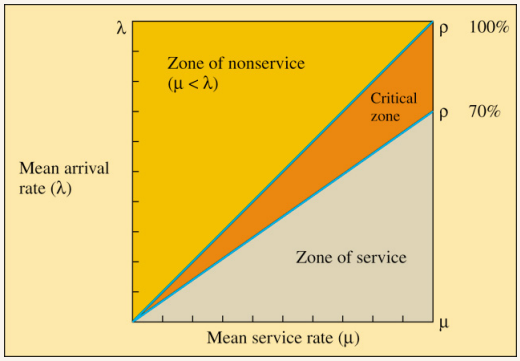
III. Planning Service Capacity

- Need to be near customers
  服務產能必須位於或接近需求所在，無法運輸
- Inability to store services
  服務產能具有易滅性，無法庫存，必須在需求發生時提供
- Volatility of demand
  服務產能容易受到需求時機、內容、顧客行為變化的影響

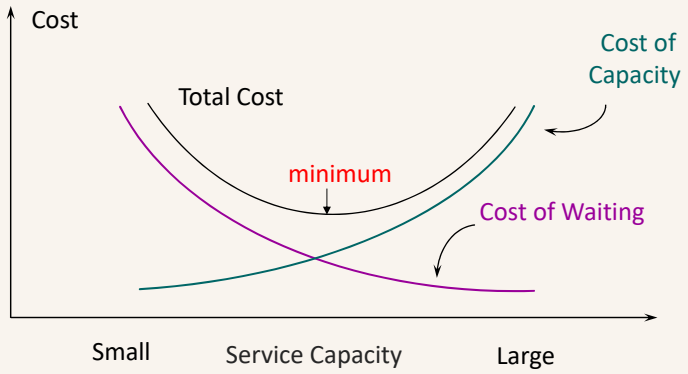
Solution: 價格行銷、兼職人員、等候線管理、預約、連鎖店、自助服務、作業標準化

Capacity Utilization vs. Service Quality

Optimal operating level ≈ Design capacity的70%



The Economies of Waiting



Total cost per hour = Cost of capacity per hour + Cost of Waiting Time

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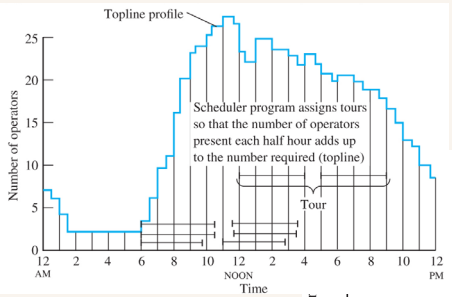
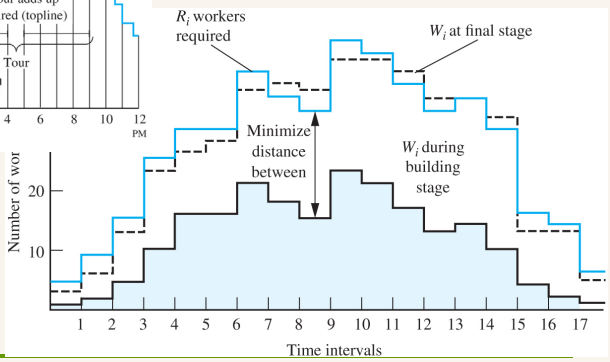
Work Shift Scheduling





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Cross-training & Part-time Employees

Training employees to be able to do different tasks

- Demand peaks: Each employee performs his specialized work (e.g., cashier in a supermarket) 尖峰時集中服務顧客
- Low demand: Employee performs additional tasks: Job is enlarged (e.g., filling the shelves in a supermarket) 離峰時後勤工作

Using part-time employees

- When demand peaks can be foreseen: Additional staff can be employed for these times (e.g., X'mas) 季節性需求
- Skills needed low: Students can be taken (e.g., bakery) 訓練容易

Customer Participation

Objectives:

- Cost reduction (less personnel is needed) 節省人力
- Capacity becomes more "variable", according to demand

Disadvantages:

- Customer expects quicker service 要讓顧客覺得有利
- Customer expects low prices (compensation for his help)
- Quality of customers "work" cannot be controlled (e.g., customer can leave his waste on the table) 顧客不遵守指示

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服務業與規模經濟

- 服務業多以連鎖店來擴充規模，並可大量採購以降低成本
- 旅行社常大量購買航空公司機位或旅館房間，以獲得降價優惠或追加佣金。

- 連鎖店經營可分直營、自願加盟、特許加盟
- 加盟者可能經營不善或不遵守總部規範
- 總部可能擴充過快或缺乏產品研發能力

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Conclusion

- Strategic capacity planning 必須以長期需求預測為依據，決策會顯著影響營運成本
- 產能擴充需考量時機、幅度、方式
- 評估economies of scale的利弊
- 以財務成本觀念來評估不同的產能選擇
- 服務業產能特性與規劃方式不同於製造業，且影響服務品質

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