

## Chapter 4

### Planning Capacity

- Capacity Strategies
- Determining Capacity Requirements
- Supplement A & B: Decision Tools

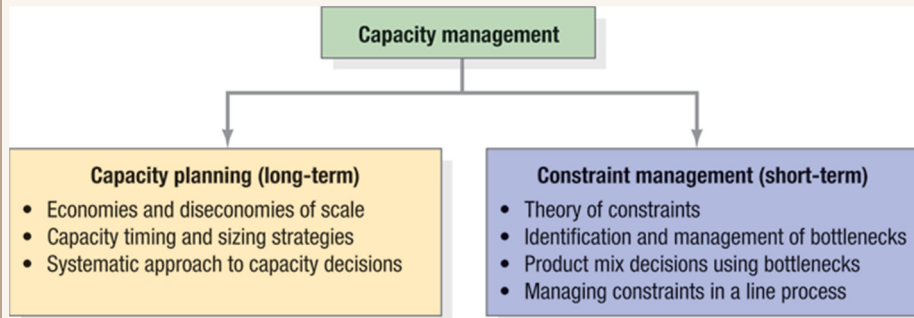
#### Case: Tesla Motors

- Tesla announced plans in 2014 to build the world's largest battery factory at an expense of \$4-5 billion.
- The factory would occupy 10M sq. feet and employ 6500 employees.
- Much of the price reduction of the new car would come from a significant decrease in the cost of battery made possible by the scale economies. 電池必須量產才能降低生產成本
- Other car manufacturers use batteries that are not compatible.



## What is Capacity?

**Capacity:** The maximum rate of output of a process or a system.



Acquisition of new capacity requires extensive planning, and often involves significant expenditure of resources and time.

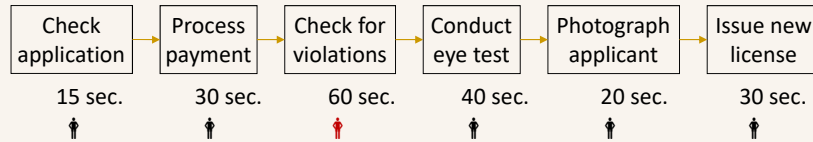
Supplement B

## Measures of Capacity

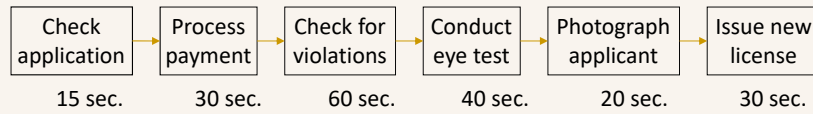
	Input	Output
汽車生產線	運轉時數	每日生產輛數
菜園	種植面積	每年蔬果產量
醫院	床位	每月住院人數
百貨公司	實際營業面積	每月營業金額

- Use **Output** Measures when:
  - The firm uses **high volume, standardized processes**
- Use **Input** Measures when:
  - The firm uses **low-volume, flexible processes**  
當產品多樣少量時

## Determine Process Capacity



- Maximal capacity = 1.0/minute = 60/hour



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## Measures of Capacity and Utilization

- Design capacity (max. capacity)
  - maximum output rate or service capacity a process can reasonably sustain for a long period.
- Effective capacity
  - Design capacity minus allowances such as personal time, maintenance, and scrap.

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

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

**Economies of Scale:** the average unit cost of a service or good can be reduced by increasing its output rate.

$$\text{Total Cost} = \text{Fixed Cost} + \text{Variable Cost}$$

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

- Spreading fixed costs
- Reducing construction costs
- Cutting costs of purchased materials
- **Process advantages:** At a higher output rate, the process shifts towards a line process with resources dedicated to individual products.

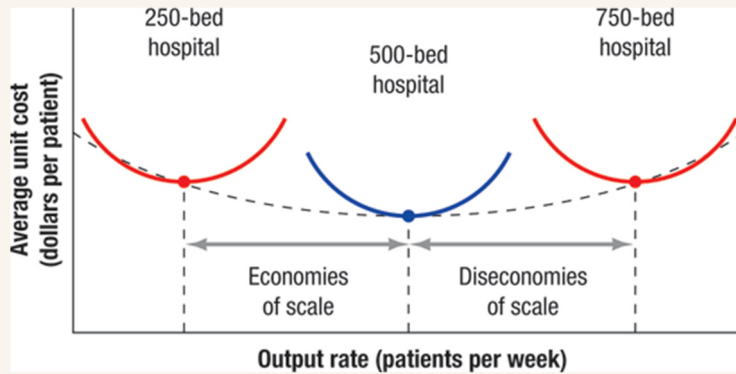
## Diseconomies of Scale

At some point, a facility can become so large that the average cost per unit increases as the facility's size increases.

- **Complexity:** Too many layers of employees and bureaucracy
- **Loss of focus:** A less agile organization loses the flexibility needed to respond to changing demand
- **Inefficiencies:** Large companies become more involved in analysis and planning that they innovate less and avoid risks

Bigger is not always Better

## Economies and Diseconomies of Scale



Total Output  $\neq$  Total Sale

## Bigger is Better in South Korea?

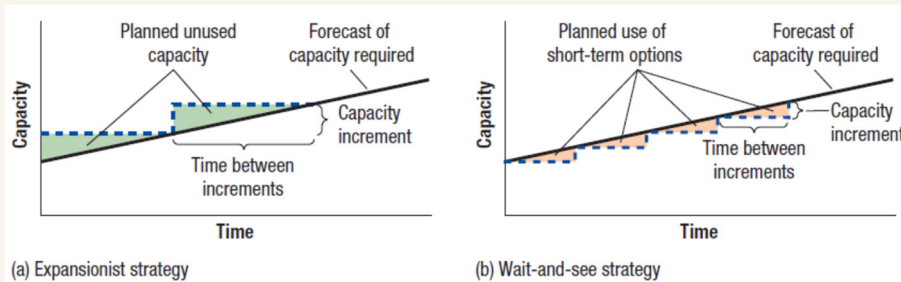


大宇曾是南韓五大財團之一，崛起迅速，被稱為大宇神話，但解體速度之快也讓人驚嘆。大宇集團由金宇中創辦于1967年，他從業務員起家到自己設廠出口紡織品。當美國準備對紡織品進口設限時，配額將依據企業過去表現而定，金宇中立刻收購同業，低價搶單，結果大宇獨得南韓配額的近40%。

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。

## Capacity Timing and Sizing Strategies

- Sizing Capacity Cushions (why large cushions?)
- Timing and Sizing Expansion



- Demand uncertainty vs. resource inflexibility

## A Systematic Approach to Long-Term Capacity Decisions

1. Estimate **future** capacity requirements
2. Identify **gaps** by comparing requirements with available capacity
3. Develop **alternative plans** for reducing the gaps
4. Evaluate each alternative, both **qualitatively** and **quantitatively**, and make a final choice



## 1. Estimate Capacity Requirements 1/2

For one service or product processed at one operation with a one year time period, the capacity requirement (workers or machines) is

$$M = \frac{D \times p}{N \times [1 - (C/100)]} \quad \text{單站、單一產品}$$

$D$  = demand forecast for the year (number of customers served or units produced)

$p$  = processing time (in hours per customer served or unit produced)

$N$  = total number of hours per year during which the process operates

$C$  = desired capacity cushion (expressed as a percent)

## 1. Estimate Capacity Requirements 2/2

Setup times may be required if multiple products are produced.

$$M = \frac{[Dp + (D/Q)s]_{\text{product 1}} + [Dp + (D/Q)s]_{\text{product 2}} + \dots + [Dp + (D/Q)s]_{\text{product } n}}{N [1 - (C/100)]} \quad \text{單站、多種產品}$$

$D$  = demand forecast for the year (number served or units produced)

$p$  = processing time (in hours per customer served or unit produced)

$N$  = total number of hours per year during which the process operates

$C$  = desired capacity cushion (expressed as a percent)

$Q$  = number of units in each lot

$s$  = setup time 換線時間 in hours per lot

### Example 4.1

A **copy center** in an office building prepares bound reports for **two clients**. It currently has three copy machines.

Item	Client X	Client Y
Annual demand forecast (copies)	2,000	6,000
Standard processing time (hour/copy)	0.5	0.7
Average lot size (copies per report)	20	30
Standard setup time (hours)	0.25	0.40

The center operates **250 days** per year, with **one 8-hour shift**.  
Management sets a capacity cushion of **15 percent**.

### Calculating Capacity Expansion and Timing

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

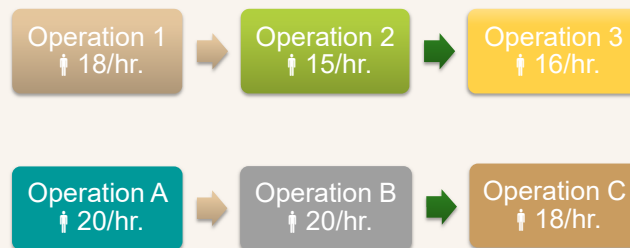
year	1	2	3	4	5
forecast	135	185	245	297	348
% of capacity	30	41	54	66	77
machine	0.9	1.23	1.62	1.98	2.31





## 2. Identify Capacity Gaps

- Identify gaps between projected capacity requirements and current capacity
  - Complicated by multiple operations (bottlenecks) and resource inputs



## 3. Develop Alternatives

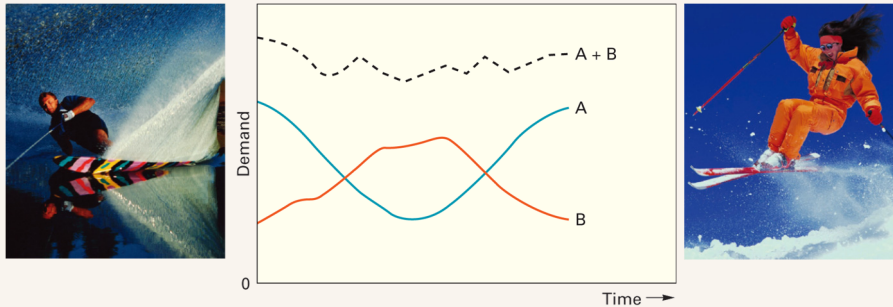
- **Base case** is to do nothing and suffer the consequences
- Expansion vs. wait-and-see vs. follow the leader
- 短期對策: overtime, temp. workers, subcontracting
- 降低產能: closing, laying off, reducing work time

## 4. Evaluate Alternatives

- **Qualitative** concerns include strategic fit, uncertainties about demand, competitors, technological change. 市場與技術
- **Quantitative** concerns may include cash flows or Return On Investment. 投資報酬

## Smooth Out Capacity Requirements

unevenness in demand  $\Rightarrow$  inventory or lost sales



Identify products or services that have complementary demand patterns.

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## Summary

- 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
- 產能擴充需考量市場不確定性、時機、幅度、方式
- 評估economies of scale的利弊
- Supplement A: 以財務成本觀念來評估不同的產能選擇
- Supplement B: 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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