2021/10/6
生產與作業管理

"Chapter 4: Strategic Capacity Management

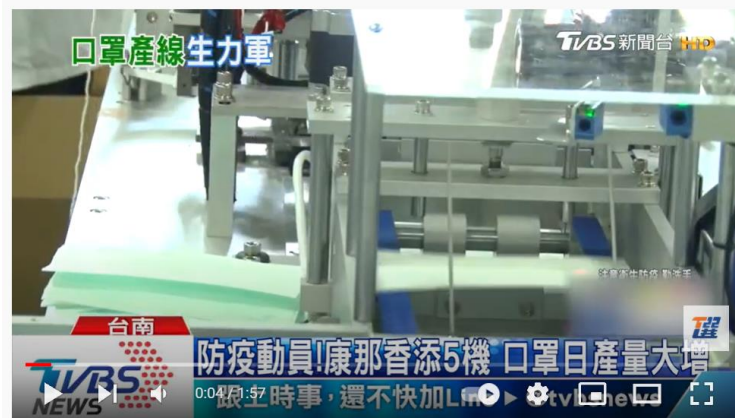# Outline

【口罩國家隊的挑戰】
3個月產能增8.5倍幕後秘辛：台灣怎麼做到？產業升級可能嗎?

國防部官兵協助口罩包裝作業。（攝影／楊子磊）

https://www.youtube.com/watch?v=wNDnElK3FW0
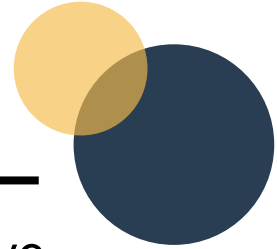
Capacity Management

- Capacity can be defined as <u>the ability to hold, receive, store, or accommodate</u>

- Time dimension of capacity:
    - **long-range**: <u>more than one year</u>; buildings, equipment…

    - **intermediate-range**: <u>monthly or quarterly </u>for the next 6 to 18 months; hiring, layoffs, new tools, subcontracting...

    - **short-range**: <u>daily or weekly </u>scheduling process to eliminate the variance between planned and actual output; overtime, personnel transfers, alternative production routing…

Strategic capacity planning
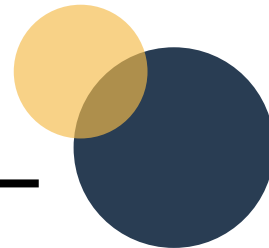
- Strategic capacity planning is an approach for determining the overall capacity level of capital intensive resources, including facilities, equipment, and overall labor force size

康那香的高速口罩生產設備整廠輸出業務，除包括開發日產能200萬片的口罩生產設備外，將提供設置規劃、動線安排、人員教育訓練等服務，並將提供生產所需熔噴布、不織布原料，讓設備、原料、訓練一次送到客戶手中，達成最快投產目的。

The importance of capacity level

1. Response rate

2. Cost structure

3. Inventory policies

4. Management and staff support requirements
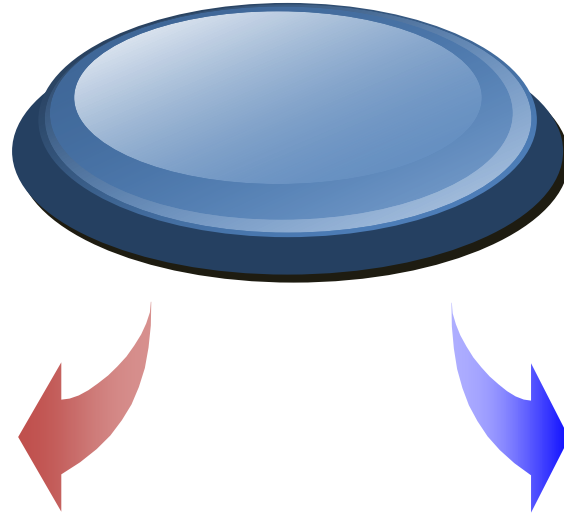
- If capacity is inadequate:
  - Lose customers through slow service or by allowing competitors to enter the market

- If capacity is excessive:
  - Reduce prices to stimulate demand
  - Underutilize its workforce
  - Carry excess inventory
  - Seek additional, less profitable products

蛋黃酥之亂結束　不二坊代購變跳樓價！黃牛哭哭

彰化知名排隊蛋黃酥名店「不二坊」本周日恢復現場販售，今天是中秋節，仍有民眾與代購業者排隊，不過長長人龍不再，只剩下在店門口短短一排不到30人，代購業者拿著早上剛出爐的蛋黃酥在兜售，現場代購價剩下73折，早上的貨到下午1點都還沒賣完，「不二坊」明起將休息5天。

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疫情導致需求端狀況不明，DRAM原廠謹慎規劃明年產能

從技術發展來看，第二季三星持續將 Line 13 部分產能由 DRAM 轉向 CIS（影像感測器），並準備啟動平澤二廠 P2L，預計下半年投入 DRAM 生產，在彌補 Line 13 投片下滑的同時，也開始拉高 1Znm 製程比重。SK 海力士 M10 廠 DRAM 投片持續轉向 CIS，同時增加 M14 產出；下半年將小幅提高無錫廠的產能，全年 DRAM 位元增加主要來自於 1Ynm 製程比重提升。

美光今年仍著重在 1Znm 製程的量產與產出比重的拉升，當前適逢量產初期且部分 OEM 處於產品驗證階段，因此 1Znm 占比不高。預計隨著驗證通過，1Znm 將成為該公司主推製程，而總產能方面則與去年大致相同。整體而言，今年三大 DRAM 原廠皆審慎擴增產能，加上疫情對需求端帶來的低潮尚未解除，預估明年位元成長仍有近七成來自 1Ynm 與 1Znm 的先進製程轉換；而廠房擴增的產能增加僅占三成。

資料來源: https://technews.tw/2020/08/19/2020-q2-dram-total-output-value/

Capacity Utilization
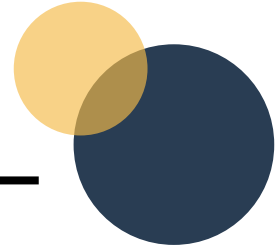
$$\text{Capacity utilization rate} = \frac{\text{Capacity used}}{\text{Best operating level}}$$

- **Capacity used**

  – rate of output actually achieved

- **Best operating level**

  – output level where average unit cost is minimized

Example of Capacity Utilization

During one week of production, a plant produced 83 units of a product. Its historic highest or best utilization recorded was 120 units per week. What is this plant's capacity utilization rate?

Answer:

Capacity utilization rate = $\dfrac{\text{Capacity used}}{\text{Best operating level}}$

$= 83/120$

$= 0.69 \text{ or } 69\%$

If the best operating level of a piece of equipment is at a rate of 400 units per hour and the actual output during an hour is 300 units, which of the following is the capacity utilization rate?

Economies & Diseconomies of Scale

Economies of Scale and the Experience Curve working:
As a plant gets larger and volume increases, the average cost per unit of output drops

Average unit cost of output

100-unit plant

200-unit plant

300-unit plant

400-unit plant

Diseconomies of Scale start working

Volume →

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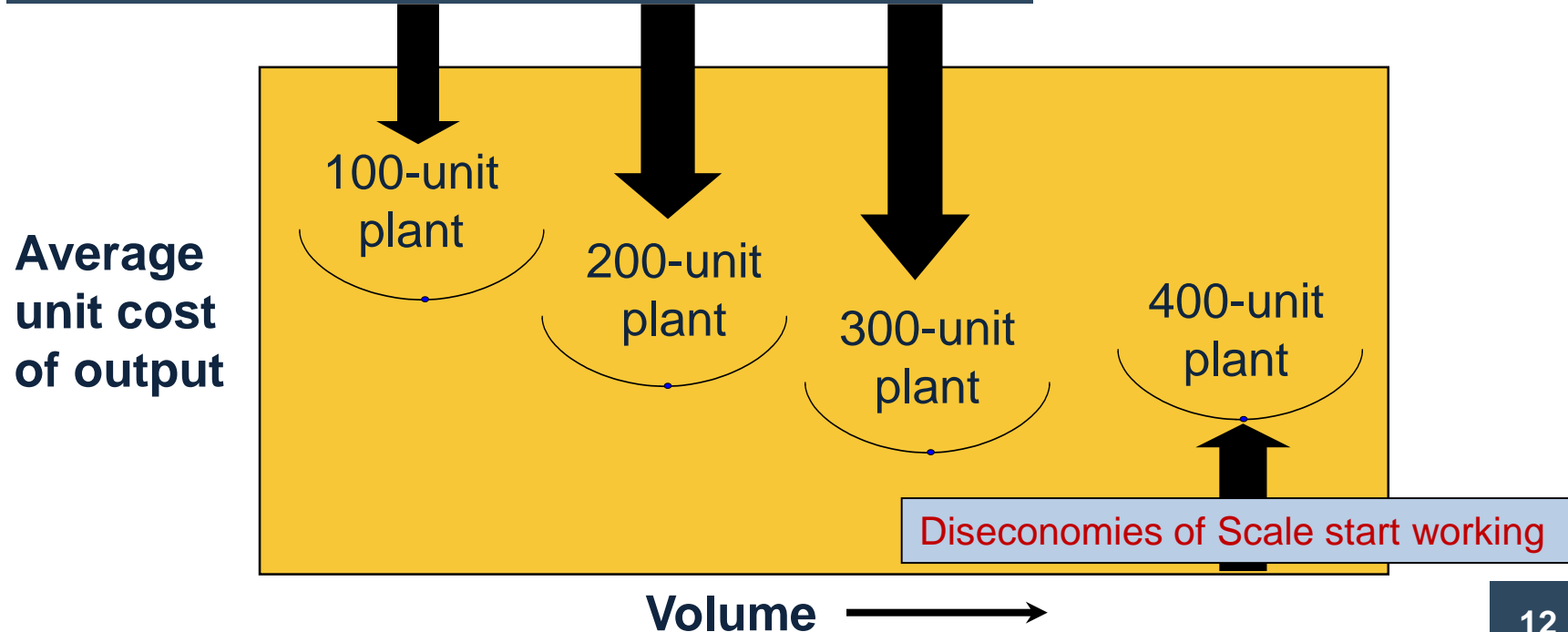
Capacity Planning Concepts

- <u>Focus factory</u> – the idea that a production facility works best when it is concentrated on a limited set of production objectives (OH9運動競技襪)

- <u>Capacity flexibility</u> – the ability to rapidly increase or decrease product levels or the ability to shift rapidly from one product or service to another

Capacity Focus
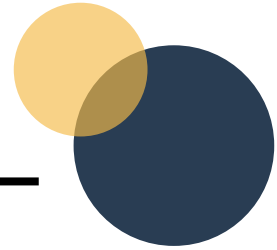
- The concept of the *focused factory* holds that production facilities work best when they focus on a fairly limited set of production objectives

- Plants Within Plants (PWP)
  - A focused plant may have several PWPs
  - Each of which may have separate suborganizations, equipment and process policies, workforce management
  - For different products

Rolex勞力士復工專注生產水鬼Daytona等熱門款　新品或2021年才出

撰文：世界高級品

👍 3

對於手錶市場的人氣天王勞力士（Rolex）而言，他們最近才剛剛從停工陰霾中重啟生產線，然而一復工就有接踵而來的問題要面對，例如剛提到的生產線分配問題，他們必需要選擇是否要在缺乏Baselworld錶展這種大舞台發佈新品的情況下，如同往常在這個時間點開始改組產線製造既有的線上款目同時生產最新款式。

而就算決定要照常生產新錶，也必需考慮客戶端和錶店端的接受度，包括消費者是不是會對新款買單，還是他們仍舊把目標放在既有款式上繼續排隊等候？以及AD店會希望銷售充滿未知的新款還是以鞏固既有熱門款為主等等。

目前傳出的消息是勞力士決定在復工之初先把火力集中在生產既有款式的暢銷款上，例如水鬼、Daytona這些作品，因為全球市場對這類明星款式的需求還是很旺，在經歷前兩個月的空窗後，品牌會想要先補上這一塊看來是頗合理的決定。

https://reurl.cc/EZXAVn

Capacity Flexibility
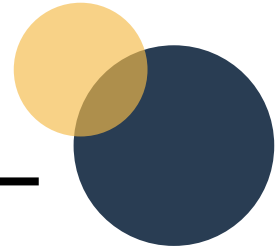
- The ability to rapidly increase or decrease production levels, or to shift production capacity quickly form one product or service to another

- Comes from the plant, processes, and workers or from strategies that use the capacity of other organizations

圖／從第一片衛生棉到如今最強口罩工廠，康那香依靠的是創新和不停止的研發精神。池孟諭攝

抓住半世紀來的最佳商機，康那香老董用「腦筋」力拚台灣最大口罩廠！

文／哈佛商業評論　攝影／池孟諭

https://www.gvm.com.tw/article/74507

成為抗疫產品的整合者－康那香除了口罩，還有其他抗疫產品，包括抗菌濕紙巾、防護衣。許多客戶要四處採購才能把防疫產品購足，因此康那香準備統合所有疫情產品，包括手套、帽子、鞋套、護目鏡等，即使沒有自行生產，也可以找相關廠商配合，讓有需要的客戶可以一站購足，商機可期。

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Capacity Flexibility (cont'd)
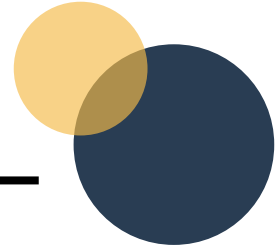
- **Flexible plants:** movable equipment, knockdown walls, and easily accessible and reroutable utilities

- **Flexible processes:** flexible manufacturing systems; simple, easily set up equipment, permitting rapid low-cost switching from one product line to another

- **Flexible workers:** workers with multiple skills, and the ability to switch easily from one kind of task to another

Capacity Flexibility
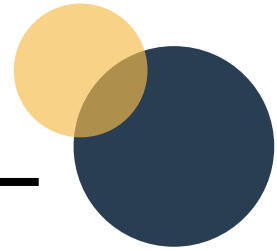
- Maintaining system balance

  - Where is bottleneck?

  - Scheduling overtime, leasing equipment, or subcontracting

- Frequency of capacity additions

  - Both frequently and infrequently are expensive

  - cost opportunities

- External sources of capacity

  - Outsourcing　(iPhone8爆裂 台廠搶食電池商機)

  - Sharing capacity (airlines)

Capacity cushion（產能緩衝）
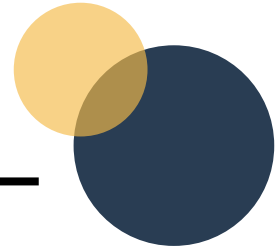
- A capacity cushion is an amount of capacity in excess of expected demand.

- When a firm's design capacity is less than the capacity required to meet its demand → negative capacity cushion

- The problems may include…

If the best operating level of a piece of equipment is at a rate of 400 units per hour and the actual output during an hour is 300 units, which of the following is the capacity cushion?

A. 25 percent

B. 100 units per hour

C. 75 percent

D. 125 percent

E. 133 percent

A capacity cushion is an amount of capacity in excess of expected demand.

Three steps to determine capacity requirement

1. Use forecasting techniques to predict sales for individual product lines (產業分析)

2. Calculate equipment and labor requirements to meet product line forecasts

3. Project labor and equipment availabilities over the planning horizon

Example 4.1

Example 4.1—Determining Capacity Requirements (pp.101-2)

- Stewart Company produces two flavors of salad dressing.

  - Paul's and Newman's

- Each is available in bottles and single-serving bags.

- What are the capacity and labor requirements for the next five years?

Determining Capacity Requirements

		Year				
		1	2	3	4	5
Paul's	Bottles (000s)	60	100	150	200	250
	Plastic bags (000s)	100	200	300	400	500
Newman's	Bottles (000s)	75	85	95	97	98
	Plastic bags (000s)	200	400	600	650	680

Step 1: Use forecasting to predict sales for individual products

The company has

- Three machines

- Each machine can package 150,000 bottles each year

- Each machine needs two operators

- Five machines

- Each machine can package 250,000 bottles each year

- Each machine needs three operators

Determining Capacity Requirements

Step 2: Calculate equipment and labor requirements

	Year				
	1	2	3	4	5
Bottles (000s)	135	185	245	297	348
Plastic bags (000s)	300	600	900	1050	1180

Bottles operation

- Capacity – 450,000
- Operators – 6
- Year 1
  - Capacity utilization $= \frac{135}{450} = 0.3$
  - Machine requirement $= 0.3 \times 3 = 0.9$
  - *Labor requirement* $= 0.9 \times 2 = 1.8$

Plastic bags operation

- Capacity – 1,250,000
- Operators – 15
- Year 1
  - Capacity utilization $= \frac{300}{1,250} = 0.24$
  - Machine requirement $= 0.24 \times 5 = 1.2$
  - *Labor requirement* $= 1.2 \times 3 = 3.6$

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Determining Capacity Requirements

Step 3: Project equipment and labor availabilities

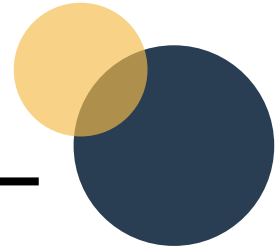|		Year				
		1	2	3	4	5
Plastic Bag Operation	Percentage capacity utilized	24	48	72	84	94
	Machine requirement	1.2	2.4	3.6	4.2	4.7
	Labor requirement	3.6	7.2	10.8	12.6	14.1
Bottle Operation	Percentage capacity utilized	30	41	54	66	77
	Machine requirement	0.9	1.23	1.62	1.98	2.31
	Labor requirement	1.8	2.46	3.24	3.96	4.62

4. AlwaysRain Irrigation, Inc., would like to determine capacity requirements for the next four years. Currently two production lines are in place for making bronze and plastic sprinklers. Three types of sprinklers are available in both bronze and plastic: 90-degree nozzle sprinklers, 180-degree nozzle sprinklers, and 360-degree nozzle sprinklers. Management has forecast demand for the next four years as follows:

	YEARLY DEMAND			
	1 (IN 000S)	2 (IN 000S)	3 (IN 000S)	4 (IN 000S)
Plastic 90	32	44	55	56
Plastic 180	15	16	17	18
Plastic 360	50	55	64	67
Bronze 90	7	8	9	10
Bronze 180	3	4	5	6
Bronze 360	11	12	15	18

Both production lines can produce all the different types of nozzles. The bronze machines needed for the bronze sprinklers require two operators and can produce up to 12,000 sprinklers. The plastic injection molding machine needed for the plastic sprinklers requires four operators and can produce up to 200,000 sprinklers. Three bronze machines and only one injection molding machine are available. What are the capacity requirements for the next four years? (Assume that there is no learning.)

Decision trees

- It is used to analyze and solve a capacity problem

- A schematic model of the sequence of steps in a problem and the conditions and consequences of each step

- Decision tree components:

  - Square: decision point

  - Circle: chance event

  - Branch from decision point: choices available to the decision maker

  - Branch from chance event: the probabilities for its occurrence

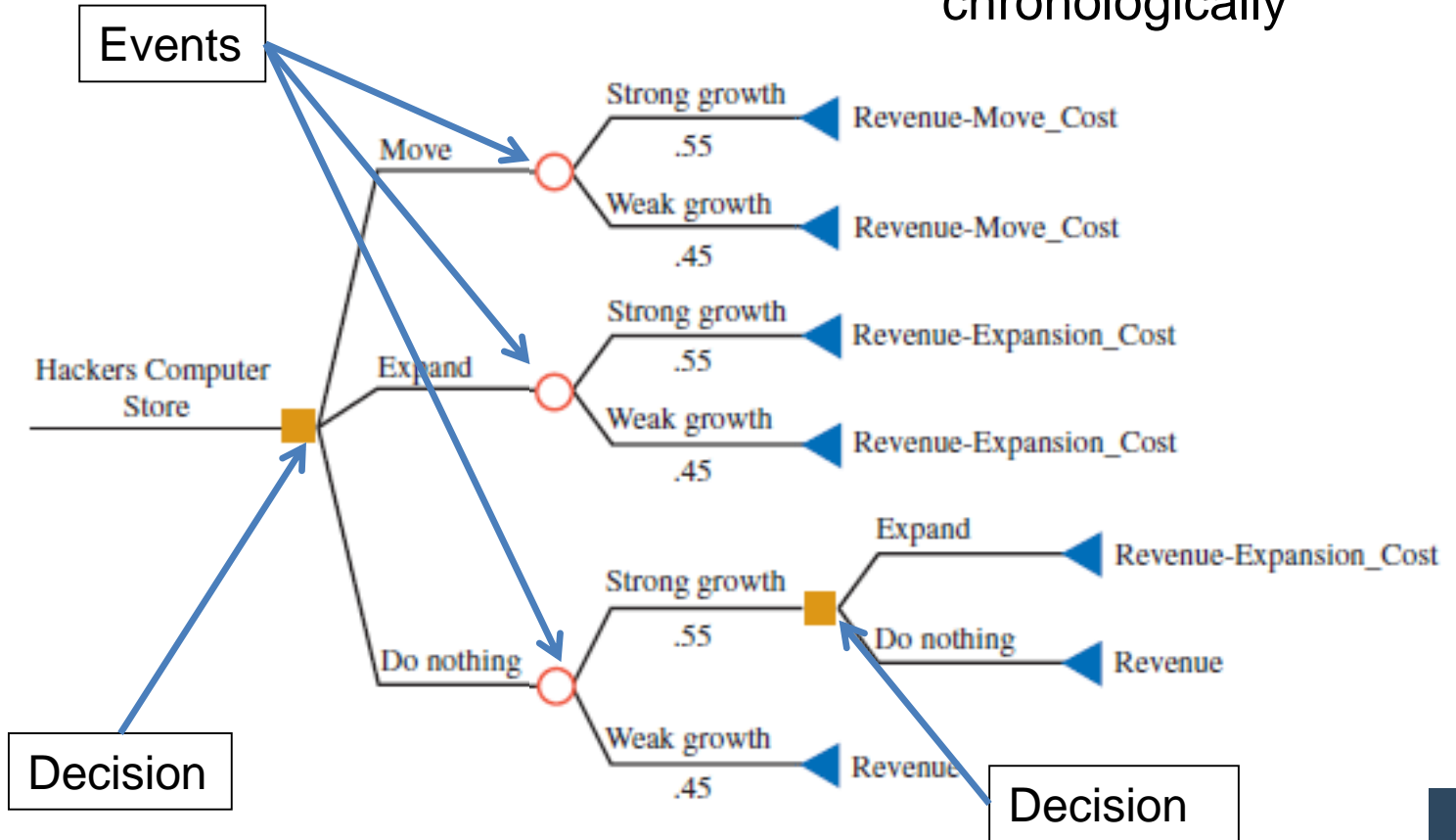# Example 4.2: Decision Trees

- The owner of Hackers Computer Store is evaluating three options

  - expand at current site

  - expand to a new site
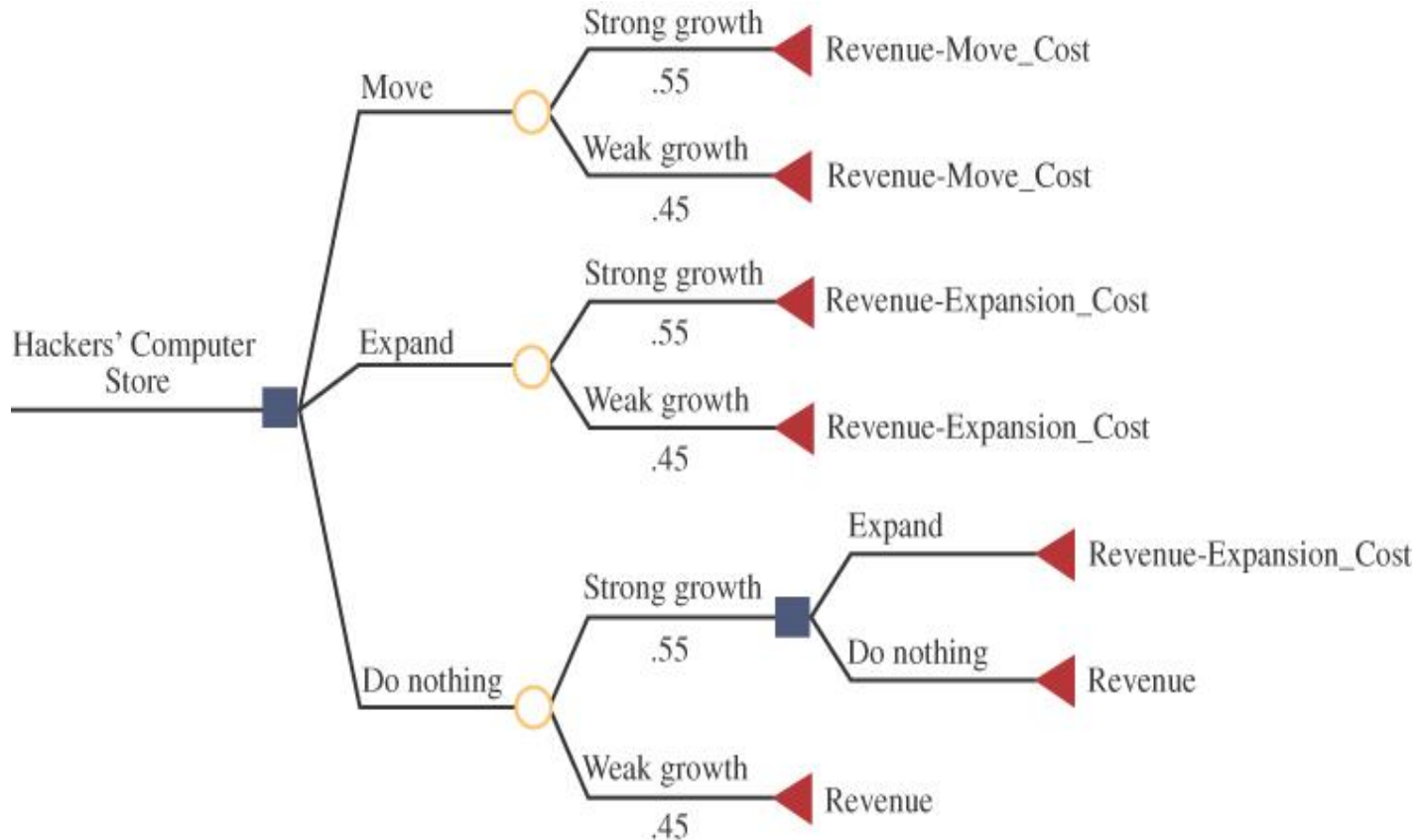
  - do nothing

Example 4.2: Decision Trees

- The decision process includes the following assumptions and conditions.
  - Strong growth has a 55% probability
  - New site cost is $210,000
    - Payoffs: strong growth = $195,000; weak growth = $115,000
  - Expanding current site cost is $87,000 (in either year 1 or 2)
    - Payoffs: strong growth = $190,000; weak growth = $100,000
  - Do nothing
    - Payoffs: strong growth = $170,000; weak growth = $105,000

Diagram the problem chronologically

Events

	Move	Strong growth	Revenue-Move_Cost
		.55	
		Weak growth	Revenue-Move_Cost
		.45	

Hackers Computer Store

Expand — Strong growth .55 — Revenue-Expansion_Cost

Weak growth .45 — Revenue-Expansion_Cost

Do nothing — Strong growth .55 — Expand — Revenue-Expansion_Cost

Do nothing — Revenue

Weak growth .45 — Revenue

Decision

Decision

Example 4.2: Decision Trees

Example 4.2: Decision Trees

Calculate the value of each alternative

ALTERNATIVE	REVENUE	COST	VALUE
Move to new location, strong growth	$195,000 × 5 yrs	$210,000	$765,000
Move to new location, weak growth	$115,000 × 5 yrs	$210,000	$365,000
Expand store, strong growth	$190,000 × 5 yrs	$87,000	$863,000
Expand store, weak growth	$100,000 × 5 yrs	$87,000	$413,000
Do nothing now, strong growth, expand next year	$170,000 × 1 yr + $190,000 × 4 yrs	$87,000	$843,000
Do nothing now, strong growth, do not expand next year	$170,000 × 5 yrs	$0	$850,000
Do nothing now, weak growth	$105,000 × 5 yrs	$0	$525,000

Example 4.2: Decision Trees
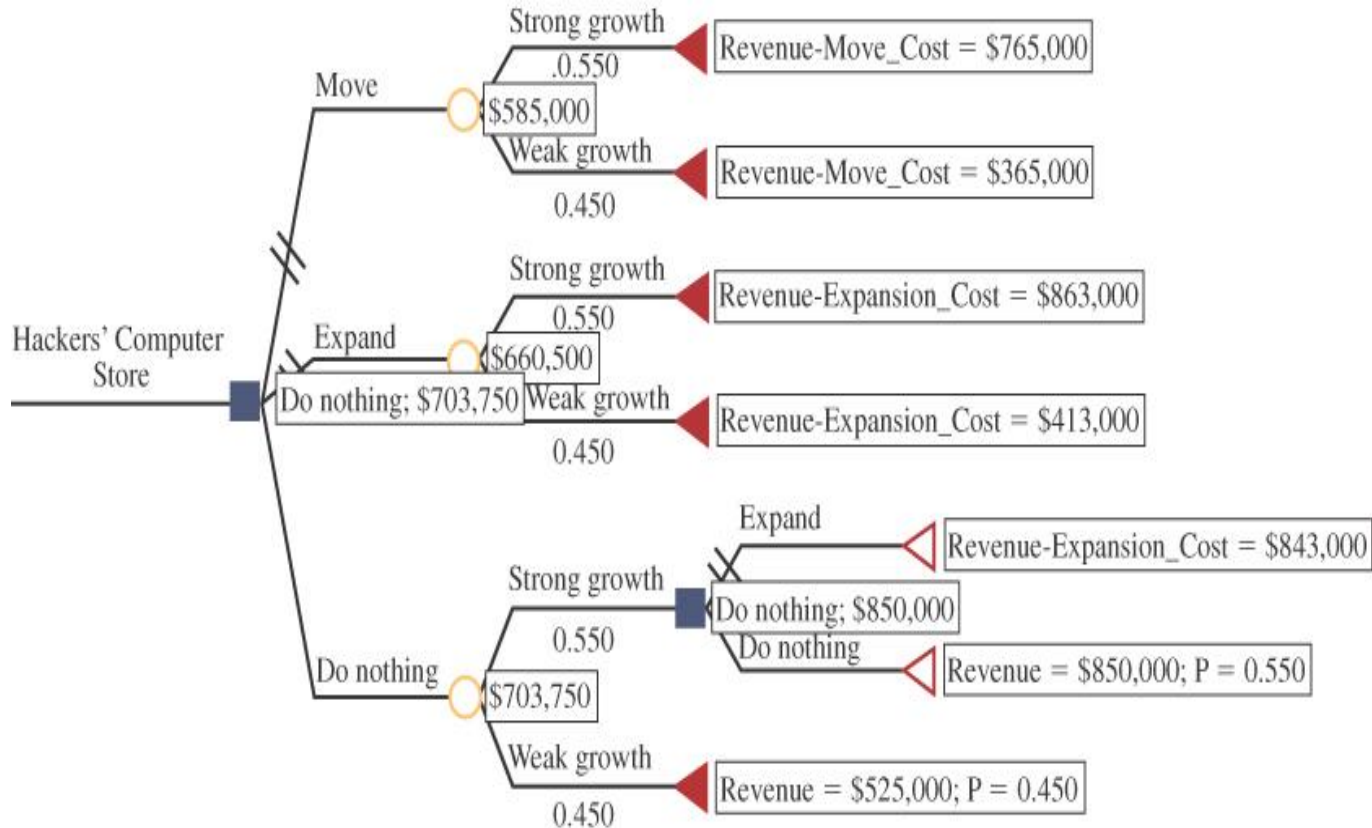
Example 4.2: Decision Trees
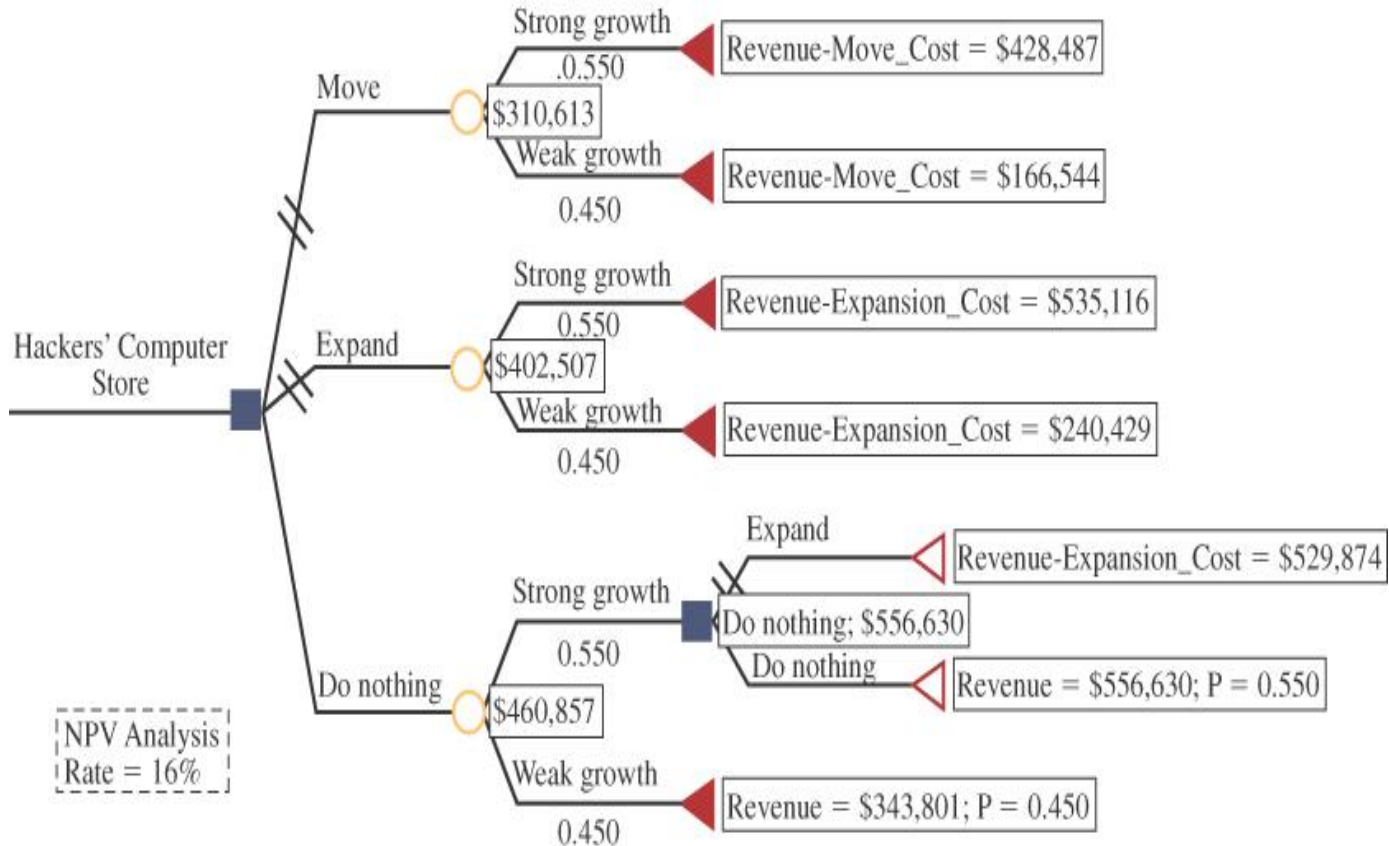
9. A builder has located a piece of property that she would like to buy and eventually build on. The land is currently zoned for four homes per acre, but she is planning to request new zoning. What she builds depends on approval of zoning requests and your analysis of this problem to advise her. With her input and your help, the decision process has been reduced to the following costs, alternatives, and probabilities:

Cost of land: $2 million.
Probability of rezoning: .60.
If the land is rezoned, there will be additional costs for new roads, lighting, and so on, of $1 million.

If the land is rezoned, the contractor must decide whether to build a shopping center or 1,500 apartments that the tentative plan shows would be possible. If she builds a shopping center, there is a 70 percent chance that she can sell the shopping center to a large department store chain for $4 million over her construction cost, which excludes the land; and there is a 30 percent chance that she can sell it to an insurance company for $5 million over her construction cost (also excluding the land). If, instead of the shopping center, she decides to build the 1,500 apartments, she places probabilities on the profits as follows: There is a 60 percent chance that she can sell the apartments to a real estate investment corporation for $3,000 each over her construction cost; there is a 40 percent chance that she can get only $2,000 each over her construction cost. (Both exclude the land cost.)

If the land is not rezoned, she will comply with the existing zoning restrictions and simply build 600 homes, on which she expects to make $4,000 over the construction cost on each one (excluding the cost of land).

Draw a decision tree of the problem and determine the best solution and the expected net profit.