Chapter 24

DECISION MAKING UNDER UNCERTAINTY

MULTIPLE CHOICE

Question Nos. 1, 2, and 19 are AICPA adapted.
Question Nos. 4-6, 8-11, and 14-17 are ICMA adapted.
Question Nos. 7, 12, 13, and 18 are CIA adapted.

A. 1. Which of the following best identifies the reason for using probabilities in capital budgeting decisions?
- **A. uncertainty**
- **B. cost of capital**
- **C. time value of money**
- **D. projects with unequal lives**
- **E. all of the above**

D 2. In probability analysis, the square root of the mean of the squared differences between the conditional values and the expected value is the:
- **A. objective function**
- **B. optimum corner point**
- **C. EOQ**
- **D. standard deviation**
- **E. none of the above**

E 3. Which of the following utilizes statistical sampling techniques in capital budgeting in order to obtain a probabilistic approximation of the profitability of a capital expenditure proposal?
- **A. sensitivity analysis**
- **B. decision tree**
- **C. linear programming**
- **D. probabilistic budgeting**
- **E. Monte Carlo simulation**

B 4. The Social Club plans to apply the expected value decision rule (criterion) to determine the number of cups of hot cider to stock. The expected value is the:
- **A. sum of the conditional profit (loss) for each event**
- **B. sum of the conditional profit (loss) of each event times the probability of each event occurring**
- **C. conditional profit (loss) for the best event times the probability of each event occurring**
- **D. sum of the conditional opportunity loss of each event times the probability of each event occurring**
- **E. revenue less the costs**

D **5.** **The Social Club plans to use a payoff table to apply the expected value decision rule (criterion) to determine the number of cups of hot cider to stock. The Social Club would select the demand level that:**

- **A. is closest to the expected demand**
- **B. has the greatest probability of occurring**
- **C. has the greatest expected opportunity loss**
- **D. has the greatest expected monetary value**
- **E. includes the event with the greatest conditional profit**

E **6.** **The Social Club plans to apply the expected value decision rule (criterion) to determine the number of cups of hot cider to stock. The maximum expected value of additional information is the:**

- **A. same as the expected profit under certainty**
- **B. sum of the conditional profit (loss) for the best event of each act times the probability of each event occurring**
- **C. difference between the expected profit under certainty and the expected opportunity loss**
- **D. difference between the expected profit under certainty and conditional profit for the best act under certainty**
- **E. difference between the expected profit under certainty and the expected monetary value of the best act under uncertainty**

C **7.** **Solutions provided by quantitative techniques based on probabilities should be considered to be:**

- **A. numerically precise and correct**
- **B. approximations based solely on past experiences**
- **C. the best estimate of expected results**
- **D. unaffected by environmental changes**
- **E. none of the above**

C **8.** **Decisions are frequently classified as those made under certainty and those made under uncertainty. Certainty exists when:**

- **A. the probabilities for each outcome of an event can be assigned with a high degree of confidence**
- **B. the probability of the event is less than 1**
- **C. there is absolutely no doubt that an event will occur**
- **D. there is more than one outcome for each possible action**
- **E. the standard deviation of an event is greater than 0**

C **9.** **Barkley & Co. has been sued by a client for breach of warranty. Barkley's controller has accumulated data from the outcomes of similar cases. Barkley & Co. can best quantify its exposure to a loss in this situation by using:**

- **A. regression analysis**
- **B. Markov analysis**
- **C. expected value analysis**
- **D. queuing theory**
- **E. Matrix algebra**

B 10. Arlington Inc. is attempting to predict the profitability of a new product line. The Marketing Department has developed three different forecasts of annual demand and their related probabilities of occurrence for the coming year—low (.2), medium (.5), and high (.3). To develop an estimate of the annual profit figure for the new product line, Arlington Inc. should employ:

A. queuing theory
B. expected value analysis
C. correlation and regression analysis
D. discounted cash flow techniques
E. PERT/CPM analysis

B 11. Expected value in decision analysis is:

A. a standard deviation using the probabilities as weights
B. an arithmetic mean using the probabilities as weights
C. the square root of the squared deviations
D. the standard deviation divided by the coefficient of variation
E. a measure of the difference between the best possible outcome and the outcome of the original decision

D 12. A proprietor who just inherited a building is considering using it in a new business venture. Projections for the business are: revenue of $100,000, fixed cost of $30,000, and variable cost of $50,000. If the business is not started, the owner will work for a company for a wage of $23,000. Also, there have been two offers to rent the building, one for $1,000 per month and one for $1,200 per month. What are the expected annual net economic profits (losses) to the owner if the new business is started?

1. $20,000
2. $(3,000)
3. $(15,000)
4. $(17,400)

E. none of the above

SUPPORTING CALCULATION:

$100,000 - $30,000 - $50,000 - $23,000 - (12 x $1,200) = $(17,400)

C 13. A firm obtained the following data based on the results shown below for 100 runs simulating the introduction of a new product.

Net Profit Before Tax:	($5,000)	$0	$5,000	$10,000	$15,000
Frequency:	.30	.30	.20	.15	.05

The firm should:

A. expect to break even if the product is introduced
B. not introduce the product
C. expect to make a profit if the product is introduced
D. expect to lose money if the product is introduced
E. none of the above

SUPPORTING CALCULATION:

Profit	Probability	Expected Value
$(5,000)	.30	$(1,500)
0	.30	0
5,000	.20	1,000
10,000	.15	1,500
15,000	.15	2,250
		$3,250

B 14. The Prep Club sells fresh hot cider at Ivy University's home football games. The frequency distribution of the demand for cups of hot cider per game is presented below.

Unit Sales Volume	Probability
10,000 cups	.10
20,000 cups	.15
30,000 cups	.20
40,000 cups	.35
50,000 cups	.20
	1.00

The hot cider is sold for $1.00 a cup, and the cost per cup is $.40. Any unsold hot cider is discarded because it will spoil before the next home game.

The estimated demand for hot cider at the next Ivy University home football game using an expected value approach is:

A. 30,000 cups
B. 34,000 cups
C. 40,000 cups
D. 50,000 cups
E. some amount other than those given above

SUPPORTING CALCULATION:

10,000 x .10 =	1,000
20,000 x .15 =	3,000
30,000 x .20 =	6,000
40,000 x .35 =	14,000
50,000 x .20 =	10,000
	34,000

A 15. The Prep Club sells fresh hot cider at Ivy University's home football games. The frequency distribution of the demand for cups of hot cider per game is presented below.

Unit Sales Volume	Probability
10,000 cups	.10
20,000 cups	.15
30,000 cups	.20
40,000 cups	.35
50,000 cups	.20
	1.00

The hot cider is sold for $1.00 a cup, and the cost per cup is $.40. Any unsold hot cider is discarded because it will spoil before the next home game.

The conditional profit (loss) per game of having 30,000 cups of hot cider available but only selling 20,000 cups of cider is:

1. $8,000
2. $12,000
3. $18,000
4. $3,000

E. some amount other than those given above

SUPPORTING CALCULATION:

$1(20,000) - $.40($30,000) = $8,000

C 16. The Prep Club sells fresh hot cider at Ivy University's home football games. The frequency distribution of the demand for cups of hot cider per game is presented below.

Unit Sales Volume	Probability
10,000 cups	.10
20,000 cups	.15
30,000 cups	.20
40,000 cups	.35
50,000 cups	.20
	1.00

The hot cider is sold for $1.00 a cup, and the cost per cup is $.40. Any unsold hot cider is discarded because it will spoil before the next home game.

The conditional profit (loss) per game of having 30,000 cups of hot cider available but being able to sell 40,000 cups of hot cider if it were available is:

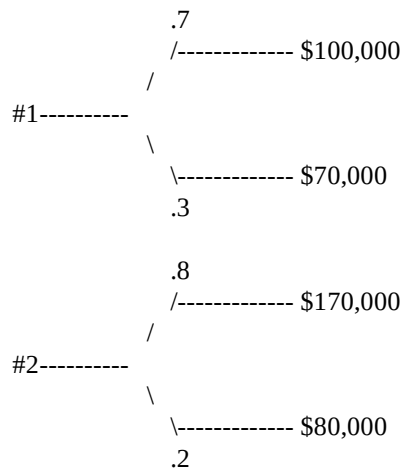
A. $14,000
B. $12,000
C. $18,000
D. $24,000
E. some amount other than those given above

SUPPORTING CALCULATION:
30,000 ($1 - $.40) = $18,000

E 17. Boyer Company is considering designing an educational computer software package. Boyer's management is aware that this project may not be feasible, that demand for the software may be low, and that competitors may offer a similar package before Boyer does. Boyer can best evaluate the possible payoffs of the computer software project by using:

A. differential calculus
B. critical path analysis
C. linear programming
D. regression analysis
E. decision tree analysis

C 18. A decision tree has been formulated for the possible outcomes of introducing a new product line.



Branches related to Alternative #1 reflect the possible payoffs from introducing the product without an advertising campaign. The branches for Alternative #2 reflect the possible payoffs with an advertising campaign costing $40,000. The expected values of Alternatives #1 and #2, respectively, are:

A. #1: (.7 x $100,000) + (.3 x $70,000)
   #2: (.8 x $170,000) + (.2 x $80,000)
B. #1: (.7 x $100,000) + (.3 x $70,000)
   #2: (.8 x $130,000) + (.2 x $40,000)
C. #1: (.7 x $100,000) + (.3 x $70,000)
   #2: (.8 x $170,000) + (.2 x $80,000) - $40,000
D. #1: (.7 x $100,000) + (.3 x $70,000) - $40,000
   #2: (.8 x $170,000) + (.2 x $80,000) - $40,000
E. none of the above

B 19. A firm wishes to compare the effects of using a new labor-saving machine with present direct labor methods. These comparisons will be made over a wide variety of operations on several typical days. The demands placed upon each operation as well as the sequence of individual operations can be described by probability distributions. The most relevant quantitative technique is:

A. cost-volume-profit analysis
B. Monte Carlo simulation
C. Program Evaluation and Review Technique (PERT)
D. statistical sampling
E. time-series or trend-regression analysis

C 20. When several unit sales volumes are multiplied by the probability of their occurrence and those products are summed, the result is the:
A. median
B. standard deviation
C. expected value
D. best estimated sales level
E. average sales level

C 21. The quantitative technique that would be most useful in projecting revenues is:
A. linear programming
B. PERT/cost analysis
C. probability theory
D. learning-curve analysis
E. queuing theory

B 22. Probabilistic estimates are most frequently used with which of the following methods of capital expenditure evaluation?
A. payback
B. present value
C. internal rate of return
D. accounting rate of return
E. none of the above

D 23. The measure of the variability of expected outcomes in a probability distribution is known as the:
A. coefficient of variation
B. standard deviation
C. expected value
D. variance
E. none of the above

A 24. Which of the following can be computed and compared for each alternative to determine the relative riskiness of investments that have different levels of expected return?
A. coefficient of variation
B. variance
C. standard deviation
D. expected value
E. none of the above

C 25. Which of these could occur in practice where the capital expenditure relates to the production of an established product or service, the demand for which is expected to vary in response to temporary changes in consumer taste?
A. perfectly correlated cash flows
B. negative cash flows
C. independent cash flows
D. mixed cash flows
E. none of the above

E 26. In capital expenditure analysis, which of the following can be constructed to evaluate alternative levels of investment?
A. normal distribution
B. bar graph
C. nonnormal distribution
D. pie chart
E. payoff table

A 27. Which of these is useful in that it gives the manager a visual map of the expected levels of each alternative action?
A. decision tree
B. Monte Carlo simulation
C. Markov chain
D. sensitivity analysis
E. none of the above

E 28. The standard deviation of the expected net present value is determined by summing the discounted standard deviations for each period over the life of the project when the cash flows in each of the periods are:
A. independent
B. positive
C. mixed
D. negative
E. perfectly correlated

E 29. If events are related, computational procedures must be modified by substituting:
A. random variables
B. slack variables
C. dependent variables
D. independent probabilities
E. conditional probabilities

A 30. An expenditure evaluation tool that explicitly incorporates both quantitative and nonquantitative factors into the decision analysis is known by the acronym:
A. MADM
B. FMS
C. CIM
D. JIT
E. none of the above

PROBLEMS

PROBLEM

1.

Probability Analysis. The operator of an office building concession stand wishes to know how many doughnuts to stock each day. The doughnuts cost $.25 each and are sold for $.35 each. Those unsold at the end of the day have no value. From past experience, the following probability distribution has been calculated:

Number of Doughnuts Sold per Day	Probability
40	.25
50	.60
60	.15

Assume that only the three quantities listed are ever sold and that the occurrences are random events.

Required:

(1) What is the average number of doughnuts sold per day? If the operator stocked this average number of doughnuts each day, what would the expected daily contribution margin be? (Round to two decimal places.)

(2) Compute the variance, the standard deviation, and the coefficient of variation of the expected value. (Round intermediate calculations to 4 decimal places and round the standard deviation and the coefficient of variation to the nearest whole cent.)

SOLUTION

(1)

Number of Doughnuts Sold	Probability	Average Number of Doughnuts Sold
40	.25	10
50	.60	30
60	.15	9
Average number of doughnuts sold per day.....		49

Expected daily contribution margin if 49 doughnuts stocked:

Number of Doughnuts Sold per Day	Contribution Margin (Conditional Value)			Prob.	Expected Daily Contribution Margin
40	(40 x $.10) - (9 x $.25)	=	$1.75	.25	$ .44
50	49 x $.10	=	4.90	.60	2.94
60	49 x $.10	=	4.90	.15	.74
Expected daily contribution margin (expected value).....					$ 4.12

(2)

(1) Contribution Margin (Conditional Value)	(2) Difference from Expected Value ($4.12)	(3) (2) Squared	(4) Probability	(5) Variance (3) x (4)
$1.75	$(2.37)	$5.6169	.25	$1.4042
4.90	.78	.6084	.60	.3650
4.90	.78	.6084	.15	.0913
				$1.8605

Standard deviation = square root(Column 5 total) = square root($1.8605)
= $1.3640

$$\text{Coefficient of variation} = \frac{\$1.36}{\$4.12} = .33$$

PROBLEM

2.
Decision Trees. The management of Seoul Industries is trying to decide whether to build a large, medium, or small plant at a new location. Demand for the company's product in the new area is uncertain, but the marketing manager has assigned probabilities to three levels of demand. These probabilities, as well as the contribution margins (conditional values, in millions of dollars) for each plant size and demand level, are as follows:

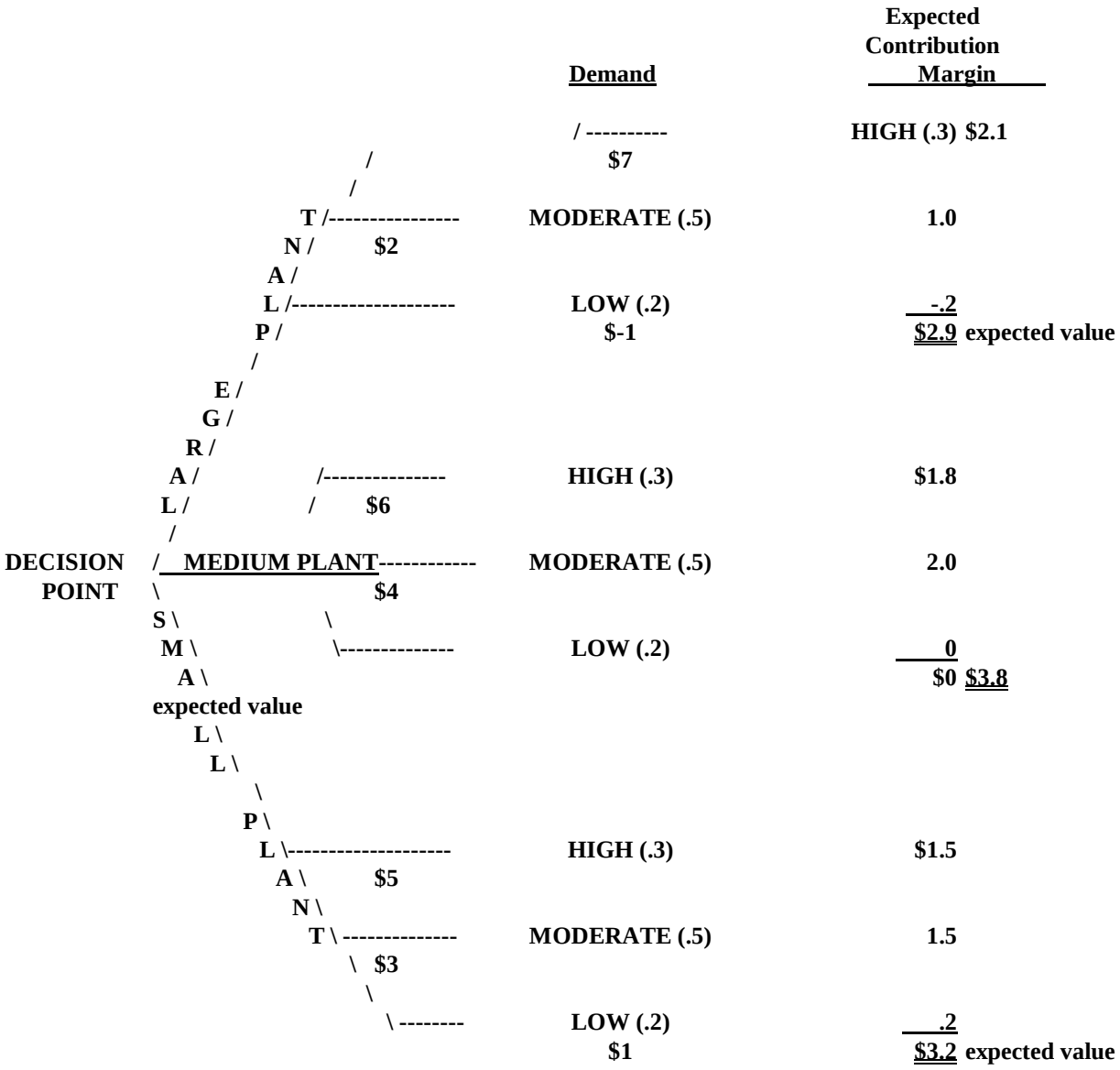
	Demand Level		
Plant Size	**High**	**Moderate**	**Low**
Large	$7	$2	$ -1
Medium	$6	$4	$ 0
Small	$5	$3	$ 1
Probability	.3	.5	.2

Required:

(1) Construct a decision tree for this situation.
(2) Choose the most profitable of the expected alternatives.

SOLUTION

(1)



(2) **Based on expected contribution margins, management should build the medium plant, which has the highest expected value.**

PROBLEM

3.
Standard Deviation for Perfectly Correlated Cash Flows. Gayle Company is considering a capital expenditure for which the periodic cash inflows are expected to be normally distributed and perfectly correlated. The expected net present value of the proposal is $10,000, and the standard deviation of the cash inflows is $2,500 in each period. The initial cash outflow has a zero standard deviation. The company's weighted-average cost of capital is 12%, and the project is expected to have a life of 4 years.

Required: **Compute the standard deviation, rounded to the nearest dollar, of the expected net present value for the Gayle Company investment. The present value of $1 @ 12% at the end of four periods is .636 and the present value of an annuity of $1 for four periods is 3.037.**

SOLUTION

Year	Periodic Standard Deviation	Present Value of $1 at 12%	Present Value of Standard Deviation
0	0	1.000	0
1-4	$2,500	3.037	$7,593
Standard deviation of net present value.....			$7,593

PROBLEM

4.
Standard Deviation and Coefficient of Variation for Perfectly Correlated Cash Flows. Laurens Manufacturing Co. is considering the purchase of a machine that will cost $100,000 and produce a new product. The machine is expected to have a useful life of 5 years and no salvage value. The after-tax cash inflows for each year are expected to be $30,000. The cash flows are expected to be normally distributed with a standard deviation of $3,000. The periodic cash flows are expected to be perfectly correlated. The weighted-average cost of capital is 12%. The present value of $1 @ 12% at the end of five periods is .567 and the present value of an annuity of $1 for five periods is 3.605.

Required:

(1) Compute the expected net present value of the capital expenditure proposal.
(2) Determine the standard deviation of the expected net present value.
(3) Compute the coefficient of variation. (Round to two decimal places.)

SOLUTION

(1)

Year	Expected Value of After-tax Net Cash Flows	Present Value of $1 @ 12%	Present Value of After-tax Net Cash Flows
0	$(100,000)	1.000	$ (100,000)
1-5	30,000	3.605	108,150
Expected net present value.....			$ 8,150

(2)

Year	Standard Deviation of Cash Flows	Present Value of $1 @ 12%	Present Value of Standard Deviation
0	0	1.000	0
1-5	$3,000	3.605	$10,815
Standard deviation of expected net present value			$10,815

(3) Coefficient of variation = 10,815/8,150 = 1.33

PROBLEM

5.

Revising Probabilities. Health Foods Manufacturing Company plans to introduce a new product known as oat bran chips. The vice-president of marketing believes that the demand for oat brand chips will be between 50,000 and 80,000 bags. The following probabilities have been assigned to each possible level of demand:

Demand	Probability
50,000	.20
60,000	.20
70,000	.50
80,000	.10

The president of the company requested that the market demand be analyzed by an expert system computer program that resulted in the following output:

Demand	Probability
50,000	.10
60,000	.10
70,000	.50
80,000	.30

Required: **Using Bayes' theorem, compute the posterior probabilities for the various levels of demand for oat bran chips, assuming that the demand probabilities generated by the expert's system provide new information (i.e., assume the expert system probabilities are conditional probabilities). (Round to four decimal places.)**

SOLUTION

(1)	(2)	(3)	(4)	(5)
Demand	Prior Probability	Conditional Probability	Prior Probability x Conditional Probability (2) x (3)	Posterior Probability (4) Line Item ÷ (4) Total
50,000	.20	.10	.02	.06250
60,000	.20	.10	.02	.06250
70,000	.50	.50	.25	.78125
80,000	.10	.30	.03	.09375
	1.00	1.00	.32	1.00000

PROBLEM

6.
Payoff Table. Sara Company buys and resells a perishable product. A large purchase at the beginning of each month provides a lower per unit cost and assures that Sara can purchase all the items it wishes. However, unsold units at the end of each month are worthless and must be discarded. If an inadequate quantity is purchased, additional units of acceptable quality are not available.

The units, which Sara sells for $3 each, are purchased at a fixed fee of $100,000 per month plus $1 each, if at least 100,000 units are ordered and if they are ordered at the beginning of the month.

The needs of Sara's customers limit the possible sales volumes to only four quantities per month — 100,000, 125,000, 150,000, or 175,000 units. However, the total quantity needed for a given month cannot be determined prior to the date Sara must make its purchases. The sales managers are willing to place a probability estimate on each of the four possible sales volumes each month. They noted that the probabilities for the four sales volumes change from month to month because of the seasonal nature of the customers' businesses. Their probability estimates for December, 19A, sales quantities are 25% for 100,000, 35% for 125,000, 30% for 150,000, and 10% for 175,000.

Required: **Prepare a payoff table showing the expected value of each of the four possible strategies of ordering units, assuming that only the four quantities specified are ever sold and that occurrences are random events. Identify the best strategy.** ***(ICMA adapted)***

SOLUTION

Table of expected values of possible strategies (000s omitted):

Purchases/Sales	100	125	150	175	Expected Value
100	$100	$100	$100	$100	$100
125	75	150	150	150	131.25
150	50	125[1]	200	200	136.25[2]
175	25	100	175	250	118.75
Probability	.25	.35	.30	.10	

[1]**Contribution margin for ordering 150,000 units and selling 125,000 units:**

Sales (125,000 x $3)	$375,000
Cost of units [$100,000 + (150,000 x $1)]	250,000
	$125,000

[2]**Expected value for purchasing 150,000 units:**

$50 x .25	$ 12.50
125 x .35	43.75
200 x .30	60.00
200 x .10	20.00
	$ 136.25

Sara Company should purchase 150,000 units for December, according to the expected value decision model because this number of units produces the largest expected value, $136,250.