Data Analysis: Analyzing Data - Other Audit Techniques

This section briefly discusses other possible methods as described in Irvin N. Gleim, *CIA Examination Review, Vol. 1, Outlines and Study Guides*, Fifth Edition, 1991. These may be useful in examining some audit/evaluation issues.
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DATA ENVELOPMENT ANALYSIS

Data envelopment analysis is an optimization method for assessing the relative efficiency of similar operational units that combine multiple resources to produce multiple results. It can be applied in a single time period or across multiple periods. Its result is the identification of the efficiency frontier. Unlike regression, it bases conclusions on best or worst practice rather than on average practice.

DISCRIMINANT ANALYSIS

Discriminant analysis statistically distinguishes between two or more groups, such as between going concerns and non-going concerns. It requires the identification of characteristics (variables) defining the differences among groups. The variables are then weighted and combined into a linear equation. (See the module on Inferential Statistics for more information.)

EXPECTED VALUE

The expected value of a decision is found by multiplying the probability of each outcome by its payoff and then summing the products.

For example, suppose one wants to buy $100 of a company's stock. The company is racing to obtain the first patent for a new manufacturing process and has a 50 percent chance of obtaining the patent. If the company gets the patent, the stock value will double. If it does not get the patent, the stock value will drop by one-quarter. The expected value (EV) of the decision to invest is:

$$(.5 * \$200) + (.5 * \$75) = \$137.50$$

This type of analysis is generally used to compare alternatives. In the above example, the expected value might be compared to the expected value of other investments, such as a savings account or stock in a different company.

GAME THEORY AND DECISION THEORY

Game theory analyzes competitive situations in which several opponents pursue conflicting goals. In a two-person game, if the loss to the loser is equal to the gain to the winner, it is a zero-sum game. If both players can profit, it is a positive-sum game. Players may base their decisions on various criteria.

- **Maximax criteria** are for players willing to accept high risk to obtain the largest possible payoff.
- **Minimax criteria** are for conservative, risk-averse players who determine the maximum loss for each decision and then choose the decision with the minimum maximum loss.
- **Minimax-regret** criteria are for players who want to minimize the effect of a bad decision in either direction.
- **Risk-neutral criteria** are for players willing to accept the expected value of the game in the long run.

Decision theory adds to game theory the availability of statistical information on the opponent's strategy.

GOAL PROGRAMMING

Goal programming is a special type of linear programming. It is used to solve problems that have no feasible solution under linear programming and permits an ordinal ranking of multiple goals. Such goals may be financial or nonfinancial, depending on how goals are mathematically expressed.

LINEAR PROGRAMMING

Linear programming is a common optimization method used to maximize or minimize a linear mathematical function containing several variables, subject to stated constraints on those variables. The constraints are expressed as either linear equations or linear inequalities.

OPERATIONS RESEARCH

Operations research encompasses a range of analytical and quantitative methods used to solve management problems, including many previously addressed in the module. As a rule, the researcher or decision-maker approaches the problem by constructing a model (idealized representation) of the system or process of interest. This model describes the structure and function of the system or process and factors in the constraints on the decision-maker. The model may be a mathematical equation, computer simulation, system or process flowchart, or other representative form.

Closely related to operations research are decision theory, game theory, linear programming, and queuing theory. Operations research often relies on the study of graphs, flowcharts, work breakdown structure, and networks.

PROBABILITY THEORY

Probability theory incorporates the element of uncertainty of future events into management decision-making. It provides a method for mathematically expressing certainty on a scale from 0 to 1. Some key concepts relating to probability are that:

- The joint probability of two events is the probability both will occur.
- The conditional probability of two events is the probability that one will occur given that the other has already occurred.
- Two events are mutually exclusive if they cannot occur simultaneously.
- Two events are independent if the occurrence of one has no effect on the probability of the other.

Some general rules of probability are that:

- The joint probability of two events is the probability of the first event multiplied by the conditional probability of the second event, given that the first event has already occurred.
- The probability that either one or both of two events will occur is the sum of their separate probabilities minus their joint probability.
- The probabilities of all possible mutually exclusive outcomes of a single experiment must add up to one.

QUEUING THEORY

Queuing theory is a branch of probability theory. It is used to study arrival-service-departure systems such as turnpike tollbooths, telephone exchanges, typing or maintenance pools, and customer service queues. The object is to minimize the total cost of the system. Two basic costs are involved:

- the cost of providing service, including facility and operating costs
- the cost of idle resources

If B is the average number of work units arriving in one unit of time, and T is the average number of work units serviced per unit of time, then:

- The average number of work units waiting in line (N) is:

$$N = \frac{B}{T - B}$$

- The average number of work units in the waiting line (N_q) is:

$$N_q = \frac{B^2}{T(T - B)}$$

- The average waiting time (W) before service is:

$$W = \frac{N_q}{B}$$

Note that B/T must be <1, or else the queue grows to infinite length.

SENSITIVITY ANALYSIS

Sensitivity analysis can be applied when any problem has been formulated into a mathematical model. It refers to the sensitivity of the solution to changes in any given variable or constraint.

SYSTEMS ANALYSIS

Systems analysis is concerned with the functioning of a system as a whole and the interrelationships among the various system components. The systems analyst is interested in the effect of changes in one system component upon total system performance. Systems analysis is often used in reviewing of general management practices such as planning, staffing, and organization structure. Systems analysis implies a broad array of other methods, such as modeling and network techniques.