

**Table 11.9.** Quantitative techniques for decision analysis

Technique	Linear programming	Queuing theory	Network analysis	Regression analysis
Description	This technique attempts to optimize the distribution of scarce resources among competing activities. This is accomplished by the maximization or minimization of a dependent variable, which is a function of several independent variables that are subject to a set of restraints, i.e., limited resources. This method is capable of being executed manually, but is very adaptable to solution by a computer.	Queuing theory is the study of the probabilities associated with the length of a waiting line and the time an individual must wait in the queuing system. This information is used to achieve a balance between the cost of waiting for a service and the cost associated with providing this service. "Cost in a medical setting invariably includes elements defined by 'good medical care' which are, at best, difficult to quantify but must be included with monetary cost to obtain the proper solution." In queuing theory, the waiting line may be organized on a first-in-first-out basis, a random basis, or by some other priority technique. The waiting line can have a finite or infinite calling population, and it is assumed that the average service rate is greater than the average arrival rate for a single-channel-single-server queuing model.	Network analysis is characterized by a network of events and activities. Activities are defined as the actual performance of tasks, whereas events represent the start or completion of an activity. Events do not consume time. This technique allows the determination of probabilities of meeting specified deadlines; identifies bottlenecks in the project; evaluates the effect of shifting resources from a noncritical activity to a critical activity and vice versa, and enables the manager to evaluate the effect of a deviation of the actual time requirement for an activity from what had been predicted. Specific network analysis models include critical path methods (CPM), program evaluation and review techniques (PERT), and graphical evaluation and review techniques (GERT). The difference between these systems lies in their different abilities to analyze complex network systems.	This is a technique that derives a mathematical equation to describe or express the relationship between the data of two or more variables over a period of time. The variable to predict in this equation is referred to as the dependent variable. The other variables in the equation are called independent variables or predicting variables. The basic measure of the relationship between the dependent variable and the independent variable(s) is depicted by a regression line, which is computed by the method of least squares. This will result in an equation, based on historical data, that will predict the future behavior of the dependent variable. This technique is used primarily for the purpose of forecasting and control.

Hospital applications	Physician, nurse, and patient scheduling problems; purchasing problems associated with hospital supplies and equipment; hospital transportation problems and assignment problems	Determination of the most effective serving system for food service operations; outpatient clinic operations, admission operations, telephone switchboard operations, etc. In each of these situations, queuing theory balances the cost of an individual waiting with the cost of additional facilities that would be incurred to prevent the individual from waiting.	Hospital planning and control efforts associated with building or research and development projects or the determination of flow allocations through a health care system, such as a mass screening facility	Used to forecast dependent variables such as a number of hospital admissions, inpatient days, outpatient days, outpatient visits, average daily census, cost per patient day, etc., and to control deviations from the planned costs associated with each of these variables
Data required	Manager must express desires in a unidimensional objective function; data that pertain to an objective function expressed in terms of maximization of benefits or minimization of costs, set of constraints, variables, and alternative courses of action	Average number of arrivals per a unit of time; specified unit of time; average service time per arrival; number of waiting lines, number of waiting line phases, and number of people in the waiting line	Data that pertain to the determination of project activities and events; determination of optimistic, pessimistic, and most likely time estimates with associated mean activity times and time required for an activity in terms of probability distribution and associated parameters	Historical data compiled daily, monthly, quarterly, or annually with respect to the dependent and independent variables of the problem
Advantages	Optimum use of productive factors; potential to increase decision quality; highlights problem bottlenecks; forces objectivity and quantification	Description of probabilities that a waiting line will contain a certain number of individuals; expected length of the waiting line and the expected waiting time for the individual	Determination of longest time paths through a network; identification of the relative frequency of occurrence of different paths; evaluation of program changes	Provides accurate forecasts of dependent variables in a three-month to two-year time frame. Allows management to analyze deviations from the planned cost of an activity or event.
Disadvantages	Inability to represent several goals/objectives in a unidimensional objective function; costs associated with data upkeep; homogeneous values in constraints; assumption of linearity	Assumption that both arrival and service completion lines follow a Poisson distribution; upkeep of data	Accurate time forecasts for activities	Cost of data upkeep; assumption of linearity; the assumption that no causal relationship exists between the variables

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