Probability and statistical information are used for both operational and marketing decisions. For instance, a time series showing monthly sales is used to track the company’s growth and to set future target sales levels. Statistics such as the mean customer order size and the mean number of days a customer takes to make payments help identify the firm’s best customers as well as provide benchmarks for handling accounts receivable issues. In addition, data on monthly inventory levels are used in the analysis of operating profits and trends in product sales.

Probability is a numerical measure of the likelihood that an event will occur. Probability values are always assigned on a scale from 0 to 1. A probability near zero indicates an event is unlikely to occur; a probability near 1 indicates an event is almost certain to occur. Other probabilities between 0 and 1 represent degrees of likelihood that an event will occur.

# Counting Rules, Combinations, and Permutations

Being able to identify and count the experimental outcomes is a necessary step in assigning probabilities. We now discuss three useful counting rules.

1. Multiple-step experiments The first counting rule applies to multiple-step experiments. Consider the experiment of tossing two coins. If an experiment can be described as a sequence of k steps with n1 possible outcomes on the first step, n2 possible outcomes on the second step, and so on, then the total number of experimental outcomes is given by (n1).(n2)……(nk)
2. Combinations A second useful counting rule allows one to count the number of experimental outcomes when the experiment involves selecting n objects from a (usually larger) set of N objects. It is called the counting rule for combinations.
3. Permutations A third counting rule that is sometimes useful is the counting rule for permutations. It allows one to compute the number of experimental outcomes when n objects are to be selected from a set of N objects where the order of selection is important. The same n objects selected in a different order are considered a different experimental outcome.

# Assigning Probabilities

The three approaches most frequently used are the

1. Classical - The classical method of assigning probabilities is appropriate when all the experimental outcomes are equally likely. If n experimental outcomes are possible, a probability of 1/n is assigned to each experimental outcome. When using this approach, the two basic requirements for assigning probabilities are automatically satisfied.
2. Relative frequency [Empirical Probability] - The relative frequency method of assigning probabilities is appropriate when data are available to estimate the proportion of the time the experimental outcome will occur if the experiment is repeated a large number of times.
3. Subjective methods - The subjective method of assigning probabilities is most appropriate when one cannot realistically assume that the experimental outcomes are equally likely and when little relevant data are available. When the subjective method is used to assign probabilities to the Experimental outcomes, we may use any information available, such as our experience or intuition. After considering all available information, a probability value that expresses our degree of belief (on a scale from 0 to 1) that the experimental outcome will occur is specified. Because subjective probability expresses a person’s degree of belief, it is personal.

Regardless of the method used, two basic requirements for assigning probabilities must be met.

* The probability assigned to each experimental outcome must be between 0 and 1, inclusively.
* The sum of the probabilities for all the experimental outcomes must equal 1.

# Some Basic Relationships of Probability

Sample Space - The sample space for an experiment is the set of all experimental outcomes. An experimental outcome is also called a sample point to identify it as an element of the sample space.

Complement of an Event - Given an event A, the complement of A is defined to be the event consisting of all sample points that are not in A. The complement of A is denoted by Ac.

Addition Law - The addition law is helpful when we are interested in knowing the probability that at least one of two events occurs. That is, with events A and B we are interested in knowing the probability that event A or event B or both occur. Before we present the addition law, we need to discuss two concepts related to the combination of events: the union of events and the intersection of events. Given two events A and B, the union of A and B is defined as follows. The union of A and B is the event containing all sample points belonging to A or B or both. The union is denoted by . Given two events A and B, the intersection of A and B is the event containing the sample points belonging to both A and B. The intersection is denoted by .

* Dependent Events
* Independent Events

Mutually Exclusive Events - Two events are said to be mutually exclusive if the events have no sample points in common.

# Conditional Probability

Often, the probability of an event is influenced by whether a related event already occurred. Suppose we have an event A with probability P(A). If we obtain new information and learn that a related event, denoted by B, already occurred, we will want to take advantage of this information by calculating a new probability for event A. This new probability of event A is called a conditional probability and is written P(A | B). We use the notation | to indicate that we are considering the probability of event A given the condition that event B has occurred. Hence, the notation P(A | B) reads “the probability of A given B.”

Jion Probability

Marginal probability

* Dependent Events
* Independent Events

Multiplication Law - Whereas the addition law of probability is used to compute the probability of a union of two events, the multiplication law is used to compute the probability of the intersection of two events. The multiplication law is based on the definition of conditional probability. Using equations above and solving for , we obtain the multiplication law.

* Dependent Events
* Independent Events

# Bayes’ Theorem

In the discussion of conditional probability, we indicated that revising probabilities when new information is obtained is an important phase of probability analysis. Often, we begin the analysis with initial or prior probability estimates for specific events of interest. Then, from sources such as a sample, a special report, or a product test, we obtain additional information about the events. Given this new information, we update the prior probability values by calculating revised probabilities, referred to as posterior probabilities. Bayes’ theorem provides a means for making these probability calculations.