Innovation Diffusion Theory:

Diffusion is the process by which an innovation is communicated through certain channels over time among the members of a social system. Diffusion is a special type of communication concerned with the spread of messages that are perceived as new ideas.

The four main elements in the diffusion of new ideas are:

The Innovation:

An innovation, simply is "an idea perceived as new by the individual." An innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption. The characteristics of an innovation, as perceived by the members of a social system, determine its rate of adoption. An innovation may have been invented a long time ago, but if individuals perceive it as new, then it may still be an innovation for them.

Communication Channels:

Communication is the process by which participants create and share information with one another in order to reach a mutual understanding. A communication channel is the means by which messages get from one individual to another. Mass media channels are more effective in creating knowledge of innovations, whereas interpersonal channels are more effective in forming and changing attitudes toward a new idea, and thus in influencing the decision to adopt or reject a new idea. Most individuals evaluate an innovation, not on the basis of scientific research by experts, but through the subjective evaluations of near-peers who have adopted the innovation.

Time:

The time dimension is involved in diffusion in three ways.

- First, time is involved in the innovation-decision process. The innovation decision process is the mental process through which an individual (or other decision making unit) passes from first knowledge of an innovation to forming an attitude toward the innovation, to a decision to adopt or reject, to implementation of the new idea, and to confirmation of this decision.

- The second way in which time is involved in diffusion is in the innovativeness of an individual or other unit of adoption. Innovativeness is the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system. There are five adopter categories, or classifications of the members of a social system on the basis on their innovativeness:

    - Innovators – 2.5%
    - Early adopters – 13.5%
    - Early majority – 34%
    - Late majority – 34%
    - Laggards – 16%

- The third way in which time is involved in diffusion is in rate of adoption. The rate of adoption is the relative speed with which an innovation is adopted by members of a social system. The rate of adoption is usually measured as the number of members of the system that adopt the innovation in a given time period. An innovation's rate of adoption is influenced by the five perceived attributes of an innovation.

The Social System:

The fourth main element in the diffusion of new ideas is the social system. A social system is defined as a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal. The members or units of a social system may be individuals, informal groups, organizations, and/or subsystems. The social system constitutes a boundary within which an innovation diffuses. How the system's social structure affects diffusion has been studied. A second area of research involved how

norms affect diffusion. Norms are the established behavior patterns for the members of a social system.

A third area of research has had to do with opinion leadership, the degree to which an individual is able to influence informally other individuals' attitudes or overt behavior in a desired way with relative frequency. A change agent is an individual who attempts to influence clients' innovation-decisions in a direction that is deemed desirable by a change agency.

Factors Affecting Rate of Diffusion:

Why do certain innovations spread more quickly than others? The innovation, to spread and be adopted should show; The characteristics which determine an innovation's rate of adoption are:

- **Relative Advantage:**
  Relative advantage is the degree to which an innovation is perceived as better than the idea it supersedes. The degree of relative advantage may be measured in economic terms, but social prestige, convenience, and satisfaction are also important factors. It does not matter so much if an innovation has a great deal of objective advantage. What does matter is whether an individual perceives the innovation as advantageous. The greater the perceived relative advantage of an innovation, the more rapid its rate of adoption will be.

- **Compatibility:**
  Compatibility is the degree to which an innovation is perceived as being consistent with the existing values, past experiences, and needs of potential adopters. An idea that is incompatible with the values and norms of a social system will not be adopted as rapidly as an innovation that is compatible. The adoption of an incompatible innovation often requires the prior adoption of a new value system, which is a relatively slow process.

- **Complexity:**

Complexity is the degree to which an innovation is perceived as difficult to understand and use. Some innovations are readily understood by most members of a social system; others are more complicated and will be adopted more slowly. New ideas that are simpler to understand are adopted more rapidly than innovations that require the adopter to develop new skills and understandings.

- **Trialability:**
  Trialability is the degree to which an innovation may be experimented with on a limited basis. New ideas that can be tried on the installment plan will generally be adopted more quickly than innovations that are not divisible. An innovation that is trialable represents less uncertainty to the individual who is considering it for adoption, who can learn by doing.

- **Observability to those people within the social system:**
  Observability is the degree to which the results of an innovation are visible to others. The easier it is for individuals to see the results of an innovation, the more likely they are to adopt it. Such visibility stimulates peer discussion of a new idea, as friends and neighbors of an adopter often request innovation-evaluation information about it.

A final crucial concept in understanding the nature of the diffusion process is the critical mass, which occurs at the point at which enough individuals have adopted an innovation that the innovation's further rate of adoption becomes self-sustaining.

The concept of the critical mass implies that outreach activities should be concentrated on getting the use of the innovation to the point of critical mass. These efforts should be focused on the early adopters, the 13.5 percent of the individuals in the system to adopt an innovation after the innovators have introduced the new idea into the system. Early adopters are often opinion leaders, and serve as role-models for many other members of the social system. Early adopters are instrumental in getting an innovation to the point of critical mass, and hence, in the successful diffusion of an innovation.

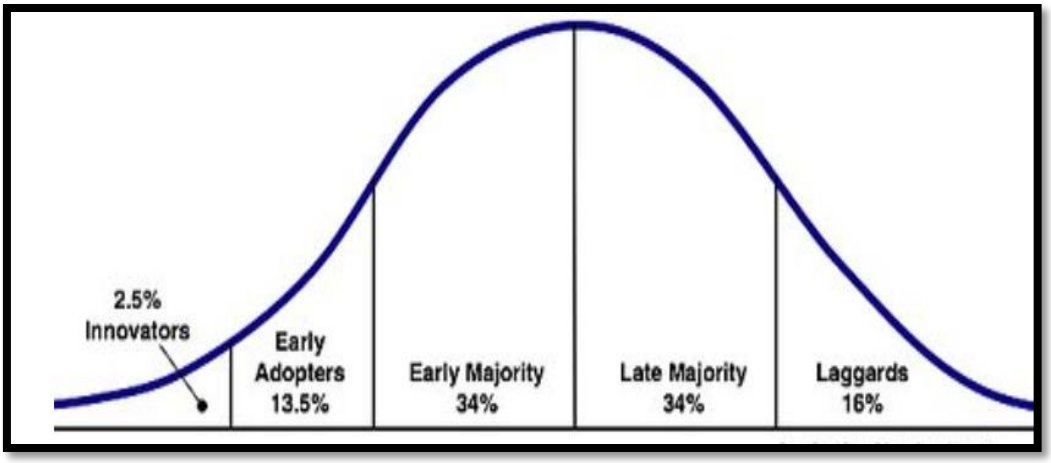


Figure 1.1: Categories of Adopters.

Adopter Categories :

- Innovators are the first 2.5 percent of the individuals in a system to adopt an innovation. Venturesomeness is almost an obsession with innovators. The innovator must be able to cope with a high degree of uncertainty about an innovation. The innovator must be able to cope with a high degree of uncertainty about an innovation at the time of adoption.

  While an innovator may not be respected by the other members of a social system, the innovator plays an important role in the diffusion process: That of launching the new idea in the system by importing the innovation from outside of the system's boundaries.

- Early adopters are the next 13.5 percent of the individuals in a system to adopt an innovation. Early adopters are a more integrated part of the local system than are innovators. Whereas innovators are cosmopolites, early adopters are localities'. Potential adopters look to early adopters for advice and information about the innovation.

  The early adopter knows that to continue to earn this esteem of colleagues and to maintain a central position in the communication networks of the system, he or she must make judicious innovation-decisions. The early adopter decreases uncertainty about a new idea by adopting it.

- Early majority is the next 34 percent of the individuals in a system to adopt an innovation. The early majority adopt new ideas just before the average member of a system. The early majority interact frequently with their peers, but seldom hold positions of opinion leadership in a system. The early majority's unique position between the very early and the relatively late to adopt makes them an important link in the diffusion process.

  They provide interconnectedness in the system's interpersonal networks. The early majority are one of the two most numerous adopter categories, making up one third of the members of a system. The early majority may deliberate for some time before completely adopting a new idea. "Be not the first by which the new is tried, nor the last to lay the old aside," fits the thinking of the early majority. They follow with deliberate willingness in adopting innovations, but seldom lead.

- Late majority is the next 34 percent of the individuals in a system to adopt an innovation. The late majority adopt new ideas just after the average member of a system.

  Like the early majority, the late majority make up one-third of the members of a system. Adoption may be the result of increasing network pressures from peers. Innovations are approached with a skeptical and cautious air, and the late majority do not adopt until most others in their system have done so.

- Laggards are the last 16 percent of the individuals in a system to adopt an innovation. They possess almost no opinion leadership. Laggards are the most localite in their outlook of all adopter categories; many are near isolates in the social networks of their system. The point of reference for the laggard is the past. Decisions are often made in terms of what has been done previously.

  Laggards tend to be suspicious of innovations and change agents. Resistance to innovations on the part of laggards may be entirely rational from the laggard's viewpoint, as their resources are limited and they must be certain that a new idea will not fail before they can adopt.

Innovation Diffusion Models:

Bass Model:

A growth model for the timing of initial purchase of new products is developed. A behavioral rationale for the model is in terms of innovative and imitative behavior. The model yields good predictions of the sales peak and the timing of the peak.

Here we will consider the development of a theory of timing of initial purchase of new consumer products. The theory is intended to apply to the growth of initial purchases of a broad range of distinctive "new" generic classes of products. Thus, we draw a distinction between new classes of products as opposed to new brands or new models of older products..

The growth modesl presented is represented by growth patterns shown in Figure 1.2. Sales grow to a peak and then level off at some magnitude lower than the peak. The stabilizing effect is accounted for by the relative growth of the replacement purchasing component of sales and the decline of the initial purchase component. We shall be concerned here only with the timing of initial purchase.

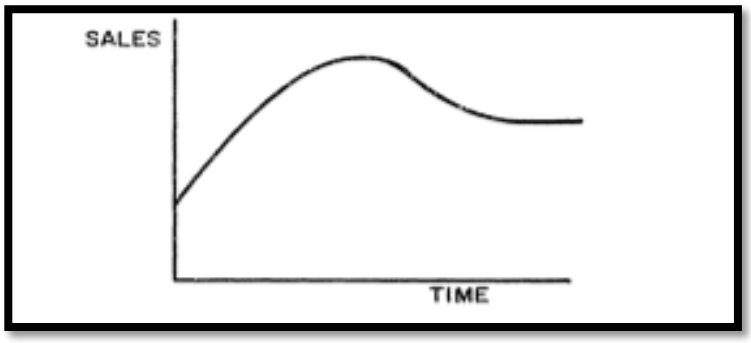


Figure 1.2: Growth of a New Product.

Notations:

$P(T) =$ Probability of initial purchase at time T

$Y(T) =$ number of previous buyers.

p = coefficient of innovation.

q = coefficient of imitation.

m = total number of purchasing during the period.

$f(T)$ = likelihood of purchase at T

$F(T)$ = cumulative number of purchases till time T

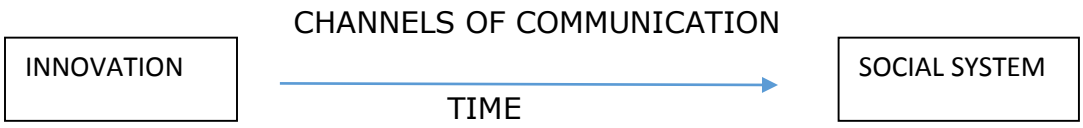
$S(T)$ = sales at time T

T^* = time at which sales rate reaches its peak.

$E(T)$ = expected time to purchase.

Diffusion Theory:

The theory of adoption and diffusion of new ideas or new products by the social system has been discussed at length by Rogers.



In applying the theory to the timing of initial purchase of a new consumer product, we formulate the following precise and basic assumption.

" The probability that an initial purchase will be made at T given that no purchase has yet been made is a linear function of the number of previous buyers."

Thus, $P(T) = p + (q/m)\, Y(T)$, where p and q/m are constants. $Y(T)$ is the number of previous buyers. Since $Y(0) = 0$, the constant p is the probability of an initial

purchase at T = 0 and its magnitude reflects the importance of innovators in the social system. The product *q/m* times *Y(T)* reflects the pressures operating on imitators as the number of previous buyers increases.

Assumptions of The Model:

The following assumptions are made while developing a model:

- The basic assumption of the model is that there exists a finite population of prospective buyers who with time increasingly adopt the product.

- The timing of a consumer's initial purchase is related to the number of previous buyers.
- Over the period of interest ("life of the product") there will be *m* initial purchases of the product. Since we are dealing with infrequently purchased products, the unit sales of the product will coincide with the number of initial purchases during that part of the time interval for which replacement sales are excluded. After replacement purchasing begins, sales will be composed of both initial purchases and replacement purchases. We shall restrict our interest in sales to that time interval for which replacement sales are excluded, although our interest in initial purchase will extend beyond this interval.

The likelihood of purchase at time T given that no purchase has yet been made is

$$\left[f\left(T\right)\right]/\left[1-F\left(T\right)\right]=P\left(T\right)=p+q/mY\left(T\right)=p+qF\left(T\right) \qquad (1.1)$$

Where $f(T)$ is the likelihood of purchase at T

$$F\left(T\right)=\int_0^T f\left(T\right)dt,\ F\left(0\right)=0$$

Since $f(T)$ is the likelihood of purchase at T and m is the total number purchasing during the period for which the density function was constructed.

$$Y(T)=\int_0^T S(t)\,dt = m\int_0^T f(t)\,dt = mF(T)$$

is the total number purchasing in the $(0,T)$ interval, therefore sales at T is given as follows: $S(T)=mf(T)=P(T)=\left[m-Y(T)\right]=\left[p+q\int_0^T S(t)\,dt/m\right]\left[m-\int_0^T S(t)\,dt\right]$ (1.2)

Expanding equation (1.2), we get

$$S(T)=pm+(q-p)Y(T)-q/m\left[Y(T)\right] \tag{1.3}$$

The behavioral rationale for these assumptions are summarized:

a) Initial purchases of the product are made by both "innovators" and "imitators," the important distinction between an innovator and an imitator being the buying influence. Innovators are not influenced in the timing of their initial purchase by the number of people who have already bought the product, while imitators are influenced by the number of previous buyers.

Imitators "learn," in some sense, from those who have already bought.

b) The importance of innovators will be greater at first but will diminish monotonically with time.

c) We shall refer to p as the coefficient of innovation and q as the coefficient of imitation.

$$f(T)=[p+qF(T)][1-F(T)]=p+(q-p)F(T)-q[F(T)]^2 \tag{1.4}$$

Now in order to find $F(T)$

we must solve nonlinear differential equation (1.4).

$$dT=dF/(p+(q-p)F-qF^2)$$

The solution is given as follows:

$$F = (q - pe^{-(T+C)(p+q)}) / q(1 + e^{-(T+C)(p+q)})$$

Since $F(0) = 0$ the integration constant may be evaluated:

$$-C = (1/(p+q)) \ln(q/p)$$

$$F(T) = (1 - e^{-(p+q)T}) / (q/pe^{-(p+q)T} + 1)$$

Then differentiating $F(T)$ we get

$$f(T) = ((p+q)^2 / p)[e^{-(p+q)T} / (q/pe^{-(p+q)T} + 1)^2] \quad (1.5)$$

$$S(T) = (m(p+q)^2 / p[e^{-(p+q)T} / (q/pe^{-(p+q)} + 1)^2]. \quad (1.6)$$

To find time at which the sales rate reaches its peak, we differentiate S

$$S' = (m/p(p+q)^3 e^{-(p+q)T} (q/pe^{-(p+q)T} - 1)) / (q/pe^{-(p+q)T} + 1)^3$$

Thus $T^* = -1/(p+q) \ln(p/q) = 1/(p+q) \ln(q/p)$ then (1.7)

$$S(T^*) = (m(p+q)^2 / 4q) \quad (1.8)$$

$$Y(T^*) = \int_0^{T^*} S(t)\, dt = m(q-p)/2q. \quad (1.9)$$

Since for successful new products the coefficient of imitation will ordinarily be much larger than the coefficient of innovation, sales will attain its maximum value at about the time that cumulative sales is approximately one-half *m.* We note also that the expected time to purchase, *E (T), is 1/q* Ln *((p + q)/p).*