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DIFFUSION OF INNOVATIONS AND COMMUNICATION

The diffusion of an innovation is the spread of a product, process, or idea perceived as new, through communication channels, among the members of a social system over time. Innovations can be a new product or output, a new process or way of doing something, or a new idea or concept. The "newness" of an innovation is subjective, determined by the potential adopter.

Diffusion Processes

Generally, the diffusion, or cumulative adoption, of an innovation over time follows an S-curve: that is, slowing growing initially, then accumulating quickly, then flattening out as the maximum level of adoption is reached. Portions of this diffusion curve (i.e., standard deviations of the normal curve) can be characterized as types of adopters. The first 2.5 percent of adopters within a social system are innovators, the next 13.5 percent are early adopters, the next 34 percent are early majority, the next 34 percent are late majority, and the final 16 percent are laggards. Innovators and early adopters are usually distinguished by high levels of "innovativeness," a general disposition toward change and trying new things, as well as higher education and higher income, among other factors.

Diffusion and adoption can be measured in a variety of ways: number or percentage of adopters at a certain time, number or percentage of organizational units adopting, average duration of usage, number of innovation components adopted, number of units sold or implemented, level of system usage (such as number of log-ons, messages sent, files stored, records processed), level of satisfaction, acceptance, diversity of planned uses, number of new uses, and so on.

Crucial to all diffusion patterns is the achievement of a "critical mass," or the number of adopters sufficient to foster sustained adoption beyond that point. This concept of critical mass is especially relevant to interactive communication innovations, such as the telephone or electronic mail. This is because the value of the overall system (the telephone system, the Internet) grows exponentially as each additional user adopts, so that later adopters perceive and obtain much greater value than do early adopters. Further, with communication innovations, there are typically competing channels already in place, so that early adopters have to use multiple channels while non-adopters, or late adopters, have to choose only one of the competing channels. Thus, it is important to provide early adopters extra incentives, or to target clusters of early adopters who have special needs for, or who can gain particular benefits from, the new innovation. Unless critical mass is achieved early, the new communication channel will likely falter. Indeed, considering time as a crucial element of diffusion, different innovations may take very different lengths of time to achieve widespread adoption. For example, in the United States, it took more than half a century to obtain broad residential adoption of the telephone, while compact disc has been quickly adopted as the standard for audio music recording and distribution.

An intriguing extension of critical mass is the concept of adoption thresholds. The idea here is that each individual has a (possibly variable) threshold for adopting a particular innovation. From a social and critical mass perspective, initial adopters have low thresholds—they may have sufficient resources, high innovativeness, unique relative advantages, and low need for social influence. Thus, they are likely to be innovators and early adopters within their social systems. Later adopters have higher thresholds, but, as more and more innovators adopt the innovation, these higher thresholds are more likely to be met. Thus, as initial innovators adopt, those close to them in the social network will now have achieved their just-slightly-higher thresholds, and also adopt. This in turn makes it more likely that others with even-slightly-higher thresholds will soon adopt. The implication here is that innovation implementers must be able to identify those with low initial thresholds and enable those to communicate soon after with those having slightly higher thresholds.

There are several interim stages in the adoption decision process: knowledge or awareness of the innovation, persuasion (reactions to and evaluations of the innovation), decision (to obtain,

purchase, try out), implementation (acquiring, adjusting, applying, including a "fair trial" period), and confirmation (including public display of the adoption, and recommending the innovation to others).

Within organizations, there are five major stages as well: agenda-setting (a general definition of the initial rationale or problem statement, which may be more or less "rational" or well-informed), matching (alternative solutions are identified, evaluated, and compared to the agenda), redefining (the attributes of the innovation are defined relative to the needs of the organization, but the alternative solutions may also lead to recasting the initial agenda), structuring and interconnecting (where elements of the current social system and/or the innovation are redesigned to integrate the innovation within appropriate procedures and processes, through both formal and informal negotiations and peer pressure), and routinization (where the innovation becomes a part of normal organizational operations).

There are, of course, many other factors influencing the success, failure, or rate of diffusion of an organizational innovation. These include the justification for the initial agenda rationale; the geographic location and closeness of potential adopters; the complexity, size, and culture of the organization (decentralized, small organizations may be much better at initiating innovations, while centralized, large organizations may be more successful at implementing them); the personalities and power bases of the organizational actors; changes in political agendas, resources, and goals that affect the nature and evaluation of the innovation; different stakeholders becoming activated by different stages in the lifecycle of the innovation; external organizational environments, including changing competitors, regulatory environments, economic resources; and technological changes, rendering a current innovation incompatible or inappropriate.

Indeed, there are many important examples where the wider economic, regulatory, and social environment heavily determine the success or failure of an innovation. "Positive feedbacks," "positive network externalities," or "complementarities" are, respectively, benefits associated with an innovation that accrue to later adopters rather than early adopters, benefits that increase the value of early versus later innovations, and services and other innovations that arise due to the success and features of an earlier innovation. For example, the Microsoft Windows operating system has extensive positive externalities because, since it is the dominant operating system, most other companies design their software applications for use under Windows. This, in turn, raises the value and market centrality of Windows. Another example is the design of the typewriter (and, thus, computer keyboard) keys. The QWERTY system (named because of the sequence of the top left-hand row of letters) was initially designed to slow down typing speed because the early metal typewriter mechanisms would become jammed if pressed too quickly. By the time that manufacturing innovations allowed for faster mechanisms (especially consider modern computer keyboards), the infrastructure surrounding the typing industry (manufacturing processes, repair, training, secretarial skills) made it too expensive (socially, organizationally, personally) to switch to a different, more efficient keyboard layout (such as the DVORAK design). Thus, initial adoption patterns can heavily constrain or influence later diffusion (an example of path dependence), often institutionalizing initial innovations that are in fact less technologically or socially innovative or effective.

Another time-based factor in the diffusion process is the "chasm" between early and later innovation design and adoption. Initial development of an innovation tends to be technology-driven, as widespread uses and critical mass have not yet been established. Here, developers attempt to design sufficient performance, features, and quality to satisfy early adopters, who are often willing to pay more (and become initial subscribers), and to tolerate poorer design, in return for new technological features and the status of "innovators" and "early adopters." However, "early" and "late" majority adopters are not typically interested in the technological aspects, but are more concerned about relative advantage, compatibility, and low complexity. Thus, the technology itself is not perceived as important; rather, usable devices, commodities, services, and content become more valued. The challenge for the developer and implementer, then, is to cross this "chasm," knowing when to emphasize technology and when to emphasize the general marketplace.

E-mail, one of the most rapidly diffused innovations of the late-twentieth century, continues to change with the introduction of products such as 3Com's "Audrey" Internet appliance, which became available in January 2001 and offers three ways to send e-mail: typical message, handwritten message, and voice message. (Reuters NewMedia Inc./Corbis)

Because of these several stages in the individual and organizational adoption process, and the wide and complex range of factors affecting diffusion, an innovation may not be rejected initially, but still may be discontinued at any stage of the diffusion process.

Innovation Attributes

Generally, potential adopters assess five main attributes of an innovation. Relative advantage is the extent to which the innovation provides greater benefits, and/or fewer costs, than the current product or process. Compatibility is the extent to which the innovation fits in with existing habits, norms, procedures, and technical standards. Trialability is the extent to which potential adopters can try out components, instead of the entire innovation, or can try out the innovation through pilot demonstrations or trial periods, but decide to return to their prior conditions without great cost. Complexity is the extent to which potential adopters perceive the innovation as difficult to understand or use. Finally, observability or communicability is the extent to which potential adopters can observe or find out about the properties and benefits of the innovation. Every innovation has positive and negative aspects of each of these attributes.

Consider, for example, electronic mail (e-mail). Clearly, a general critical mass of users has been achieved, especially within communities of certain online information services, but certain subgroups have low overall levels of adoption so would not experience critical mass. E-mail has relative advantages over a face-to-face interaction because one can send the message at any time, regardless of where the other person is or how difficult it would be to actually meet up with them. To many people, e-mail is still somewhat incompatible with traditional social norms such as sending holiday greetings, but it is highly compatible with other work and computer applications. With trial subscriptions or even free e-mail now offered, it is relatively inexpensive to try out electronic messaging, but one still has to have purchased a modem and communication software. Regardless of how simple advertisements make using e-mail appear, the various functions and interconnections with other applications still make e-mail fairly complex to understand and use. It is fairly easy to communicate the basic features, uses, and benefits of e-mail to others, but it might be hard to actually observe some of those benefits, or even one's own e-mail, without taking the time and effort to check the e-mail system. However, developments such as accessing one's e-mail by WebTV or a standalone e-mail appliance for the kitchen will make the benefits of e-mail more compatible and observable and less complex.

A major development in the conceptualization of an innovation was the realization that an innovation is not a fixed, static, objective entity. Rather, it is contextual, flexible, and dynamic. It may be adapted and reinvented. A reinvention is the degree to which an innovation is changed by the adopter(s) in the process of adoption and implementation, after its original development. A reinvention may involve a new use or application of an already adopted innovation, or an alteration in the innovation to fit a current use. Reinventions

may be categorized based on intentionality—whether they are planned (intentional) or vicarious (learning by other's mistakes)—and source—whether they are reactive (solving a problem generated by the innovation itself) or secondary (solving unintended consequences elsewhere in the organization or innovation due to the reinvention). The four levels of reinvention include unsuccessful adoption (low integration), successful adoption (clockwork systems), local adaptation (expanding systems), and systemwide adaptation (high-integration systems).

One significant distinction within organizational settings is between administrative (managing organization processes) and technical (specific manufacturing or service processes) innovations, each fostered by different influences and each having different consequences. Another distinction, often found in consumer studies of innovations, is the extent to which the innovation is perceived as being part of a "cluster" of already adopted products, processes, or ideas. A marketer or implementer can attempt to determine these innovation clusters, and then position the proposed innovation as having relative advantage to, yet compatibility with, things already familiar and valued. So, for example, while designers of desktop videoconferencing thought that users would perceive this innovation as similar to face-to-face interaction, they typically perceive it as more similar to the telephone. Thus, design, marketing, implementation, and pricing efforts should take this into consideration.

Another major factor influencing both the initial agenda rationales, relative advantage, observability, and management of organizational innovations is the extent to which the innovation is information-based as opposed to material-based. Information is difficult to completely own because it is easily copied and distributed to others. Furthermore, some uses and values of information are unpredictable, and can only be determined through usage by specific adopters. Because all the benefits of information-based innovations cannot easily be appropriated by the innovator, it is not economically rational to fully invest in innovations. Thus, the legal and economic infrastructure of copyright, patents, licenses, disclosure agreements, royalties, and so on has been developed to help guarantee innovators that their ideas, and the benefits associated with them, accrue to the developers during a specific period. Furthermore, it is difficult to identify, much less estimate, all the long-term benefits associated with information-based innovations, so initial agenda rationales based on traditional return-on-investment calculations will suppress the adoption of many innovations. Thus, specific institutions have arisen, such as universities, government and other funding agencies, incubator organizations, and "skunkworks" in protected units within organizations, to foster the development of innovations.

Communication Channels

Communication channels also play an important role in diffusion. Because the innovation is a new product, process, or idea, it must be communicated to potential adopters in order for them to assess its attributes and decide whether to try out and eventually adopt it. Very broadly speaking, mediated communication and interpersonal communication play complementary, but different, roles. Electronic mass media channels such as television and radio are useful for raising awareness about the innovation, but cannot provide much detail (except for specialty radio programs). They can provide images and brand name identification, helping the attributes of compatibility and observability. Print mass media channels such as newspapers and magazines (and, to some extent, the Internet) are useful for explaining conceptual and technical details, helping out with the attributes of relative advantage and complexity. New media such as the World Wide Web can provide interesting mixtures of image, explanation, and demonstrations, thus also fostering trialability.

Interpersonal communication is especially important in changing opinions and reducing uncertainty about the innovation, as potential adopters turn to credible and important sources to provide first-hand experiences and legitimization of the new idea. Much innovation research shows the significant role that social influence, peer pressure, and social learning plays in affecting not only the final adoption decision, but also the evaluation of the attributes of the innovation. This is particularly important when initial relative advantages are low (high adoption costs or low observability), critical mass has not yet been achieved (thus representing higher learning and adoption costs for early adopters), or when the innovation is not obviously

compatible with current social or group norms. In such cases, certain innovation roles become crucial.

The "cosmopolite" is a member of a social system who travels more, communicates and uses the media more, attends more conferences, and is generally more aware of the external environment, than other members. Thus, the cosmopolite is a valuable source to the social system for innovations. Within particular groups or organizational units, this role may be filled by a "technical gatekeeper," who seeks out and brings into the group relevant facts and practices, freeing the rest of the group to focus on the group's task but also keeping it informed of innovative ideas. Within a social system, the "opinion leader" plays the valuable role of evaluating and legitimizing new ideas, especially normative ideas that fit in with the general social context of the group. The opinion leader must be fairly similar to the rest of the group in order to represent the central norms and values of the group, but tends to be just slightly more educated and experienced, and receives more communication, than the other members. Different types of innovations or social norms may be regulated by different opinion leaders. For example, political, religious, and agricultural innovations would probably be discussed and evaluated by different (if somewhat overlapping) social groupings and opinion leaders. Thus, an important diffusion strategy is to identify the appropriate opinion leader for the type of innovation, communicate the relative advantage and compatibility of the innovation for that social system, and then provide incentives and communication channels for the opinion leader to diffuse the idea to other members.

Radical or "taboo" innovations are highly incompatible with the norms and practices of a social system, so an opinion leader will quickly reject such suggestions, even presuming the leader will have been exposed to the idea. Thus, the social "isolate" (who is not heavily constrained by group norms) or the cosmopolite who has many "weak ties" (infrequent, somewhat distant, or diverse communication with others outside the social group) are necessary to ensure that social groups become exposed to, and eventually try out, innovations. For example, highly traditional or conservative groups are unlikely to find out about, much less try, radical or taboo innovations, largely because of their social structure and use of communication channels. A well-known example is the adoption of family planning within Korean villages. The concept was so taboo that husbands and wives did not communicate about it, and it certainly was not discussed in public meetings or media. However, relatively isolated individual "mother's clubs" with innovative leaders began talking about and practicing family planning, motivated by face-to-face communication with change agents. Adoption spread within the boundaries of these small social systems, and, with increasing evidence of relative advantage, began to diffuse through the more-normative mother's clubs. However, clubs that did not have the active support of their opinion leaders were either late adopters or nonadopters.

The diffusion of innovations is a rich, complex, challenging, and rewarding area for communication and information research and practice.

See also: INTERNET AND THE WORLD WIDE WEB; ORGANIZATIONAL COMMUNICATION; TECHNOLOGY, ADOPTION AND DIFFUSION OF.

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