Organization Science

Vol. 15, No. 5, September–October 2004, pp. 569–585
ISSN 1047-7039 | EISSN 1526-5455 | 04 | 1505 | 0569

DOI 10.1287/orsc.1040.0081

A Test of the Individual Action Model for Organizational Information Commons

Janet Fulk
Annenberg School for Communication, and Marshall School of Business, University of Southern California, 3502 Watt Way, Los Angeles, California 90089-0281, fulk@usc.edu

Rebecca Heino
McDonough School of Business, Georgetown University, 37th and O Streets, NW, Washington, D.C. 20057, rdh26@georgetown.edu

Andrew J. Flanagin
Department of Communication, University of California, Santa Barbara, Santa Barbara, California 93106, flanagin@comm.ucsb.edu

Peter R. Monge
Annenberg School for Communication, and Marshall School of Business, University of Southern California, 3502 Watt Way, Los Angeles, California 90089-0281, monge@usc.edu

François Bar
Annenberg School for Communication, University of Southern California, 3502 Watt Way, Los Angeles, California 90089-0281, fbar@usc.edu

This research elaborated and empirically tested the individual action component of the collective action model as applied to individual contributions to organizational information commons. The model extended prior theory and research by making six elaborations on the classic collective action model based on unique characteristics of information goods compared to material collective goods. The structural equation model was tested via LISREL analyses of data provided by 781 respondents in three high-tech firms who had access to corporate intranets as shared information goods. The results were highly similar across organizations and indicated that (a) level of production, information retrieval, and cost predicted the perceived value of information, (b) information value and cost predicted gain, and (c) information retrieval and gain predicted the level of individual contributions to the commons.

Key words: intranet; collective action; public goods; communication technology; information technology

Information and knowledge are key resources in the knowledge economy (Due 1995). Castells argues that in this age of "informationalism" the "source of productivity lies in the technology of knowledge generation, information processing, and symbol communication" (1996, p. 17). Increasingly, organizations attempt to leverage knowledge resources by consolidating them into shared repositories such as expert databases, groupware, data warehouses, project websites, intranets, shared whiteboards, and lessons learned databases (Korth and Silbershatz 1997). Such repositories are becoming integral to a variety of tasks and to overall organizational functioning (Simon and Marion 1996). Collective repositories are stocked to some degree by "discretionary" information (Connolly and Thorn 1990), which is information that is under the private control of individuals, who may or may not be motivated to voluntarily share the information with others.

Motivating individuals to contribute discretionary information to a collective repository can be a daunting challenge. Consider, for example, lessons-learned databases. The purpose of these repositories is to permit individuals to voluntarily contribute lessons they have learned from experience and mistakes, as well as to retrieve learning posted by others. The overwhelming failure of many lessons-learned databases highlights motivational impediments to individual information contributions (Jackelen 2000) and illustrates the willingness of individuals to "free ride" on the contributions of others (Olson 1965).

The challenge of securing individual contributions for a collective has been formulated as a problem of collective action (Butler 2001, Connolly and Thorn 1990, Fulk et al. 1996, Monge et al. 1998). Collective action theory has a long and distinguished history in economics, sociology, and political science (Hardin 1982, Olson 1965, Marwell and Oliver 1993, Samuelson 1954). The central concern is how individual motivation to participate in collective action is dependent upon the progress of the action itself at the collective level. Markus (1990) and Connolly and Thorn (1990) note that for information sharing, motivation to contribute is likely to increase with increases in the probability of collective level success (e.g., creation of a valuable database). Prior collective action research has sought to explain the success or failure of collective actions primarily by focusing at the

collective level, addressing concerns such as heterogeneity in the distribution of contributable resources within the community as a whole (e.g., Marwell and Oliver 1993, Monge et al. 1998).[1]

The research reported here develops and tests a model of how individual-level factors interact with perceptions of collective action in influencing individuals' motivations to contribute privately controlled information to a collective repository. A conceptual model is drawn from the individual action component of collective action theory. The model is then elaborated to address individual motivations to contribute discretionary information to collective databases, and a revised model is proposed. The model is tested with data from individuals in three different organizations that have implemented corporate intranets to support collective information sharing.

Intranets were chosen in part because they pose a significant collective action challenge. Intranets are complex information tools that have grown in popularity in all types of organizations. Although information for some portions of an intranet can be provided centrally (e.g., an online phone directory), much of the information needed for a successful intranet requires that many individual users contribute their own discretionary information (e.g., lessons learned). As noted by Head (2000) and Hollingshead et al. (2002), many intranets do not achieve their potential as shared resources because individuals fail to participate effectively in producing a collective store of information.

Background: The Individual Action Component for Collective Action

Public Goods Equation for Collective Action

The key social dilemma in producing a collective good arises when noncontributors cannot be excluded from benefiting from the good. The incentive structure created by nonexcludability favors free riding by individuals on the contributions of others (Hardin 1968, Olson 1965, Sweeney 1973). At the extreme, the result of the combined individual-level decisions to free ride is that there ultimately is nothing to free ride on, since no one is motivated to contribute.

The logic of the individual component of collective action is expressed by the following equation from Marwell and Oliver (1993):

$$g_i = v_i[P(R)] - c_i(r_i).$$

The gain, g_i, that accrues to the ith individual from contributing to a collective equals the value of the good produced by the collective action, $v_i[P(R)]$, minus the individual's cost of contributing resources, $c_i(r_i)$. Unpacking the $v_i[P(R)]$ term, P is the current level of production of the good, which is a function of the total resources contributed by all persons to date, R. The total resources term, R, is the sum of the individual resources contributed by all individuals, $\sum r_i$. The $c_i(r_i)$ term indicates that individual costs of contributing, c_i, are a function of the resources that the particular individual has contributed, r_i.

According to Hardin (1982), if some individuals perceive a gain from contributing to a collective good, the community is "privileged" and will likely succeed in achieving the good. However, if no one perceives a gain from contributing, the community is "latent" and will not succeed on its own, although contributions might be induced by external incentives. That is, on the average and across individuals, the presence of gain from making contributions will increase the likelihood that more individuals will indeed contribute. However, a gain for any particular individual does not guarantee that this individual will contribute rather than free ride. Collective action theory is concerned with tendencies within groups rather than any one individual's behavior. In a similar fashion, we argue that there should be a positive relationship between gain and contributions across sets of individuals, although the prediction may not hold true for any specific individual, as some people may elect to free ride.

As the public goods equation specifies, the *value* of the collective good to an individual at any time is a function of the *collective resources that have been contributed* to it. The value term approaches zero when collective contributions are low, which depresses gain and lowers individuals' motivation to contribute. In this way, individual motivation and cumulative collective contributions by all members of the community are intertwined. What happens at the collective level influences individual choices, which, in combination across individuals, influences the collective. Economists also refer to this individual-collective interdependence as network externalities (Shapiro and Varian 1999). That is, the collective good comes to have more value to the individual not only in and of itself, but also as a result of factors external to the nature of the good. In this case, the externalities are the number of other contributors and the amount of resources already contributed.

Information Goods

In the subsequent sections we elaborate the public goods equation to apply to contributions to information goods. In making these arguments, we draw on a number of features of information as a resource that distinguish it from material resources. The first feature relates to securing the benefits of ownership. Ownership of material resources or money can be transferred from the individual contributor to the collective. By contrast, information contributions continue to be held privately by contributors because information is reproduced for the collective rather than transferred to it. Donors of a material resource have continuing benefit from their

resource only indirectly via the collective good that the contribution has helped to secure. Contributors of an information resource maintain direct benefit from the resource because they continue to hold it privately (Oliver and Marwell 2001, Monge et al. 1998). Thus, the contributions of *others* provide the key benefits for participants in information repositories.

A second set of concerns relates to the relative invisibility of some aspects of information. Free riding is more difficult to assess for information stores, since people do not have windows into what unshared information other people possess. Furthermore, without knowing what other individuals know, no outsider can create an effective mandatory contribution system. As Kim and Mauborgne (1997, p. 67) note, "Unlike the traditional factors of production—land, labor, and capital—knowledge is a resource locked in the human mind. Creating and sharing knowledge are intangible activities that can neither be supervised nor forced out of people." Incentive systems can overcome some of these problems, but in the absence of the ability to monitor and control quality for each contribution, such systems can spark a flood of low-quality information contributions (Connolly and Thorn 1990, Kalman et al. 2002). As Kalman et al. (2002, pp. 126–127) note, people "are ultimately at a disadvantage in any contest with [others] over the control of many types of information (Miller 1992)." A related concern is that there is typically no known capacity limit for fully realizing a collective information good (Hansen and Haas 2001). Marwell and Oliver's formulation is based on the assumption that there is a fixed ceiling at which the collective good is fully realized. (This issue will be discussed in more detail later.)

A third set of concerns relates to the instability in value of any piece of information across settings and across time. The information life cycle includes decay (Allen 1990) such that accumulations of information in repositories must be regularly updated to avoid a decline in value. Furthermore, the value of information is partly determined by how exclusively or extensively it is distributed (National Research Council 2000). The value of the same information item to an information holder often declines as the information becomes more widely held within the community. Furthermore, as an "experience good" information must be experienced to be valued, and it must be consumed to be experienced (Shapiro and Varian 1999). Value cannot be accurately assessed a priori.

A final set of concerns relates to assessing the costs of contributing information. Although information can be costly to produce in the original, it can be inexpensive to reproduce (Shapiro and Varian 1999). Information contribution costs will vary tremendously from the first copy to the *n*th copy of the same item of information. Drawing on these features of information and information goods, the next section presents arguments for six modifications to the public goods equation for the case of information goods.

Public Goods Equation for Collective Information Goods

1. *Individual Gain, g_i, Predicts Individual Information Contributions.* The individual action component of collective action models is built on the premise that individuals will contribute more resources to collective action as their personal gain increases (Marwell and Oliver 1993). Our modified model explicitly recognizes the relationship of individual gain to individual contributions. The model is designed to explain information contributions as a function of factors identified in the collective action model. Thus, we specify that, on average, individual information contributions are a function of individual gains.

2. *Level of Production for Information Goods [P] Is a Function Not Only of Total Contributions (R), but Also a Variety of Subjective Factors that Vary Significantly Across Individuals.* When collective goods are tangible, the level of production may be highly visible, and thus members of the collective may tend to have similar perceptions of it. They may, for example, see that a fund for a new piece of equipment has 50% of the dollars needed to purchase the equipment, or they may see that new construction is approximately 75% completed. Within some small amount of perceptual error, people tend to reach similar conclusions about level of production of a tangible collective good.

With information goods, however, there are three reasons that members of the collective may perceive the level of production quite differently. First, the volume of total information and the number of contributors to a collective repository may not be highly visible to users. For example, although organizations might make statistics available on who is using an intranet and for what purpose, in practice that kind of information is not typically available to users or nonusers.

Second, even if visibility is enhanced by regular updates on the parameters and details of the repository, there would still be variation in perceptions of the maximum volume possible—the metric against which the current level of production is assessed. Individuals can only guess at what other information any person may be withholding. Monge and Contractor (2003) note that "people have their own 'cognitive' perceptions of the knowledge network, that is, each person embodies his or her own idea of how knowledge is distributed among others" (p. 92). Indeed, one advantage of intranets, expert databases, bulletin boards, and other communal repositories is that each user need *not* know who knows what to receive benefit—as long as those people have contributed their information to the repository. Communal repositories offer generalized exchange (Ekeh 1974)

as a replacement for direct exchange with known knowledge holders (Fulk et al. 1996). Overall, then, individuals will likely draw different conclusions as to *the upper* limit of possible contributions and thus how far the collective has progressed toward the *limit*.

Third, different types of information have different saliency and value to different persons, so the judgment of how much valuable information a database contains is likely to be highly subjective. For example, a project management database that contains the latest specifications for a new product being developed will be more valuable to product designers than to financial staff. Thus, for information goods we modify the collective action theory premise that there is an objective level of production (Marwell and Oliver 1993, p. 26). Instead, level of production will be a highly individualized perception, even among those participating in the same collective information good.

3. *Individual Costs Related to Information Goods, c_i, Are Sufficiently Complex and Multifaceted that They Are Not Constant Multiples of Individual Resources Contributed, r_i.* For each unit of material resources contributed to a collective, the contributor's own resource base declines by an equal amount; contribution costs equal the decline in resources experienced by the contributor, $c_i(r_i)$. If an individual contributes \$1,000 to a collective cause, that individual's cost is \$1,000.

For information resource contributions, however, there is not an equal decline in an individual's resource base. Contributors may lose some control of the resource as it becomes part of the public domain (Cheverie 2002), but they still possess the resource (Arrow 1971). For example, when an individual contributes a lesson to a lessons-learned database, that individual does not lose the lesson. In fact, the act of formulating the contribution in a way that will be useful to others may even reinforce and clarify the lesson for that individual. Of course, the value of that information might change once it enters the community domain. From an economic standpoint, if people initially possess "exclusive information, the consequential information advantage must be considered when deciding to use or sell the information" (Allen 1990, p. 272). The principle that information changes in value as it becomes distributed more widely underlies intellectual property law for information products (e.g., National Research Council 2000). Contribution costs also vary based on whether contribution of information requires acquiring, compiling, and formatting the information (more costly) or simply reproducing information that has already been compiled and formatted (much less costly; Shapiro and Varian 1999). Contribution costs also are tied to such factors as the ease or difficulty of making the contribution itself and will vary tremendously by implementation, organization, support, and user skill level (Connolly and Thorn 1990, Marwell and Oliver 1993, Monge et al. 1998, Cheverie 2002). If making a contribution to an intranet is as easy as saving a file to a desktop, the costs will be low; if that same information must be organized, converted to another format, password protected, and uploaded to a website, then the costs are likely to be higher, particularly if system access is difficult because of technical challenges. Overall, then, we specify information contribution costs as subjective and variable rather than as constant multiples of individual resources contributed, r_i.

Contribution costs are also intertwined with retrieval costs for collective information repositories, in part because information is an experience good. Individuals must acquire information before they can assess the benefit of having it (e.g., they must acquire the newspaper before they can read it, and they must read it to assess whether it is useful; Allen 1990). To assess the likelihood of benefiting from the contributions of others, individuals must be able to access the repository and retrieve information without substantial cost. Contributing information to an intranet, web board, expert database, or other repository that one could not access or could access only at high cost would be tantamount to pouring information down a black hole. In such a case, motivation to contribute is likely to be quite low. Any consideration of costs related to information repositories needs to consider the costs of processing information related to the repository in general. Thus, the cost term, c_i, involves the intertwined overall participation costs of both contributing and receiving information. To signify that costs are not simply a function of resources contributed, as in $c_i(r_i)$, we use the general term c_i to represent costs related to the ease or difficulty of submitting and retrieving information contributions.

4. *Individual Value, v, Is Subjective and Will Vary Across Individuals.* For a material collective good, the value of the good to each individual is based on conversion of contributions into a common metric such as money. For example, if \$5,000 has been contributed to a fund to support legal action on behalf of a collective, the value of the good at that point in time for each and every member of the collective is \$5,000. That is, the individual value is a constant function of level of production of the collective good.

It is more difficult to translate the value for information goods to a common metric such as money. How much is a lesson learned worth? The value of the collective good at any point in time is a function of the number of contributors and the users' individualized perceptions of the quantity and quality of information resource contributions that comprise the good. In addition, interdependence between contributors may influence perceptions of the level of production. For example, when information is distributed differentially among individuals and is nonredundant across individuals, and when each piece is critical to producing a good,

the good may be of little value to individuals unless and until all other members of the community have contributed. Such is the case, for example, with information held by the members of cross-functional design teams in which individual outputs combine nonredundantly to form the end product. By contrast, when there is some redundancy in information held by community members, it is possible to have a highly valued good without 100% participation, as long as all the pieces of critical information have been contributed. Individual values also are influenced by the individual's levels of knowledge about others' contributions as well as a subjective assessment of the utility of these contributions. Thus, we propose that for any particular perceived level of production, value may vary across individuals.

5. *Individual Cost Also Predicts Individual Value.* Marwell and Oliver (1993, pp. 15–18, 27) argue that individual cost and individual value influence each other. Yet to simplify the gain equation they treat these two factors as independent, based on four simplifying assumptions (1993, pp. 17, 18, 64). First, individual costs are assumed to be fungible; that is, they "can be reduced to a single, quantifiable metric such as money" (p. 17) or can be converted to a private good that can be sold or traded (Hardin 1982, pp. 69–72). As noted earlier, information goods are not readily reduced to a common metric such as money. Although information is certainly a commodity that can be traded under conditions of demand (for example, the location of a criminal cell is of interest to law enforcement), in many organizational information commons, most individuals are likely to attempt to secure information that is useful to their organizational tasks and will not attempt to convert it to cash or to sell it on the market.

Assumptions two through four are intertwined. In the second assumption, level of production, P, is assumed to have a *fixed capacity limit of 1* and can assume any value between 0 and 1. Third, individual value, v_i, is assumed to be a *"constant multiple of provision level"* (p. 64) and thus is linearly and perfectly correlated with total contributions, R. Finally, contributions (r and R) and value (v_i) can be expressed using the *same metric* that defines them in relation to the total cost of the maximum production level. These assumptions are also violated for information goods. The upper bound of production of an information good is not a fixed limit, as discussed earlier; nor is there a common metric linking value, cost, and level of production. Even use of a "common" measure such as time needed to prepare a contribution or to retrieve others' contributions is problematic. As Hardin (1982) notes, one hour of a very busy person's time may be more subjectively costly than one hour of time for a less busy person. Also, when costs involve activity rather than money, individual costs represent a trade-off as to how a person spends his or her time and energy. Assessments of the costs and values of these trade-offs will be highly personal. The violation of all four assumptions implies that cost and value cannot be specified as independent of each other.

Overall, then, costs will be dynamic and subjective as people experience trade-offs, decide whether to accept the recurring costs of contributing and updating information, and experience relative success or failure with retrieving information from the commons. High subjective costs can spur psychological mechanisms that devalue a good in the minds of people who are unwilling or unable to incur such costs. For example, if individuals cannot get access to a database easily because the system on which it resides is slow and error prone, they are likely to seek other sources for the information and conclude that the database is not really helpful. Because individual costs are activity based, subjective, not fungible, and tied to individual utility functions for trade-offs in activities, they are not fixed but rather are subjectively manipulable. We argue that subjective value is a function not only of production level, but also of subjective costs.

The violation of these assumptions has another fundamental implication for specification of an individual model of motivation toward collective action. Marwell and Oliver's (1993) assumptions simplify the public goods equation into a straightforward accounting formula. At any one point, level of production is a constant and value is a constant multiple of it and is perfectly linearly correlated with it. Costs are a direct calculation based on resources contributed, which are assessed objectively. Thus, at a single point in time, differences in gain across persons are treated as a direct function of differences in individual resources contributed. Assessing gain thus requires a straightforward calculation based on resources contributed.

With the violation of these assumptions for information goods, gain is not a straightforward calculation based on resources contributed. Gain will vary on the basis of individualized perceptions of level of production, value, and costs. Without the simplifying assumptions, the gain equation changes from a straightforward calculation to a set of simultaneous equations to be solved for the coefficients of all the variables. Thus, we present the individual action component of collective action for information goods for a particular point in time as a structural equation model.

6. *Retrieval of Information by Individuals Impacts Both Their Perceived Value of the Good and Their Contribution Behavior.* In collective action theory, "lumpy" goods must be produced in total before any individual benefits can be realized (e.g., a bridge). By contrast, "divisible" goods may be distributed prior to full realization. Information goods are divisible, offering individuals the opportunity to reap some benefits during the process of production (Flanagin et al. 2001). Although an intranet

may not yet be well enough developed to have very much of the information individuals need, there may be some useful information they can acquire. Divisibility is important, since information must be experienced to be valued (Shapiro and Varian 1999). We argue below that when individuals receive distributions of information from the collective store, even at fairly low levels of production, their value assessments and actual contribution behavior will be affected. Although some persons may free ride, there should be a general tendency across persons for greater contributions after retrieving information.

Information held by members of a collective acquires value for other participants on the basis of at least two factors: the information's own independent utility and additional utility arising from its integration with other information in the pool. Although a particular piece of information in the pool might be most valuable when fully integrated with all other pertinent information, it may be sufficiently valuable to individuals because of its independent utility to induce them to retrieve it from the pool even when the pool contains little other information. That is, individuals do not need to wait until the collective good is fully produced before they receive benefits from it.

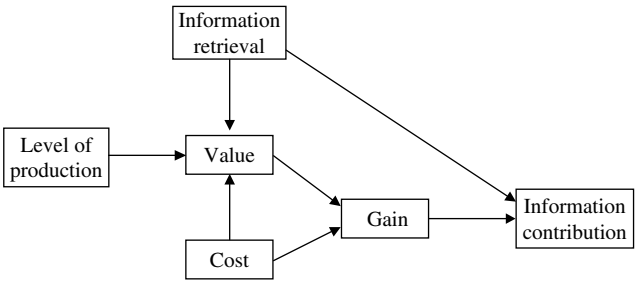
There are three reasons that the ability of potential contributors to retrieve some information even early in the production process should affect individual value. First, individuals who retrieve information from the pool may then conclude that the pool holds valuable information. Of course, information retrieved should have utility and be accessible without substantial cost; retrieval of poor-quality or very costly information would not have this effect. Second, individuals who retrieve valuable information may conclude that others hold information they would find useful and, further, that these people are willing and able to pay the costs of contributing it to the commons. For example, when individuals receive answers to technical questions from an expert database, they will learn both that other people have useful answers to such questions and that other people are willing to contribute those answers to the expert database. Third, individuals who retrieve information may see it as compensation for some of the costs they have already incurred for contribution. If the individuals who receive the valuable technical answers have already contributed some information, they are likely to feel that this effort has been reciprocated, making up for some of the time and energy expended to make the contribution. In general, the more useful information individuals retrieve from the commons at a particular level of production, the greater will be those individuals' values for the commons at that particular level of production. Thus, we propose that information retrieval by individuals will be positively related to those individuals' subjective value of the commons.

There are three reasons that information retrieval may also directly influence contribution behavior. First, successful retrieval may demonstrate how individuals' own contributions might be accessed by and found valuable to others. When people obtain information from a web-based discussion group, they learn how others would access their contributions to the discussion (were they to contribute). Kalman et al. (2002) use the term "connective efficacy" to refer to people's beliefs that others would be willing and able to retrieve information if they contributed it to the pool. In their study of an information commons, individual perceptions of connective efficacy related positively to individual motivations to contribute information.

Second, retrieval of information may stimulate feelings of pressure toward reciprocity within individuals (Connolly and Thorn 1990, Monge et al. 1998). Third, information retrieval followed by appropriate applications in task realms may increase individuals' perceptions that the commons offers task-related benefits for the collective as a whole, what Kalman et al. (2002) call "organizational instrumentality." They found that organizational instrumentality perceptions were positively related to motivations to contribute under conditions of individual organizational commitment. Thus, we propose that individual information retrieval will be positively related to individual contributions.

Summary on Individual Action Component for Collective Action. In the preceding paragraphs we have proposed the following elaboration of the individual action component of the theory of collective action as applied to individual contributions to information repositories: (1) on average, individual contributions are predicted by individual gains, (2) level of production is a perceptual factor that varies across persons for the same information repository and the same point in time, (3) costs, rather than being fully fungible, are subjective and vary across individuals for the same amount of contribution, (4) individual costs influence assessment of individual values, (5) individual value is subjective and will vary across individuals, and (6) individual information retrieval predicts both individual value and individual information contributions. The final structural model of individual contributions to information commons is shown in Figure 1.

Figure 1 Individual Action Model



Individual Contributions to Collective Goods via Intranets

The model proposed here is designed to apply to many varieties of information commons, such as web boards, lessons-learned databases, expert databases, referral sites, online discussion groups, project websites, and the like. Information commons need not be limited to electronic media but may also include nonelectronic commons such as the community bulletin board in the supermarket or the local library. In this study, we examine our model of the individual action component of collective action theory through a study of individual participation in information commons via corporate intranets. In this section, we briefly describe intranets as a form of collective information goods. The analysis indicates how private and collective aspects are intertwined in intranets.

Intranets are complex repositories for a variety of information. They include personnel manuals, phone books, personal websites, divisional newsletters, breaking news, progress reports on product development, and many other types of information. Intranets typically also offer the ability for users to interact with a database and make changes to it, such as updating one's personnel file, ordering new office supplies, updating information in an expert database, or posting information to a shared forum. Another feature is the ability of individuals to communicate with and disseminate documents to other people, via, for example, distribution lists or project websites. An advanced intranet may offer additional tools for teamwork, such as shared whiteboards and conferencing tools. The tools and features will vary by site and implementation.

Much of the information needed for a successful intranet requires that many individual users contribute their own discretionary information. Users themselves must stock these databases (e.g., web boards). Other parts of intranets involve information that is not discretionary for the bulk of users (e.g., the company personnel manual). Even where a portion of an intranet is stocked by a small subset (e.g., a human resources manager posts the personnel manual), it becomes incorporated within an overall community resource. In addition, although some interactions with an intranet will be highly relevant to other users (e.g., contributions to an expert database), others will not (e.g., individual retirement allocations), yet they are incorporated in complex ways into the overall system. Our research does not attempt to assess each of the many possible types of interactions with an intranet to determine how much each involves direct discretionary contributions by a large number of persons. We focus instead on the intranet system as a whole, recognizing that these many functions are highly intertwined, both in the system and in the minds of participants.

Even if we were able to untangle the many strands, we would likely find that utilization of less discretionary portions impacts discretionary contributions. For example, accessing nondiscretionary information can do several things: spur interest in the intranet as a whole and thus increase perceptions of its value as a collective good; help to develop skills at navigating the intranet, which reduces individuals' contribution costs; and help to integrate intranet contribution and retrieval into everyday work practice, which can reduce individuals' recurring costs. Furthermore, Marwell and Oliver (1993) note that "what is discretionary is partly determined by subjective factors" and "perceptions of discretion are probably themselves influenced by the extent of the individual's interest in the collective goal" (p. 17). Thus, our conceptualization includes overall contributions and retrieval via the intranet.

Our focus is on total contribution behavior across different applications and services because ultimately collective action theory is concerned with the success of the collective action as a whole. For complex information systems such as intranets, overall success rarely rests on any single function. Research has shown differences in value of specific services for different members of the collective (Griffith and Northcraft 1994). Indeed, the diversity of options available might promote successful collective action as different individuals come to value the system as a whole based on experience with different features. The analogy often used in collective action literature is the political platform (Hardin 1982): Individuals will support a platform that has some elements that they value highly even if there are other elements that they do not value nearly so much or if other important elements are missing from the platform.

Method

Marwell and Oliver (1993) tested their gain equation via simulations in which they held certain variables constant while testing for others. Such experimentation and manipulation is particularly helpful for assessing the internal validity of the model. This research is based on organizational data collected in three field settings. It empirically tests the theoretical model, brings to bear rare and important evidence on external validity, and assesses the stability of the proposed model across different contexts.

Participants

Three different organizations (all represented by pseudonyms) participated in this study: Grassroots, Top-Down, and Integrative. Each company has a unique history and manifestation of its intranet.

Grassroots. Grassroots is a supplier of high-performance interactive computer systems. It is an international company founded in the early 1980s, with about 80 international offices, 75 within the United States. It employs about 10,000 people worldwide, two-thirds of whom are in the United States. Grassroots' first

intranet was a grassroots effort that came out of the engineering division in 1993 (coinciding with the release of the Mosaic prototype) to facilatate information sharing about projects within the division. At the time, there were no tools to quickly and easily create web pages, but engineers had the necessary programming skills to figure this out for themselves. They exchanged tips and tools and generally helped each other through the learning process. This early intranet quickly became popular and grew organically to thousands of web pages. No one controlled or governed it.

In 1994, Grassroots executives realized the potential of the intranet and decided to create the first corporate intranet as an overlay on the existing intranet. It was conceived both as a gateway to information and as a way to improve corporatewide communications. The second-generation intranet included links to a variety of company information, including handbooks, magazines, technical specifications, organizational charts, phone numbers, and special interest groups. It also offered many online forms for employees to order supplies, request funds, make travel arrangements, sign up for training, and in general take care of most administrative tasks.

While the corporate intranet continued to expand, it was never intended to replace the various grassroots intranets that grew in the company over the years. It offered an overall map to the various resources and tried to persuade individual web designers to adopt common standards or to share indexing and searching tools, but it never sought to take them over. As a result, ownership of the company's intranet is shared among three groups. The Employee Communications Division helped to develop the overall structure and now maintains it. The Information Systems Group manages infrastructure issues. Underneath this level is a third group that includes a multitude of web resource people who maintain specific pages or subareas of the intranet. Overall, the primary force behind the continuing development of Grassroots' intranet is the desires of its end users to build tools that help them address the business issues they directly perceive.

Top-Down. Top-Down provides a broad array of financial services in both traditional modes and online formats. Top-Down is an international corporation with more than 13,000 employees spread across 300 offices worldwide. The company fosters a high-tech culture and encourages the development and use of information technology for employees and customers. Top-Down came to the intranet much later than Grassroots, launching its pilot intranet early in 1997 with 220 people from the Corporate Administrative Division. Prior to this, a smattering of individual home pages did exist, but with no cohesive or overarching organization. Shortly after the completion of the pilot phase, company executives decided to promote the deployment of a corporate intranet, according to a systematic, top-down approach.

They decided to focus first on employee information dissemination, using the intranet as a substitute for the distribution of printed documents. Their next phase addressed critical human resources functions, such as the integration and training of new hires. The intranet supported the redesign and streamlining of that process, making it possible to assimilate new hires much more quickly. Intranet deployment then proceeded by addressing every work process in turn, looking for ways to improve and accelerate existing processes. Some sections of the intranet supported exchanges among employees and the creation of communal knowledge repositories. The overarching focus of Top-Down's intranet is transaction oriented, designed to increase employees' independence and to encourage self-service. The initial force behind the development of Top-Down's intranet was a corporate-level desire to solve a problem keenly perceived by all employees, namely the assimilation and integration of new hires. Overall, that pattern endures as successive stages of intranet development typically continue to be corporate-level initiatives aimed at addressing business issues widely recognized by Top-Down's employees.

Integrative. Integrative Corporation, founded in 1980, is a computer storage company that specializes in hard drives and tape drives. Integrative employs more than 6,000 people worldwide with a strong presence in North America, Europe, and Asia-Pacific. They also have international distribution and recently entered the retail market. Integrative's culture focuses on building relationships through consensus and teamwork, with an emphasis on human interaction. This led the company to reject central control over many information technologies because it feared that would change the relationship-oriented organization. As an example, at the time of our study, Integrative was using a variety of e-mail solutions within the company. It had considered—and rejected—the deployment of a corporate intranet in 1994. Despite this decision, an informal intranet began to grow organically in different departments. By 1998, the company had about 150 loosely linked websites managed by different web resource persons in various departments who had complete responsibility for content and design. At that time, the company decided to bring order to its chaotic web and to introduce centralized control over its intranet.

The first step toward centralization was the creation of a portal page with links to all the departments as well as an electronic directory. The next stage created a unified web strategy in which the Internet, intranet, and extranet were linked to provide services not only to employees, but also to the community and other businesses. The intranet could then provide more than just

static information; internal documents, information systems applications, and workflow could be included under one interface. At the time of our survey, Integrative was preparing to embark on this second stage.

To reduce duplication of efforts, Integrative determined that the best way to manage its intranet would be to combine top-down oversight with end user decisions about content. The result was a unified brand and look with standard navigation and guidelines for presenting content. At the same time, the company could allow employees to determine what content was important to them, to define business requirements, and to set access permission to their documents. As a result, Integrative's intranet was developed in a position midway between a scattered grassroots effort and a centrally organized system with decentralized responsibility over content. Overall, the driving force behind the development of Integrative's intranet is the attempt to provide a corporatewide framework for a series of relatively scattered individual sites. Unlike Grassroots' intranet, it is very new, relatively thin, and cannot rely on long-standing practice from end users. Unlike Top-Down's, its overall mission to integrate is not directly connected to a problem widely acknowledged within the company, making its motivation more abstract.

Each of these intranets was at a different stage of development at the time of the study. This diversity offers an advantage is assessing the gain equation. Marwell and Oliver (1993) propose that the gain equation is descriptive of collective action at all levels of realization. This includes nascent collective actions that have not achieved critical mass (the point at which a collective action becomes self-sustaining) as well as those that are well established.

Procedures

Following an initial set of in-depth case studies of intranet development at each company, a multipart web-based survey was administered through each company's intranet. Two thousand employees were selected from each company's entire employee roster, using a random sampling procedure. Random sampling was particularly important because levels of usage of the intranet varied, and it was important not to bias the sample toward any particular type of user or nonuser. Participation in the survey was encouraged by management but not required. The survey was administered in two parts, separated by approximately three weeks. The first part included historical information on individual intranet participation and the information contribution and retrieval measures. The second part included the remaining measures of the revised gain equation: level of production, costs, value, and gain.

Participants were notified about each part of the survey with an e-mail that contained a URL that pointed to the online survey. A follow-up e-mail reminder was sent a week later. The surveys were anonymous; however, participants created personal identification numbers that preserved their anonymity but enabled researchers to link the parts of the survey for each respondent.

For Grassroots, the initial response rate was quite low, in large part because of a problem with the web survey triggering the company's antispam defenses; thus, a second random sample of 2000 was also selected. The total response rate in Grassroots, including both samples, was 16% ($n = 320$). Response rates—including those who answered at least one part—were 42% for Top-Down ($n = 836$) and 27% for Integrative ($n = 534$). A number of follow-up personal interviews were also conducted.

The analyses reported here include only those cases where respondents completed both parts. The numbers of cases for the analyses were 272, 429, and 193 for Grassroots, Top-Down, and Integrative, respectively. Job levels included senior and middle management, supervisors, and nonmanagerial staff for all three organizations. Participants came from each of the major organizational functions, and most were located in the United States.

Although it was not possible to directly test for nonresponse bias, we conducted a surrogate analysis on the premise that late respondents would be more like nonrespondents than would earlier respondents. We computed means and standard deviations for all items and demographics for the final 15% of respondents who replied to the survey and compared these statistics to those for all other respondents. No differences were found for any of the measures.[2]

Measures

The measures on part two were pretested in a large project development team ($n = 28$) in the aerospace industry that had a shared information repository through its project management software. The items were modified for the current study by replacing the name of the project development software with the name of each organization's intranet. *Perceived level of production* was measured by the following items: "Select one number from 0 to 10 that describes how you see the [intranet] being used today. 1. To what extent does everyone provide all their work-related information? 2. To what extent is that information used by everyone else?" Only the end points were anchored, using the adjectives "not at all" and "totally." Cronbach's alphas were 0.79, 0.83, and 0.81 for Grassroots, Top-Down, and Integrative, respectively. *Value* was assessed by the following item,[3] also on a scale of 0–10: "Given the way you have described how the [intranet] is being used today in the previous question, how valuable is this level of use to you now?" *Gain* was measured by the following, also on a 0–10 scale: "Think about how valuable the [intranet] has been in helping to share your work-related information. Given the time and effort you have expended using it, to what extent do you think the [intranet] is worth it?" *Cost* was measured by the

following items, reported on a five-point Likert scale from "strongly disagree" to "strongly agree": "1. I could not gain access to the [intranet] when I wanted to because the system was very slow. 2. Using the [intranet] was so time consuming that I wasn't able to complete other tasks. 3. Locating specific information on the [intranet] was too time consuming." Cronbach's alphas for the scales were 0.80, 0.75, and 0.84 for Grassroots, Top-Down, and Integrative, respectively.

The measures on part one were crafted specifically for this study, based on interviews that focused on frequency of intranet access and type of intranet use in each organization. *Information retrieval* was measured as follows: "1. During your last full day of work, how often did you use the [intranet] to obtain information for *routine* tasks? 2. During your last full day of work, how often did you use the [intranet] to obtain information for *nonroutine* tasks?" Responses were on a five-point frequency scale, using adjectives deemed to indicate approximately equal intervals in measurement research (Schriesheim and Schriesheim 1974, 1978): never, seldom, sometimes, often, and very often; not applicable was also an option. Cronbach's alphas were 0.72, 0.66, and 0.70 for Grassroots, Top-Down, and Integrative, respectively. *Information contribution* was measured by the same two items, replacing "obtain" with "provide." Cronbach's alphas were 0.88, 0.87, and 0.88 for Grassroots, Top-Down, and Integrative, respectively.

Analysis

The items measuring each construct were averaged to create a scale score for each respondent on each of the multi-item scales. Then, the model (see Figure 1) was analyzed using a causal model for directly observed variables via the LISREL 8 computer program (Version 8.54; Joreskog and Sorbom 1996). This technique provides global tests of the adequacy of the entire model as well as simultaneous estimation of all structural coefficients (Joreskog and Sorbom 1988). The χ^2 goodness-of-fit statistic is reported as an index of model adequacy, where a nonsignificant value indicates good fit of the model to the data. The χ^2 to degrees-of-freedom ratio is also reported, where a value less than five indicates good fit, since χ^2 has been shown to be sensitive to sample size (Bollen 1989). Other common fit indices that also show how well the specified model accounts for the data are also reported. These include root mean squared residual, goodness-of-fit index, adjusted goodness-of-fit index, normed fit index, nonnormed fit index, and comparative fit index. Root mean squared residual values less than 0.05 typically indicate good fit. For the other indices, values range from 0 to 1.00, with higher values indicating better fit; 0.90 and above is generally considered to represent good fit. The modification indices were also examined to assess how comprehensive the theoretical model was in capturing the relationships shown in the data. Large modification indices would suggest that there are other relationships in the data that are not captured by the theoretical model.

We also followed procedures for controlling and assessing method variance as suggested by Podsakoff et al. (2003). First, measurement of the intranet use variables (contribution and retrieval) was separated temporally from the other variables by placing these items in part one of the survey while the remaining items were included in part two, which was administered several weeks later. Second, the response set for the intranet usage variables was a five-point scale measuring frequency, whereas the response set for the other variables included a 0 to 10 scale measuring extent and a five-point agree-disagree response set. Third, in addition to these procedural remedies, we conducted a set of supplemental statistical analyses (Podsakoff et al. 2003). Four confirmatory factor models were estimated (Fink and Monge 1985): (1) a null model that specified as many factors as items, (2) a method-only model in which one latent factor was proposed to underlie all the observed variables, (3) a measurement model that specified that the constructs in the hypothesized model were latent rather than observed, and that individual items were observed measures of the latent constructs, and (4) a measurement model that also included a latent method construct on which all items were specified to load. The models were compared based on fit statistics.

Results

The correlation matrices for each company are presented in Table 1. The results for the global tests of the model are shown in Table 2. The χ^2 tests for the three samples (Grassroots, Top-Down, and Integrative, respectively, here and throughout all results) were 12.27, 24.29, and 12.55, which are low but are nevertheless statistically significant. The χ^2 to degrees-of-freedom ratios were 2.45, 4.86, and 2.51; all were less than the criterion of 5. All five goodness-of-fit indexes were above 0.90 in all three samples. Taken together, these global tests indicate a reasonably good fit of the theoretical model to the data. Modification indices in all three samples were small. The largest modification index was found in Top-Down for a recursive path from gain to value, which would have produced a nonsignificant negative beta coefficient if it had been added to the model. Overall, the modification indices suggest that, given the theoretical model, there are no additional statistically significant relationships among the variables in the dataset.

The results of the statistical tests for the individual paths are shown in Figure 2. Again, all of the results in the text and figure, including the magnitude and significance of the coefficients, are reported in order of Grassroots, Top-Down, and Integrative. Squared multiple correlations for each endogenous variable in each sample were as follows: value—0.50, 0.57, 0.48; information

Table 1 Polychoric Correlation Matrices for All Three Companies

	Value	Information retrieval	Information contribution	Cost	Gain	Level of production
Grassroots						
Value	1.00					
Information retrieval	0.40	1.00				
Information contribution	0.37	0.67	1.00			
Cost	−0.22	−0.03	−0.07	1.00		
Gain	0.71	0.35	0.39	−0.26	1.00	
Level of production	0.65	0.25	0.32	−0.14	0.52	1.00
Top-Down						
Value	1.00					
Information retrieval	0.51	1.00				
Information contribution	0.39	0.61	1.00			
Cost	−0.25	−0.12	−0.01	1.00		
Gain	0.71	0.43	0.36	−0.32	1.00	
Level of production	0.68	0.36	0.31	−0.11	0.55	1.00
Integrative						
Value	1.00					
Information retrieval	0.43	1.00				
Information contribution	0.21	0.62	1.00			
Cost	−0.17	−0.09	−0.01	1.00		
Gain	0.72	0.40	0.29	−0.17	1.00	
Level of production	0.65	0.33	0.24	−0.14	0.50	1.00

Notes. Correlations are significant at $p < 0.05$ when the absolute value is greater than or equal to 0.12 for Grassroots, 0.10 for Top-Down, and 0.15 for Integrative.

contribution—0.47, 0.38, 0.38; and gain—0.52, 0.53, 0.52.

There are several interesting patterns in these results. First, the results are virtually identical for Grassroots and Top-Down, with all links roughly the same size and statistical significance. The links for Integrative are also roughly the same size, but three of the links that are significant in the other two companies (cost ⇒ gain: −0.11 and −0.15, $p < 0.05$; cost ⇒ value: −0.13 and −0.15, $p < 0.05$; gain ⇒ information contribution: 0.18 and 0.12, $p < 0.05$) are not significant for Integrative. Second, cost was not as important a predictor as was value. Even though significant in two companies, the coefficients of the paths from cost are practically small in comparison to the coefficients on the paths from value to gain in all three companies (0.69, 0.67, and 0.71, $p < 0.05$). In addition, level of production was a strong predictor of value (0.57, 0.56, and 0.56, $p < 0.05$). Third, information retrieval was a highly significant predictor not only of value (0.25, 0.29, and 0.24, $p < 0.05$) but also of information contribution in all three companies (0.61, 0.56, and 0.60, $p < 0.05$).

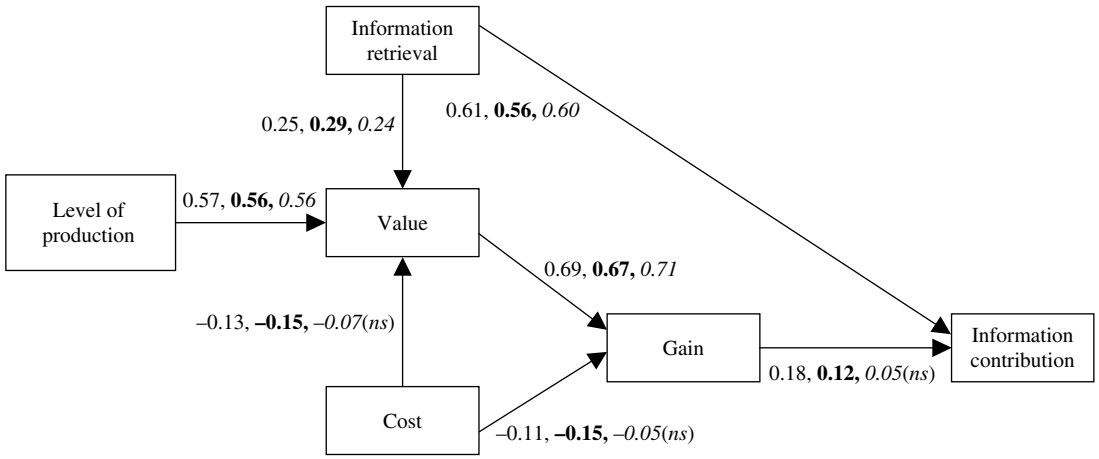
Table 2 Results for the Overall Tests of the Theoretical Model

	Grassroots	Top-Down	Integrative
Number of cases	272	429	193
Degrees of freedom	5	5	5
χ^2	12.27	24.29	12.55
P	0.031	0.00019	0.028
χ^2/degrees of freedom	2.45	4.86	2.51
Root mean squared residual	0.03	0.03	0.03
Goodness-of-fit index	0.99	0.98	0.98
Adjusted goodness-of-fit index	0.94	0.92	0.91
Normed fit index	0.98	0.98	0.97
Nonnormed fit index	0.96	0.94	0.94
Comparative fit index	0.99	0.98	0.98

In combination, these results support the model in Grassroots and Top-Down. For Integrative, the results are generally consistent only for the value portion of the model and for information retrieval as a predictor of information contribution. Overall, these findings are reasonably consistent with Marwell and Oliver's (1993) public goods equation and offer substantial support for the modifications proposed here.

The results of the tests for common method variance were conducted for Grassroots and show that the results cannot be explained by common method variance. The comparative fit index, 0.97, showed that the measurement model was statistically superior to the null model. Results for comparison of the other models are shown in Table 3. In all respects, the measurement model was far superior to the method-only model. The comparison of the measurement model to the combined measurement-plus-methods model shows little improvement. Although the chi square was slightly lower for the combined model, the ratio of chi square to degrees of freedom was higher. The other criteria were essentially similar, with some improvements and some decrements for the combined model. In addition, none of the loadings on

Figure 2 Results for the Three Companies



Notes. Coefficients are reported in order of Grassroots, **Top-Down**, and *Integrative*. To facilitate reporting for all three samples on a single graphic, only the three nonsignificant (ns) coefficients are indicated. The remaining 18 coefficients are significant at $p < 0.05$.

the method factor in the combined model was statistically significant, whereas all of the loadings on the other factors were significant. Based on these results, no additional tests for common method variance were deemed necessary.

Discussion

The goal of this study was to develop and test a model of how individual-level factors interact with perceptions of collective action in influencing individuals' motivations to contribute privately controlled information to a collective repository. To this end, we developed a revised model tailored specifically to the unique features of information resources and to information commons as sources of collective benefits. We collected survey data from members of three international organizations in which intranets were being implemented to assess the structural model for information commons.

Overall, our findings are consistent with Marwell and Oliver's (1993) original model in two important respects. First, the value of the information store to members increased in relation to perceptions of level of production of the good. Second, greater subjective value translated to a perceived overall gain for individual members in all three organizations.

Table 3 Results for Common Method Variance Analysis for Grassroots

	Method only	Measurement only	Measurement and method
Degrees of freedom	44	21	13
χ^2	779.94	60.81	54.63
P	0.00	0.00	0.00
χ^2/degrees of freedom	17.72	3.04	4.20
Root mean squared residual	0.160	0.025	0.020
Goodness-of-fit index	0.63	0.96	0.96
Adjusted goodness-of-fit index	0.45	0.91	0.86

The Individual Action Component in Production of Information Commons

The key dynamic in all formulations of public goods theory is the prediction of individual gains by balancing values against the amount of actual costs of contributing resources. We argued that because contributing information does not reduce individuals' resource pools by equivalent amounts, costs must be considered subjective and not fully predicted by the amount of resources contributed. We also relaxed the assumptions of Marwell and Oliver (1993) that treated the production function as an accounting equation. The net result was a search for coefficients of cost and value as predictors of gain. Interestingly, we found that although the coefficients for cost were in the predicted direction, they were significant in only Grassroots and Top-Down and were of consistently lower magnitude than those for value.

Differences across the three companies may explain the patterns of results. Individuals' mental models as well as organizational culture and structure can significantly affect how new information technologies are implemented and used; this is true especially in the beginning period of implementation and might change as the system is adopted into the organization (Orlikowski 1992). The system at Integrative developed from a strong bottom-up effort, and at the time of the study end users still had major control over content. This may well have created a strong sense of ownership of the information commons and a stake in its success that transcended concerns about costs. Also, in this people-oriented culture, social networks may have reinforced this attitude toward the new technology (Rice and Aydin 1991). Grassroots and Top-Down both had strong corporatewide systems

that supported personal transactions as well as collective information sharing. These transactional capabilities may have served as training grounds for the more complicated processes of communal data sharing by reducing start-up costs and helping to incorporate use of the intranet into everyday routines.

Grassroots and Top-Down were also pioneers. Grassroots was a very early adopter of intranets and is often singled out as an example of a successful, well-developed, and well-managed intranet. Top-Down was the last among the three to adopt an intranet but is generally considered among the most advanced in the financial services industry in employing networking technology to forward its strategic vision. In each case there were subtle benefits to users who bought into the concept of effective intranets, providing additional external incentives. At Grassroots, several participants in the follow-up personal interviews commented that employees who made particularly valuable contributions to the common knowledge base gained rewarding notoriety within the company. Furthermore, many information repositories within the Grassroots intranet were created by end users in direct response to their own perceived needs (for example, software engineers created a database to track software bugs and solutions). Thus, they were acutely aware of the localized gains they derived from contributing to specific databases. At the time of our survey, both Grassroots and Top-Down had official, longstanding corporatewide intranets, so that employees reported benefits from going along with the company's stated strategy.

By contrast, Integrative stumbled its way to the intranet after having explicitly rejected the idea a few years earlier. Integrative has been consistently wary of any technology that might depersonalize its culture (including our web survey) and jealously guarded what it considers to be a core competence in the management of human resources. At the time of our survey, Integrative had just decided to endorse a corporatewide intranet, and it was clearly not yet part of the employees' culture to turn to this new information commons. Instead, they typically relied on direct interaction with colleagues to locate information. Nevertheless, the majority of respondents reported contributing in some way to the intranet.

Possible explanations for our somewhat weaker findings on cost can be gleaned from participants' free-form comments that we collected as part of the survey. Many respondents pointed out that resource contributions, such as posting information to the intranet, often were relatively straightforward and painless, seldom more taxing for individuals than saving files to their own hard drive. They incurred the costs of creating documents anyway, and the marginal costs of posting them on the intranet were negligible. In all three organizations, intranet applications were well integrated within users' desktops and the perceived individual costs of using these applications were very low overall.

In effect, participants stated that the more information they provided via the intranet, the more they "saved" time and effort compared to use of other media. Thus, when contributions did not reduce individuals' resource base, as is the case with information, cost perceptions were tied to other factors and may have followed a very different dynamic. Some of these factors may even have compensatory effects, such as the relative efficiency described by these respondents.

It is important to note that intranet use was not yet institutionalized in these samples; consequently, we could be observing the transitory effects of the conversion from traditional communication systems to intranets. Over time, the sustainability of information commons may be both positively and negatively affected by membership size and communication activity (Butler 2001). Future research focused on assessments of technological information commons over time can provide increased understanding of value and gain for different levels of production of information goods.

An additional possibility is that individuals simply may have placed much more emphasis on benefits than on costs. This is consistent with a focus on top-line results rather than net benefit, as has been proposed in the literature on firm-level information technology investments (Tallon et al. 2000) and with the recent trend in strategic management away from transaction costs as drivers of decision-making in favor of assessment of transaction values (Dyer 1997). The importance of top-line value relative to bottom line net benefits in assessing decisions to commit resources offers an interesting research agenda for information systems researchers.[4]

We also proposed a modification to Marwell and Oliver's (1993) formulation by predicting that subjective values would be determined in part by subjective costs. The results supported this modification in the same pattern as for the link from costs to gains. The coefficients were all in the predicted direction and were small but significant in Grassroots and Top-Down. It appears that for information goods, costs and values cannot reasonably be considered independent of each other. In combination, these results suggest the need for detailed theoretical and empirical examination of the nature and dynamics of the costs of participating in information commons.

Our final modification to the production model was to propose that individual contributions would be predicted by gains. Despite a slight skew of the contributions variable toward the lower end of the scale, the results nevertheless produced significant coefficients for Grassroots and Top-Down. The results were in the predicted direction for Integrative, where there was a somewhat larger skew toward low contributions, but the results were not

statistically significant. The weaker results for Integrative could reflect the relative novelty of its intranet. Users had not had much time to develop a clear perception of the importance of their contributions. Reasons for the weaker results for Integrative may also lie in its team-oriented culture. Had we measured team gains, perhaps the results would have been quite different. Kalman et al. (2002) found that when individuals were committed to their organization, perceived organizational gains predicted motivations to contribute. In a similar fashion, under conditions of commitment to a team, perceived team gains may predict information contributions. Clearly, a next step in expanding the theory for information goods must consider payoffs and costs beyond the individual level.

Information Retrieval

The results support our modifications based on information retrieval. First, information retrieval was positively related to the perceived value of the information commons in all three organizations. Our explanations centered on the ability of retrieved information to demonstrate both the utility of information in the common pool and the ability and/or willingness of others to contribute such information. Retrieval may also offset some costs, which themselves are related to subjective values. Future research could address different types of information within the intranet, focusing on which types garner more attention or are perceived as more valuable (Hansen and Haas 2001).

Second, information retrieval strongly predicted contribution behavior in all three organizations. These results are consistent with explanations based on perception of connective efficacy and organizational instrumentality, as well as felt pressures toward reciprocity. The data, however, cannot differentiate among these possible explanations. Nonetheless, they do suggest that the overall incidence of free riding on the contributions of others in these systems was low. The findings are further confirmed by qualitative data from free-form survey comments and follow-up interviews. In all three organizations, respondents indicated that they were more inclined to contribute to parts of the intranet that showed evidence of greater contribution from their colleagues. They also perceived these areas as more valuable.

Third, comments from respondents in all three organizations, but most notably from Grassroots, indicated that they did not view the intranet as a single entity but rather as a "network of networks," a federation of subintranets, each with a specific work-related theme (e.g., human resources, sales, or product development). Several indicated that their responses to the survey questions were true overall but that they would have answered differently for distinct parts of the intranet. In particular, organizational or geographic proximity to other participants in a subintranet appeared to affect respondents' attitude toward contribution or retrieval and to their motivations for engaging in such activities. This suggests that the model could be extended to account for coalitions and subnets that serve as subcollectives with different properties than the collective as a whole. Theoretical development of this concept of embedded collectives suggests an interesting area for future research.

Limitations

One limitation of this study was that the measures of gain and value were single items. Because we have only one item from the domain of each concept, we neither computed nor provided direct evidence for reliability (Nunnally 1978). However, there is indirect evidence bearing on the likely reliability of these items. The patterns of findings were similar in direction and magnitude across all three sites for value and two of the sites for gain. As described earlier, these organizations had very different cultures, intranet implementations, and control systems. If these items were tapping variance unique to a site, then we would not have found this consistent pattern across such disparate systems. In essence the items were reliable across sites. Also, as noted in Endnote 1, these items had large significant correlations with reliable multi-item scales that were developed subsequent to this data collection.

A second limitation is the possibility of bias in the sample, perhaps toward heavier users of the intranet. The random sampling procedure was designed to avoid such bias, but the relatively low response rates within the samples suggest the possibility of bias in who responded to the survey from among the random sample. Attempts were made to encourage participation by keeping each part very short (about 10 minutes to complete the survey) and entering all respondents in a raffle to win a prize (tickets to a major university football game in the region where the headquarters was located). We also followed up after one week, but since the survey was anonymous, the follow-up could not be targeted more narrowly than the full sample. The distributions of the intranet contributions variable in the three samples, even with a slight skew toward less-frequent users, suggest that we did capture a full range of use frequencies. Nevertheless, we cannot rule out the possibility that those who answered the survey were, as a group, not completely representative of the organization as a whole.

A third limitation is that the information retrieval and contribution data were gathered at a single time (Part I), and the remainder of the variables were gathered together at another single point in time (Part II of the survey). We took the procedural remedy of using several different response scales (Podsakoff et al. 2003). Nevertheless, these sets of variables might be subject to some within-administration inflation due to common method variance. However, this limitation does not apply to the model as a whole, which cuts across administrations, and

which our statistical analyses suggested were not subject to substantial common method variance.

Finally, causal inference is always a challenge in field research, especially in the absence of longitudinal data. However, the research reported here followed standard procedures for structural equation modeling of correlational data, including the conditions that must be met to make some inferences regarding causality (Bollen 1989). Crucial to this process is the a priori specification of strong theory, followed by assessment of the fit of the data to the theory, which includes examination of alternative plausible causal orderings. These procedures included examining the adequacy of the global model, testing the hypothesized individual coefficients for statistical significance, and examination of unspecified alternative paths via the modification indices (Bollen 1989). Of course, these procedures do not "prove" causality. However, they do improve the likelihood that the inferences drawn about the fit of the theoretical principles to the data are correct. Further evidence awaits additional research.

Future research employing longitudinal designs will also help to improve assessments of the processual nature of the production of information goods. Previous research that has looked at over-time processes in the production of other types of public goods is heavily based in simulation and laboratory experiments. This study advances the research agenda by adding important findings from field sites and from production of information goods in real organizational settings. Future research can advance this agenda by tracking processes themselves as they unfold at individual and collective levels.

Implications for Practice

Although the benefits of organizational information commons can be substantial, their production and maintenance pose serious challenges to contemporary organizations. A major challenge is convincing individuals to provide information that they already possess, despite costs such as time, effort, and learning new ways of doing things. This challenge is exacerbated by the presence of unclear or meager benefits in the early stages of production, as well as ambiguity in the ultimate worth of systems that evolve over time in sometimes-unpredictable ways. According to Goodman and Griffith (1991), successful implementation of technological innovations requires socialization about a technology and its usage, commitment and reward allocation for its use, methods of feedback and redesign, and diffusion within the social system. Gaining commitment is crucial in this process, as it increases the probability of behaviors consistent with the utilization of the technology, stimulates the development of positive attitudes about the technology, and influences how individuals process discrepant information about the technology.

In the case of organizational information commons, attaining early commitment in the absence of clear benefits may be especially critical in establishing such systems and demonstrating benefits to potential later adopters (Marwell and Oliver 1993). Based on our findings, the level of production does appear to be an important driver. Information retrieval itself, however, also appears to yield information contributions.

Thus, our findings suggest that providing incentives for early contributors might be one effective strategy by which to jumpstart contributions to the good. For example, technical or other support, reward or monetary incentives, or disincentives for nonuse might help to begin the process of contributing toward the realization of an effective information commons. Some of the organizations we studied encouraged early intranet use by withholding certain kinds of information from traditional channels (e.g., they stopped printing the company newsletter, making it available only on the intranet) or by positioning the intranet as a "premium" channel (e.g., travel expenses would be reimbursed within a few days if submitted via the intranet but would languish for several weeks when submitted in paper form). They thus hoped to "prime the pump," creating familiarity with the new medium that would later extend to other uses.

However, the nature of the good itself dictates the extent to which incentives might be effective in motivating individuals to participate, and adoption of an intranet for some early transaction-oriented applications does not always automatically extend to other domains. For instance, depending on whether information is distributed widely versus clustered in a subset of individuals, a small number of information-rich participants may be able to provide sufficient information to provide value for all members (Fulk et al. 1996). Such is the case of online distribution of the company newsletter, where a centralized decision can be made and can lead to successful implementation. However, when information is relatively evenly distributed, more widespread contributions are required, although some degree of heterogeneity of interests and resources may bolster the potential for success (Fulk et al. 1996, Marwell and Oliver 1993, Monge et al. 1998). For these more complex, more decentralized intranet uses, other mechanisms will be needed to initiate and sustain contributions.

Generally weaker results for Integrative than for Grassroots or Top-Down, particularly in the significance of costs and values as predictors of gains, also suggest lessons for corporations trying to deploy and sustain an information commons. While Grassroots and Top-Down each followed very different deployment strategies, both incorporated explicit focus on end user needs—by giving end users control at Grassroots and by focusing corporate-level efforts on a clearly perceived user need at Top-Down. By contrast, Integrative's goal was more abstract and, while a long-term case could be made for

the benefits of its approach, short-term benefits were less obvious to end users. The results suggest that organizations need to include clear, immediate benefits for the end users in their overall deployment strategy to win over early contributors.

Overall, the effectiveness of offering incentives for collective actions depends on the nature of the good and the relative distribution of resources required for production. This suggests that practitioners should pay particular attention to the selection of their initial target users as they deploy information goods such as intranets. Early successes will make it easier to build trust in the system, thereby creating the conditions for a virtuous cycle where resource contributions and acquisitions feed on each other.

A final recommendation is to provide for adequate training in use of system features. It is not unusual for organizations to invest heavily in hardware and software but to neglect to train users in how to use these tools most effectively. This has been compared to having a fine car but not knowing how to drive it. Although attending training sessions might be costly to potential users in the short term, in the longer term it should decrease their overall costs by helping them avoid the missteps and frustration that can accompany trial and error learning.

Conclusion

A substantial challenge exists for creating and maintaining the knowledge-sharing systems that undergird new organizational forms (Fulk and DeSanctis 1999). The failure of many such systems to garner wide-scale support from potential contributors (Head 2000) would seem to reinforce Samuelson's (1954) classic postulate that such public goods cannot be provided among individuals spontaneously. This raises the key question of how to create the conditions for success.

Our purpose in this study was to develop and test a model of individual-level factors that contributes to organizational knowledge sharing systems. Our goal was to contribute to a better understanding of the conditions and processes that can energize effective knowledge sharing in organizations. The Integrative model tested in this research demonstrated considerable promise. It also showed several areas that require further theoretical and empirical work as researchers attempt to understand the collective action challenges for knowledge sharing in contemporary organizations. Our research also demonstrated that it is possible to develop important insights regarding public goods outside of the laboratory in the complex, often messy world of real-life organizations.

Acknowledgments

This research was made possible by grants from the National Science Foundation (SBR9422537, SBR9602055, and IIS-9980109) and a collaborative research partnership with the Stanford Computer Industry Project (SCIP). Special thanks are extended to the authors' SCIP partners, Emily Murase, Christian Sandvig, Li Gong, Leslie Sept, and Guilliaume Vambenepe from Stanford University, and Noshir Contractor from the University of Illinois, Urbana-Champaign. The authors also extend their appreciation to Anita Elberse, Wan-Ying Lin, Kijung Kim, and Yu Yuan (graduate students at the Annenberg School for Communication, University of Southern California) for assistance with data processing and analysis.

Endnotes

[1]Other research outside the collective action realm has focused on the individual, applying motivational models based on subjective expected utility theory and its variants (e.g., Kalman et al. 2002). The subjective expected utility framework offers a coherent individual motivational model, but it lacks a precise linkage to issues at the collective level, such as how individual perceptions of collective contributions are implicated in individual choices to share discretionary information.

[2]Details of these analyses are available from the first author.

[3]Pilot testing to create multi-item scales for value and gain is ongoing. The first set of results for 13 project teams from a variety of organizations ($n = 105$ individuals) found that the single items employed here correlated 0.65 and 0.78, respectively, with three-item scales having coefficient alphas of 0.88 and 0.91 for each of value and gain. Additional validation data are currently being gathered from other project teams.

[4]We are indebted to Kevin Kobelsky for this insight.

References

Allen, B. 1990. Information as an economic commodity. *New Developments Econom. Theory* **80**(2) 268–273.

Arrow, K. J. 1971. The value of and demand for information. C. B. McGuire, R. Radner, eds. *Decision and Organization*. North Holland, Amsterdam, 131–139.

Bollen, K. A. 1989. *Structural Equations with Latent Variables*. Wiley-Interscience, New York.

Butler, B. S. 2001. Membership size, communication activity, and sustainability: A resource-based model of online social structures. *Inform. Systems Res.* **12**(4) 346–362.

Castells, M. 1996. *The Rise of the Network Society*. Blackwell, Oxford, U.K.

Cheverie, J. F. 2002. The changing economics of information, technological development, and copyright protection: What are the consequences of the public domain? *The J. Academic Librarianship* **28**(5) 325–331.

Connolly, T., B. K. Thorn. 1990. Discretionary databases: Theory, data, and implications. J. Fulk, C. Steinfield, eds. *Organizations and Communication Technology*. Sage Publications, Newbury Park, CA, 219–233.

Due, R. T. 1995. The knowledge economy. *Inform. Systems Management* **12** 76–78.

Dyer, J. H. 1997. Effective interfirm collaboration: How firms minimize transaction costs and maximize transaction value. *Strategic Management J.* **18**(7) 535–556.

Ekeh, P. P. 1974. *Social Exchange Theory: The Two Traditions.* Harvard University Press, Cambridge, MA.

Fink, E. L., P. R. Monge. 1985. An exploration of confirmatory factor analysis. B. Dervin, M. Voigt, eds. *Progress in Communication Sciences*, Vol. 6. 167–197.

Flanagin, A. J., P. R. Monge, J. Fulk. 2001. The value of formative investment in organizational federations. *Human Comm. Res.* **27** 69–93.

Fulk, J., G. DeSanctis. 1999. Articulation of communication technology and organizational form. G. DeSanctis, J. Fulk, eds. *Shaping Organizational Form: Communication, Connection and Community*. Sage, Newbury Park, CA, 5–32.

Fulk, J., A. Flanagin, M. Kalman, P. R. Monge, T. Ryan. 1996. Connective and communal public goods in interactive communication systems. *Comm. Theory* **61** 60–87.

Goodman, P. S., T. L. Griffith. 1991. Process approach to implementation of new technology. *J. Engrg. Tech. Management* **8** 261–285.

Griffith, T., G. Northcraft. 1994. Distinguishing between the forest and the trees: Media, features, and methodology in electronic communication research. *Organ. Sci.* **5**(2) 272–286.

Hansen, M. T., M. R. Haas. 2001. Competing for attention in knowledge markets: Electronic documentation in a management consulting firm. *Admin. Sci. Quart.* **46** 1–28.

Hardin, G. 1968. The tragedy of the commons. *Science* **162** 1243–1248.

Hardin, R. 1982. *Collective Action*. Johns Hopkins University Press, Baltimore, MD.

Head, A. J. 2000. Demystifying intranet design: Five guidelines for building usable sites. *Online* **24** 36–42.

Hollingshead, A. B., J. Fulk, P. R. Monge. 2002. Fostering intranet knowledge-sharing: An integration of transactive memory and public goods approaches. S. Kiesler, P. Hinds, eds. *Distributed Work: New Research on Working Across Distance Using Technology*. MIT Press, Boston, MA, 335–355.

Jackelen, G. 2000. The need for a useful lessons learned database. *Crosstalk: The J. Defense Software Engrg.* http://www.stsc.hill.af.mil/crosstalk.

Joreskog, K. G., D. Sorbom. 1988. *LISREL 7: A Guide to the Program and Applications*. SPSS, Chicago, IL.

Joreskog, K. G., D. Sorbom. 1996. *LISREL 8: User's Reference Guide*. Scientific Software International, Chicago, IL.

Kalman, M., P. R. Monge, J. Fulk, R. Heino. 2002. Motivations to resolve communication dilemmas in database-mediated collaboration. *Comm. Res.* **2** 125–154.

Kim, W. C., R. Mauborgne. 1997. Fair process: Managing in the knowledge economy. *Harvard Bus. Rev*. **74**(4) 65–75.

Korth, H. F., A. Silbershatz. 1997. Database research faces the information explosion. *Comm. ACM* **40**(2) 139–142.

Markus, M. L. 1990. Toward a "critical mass" theory of interactive media. J. Fulk, C. Steinfield, eds. *Organizations and Communication Technology*. Sage Publications, Thousand Oaks, CA, 194–218.

Marwell, G., P. Oliver. 1993. *The Critical Mass in Collective Action: A Micro-social Theory*. Cambridge University Press, New York.

Miller, G. J. 1992. *Managerial Dilemmas*. Cambridge University Press, New York.

Monge, P. R., N. S. Contractor. 2003. *Theories of Communication Networks*. Oxford University Press, Oxford, U.K.

Monge, P. R., J. Fulk, M. Kalman, A. Flanagin, C. Parnassa, S. Rumsey. 1998. Production of collective action in alliance-based interorganizational communication and information systems. *Organ. Sci.* **9** 411–433.

National Research Council. 2000. *The Digital Dilemma: Intellectual Property in the Information Age*. National Academy Press, Washington, D.C.

Nunnally, J. C. 1978. *Psychometric Theory*, 2nd ed. McGraw-Hill, New York.

Oliver, P., G. Marwell. 2001. Whatever happened to critical mass theory: A retrospective and assessment. *Sociological Theory* **19**(3) 292–311.

Olson, M. 1965. *The Logic of Collective Action*. Harvard University Press, Cambridge, MA.

Orlikowski, W. 1992. Learning from notes: Organizational issues in groupware implementation. J. Turner, R. E. Kraut, eds. *CSCW '92 Proc. Conf. Computer-Supported Cooperative Work*. ACM Press, New York, 362–369.

Podsakoff, P., S. MacKenzie, J. Lee, N. Podsakoff. 2003. Common method biases in behavioral research: A critical review of the literature and recommended remedies. *J. Appl. Psych.* **88**(5) 879–903.

Rice, R., C. Aydin. 1991. Attitudes toward new organizational technology: Network proximity as a mechanism for social information processing. *Admin. Sci. Quart.* **36**(2) 219–244.

Samuelson, P. A. 1954. The pure theory of public expenditure. *Rev. Econom. Statist.* **36** 387–390.

Schriesheim, C. A., J. F. Schriesheim. 1974. Development and empirical verification of new response categories to increase the validity of multiple response alternative questionnaires. *Ed. Psych. Measurement* **34** 877–884.

Schriesheim, C. A., J. F. Schriesheim. 1978. The invariance of anchor points obtained by magnitude estimation and pair-comparison treatment of complete ranks scaling procedures: An empirical comparison and implications for validity of measurement. *Ed. Psych. Measurement* **38** 977–983.

Shapiro, C., H. Varian. 1999. *Information Rules: A Strategic Guide to the Network Economy*. Harvard Business School Press, Boston, MA.

Simon, A. R., W. Marion. 1996. *Workgroup Computing: Workflow, Groupware, and Messaging*. McGraw-Hill, New York.

Sweeney, J. W. 1973. An experimental investigation of the free-rider problem. *Social Sci. Res.* **2** 277–292.

Tallon, P., K. Kraemer, V. Gurbaxani. 2000. Executives' perceptions of the business value of information technology: A process-oriented approach. *J. Management Inform. Systems* **16**(4) 145–173.