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Model of Acceptance with Peer Support: A Social Network Perspective to Understand Employees' System Use[1]

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Abstract

Prior research has extensively studied individual adoption and use of information systems, primarily using beliefs as predictors of behavioral intention to use a system that in turn predicts system use. We propose a model of acceptance with peer support (MAPS) that integrates prior individual-level research with social networks constructs. We argue that an individual's embeddedness in the social network of the organizational unit implementing a new information system can enhance our understanding of technology use. An individual's coworkers can be important sources of help in overcoming knowledge barriers constraining use of a complex system, and such interactions with others can determine an employee's ability to influence eventual system configuration and features. We incorporate network density (reflecting "get-help" ties for an employee) and network centrality (reflecting "give-help" ties for an employee), drawn from prior social network research, as key predictors of system use. Further, we conceptualize valued network density and valued network centrality, both of which take into account ties to those with relevant system-related information, knowledge, and resources, and employ them as additional predictors. We suggest that these constructs together are coping and influencing pathways by which they have an effect on system use. We conducted a 3-month long study of 87 employees in one business unit in an organization. The results confirmed our theory that social network constructs can significantly enhance our understanding of system use over and above predictors from prior individual-level adoption research.

Keywords: TAM, UTAUT, social networks, behavioral intention, system use, network centrality, network density

Introduction

Many of today's information systems are complex and pose significant challenges for users, especially by overwhelming users with numerous features and the accompanying need to learn how to use them effectively (Kanter 2000). Users thus face knowledge barriers to system use even after a system's

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formal organizational adoption (Fichman and Kemerer 1999). There is an accumulation of evidence suggesting that organizations do not utilize installed IS applications to their full functional potential, and new implementations continue to fail at an alarming rate (Davis and Venkatesh 2004; Jasperson et al. 2005). Another distinguishing characteristic of many systems today is their configurability. Employees can both adapt to a new system by learning and altering their work processes, as well as by influencing system deployment and selectively appropriating the system, resulting in a process of *coadaptation* (Beaudry and Pinsonneault 2005; Leonard-Barton 1988; Majchrzak et al. 2000). Rather than being deployed in a predetermined manner, systems can be customized to the specific business processes and practices of the organization and/or the preferences of the users. Today's systems often offer multiple potential choices for software configuration (Tornatzky et al. 1990), offer multiple features that may be selectively appropriated (DeSanctis and Poole 1994), and create problems for sensemaking as much of their internal workings are concealed from the user (Weick 1990). Thus, understanding system use with a focus on user coping and influencing mechanisms will help us in devising ways to manage user–system coadaptation processes and fostering successful system implementations.

Individual adoption and use of information technologies is one of the most mature streams of IS research (Venkatesh et al. 2003). There have been several models that have been employed to predict *behavioral intention to use a system* and, consequently, *system use* (Venkatesh et al. 2003; Venkatesh et al. 2007). While such models have helped us make substantial progress in understanding adoption and use, their focus has primarily been on the individual-level psychological processes and contingencies that manifest as technology-related perceptions and situational factors respectively (Venkatesh et al. 2003; Venkatesh et al. 2007). Although social influences have been incorporated in prior models and have been suggested to be critical determinants in the early stages of use (e.g., Venkatesh and Davis 2000; Venkatesh et al. 2003), such social influences have primarily been treated as external pressures exerted by peers and superiors such that they sway an individual's perceptions related to system use. Thus, prior research explaining system use has not fully taken into account the richness of social interactions that can ensue in the post-adoptive phase of a system implementation. We suggest that a *social network perspective* (e.g., Burt 1992; Walker et al. 1994) will help us gain insights into the dynamics of workplace interactions related to coping and influencing and their impact on system use.

While the social network perspective is expected to be relevant in the study of individual adoption and use of information technology, it can be expected to be particularly useful in the context of complex system implementations because such systems are more likely to have a variety of features, intricate user interfaces, and/or could potentially alter business processes/workflows as well as needing more domain knowledge to operate such that individuals are more likely to rely on coworkers' knowledge and skills to help them navigate and use the system effectively.

The complexity and configurability of today's information systems pose the need to support users in overcoming knowledge barriers constraining the use of these systems and the need to ensure that the requirements of different users are reconciled. Within an organizational unit, significant support can be provided by the more skilled and resourceful employees to those who need help. For example, an employee may introduce a colleague to a useful feature or a shortcut in an application or walk them through a complex processing step that the colleague may not be able to learn on his or her own. Such support from organizational peers is critical given that formal support mechanisms, such as IT help desks, are often overwhelmed and, in most cases, IT support staff lack business domain expertise that is crucial in fully resolving users' problems (Govindarajulu 2002). Further, interactions among users also create bases of power that may affect how a new system is configured. Attending to the social network by focusing on interactions among users seeking and providing help related to the system will enable us to understand system use and devise interventions to positively influence use. Anecdotal and case study evidence illustrate this important point:

> [Organization] used a power user concept for training users. They identified users in each of the business units that were influential in their units and that were interested in [system], and trained them extensively in how to do transaction processing as well as in how processes were changing and being integrated. However, there was more emphasis on the "how-to" than on process changes. Users largely learned the latter on the job as they began to use the system. As power users shared their knowledge with other users, knowledge about how to use [system] began to permeate the organization. (Jones and Price 2004, p. 29)
>
> These key users displayed and generated a high level of enthusiasm and motivation and proved to be highly productive because of the combination of their strong domain/functional knowledge and their freshly acquired technical expertise. Such key users were often instrumental in seeking and working

> toward resolutions when other key users chose to criticize [system] dynamics. (Bagchi et al. 2003, p. 154)[2]

Social networks have received extensive attention in the management and organizational behavior literatures to study various phenomena (for a review, see Borgatti and Foster 2003). The social network perspective conceptualizes a social structure as patterns of specifiable relations linking social actors (Marsden 1990). Social structures are analyzed in terms of networks and constraints placed on the actors by their embeddedness within the social structure and the differential opportunities, such as resources or social support, afforded by an actor's network position. Attention to social networks has augmented our understanding of many important organizationally relevant phenomena. Barley (1990) used network analytic techniques to show how relatively small differences in initial roles led to different social structure outcomes over time. Similarly, by focusing on social networks, Shah (2000) obtained insights into organizational downsizing, showing that the loss of structural equivalents (actors are structurally equivalent if they occupy similar positions in a social network) benefited survivors of layoffs and resulted in increased satisfaction with promotion opportunities. Despite the promise of this approach, limited attention has been devoted to social networks in the context of technology implementations and planned change within organizations (Tenkasi and Chesmore 2003). As suggested earlier, we expect attention to social networks will provide insights into the impact that interpersonal interactions will have during the early stages of system use and, thus, help us move beyond individual perceptions about system use as the only determinants of individual system use.

Against this backdrop, this paper has the following objectives:

(1) Introduce relevant social network research and extend the applicability of the constructs to the IS context.

(2) Develop a model of system use, termed the model of acceptance with peer support (MAPS), that incorporates key social network constructs.

(3) Empirically validate the proposed model in a field study, and benchmark the model against an intention-based model of individual-level adoption and use.

[2]The cases used fictitious organization and system names.

Theory

Individual Adoption and Use of Information Systems

Individual adoption and use is one of the richest streams of IS research, with several models explaining the key dependent variables of interest, that is, *behavioral intention to use a system* and *system use*. Behavioral intention is defined as "a person's subjective probability that he will perform some behavior" (Fishbein and Azjen 1975, p. 288). Highlighting the extent of planning associated with performing a particular behavior is a related definition that suggests behavioral intention "as the degree to which a person has formulated conscious plans to perform or not perform some specified future behavior" (Warshaw and Davis 1985, p. 214). System use is defined as the frequency, duration, and intensity of an employee's interactions with a particular system (see Venkatesh et al. 2003). Research in this stream was originally rooted in psychology research, with the technology acceptance model (TAM; Davis et al. 1989) being the most influential model. Recently, eight models with theoretical roots in IS, psychology, and sociology were reviewed, synthesized, and tested (see Venkatesh et al. 2003). Beyond behavioral intention to use a system, facilitating conditions is the other direct determinant of system use (Taylor and Todd 1995; Venkatesh et al. 2003). Facilitating conditions is defined as the "degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system" (Venkatesh et al. 2003, p. 453). The various models have performed quite well in explaining behavioral intention to use (see Venkatesh et al. 2003), with the unified theory of acceptance and use of technology (UTAUT) explaining about 70 percent of the variance in behavioral intention to use a system, and about 40 percent of the variance in system use. Adapted from Venkatesh et al. (2003), Figure 1 presents an overview of prior technology adoption research, with a focus on the direct determinants of system use.

Social Network Perspective

The social network perspective draws on the patterns of interactions and exchanges within social units in which an actor is embedded to explain outcomes experienced by the actor (for a review, see Borgatti and Foster 2003). In this perspective, an employee's position in a social network is linked to performance (Ahuja et al. 2003) and provides advantages, such as organizational assimilation (Sparrowe and Liden 1997) and promotion (Burt 1992), or leads to disadvantages, such as organizational exit (Krackhardt and Porter 1986). The structure of social interactions enhances or constrains access

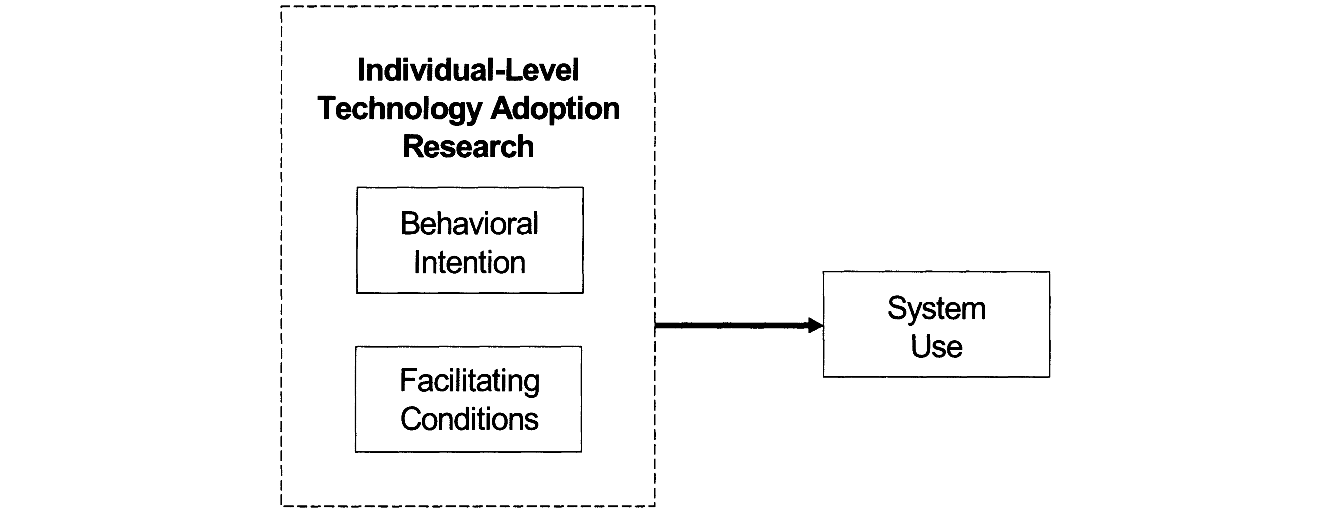


Figure 1. Individual-Level Technology Adoption Model

to valued resources (Brass 1984; Ibarra 1993a, 1993b). Work-related resources, such as task advice and strategic information, are accessible through social networks that may also transmit social identity, norms, and social support (Podolny and Baron 1997).

Learning to use a new system entails a knowledge transfer process across users with different levels of skills. Informal interpersonal networks play a critical role in the knowledge transfer process in organizations (Reagans and McEvily 2003). An important way that people learn new ideas is by associating those ideas with existing knowledge. People find it more difficult to absorb new ideas outside of their immediate area of expertise. It is easier for knowledge to transfer among people with similar training, background, and job characteristics. This implies that employees in an organizational unit are more likely to be fruitfully engaged in knowledge sharing that shapes their use of new systems.

Our focus is on emergent networks that play a critical role in shaping an employee's influence and access to resources. These networks involve discretionary patterns of interaction, where the content of relationships may be work-related, social, or a combination of both (Galaskiewicz 1979). We focus on two key mechanisms by which social networks can influence coadaptation: through ties to other employees conferring social support and through the position in the social network conferring influence. Ties refer to relationships between two or more individuals and such ties typically involve different kinds of resource exchange. We focus on two types of ties: obtaining help from others that helps an employee learn how to use the system, and giving help to others that helps an employee influence how the system is configured and deployed. While help networks may be formally designed (e.g., formal mentoring networks, we focus on the network that emerges through *informal* interactions).[3]

Network density and *network centrality* are important structural characteristics capturing patterns of social exchanges in an organizational unit. We use these constructs to help us model help-giving and influencing mechanisms.[4] *Network density* describes the connectedness of a network (Scott 2000) and is defined as the actual number of ties in a network as a proportion of the maximum possible number of ties. The density of ties is a predictor of the level of material support received from others (Albrecht and Adelman 1987). It has also been shown to be associated with greater cooperation, information sharing, and accountability (Sparrowe et al. 2001). In this research, we adopt an egocentric conceptualization of density referring to an individual's interaction with others in an organizational unit to *obtain* help—that is, each employee has a score that reflects how much help he or she gets from coworkers.

[3]While the term *advice networks* is more widely used and somewhat consistent with what we study, we were advised by the organization to use the word *help* rather than *advice* in our initial survey. To be consistent with this, we use the term *help networks* rather than the term *advice networks*.

[4]Given that organizational ties may be multiplex in nature (Scott 2000), in the context of this research, network density refers to ties where an employee obtains help from others in the organizational unit (i.e., the "get-help" network) while network centrality refers to ties where an employee provides help or advice needed by others (i.e., the "give-help" network).

Past research on social networks has primarily focused on structural aspects of the network (i.e., the observed pattern of ties). However, researchers have called for the need to "bring the individual back in" when conducting structural analysis (Kilduff and Krackhardt 1994). To address this need, in addition to the structural conceptualizations, this work contributes a *richer conceptualization* that takes into account the strength of the tie and the characteristics of the individual who is connected through the tie to the focal employee—termed *valued network density*. This refers to the connectedness of a focal employee to others, weighted by the perceived strength of the tie and the alter's[5] control of system-related *information* (such as system features, upcoming releases, demo dates), *knowledge* (such as tips and tricks, short-cuts, process sequences), and other tangible *resources* (such as training resources, manuals, tutorials) that are needed for effective use of a system.

Network centrality is defined as the extent of an individual's involvement in assistance exchanges with coworkers (Mossholder et al. 2005; Sparrowe et al. 2001). An individual's centrality has been linked to influence (Burkhardt and Brass 1990), involvement in innovation (Ibarra 1993a, 1993b), and attitudes toward new technology (Rice and Aydin 1991). Centrality has been conceptualized in multiple ways in the social networks literature (Freeman 1979). Drawing from extant prior research, we focus on centrality based on the number of ties an individual has with others in an organizational unit to *provide* help. In addition, we present a richer conceptualization of centrality that takes into account the control of resources related to the new system. This conceptualization, which we term *valued network centrality*, refers to peers' perceptions of the level of system-related resources controlled by a focal employee.

Hypothesis Development

We integrate constructs from individual-level technology adoption research and social network constructs to develop the model of acceptance with peer support (MAPS). Figure 2 presents the proposed research model.

Individual-Level Technology Adoption and Use Research

Earlier, we noted that behavioral intention to use a system and facilitating conditions were key predictors of system use. Here, we present the mechanisms underlying these established effects. Behavioral intention reflects the motivational influences that drive an individual to perform a behavior. According to the theory of planned behavior (Ajzen 1991), behavioral intention is determined by the attitude toward the behavior, social influences from important referents, and the internal (e.g., ability, efficacy) and external (e.g., resources) constraints associated with behavioral performance. Ajzen (1991) also suggests that the stronger the intention, the harder an individual will try to perform the behavior (see also Venkatesh et al. 2006). In IS and other fields, behavioral intention to perform a behavior has been strongly associated with behavioral performance (e.g., technology use, turnover, and purchase) with correlations between the constructs being about .50 (e.g., Albarracin et al. 2001; Sheppard et al. 1988; Venkatesh et al. 2007; Venkatesh et al. 2003). Behavioral intention to use a system, including judgments formed immediately following training and before any substantial experience with the new system, has been shown to have a direct effect on system use, be it self-reported (e.g., Davis et al. 1989) or objective/actual use (e.g., Morris and Venkatesh 2000; Venkatesh et al. 2003). Therefore, we hypothesize

> *H1(a): Behavioral intention to use a system will positively influence system use.*

Facilitating conditions predicts behavior in situations where the behavior is not fully volitional. Although an individual may have formed a positive behavioral intention to perform a behavior based on motivational considerations, it is possible that the behavior may not be under an individual's volitional control (Ajzen 1991). In general, the facilitating conditions construct in IS research has focused on formal training, guidance, infrastructure, and help-desk support that is available to employees, and these facilitating conditions can foster or hinder system use (see Venkatesh et al. 2006). Facilitating conditions has been shown to have a direct effect on system use (e.g., Taylor and Todd 1995), including assessments made immediately after training and before any significant experience (see Venkatesh et al. 2003). Therefore, we hypothesize

> *H1(b): Facilitating conditions will positively influence system use.*

Social Network Hypotheses

Effective information systems implementations require coadaptation of the information system and the organization. The implementation of a new information system engenders a process whereby employees may adapt to the system, but may also seek to appropriate specific features of the system and modify others (DeSanctis and Poole 1994; Majchrzak et al. 2000; Tyre and Orlikowski 1994). Facilitation of the process

[5] In a social network, *alter* refers to a node adjacent to a previously referenced node (Borgatti and Everrett 1993).

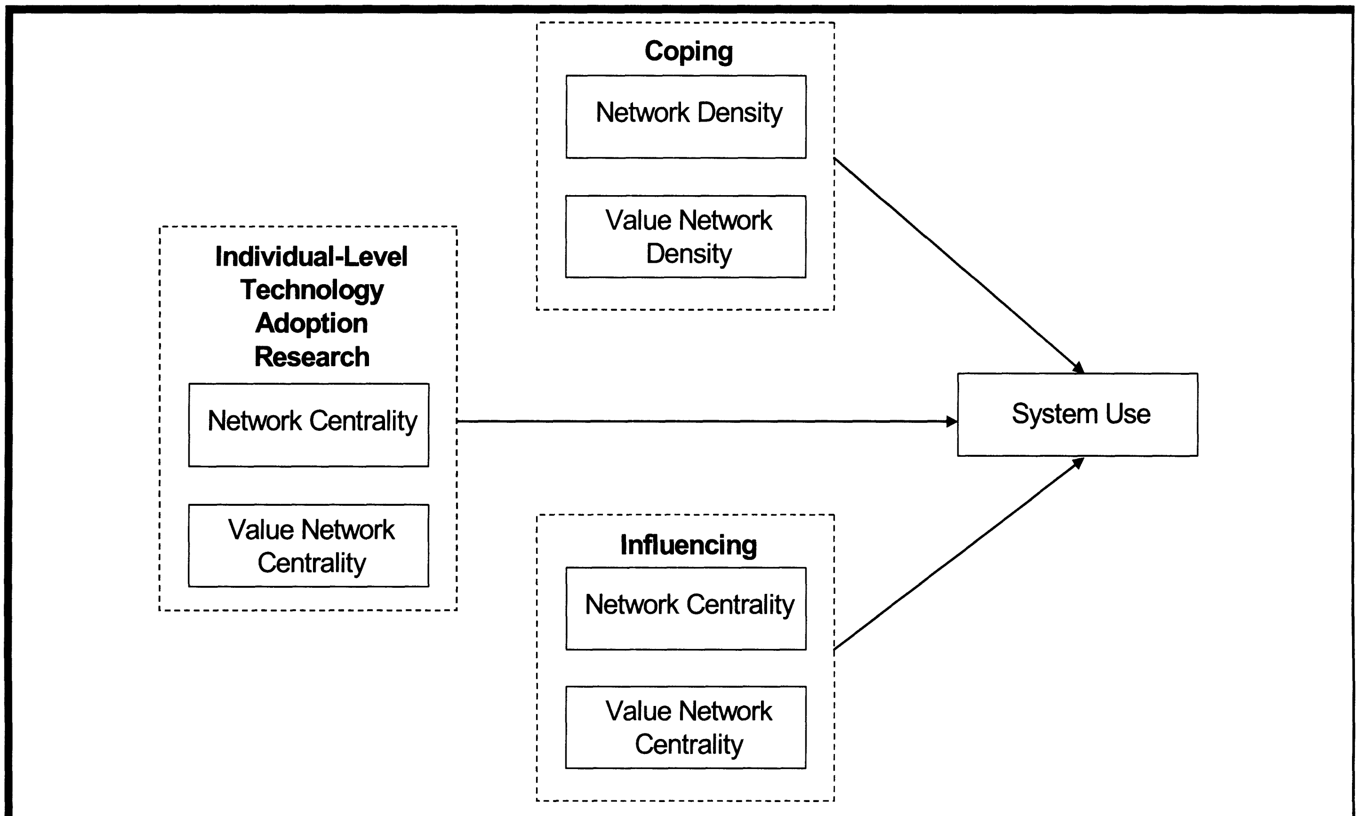


Figure 2. Model of Acceptance with Peer Support (MAPS)

of coadaptation of the organization and the technology would lead to better employee acceptance and successful deployment of new information systems (Leonard-Barton 1988). We propose adaptation may occur through two pathways: knowledge sharing and learning termed the *coping pathway* and changing the system design, configuration, and deployment characteristics termed the *influencing pathway*. While such *coping* and *influencing* occurs in the formal organizationally created teams and units, there is also likely to be a significant role for informal networks in this context. We expect the social network constructs of *density* and *centrality* to help us conceptualize *coping* and *influencing* respectively and to understand their impact on system use. These pathways have been reported in earlier studies of adaptation in the context of new systems (e.g., Beaudry and Pinsonneault 2005; DeSanctis and Poole 1994; Tyre and Orlikowski 1994). Information and resources needed for effective system use derived from an employee's access to resourceful others play an important role in supporting coping-based adaptation. The structuring of relationships also creates bases of power and control in the implementing organization while the employee's structural position serves to affect his or her ability to influence the way the system is designed, configured, and/or deployed. Together, these two adaptation pathways are the mechanisms by which network density, valued network density, network centrality, and valued network centrality affect system use over and above behavioral intention and facilitating conditions.

An individual's perceptions of others' system-related centrality and density can be anchored to general friendship and advice networks and also networks related to other (older) system implementations. Therefore, it is possible for the social network constructs of centrality and density related to a specific system to be formed after training and before actual organizational implementation of the system. Like behavioral intention and facilitating conditions, we thus examine the role of perceptions of the four social network constructs (network centrality, network density, valued network centrality, and valued network density) immediately post-training and prior to the actual use of the system.

Coping Pathway. The coping pathway is based on employees using their network ties to gain access to resources. Prior research has shown that employees in organizations are often dissatisfied with formal channels of support such as help desks (Govindarajulu 2002). IT help desks are particularly hindered by a lack of domain expertise needed for effective use of business applications. Under such circumstances, employees' social ties constitute an important, and sometimes only, means of support to solve problems related to information systems. Informal social networks allocate a variety of instrumental resources that are critical for job effectiveness (Tichy 1981) and play a vital role in providing information and facilitating work duties (Shah 2000). An employee's personal network, and his or her chances of accessing resources available in that network, is expected to help an employee cope with a new system. Prior research has noted that network density influences an individual's ability to access relational resources (Garton et al. 1997).

The deployment of a new information system is likely to create initial challenges for employees as they cope with new work processes, technology features, and user interfaces (see Beaudry and Pinnsoneault 2005). Complex technologies can be especially mentally fatiguing and frustrating (Mumford et al. 1987) and pose substantial learning requirements (Aiman-Smith and Green 2002). Resources accessed through the social network at the workplace can help employees learn features unique to the new system, gain the skills needed to use the new system, and deal with the new work processes. Familiarity through frequent contact, social pressure from peers, and altruism toward intimates are diverse explanations proposed for the provision of social support (House et al. 1988). A network of strong, interrelated (dense) contacts also means that the providers of support are familiar with the employee's role requirements and needs (Morrison 2002). Such support is expected to enhance the employee's competence in using the information system and lead to greater use. Therefore, we hypothesize

H2(a): Network density will positively influence system use.

The support received by employees through their social network is likely to be greater if the network consists of people who occupy social positions that control resources (Wellman and Wortley 1990). As noted earlier, valued network density takes into account the focal actor's social ties weighted by the alter's control of knowledge, information, and other resources that support information system use. The introduction of an information system in an organization creates uncertainty, and those who can direct resources to desired ends may be better able to deal with such uncertainty (Burkhardt and Brass 1990). Thus, over and above the presence of ties, employees need to be connected with people who command resources that would help manage the uncertainty. Such resources could be applied to learn system intricacies, procure complementary assets, or experiment with system parameters, among other steps that could facilitate system use. Therefore, we hypothesize

H2(b): Valued network density will positively influence system use.

Influencing Pathway. The structure of employees' relationships (ties) with others in the organization has been associated with influence (Brass and Burkhardt 1992; Marsden and Friedkin 1993) and reputation (Kilduff and Krackhardt 1994) in the organization. Network centrality is the structural property most often associated with instrumental outcomes, such as power (Brass 1984) and influence in decision making (Friedkin 1993). A more central position in help networks is expected to augment an employee's access to knowledge, thus affecting his or her ability to recognize opportunities and influence others in the work unit (Burkhardt and Brass 1990). Actors who are centrally located within organizational networks enjoy a broad array of benefits and opportunities unavailable to those on the periphery of the network (Ibarra and Andrews 1993). Past research on new information system implementations in organizational settings has found that more powerful parties often try to force a shift in the medium of information exchange to gain greater control in specific hierarchical relationships (Baba 1999). Prior research has also emphasized the political symbolic processes in information system implementations where the outcomes may be primarily influenced by political, rather than functional, criteria (Franz and Robey 1984; Markus 1983). Centrally positioned individuals tend to be more active in organizational innovation (Ibarra 1993a, 1993b) and can be expected to be early and more proficient users of new information systems. Given that power is derived from structural position, we expect that an employee's position in the social network would confer influence in decisions related to the design, configuration, and deployment of the information system. Thus, the system features would be in greater consonance with central employees' preferences and be more acceptable to them, leading to greater use. Therefore, we hypothesize

H3(a): Network centrality will positively influence system use.

The deployment of information systems is both a social and political process (Clausen and Koch 1999). Diagnosing politics and power relationships is a key factor in managing the human threat to information system implementation. Conflict over scarce resources, divergent priorities, access to specialized knowledge, and the like, expected to arise during the course of the use of an information system, leads to political behavior (Levine and Rossmore 1994/95). Further, as information systems have a social, symbolic, and not just a material existence, influence over how they get shaped is seen as securing an actor's position in the organization (Coombs et al. 1992). Thus, it is important to supplement the network structure-based conceptualizations, such as centrality, that reflect a pure structuralist perspective, to include employee perceptions of control of organizational resources relevant to the new system but not immediately reflected in the structures that are enacted. Valued network centrality reflects the perception of an employee's peers about the extent to which the employee controls resources that enable effective use of new information systems. Employees who control resources that enable knowledge barriers related to a new technology to be surmounted would be able to reduce technological uncertainty for themselves and others (Tushman and Romanelli 1983). Individuals who are in control of valued resources would be sought by others and be able to become early, frequent, and effective users of the new system. Therefore, we hypothesize

H3(b): Valued network centrality will positively influence system use.

Method

We conducted a social network study in a supplier-focused business unit of a large multinational company in Finland. The data were collected with a survey administered before the use of the new system (i.e., immediately after training). System use was measured over the course of the 3-month period immediately after training, with use being average time of use per week over the course of the 12 weeks.

Context

The role of the organizational unit studied was to serve as a liaison to suppliers; specifically, the supplier liaisons and their supervisors were the focal participants in this study. The supplier liaisons comprised the largest part of the sample. Their job duties included identifying suppliers, sending out calls for bids, receiving and processing bids, selecting suppliers, and ordering parts, materials, and services. Once the orders were placed, the appropriate other business units such as those responsible for inventory control, manufacturing, and accounts payable were notified. The organizational unit was headed by a vice president, to whom three product group managers reported. Each product group manager supervised product line supervisors. Product group A had three product line supervisors, while groups B and C had four product line supervisors. Reporting to the product line supervisors were between five and eight supplier liaisons. There were four administrative/secretarial personnel in the department, with each of them reporting to the vice president or product group managers. Their services were available to the members of the department on an as-needed basis. Given the focus of this work, they were not included in the study.

New Information System

The organization's objective in implementing the new information system was to replace the old fragmented systems to better support management of content. Content management systems organize and create better access to information. They enable more effective management of back-end processes such as defining, standardizing, controlling, staging, routing, storing, and delivering content (Guenther 2001). The implemented content management system was sophisticated and helped manage all types of multimedia content including voice mail, fax, and text documents pertaining to interactions with suppliers. The system helped streamline the process of managing content through well-defined workflows and templates. A core foundation of the content management system was a database to store information assets including templates, graphics, multimedia content, and application code. The system included templates to create requests for quotes (RFQs), purchase orders (POs), etc. The system was also integrated with related systems in inventory control and accounts payable. Before the new system was introduced, employees were using an assortment of off-the-shelf content management software. Jobs in the business unit were designed to be mostly autonomous, but there were collective goals for each product line and the business unit

The information system being introduced was created in-house by the information technology department of the company. It included a new hardware platform and new software packages. The system was developed over a period of 8 months. Suppliers to the organization connected to the front-end of the system, while the employees of the business unit worked on the back-end to configure the content made available to the suppliers. System use was voluntary and employees could continue to use the old or alternative systems that they had been using prior to the implementation of the new system. Further, users could choose to use part of the feature set offered by the new system. For the purpose of this study, we focus on the system use by the focal business unit personnel in the fulfillment of their job responsibilities.

Participants

The unit of analysis in this study is an individual employee, that is, a potential user of the new system. The sampling frame consisted of all employees of a business unit in the organization. The members of the business unit were knowledge workers whose use of the new system was voluntary. Membership in the business unit formed an appropriate boundary for our study because the members interacted in the context of the system that bound them with interdependent processes and a shared symbol system (Lauman et al. 1983). There were 108 employees in the business unit, not including secretarial staff and the leadership team (vice president and product group managers). The researchers interacted extensively with the leadership team regarding the objectives of the study and were the stakeholders to whom we provided feedback—therefore, we did not include them in the analyses as it was likely to introduce biases. Of the 108 employees, 87 people, including 22 women (25.3 percent), provided usable responses, for a response rate of 80.5 percent. The average age of participants was 38.9 with a standard deviation of 8.8. The average organizational tenure of participants was just over 5 years. The demographic profile of the respondents matched the business unit's demographic profile. The nonrespondents did not differ significantly from the respondents in terms of age or organizational tenure. Nonresponses were due to lack of desire to participate, incomplete responses, etc., and the researchers had no control over these problems but the high response rate and the matching demographic profile alleviate concerns about nonresponse bias. It should be noted that in studies using primary social network data, a sample size of 87 is considered to be quite large (see Borgatti and Foster 2003).

Measurement

Individual-Level Adoption Constructs

Behavioral intention was measured using items from Venkatesh et al. (2003), which were based on much prior research on technology adoption. The three items we used were: (1) I intend to use the system in the next <n> months; (2) I predict I would use the system in the next <n> months; and (3) I plan to use the system in the next <n> months. We collected data about intentions for different periods of time; in this paper, we use the data corresponding to an *n* of 3 months. The facilitating conditions scale was also adapted from Venkatesh et al. (2003), who synthesized the scales of Thompson et al. (1991) and Taylor and Todd (1995). The three items we used were: (1) The organization has provided the necessary resources for me to use the system; (2) A specific help support person or group is available for assistance with system difficulties; and (3) Organizational technical and support infrastructure are available to help me in case of problems. A seven-point Likert scale was used to measure both constructs.

Predictors Related to Social Networks

We collected social network data using a roster-based sociometric approach (Wasserman and Faust 1994). This approach employs a fixed contact roster and asks respondents to describe their relationship with every individual on the roster. The benefit of this approach is that it provides information on all interactions in a network. These data were used to compute the four social network constructs discussed earlier: (1) network density, (2) valued network density, (3) network centrality, and (4) valued network centrality.

In keeping with our theory development, here, a social network is seen as a set of individuals and the ties or linkages between them, where the ties represent communication or work interaction directed toward seeking or providing help to peers. A help network matrix was created by having each person in the business unit assess their frequency of help-seeking and help-giving vis-à-vis all others (with values ranging from 0 to 5, where 0 indicated not connected and 1 through 5 indicated the extent of help-seeking or help-giving). In addition, they evaluated the control of knowledge, information, and other resources relevant to the use of the new information system (with values ranging from 0 to 7, where 0 indicated no control and 1 through 7 indicated the extent of control). This resulted in five matrices for each respondent *i* with respect to an alter *j*:

Get-help$_{ij}$	Assessment of frequency of contacts made to get help from employee *j*
Give-help$_{ij}$	Assessment of frequency of contacts made by employee *j* seeking help
Know$_{ij}$	Assessment of control of system-specific knowledge by employee *j*
Resource$_{ij}$	Assessment of control of system-specific resources by employee *j*
Info$_{ij}$	Assessment of control of system-specific information by employee j

For example, Info$_{ij}$ was elicited through the following statements: "For the following people, indicate the extent to which they have access to information needed for effective use of <System X> (e.g., system features, upcoming releases, demo dates, etc.). You should include all people that you interact with. You may include people that you do not interact with, if you are able to make a reasonable assessment of their access to information." Similarly, Get-help$_{ij}$, Give-help$_{ij}$, Know$_{ij}$, and Resource$_{ij}$ were elicited.

We used the *get-help network* to create the *network density* measures because these measures reflect the employee's ability to cope with the new information system using the help of peers, and the *give-help network* to create the *network centrality* measures because the centrality measures reflect the employee's ability to influence the deployment of the new information system by channeling their control of information system-related resources.

Network Density: A density measure was computed for each ego (employee), considering the out-neighborhood (i.e., actors with a tie from ego in the *get-help* network). The density is given by the number of dichotomized ties divided by the number of possible pairs.

Valued Network Density: A density measure was created for each ego (employee) by weighting tie-strength by the average assessment of resources controlled by the alter (for each vertex *i*) =

$$\sum_j \begin{array}{l}(1/(n-1))[(\text{get-help}_{ij}) * (1/(n-1)) \\ (\sum_k (\text{know}_{kj}) + (\text{info}_{kj}) + (\text{resource}_{kj}))]\end{array}$$

Network Centrality: Bonacich's power based centrality measure (Bonacich 1987) was computed for every vertex in the give-help network. Given an adjacency matrix A, the centrality of vertex i (denoted c_i), is given by $c_i = \sum A_{ij}(a + bc_j)$, where a is the normalization parameter and b is the attenuation factor. The adjacency matrix was constructed from the *give-help* matrix. The attenuation factor was chosen as 0 so that the centrality measure is directly proportional to the degree of each vertex, as the ties in question represent both "zero-sum" relations as well as "non-zero-sum" relations (Scott 2000, p. 88).

Valued Network Centrality: This construct was operationalized based on an assessment derived from respondents' evaluations of resources controlled by other employees (for each vertex *j*) = $(1/(n-1))(\sum(\text{know}_{ij}) + (\text{info}_{ij}) + (\text{resource}_{ij})$.

Dependent Variable: System Use

System use was assessed for 3 months after the system went live. System use is an objective behavioral outcome that is measured as the amount of time an employee is engaged in hands-on interaction with the computer-based system. In keeping with earlier research (e.g., Venkatesh et al. 2000), an objective measure was captured via computer logs based on the aggregate amount of active time that the employee spent using the system per week, averaged over the span of 12 weeks. This measure excludes idle times of 2 minutes or more when employees may have been logged in but not actively engaged in using the system. Although our measure of system use does not capture the elements of frequency and depth, by being an objective measure, our measurement approach is not subject to source biases that characterize self-report measures (see Venkatesh et al. 2003).

Data Collection

After the completion of two days of training on the new system, employees completed an initial survey and provided data regarding their perceptions of the new system and their help networks. Each respondent was provided with the names of all other people in the business unit and asked to evaluate their contact with them as well as assess their control of information, knowledge, and resources. The names of respondents were coded in our data file in order to preserve the confidentiality and privacy of the participants, with a separate file maintained with the names and codes—a file that was deleted upon completion of the data collection. This was followed by a period of 3 months where actual use data was collected using system logs. Three important features of the study should be noted. First, the study was conducted concurrently with the system deployment rather than on a retrospective basis. Second, data collection with objective use data from system logs ensured that there were no temporal or perceptual biases. Finally, as already noted, the study was conducted in a real-world setting.

Illustration of Social Network Analysis

We illustrate the social network analysis conducted on the full sample with the help of a small subsample of the sociometric data. Tables 1 through 5 show the data for seven employees (the names used are pseudonyms) obtained through our survey. Social network analysis is generally concerned with dichotomous ties within a network, either being present or absent (1 or 0). We asked respondents to give us more information by having them classify their help ties and beliefs of others using Likert scales. This allowed us a more in-depth examination of the relationships. However, in order to illustrate actual get- and give-help networks and not incidental contact with other members of the organization, we only show network links of strength 3 or above in the network diagrams. This convention is followed as a score of 3 indicates help-tie activation at least once a week and thus, can be considered a normal part of the employee's work experience. In Tables 1 and 2, the numbers in parentheses indicate the existence of a tie (1) or the absence (0).

Table 1 captures the extent to which a focal employee (row) contacts and gets help from the six other employees (columns). For example, we see that Jan contacts Jennifer

Table 1. Get-help Matrix

	Jennifer	Sue	Jan	Fred	Gordon	Cheri	Mike
Jennifer		0 (0)	3 (1)	4 (1)	0 (0)	3 (1)	0 (0)
Sue	4 (1)		0 (0)	3 (1)	0 (0)	3 (1)	0 (0)
Jan	1 (0)	1 (0)		5 (1)	0 (0)	0 (0)	0 (0)
Fred	4 (1)	5 (1)	4 (1)		5 (1)	1 (0)	2 (0)
Gordon	0 (0)	0 (0)	0 (0)	3 (1)		4 (1)	5 (1)
Cheri	0 (0)	1 (0)	1 (0)	4 (1)	4 (1)		2 (0)
Mike	0 (0)	0 (0)	0 (0)	3 (1)	0 (0)	0 (0)	

Table 2. Give-help Matrix

	Jennifer	Sue	Jan	Fred	Gordon	Cheri	Mike
Jennifer		2 (0)	2 (0)	4 (1)	0 (0)	0 (0)	0 (0)
Sue	1 (0)		1 (0)	4 (1)	0 (0)	0 (0)	0 (0)
Jan	1 (0)	1 (0)		5 (1)	0 (0)	0 (0)	0 (0)
Fred	1 (0)	3 (1)	1 (0)		4 (1)	5 (1)	3 (1)
Gordon	0 (0)	0 (0)	0 (0)	4 (1)		5 (1)	4 (1)
Cheri	3 (1)	3 (1)	0 (0)	5 (1)	3 (1)		4 (1)
Mike	0 (0)	0 (0)	0 (0)	1 (0)	1 (0)	4 (1)	

and Sue for help less than once a month (tie-strength is rated as 1), while Jan contacts Fred for help many times a day (tie-strength is rated as 5).

Table 2 captures the extent to which other employees contact and get help from a focal employee (i.e., the people to whom the focal employee gives help). For example, we see that Fred gives help at least once a week (rating of 3) to Sue and Mike, at least once a day to Gordon (rating of 4), and many times a day to Cheri (rating of 5). We should note here that the two networks are based on perceptions of the individuals, and, as such, the two tables are not necessarily related to one another (i.e., the tables are not the inverse of each other).

Tables 3 through 5 provide an employee's perceptions of the level of each of the other six employees' control of system-related information, knowledge, and resources. These perceptions of others about a focal individual in the network are used to calculate valued network centrality and valued network density because people who are considered more knowledgeable about the system, in control of system-specific resources, and system-specific information are likely to be more highly sought out for help and/or have more useful help to give to others.

From Table 3, for example, we see that Jan rates Cheri as extremely knowledgeable about the system (rating of 5) while Jan rates Sue as not at all knowledgeable (rating of 1).

Table 4 shows that Gordon rates Jan as having a great deal of control over information about the system (rating of 5), but feels Jennifer has little (rating of 1) and Mike has none at all (rating of 0).

Table 5 shows the ratings that alters give a focal employee on their control over system-specific resources. For example, Mike views Cheri as having a great deal of control over system-specific resources (a rating of 5), while he views Jennifer and Sue as having no control over system-specific resources (a rating of 0).

Figures 3 and 4 provide a visual depiction of the patterns of help interactions in this network of seven employees. This visualization is based on dichotomizing the help matrices. A relationship rated at 3 or above is treated as a tie being present while ratings of 2 or below are indicative of the absence of a tie. As can be observed in the get-help network, employees have significant variance in how many other employees they approach for help. Mike gets help from only one other person

Table 3. Control of Knowledge Matrix

	Jennifer	Sue	Jan	Fred	Gordon	Cheri	Mike
Jennifer		4	2	2	0	1	3
Sue	4		2	1	3	5	4
Jan	4	1		2	4	5	4
Fred	0	4	1		4	0	4
Gordon	0	0	1	1		5	4
Cheri	0	5	2	3	5		5
Mike	2	0	2	1	4	5	

Table 4. Control of Information Matrix

	Jennifer	Sue	Jan	Fred	Gordon	Cheri	Mike
Jennifer		4	2	1	4	0	3
Sue	4		2	3	3	5	4
Jan	1	1		2	3	0	0
Fred	1	4	1		4	4	0
Gordon	1	3	5	2		4	0
Cheri	1	2	0	0	0		3
Mike	2	2	0	0	4	0	

Table 5. Control of Resources Matrix

	Jennifer	Sue	Jan	Fred	Gordon	Cheri	Mike
Jennifer		4	3	0	0	4	3
Sue	4		2	0	4	5	4
Jan	0	1		2	0	4	0
Fred	0	4	1		4	4	0
Gordon	0	0	1	1		5	0
Cheri	2	0	5	3	5		0
Mike	0	0	2	1	4	5	

Table 6. Social Network Measures

	Network Density (1)	Valued Network Density (2)	Network Centrality (3)	Valued Network Centrality (4)
Jennifer	3.00	0.61	1.00	1.44
Sue	3.00	0.57	1.00	2.17
Jan	1.00	0.30	1.00	1.89
Fred	4.00	1.35	4.00	1.39
Gordon	3.00	0.83	3.00	3.06
Cheri	2.00	0.75	5.00	3.39
Mike	1.00	0.12	1.00	2.28

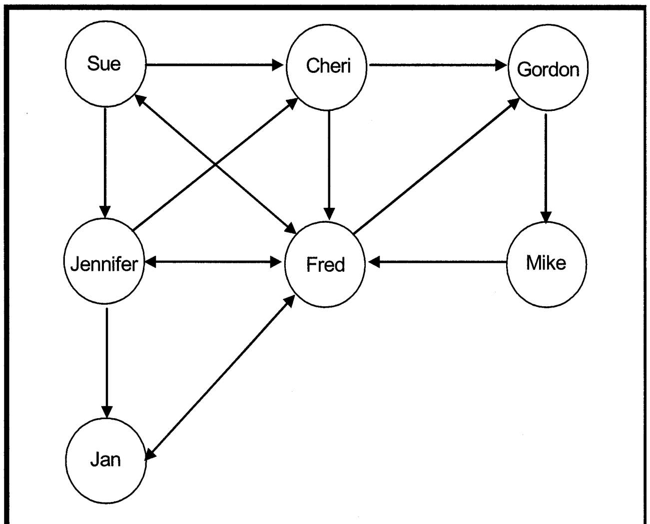


Figure 3. Visualization of Get-Help Network

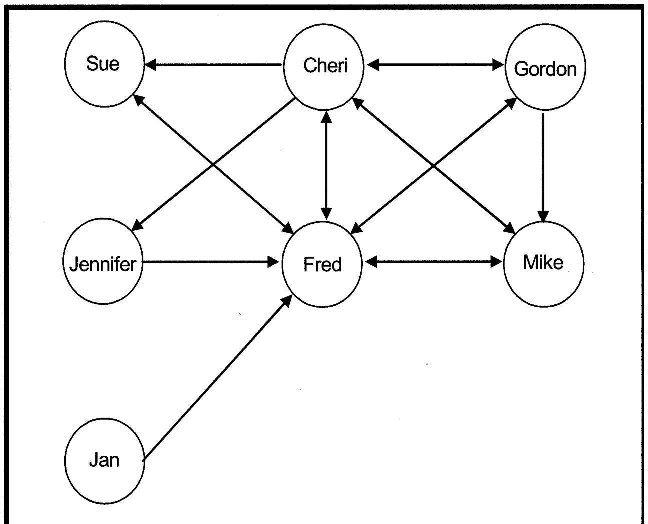


Figure 4. Visualization of Give-Help Network

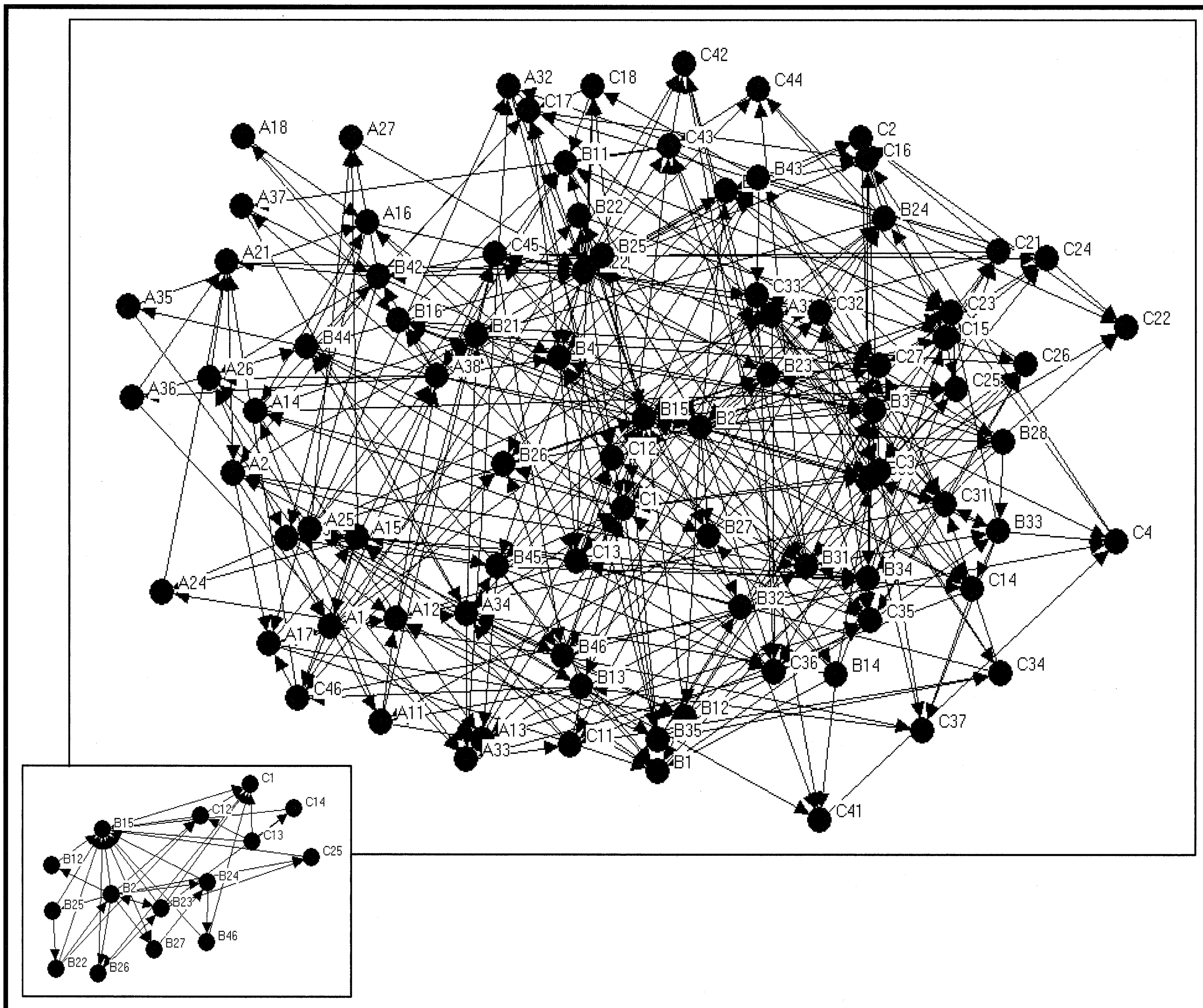
(Fred), but Fred gets help from four others (Jennifer, Sue, Jan, and Gordon). Similarly, there is variation in the help given by employees and some employees (Cheri and Fred) are more central than others. In the get-help figure, an arrow from one actor to another indicates that the actor is getting help from the person the arrow is pointing to. In the give-help figure, an arrow indicates that the actor gives help to the person the arrow is pointing to. In both types of figures, a double-headed arrow indicates a reciprocal relationship.

Table 6 summarizes the social network measures calculated for this network. In order to obtain network density and network centrality measures (columns 1 and 3 in Table 6), the help matrices were dichotomized—a tie rated 3 and above was coded as a 1 while a tie with a rating of 2 or below was coded as a 0 (Scott 2000). Dichotomization of ties allows the computation of parsimonious structural measures of the social interactions. The measures show that Fred receives most help while Cheri gives most help in this small network.

In order to compute the network measures that take an employee's control of information, knowledge, and resources into account, we use Tables 1 through 5. Valued network density (column 2 in Table 6) is computed by weighting each help tie with the alter's resource control (averaged over all respondents). As an example, Jennifer's tie with Fred is weighted by 1.39 (the average of Fred's assessment of resource control by all others). Valued network centrality (column 4 in Table 6) is the average of resource control of the ego. As seen in Table 6, these measures differ from the density and centrality measures that are based only on the existence of ties. For example, while Fred has the second-highest measure of network centrality, his valued network centrality measure is the lowest. Similarly, while Jan and Mike rate equally low on the network density measure, Jan has a much higher valued network centrality score (0.30) compared to Mike (0.12) because of the greater resources controlled by her alters.

Results

We used UCINET Version 6.29 (Borgatti et al. 2002) to analyze the sociometric data. Figure 5 presents a visual representation of the complete help network. As noted earlier, there are three product groups, each headed by a manager; product group A had three product lines and product groups B and C each had four product lines, with each of the product lines headed by a supervisor. Each node in Figure 5 shows an employee. The supervisors of specific product lines are shown as a two-character code, the first is a letter to represent the product group and the second is a number that denotes the product line that the person supervises; for example, C2 is an employee who supervises the second product line within product group C. As far as employees are concerned, a three-character code is used, with the first character denoting the product group, the second and third characters are both numbers with the second character denoting the product line and third character denoting an employee within that product line; for example, node C42 is the second employee in product group C in product line 4. We found that all employees had some help ties. However, some individuals were involved only with giving help; for example, C2 did not receive



Note: Insert shows the get-help ties of employee B15.

Figure 5. Dichotomized Get-Help Ties

help from anyone, but provided help to six others. All employees gave help to at least one other employee. Four individuals give help to only one person and eight people get help from only one other person. While individuals typically provide help to and receive help from just a few others, there are some individuals who are connected to many others—for example, as shown in the inset in Figure 5, B15 provides help to 14 others and B2 receives help from 25 others.

Figure 6 shows only the ties of one product line or workgroup (nodes in the oval), the one supervised by A1, to the other employees in the business unit. Some key observations can be made from this map. The help ties span workgroups, which may be due to employees who are part of one workgroup helping or receiving help from structural equivalents in other workgroups. When overlaid with the formal organizational chart, the social network suggests that help dynamics transcend the formal structure. For example, the subordinates of A2 actually do not engage in help interactions with A2. It should be noted that the elicitation questions used for creating the help network asked employees to specifically exclude administrative interactions.

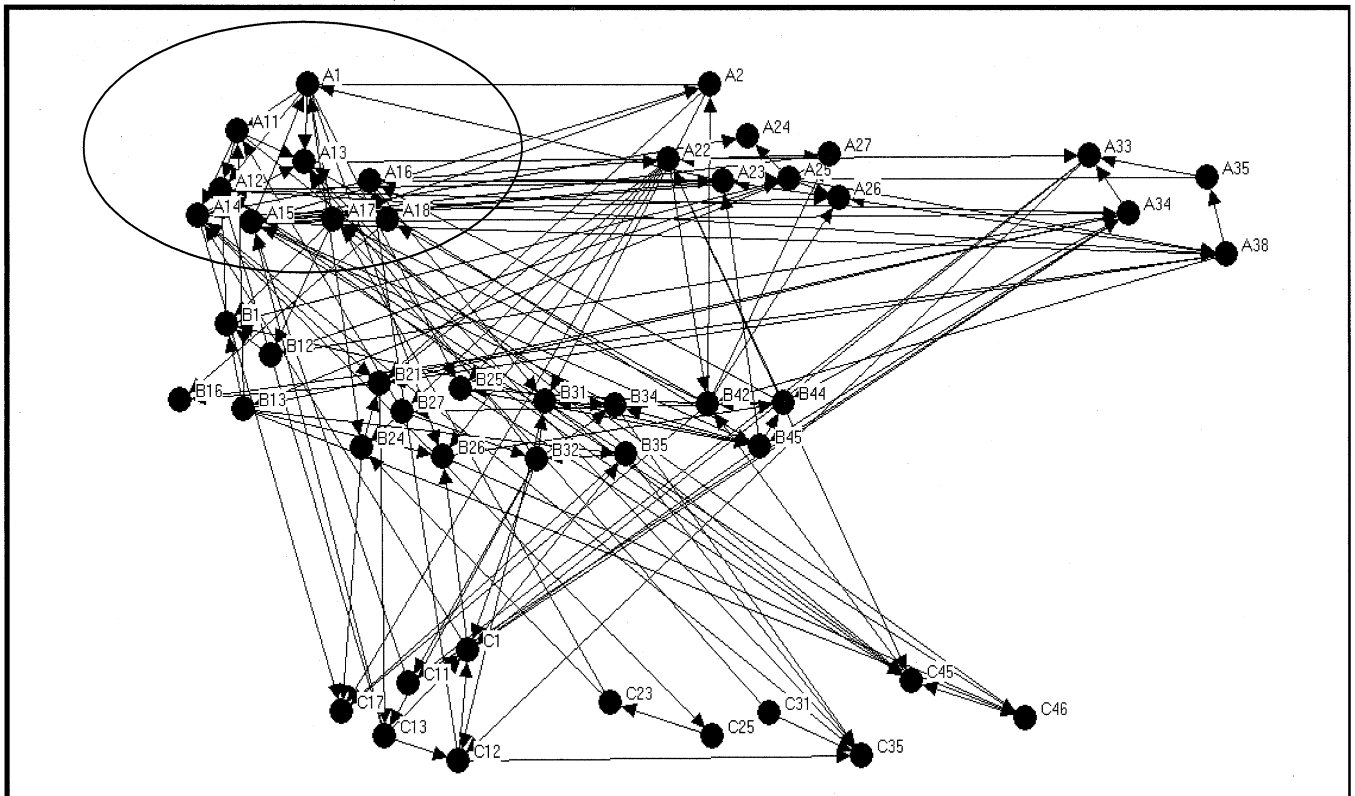


Figure 6. Help Ties to Employees Supervised by A1

We used partial least squares (PLS) to test the research model. The specific software package used for the analysis was PLS Graph, version 3, build 1126. The measurement model estimation provides information regarding reliability, internal consistency, and discriminant validity. Of the various constructs used in our model, the only constructs for which reliability and validity were assessed using the measurement model are behavioral intention and facilitating conditions because they are measured using multiple items. Network centrality, valued network centrality, network density, and valued network density are each determined using the measures and formulas presented earlier, resulting in one score (indicator) per construct per individual. System use was determined objectively using system logs, with the final measure being the average of each week's use for the first 12 weeks post-implementation, thus also resulting in a single indicator. The scales measuring behavioral intention and facilitating conditions were reliable, with internal consistency reliability (ICR) scores being well above the recommended level of 0.70 (Nunnally and Bernstein 1994). We tested the measurement models in conjunction with each of the four structural models that were tested. However, due to space constraints, we report the descriptive statistics and correlations in conjunction with the full model in Table 7. Internal consistency is adequate when constructs have an average variance extracted (AVE) of at least 0.50 (Fornell and Larcker 1981) and for satisfactory discriminant validity, the AVE for the construct should be greater than the variance shared between the construct and other constructs in the model (Chin 1998). The loadings for behavioral intention and facilitating conditions were all greater than .81 and the cross-loadings were all .22 or less, further supporting internal consistency and discriminant validity; these results are not shown here due to the consistency with much prior research. The assumed loadings of network density, valued network density, network centrality, valued network centrality, and system use were 1.

A few additional observations can be made about Table 7. The averages of behavioral intention and facilitating conditions were about 4, with a standard deviation greater than 1. The correlations between behavioral intention and system use, and facilitating conditions and system use were consistent with what has been observed in prior research (see Venkatesh et al. 2003). In order to understand the means and standard deviations of network centrality, network density, valued network centrality, and valued network density, it is important

Table 7. Psychometric Properties, Descriptive Statistics, and Correlations

		ICR	Mean	Std Dev.	1	2	3	4	5	6	7
1	BI	.92	4.41	1.04	.82						
2	FC	.84	3.91	1.06	.40***	.79					
3	ND	NA	5.04	2.27	.17**	.08	NA				
5	VND	NA	2.78	2.11	.19***	.24***	.29***	NA			
4	NC	NA	5.17	2.38	.19***	.16*	.34***	.23***	NA		
6	VNC	NA	3.61	2.01	.23***	.22***	.20**	.30***	.28***	NA	
7	Use	NA	7.74	2.98	.60***	.28**	.31***	.28***	.42***	.44***	NA

Notes:

1. BI: Behavioral intention; FC: Facilitating conditions; ND: Network density; VND: Valued network density; NC: Network centrality; VNC: Valued network centrality.
2. N = 87.
3. The numbers on the diagonal denote square root of average variance extracted.
4. *p < .05; **p < .01; ***p < .001; NA = Not applicable.

to understand the scaling and range associated with each construct. Network density reflects the number of ties (in-degree) in the in-neighborhood in the get-help network. To facilitate interpretation, we report the in-degree measure, which is the maximum number of possible ties minus 1 (in this case, 86). On average, an employee in the organizational unit gets help from about five coworkers. The valued network density measure is an average of the ties with alters weighted by tie strength and alter resource control. This measure is theoretically bounded by the network density measure. The average valued network density is 2.78. The network centrality measure reflects the number of ties in the out-neighborhood in the give-help network. On average, an employee helps about five coworkers. The valued network centrality measure suggests that the average employee is rated at about the mid-point of the scale (seven-point Likert scale) in terms of their control of information system-related resources. Overall, an important insight from the descriptive statistics is that an employee typically engages in helpful interactions with a small number of people compared to the theoretical maximum of 86 others. This is also consistent with past research showing that an individual typically interacts with a small number of people and these people are the ones that he or she counts on for help and support in organizational and personal settings (Sparrowe et al. 2001). All social network constructs were correlated with each other. Interestingly, the valued network centrality system use and valued network density system use correlations were both higher than the network centrality system use and network density system use correlations.

Four structural models were tested to understand the explanatory power of the social network constructs. The bootstrap resampling method (100 resamples) was used to determine the significance of path coefficients in the structural model. Table 8 presents the results from the different structural model tests. A baseline model (Model 1 in Table 8) was tested based on the predictors from prior technology adoption and use research. Both behavioral intention and facilitating conditions were significant predictors of system use, thus supporting H1(a) and H1(b). The variance explained by this model was 34 percent, which is fairly consistent with prior research (see Venkatesh et al. 2003). Next, we tested the model that included predictors from prior technology adoption research and the predictors related to social networks as conceptualized in prior social networks research (Model 2 in Table 8). Both network density and network centrality were significant predictors of system use above and beyond behavioral intention and facilitating conditions, thus supporting H2(a) and H3(a). Model 2 explained 41 percent of the variance, a 7 percent increase in variance beyond what is explained by prior technology adoption constructs. Model 3 in Table 8 incorporated both prior technology adoption constructs and valued network centrality and valued network density, all of which were significant, thus also supporting H2(b) and H3(b). Model 3 explained 50 percent of the variance, a 16 percent improvement over Model 1. Model 4 in Table 8 is the proposed research model (i.e., MAPS) that incorporates behavioral intention, facilitating conditions, and all four social network constructs (i.e., network density, network centrality, valued network density, and valued network centrality) as predictors explained 56 percent of the variance in system use. It is interesting and important to note that although the beta coefficients for behavioral intention and facilitating conditions declined from models 1 through 4, as can be expected, the decrease was marginal, thus suggesting

Table 3. Structural Model Results

	Model 1	Model 2	Model 3	Model 4
R^2	.34	.41	.50	.56
Adjusted R^2	.33	.38	.46	.52
BI	.54***	.50***	.47***	.44***
FC	.21***	.17*	.16*	.13*
ND		.21**		.17*
NC		.17*		.15*
VND			.31***	.29***
VNC			.29***	.25***

Notes:

1. BI: Behavioral intention; FC: Facilitating conditions; ND: Network density; VND: Valued network density; NC: Network centrality; VNC: Valued network centrality.
2. N = 87.
3. *p < .05; **p < .01; ***p < .001.

that there was fairly minimal shared variance between the individual-level constructs studied in prior research and the social network constructs. In sum, the results here provide strong support for our model (i.e., MAPS).

Discussion

We theorized that the social network constructs of network density and network centrality would be predictors of individual system use in the early stages of a new system's use. The empirical study lent support to the proposed model, MAPS, with the social network constructs explaining about 20 percent additional variance beyond the previously established determinants of system use, namely behavioral intention and facilitating conditions. We tested four models that included a combination of behavioral intention, facilitating conditions, and social network constructs. The first of these was a baseline model (see Venkatesh et al. 2003), with only behavioral intention and facilitating conditions as predictors. In addition to the two individual-level constructs, the second model incorporated network centrality and network density as predictors, which is consistent with much prior research on social networks. The difference between the second and third model was that the conventional centrality and density constructs were replaced by valued network centrality and valued network density as predictors, which are important conceptual advances that we made to tailor the social network constructs to the domain of help ties in complex information system use. The fourth model, MAPS, incorporated the two individual-level constructs and all four social network constructs, thus integrating prior social networks research with the ideas advanced in this paper. Each of the latter three models explained significant additional variance in system use beyond what was found in the baseline model, with MAPS being the most predictive of system use.

Theoretical Contributions and Implications

This paper contributes to IS research by deepening our understanding of employees' system use. The social network constructs contribute to this explanation and help us go beyond behavioral intention and facilitating conditions as the key predictors of system use. Our study suggests that the social network constructs effectively capture interpersonal help that may not be accounted for by the behavioral intention construct. Similarly, the facilitating conditions construct does not capture the informal interactions that complement the formal support infrastructure.

Not only do the social network constructs explain additional variance, but also they provide insights that can guide managerial action. The introduction of social network constructs and associated analyses represents a substantial shift in the thinking associated with the prediction of individual-level system use. Over the past two decades, while the variance explained in behavioral intention and system use has steadily increased through a series of studies, much of this research has employed individual perceptions related to the system and system use. An alternative lens, such as the social network perspective, helps us view the problem differently, identifies new explanations, and creates opportunities for further research that could potentially question, challenge, or clarify earlier findings and, thus, advance the state of knowledge. Further, the social network perspective could be employed in a variety of streams in IS research to gain insights into various phenomena, much like it has aided the understanding of phenomena in management research.

There are several fruitful areas where social networks can be employed in IS research. We discuss future directions related to the following areas: (1) conceptualizations and constructs related to social networks; (2) hierarchy and boundary spanning; (3) individual characteristics—that is, demographic and personality variables; (4) different types of use, long-term use, and changing social networks; (5) exploring distributed contexts; (6) business value of IT; and (7) software development. We do not mean to suggest this as an exhaustive list but rather as an interesting set of directions.

There are several different conceptualizations of a social network that can guide fruitful future investigations. The focus in our work was direct connections to help networks, whereas it may be possible to get help by having access indirectly (i.e., the friend of a friend) to information and resources. It is, of course, also possible to exert influence indirectly. Freeman (1979) proposed different conceptualizations of centrality that take into account indirect ties that could help an individual control the flow of information and resources in the network. The idea of *closeness* that captures the geodesic distance—the number of relations in the shortest possible walk from one actor to another—among nodes bears further investigation. Geodesic distance is widely used in social network analysis because it is often the most optimal or efficient connection between two actors. A related yet distinct idea is *betweenness centrality*, which is defined as the extent to which a particular node serves to connect other pairs of nodes (Freeman 1979). There is mixed evidence regarding whether betweenness centrality provides a different view of centrality (e.g., Kilduff and Krackhardt 1994) or not (e.g., Ahuja et al. 2003). Examining the correlations and unique variance explained by different conceptualizations in this context is important to aid our understanding and guide interventions. Different patterns of findings can yield insights into the role and impact that such connecting players may have. Research can also examine the formation of collectivities, such as cliques in social interactions, and explore the role of individuals that may be able to bridge structural holes (Burt 1992) that retard information exchange across subgroups. Related to this, we proposed coping and influencing as the theoretical mechanisms underlying the impact of density and centrality on use, but we did not explicitly test these mechanisms. Future research should empirically validate these ideas. In this study, the social network was constructed based on self-reports of assistance behaviors. Future research can compare data on social ties obtained via questionnaires to data obtained via monitoring of communication or other objective observations.

We did not specifically model organizational position and examine its differential impacts. Future research should examine all levels of the organizational hierarchy and examine the impact those higher up in the hierarchy could have. While it is intuitive to expect that those higher in the hierarchy may have access to greater support and have greater influence, it will be important to understand the impact of those who are lower in the hierarchy but have strong ties to those higher up in the hierarchy. We restricted our research to employees in one business unit. Given the challenges associated with collecting primary social network data, such as determining the appropriate boundaries of the network as well as effort required on the part of respondents (Marsden 1990), practical constraints limited our study. However, given the encouraging findings here, future research should study boundary spanning social networks across organizational units, including ties to the IT department.

There is evidence of the importance of demographic characteristics, such as gender and age, on social influences (e.g., Gefen and Straub 1997; Venkatesh and Morris 2000; Venkatesh et al. 2003). It is reasonable to expect that gender, age, and organizational tenure will play a significant role both as direct determinants of key social network constructs and as moderators of key relationships. These demographic variables have been found to affect the importance of maintaining and accruing power, thereby helping us to understand help-seeking behavior (Lee 1999). Similarly, general psychological characteristics (e.g., Big Five, Watson and Clark 1997) and technology-specific characteristics e.g., computer self-efficacy, Compeau and Higgins 1995) can have both direct and moderating effects, and should be studied further.

Recently, we have seen a growing interest in understanding different types of use (see Burton-Jones and Straub 2006; Venkatesh et al. 2008). Research should focus on how social network constructs can explain various types of use. As the use measure employed in this work is a lean measure, it would be worth understanding how social network constructs relate to richer conceptualizations and measures of use. Additional work is necessary to deepen our understanding of the dynamic nature and evolution of social networks and their effects on system implementation and success. Obviously, the study of longer-term use is important to achieve that goal. As complex information technologies can change business processes and jobs rather drastically, it is possible that social networks may also change and evolve. Such effects are important to understand as established strong ties may become weak or nonexistent, or weak or nonexistent ties could become established and strong, both in terms of giving and/or receiving help, thus potentially changing an employee's future use of the target system or use of other future systems. Enterprise systems also lead to changes in business processes and workflows. Enterprise applications typically are cross-functional and are likely to replace traditional stovepipe systems. Researchers need to elaborate the processes by which new systems implementations catalyze changes in a social network. Future research can also examine the impact of a social network on trajectories of use across time to discover if the variance in use may be ascribed to a slower uptake rather than a reduced level of use. Also, this study has focused on the positive impact of network ties on system use. However, stable and highly connected relationships can also create a "fortress" effect, thus deterring personal growth and the acquisition of new information and resources (Albrecht and Adelman 1987). Future research can try to explicate the conditions under which these detrimental impacts can occur that retard the acceptance of new systems.

Information and communication technologies have led to the increasing use of far-flung or geographically distributed teams in organizations (Majchrzak et al. 2004). Employees who work in such teams need to coordinate their work on interdependent tasks while overcoming the physical separation. In such distributed contexts, the lack of face-to-face interactions raises obstacles to the formation of trust and familiarity with others (Hinds and Kiesler 1995). This would hinder the extent to which an employee would be willing to seek or give help (Borgatti and Cross 2003). Given that technology is a critical enabler of work in such distributed contexts, researchers can help provide insight into how interpersonal ties may be formed and sustained in these contexts and point to ways to provide technology support for helpful interactions.

One important body of work has examined the business value of IT primarily using behavioral and economic perspectives. The behavioral perspective has focused on organizational characteristics (e.g., innovation climate) and psychological characteristics (e.g., leadership) to examine the success and value of IT implementations. Some recent work suggests that explanation for the failure of systems to yield productivity improvements may be due to lack of system use (Devaraj and Kohli 2003). As this study shows, the social network perspective sheds light on potential help networks and resource control mechanisms that in turn explain individual use of a system. Taken together, this calls for research examining a more holistic model tying together investments in IT (Devaraj and Kohli 2003), social networks, system use (Venkatesh et al. 2003), and productivity gains.

While there are many streams of research related to software development, one of the streams that can benefit greatly from a social network analysis is tied to requirements determination and structuring. Much prior research has emphasized the importance of communication between the users and analysts. While most approaches involve users in some way, how such users are identified varies greatly. There is a temptation to involve high performers. However, it is possible that employees with larger social networks may be able to better reflect the opinions of the user community at large. Further, social network analysis can shed light on patterns of influence that in turn could help foster diffusion and gain user buy-in. Research studying social networks could deepen our understanding of how requirements are structured and influenced by various players in the social network. This would allow for the design of managerial interventions by co-opting key players in the social network.

Practical Implications

Our findings have implications for managerial interventions in two areas that support new information systems implementations in organizations. These interventions can be targeted to better support the coping of users of new information systems, and more effective adaptation of information systems deployments to user needs and preferences. Organizations must recognize the informal network of help ties in the organization, diagnose them, and in response, proactively create appropriate interventions to support organization–technology coadaptation.

An exploration of the sociometric data collected in this study suggests the possibility of help-ties and control of relevant resources not being "in synch" within an organizational subunit. As an example, in our earlier illustration, Fred is centrally located in the help network. His peers admit to getting help from Fred, yet he is rated among the lowest for control of system-related information, knowledge, and resources. This may be due to personal characteristics, such that Fred does not leverage his network position to garner resources, despite striving to help others. However, it points to the possibility of the organization not recognizing and supporting him. By exploring the social network structure, appropriate measures can be taken to allocate resources that will help people like Fred such that both he and the organization can benefit most from his expertise.

To better support coping, managers should attend to isolated users who may be cut off from access to help from peers and system-related resources. Such users might be targeted to receive more formal support, such as personalized training. Over time, such isolated users might also be encouraged to engage with other employees through socialization activities. Managers also need to understand how to cultivate and sustain ties between the proficient users ("super-users") of a new system and those who need help. At the same time, they need to be careful to make sure that these super-users are not spending too much of their time and effort in supporting others. In some cases, such super-users could be relieved of some of their day-to-day job responsibilities so as to provide valuable support to their colleagues. There is evidence, even in the trade press, of a chasm between technology support staff and business users, with the former often failing to situate their knowledge in business practice and communicate in terms that end users can follow (e.g., Fisher 2003). Workplace ties among users of the same system would, therefore, constitute an additional source of knowledge to supplement more formal technical help. Finally, workplace ties can provide quick and timely answers even to procedural questions, especially if the help desk personnel are not readily available. The social network maps will reveal specific and detailed information for targeted managerial action and support.

To better manage the influencing pathway, managers need to understand the structure of the social network to make sure that isolated employees have a say in the process of generating requirements and in ongoing systems design and development activities. They also need to recognize that informal social networks can create bases of power in the organization that may undermine or supplement more formalized structures. An organization needs to ensure that different viewpoints across user groups have a balanced representation in the decision-making process for information systems design. Once again, the social network maps can reveal valuable information to help management ensure that adequate and appropriate representation and buy-in is obtained. Social networks can also reveal ties that channel information in the organization (e.g., Abrahamson and Rosenkopf 1997). It can help to identify bottlenecks—central nodes that provide the only connection between separate parts of the network. This will allow the organization to gain insights into how perceptions about the new system are shaped over time, enabling better targeting of the provision of information to employees.

Conclusions

This research has shown that an employee's social network characteristics, capturing his or her structural position in the peer help network, aids in our understanding of new information system use. The social network constructs of network density and network centrality explain variance in system use over and above the predictors from the individual technology adoption perspective (i.e., behavioral intention and facilitating conditions). The valued network density and valued network centrality, which take tie-strength and control of information system-related resources into account, explain additional variance in system use over and above the traditional structural network characteristics of density and centrality. Also, this work shows the social network perspective is a valuable tool that information systems researchers can employ to understand various phenomena.

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