

Information Seeking in an Information Systems Project Team

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Abstract—*Why does a team member prefer some colleagues to others in information seeking? Past literature suggests that the physical accessibility of a knowledge source, the information quality of the source, and relational concerns are important to such a choice. This study extends past literature by suggesting that formal structural factors are also important. Particularly, job interdependence, competition and supervisory relationship are hypothesized to affect information sourcing frequency. Our social network analysis of an information systems project team indicates that formal structural factors are important to the development of informal network in an organization and the perception of the information quality of a source. They have both direct and indirect impact on sourcing behavior. Implications for information systems project management are discussed.*

Index Terms —*Knowledge acquisition, social factors, information systems, personal communication networks, professional communication*

Information seeking is one of the most important activities in professional practice. According to a survey of more than a thousand middle managers by Accenture [1], managers spend up to two hours a day searching for information. However more than 50 percent of the time, they find it difficult to obtain information of value. Information seeking is therefore a critical factor to employee productivity.

Successful information seeking is also considered a critical factor to the success of information systems (IS) development projects. IS projects are notorious for their high failure rates, budget overruns, and inflated schedules [2], [3]. Many projects fail to deliver the promised value even when they are completed on time and within budget [4]. For example, enterprise system like SAP R/3 used to have up to 90% failure rate [5]. IS project failure could also cause a firm to go bankrupt [6]. Recent research [4] has summarized the past literature on IS project into two streams: those taking a technical view with a focus on system development tools and methods, and those taking a social interactionist view with a focus on project team process and organizational issues. Both technical and social views are important; neither is sufficient on its own. However, it is becoming clearer that teamwork and communication exert a critical impact on the outcome of a project [3], [7], [8].

The transfer of knowledge and information are important aspects of the social process in IS project teams [3], [8], [9], [10]. In fact, IS project development has been regarded as a knowledge-intensive activity because it not only streamlines and automates current business practices, but also introduces radical changes that can be strategically beneficial to the organization [11]. Consequently, understanding how knowledge and information are shared, transferred, internalized and applied can offer insights into the success of IS projects in particular and organizational communication in general [3].

Past literature has investigated how collaboration among team members facilitates knowledge and information transfer, which helps improve the project quality [3], [8], [12]. Past literature has also studied knowledge sharing in IS teams [13] and in electronic knowledge repositories [14]. However, little is known about how IS professionals *seek* knowledge within a team. Obviously, sharing is only one side of the organizational learning story and employees rarely share information without being asked [15]. Information is more often shared when one seeks it from

another. As pointed out by [16], the fundamental level of organizational learning is individual learning. Accordingly, individual learning and information seeking in IS project teams is fundamental to the knowledge flow and success of a project.

How do project team members learn? Past literature in organizational learning has accumulated a substantial body of findings on employee learning and information seeking. For example, researchers have investigated why some employees seek more information than others [15], [17] and why a seeker prefers certain information sources to others [18], [19], [20], [21], [22]. While the literature on employee learning is ample, there is a paucity of information seeking research that takes an IS project team as the investigation context. At a more theoretical level, past research has focused on the impact of personal relationship on information seeking [18], [19] with little attention paid to the impact of formal organization structure. To date, the findings on source choice are inconclusive and competing views exist regarding the importance of source accessibility, the information quality of the source, and the seeker-source relationship [18], [22], [23]. Moreover, while an advice network that facilitates knowledge flow in an organization is considered valuable, there is little research on how it comes into being [24].

This study focuses on information seeking in an IS project team. We are particularly interested in the factors that affect a team member's frequency of approaching another member as an information source. We use seeker-source dyads as our unit of analysis and we define *sourcing frequency* at the dyadic level as the frequency of one party seeking information from a particular other party. Sourcing frequency is an important variable because theoretically it measures the tie strength of dyadic communication and practically depicts the major information flow in an organization. Based on sourcing frequency, managers may want to facilitate the desired communication (e.g., with new information and communication technologies) and reduce undesired communication with appropriate interventions.

Building upon findings from extant literature in employee information seeking, we enhance them with a social network perspective by introducing structural factors such as job interdependence, competition, and supervisory relationship. Based on the social network perspective, a major expected contribution of the study is to measure the impact of both formal organizational structure and informal personal relationships on sourcing frequency. Knowledge of this would help managers understand how an advice network in an organization is formed and how to change this network by properly modifying its causal factors.

To make the study manageable, information sources in our study refer only to personal sources (e.g., colleagues), but not to impersonal sources (e.g., repositories, library). Employees could collect information by passively learning from what others are talking about. However, this study focuses on active information seeking because that is the major channel of employee learning [21]. By active information seeking, we refer to employees who take the initiative to approach other colleagues and ask for information for problem solving. Moreover, because there is no clear-cut boundary between the definition of knowledge and information [25], [26], this study does not attempt to differentiate knowledge and information. Our scope of information/knowledge is practice-oriented: It is the information helpful to a team member's problem solving in his or her job assignments.

This article is organized as follows: First, we review the past theoretical frameworks to explain information seeking behavior. In particular, we review the cost-benefit framework and the relational view of knowledge seeking. We then introduce the structural factors that could affect information seeking. Hypotheses are proposed based on existing theories and our conceptual

development. After that, we report on an empirical study of an IS project team using a social network survey. Statistical hypothesis testing was done to verify our hypotheses. We then discuss the findings and examine the implications of our study.

Hypotheses Development

The Cost-Benefit Framework The cost-benefit framework is probably the oldest framework to explain the formation of organizational advisory relationships [27]. In this framework, cost refers to the proximity and accessibility (or physical distance) of an information source to a seeker [18], [21], [22], [27]. Benefit mainly refers to the information quality of the source [18], [21], [23], that is, the reliability, relatedness, novelty, and understandability of the information received [22]. The cost-benefit framework posits that a seeker's choice of a source is determined mainly by the accessibility and perceived information quality of the source.

While this framework is simple and intuitive, there is a discrepancy regarding the relative importance of the two factors. Early studies of engineers' information seeking behaviors [27] found the easy accessibility of a source to be the dominating factor, while information quality plays a minor or insignificant role. O'Reilly [17] suggested that this "least-effort principle" might be a result of the ambiguity of information quality; other researchers attributed it to time pressure [28]. However, no substantive empirical evidence has been provided for these explanations. Nevertheless, the dominating role of accessibility has been repeated in recent studies [29] [30].

In contrast, other researchers argued for the dominating role of the information quality of a source [18]; [21]. This stance is not surprising, because the ultimate goal of information seeking is to reduce uncertainty with high-quality information [28]. The proximity of a source is ultimately meaningless if the source cannot offer quality information and help solve the seeker's problem. Empirical support for this stance is also rich [23], [31].

In the presence of conflicting findings, the argument on the relative importance of cost and benefit is not fully settled. The cost-benefit framework suggests that both cost and benefit shall play a role in information seeking. Therefore, we hypothesize:

H1. The perceived information quality of a source is positively related to a seeker's sourcing frequency.

H2. The perceived physical distance of a source is negatively related to a seeker's sourcing frequency.

The Relational View The relational view is another major effort to resolve the issues posed by the cost-benefit framework [18]. Based on social network theories, this stream of research incorporates dyadic relationships between a seeker and a source as antecedents of sourcing frequency. A dyadic relationship could be characterized as the social risk embedded in information seeking when the seeker reveals his ignorance or incompetence [18], [21], [22], [23], [32], the willingness of the source to share [18], [33], or the friendship and the benevolence-based trust between two parties [34]. While benevolence-based trust has been found to be a significant factor [34], social risk was found insignificant in all studies [18], [21], [22], [23], [35]. A source's willingness to share saw mixed findings and was not conclusive [18], [33]. Borgatti and Cross [18] suggested that social risk is insignificant because it pertains to the culture of a team rather than to the unique relationship of a dyad. Therefore, it is more likely to be

homogenous to all dyads of a team. They also suggested that social risk and source's willingness to share are more likely to affect seeker's learning outcome rather than sourcing frequency. In this study, we focus on personal relationship because (1) it is a key indicator of tie strength in a relational network that could facilitate information seeking, and (2) it has been found to be significant in past studies [34].

We define a personal relationship as an intimate relationship beyond the work context. This definition differs from the past relational view [18] in emphasizing the non-work relationship; it is closer to the definition of friendship in the social network literature [36].

In consistence with the relational view, personal relationships form an informal relational network in an organization. They affect sourcing frequency because close relationships reduce the perceived obligation to reciprocate. Close friends are more likely to have a wider range of reciprocal social exchanges; hence it is less a concern about disturbing the social balance with knowledge seeking. A close personal relationship also implies the source's willingness to share; it therefore increases the chance of successful sourcing. We hypothesize:

H3. A strong personal relationship between a seeker and a source is positively related to the seeker's sourcing frequency.

The Structural Perspective The cost-benefit framework and the relational view have paid little attention to the organization context that dyads reside in. Organizations are known to have both a formal structure and an informal structure that influence individual behavior [37], [38]. A formal network of employees in an organization represents the legitimate authority of the organization and is typically reflected by the organizational chart and business processes. A formal network represents channels of communication through which orders and business information are vertically or horizontally transmitted. In contrast, an emergent network refers to an informal, naturally occurring personal network which could overlap with the formal network but not confined by it [37]. Researchers have provided considerable evidence for the coexistence of the two networks [38].

Although past research on social networks has also proposed a structural perspective, the focus was on the structure of informal relationships. Little attention was paid to the formal structural perspective. Tie strength is often defined as the strength of personal relationship or consequently the frequency of communication between a dyad [36]. Strong ties sometimes allude to within-department ties which carry similar knowledge, and weak ties allude to cross-department ties that bring in novel knowledge [34], [36]. The question of how formal structure affects the development of informal structure and how formal structure works with informal structure to shape the advice network has not been answered.

Based on this structural perspective, this study suggests that formal structural factors are important antecedents of informal relational factors, and both formal and informal structural factors influence the formation of an advice network. The informal relational factors have been studied in the relational view [18]. In the context of information seeking, we identify job interdependence, competition, and the supervisory relationship between a source and a seeker as important formal structural variables [39].

Our inclusion of the three structure variables is based on the knowledge-based view of a firm [40]. Based on this view, a firm exists and survives because of its advantage in integrating knowledge of its employees and applying it to production. The choice of organization structure is

to facilitate knowledge integration through coordination. The two major structural designs for coordination are organization hierarchy and within-department or team-based cooperation. Organization hierarchy achieves coordination through authority; teams achieve coordination through collective performance and reward. The above tenets suggest that supervisory relationship and job interdependence are two important structural factors in organizational learning. The knowledge-based view of a firm [40], together with other institutional economics (e.g., the notion of opportunism in the transaction cost economics and agency theory) and organization theory (e.g., resource imitability in the resource-based theory of a firm) suggests that coordination does not occur without barriers. Tensions exist among employees to maintain their specialty in a domain to increase bargain power. Therefore, competition is identified as the third structural factor in information seeking. The effect of these factors is further elaborated below.

Job Interdependence Job interdependence refers to the interdependence between a seeker and a source in accomplishing their job assignments. It reflects the horizontal cooperation two individuals need to carry out in a business process and is expected to facilitate information seeking. First, sources with interdependent jobs are more likely to be sought because they possess relevant knowledge. Interdependent jobs are more likely to involve similar task information, technical processes, or covert and overt knowledge. For example, Eveland [41] found that IT helper/helpee dyads share at least five similar information tasks that increase their chance of information seeking from each other. More importantly, the seeker and source of interdependent jobs affect each other's performance. Van de Ven and Ferry [42] define workflow as the materials and objects, or clients and customers that are transacted between units, hierarchical levels, and organizations. If two parties are involved in the same workflow or business process and one's input is the other's output, they have more chances to work together to accomplish the assignments. One's substandard performance is very likely to incur more effort for the other or degrade the final output. Rice et al. [43] also observed that task interdependence has a significant effect on an employee being sought as an information provider. Third, job interdependence increases the seeker's awareness of the source's expertise. In Borgatti and Cross's [18] study, it is suggested that the decision to seek information from another is influenced by one's awareness of another's expertise. Awareness is regarded as the baseline condition for knowledge seeking. That is, a seeker should have some understanding of the source's expertise. Given the relatedness, awareness, cooperation, and more importantly, performance interdependence between a seeker and a source, we hypothesize that it affects the perceived information quality of a source. Concomitant with the cooperation of the dyad, a stronger personal relationship is likely to develop. In the context of an IS project, it has been demonstrated that interdependent team members have a higher productivity with more organic communication [7]. It has also been shown that formal job designs to accommodate job interdependence boost project performance [3]. Therefore:

H4. Job interdependence between a seeker and a source is positively related to their personal relationship.

H5. Job interdependence between a seeker and a source is positively related to the perceived information quality of the source.

Competition Throughout a business process, multiple employees might hold the same job position. Burt [44] defined individuals occupying the same network position as structural

equivalents. Structural equivalents are likely to be competitors [44]. Because of the similarity of their ties and interaction patterns with other people, and because of their similar expertise and skills, employees who are structurally equivalent are viewed as interchangeable; one can be substituted for another. Employees who are structural equivalents tend to compete with each other for the same position as well as influencing each other through common connections [45]. These employees might compete for a limited pool of resources such as pay raises and performance bonuses. In the context of an IS project, Yetton et al. [46] reported that team conflict leads to significant budget overrun, presumably due to its negative effect on communication. Barki and Hartwick [47] found that IS team conflict is reflected in disagreement, interference and negative emotions between members. These consequences would thwart information seeking. Hence, we propose that competition creates emotional tension between employees and degenerates coordination, although those colleagues are relevant information sources because of the similarity in skills and positions. Defining competition as the perceived substitutability in position, we hypothesize:

H6. Competition between a seeker and a source is negatively related to their personal relationship.

H7. Competition between a seeker and a source is positively related to the perceived information quality of the source.

Supervisory Relationship While interdependence and competition can be considered horizontal structural relationships in a business process, supervisory relationship (i.e., a source is the supervisor of a seeker) reflects the hierarchical structural relationship between two employees. Some researchers have shown that direct supervisors are the most important information sources among all possible sources [48], [49]. Supervisors tend to be highly accessible and familiar with the employee's job. This familiarity adds to the relevance of the information sought by a seeker. Supervisors are accessible in the sense that they have the duty and responsibility to share knowledge for the sake of better group performance [17], [27], [50]. Finally, employees would seek supervisors for knowledge for purposes other than problem solving. They are sought for future direction of action, confirmation and official support [34]. They are also sought because subordinates might want to take the opportunity of information seeking to build a better personal relationship [35] and to discharge future surprises [23]. Greller and Herold [51] have showed empirically that employees rated their supervisors as the most informative sources. In the context of an IS project, managers often assume the responsibility of project scoping, scheduling, budgeting, quality control, risk management and stakeholder communication [52]. They are the main information intermediary among stakeholders. Their absence in the project communication network is a critical factor leading to project failure [53]. Consistent with these findings, we propose:

H8. The supervisory relationship between a source and a seeker is positively related to the perceived information quality of the source.

H9. The supervisory relationship between a source and a seeker is positively related to the seeker's sourcing frequency.

Research Methodology

Research Method and Survey Instrument To test our hypotheses, we conducted a social network survey by collecting the social network data from an IS project teams in China. The team was at a major university in Shanghai. There were 35 IS/IT professionals and supporting staff in the team, whose main objective was to develop a new integrated information system for the university. This team was responsible for both the network infrastructure deployment and the development of fundamental information systems, such as course management systems, registration systems, human resource systems and logistic systems. This project team had initiated the project about six months prior to the time of this study. The plan of a university-wide system including the network infrastructure and functional components of applications had already been laid out. However, different sub-projects were not at the same stage. For example, the networking team was at the implementation stage (e.g., wiring, setting up servers), and the application development team was implementing core new systems, integrating with reusable old systems, and planning some new systems. The various stages team members were involved in made the seeking and sharing of knowledge an important activity of their work. Typical information sought by members included user requirements, project management (i.e., assignments, deadlines, resources allocation) and technical knowledge (i.e., coding, debugging, system installation).

The team members were mainly stationed in one building, but they were distributed at four floors and six rooms. The distributed nature of the project team provided us with an opportunity to investigate the impact of source accessibility.

The project team had two managers, four deputy managers, and two secretaries; the rest were team members. However, for teams of various work nature (e.g., networking, system development), a team leader was appointed. Preliminary interviews indicated that while the project team members had relatively well-defined job assignments, they did work together in various areas and help each other out. The organizational structure of the project team could be regarded as a mix of functional structure and project-based structure, with members having a clear professional focus (e.g., networking, coding) yet had to form a task force for a specific assignment (e.g., develop a new system for the Estate Management Office) until the assignment was completed. The organizational structure was another factor that required knowledge seeking and sharing among members. Therefore, we considered this team adequate for our study.

Our survey was paper-based. A debriefing session was held before the survey to solicit participation and to inform the participants about the general purpose of the study without disclosing the research model. Participants were given one week to return the survey although most of them returned within two days. The rest were reminded after two days and we collected all questionnaires in a week.

<<Insert Table 1 about here>>

Our survey questionnaire was developed in Chinese and English simultaneously to ensure consistency. As is typical in network research, each independent variable was measured with a single question [54], [55]. While some have criticized the practice of asking a single question to measure a theoretical variable [56], Marsden [57] suggests that these indices are largely reliable when appropriate procedures are followed to help individuals accurately report their network links. Our measures were based on tested items in the literature whenever available. We also

discussed the items with a local manager who was informed but not involved in the project to ensure that the items would be interpreted correctly. Minor adjustments were made to suit the survey locale. Table 1 gives the English version.

It is important to note that dyad was the unit of analysis in our study, which means all the variables were measured at the dyadic level. Each subject was asked to evaluate the other 34 team members on the independent and dependent variables in an ego-centric fashion. In total, there were 1190 dyads. There were seven variables in total as indicated in Table 1. The data were cross-sectional and all of the variables were collected at the same time point. Independent variables were assumed to refer to aspects of enduring and ongoing relationships with others, while the dependent variable referred to discrete transitory events that recently occurred. This is known as the backcloth/traffic distinction in network analysis [58].

Subjective perception of job interdependence, competition, personal relationship and information quality of a source were measured with an 11-point scale (e.g., 1=very low interdependence, 11=very high interdependence). Supervisory relationship (1=source is seeker's supervisor, 0=otherwise) was reported by respondents. Physical distance was based on the objective location of each respondent.

To measure the frequency of information seeking in a dyad, we followed Borgatti and Cross' [18] practice. For the seeker, we asked: How often did you turn to X for information (GetInfo)? For the source, we asked: How often has X turned to you for information (GiveInfo)? The dependent variable was the average of the GetInfo variable and the corresponding GiveInfo variable.

Control Variables Personal relationship is not only affected by structural factors, but also by demographic factors. The homophily literature [59], [60] has suggested that gender and age difference can affect personal relationship as well. We included the age difference (i.e., the absolute value of source's age - seeker's age) and gender difference (1 = same gender, 0 = different gender) as control variables for personal relationship. Notice while physical distance served as a main independent variable to sourcing frequency, it was a control variable to personal relationship. A factor that could affect the perception of knowledge quality, but is not a formal structural factor is job tenure. Old-timers tend to have more experience with an organization, hence are likely to be regarded as more knowledgeable. Therefore, we include the job tenure seniority (source's job tenure – seeker's job tenure) as a control variable for information quality of a source.

Data Analysis

Among the 35 respondents, twenty-nine (29) were in the 20-30 age group, with five (5) in the 30-40 group and only one in 40-50. There were twenty-five (25) males and ten (10) females. Twenty-four (24) had a bachelor's degree, ten (10) held a master's degrees or above. Ten (10) of them worked for the university for less than two years, nineteen (19) for 2-5 years, four (4) for 5-10 years, and one for more than 10 years.

We employed a two-step process to test our hypothesis. In the first step, we used network analysis to generate the correlations among the variables. Because network data do not satisfy the assumption of statistical independence, ordinary least squares regression could not be used. Following Borgatti and Cross [18], quadratic assignment procedure (QAP) was used to get the correlations among variables. QAP uses a randomization/permutation technique to construct

significance tests. The significance levels for correlation were based on distributions generated from 2,000 random permutations in our study.

Table 2 gives the correlation matrix among all variables. Several observations could be made. The positive correlations between supervisory relationship, personal relationship, information quality of a source, and sourcing frequency were as expected. The negative correlation between physical distance and sourcing frequency was also as expected. The correlation between competition and sourcing frequency was positive, which contradicted our expectation, but it was insignificant.

<<Insert Table 2 about here>>

Because our research model has multiple dependent variables, the often adopted multiple regression quadratic assignment procedure (MRQAP) [61], [62] was not applicable to our study. Instead, path analysis using LISREL was employed to test hypotheses with the correlation table obtained from the quadratic assignment procedure as input.

Figure 1 reports the hypothesis testing results with standardized coefficients. Regarding sourcing frequency, information quality of a source ($b=0.17$, $p<0.001$), physical distance ($b=-0.15$, $p<0.001$) and personal relationship ($b=0.14$, $p<0.001$) were all significant, lending support to H1, H2 and H3 respectively. Regarding the antecedents of personal relationship, results indicate that job interdependence ($b=0.29$, $p<0.001$) was significant, lending support to H4. However, competition ($b=-0.04$, $p=0.34$) was insignificant to personal relationship, lending no support to H6. The control variables of personal relationship, age difference ($b=-0.06$, $p<0.05$), gender homophily ($b=0.15$, $p<0.001$) and physical distance ($b=-0.13$, $p<0.001$) were all significant. Regarding the antecedents of information quality of a source, both job interdependence ($b=0.37$, $p<0.001$) and competition ($b=0.15$, $p<0.001$) were significant, lending support to H5 and H7 respectively. Control variable tenure seniority was significant ($b=0.13$, $p<0.05$). However, supervisory relationship ($b=-0.01$, $p=0.28$) was insignificant, lending no support to H8. Nevertheless, supervisory relationship was significant to sourcing frequency directly, which was in support of H9.

<<Insert Figure 1 about here>>

Discussion and Implications

Discussion of Data Analysis With an objective to investigate factors that affect a member's information sourcing frequency in a team context, we found structural factors such as job interdependence, competition and supervisory relationship directly or indirectly affect sourcing frequency in an IS project team. Most hypotheses were significant as postulated based on theoretical reasoning, but a few failed. Overall, the model has explained a reasonable portion of the variance in dependent variables (i.e., personal relationship: $R^2=0.13$; source quality: $R^2=0.18$; sourcing frequency: $R^2=0.12$).

Why was competition insignificant to personal relationship? The most plausible reason is that a member was only competing with a very small number (e.g., 1 or 2) of other colleagues. Overall, the average competition was very low (mean = 1.22 out of an 11-point scale). The low competition could also be due to the early stage of the project. Because the project team was still expanding and many of them were within the first two years in the project, it was less likely for members to worry about competition and job security in the near future. Third, respondents'

responses to this question might be subject to the social desirability bias as well. All these reasons could make competition insignificant in this study.

Why was supervision insignificant to source quality? The significance of Hypothesis 9 indicated that supervisors were in fact sought after for information. However, the perceived information quality of a source was not attributed to a supervisory position the source assumed. A plausible explanation is that the information seeking motivations could be different for peers and supervisors. Supervisors were probably sought for approval, endorsement and support rather than technical solutions [34], especially in a culture of larger authority distance. Another possibility was that the supervisors were not technical experts. However, in this team, except for one, the rest had extensive experience in IT development. This explanation was less tenable.

While they were not the focus in this study, the control variables in this study revealed interesting findings too. First, homophily factors (i.e., gender homophily and age homophily) were found to be important facilitators to the development of personal relationship which in turn boosts information sourcing. Physical distance was often regarded as a cost factor in information seeking [18], [21], [22], [27]. What this study suggests is that it hampers the development of personal relationship too, hence further thwarts information sourcing. In addition to formal structural factors, tenure seniority was found to be another factor significant to the perception of information quality of a source. While it is intuitive that employees' knowledge grows with their experience over time, the finding confirms the importance to mix the experienced and inexperienced in job design.

Limitations There are a few significant limitations to the findings of this study. First, it was cross-sectional. The dependent variables were measured at the same time as the independent variables, and both were retrospective. As common in similar studies [18], [19], the relationships found should be interpreted as correlational or weakly causal. Second, this study would benefit from a direct measure of social desirability and controlling it in hypothesis testing. Third, the study was conducted with only one team in a Chinese university context. Although the hypotheses were development based on theoretical reasoning that is not confined by this context, the context might have an effect on the testing result. Because the Chinese culture is often regarded as collectivistic rather than individualistic [63], generalizing to other contexts of significant difference should be treated with cautions. Besides the methodological limitations, this study did not differentiate types of knowledge one seeks [18], [35], which represents an interesting future direction for research. Moreover, other variables pertaining to the formal and informal relationship between a seeker and a source can be added in future studies to improve the explanatory power of the model.

Theoretical Implications Given the limitations and precautions to interpret this study, we believe this study still generates interesting theoretical and empirical implications for future research. First, this study offers insights to understand at a dyad-level how team members of an IS project learn. Most prior studies on IS projects were conducted at the project level [3], [7], [8], [12]. These studies to a large degree have established (1) the importance of team social interactions to the success and outcome of a project and (2) the nature of social interaction being knowledge transfer. However, there is no study on what affects the degree of knowledge transfer. This study offers a partial answer to the question: It explains how team members seek knowledge from each other through the knowledge and relational network. We consider knowledge seeking

a key element in knowledge transfer and creation because voluntary knowledge sharing is known to be a difficult task [13], [14]. Active knowledge seeking is a major means of individual learning [21]. It is through active knowledge seeking that an advice network comes into being to facilitate knowledge transfer and creation in an organization. To this end, this study provides a conceptual model to explain team members' sourcing frequency which is essentially a measure of frequency of knowledge transfer in an organizational advice network.

Second, we further introduce a set of important structural factors to explain the formation of advice and relational networks in IS project teams – job interdependence, competition and supervisory relationship. These constructs extend the cost-benefit framework and the relational view by highlighting the importance of formal structure in shaping the informal network and advice network. Past social network studies tend to emphasize the importance of an informal “shadow network” [38] on how work actually got assigned and done. Our study, at least in a professional IS project team, suggests that formal structural factors like job interdependence and supervision relationship are critical to the sourcing behavior. Particularly, job interdependence affects knowledge sourcing through both relationship building and perception of the information quality of a source. Competition, though insignificant to personal relationship, contributes to the perception of the information quality of a source which in turn leads to sourcing. Supervisory relationship seems to contribute directly to knowledge sourcing because supervisor provides a different kind of information that is unavailable from peers. In short, we explain how formal structure serves as a springboard for the development of advice network.

Structural factors offer a platform for frequent social interactions in IS project teams. Tiwana and McLean [8] suggested the importance of relational capital in a project to expertise integration. In their study, relational capital is defined as the closeness and trust displayed in working relationships among members. A trusting relationship facilitates the exchange of complex and tacit knowledge. Andres and Zmud [7] proposed the concept of organic coordination, which is informal, decentralized and cooperative coordination in IS project teams, and considered it to be more critical in complex projects. Patnayakuni et al. [3] made similar observations. What past studies did not illuminate is the mechanism that leads to frequent and hopefully better social interactions. We suggest structural factor, particularly job interdependence, does not necessarily work as an iron cage against the development of informal relational capital. In contrast, it can serve as an important facilitator. While job interdependence per se does not guarantee a trusting relationship or organic coordination, it is the prerequisite for frequent information seeking. Without job interdependence, there will be less communications among team members and consequently less knowledge transfer and creation. This observation emphasizes the importance of formal job design in an IS project. However, since job interdependence incurs coordination cost, there is a need to balance coordination cost and social interaction in job design.

Third, joining prior literature, this study is in support of the notion that knowledge seeking in IS project teams is also a knowledge creation process. Particularly, knowledge seeking might not be the simple “ask and give”. The significance of job interdependence to the information quality of a source seems to suggest that knowledge seeking is often a knowledge co-producing process [8]. It is not necessarily the objective level of the knowledge a source possesses that is attractive to the seeker, it is the repeated cooperation that makes the two parties coauthor the problem solving knowledge. This characteristic differentiates the knowledge seeking behavior of IS project teams from the more general information seeking behavior in organizations whereby the

information quality of a source is assumed to be independent of the seeker [18], [19], [20], [21], [22], [35]. Borgatti and Cross [18] suggested that awareness of the other's expertise leads a seeker to access a source. When the seeking is successful, it strengthens the seeker's belief that the source is good and increases the dependence of the seeker on the source, a phenomenon known as path-dependency. Our finding explains an important reason to path-dependency, which is through knowledge coauthoring as demanded by job interdependence. In this regard, it is also important to identify factors that lead to knowledge coauthoring. Factors like the organizational structure of a team, job design, and organizational culture can potentially play a role. Future research in this direction is needed. Meanwhile, this study suggests a possible way to resolve the path-dependency effect in organizational learning. Our study suggests that job interdependence is an influential factor in information seeking. Therefore, altering mutual responsibility for work accomplishments could alter the existing path-dependency to a relationship desirable to the organization.

Finally, our study offers a theoretical explanation to the formation of tie strength in the advice network of a project team. From the social network perspective, tie strength is often measured by communication frequency [36]. Communication frequency subsumes active knowledge seeking and passive knowledge receiving. Proactive knowledge seeking is the major form of employee learning [21]. While earlier literature has used tie strength mainly as an independent variable to explain employee behavior such as problem delegation, turnover and new technology adoption [38], our investigation aims to explain the antecedents of its major component: sourcing frequency. In this regard, this study suggests structural factors exert an important influence on the tie strength in a professional project team.

Practical Implications The impact of structural factors has practical implications as well. First, it suggests job interdependence should be planned into job design. While job rotation has been suggested as a method to prevent organizational forgetting, it simply alleviates organizational forgetting through knowledge duplication. Designing jobs for interdependence, however, is a technique that fosters learning. Job interdependence might be achieved by changing the incentive system so that members are rewarded by group performance and are responsible for joint output. It also can be achieved by assigning new tasks that require mutual effort and collaboration. Overspecialization should be avoided in job design.

This study has direct implications for IS project teams. IS development methods often stress creating software or hardware in modules [7]. Modular design is important to ensure development quality, but if job design simply echoes the modular structure of a system, it might lead to insufficient knowledge seeking among members. A team member could be assigned to modules from different domains, such as modules for different business functions or modules at different project stages (e.g., requirement analysis, system design, coding and user test). Such assignments alleviate organizational forgetting and force members to learn from each other's domain. Of course, in practice, there is a need to balance specialization and skill diversity so that members are not overloaded.

Second, this study suggests that competition is not necessarily a negative factor in a team when carefully managed. In this example, competition did not imply a relational tension, but implied the relevance of a source which was conducive of information seeking. Therefore, it is not a manager's objective to eliminate competition, but rather to control it at a level that does not jeopardize interpersonal relationships.

Third, managers need to realize that the information role of a supervisor is often not a solution provider, but rather a provider of direction of actions, confirmation and official support [34]. Supervisors are also sought because subordinates might want to build a better personal relationship [34] and to discharge future surprises [23]. The awareness of such information roles would help a manager manage a team more effectively. The typical career path for IS professionals is often to upgrade from a developer to a project manager. The professional training such as Project Management Body of Knowledge (PMBOK) stresses the importance of project management knowledge areas. However, this study suggests the communication between managers and their team has a broader spectrum than the communication of technical project knowledge.

Together with extant research, our study confirms that proximity plays an important role in knowledge distribution. In IS project teams, proximity is still an important factor in knowledge seeking even though the project teams might have access to various digital communication media like teleconferencing. Modern communication technology might solve the problem of information transmission; it does not solve the problem of building a close personal relationship which is conducive to future information sourcing. For distributed teams, possible relationship building mechanisms include interdependence in job design and scheduled conferences at a central location.

While our study took an IS project as the context of the study, our findings are of reference value to other engineering domains as well. For example, Pinelli et al. [64] found that U.S. aerospace engineers and scientists spent 77% of their time on communication with others, among which 13.97 hours per week were spent on the communication received from others. Facilitating communication in these engineering teams could help boost their productivity.

In conclusion, while this study is limited in scope, it introduces an important aspect to our understanding of employee knowledge seeking behavior in project teams. It indicates that formal structural factors should not be neglected in studying sourcing frequency; they can exert a very significant impact via the formation of advice and relational network. Going beyond the simple cost-benefit argument, this study introduces important structural factors that affect information seeking in IS project teams. These factors, together with traditional view of cost and benefit, help explain the formation of relational and advice network in project teams.

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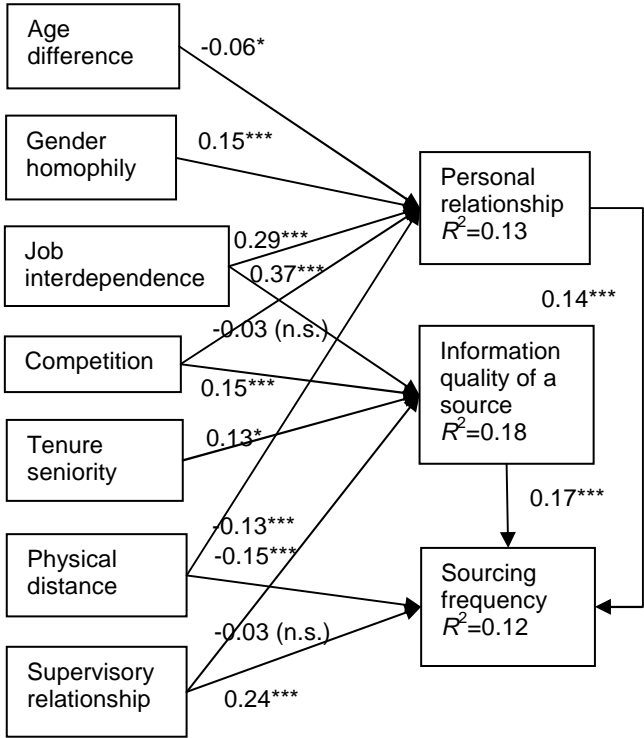
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Table 1
Questionnaire Items for Dependent and Independent Variables

Construct	Item
Job interdependence	My job is closely related to his/hers. For example, if he/she does not carry out his/her work properly, my performance in the project will be affected. How likely will his/her performance affect yours? (new item)
Competition	How likely will you and he/she apply or compete for the same job position in the future? (new item)
Supervisory relationship	Who is your direct supervisor in the project team? [35]
Personal relationship	How close is the personal relationship between you and him/her beyond working relationship? (new item)
Information quality of a source	How is the quality of information he/she provided to you in the past (for example, the sufficiency, reliability, relevancy and novelty of information)? [22]
Physical distance	1 = same room, 2 = same floor, 3 = some building [35]
Sourcing frequency	(GetInfor) Please indicate the average times that you have turned to him/her for project-related information or knowledge per week. [18] (GiveInfo) Please indicate the average times that he/she has turned to you for project-related information or knowledge per week. [18]
Age difference	The absolute value of the difference in age
Tenure seniority	Source's job tenure minus seeker's job tenure

Figure 1
Hypothesis testing result



*p<0.05, **p<0.01, ***p<0.001.

Table 2
Correlation among Variables

	Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Age difference	4.83	5.05	1								
(2) Competition	1.22	2.09	-0.19**	1							
(3) Job interdependence	2.01	2.67	0.21*	0.01	1						
(4) Physical distance	1.18	0.74	0.13	-0.22**	-0.05	1					
(5) Personal relationship	4.06	2.78	-0.01	0.01	0.30***	-0.14*	1				
(6) Info. quality of a source	5.13	3.43	-0.01	0.17*	0.37***	-0.15*	0.50***	1			
(7) Gender homophily	--	--	0.00	-0.05	0.08	0.04	0.17**	0.05	1		
(8) Supervisory relationship	--	--	0.04	-0.02	0.25***	-0.06	0.05	0.06	0.02	1	
(9) Tenure seniority	0	28.16	0.00	0.05	0.04	0.00	-0.05	0.15*	0.00	-0.01	1
(10) Sourcing frequency	1.87	3.23	0.09	0.04	0.55***	-0.21***	0.26***	0.28***	0.09*	0.27***	-0.01

*p<0.05, **p<0.01, ***p<0.001.