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Creative Ties and Ties That Bind: Examining the Impact of Weak Ties on Individual Performance

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Abstract

This paper examines whether the information sources used by knowledge workers have an impact on individual performance and creativity. Although it is widely recognized that new knowledge is created through the combination and exchange of existing knowledge, there is a large variety of knowledge sources available to individuals. In this study, we examine whether individual performance varies as a result of (1) individual factors, (2) usage of a variety of information sources, (3) reliance on colocated colleagues, or (4) participation in an organizational electronic community. Results indicate that experience and education predict general performance, regardless of the type of information sources used. However, the type of information sources used by individuals relates significantly to creativity. Reliance on colocated colleagues results in less creativity while participation in an electronic community leads to higher creativity. Additional analysis reveals that participation in the electronic community does not have a direct effect on creativity, rather participation has a direct impact on the acquisition of new knowledge, which in turn influences creativity. Group tenure and type of participation (posting questions vs. responses) are also important predictors whose effects are fully mediated through knowledge acquisition. Finally, professional commitment did not contribute to knowledge exchange in the electronic community, rather professional commitment had a direct effect on creativity.

Keywords: Knowledge management, electronic community, internet, performance

1. INTRODUCTION

Due to the fundamental shift away from the industrial economy to an age of information, an increasing number of scholars are claiming that knowledge and the creation of new knowledge through its combination and exchange is perhaps the only "true" source of competitive advantage for a firm (Drucker 1991; Grant 1996; Nahapiet and Ghoshal 1998; Nonaka 1994). In today's competitive environment, firms are experiencing increasing pressure to do a better job of gaining access to new knowledge in their business environment while at the same time leveraging their existing knowledge within the boundaries of the firm (Bartlett and Ghoshal 1989; Doz and Hamel 1997; Drucker 1990; Hedlund and Nonaka 1993). However, these efforts are becoming increasingly complex as employees become more dispersed due to globalization and the expansion of the number of information sources (Hagström and Hedlund 1998). Thus, companies are responding to the new competitive situation by increasing their knowledge management activities (Ruggles 1998).

Due to advances in information and communication technologies, companies are relying heavily on technical knowledge management solutions. Companies are implementing applications that facilitate the capturing of codified experiences and reusable

work products in databases and other knowledge repositories. In addition, technologies are being used to facilitate communication and collaboration, reducing the impact of time and geographic constraints. These technologies include company intranets, directories, knowledge maps, and groupware (Ruggles 1998).

However, an increase in the availability of knowledge may not translate into new knowledge creation and improved performance, especially in complex knowledge environments. The codification of knowledge only increases the amount of "static" knowledge available to individuals, but does not ensure that people actually access this knowledge. In many cases, people seek information that is the most easily accessed (such as asking colocated colleagues), rather than search for the best information (O'Reilly 1982). Yet, theories of weak ties suggest that the knowledge provided by colocated colleagues is largely redundant, and knowledge accessed through weak tie relations located beyond traditional community boundaries is critical for fostering new developments and innovations (Granovetter 1973, 1983). Thus, weak structural links or "bridging links" between organizational members facilitate critical knowledge flows, enabling the transfer of new ideas and innovations across local communities (Granovetter 1973).

The goal of this research is to examine whether the type of information sources used by individuals impacts individual performance and how. Such inquiry makes three important contributions. First, it clarifies how information sources are related to individual performance in complex knowledge environments. Second, the results of this research can guide theory building on the importance of weak ties for accessing new knowledge and enhancing creativity by crossing strong tie networks. And finally, this research makes possible more precise theoretical models of how information technologies can be designed and deployed to support knowledge exchange and the creation of new knowledge to enhance both individual and organizational performance.

2. THEORETICAL BACKGROUND AND HYPOTHESES

First, we are interested in examining whether there is a relationship between individual performance and the information sources used by individuals in complex knowledge environments. In addition, we are interested in examining two types of performance: general performance (ability to meet one's job demands) and creativity (ability to develop creative solutions). We expect that the information sources used by individuals will impact general performance and creativity in different ways, i.e., general performance is reflective of application of current knowledge, while creativity is concerned with new knowledge creation and innovation (specific hypotheses follow). In addition, individual factors, often referred to as human capital, are also key predictors of performance. Therefore, we control for both education and experience to examine the impact of information sources on performance above and beyond human capital.

Today's employees have a wealth of synchronous and asynchronous information and communication channels at their fingertips and can relatively easily search company intranets and databases, as well as external information sources for advice or existing solutions (Constant et al. 1996). The assumption underlying these investments in technology is that increasing an individual's access to more knowledge resources will improve the performance of individual knowledge workers, ultimately driving increases in business performance (Davenport et al. 1998; Davenport and Prusak 1998; O'Dell and Grayson 1998). This assumption is based on the belief that new knowledge is created through the combination and exchange of existing knowledge (Nahapiet and Ghoshal 1998; Nonaka 1994). Thus, increasing the amount of information sources and communication channels employees have available should increase the likelihood of new knowledge creation, resulting in higher creativity. This leads us to our first hypothesis:

> *Hypothesis 1a:* *The greater the use of a variety of information sources, the higher the level of individual creativity.*

However, increased access to more information could potentially lead to information overload. Although knowledge is often viewed as the most important firm resource, new knowledge is created in the minds of individuals through focused attention. Therefore, attention is the most important resource available to individuals and critical for new knowledge creation (Davenport and Prusak 1998). With increased access to more information sources, employees may spend more time searching for information and less time performing the task at hand. This leads us to our second hypothesis:

> *Hypothesis 1b:* *The greater the use of a variety of information sources, the lower the level of individual general performance.*

Although people have access to a variety of resources, research has consistently found that people share knowledge with others in their physical proximity, demonstrating that people often rely on colocated colleagues for knowledge sharing (Allen 1977;

Monge et al. 1985). Ethnographic research on actual work practices finds that people working in close proximity on similar issues develop communities of practice. Members of these communities share the same language, code of behavior, and identity and these communities are instrumental for sharing ideas and assimilating new members, resulting in higher performance of the community as a whole (Brown and Duguid 1991, 1998; Wenger 1998). This leads to our next hypothesis:

> *Hypothesis 2a:*   *The greater the reliance on co-workers as information sources, the higher the level of general performance.*

However, theories of weak ties suggest that, due to the redundant nature of the knowledge residing in strong tie networks, weak ties are essential for bringing new ideas and innovations to the strong tie community. The theory of weak ties argues that those individuals who access a broader network of acquaintances and relative strangers can gain more useful information compared to those individuals who rely to a higher degree on individuals with whom they have strong ties (e.g., family, close friends, and working relations). The key point is that these strong ties provide little additional information over what an individual already knows (Granovetter 1973).

> *Hypothesis 2b:*   *The greater the reliance on co-workers as information sources, the lower the level of creativity.*

Finally, there is a third perspective regarding the use of technology to support knowledge management, that of using technology to create electronic communities of practice. Communities of practice traditionally emerged through the mutual engagement in work, and that work was mostly performed by workers who were colocated (Wenger 1998). Advances in ICT such as bulletin boards, listservs, and chat rooms connect knowledge workers electronically to communities of globally dispersed individuals, and these technologies provide a new means to manage knowledge. Within these electronic communities, individuals are able to share knowledge through mechanisms that support posting and responding to questions, sharing stories of personal experience, and discussing and debating issues relevant to the community (Wasko and Faraj 2000). As a result, knowledge is continuously created and shared through open discussion and collaboration, regardless of distance.

Non-colocated colleagues are able to quickly communicate and help each other solve problems, thus making expertise and ideas available regardless of location and reducing dependence on colocated colleagues.

These electronic communities facilitate the creation of weak structural links or "bridging links" between like-minded, but dispersed, professionals. Research suggests that the most useful sources of technical advice are provided by organizational actors linked only through weak ties on computer networks (Constant et al. 1996). Therefore, electronic communities advance the knowledge of the community as a whole (increasing general performance) and weak ties are created by electronic links increasing access to new ideas and innovations. This then leads us to our third set of hypotheses:

> *Hypothesis 3a:*   *The higher the level of participation in an electronic community, the higher the level of general performance.*

> *Hypothesis 3b:*   *The higher the level of participation in an electronic community, the higher the level of creativity.*

Figure 1 provides an overview of the information sources framework.

3. RESEARCH SETTING

This research was undertaken in the Nordic operations (Denmark, Finland, Norway, and Sweden) of Cap Gemini.[1] Cap Gemini is Europe's largest IT services and management consulting company with more than 40 offices and 4,500 employees in the Nordic region alone.[2] The choice of this site was motivated primarily on the basis that employees at Cap Gemini were knowledge workers, i.e., creating an information product and leveraging knowledge was critical to their individual performance. Not only

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[1]This study was performed prior to the merger of Cap Gemini and Ernst &Young Consulting. As a result, the company description takes only the Cap Gemini organization into consideration.

[2]Of these 4,500 employees, 3,000 are consultants working with the direct delivery of services while the remaining 1,500 have administrative and sales responsibilities.
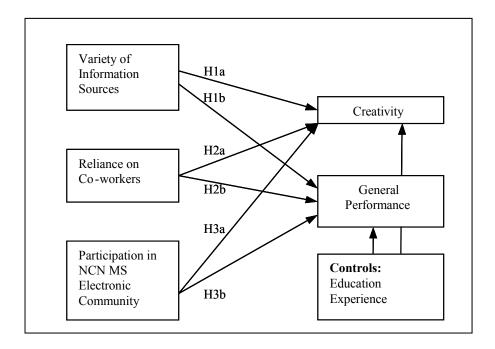
Figure 1. Impact of Information Sources on Performance

were these employees using the latest technology but they also had access to a wide variety of information sources including knowledge directories and documentation. In addition, these employees used electronic media to communicate to a very high degree due to Cap Gemini's dispersed organization.[3]

Within the Nordic region, Cap Gemini has numerous networks designed to enhance the company's knowledge management activities. We chose one electronic community, the NCN MS, because it was recognized as a successful, vital conduit of information exchange. This community's members consisted of IT consultants working with the application of Microsoft products within projects for Cap Gemini's clients. The job required a considerable amount of creativity as new problem situations constantly arose due to the rapid pace of change in information technology as well as the variance among client projects. The NCN MS electronic community was then used by its members to draw upon other community members for task-related problem-solving advice. The NCN MS community members primarily used the community's listserv when they had a question regarding how to perform their tasks at work. Thus, when one person needed help, he or she posted a question to the whole community through the listserv. At the time of the data collection, there were between five and ten requests for help per day on the NCN MS listserv.

4. STUDY DESIGN AND DATA COLLECTION

In November 1999, we began the data collection with five in-depth interviews with people involved within Cap Gemini Nordic's knowledge management operations. Interviews were conducted to better understand the implementation and use of electronic communities within Cap Gemini. Through these interviews, it was decided to choose the NCN Microsoft Community as the site for our data collection. This electronic community had 350 members spread across the Nordic countries and the members of this community all worked with applying Microsoft products in their responsibilities with Cap Gemini. The primary data collection involved the electronic survey technique (EST) of a web-based questionnaire.

We pilot tested the questionnaire on a group of 15 programmers. Pilot tests results indicated that the survey instrument was too long, thus items outside of the scope of this research were dropped from the survey. A copy of the revised survey was sent to each of the NCN Microsoft Community members asking him or her to complete the questionnaire during January 2000. Throughout

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[3]It is also important to mention that the Nordic area is at the forefront of digital communications technology, with one of the highest penetration rates in the world in PCs, Internet access, and cellular telephones.

the data collection process, individuals were assured that their responses would be kept confidential and that all results would be presented only on an aggregate level. Of the initial 350 individuals, five e-mails were electronically returned due to an invalid address. We received a total of 83 usable survey responses from the 345 participants with valid email addresses for a response rate of 24%. The average age of the respondents was 35.6 years with an average of 4.0 years employed at Cap Gemini and 7.7 years of experience in their competence. The sample was 8% women, which was representative of the number of women working within the NCN MS electronic community. See Appendix A for details on the dependent and independent measures used for this analysis. Summary statistics for control variables and the other variables are presented in Table 1.

Table 1. Means, Reliabilities, and Correlations: Information Sources Framework

	Scale Range	Mean	s.d.	Cronbach's Alpha	1	2	3	4	5	6
1. Electronic community participation	1-7	2.3	.82	n/a						
2. Education	1-5	2.87	.97	n/a	-.07					
3. Experience	0-35	7.69	7.79	n/a	.16	-.07				
4. Colocated colleagues	1-7	5.9	1.64	n/a	.04	-.08	-.15			
5. Variety of info sources	1-7	3.14	1.50	.86	.53	-.06	.17	.16		
6. Creativity	1-7	4.23	1.24	.72	.46	-.15	.27	-.16	.34	
7. General performance	1-7	4.47	.81	.75	.03	-.22	.29	-.05	.15	.38

$N = 83$

Correlations > .22 are significant at the $p < .05$ level

5. ANALYSIS AND RESULTS: INFORMATION SOURCES FRAMEWORK

Factor analysis shows clean separation between the use of a variety of information sources versus colleagues in addition to a clean separation between performance measures. (See Appendix A for the results of the factor analysis.) We used hierarchical regression analysis to test the theoretical model. We ran two sets of hierarchical regressions, one for general performance and one for creativity. In the first step, we entered the control variables, level of education, and experience. In the second step, we entered the three information sources to see if different information sources impact individual performance.

Table 2 presents the results of the hierarchical regression analysis for general performance. Model 1 investigates the impact of the control variables, education and experience, on general performance. The R^2_{adj} of the model is 12%, and is statistically significant ($F = 6.04$, $p < .01$). Thus, individual control variables are associated with general performance.

Model 2 presents the regression results associated with information sources factors (colocated colleagues, variety of information sources, and participation in the NCN MS community). While the overall model is still significant, information sources were not significant predictors of general performance ($R^2_{adj} = .14$, $\Delta R^2 = .005$, F for $\Delta R^2 = .13$, ns). In the full model (Model 2), we note that the control factors predict general performance, regardless of the type of information sources that are used. The level of experience has a positive, significant relationship with general performance ($b = .31$, $p < .01$). In addition, the level of education has a significant, negative relationship with performance ($b = -.26$, $p < .05$).

Table 3 presents the results of the hierarchical regression analysis for creativity. Model 1 investigates the impact of control variables. The R^2_{adj} of the model is 10%, and is statistically significant ($F = 4.85$, $p < .05$). Thus, individual factors are related to creativity. Model 2 presents the regression results associated with information sources factors (colocated colleagues, variety of information sources, and participation in the NCN MS community). The overall model is significant, and information sources were significant predictors of creativity ($R^2_{adj} = .26$, $\Delta R^2 = .19$, F for $\Delta R^2 = 6.29$, $p < .001$).

In the full model (Model 2), we note that the control variables are no longer significant predictors of creativity, rather differences in creativity are significantly related to the type of information sources used. People who rely on colocated colleagues for information have a significant, negative relationship with creativity ($b = -.155$, $p < .05$), indicating that people who access information mainly from co-workers have a lower degree of creativity. In addition, participation in the NCN MS electronic community has a positive, significant relationship to creativity ($b = .33$, $p < .01$). This indicates that people who participate in the community are more creative. There was no relationship between people who use a variety of information sources and creativity.

Table 2. Results of Hierarchical Regression Analyses for General Performance: Information Sources Framework

	Model 1 Control	Model 2 Information Sources
Control β		
Education	-.25*	-.26*
Experience	.30**	.31**
Information Sources β		
Colocated colleagues		-.05
Variety of information sources		-.04
Electronic community participation		-.01
R^2	.15	.15
R^2 adj	.12	.09
F	6.04**	2.40*
ΔR^2		.005
F for ΔR^2		.13

  * p < .05
 ** p < .01
 *** p < .001

Table 3. Results of Hierarchical Regression Analyses for Creativity: Information Sources Framework

	Model 1: Control	Model 2: Information Sources
Control β		
Education	-.18	-.155
Experience	.311**	.201
Information Sources β		
Colocated colleagues		-.22*
Variety of information sources		.116
Electronic community participation		.33**
R^2	.12	.31
R^2 adj	.10	.26
F	4.85*	6.15***
ΔR^2		.19
F for ΔR^2		6.29***

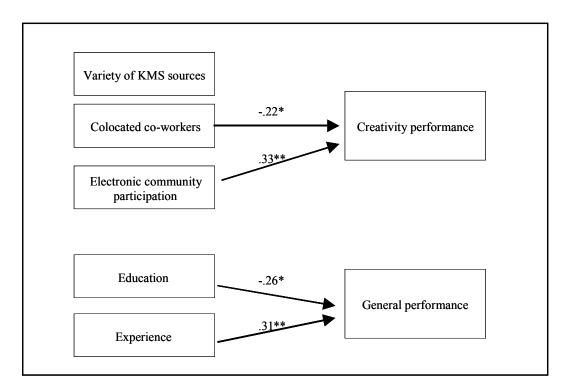 * p < .05
 ** p < .01
 *** p < .001

Figure 2. Results of Hierarchical Regression Analyses for the Information Sources Framework

Figure 2 provides an overview of the findings regarding the information sources framework.

6. KNOWLEDGE EXCHANGE FRAMEWORK

Given the results of the first analysis, we explored in more detail why participation in the electronic community leads to more creative performance. As discussed above, participation in an electronic community enables an individual to communicate with other individuals who are connected through weak ties and are dispersed across a firm's geographical locations. Thus, knowledge exchanged through such participation is often that which is not available from strong tie connections and formal documentation. The ability to then acquire new knowledge and combine it with existing knowledge should enable a higher level of creative performance.

In an electronic community, the combination and exchange of knowledge occurs through two mechanisms termed knowledge exchange: (1) acquiring knowledge through participation in the community and (2) contributing knowledge to other community members. Knowledge acquisition occurs when people learn from their participation in the group. Knowledge contribution occurs when people feel that the knowledge they contributed to help others resulted in others having new insights. However, knowledge contribution could also result in creativity. Helping others with their complex knowledge problems often results in new solutions, triggered by the problems of knowledge seekers. Thus, this leads us to our fourth hypothesis:

> *Hypothesis 4:*   *The higher the level of individual perceptions of knowledge exchange (both knowledge acquisition and knowledge contribution), the higher the degree of individual creativity.*

We assume that both individual factors as well as the type of participation in the community affect creativity, but these effects are mediated by the combination and exchange of knowledge. Therefore, the following hypotheses are expected to have direct effects on knowledge acquisition and knowledge contribution, and indirect effects on creativity (i.e., knowledge exchange mediates the relationships between antecedents and creativity).

Participation. In addition to individual assessments of knowledge exchange, higher rates of participation in the community should be an indicator of both knowledge contribution and knowledge acquisition. People who spend more effort participating in the

group are more likely to come across new ideas and innovations posted there, as well as be presented with opportunities to offer their help to others. This leads to our next hypothesis:

> *Hypothesis 5:   Higher levels of participation will have a direct effect on knowledge exchange.*

Group Tenure. Longer group tenure increases the likelihood that individuals have access to more flows of information being exchanged in the group. In addition, longer group tenure is indicative that people are committed to the group, thus are more likely to feel an obligation to participate in knowledge exchange. Finally, and perhaps most importantly, longer group tenure is related with the development of an understanding of the community's vocabulary, norms, codes, and routines. This shared understanding facilitates knowledge sharing and the ability to combine and exchange knowledge (Brown and Duguid 1991, 1998; Wenger 1998). Thus, we predict the following:

> *Hypothesis 6:   The longer the group tenure, the higher the level of individual knowledge exchange.*

Professional commitment. A final individual factor that could influence creativity is the level of professional commitment that an individual has. Professional commitment assesses the extent to which people are committed to the occupational community as a whole, have a vested interest in participating in the wider professional community, and feel an obligation to advance the community. People who have a strong professional commitment may be more likely to contribute knowledge to the group because of a strong personal commitment to their profession. In addition, people who are professionally committed are more likely to be able to acquire knowledge from their participation due to their sense of identification with the community.

> *Hypothesis 7:   The higher the level of professional commitment, the higher the level of knowledge exchange.*

Type of Exchange. Besides individual factors, the type of participation in the community should also be an important determinant of knowledge acquisition and knowledge contribution. There are basically two types of participation in the electronic community: (1) posting questions that seek advice and help and (2) posting answers that provide knowledge to the information seekers. In this environment, people posting questions will most likely have a direct relationship with knowledge acquisition since they are specifically asking for knowledge. Besides posting questions, people also post responses. People who respond to requests for help will have a direct relationship with knowledge contribution and also a positive, direct relationship with knowledge acquisition. When people work through each other's problems, they often develop insights into new methods and new applications for existing knowledge (Wenger 1998). Exercising intellect by helping others is also likely to help people maintain and even improve their technical skills. Therefore, people that participate by posting responses will also acquire knowledge from participation, but the impact of posting (both questions and answers) on creativity will be fully mediated by knowledge acquisition.

> *Hypothesis 8:   The more an individual posts questions to the electronic community, the higher the level of individual knowledge acquisition from the electronic community.*

> *Hypothesis 9:   The more an individual posts responses to in the electronic community, the higher the level of knowledge exchange.*

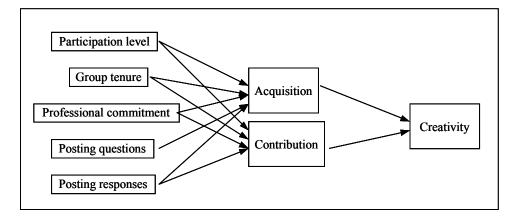Figure 3 contains a model of the knowledge exchange framework.

Figure 3. Knowledge Exchange Framework

7. ANALYSIS AND RESULTS: KNOWLEDGE EXCHANGE FRAMEWORK

Specific measures and details of independent and dependent variables are provided in Appendix B. Summary statistics are presented in Table 4. To examine why participation leads to creativity, we chose path analysis as the modeling technique for this part of the study due to its ability to assess causal relationships and decompose effects into direct and indirect components (Pedhazur 1982). The major advantage of path analysis is its ability to derive the relative magnitude of the direct effects on creativity, and the indirect effects through knowledge contribution and knowledge acquisition.

Table 4. Means, Reliabilities, and Correlations: Knowledge Exchange Framework

	Scale Range	Mean	s.d.	Cronbach's Alpha	1	2	3	4	5
1. Electronic Community Participation	1-7	2.3	.82	n/a					
2. Group Tenure	1-50	10.81	11.64	n/a	.06				
3. Prof Commitment	1-7	3.53	1.50	.87	.29	-.03			
4. Knowledge Acquisition	1-7	2.34	1.57	.95	.59	.23	.22		
5. Knowledge Contribution	1-7	3.62	1.75	.85	.52	.29	.29	.52	
6. Creativity	1-7	4.23	1.24	.72	.46	.14	.41	.58	.34

$N = 83$

Correlations > .22 are significant at the $p < .05$ level

The model explained 40% of the variance in creative performance. Figure 4 summarizes the significant paths. Only one dimension of knowledge exchange, knowledge acquisition, was a significant predictor of creativity. Perceptions of knowledge contribution had no relationship with creativity. In addition, our speculations about the role of participation in the NCN MS electronic community are only partially supported. Higher participation levels have a direct relationship with knowledge acquisition, but no relationship with knowledge contribution, and the impact of participation on creativity is fully mediated through knowledge acquisition. As predicted, group tenure had direct positive relationships with both knowledge acquisition and knowledge contribution. Hypothesis 7 was not supported. Professional commitment did not predict either type of knowledge exchange, but had a positive, direct effect on creativity. This may be because people committed to the profession are more likely to maintain weak interpersonal ties to the wider community that transcend the combination and exchange of knowledge that occurs in the electronic community.
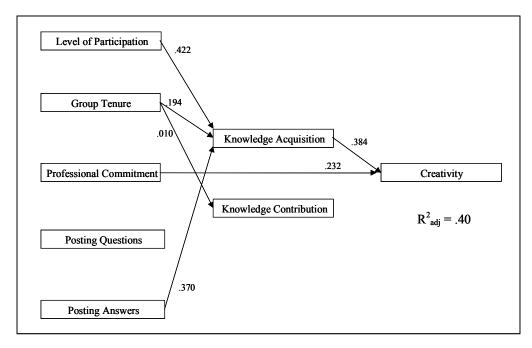

Figure 4. Results of Path Analysis: Knowledge Exchange Framework

In addition to individual factors, the type of participation (hypotheses 8 and 9) also influenced knowledge exchange, but inconsistent with our prediction. People who mostly post questions do not feel that they have acquired knowledge, nor that they have contributed knowledge to others. On the other hand, people who post answers to others feel that this type of participation does result in the acquisition of new knowledge. However, there was no relationship between posting answers and the perception that they had contributed knowledge to others.

8. DISCUSSION

In general, we found that the type of information sources that people use in their work does not affect their general performance. General performance was predicted by experience with the organization, indicating that experience in complex knowledge environments is critical for meeting job expectations. In addition, we found that education had a significant, negative relationship with general performance. Therefore in our context, experience rather than education is critical for meeting basic objectives of complex knowledge work. However, information sources affect creativity above and beyond experience and education. We found that people who use a variety of information sources do not exhibit higher levels of creativity, indicating that more knowledge flows are not necessarily better. Rather knowledge exchange should be tailored to the task at hand.

An alternative theory suggests that due to the tacit nature of knowledge and the natural tendency of employees to rely on others in their physical proximity, knowledge exchange is best supported by conversations between colocated colleagues. However, we found that people who rely primarily on strong tie relationships with colocated colleagues as information sources reported lower levels of creativity. While strong tie relationships are necessary for socio-emotional and other forms of support, weak ties that bridge strong tie communities offer access to new information and innovative ideas. This finding indicates that organizations concerned with knowledge management need to rethink their knowledge strategies and find a balance between reliance on colocated colleagues and promoting cross-community knowledge flows to ensure the right degree of creativity in the firm.

Thus, although there is an increasing amount of research emphasizing the importance of communities of practice for supporting learning and innovation, our research suggests that communities characterized by strong tie networks could potentially lead to less creativity and the "not invented here" syndrome. Our results suggest that creativity results from participation in electronic communities of practice, where the technology serves as a weak tie link between dispersed individuals with similar knowledge needs and work requirements.

In our second analysis, we explored how participation in the NCN MS community influenced creativity. This supports the need for more research to examine not only that ties bridging network segments are disproportionately weak, but also that something flows through these bridges and that whatever it is that flows actually plays an important role (Granovetter 1973, 1983). We predicted that creativity resulted from the combination and exchange of existing knowledge. However, only the perception of knowledge acquisition, or the perception that participation in the group resulted in the acquisition of new knowledge predicted creativity. In addition, people who participate more, spend their time helping others with their problems, and have been with the group longer were more likely to acquire knowledge and be creative in their jobs. These findings suggest that using technology to develop repositories and other "static" knowledge management tools may not support new knowledge creation resulting in individual creativity. Rather, connecting experts with knowledge seekers and the mutual engagement in problem solving results in higher levels of creativity.

Finally, this study suggests an important new use of ICT to support knowledge management. Rather than using technology to replace traditional knowledge management techniques, we need to think of non-traditional ways to leverage these new technologies for improved knowledge management within the firm. This study showed that the creation of weak structural links between like-minded people, in other words, creating electronic communities of practice, was important for individual creativity.

9. LIMITATIONS AND AREAS FOR FURTHER RESEARCH

We should note the limitations of the study, and caution that this study was mostly exploratory and the contributions should act as guidelines for further research. First, this study only examined one electronic community in one company, thus limiting the generalizability of our findings. Further research should include both multiple communities and multiple organizations. In addition, we only surveyed those people listed as members of the NCN MS community, and our response rate, although adequate for this community, is relatively small to make conclusive statements outside of this context. Further research should include all organizational knowledge workers, the impact of location, and internal as well as external organizational information sources. Another limitation is our use of self-report, survey measures only. Further research should include objective data sources in addition to survey data. Finally, we chose the NCN MS community because of anecdotal evidence indicating its success.

However, Cap Gemini has several electronic communities that are not as successful. Further research should investigate what factors contribute to successful electronic communities and how organizations can implement and support these communities.

10. CONCLUSION

This paper examined the impact of the choice of information sources on worker performance. We found that weak tie connections that bridge strong tie communities were important predictors of creativity. Therefore, weak ties seem to be useful resources for new ideas and innovations. We found that weak ties do not have a direct impact on creativity; rather, weak ties support the acquisition of new knowledge, and it is knowledge acquisition that is a direct predictor of creativity. Finally, data show that people who rely on their strong tie relationships as information sources reported lower levels of creativity. This indicates that strong tie relationships, although critical for other types of support and influence, are ties that bind people to the same ideas and information, and potentially impede the creation of new knowledge and stifle creativity. Therefore, organizations concerned with knowledge management and creative solutions should focus on bridging strong-tie communities with electronic weak ties to promote knowledge exchange and increase individual creativity.

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Appendix A: Measure and Results of Factor Analysis: Information Framework Sources

The questionnaire contained a series of seven-point Likert scale questions, as well as several open-ended questions regarding certain aspects of community participation to provide some qualitative data. Details of the measures follow. The exact wording of specific items is listed in Appendix C.

Dependent Variables

Several different approaches exist for measuring performance, including both subjective and objective measurements. Following discussions with Cap Gemini's management, it became apparent that objective performance measures would be difficult to obtain due to issues of employee confidentiality. Accordingly, we opted to measure performance subjectively. Self-ratings were used because a number of previous studies have found them to be superior (Heneman 1974; Wexley et al. 1980) and not upwardly biased (Churchill et al. 1985). As described earlier, two measures of performance were measured: general performance and creativity.

Creativity refers to the ability to gain access to new ideas from whatever sources are appropriate to develop innovative solutions to work-related problems. As listed above, creativity was important within one's job at Cap Gemini due to the continuous challenges in an IT consultant's everyday work that resulted from rapid changes in information technology and client demands. Individuals were asked to answer three questions that created a creativity scale. The first two of these questions were taken from Teigland (2000) and the third was added based on information gathered during the interviews (three items, $\alpha = .72$).

The second measure, *general performance*, asked respondents to answer to what degree they felt they met deadlines and objectives set by their immediate superiors relative to their colleagues (two items, $\alpha = .75$).

Independent Variables

These variables included the different dimensions of the information seeking process, variety of KMS sources, co-workers, and electronic community. We measured the information sources that people found useful by listing a variety of potential information sources and asking respondents to rate, on a seven-point scale, "How often do you use the below information sources in your everyday work?" The variety of information sources consisted of six items ($\alpha = .86$). We measured weak tie, electronic information sources by asking respondents, on a seven-point scale, "How often do you participate in the NCN MS electronic community?"

Control Variables

These variables included level of education (one to five scale) and related work experience (years).[4]

Rotated Component Matrix for Information Sources

Cap's phonebook	.738	
Cap Gemini colleagues in another location	.802	
Documents produced by Cap Gemini	.800	
Cap's electronic communities	.619	
NCN MS electronic communities	.873	
Cap's Knowledge Galaxy	.733	
Colocated colleagues		.965

Rotated Component Matrix for Performance Measures

Creativity	.829	
	.842	
	.740	
General Performance		.944
		.919

Appendix B: Measures and Results of Factor Analysis: Knowledge Exchange Framework

Questions for the knowledge exchange framework were part of the same questionnaire as that used for the information sources model. Details of the measures follow and the exact wording of specific items is listed in Appendix D.

Dependent Variables

Creativity was measured in the same manner as under the information sources framework.

Independent Variables

Individual factors. Level of participation was measured by asking respondents to indicate the extent of their participation in the electronic community. Professional commitment was adapted from Mowday et al. (1982) and asked respondents to what degree they agreed with a series of three statements (three items, $\alpha = .87$). Group tenure was assessed by asking respondents how many months they had participated in the NCN MS electronic community.

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[4]In order to avoid multicollinearity problems, we decided not to include age as it correlated highly with related work experience.

Mediating Variables

Knowledge exchange. Both knowledge acquisition and knowledge contribution were adapted from Faraj and Wasko (1998). We measured knowledge acquisition (two items, $\alpha = .95$) and knowledge contribution (two items, $\alpha = .85$) by asking people to rate the extent to which they both contributed knowledge to and acquired knowledge from the NCN MS electronic community.

Rotated Component Matrix for Knowledge Exchange Model

Professional Commitment	.902		
	.897		
	.859		
Knowledge Contribution		.898	
		.880	
Knowledge Acquisition			.920
			.936

Appendix C: Exact Wording for Information Sources Framework Variables

Dependent Variables

1. Creativity

Please rate the extent of your agreement with each statement using the scale below:

My work tasks demand creative and totally new ideas and solutions	1, strongly disagree, 7, strongly agree
The others at Cap Gemini think that I am creative	1, strongly disagree, 7, strongly agree
My colleagues at Cap Gemini consider me to be a Guru	1, strongly disagree, 7, strongly agree

2. General Performance

On average, how would you rate your abilities:

Ability to meet my deadlines relative to your colleagues at Icon	1, below average, 7 above average
Ability to meet objectives set by my immediate superior relative to your colleagues at Icon	1, below average, 7 above average

Independent Variables

3. KMS Sources

How often do you use the below information sources in your everyday work?

Cap's phonebook	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom
Cap Gemini colleagues in another location	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom
Documents produced by Cap Gemini	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom
Cap's electronic communities	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom

NCN MS electronic community	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom
Cap's Knowledge Galaxy (Cap Gemini intranet)	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom
Colleagues in my location	1 – several times a day, 2 – once a day, 3 – once every two days, 4 – once every week, 5 – once every two weeks, 6 – once a month, 7 – more seldom

4. Level of Participation in Electronic Community

How often do you participate in the NCN MS electronic community?
1 – Never
2 – I mostly lurk (read messages without posting)
3 – 0-5 times a week
4 – 6-10 times a week
5 – 11-20 times a week
6 – More than 20 times a week

Control Variables

5. Education

Please list the school degrees that you have.
1 – High school
2 – High school plus additional coursework
3 – College or university bachelor equivalent
4 – Master's degree
5 – Ph.D.

6. Work Experience

How long have you worked in your area of competence? _____ years

Appendix D: Exact Wording for Knowledge Exchagne Framework Variables

Dependent Variables

1. Creativity – Same as in Appendix C.

Independent Variables

2. Professional Commitment

Please rate the extent of your agreement with each statement using the scale below:

I am extremely glad that I chose this profession over others	1, strongly disagree, 7, strongly agree
For me this is the best of all possible professions for which to work	1, strongly disagree, 7, strongly agree
I am proud to tell others that I am part of this profession	1, strongly disagree, 7, strongly agree

3. Group Tenure

How long have you been a member of the NCN MS electronic community? ___months

4. Type of Participation

What percentage of your participation is:
___ Posting questions ___ Posting answers ___ Other

Mediating Variables

5. Knowledge Acquisition

From your interaction in the NCN MS electronic community have you:

Acquired knowledge that caused you to develop new insights	1, to a very small extent, 7, to a very great extent
Acquired knowledge that enabled you to perform new tasks	1, strongly disagree, 7, strongly agree

6. Knowledge Contribution

From your interaction in the NCN MS electronic community have you:

Contributed new knowledge to the NCN MS electronic community	1, to a very small extent, 7, to a very great extent
Contributed knowledge to other NCN MS electronic community members that resulted in their development of new insights	1, strongly disagree, 7, strongly agree