ISBN: 9789052693958

INTRA-FIRM, INTERDISCIPLINARY NETWORKS IN MULTI-NATIONAL ENGINEERING ORGANIZATIONS

AMY JAVERNICK-WILL
Assistant Professor
University of Colorado at Boulder
428 UCB
Boulder, Co 80309
USA
amy.javernick@colorado.edu

ABSTRACT

To gain a competitive advantage, project organizations are interested in sharing knowledge gained through their experiences across the organization. Despite the advantages, this can be particularly challenging for multi-national engineering organizations. These organizations not only encounter typical knowledge sharing constraints due to lack of resources, individual motivations, and a project-based focus; but also the additional challenges of geographical, cultural and disciplinary boundaries. However, gaining knowledge from the diverse environments in which multinational engineering organizations work is a large advantage for working globally. To better understand the networks that exist for sharing knowledge within these organizations, this research employed a case study of a sustainability network within a large multinational engineering organization. The organization selected individuals from offices that were dispersed across nineteen countries. These individuals responded to ego-centric social network surveys that contained questions about their background and the people with whom they share knowledge. The results found that geographic distance created large barriers in the knowledge-sharing network. There was a high prevalence for regional knowledge sharing, which resulted in regional and country level silos with weak ties to offices in other geographies, particularly for knowledge sharing that occurred on a more frequent basis. The research also found a significant focus on knowledge centered from and with the home region for the organization. The results also found that a person's disciplinary background influences the frequency of knowledge sharing within the network. Intra-disciplinary knowledge sharing connections increase with knowledge exchange that occurs on a more frequent basis. The results highlight the need for focused strategic efforts by the firm to encourage knowledge sharing ties between offices and countries separated by geography. In addition, to reap the advantages of working globally, firms must focus on creating low levels of centrality to encourage knowledge flow from offices in emerging countries.

Keywords: Knowledge Management, Organizations, Networks, Global

INTRODUCTION

To meet the trillions of dollars of needed infrastructure (Launch 2003) for a growing global population, multinational engineering and construction companies are expanding their operations to a diverse array of markets and regions (ENR 2010). A common goal of multinational organizations is to learn from each market that they enter to gain collective organizational knowledge across geographical regions (Miller and Chen 1996). In fact, this attribute is one of the key advantages of the multinational organization because the ability to use the organization's collective knowledge acquired throughout the world is expected to achieve higher performance (Ghoshal 1987; Zahra 2000).

However, in order for an organization's collective knowledge to add value, the knowledge needs to be accessible when and where it is needed. Creating global knowledge sharing networks is fundamentally important for communities of practice (CoP) within multinational organizations because connections between people that span physical barriers can increase opportunities to access information and improve performance (DeSanctis & Monge 1999). Specifically, recent research has demonstrated that task-relevant knowledge sharing between people in different geographic regions can boost performance at the project level (Cummings 2004) and at an individual level (Cross and Cummings 2004).

Organizations that are successful at fostering inclusive knowledge sharing relationships have the potential to reap rewards of not only improved project and individual performance, but also innovative changes in the way they conduct business. Much of today's environment has diverged from the past. Rather than a traditional exploitative, cost-based relationship, a growing number of multinational organizations want to include employees within emerging markets within their knowledge networks to gain benefits. Specifically, emerging markets are believed to help an organization create disruptive innovations that can help the company adapt to operate in emerging markets, and they also have the potential to alter the way business is done throughout the world (Economist, 2010). However, this potential can only be realized if organizations can engage knowledge flows across the organization regardless of location.

Connecting people across geographical and cultural boundaries, in addition to the project and disciplinary boundaries inherent in construction and engineering, has its challenges; however, there is a clear need to integrate knowledge by fostering these connections and creating an inclusive global knowledge-sharing network. This paper seeks to increase our understanding of knowledge sharing connections in multinational organizations by analyzing individual attributes of employees engaged in knowledge sharing connections. Specifically, we analyze the influence of geographical location and discipline practice on the creation of knowledge sharing network connections.

ORGANIZATIONAL KNOWLEDGE

Many organizations are learning disabled: they "don't know what they know" they "know more than they can tell" (Polanyi, 1967). As a result, in recent decades, organizations have aimed to improve their knowledge sharing abilities, as this can help to encourage new collaborations, foster new ideas and share best practices while avoiding repeated mistakes and the "reinvention of the wheel". In fact, under the knowledge-based theory of the firm, organizational knowledge is a resource with at least the same level of importance as capital (Grant 1996, Spender 1996). If, however, knowledge is the most important resource of the firm and knowledge resides within individuals, then the most important organizational capability is the *integration of* individuals' knowledge (Grant 1996). Therefore, an organization must concentrate on connecting employees to encourage knowledge sharing within communities of practice (CoPs) to build competencies and achieve high performance.

Connecting people to enhance knowledge sharing across an organization is particularly difficult in the project-based engineering and construction industry. The autonomy of projects can cause the project team to become siloed, making knowledge sharing challenging across projects and regions (Sydow, Lindkvist and DeFillippi 2004). In addition, the incomplete transfer of knowledge can cause unnecessary rework and delay for projects and the engineering or construction organization (Paulson, 1976; Jin and Levitt, 1996). However, due to the fragmented nature of tasks in the engineering and construction industry, coordination and sharing of knowledge is fundamental for projects (Jin and Levitt, 1996), innovations (Taylor and Levitt 2007), and organizational success. Therefore, the engineering and construction industry in particular must focus on breaking barriers inherent in the industry to share their knowledge across the organization.

GLOBAL KNOWLEDGE NETWORKS

Today's global environment creates additional hurdles due to distance and dispersion. Organizations no longer have the luxury of discussing projects and strategy in the corridor or around the water cooler in the same office. Instead, they must coordinate and share knowledge globally through virtual platforms. But these challenges do not end with physical distance. Organizations are no longer homogenous; they are now comprised of employees from multiple cultures and countries, creating an office with diverse socio-cultural backgrounds. These backgrounds condition how individuals perceive information and interact in various countries and locations (Hofstede 1991, House 2004) and can increase costs and schedule delays on projects due to misinterpretation and miscommunication (Orr and Scott 2008). In addition, engineering and construction organizations employ specialized actors with diverse disciplinary backgrounds to meet project requirements. The geographic distance, socio-cultural differences and interdisciplinary CoPs all increase the complexity and uncertainty of networks within the global organization and thus increase the challenges of coordination and knowledge sharing.

Despite these challenges, the global environment in which we operate can offer significant benefits. The long-known concept of "boundary spanning" influences how information enters organizations (Tushman, 1977). More recently, research has found that relationships that cross department or functional boundaries are important for effective knowledge transfer within organizations (Tsai, 2001) and that relationships spanning geographic locations can boost performance at the project level (Cummings, 2004) and at the individual level (Cross and Cummings, 2004). Thus, a key competitive advantage for global organizations and teams is the ability to foster the exchange of diverse ideas from people of various backgrounds, helping to facilitate learning and innovations (Barkema and Vermeulen, 1998; Ghosal 1987). However, this only becomes an advantage if knowledge and ideas can be shared across members.

Recognizing the need for inclusive global knowledge sharing networks and addressing prior calls to explain network emergence (Monge & Contractor 2001, 2003), this research will fill an important gap, focusing on the unit of analysis of network connections to understand how and why these connections are formed and maintained.

To answer these questions, we will utilize and expand upon social network analysis applied to construction. Social network analysis is a tool that provides researchers an understanding of a group's social structure and relationships visually and mathematically. Therefore, the analysis is ideal for understanding how knowledge-sharing connections exist within an interdisciplinary community of practice. Chinowsky and colleagues developed the Social Network Model for Construction to expand the traditional focus on efficiency within the engineering and construction industry to focus on performance (Chinowsky, Diekmann and Gallotti 2008). The model incorporates a social network perspective to recognize the importance of collaboration and knowledge exchange to achieve this higher performance without abandoning the required dynamics of information exchange for task completion. This model has been applied to both construction project teams (Chinowsky, Taylor and DiMarco 2009) and management teams (Chinowsky, Diekman and O'Brien 2010) within construction and engineering organizations.

RESEARCH METHOD

To determine knowledge sharing connections and patterns, we employed social network surveys and analysis within a community of practice (CoP) in a multinational engineering organization. We worked with the organization to identify a CoP that was interdisciplinary and globally distributed across all operating locations and selected the sustainability CoP. The sustainability CoP is comprised of people from the majority of disciplines within the organization, including mechanical engineering, civil engineering, environmental engineering, environmental consulting, structural engineering, etc. The goal of the CoP is to develop and share sustainability knowledge, primarily environmental, but also social, and sustainability tools across the global organization. Selecting this global, interdisciplinary CoP was important to encourage boundary-spanning ties across disciplines and geographic distance. Because the sustainability CoP included 1,333 employees, the organization selected employees that represented the major regions and countries in which the organization has a permanent office to participate in the research. This allowed us to examine regional and disciplinary representation in the knowledge-sharing network.

Ultimately, thirty-seven of the CoP employees responded to the questionnaire. These employees represented thirty-two different offices within nineteen different countries. These individuals answered the questionnaire, which was developed from the Social Network Model for Construction (Chinowsky, Diekmann, and Galotti 2008). The questionnaire asked three categories of questions, including mechanics, dynamics and attributes. On the mechanics side, the survey included questions on information and knowledge exchange. For example, on the mechanics side, respondents were asked: "What individuals have you exchange job related sustainability issues with?" and included various questions regarding frequency of communication from annual up to daily communications. On the dynamics side, the questionnaire elicited responses to questions that asked respondents to rate the amount of dependence, reliance and trust they have that the other individual will complete their job related sustainability tasks. In addition to the prior questions developed from the Social Network Model for Construction, we asked additional questions related to individual attributes that may influence the mechanics and dynamics of the network. These questions included the respondent's professional discipline, location of birth, business practice, generation, level within the organization, number of years employed by the organization and prior physical locations worked. We used Network Genie, an on-line survey system designed specifically for managing social network analysis surveys (Hansen et al 2008), to deliver the survey.

"Egos", or the respondents to the survey, reported 407 knowledge sharing connections across a network of 320 individuals, which included both the "egos" and "alters", or people that did not respond directly to the questionnaire but whom "egos" reported knowledge sharing connections with. Attribute data on the alters was obtained through the organization. Data collected from the survey was used to identify and analyze the global knowledge-sharing network and connections within each organization using the UCINET Social Network Analysis software (Borgatti, Everett, and Freeman 2002). The UCINET software provides the mathematical measurements (Wausermann and Faust 1994) as well as the graphical representations required to conduct a Social Network Analysis. Additionally, we analyzed survey responses using traditional spreadsheet analysis to report connections and test the influence of attributes.

RESULTS

For the purpose of this paper, we analyzed the global sustainability network for frequency of job-related knowledge sharing based upon geographical location and discipline.

Influence of geographical location on knowledge sharing

To understand the global distribution of knowledge sharing, we first analyzed the existence and frequency of communications according to geographical location. When respondents were asked who they exchanged job-related sustainability knowledge within in the last 12 months, 407 knowledge sharing connections were reported. The graphical representation of these annual knowledge-sharing connections is shown in Figure 1. Within the network figures depicted, a shape or node represents each individual, while the knowledge sharing connections are displayed as lines between the nodes. We attempted to display these graphically according to region (Asia, Australia, Africa, Middle East, UK, Eastern Europe, Europe–Other and North America). The black nodes represent individuals whose information is not known, either because they left the company or could not be identified from the survey.

Within the annual communications, we witness a propensity towards regional knowledge sharing. Specifically, 62% of the knowledge-sharing connections are between individuals from the same office (e.g. an employee from the San Francisco office sharing knowledge with another employee from the San Francisco office), same region (e.g. an employee from the Cape Town office sharing sustainability related knowledge with a person from the Johannesburg office) or similar region (e.g. a person from the Milan office sharing knowledge with a person from the London office). 29% of the knowledge-sharing connections occur between employees located in different regions (e.g. a person from the San Francisco office sharing knowledge with a person from the Bangkok office) and 9% of the connections are tied to individuals with whom no geographical information is known.

The analysis of these knowledge sharing connections reveals that knowledge sharing patterns based upon geographical location (either the same office, same region, or similar region) or sharing knowledge with the "home office region", in this case, the UK. Table 1 lists the percentage of knowledge sharing connections originating from a region (e.g. Australia has 27 knowledge sharing connections reported from the region) along with the percentage of ties to other regions (e.g. 89% of Australian employee's sustainability knowledge sharing connections are with other employees located in Australia). All regions exhibit the same knowledge sharing patterns, with the majority of knowledge sharing connections existing amongst employees within the same region and the second highest percentage of knowledge sharing connections with employees from the home office region of the UK.

From these results, we build the following propositions:

Proposition 1: Of the knowledge sharing connections that exist between employees in a globally distributed community of practice, the majority of connections will exist between employees located in the same geographical region.

Proposition 2: Of the knowledge sharing connections that exist between employees in a globally distributed community of practice, the majority of connections external to a region will exist with employees from the home office region.

We analyzed these connections further to determine if geographical location impacted the frequency of knowledge exchange. Figure 2 depicts the knowledge sharing ties within the CoP based upon quarterly knowledge exchange. Analyzing the quantity of connections by region for quarterly communication, we discover that 80% of the knowledge sharing connections occur within a region, 14% occur between a region, and 6% of the connections are with an alter whose location is unidentified. Table 2 lists the percentage of knowledge sharing ties according to region for quarterly communications.

When we analyzed the knowledge sharing connections at increasingly higher frequencies of exchange, we witness increased regional knowledge sharing with decreased global knowledge exchange. For example, 88% of the 139 connections that exchange knowledge at least monthly (depicted in Figure 3) are located within the same region. For the sixty-nine connections that exchange knowledge at least weekly (depicted in Figure 4), 93% of the exchanges occur within the same region. Table 3 lists the knowledge sharing connections according to frequency of knowledge exchange for intra-region, inter-region and unknown connections.

From these results, we build proposition 3:

Proposition 3: Geographical location impacts the frequency of knowledge exchange. Knowledge exchange that occurs on a more frequent basis will occur between employees located in the same region.

Influence of Discipline on Knowledge Sharing

Within the sustainability network, interesting results also emerged regarding the influence of discipline on knowledge sharing connections. Whereas we expected to see a bias of knowledge sharing within the same discipline, 58% of the connections were classified as interdisciplinary, 15% were unknown, and only 27% of the knowledge sharing connections occurred between individuals with the same disciplinary background.

Similar to the geographical location, we analyzed these knowledge sharing connections further to determine if the frequency of communication was impacted by disciplinary background. Table 4 displays the inter-disciplinary, intra-disciplinary and unknown knowledge sharing connections based upon frequency of knowledge exchange. As the frequency of communication increases from annual communications to weekly communications, we witness an increase in intra-disciplinary knowledge sharing connections and a decrease in inter-disciplinary knowledge sharing connections. Specifically, interdisciplinary knowledge sharing connections make up 58% of knowledge sharing connections on an annual basis, but gradually decrease to 38% of connections on a weekly basis. Conversely, intra-disciplinary knowledge sharing connections make up only 27% of the annual connections, but increase to 41% of the connections that share knowledge on a weekly basis.

From these results, we build proposition 4:

Proposition 4: Background discipline impacts the frequency of knowledge exchange in interdisciplinary communities of practice. Intra-disciplinary knowledge sharing connections increase with knowledge exchange that occurs on a more frequent basis, whereas inter-disciplinary knowledge sharing connections increase with knowledge exchange that occurs on a less frequent basis.

CONCLUSION

Prior findings have highlighted a need to share knowledge across departmental boundaries to increase knowledge flow (Tsai 2001) and across geographic locations to increase performance (Cummings 2004, Cross and Cummings 2004). However, little is known about how geographic locations and disciplinary backgrounds of participants in an interdisciplinary engineering CoP influences frequency of knowledge sharing.

This research found that the majority of knowledge sharing connections occurred within a region. When we analyzed knowledge exchange according to frequency, we found that knowledge exchange that occurs on a more frequent basis will occur between employees located in the same region. This becomes a large concern based on research in small group communication that emphasizes the need for frequent exchange to ensure the transfer of ideas between participants (Fisher 1974).

When knowledge-sharing connections were analyzed inter-regionally within the network, we found that the majority of knowledge sharing connections was with the home region, in this case the UK, for all regions in which the company operates. This may be indicative of a transfer bias towards centralized knowledge exchange patterns which limits the amount of flexibility firms have to create "boundary spanning" ties to increase innovations.

In addition to geographic location, we wanted to study the influence of disciplines on the creation of knowledge sharing connections within interdisciplinary CoPs in an engineering organization. In addition to the knowledge sharing barriers created in a project-based industry, the industry is also comprised of individuals with diverse disciplinary backgrounds. When we analyzed the knowledge sharing connections for the attribute of disciplinary background, a surprising result was that a majority of ties were interdisciplinary. However, when we analyzed the network for more frequent connections, we discovered that inter-disciplinary knowledge sharing connections decreased and intra-disciplinary knowledge sharing connections increased for more frequent knowledge sharing connections. If, in fact, knowledge sharing that occurs more frequently adds increasing value, this again highlights an area of concern for the organization. Because today's large challenges require an increasingly diverse combination of disciplines to solve, organizations will want to focus on creating connections that span traditional disciplinary and functional backgrounds.

Our future work plans include analyzing the additional attributes collected to determine their influence on both the dynamics and mechanics of the knowledge sharing network. In addition, we plan to expand the study to include additional CoPs from other multinational engineering organizations that include both interdisciplinary and discipline- specific CoPs.

REFERENCES

Barkema, H. G. and F. Vermeulen (1998). "International Expansion through Start up or Acquisition: A Learning Perspective." *Academy of Management journal* **41**(1): 7.

Borgatti, S.P., Everett, M.G. and Freeman, L.C. 2002. Ucinet for Windows: Software for Social Network Analysis. Harvard, MA: Analytic Technologies.

Chinowsky, P., Diekmann, J., and Galotti, V. (2008). "The Social Network Model of Construction," *Journal of Construction Engineering and Management*, 134(10), 804-810.

Chinowsky, Paul S., Diekmann, James, and O'Brien, John (2010). "Project Organizations as Social Networks," *Journal of Construction Engineering and Management*, ASCE, 136(4).

Chinowsky, P., Taylor, J., and Di Marco, M. (2009). "Project Network Interdependency Alignment: A New Approach to Assessing Project Effectiveness," *LEAD Specialty Conference on Global Governance in Project Organizations*, Lake Tahoe, CA.

Cross, R. and J. N. Cummings (2004). "Tie and Network Correlates of Individual Performance in Knowledge-Intensive Work." *The Academy of Management Journal* **47**(6): 928-937.

Cummings, J. (2004). "Work groups, structural diversity, and knowledge sharing in a global organization." *Management science* **50**(3): 352-364.

Desanctis, G. and P. Monge (1999). "Introduction to the special issue: Communication processes for virtual organizations." *Organization science* **10**(6): 693-703.

Economist, The (2010). "The world turned upside down". http://www.economist.com/node/15879369

ENR (2010). "The Top 225 Global Contractors" from http://enr.construction.com/toplists/GlobalContractors/001-100.asp.

Ghoshal, S. (1987). "Global Strategy: An Organizing Framework." *Strategic management journal* **8**(5): 425-440.

Grant, R. M. (1996). "Toward a knowledge-based theory of the firm." *Strategic management journal* **17**(WINTER): 109-122.

Hansen, William B., Reese, Eric, Bryant, Kelvin S., Bishop, Dana, Wyrick, Cheryl H., and Dyreng, Douglas I. (2008). *Network Genie User's Manual*, Tanglewood Research, Inc.

Hofstede, G., Ed. (1991). *Culture and Organizations: Software of the Mind*. New York, McGraw-Hill.

House, R. J. (2004). *Culture, Leadership, and Organizations: The Globe Study of 62 Societies*, Sage.

Jin, Y. and R. E. Levitt (1996). "The virtual design team: A computational model of project organizations." Computational & Mathematical Organization Theory **2**(3): 171-195.

Launch, T. (2003). Connecting East Asia: A New Framework for Infrastructure. Washington D.C., Asian Development Bank, The World Bank, Japan Bank for International Cooperation**:** 1-217.

Miller, D. and Chen, M. (1996). **"**The Simplicity of Competitive Repertoires: An Empirical Analysis". *Strategic Management Journal*, 17(6): 419-439.

Monge, P., & Contractor, N. 2001. Emergence of communication networks. In F. Jablin & L. Putnam (Eds.), *The new handbook of organizational communication:* 440–502. Thousand Oaks, CA: Sage.

Monge, P., & Contractor, N. 2003. *Theories of communication networks.* New York: Oxford University Press.

Orr, R. J. and W. R. Scott (2008). "Institutional exceptions on global projects: a process model." *Journal of International Business Studies* **39**: 562-588.

Paulson, B. C. J. (1976). "Designing to Reduce Construction Costs." *Journal of the Construction Division* **102**(4): 587-592.

Polanyi, M. (1967). "The Tacit Dimension." New York.

Sydow, J., L. Lindkvist, et al. (2004). "Project-Based Organizations, Embeddeness and Repositories of Knowledge." *Organization Studies* **25**(9): 1475-1489.

Taylor, J. a. L., R. (2004). Understanding and Managing Systemic Innovation in Project-based Industries. *Innovations: Project Management Research*. D. Slevin, Cleland, D. and Pinto, J. Newton Square, Pennsylvania, Project Management Institute**:** 83-99.

Tsai, W. 2001. Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business-unit innovation and performance. *Academy of Management Journal*, 44: 996

Tushman, M. 1977. Special boundary roles in the innovation process. *Administrative Science Quarterly*, 22: 587-605.

Wasserman, Stanley, & Faust, Katherine. (1994). *Social network analysis.* Cambridge, MA: Cambridge University Press.

Zahra, S. A. (2000). "International Expansion by New Venture Firms: International Diversity, Mode of Market Entry, Technological Learning, and Performance." *Academy of Management Journal* **43**(5): 925-950.

FIGURES

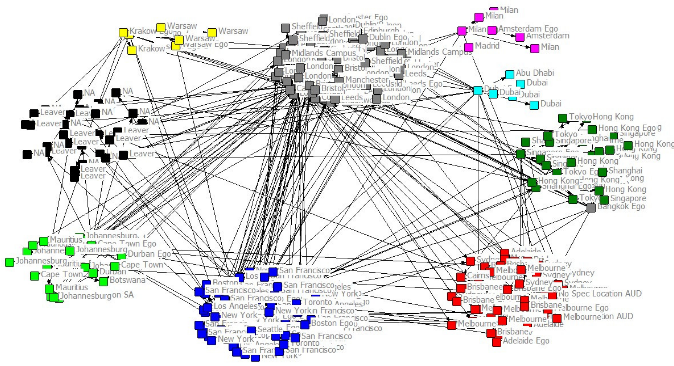

Figure 1: Annual Knowledge Sharing Connections

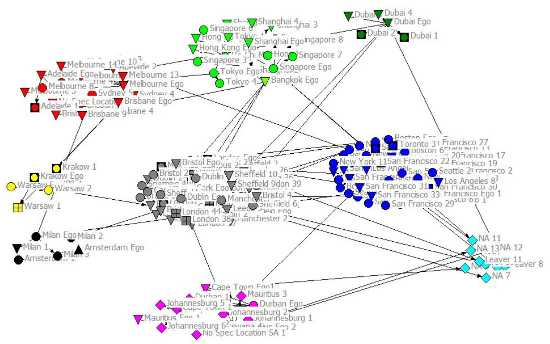

Figure 2: Quarterly Knowledge Sharing Connections

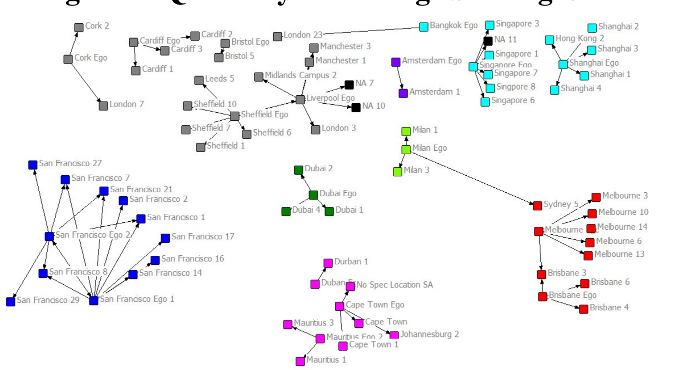

Figure 3: Weekly Knowledge Sharing Connections

TABLES

Table 1: Annual Knowledge Sharing Connections by Region

		EGO'S							
		Africa	Asia	Australia	Eastern Europe	Europe	Middle East	North America	UK
ALTERS	**Africa**	**58%**	-	-	-	-	-	-	5%
	Asia	-	**59%**	-	-	-	-	3%	3%
	Australia	8%	14%	**89%**	-	14%	18%	6%	10%
	Eastern Europe	-	-	-	**33%**	-	-	-	-
	Europe	-	-	-	-	**43%**	-	-	1%
	Middle East	-	-	-	-	-	**29%**	-	-
	North America	6%	7%	-	7%	-	12%	**71%**	13%
	UK	**28%**	**20%**	**7%**	**27%**	**29%**	**29%**	**15%**	**58%**
	NA	19%	7%	4%	33%	14%	12%	5%	10%
		n=43	*n=47*	*n=27*	*n=15*	*n=7*	*n=17*	*n=136*	*n=115*

Table 2: Quarterly Knowledge Sharing Ties by Region

		EGO'S							
		Africa	Asia	Australia	Eastern Europe	Europe	Middle East	North America	UK
ALTERS	**Africa**	83%	-	-	-	-	-	-	-
	Asia	-	67%	-	-	-	-	-	-
	Australia	-	10%	100%	-	17%	13%	2%	-
	Eastern Europe	-	-	-	100%	-	-	-	-
	Europe	-	-	-	-	67%	-	-	-
	Middle East	-	-	-	-	-	50%	-	-
	North America	-	5%	-	-	-	-	88%	20%
	UK	-	14%	-	-	17%	25%	7%	75%
	NA	17%	5%	-	-	-	13%	3%	6%
		n=18	*n=21*	*n=14*	*n=3*	*n=6*	*n=8*	*n=60*	*n=51*

Table 3: Knowledge Exchange Frequency based upon geographical location

	Frequency of Knowledge Exchange			
	Yearly	***Quarterly***	***Monthly***	***Weekly***
Intra-Region	62%	80%	86%	93%
Inter-Region	29%	14%	8%	2%
NA	9%	6%	6%	4%
	n=407	*n=181*	*n=139*	*n=69*

Table 4: Knowledge Exchange Frequency based upon discipline

	Annual	**Quarterly**	**Monthly**	**Weekly**
Inter-disciplinary	58%	50%	44%	38%
Intra-disciplinary	27%	33%	35%	41%

Unknown	15%	18%	21%	22%
	n=407	*n=181*	*n=139*	*n=69*