

Inter-Organisational Knowledge Transfer in Small-World Networks

Silke Retzer

(School of Information Management
Victoria University of Wellington, New Zealand
silke.retzer@vuw.ac.nz)

Pak Yoong

(School of Information Management
Victoria University of Wellington, New Zealand
pak.yoong@vuw.ac.nz)

Val Hooper

(School of Information Management
Victoria University of Wellington, New Zealand
val.hooper@vuw.ac.nz)

Abstract: Small-world networks represent a decentralised network topology in which several actors are strongly connected with each other. A high clustering coefficient and a high number of short paths within a social network characterise such a network. Particularly in the context of inter-organisational knowledge transfer among R&D organisations, the structure of small-world networks appears significant for effective knowledge transfer. This paper reports on an investigation into the nature of inter-organisational knowledge transfer among R&D organisations. The topology of a social network is explored using UCINET social network analysis software. From these findings, implications are drawn for ICT support at an inter-organisational level.

Keywords: knowledge transfer, inter-organisational, R&D, social network, small-world network, ICT, decentralised, peer-to-peer, KMS

Categories: J.4., H.4.2, H.4.3

1 Introduction

Inter-organisational knowledge transfer is the exchange of knowledge among diverse organisations with the aim to expand and leverage their capabilities and resources [Grant and Baden-Fuller 1995]. Although there can be various emphases, in the context of this research, it refers to the movement of knowledge between two or more organisations in a knowledge-intensive environment, such as the Research and Development (R&D) sector. The aim of inter-organisational knowledge transfer is to reuse existing knowledge and also facilitate innovation. Although the larger part of research into knowledge transfer has been undertaken at the organisational level, more recent studies have investigated the benefits of knowledge transfer in inter-organisational environments including strategic alliances, business clusters, value

chains and informal networks and communities of practice [Cranefield and Yoong 2005]. Research into the inter-organisational transfer of knowledge, particularly in informal networks in the R&D sector, appears to be relatively rare [Allen et al. 2007]. There is also a lack of research in elucidating Information and Communication Technology (ICT) support for the transfer of knowledge in social relationships in this environment.

This paper reports results of a case study that investigated knowledge transfer in an inter-organisational social network in the New Zealand (NZ) environmental Research and Development (R&D) sector. This study was guided by two research goals. The first aim was to elicit key knowledge transfer structures, such as the network topology, among R&D organisations. The second aim was to draw implications regarding ICT support. This paper specifically focuses on the identification of the network topology which is a major indicator for knowledge transfer and ICT support [Kwon et al. 2007].

2 A small-world network topology: A Social Network Perspective on Knowledge Transfer

Social networks and knowledge transfer

A social network consists of a set of social entities, such as individuals, groups or organisations that are linked to each other in order to exchange information [Haythornthwaite 1999]. Social network research focuses on relationships between these entities, which can be represented by communications among members of a group [Wasserman and Faust 1994] and informal, interpersonal relations in social systems [Scott 2000]. The transfer of knowledge in social networks can be facilitated by different means that may include various ICT's, especially in the case of people working in distributed locations. Like other types of media, ICT may enhance the accessibility of a person's knowledge to other people in the network. This accessibility is a statistically significant relational characteristic of knowledge seeking behavior in a network [Borgatti and Cross 2003].

The network topology

In terms of network topology, social network structures can show diverse levels of centrality, which is a major indicator for knowledge transfer in the network. Centralised structures include Barabasi or Moderate Scale Free network structures, whereas more decentralised structures are presented by random or small-world networks [Kwon et al. 2007]. Small-world networks in particular are characterised by a more decentralised structure than completely random networks. A small-world network structure includes some degree of centralisation in the form of local clusters and can therefore be differentiated from a pure random network [Kwon et al. 2007] [Watts and Strogatz 1998]. Local clustering in small-world networks facilitates reliable accessibility and links between local clusters can provide easy access in the network [White and Houseman 2003].

In terms of social network analysis, small-world networks can be identified by two main characteristics: firstly, a high number of short paths (small average path

length) between any two members in the network: and secondly, a high clustering coefficient that indicates the existence of a certain degree of centralisation in an overall decentralised network. In general, a path in a network is a linkage between at least two network members and is illustrated by lines in a visualised network. However, no connection is repeated and no network member is visited twice [Borgatti 2005]. The length of a path is represented by the number of nodes (network members) it contains [Borgatti et al. 2002]. A short path directly links two members in a network [Kwon et al. 2007] whereas a long path also includes linkages to other members. Such direct linkage, as provided by a short path, allows for direct communication and therefore quick transfer of knowledge - particularly if the contact frequency is high, too. The other typical characteristic for small-world networks is a high clustering coefficient which represents the average of an high neighborhood connectivity per network member [Kwon et al. 2007]. Watts and Strogatz [Watts and Strogatz 1998] introduced the clustering coefficient measure in 1998. In particular, they determined that the neighborhood connectivity in small-world networks is higher than in comparable random networks [Watts and Strogatz 1998]. These two characteristics were applied to the empirical data of this study.

3 Results AND Analysis

The social network in this case study was identified as a small-world network. Sixty-seven study participants took part in data collection. Key groups of participating organisations were local and central government agencies, Crown Research Institutes (CRIs), private businesses and universities. Results are based on study participants' contact frequencies for advice giving and seeking activities in the workplace.

Small-world network characteristics – high clustering coefficient

The network's clustering coefficient was significantly higher with 0.79 than the clustering coefficient in a comparable same-sized random network with 0.42 as shown in the following table. In addition, Table 1 illustrates the clustering coefficients in relation to the network's overall density. The measures were conducted by using UCINET software¹ [Borgatti et al. 2002].

Clustering coefficient	Clustering coefficient for a comparable random network	Overall network density
0.79	0.42	0.62

Table 1: Clustering coefficients and network density

The figures in Table 1 confirm that, due to their considerably dense local neighborhoods, this network shows a higher clustering coefficient compared to a random network of the same size. In order to avoid an 'over-interpretation' of high clustering coefficients, [Hanneman 2005] recommends a comparison of the clustering coefficient to the overall density of the network. The density is the total number of

¹ UCINET 6.188

members. A high degree of local clustering and a high number of short paths in the small-world networks allow for a facilitation of routine communications among people by ICT [Kwon et al. 2007].

Due to this network's decentralised structure, decentralised ICT and particularly decentralised a KM system may be the best support solution at the inter-organisational level, as knowledge processes often cross organisational boundaries [Maier and Hädrich 2006]. A decentralised KM solution (such as Groove) is based on a peer-to-peer architecture. In line with this study's identified small-world network topology, a peer-to-peer KM system seems appropriate. Such a decentralised system allows several powerful groups of organisation which are strongly connected to use peer-to-peer connections efficiently. Weak and intermediate connections may use the peer-to-peer connections less often, but as a decentralised KM system is less costly in maintenance than a centralised system, it even seems more appropriate to support knowledge transfer among weak ties. Moreover, peer-to-peer systems typically reduce the barriers of knowledge transfer at the individual level. Individual knowledge workers are more motivated to participate in a peer-to-peer KMS and share the benefits [Maier and Hädrich 2006]. As the presented results are based on data of individuals' advice giving and seeking activities, a decentralised KMS may thus also provide support at the individual level.

5 Outlook

Further research could investigate specific services such as infrastructure services and knowledge services of a decentralised KMS [Maier and Hädrich 2006] in regard to additional study results, including the types of knowledge transferred and ICT security standards in the inter-organisational networks. These investigations could help develop further recommendations for ICT support.

References

- [Allen et al. 2007] Allen, J., James, A. D., and Gamlen, P. "Formal versus informal knowledge networks in R&D: a case study using social network analysis," *R&D Management*, 37, 3, (2007), pp 179-196.
- [Borgatti 2005] Borgatti, S. 2005. "Centrality and network flow," *Social Networks*, 27, (2005), pp 55-71.
- [Borgatti et al. 2002] Borgatti, S. P., Everett, M. G. and Freeman, L. C. *Ucinet for Windows: Software for Social Network Analysis*. Harvard, MA: Analytic Technologies (2002).
- [Borgatti and Cross 2003] Borgatti, S. and Cross, R. "A Relational View of Information Seeking and Learning in Social Networks," *Management Science*, 49, 4, (2003), pp 432-445.
- [Cranefield and Yoong 2005] Cranefield, J. and Yoong, P. "Organisational factors influencing inter-organisational knowledge transfer in the New Zealand State Sector:

a case study,” *The Electronic Journal for virtual organizations and networks*, 7, (2005), pp 9-33.

[Grant and Baden-Fuller 1995] Grant, R. and Baden-Fuller, C. A knowledge-based theory of inter-firm collaboration. *Academy of Management Best Paper Proceedings*, (1995), pp. 17-21.

[Hanneman 2005] Hanneman, R. and Riddle, M. *Introduction to social network methods*. (2005), <http://faculty.ucr.edu/~hanneman/nettext/>.

[Haythornthwaite 1999] Haythornthwaite, C. *A Social Network Theory of Tie Strength and Media Use: A Framework for Evaluating Multi-level Impacts of New Media* (No. No. Technical Report UIUCLIS--2002/1+DKRC). (1999), Champaign: Graduate School of Library and Information Science.

[Kwon et al. 2007] Kwon, D., Oh, W. and Jeon, S. “Broken Ties: The Impact of Organizational Restructuring on the Stability of Information-Processing Networks”, *Journal of Management Information Systems*, 21, 1, (2007), pp.201-231.

[Maier and Hädrich 2006] Maier, R. and Haedrich, T. “Centralized Versus Peer-to-Peer Knowledge Management Systems,” *Knowledge and Process Management*, 13, 1, (2006), pp.47-61.

[Nguyen 2006] Nguyen, V.K. *Small-World Graphs: Models, Analysis and Applications in Network Designs*. Davis: University of California (2006).

[Schilling et al. 2005] Schilling, M. and Phelps, C. “Interfirm Collaboration Networks: The Impact of Small World Connectivity on Firm Innovation. Cambridge”, *Social Science Research Network*, (2005), http://papers.ssrn.com/sol3/papers.cfm?abstract_id=564422.

[Scott 2000] Scott, J. *Social Network Analysis: a handbook*. London: Sage Publications Ltd (2002).

[Wasserman and Faust 1994] Wasserman, S. and Faust, K. *Social Network Analysis: Methods and applications*. Cambridge, UK: Cambridge University Press (1994).

[Watts and Strogatz 1998] Watts, D. and Strogatz, S. “Collective dynamics of ‘small-world’ networks,” *Nature*, 393, 6684, (1998), pp 440-442.

[White and Houseman 2003] White, D., and Houseman, M. The navigability of strong ties: Small worlds, tie strength, and network topology. *Complexity*, 8, 1, (2003), pp 82–86.