



Understanding key issues in designing and using knowledge flow networks: An optimization-based managerial benchmarking approach

Su Dong, Monica Johar, Ram Kumar*

Belk College of Business, University of North Carolina at Charlotte, NC 28223, United States

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ABSTRACT

There is an increasing recognition that knowledge can be an organization's source of competitive advantage. Hence, knowledge management (KM) has been extensively researched. Prior knowledge management research has recognized the importance of making individual knowledge available throughout the organization. Most KM research, however, has thus far focused on a technology-based KM strategy with relatively little discussion on how knowledge can be effectively shared using organizational social relationships. This paper focuses on how knowledge-intensive organizations can design and use "knowledge flow networks (KFNs)" in order to facilitate knowledge sharing. Designing and using KFNs to maximize knowledge sharing is a complex problem. We formulate a mixed integer programming model (MIP), and present a heuristic in order to facilitate systematic analysis and understanding of effective KFNs. We consider organizations that support multiple skills and have workers with varying levels of competence who are connected through IT-facilitated organizational social relationships. Our results, based on computational experiments, provide several interesting insights and intelligence into the design of an effective KFN. First, our results highlight that average workers play a vital bridging role in knowledge sharing. Second, social networking concepts of ties and cohesiveness are used to better understand the dynamics of knowledge sharing. The importance of indirect relationships between expert workers and the network effects due to indirect relationships are illustrated. For effective KM, we also illustrate how organizations can reduce the total number of ties required in a multi-skill environment. In our model extensions, we study the impact of worker turnover and knowledge depreciation on the design and use of effective KFNs. Managerial implications of these results are discussed. The model and solution procedure proposed in this paper can serve as a managerial benchmarking framework for effective management of KFNs.

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1. Introduction

There is a growing recognition that employees' knowledge is an organization's most valuable asset, particularly in knowledge-intensive environments such as consulting, research, and IT service delivery [16,18,19]. Such organizations consider knowledge creation [43] and knowledge application [23] to be vital to organizational performance. Knowledge management research has recognized the concept of "a knowledge-creating company" [43]. The concept of "knowledge reservoirs" has also been proposed as a source of long-term competitive advantage [2]. Prior research has recognized that "making personal knowledge available to others is the central activity of the knowledge-creating company. It takes place continuously and at all levels of the organization" [43]. Hence, firms are increasingly investing in Knowledge Management (KM) projects expecting to improve employees' knowledge levels [22].

Most KM research has thus far focused on information technologies [13,15], with relatively little discussion on how knowledge can be shared effectively among employees using organizational social relationships [39]. In practice, however, organizations are finding that employees often prefer to consult their peers and colleagues (organizational social relationships) in order to acquire knowledge, rather than access electronic knowledge bases [13]. Recognizing the importance of using organizational social relationships to transfer knowledge, an increasing number of Chief Knowledge Officers (CKOs) are moving from a technological-based KM strategy to a socialization-based KM strategy [42]. Such a strategy uses organizational information flow networks (IFNs) to facilitate knowledge sharing [42]. Such IFNs use ties (or information flow connections) between individuals in order to transfer knowledge. Recent research [18] has illustrated that the structure of IFNs and associated knowledge sharing behavior significantly impact organizational performance and employees' knowledge level.

Knowledge management research has only recently begun to focus on designing effective "knowledge flow networks" (KFNs) [25,36,53]. In this paper, we use the term KFNs to refer to organizational IFNs that facilitate knowledge sharing. KFNs can be studied from two perspectives. First, organizations are increasingly interested in using existing

* Corresponding author.

E-mail addresses: sdong1@uncc.edu (S. Dong), msjohar@uncc.edu (M. Johar), rlkumar@uncc.edu (R. Kumar).

KFNs effectively for KM [25,53]. This is the use perspective. Second, organizations are also interested in designing effective KFNs as a part of organization design initiatives [36]. Leading consulting organizations such as IBM recognize the importance of optimizing social networks in the context of KM. For example, “IBM Global Business Services — offers a social network analysis (SNA) service designed to help reveal a multitude of underlying personnel issues, such as where collaboration falls apart, where talent and expertise could be better used, where decision-making gets bogged down, and where opportunities for innovation are being lost....While SNA can pinpoint problems and improvement opportunities, social network optimization (SNO) provides decision support for what to do next” (<http://domino.watson.ibm.com/odis/odis.nsf/pages/board.13.html>). Understanding effective KFNs allows organizations to compare their existing KFNs with effective KFNs. This, in turn, provides managerial guidance on what to do next. Hence, design and use of effective KFNs is an important problem, with significant real-world interest. However, academic research on this problem is limited.

We focus on the following research question: *how should knowledge-intensive organizations design and use their KFNs in order to maximize employees' knowledge level (over a planning horizon) through sharing under different organizational environments?* In order to answer this question, we examine organizations that support multiple skills and have workers with varying levels of knowledge in these skills. These workers are connected to each other through IT-facilitated organizational social relationships. Designing and using KFNs to maximize knowledge sharing is a complex problem. We formulate a Mixed Integer Programming Model (MIP), and present a heuristic in order to facilitate systematic analysis and understanding of the above research question. In summary, the model and solution procedure proposed in this paper can serve as a managerial benchmarking framework for effective management of KFNs.

Our computational results provide several interesting insights and intelligence into the design of an effective KFN. First, our results highlight the important role of average workers. In contrast to the common practice of encouraging knowledge sharing between experts and novices, we find that most knowledge sharing happens between average and expert workers, followed by knowledge sharing between average and novice workers. Second, the value of a direct tie is significantly enhanced by indirect ties. Cohesive groups of experts allow less competent workers to access more experts through indirect ties. Such cohesive groups are less important for lower skilled worker groups. Third, we examine the impact of number of skills supported by an organization on an effective KFN. Organizations supporting multiple skills need to create direct ties between workers with complementary skill sets, particularly between experts. Such ties tend to be used extensively, which reduces the number of direct ties needed as the number of skills supported by the organization increases. In our model extensions, we study the impact of worker turnover and knowledge depreciation on the design and use of effective KFNs. We find that for effective KM, organizations need to compensate for high worker turnover and high knowledge depreciation by encouraging the creation of more direct ties and creating more cohesive groups of workers.

The rest of this paper is organized as follows. Section 2 discusses related literature that serves as the foundation for our research. The mathematical model of KFNs and solution procedure to solve this model is discussed in Sections 3 and 4, respectively. Design of the simulation-based experiments is described in Section 5. Computational results are the focus of Section 6. Section 7 discusses the performance of the proposed Heuristic. Model extensions are presented in Section 8. Sections 9, 10, and 11 focus on managerial implications and conclusions, limitations and future research, and conclusions respectively.

2. Literature review

Our research integrates concepts from prior research on using and creating organizational social relationships, knowledge management using organizational social relationships, and social network measures.

2.1. Using and creating organizational social relationships

Prior research on knowledge management shows that the strength of organizational social relationships (ties) significantly impacts the efficiency of knowledge sharing [7,13]. We use the term “tie” in order to refer to relationships resulting from sustained information exchange due to repeat interactions. We consider two types of ties between workers that have been identified in prior research as being likely to be used for knowledge transfer: strong ties and weak ties [6,24,38,47]. Strong ties occur between workers who know each other directly through organizational relationships. Workers connected by weak ties do not know each other directly, but have strong ties with another (intermediate) worker. A common worker plays a bridging role that allows the two workers to get acquainted and to share knowledge with each other. Direct ties (strong ties) are more efficient than indirect ties (weak and performative ties) when used to transfer knowledge [26]. However, indirect ties allow workers to access larger number of colleagues as compared to direct ties [11,26]. In addition, it is important to note that all direct ties are not equally efficient and their efficiency often depends on the strength of the relationship. In order to develop strong ties between workers, considerable amount of time and effort is required, while weak ties could exist between acquaintances who share common contacts [11,26].

There is a growing body of research on understanding factors that influence the formation of social ties. Workers are required to spend time in cultivating such direct ties [26]. For example, workers may need to frequently meet with each other and attend common meetings. Kotlarsky and Oshri [33] present two case studies at SAP and LeCroy to illustrate the importance of establishing social ties for knowledge sharing among distributed IS development teams. They recommend face-to-face interactions and frequent communications (via email or instant messaging) as an effective mechanism for creating social relationships. In addition, organizations could also facilitate desired ties via reporting relationships, collocation, project experience, etc. [www.orgnet.com, 24,47].

There is a growing body of research on mining social networks and expertise profiling. Social networks can be mined from different types of organizational data including email, wikis, blogs [24,50], and social network information [31]. For example, *Pass It Along* is a system developed by IBM to help organizations take a collaborative approach to knowledge sharing based on social network information (www.ibm.com/developerworks/web/library/wa-piabetta/index.html). Expertise profiling is possible using commercially available tools such as KIN and Tacit Systems EKG [13], Collaboration-and-Expertise-Networks (www.autonomy.com), Knowledge Xchanger (<http://www.comintell.com>), and Iknow (<http://www.iknow.us.com/Pages/Expertise.asp>) or in-house developed tools such as Microsoft SPUD [15]. Other tools capable combining social network mining with expertise profiling include SABA Social (www.saba.com/enterprise-social-networking) and IBMGBS Practitioner Portal [3].

This stream of literature is relevant since business intelligence regarding social networks and expertise profiling is critical for designing optimal KFNs.

2.2. Knowledge management using organizational social relationships

IS researchers are increasingly interested in knowledge management using social relationships [1]. In addition, prior research on social networking and organizations has recognized that “the ability of a firm to be productive depends not only on the talents of its employees but largely on the way in which they interact” [28].

Cowan and Jonard [12] use simulation to study the impact of different types of network structures in the context of knowledge diffusion across organizations. Levine and Prietula [39] use agent-based simulation to study the impact of different types of ties between workers on knowledge sharing. They illustrate that having some performative ties in an organization improves average task completion times. Dong et

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