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# UNDERSTANDING THE ROLE OF ADVICE NETWORKS IN SOFTWARE DEVELOPMENT

*Research-in-Progress*

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## Abstract

*The demand for software-enabled products and services continues unabated in almost all facets of life. With this increasing demand comes an intense pressure on the developers of software to be innovative in all aspects. While researchers have examined how a variety of individual, group, and organizational factors shape innovation in information systems development, the role of advice networks has received limited consideration to date. A greater understanding of advice network structures in software development is important as numerous studies from the social network tradition demonstrate that advice seeking behaviors play a key role in people's ability to do their jobs effectively. Drawing from social network theory, we develop a number of hypotheses relating the structure of a software developer's advice network for technological developments to personal innovativeness. To test these hypotheses, social network analysis and interview data will be gathered from a software development division of a large organization.*

*Keywords: Software development, advice networks, innovation, social network analysis*

## 1. Introduction

It is widely acknowledged that innovation has become a core part of the information systems development (ISD) (Sampler and Galleta 1991; Lobert and Dologite 1994; Zmud, 1983). Creative activities need to be core to all aspects of ISD, from requirements definition through to program design (Cougar (1990). Lobert and Dologite (1994) offer three reasons why this is a necessity. Firstly, technology is evolving so quickly that developers need to continuously figure out new ways to utilize existing resources. Secondly, the more simplistic systems have already been developed. The challenge ahead is to develop the more challenging and sophisticated systems that remain. Finally, many existing systems are becoming obsolete and will have to be replaced, as they do not meet rapidly changing demands. For these reasons, innovative software developers are essential to the ISD process (Gallivan 2003). Indeed, researchers such as Brooks (1987) even contend that the critical problems in ISD may not be addressed by ISD methods per se, but rather how those methods facilitate creativity and innovation.

This necessity for innovative software has been a driving motivator for change in ISD methods, most recently witnessed in the agile method movement (Cockburn, 2002; Highsmith, 2002). Software development is becoming increasingly complex and agile advocates believe that creativity, not voluminous written rules, is the only way to manage this complexity (Crispin and House, 2003; Cockburn, 2002; Highsmith 2002). Highsmith (2002) has been one such advocate and purports that “*agile approaches are best employed to explore new ground and to power teams for which innovation and creativity are paramount*”. Even more disciplined agile ISD approaches, such as eXtreme Programming (XP), still place a significant emphasis on fostering creativity and communication (Highsmith, 2002a; Crispin and House, 2003).

While researchers have examined how a variety of individual, group, and organizational factors shape innovation in ISD, the role of advice networks has received limited consideration to date. A greater understanding of advice network structures in ISD is important as numerous studies from the social network tradition demonstrate that advice seeking behaviors play a key role in people's ability to do their jobs effectively. Members of organizations rely on each other for advice, especially in knowledge intensive organizations. An advice network represents a set of paths through which appropriate information circulates among members of an organized setting. The allocation of this resource through informal ties and interactions reduces the costs of its acquisition during the process of making decisions to solve problems (Lazega et al, 2009).

For this research-in-progress paper, we draw from social network theory and develop a number of hypotheses relating the structure of a software developer's advice network for technological developments to personal innovativeness. We seek to predict personal innovativeness: the extent to which an individual actively generates, discovers, and promotes creative ideas. Once refined and validated, these hypotheses will be tested by way of questionnaire data gathered from a software development division of a large organization. Semi-structured interviews with software developers will also be conducted and triangulated with the quantitative data.

It is envisioned that this study will make a number of unique contributions. Firstly, as far as we are aware, this study denotes the first investigation of the relationship between advice network structures and personal innovativeness in ISD settings. These results will prove useful to ISD managers wishing to enhance innovation and creativity throughout their business units. Secondly, rather than follow the traditional treatment of advice networks as a unitary concept, we disaggregate the advice network concept into give- and get-advice and examine how the interaction effects between the two relate to innovation. This separation provides a truer picture of how advice networks function and enables us to gain a deeper understanding of specific benefits that different types of advice ties provide (Sykes et al. forthcoming). Thirdly, this study will make a methodological contribution to the IS social network literature by adopting a multi-method approach which combines quantitative and qualitative data and analyses. Such research strategies have been sorely lacking in the growing number of social network studies in the IS literature (Whelan et al. forthcoming).

## **2. Theory Development**

First we discuss the importance of social interaction in ISD environments. We then discuss advice networks and their impact on performance. Drawing from this literature, we develop our hypotheses relating advice network structure to individual innovativeness.

### **2.1 Social Interaction in ISD**

The critical role of social interactions has long been recognized in ISD (e.g. Kraut and Streeter 1995; Russo & Stolterman, 2000; Sawyer et al 2010), with the variations in these social interactions explaining performance differences among ISD teams (Agerfalk & Eriksson, 2006; Sawyer et al 2010). Some have even argued that the social aspects of ISD often surpass the considerable technical complexities (Robey & Newman, 1996). This fact is affirmed by the growth of agile software development practices which advocate the need for face-to-face communication. Agile practices claim to solve many issues of software development, including budget overruns, unmet requirements, and long development times (Holmstrom et al 2006). Moreover, numerous studies report that the increased difficulties in distributed software development are primarily due to the reduction in interpersonal communication (Grinter et al 1999; Komi-Sirvio and Tihinen 2005).

Social interaction between software developers is a necessity due to the complexities in producing software that meets user requirements. Developing an IS requires a disciplined knowledge of how best to develop software, a broad knowledge of the intended domain, and exacting knowledge of processing logic and data structures (Iivari et al., 2004). It is unreasonable to expect one developer to possess all the skills to excel in all these activities. Thus, social interactions in ISD are needed to es-

establish how activities will be performed, informally share ideas and information on new technologies or processes, and resolve the conflicts that arise in the course of working together (Sawyer et al. 2010). Indeed, when in co-located settings, software developers can spend up to 75 minutes each day in “unplanned interpersonal interaction” (Perry et al 1994) with much of this time spent disseminating and acquiring work related advice. Yet, the details of the relationships among social interactions and ISD performance are still not well understood empirically or theoretically (Sawyer et al. 2010). Our purpose is to address this gap by examining how advice on new technologies and developments flow around the ISD social network, and how a software developer’s position within that advice network relates to their personal innovativeness.

## 2.2 Advice Network Structure

The social network tradition has its origins in sociology and anthropology and has long considered how the pattern of social interaction shapes substantive outcomes at the individual, group, and organizational levels. Early network scholars distinguished themselves from other social scientists by focusing not on individuals as entities, or abstract collections of individuals, but by exploring how particular social structures constrain or promote human behavior. The social structure of interest manifests itself in the pattern of relationships between network actors, patterns that may not even be apparent to participants. As such, “*Network analysts search for deep structure - regular network patterns beneath the often complex surface of social systems*” (Wellman 1983: 157).

Social networks have received extensive attention in the management and organizational behavior literatures. At the team level, researchers have found that social network structures such as density, centrality, and cohesion have an impact on task performance (Balkundi and Harrison 2006; Pentland 2012), project quality (Cataldo & Ehrlich, 2012), and IS implementation success (Sasidharan et al., 2011). At the individual perspective, an employee’s position in a social network is linked to performance (Ahuja et al. 2003; Sykes et al. forthcoming) and provides advantages, such as organizational assimilation (Sparrowe and Liden 2005) and promotion (Burt 1992), or leads to disadvantages, such as organizational exit (Krackhardt and Porter 1986).

While the structure of a social network can predict a variety of outcomes, the nature of the resources that flow through that structure is equally important. The ties most commonly studied in organizations tend to be *expressive* and *instrumental* ties (Lincoln & Miller, 1979). Expressive ties reflect friendships and are important conduits of social support and values (Ibarra, 1993; Lincoln & Miller, 1979). Instrumental ties are the pathways of work-related advice and are considered more important for understanding performance outcomes (Ibarra, 1993). Such ties may emerge from a formal relationship (e.g., leader-subordinate, work colleagues), and the primary content exchanged through them is information resources or knowledge that is relevant to succeeding in one’s job within a unit. Thus, this particular study examines advice networks in ISD environments. Workplace advice networks comprise employees in a defined workplace setting (e.g., business unit) who seek and provide information, assistance and expert knowledge to and from one another in order to perform their jobs (Sparrowe et al. 2001).

While prior social network research has tended to treat advice as a unitary concept (i.e. person A gets advice from person B), we adopt the approach of Sykes et al. (forthcoming) and disaggregate the advice network concept into give- and get-advice and examine how the interaction effects between the two relate to innovation. Such a disaggregation of advice networks provides a richer and more accurate understanding of these social structures as giving advice represents power and influence (Sparrowe and Liden 2005), whereas getting advice represents knowledge acquisition (Hansen, et al 1999). For example, Sykes et al. (forthcoming) examined how the implementation of a new enterprise system impacted employee performance. Those employees who were highly embedded in both the giving and getting software advice network were the highest performers, while employees with high embeddedness in the getting software advice network but with little embeddedness in the giving software advice network, were the lowest performers.

## 2.3 Hypothesis Development

In this study, we focus on the giving and getting of a particular type of advice, namely advice relating to new technologies and developments that can be applied to and improve ISD. We refer to this as the technological advice network. We have specifically chosen to focus on this type of advice as research has consistently shown that exposure to such information is a pre-requisite for innovation (Allen 1977, Chesbrough 2003, Zmud, 1983). An overview of our research model is given in figure 1 and we now present our hypotheses that relate a software developer's position in each type of advice network to their levels of personal innovativeness.

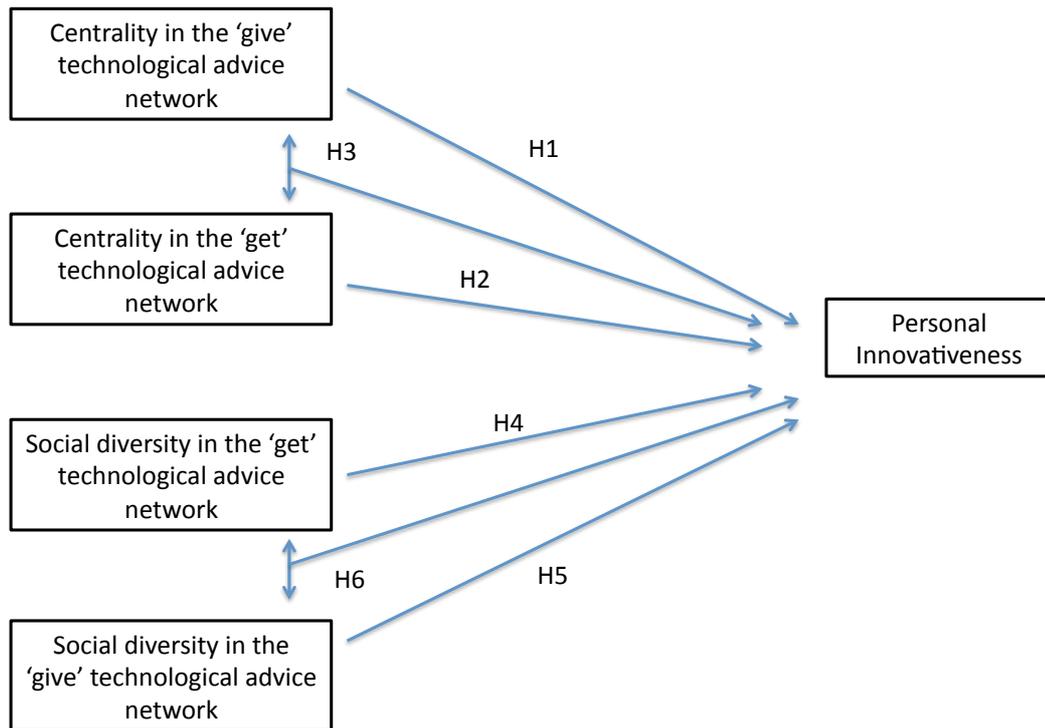


Figure 1. Research Model

### *Give technological advice network*

An actor's positional embeddedness in an advice network has been a dominant concept in the study of social networks. Network embeddedness is the extent to which an actor is connected to other nodes and how interconnected those nodes are to each other (Granovetter 1973). Employees who are heavily embedded in the give-advice networks will be seen by their supervisors as performing a valuable service, as such employees not only improve coworker and organizational performance, but also engage in extra-role behaviors and gain in prestige (Völker and Flap 2004). Indeed, the highest organizational performers tend to be those who are highly embedded in the give advice network (Skyles et al, forthcoming). The giving of advice, and particularly advice on new technologies and developments, denotes that the provider is an expert in a particular knowledge domain. Such employees expose their colleagues to new ideas and are considered an essential cog in the firm's innovation pursuits (Allen 1977). Thus, we hypothesize:

H1: A software developer's embeddedness in the 'give' technological advice network will be positively associated with personal innovation.

### *Get technological advice network*

In order to be continuously innovating, employees need to be acquiring novel knowledge. Getting advice from work colleagues is a primary system through which employees can learn of such knowledge. The more embedded one is in the get advice network, the more opportunities that exist to acquire relevant information. Being embedded in the 'get' advice network will help employees learn improved ways of accomplishing tasks using the new ideas, thereby helping achieve high levels of performance and/or performance gains (Skyles et al, forthcoming). Compared to less embedded people, central individuals are more likely to be aware of whatever is going on in the network, and this has been found to facilitate creativity in researchers (Perry-Smith 2006). Also, more embedded employees are able to use their central position to better identify and leverage the resources available in the network (Kane and Alavi 2008). Thus, we hypothesize:

H2: A software developer's embeddedness in the technological information 'get' advice network will be positively associated with personal innovation

#### *Interaction between give and get advice networks*

Innovation researchers have long been interested in better understanding the processes through which novel technological information from outside the firm becomes absorbed and exploited internally (Allen 1977; Cohen and Levinthal 1990, Chesbrough 2003). The 'technological gatekeeper' has been a central feature within this thinking (Allen 1977; Tushman 1977; Whelan et al. 2008). Technological gatekeepers are those key individual technologists who consistently receive information on emerging technological developments from their many external colleagues, and who possess the ability to translate this information and pass it on to their internal colleagues who can exploit that information. Essentially, gatekeepers are highly embedded in external get advice network and the internal give advice network. Studies have found that gatekeepers are essential in the innovation process and development projects with gatekeepers were significantly higher performing than those without. While the literature suggests that gatekeepers primarily receive their technological information from contacts outside the firm, we modify the principle and apply it to internal advice networks. Thus, we hypothesize that:

H3: The interaction of a software developer's embeddedness in the technological information get- and give-advice networks will have a positive effect on personal innovation

#### *Social diversity in get advice network*

A core principle in the social networks literature is that individuals are more likely to access novel information when they are connected to people who are themselves not connected to one another (Burt 1992). There are two explanations offered as to why this is the case. Firstly, members of a group, over time, tend to learn what each other know and this reduces the variation in their knowledge (Kilduff and Tsai 2003). Secondly, the principle of homophily explains that people tend to associate with others with whom they share some degree of similarity (McPherson et al. 2001).

The gap between groups or individuals, a *structural hole* (Burt 1992), creates advantages for those who can act as a broker and obtain non-redundant information (Hargadon and Sutton 1997; Reagans and Zuckerman 2001). Obtaining information from a diversity of social contacts creates the opportunity to recombine different knowledge domains, which is how innovation occurs in reality (Cohen and Levinthal 1990; Hargadon and Sutton 1997). Employees who span structural holes are better able to observe, evaluate, and import unique ideas (DiMaggio 1992) and are therefore, likely to be more innovative in their behaviors (Burt 1992). In support of his theory, Burt provides network analysis data showing how managers with rich structural holes, are associated with early promotions, higher compensation, and positive evaluations. These honors are assumed to reflect their superior ability to add value to their organization (Gargiulo and Benassi 2000). Therefore, we hypothesize;

H4: The extent to which a software developer receives technological information from work colleagues who are themselves not connected to each other, will predict that individual's level of personal innovativeness.

### *Social diversity in give advice network*

While the advantages of obtaining information from a diversity of social contacts is well established in the literature, what is less well understood is whether such advantages accrue to the person who distributes information to disconnected others, as opposed to a tight-knit group. The literature on social capital informs us that investing in social relationships provides opportunities to exploit these resources (Coleman 1988). Thus, one could expect that software developers who give advice to a diversity of others can gather more support for their own innovation initiatives and thus more likely to be recognized by managers as being creative and innovative. In personal relationships, advice givers themselves benefit from providing help, either through increasing the beneficiary's obligation to reciprocate or through receiving the beneficiary's esteem or both (Constant et al, 1996). Sykes et al (forthcoming) found that employees' level of embeddedness in give advice networks was positively associated with job performance. However, their study did not consider the social diversity of those they gave advice to. We purport that the positive effects of giving advice to others will be amplified when the receivers are disconnected from each other i.e. more social diverse. Thus, we hypothesize:

H5: The extent to which a software developer gives technological information to work colleagues who are themselves not connected to each other, will predict that individual's level of personal innovativeness.

### *Interaction of socially diverse give and get advice networks*

Software developers who acquire advice on technological information from social diverse colleagues, and who distribute the novel information they acquire to a diverse set of others, will be more innovative than those who are not as social diverse in both giving and getting information in the technological advice network. This assertion is based upon extensions to the structural holes theory. Obstfeld (2005) explored the relationship between a tertius iungens orientation (i.e. when individuals chose to sacrifice control and casually introduce disconnected others), and innovation involvement in the firm. In an extensive study of engineers involved in an automobile design, a tertius iungens orientation was found to be a strong predictor of innovation involvement. Rather than destroying the structural holes theory, Obstfeld explains that these results need to be interpreted with an element of caution. Innovation is a fundamentally different dependent variable than the individual performance measures - salary, bonuses, promotion - used by Burt and others. Innovation requires cohesive and fragmented networks to join together. These findings suggest that the optimal strategy in terms of innovation is for brokers to be constantly creating new structural holes. When 'A' introduces 'B' to 'C', an existing structural hole is closed. However, if 'B' reciprocates and introduces 'A' to 'D', then a new structural hole is created. Such closure may actually constitute the reaping of network potential that may otherwise go unrealized (Obstfeld 2005). Thus, through the process of giving advice to and getting advice from social diverse colleagues, such individuals are continuously opening and closing structural holes and will gain advantages in terms of innovative performance. Thus, we hypothesize;

H6: The interaction of a software developer's social diversity in the technological information get- and give-advice networks will have a positive effect on personal innovation.

## **3. Methods**

Data will be collected from the 80 software developers comprising one ISD unit of multinational technology firm. All 80 developers are co-located in the firm's Irish subsidiary. The term 'software developer' includes such roles as programmer, analyst, system tester, database administrator, domain expert seconded to the ISD team and the team's technical leads and project managers (Sawyer et al., 2010).

Data will be gathered in a number of phases. Firstly, all 80 software developers will be issued with a short questionnaire that seeks information on their advice seeking behaviors. The specific question used to obtain this data is adapted from Sykes et al (forthcoming) and reads as follows: *In general, how often do you contact or are contacted by the persons listed below for advice on **emerging technological developments related to your work**. Please leave the row blank if you do not interact with that*

person at all. Respondents can select the following options; many times a day, once a day, once a week, once a month, or less than once a month. Following prior research (e.g., Allen 1977; Krackhardt & Hansen 1993), a relationship with a frequency of once per week or above will be treated as a tie being present whereas less than once a week indicates the absence of a tie.

Our dependent variable will be an assessment of each developer's level of personal innovativeness as reported by external evaluators who could more objectively assess innovative behaviors (Shalley et al. 2004). We will use the well established innovativeness scale developed by Scott and Bruce (1994). In consultation with management at the ISD unit, the scales were adapted to more accurately reflect the work of the group. The innovativeness of each developer will be assessed by their direct manager using the following likert scales: This person generates creative work-related ideas; This person promotes and champions work-related ideas to others; This person is innovative.

Finally, the firm have granted permission for 10 interviews to be conducted once the data from the initial quantitative phases has been analyzed. The interviews will be semi-structured in nature and will be used to; (1) provide more richness regarding the nature of information flows in give and get advice networks, and (2) validate that the patterns resulting from the initial SNA reflect reality. Proponents of this multi-method approach argue that using a single method fails to test alternative interpretations of the data thus its validity is open to question. By combining different methods, the individual weaknesses of each approach can be overcome, therefore increasing the confidence that the research reflects reality rather than methodological error (Mingers 2003). Moreover, the robustness of results can be increased through the triangulation of results (Yin 1994). We believe this multi-method approach will make a methodological contribution to the IS social network literature such research strategies have been sorely lacking in this growing IS field (Whelan et al. forthcoming).

#### 4. Conclusion

While the critical role of social interaction in producing effective software is well documented in the ISD literature, what is less well understood is how the pattern of interactions among developers shapes important outcomes. This research-in-progress will address this gap by examining how the structure of advice networks in ISD are related to personal innovativeness. Software developers are under pressure to produce software that is innovative, and not just functioning effectively. Thus, this research will shed light on the advice seeking behaviors and network structures that contribute to innovation in ISD. Drawing from social network theory, and specifically advice networks, a number of hypotheses are developed. The next phase of our research will see these hypotheses been tested at an ISD unit of a multinational corporation.

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