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A Social Network Perspective of Information Systems Project Management

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ABSTRACT

This study looks at the social network that exists during information systems development (ISD). By introducing a social network perspective of information systems project management, social network analysis and its concepts of embeddedness, structural holes, and centrality can be used to reveal organizational phenomena that might otherwise be overlooked. In this study we analyze the social network from a successful systems development project in a health care setting, looking particularly at the emergence and role of change agents. The results of this research suggest that the ISD transactions are embedded in the social relations, implying that social relations and ISD must be managed jointly to achieve a successful (system solution) project. Social network analysis allows simultaneously measuring the ISD project transactions and the social relationships that tie them together, providing a new perspective that can be used to build an effective project management infrastructure.

Keywords

Information System Development, Project Management, Social Network Analysis, Change Agent, Participation.

INTRODUCTION

A social network is defined as a set of participants and the relations, such as, communication channels and work processes that connect them (Kilduff et al. 2003). This study looks at the social network in place during information system development (ISD), as the configuration of interactions among the change agents, participants, and other stakeholders. By introducing a social network perspective to ISD, the concepts of embeddedness, structural holes, and centrality can be used to reveal organizational phenomena that might otherwise be overlooked. A better understanding of how social networks are configured may lead to more effective management of ISD participants and their roles, thus increasing the likelihood for a more successfully managed project.

The concept of embeddedness maintains that work-related transactions tend to overlap with social relations (Granovetter 1985). Thus, taking a social network perspective this study possibly suggests that an ISD project is embedded in a social network, and therefore patterns of activities and processes connecting participants and change agents may depart from what might be expected from a purely economic perspective.

Structural holes are gaps in the information flows of the social network. Such gaps can be bridged by liaison roles (Burt 1992). This is significant because a lack of communication between project managers, systems analysts and end users is often linked to system failure, and thus the coordinator or broker role which is responsible for bridging ties in the information flow, can be instrumental to a successful system.

Centrality in information flows of social networks is implicit in discussions about structural holes. Centrality refers to the extent to which a participant occupies a central position in the social network in one of the following ways: having many ties to other participants (degree centrality); being able to reach many other participants (closeness centrality); connecting other participants who have no direct connections (between centrality); or having connections to centrally located participants (eigenvector centrality).

As the concepts above indicate, social network analysis (SNA) can provide a distinct perspective by mapping out and explaining more fully, the richness and complexity of human behaviour (Cohen et al. 1989) during the development of a successful (system solution) project. SNA may help us answer questions such as "What relationships exist between specific actors in a 'goal directed' social network structure, and how strong are these relationships?" and "Does a broker role node in a

social network associated with a successful (system solution) project have more communication than other nodes?" By answering these questions, we can use what we learn to be proactive during the development of a (system solution) project.

This research suggests that ISD transactions overlap with social relations, thus defining a social network. This implies that the social relations and the ISD project form a combined infrastructure that must be simultaneously managed to achieve a successful (system solution) project. SNA is a way to simultaneously measure the ISD transactions and the social relationships that tie them together. Structural holes and centrality are two of these measurements used in this study to provide a social network perspective of ISD.

Characteristics of SNA

SNA encompasses theories, models, and applications that are expressed in terms of relational concepts or processes and is based on an assumption that relationships among interacting units (social networks) are important (Wasserman et al. 1994). There are distinct theoretical social network perspectives and techniques for collecting data, statistical analysis, and visual representation. In the 1970s, mathematical tools and methods from graph theory and the availability of computers helped the study of social networks to take off as a new, interdisciplinary research area. Today, SNA is used in a variety of disciplines, including management, information systems, marketing, and health care, as well as social psychology, sociology, and anthropology. SNA research focuses on relationships between actors rather than attributes of actors; that is, the analysis depends on the availability of relational rather than attribute data. It is helpful to keep in mind that social network variables can and do serve as both dependent and independent variables. A comprehensive review of the social network paradigm in organizational research is given by Borgatti and Foster (2003).

Participation in ISD and the Significance of SNA

Participation in ISD refers to the whole process (including the management of the project), but it is important to note that the terminology has evolved to include alternative combinations and descriptions of the phases and how actors participate in the phases. Existing social networks can supply data on how actors participate in ISD, and SNA can present the cues and patterns that allow us to better understand the relationship of participation in ISD to project management and systems outcomes. In addition, visual representations of social networks help us understand the data and convey the results of the analysis. Often the relationship of participation to the specific activities and processes that contribute to systems success are not clearly seen, and thus social networks can be an important source of information and contribute to the practices and guidelines that help increase the chance of success in a specific systems context.

Many types of users exist, including different levels of management, and day-to-day users. Users play different roles at various stages in the ISD process, therefore the IS literature frequently calls them participants. The word stakeholder has also become commonly used in the IS user participation literature and generally refers to “those who are likely to be affected by a solution, whose acceptance and use of that solution could be problematic, and who are therefore logical candidates for participating in solution development” (Markus et al. 2004).

Participants are the members of the subset of stakeholders who are actually given the chance to participate in the ISD activities. The selection of good participants from among the stakeholders is often the job of the change agent. Change agents can be a subset of existing stakeholders (managers, IS professionals, HR professionals), or they can be external consultants and/or vendors. They are the “people who play important roles in designing and executing participation opportunities for stakeholders” (Markus et al. 2004). They decide who the participants will be, how they will participate (via surveys, JAD sessions, or on ISD project teams), and what participation techniques and tools (e.g., CASE, discussion aids, wikis) are used. In addition, change agents are often the team leader or facilitator in the process of participation and may have the authority to resolve or remove other participants if conflict occurs (Sabherwal et al. 1993). Therefore, the social network of actors in an IS project includes the roles of change agent, participants, and stakeholders (see figure 1).

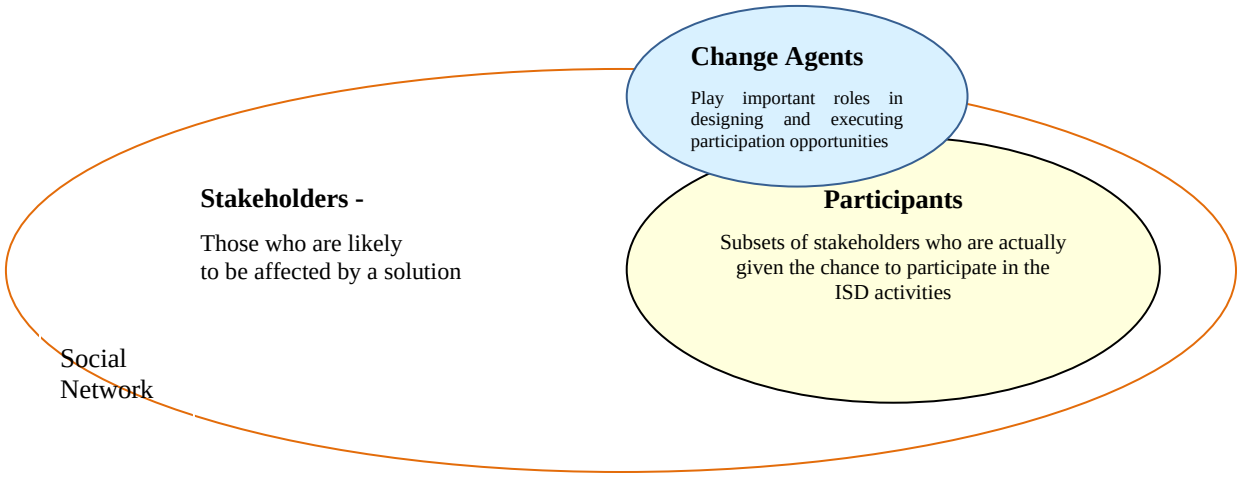

Figure 1. Participation: Social Network Derived from Markus and Mao (2004)

Goal-Directedness and Participation

In considering social networks and participation in the development of successful systems solutions, we must distinguish between two prevalent underlying processes: *goal-directedness* and *serendipity*. These two processes differ in operational and structural dynamics and produce quite different systems solutions over time. With goal-directedness, relationships are formed to achieve, plan, coordinate, or decide on individual or collective activities, whereas with serendipity relationships happen, like those between people who accidently meet and like one another (Kilduff et al. 2003; Salancik 1995). Although serendipity may not be totally absent, participation in ISD (through identifiable roles) would normally be dominated by goal-directedness.

User participation in an IS project is an example of a network change, driven primarily by goal-directedness. Kilduff and Tsai (2003) put forth a description for social networks that are dominated by goal-directed processes. The following list shows how this concept relates to our study:

- The underlying assumptions of goal directedness are teleological and instrumental because participants, stakeholders, and change agents share a goal.
- A social network (as define in Figure 1) is formed to achieve this goal.
- The typical social network is fast to form around the shared goals.
- New goals can evolve that prolong the need for participants in a project.
- There is a centralized structure around change agents, a core-periphery (refer to Figure 1).
- Sub-network formation is common.
- A homogeneous group of participants make solution success more probable.
- Individual participants are chosen because they share goals, have a predicable career path, and have mobility across similar organizations.
- An emphasis on network wide trust is important to solution success.
- Solution success is measured against the project goals and objectives.
  If conflicts arise over goals, solution failure becomes more probable.
- The survival of a group of participants can be threatened by both solution success and failure.

Our study (as well as others, e.g. (Markus et al. 2004)) suggests the need to investigate the rapidly changing ISD issues and contexts that we face today. Change brings with it new tools that facilitate participation in ISD in ways never seen before (Markus 2004). Therefore, we agree that we need to revisit user participation in ISD (He et al. 2008; Mao et al. 2004; McLeod et al. 2007) and address the need to have a broader and more comprehensive description of user participation in ISD that fits the world we live in today. A social network perspective and the concept of goal directedness supply new concepts which can be used to look at the roles that exist when users participate in information systems development. We will hypothesize that this lens can provide a richer understanding of the complex process of IS project management.

HYPOTHESES

Our first hypothesis is the baseline prediction for goal-directedness. According to Kilduff and Tsai (2003), one of the key identifying features for goal-directedness is the emergence of one or more administrative entities that acts as a broker to plan and coordinate activities of the network as a whole. This entity can be a member of the network itself or a separate actor with a specialized coordinating role. This concept bears directly on this study, because the role of a change agent (broker role) is to help build the network (select the participants), coordinate and manage the participation activities, support network goals (deliver solution success shared by participants), and provide a centralized location (physical or virtual) for performing key activities, which include the resulting communications within the network. For example, the communication within a network of participants might be structured in specific ways that help develop a successful (system solution) project. All the relationships within the network of participants may be structured to achieve this goal. Because the baseline prediction that "goal-directedness is a more useful predictor of solution success… than the process of serendipity", we test the hypothesis that in systems solutions with goal directed structures, an administrative entity tends to emerge that acts as a change agent (broker) to plan and coordinate activities of the network as a whole:

Hypothesis 1. Successful systems solutions with goal directed social network structures tend to have multiple change agents that act as brokers who plan and coordinate activities.

Our second hypothesis derives from an unbundling of the goal-directedness construct:

Hypothesis 2. Successful systems solutions with multiple change agents tend to have more communication in goal directed social structures.

RESEARCH DESIGN

In this study we analyze the approach to ISD participation in a successful health care setting by identifying the change agents that act as brokers. We also test for specific kinds of broker structures, where the broker is a coordinator. These tend to have more information-flow than other types of broker structures. Table 1 below outlines our research design.

Measures and Guidelines from the literature (Scott 1991)	**Whether/how the guidelines are followed in this study**
(Data) Use multiple sources of evidence Sampling Units	Project management documents in a variety of formats. A nested two-stage research design that involves a higher-level system (complex formal organization) within which lower-level entities (identified roles participating in an ISD project) comprises the actors.
Relational Form and Content Level of Data Analysis	Transaction relations: Actors exchange control over physical (frequency of communication and when they will occur) or symbolic media (purpose). Communication relations: Linkages between actors are channels (reports, meetings, presentations, etc.) through which messages may be transmitted. Directed triad network. The broker is middle node of the directed triad. This is a network consisting of roles (i.e. PM, IMD AD, IMD A, etc.).
(Measures) Embeddedness, Centrality, and Structural Holes	Graphs for the visualizations of the social networks and participation matrices. This give us the ability to manipulate mathematical representation of relational data and construct insightful and meaningful sociograms

Table 1. Research design

Two software packages are used in this study: **(1)** Ucinet **(**shareware) is maybe the most well known and utilized software (Borgatti et al. 2008) for analyzing social networks, and one of the most comprehensive ones. (2) NetDraw (free software) is intended for visualizing social networks, but also contains some routines specifically designed to analyze network datasets. NetDraw is a free program written by Steve Borgatti for visualizing both 1-mode and 2-mode social network data.

DATA ANALYSIS, RESULTS AND DISCUSSION

In this section, we look at a single directed binary social network that describes the flow of information among eleven indentified formal roles taken from a successful system project conducted in a health care organization. Of course, network data come in many forms (undirected, multiple ties, valued ties, etc.) and each analysis uses the measures that best capture the data in a way that answers the research questions and tests the hypotheses put forth in the study. It is sometimes surprising how much information can be "extracted" from a single binary matrix using basic graph concepts.

Descriptive Analysis

Our study focuses on a successful healthcare setting in Southeast Asia. The investment in information technology (IT) for hardware, software and manpower in this healthcare setting has been substantial because management believes that IT is a driver for quality medical care, excellent customer service, and improved financial viability. The projects focus on the areas of patient care and administrative systems development, hardware and network infrastructure expansion, and quality assurance management.

To keep pace with constant change and effectively support high quality patient care, drive improvement in customer service, and help improve operational efficiency, the Information Management Department (IMD) revisited its strategic goals. They adopted a step-by-step approach (which included user participation as a major component) and identified three major phases for improvement of the department. These phases determine the focus of improvement efforts and not the operational activities and projects of the department. Since goal-directedness is defined as involving relationships that are formed to achieve, plan, coordinate, or decide on individual or collective activities (Kilduff et al. 2003; Salancik 1995), the analysis of the strategic goals in this health care setting using action items and other project documents suggests that the social network emerged as a result of the strategic goals of the organization.

The Emergence of a Social Network

There are different roles that a participant, stakeholder, and change agent (types of ego) can play, depending on network structure and composition. Table 2 shows the roles identified in the healthcare setting at the onset of the ISD project. Knowing and understanding the roles that exist is important for project management succeed. This research extends the attributes of a role, by showing the power of the relationships. The relationships between the roles further explain the social network that emerges. Roles and relationships between them make up the social network. Therefore, the social network of participants that emerges is related to the specific activities and processes that contribute to systems success. In addition, it is important to note that the strategic goals of the project include the need for effective communication and improved communication between the units. The Information Management Department (IMD) is defined as a communication and information technology enabler, which should lead the effort to improve communications within the different units.
The project promotes using effective and efficient tools to collaborate and interact, including: IMD Projects; WikiCollaboration and Conference Server; Intranet Portal; and SMS and Mobile technology.

Role	Role Abbreviation
1 Information Management Department Associate Director	(IMD AD)
2 Information Technology Steering Committee	(IT SC)
3 Information Management Department Managers	(IMD M)
4. Senior Vice President of Finance	(SVP F)
5. Information Management Department Associates	(IMD A)
6. Project manager	(PM)
7. Project Sponsor	(PS)
8. Co-Project Manager	(C PM)
9. Team Leader	(TL)
10. Project Development Team	(PDT)
11. Functional Team Leads	(FTLS)

Table 2. Roles in the Health Care (System Solution) Project

The ISD project includes the development and implementation of an IMD communications plan (Figure 2). This becomes the formal plan on how the roles will relate to each other.

Who conducts/ initiates the meeting	Stakeholders / Target audience	Purpose of communicating with each group	How will you communicate with each stakeholder group?	Frequency of communication & when they will occur
IMD Associate Director	IT Steering Committee	See IT Steering Committee Charter	Presentation/Discussion, hard copy of presentation	Quarterly
IMD Associate Director / IMD Managers	SVP-Finance	To communicate status of and issues in projects	discussion, hardcopy report	Monthly
	IMD Associate Director and IMD Managers	IMD Internal Project Status	discussion	Bi-monthly or as needed
IMD Managers	IMD Associate Director	Review	progress reports	weekly
IMD Associate Director / Managers	IMD Associates	Communicate Department issues, announcements, accomplishments	discussion	every 2 months or as needed
Project manager	Project Sponsor, Co-Project Manager	Review	discussion	Bi-monthly
Project Manager or Team Leader	Project Development Team, FTLs	Team review	group discussion	as needed
cell-content	cell-content	cell-content	cell-content	cell-content

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Figure 2. Communication Plan for the Health Care (System Solution) Project

Social Network Impact Analysis

Figure 3 shows the di-graph (directed graph) for the Health Care (system solution) project (HCSS) derived from the communication plan and project data. There are a limited number (eleven) of roles here, and all of them are embedded in a connected social network. But, clearly not every possible connection or role is present. This plan is a template of attributes intended to induce successful communication and promote social capital. The digraph visualizes the relationships that are initiated and the structural holes that are present in the emerging social network.

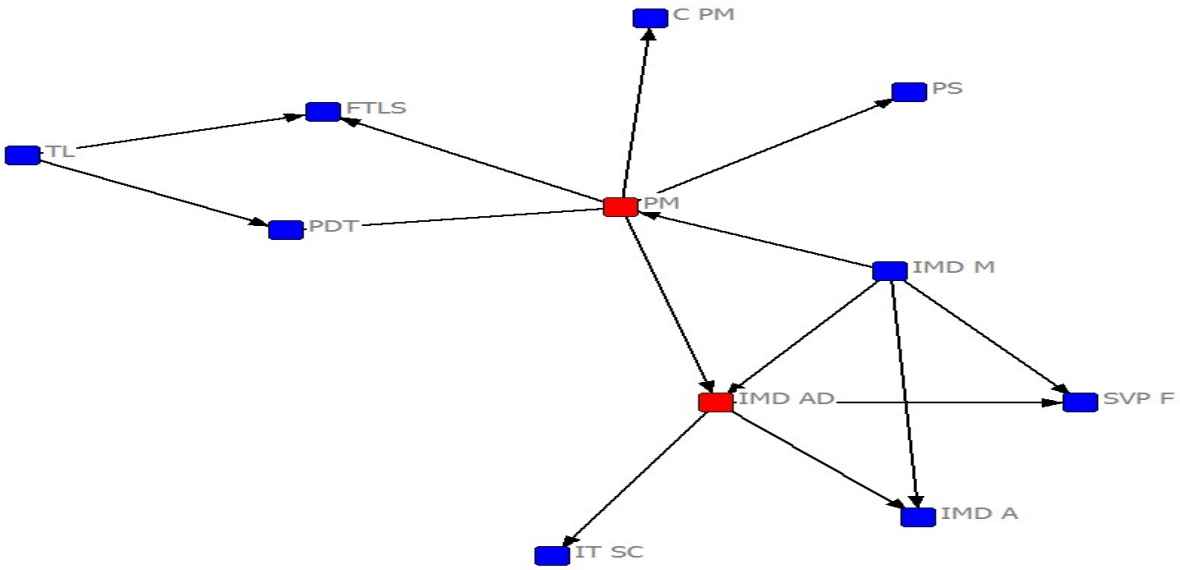

Figure 3. Di-graph (Directed Graph) for the Health Care (System Solution) Project

A broker is middle node (PM) of a directed triad (note: (C PM) is NOT connected to (PS). Another example of a middle node is (IMD AD) of a directed triad (note: (IT SC) is NOT connected to (IMD A)). The results of the analysis suggest that (PM) and (IMD AD) are brokers. They emerge as administrative entities that act as change agents. They plan and coordinate activities of the network as a whole, thereby accumulating social capital.

The notion of social capital suggests that people can create and accumulate value for themselves and others. Resources that are productive are not just entities (e.g. things and people), but are also social relations among people (Coleman 1988; Putnam 1993). In information systems, social capital brings together a variety of research relating a person's ties (or network position) to significant outcomes such as power, leadership, mobility, influence, and group performance (Burkhardt et al. 1990; Chen 2007; Cohen et al. 2001; Huysman et al. 2004; Johnson 2007; Kianto et al. 2007; Wasko et al. 2005; Widen-Wulff et al. 2008; Ye et al. 2003a; Ye et al. 2003b). The outcomes are an emergent side effect of previous activities and enablers of future activities.

(PM) and (IMD AD) are also cut-points and/or bridges. It is important to note that these roles can be more easily disrupted than networks with redundant paths. For example, if (PM) is removed from the (ISD) project, then the social network splitters into two groups (group A and B). This means that when a role from group A conducts/initiates meetings, discussions, and presentations, then group B would not have a relationship to group A, thus the flow of communication and/or ideas will be disrupted if the only method of information flow was through the (PM) and (IMD AD).

There appear to be some differences among the roles in how connected they are (compare role (IT SC), IT Steering Committee member, to the role of (PM), a project manager). (PM) and (IMD M), are more likely to be senders than receivers of information. As a result of the variation in how connected the roles are, some roles may be at quite some "distance" from other roles. There appear to be groups of roles that differ in this regard ((PM) and (IMD AD) seem to be in the center of the action, (IT SC) and (C PM) seem to be more peripheral).

Betweenness centrality (of binary data) views a role as being in a central position to the extent that the role falls on the geodesic paths between other pairs of presented roles in the social network. In other words, the more people depend on a particular role in the social network to make connections with other people, the more power that role has. However, if two roles are connected by more than one geodesic path, and the role is not on all of them, the role loses some power. Using Ucinet, it is quite easy to locate the geodesic paths between all pairs of roles, and to count up how frequently each role falls in each of these pathways. Ucinet adds up, for each role, the proportion of times that they are "between" other roles for the sending of information in the health care (system solution) project data. This sum is a measure of role centrality. We can norm this measure by expressing it as a percentage of the maximum possible betweenness that a role can have. The results from using Ucinet to calculate Freeman's betweenness measures for actors are shown in Figure 4.

We can see that there is a small amount of variation in actor betweenness (from zero to 4), and that there is quite a bit of variation (std. dev. = 1.543 relative to a mean betweenness of .727). The overall network centralization is relatively high. This makes sense, because we know that most connections cannot be made without the aid of a broker – hence there is a lot of "betweenness." There is a lot of structural constraint (power) in this network. (PM) and (IMD AD) appear to a good bit more powerful than others by this measure. Clearly, there is a structural basis for these roles to perceive that they are "different" from others in the population. Indeed, it would not be surprising if these two roles saw themselves as the brokers (for the whole network) that plan and coordinate activities. Therefore, the betweenness power in the system would be important for group formation and stratification.

Betweenness centrality characterizes the roles (identified in this study) as having positional advantage or power, to the extent that they fall on the shortest (geodesic) pathway. The idea is that the particular roles that are "between" others, and on which other roles must depend to conduct communications, will be able to translate this broker role into power.

It is important to note the case where two of the identified roles want to have a relationship, but the geodesic path between them is blocked by a reluctant broker. When another pathway exists, the roles that were blocked are likely to use the new pathway even if it is longer and "less efficient."

Un-normalized centralization: 36.000

		1 Betweenness	2 nBetweenness
1	IMD AD	4.000	4.444
3	PM	4.000	4.444
2	IMD M	0.000	0.000
4	TL	0.000	0.000
5	IT SC	0.000	0.000
6	SVP F	0.000	0.000
7	IMD A	0.000	0.000
8	PS	0.000	0.000
9	C PM	0.000	0.000
10	PDT	0.000	0.000
11	FTLS	0.000	0.000

DESCRIPTIVE STATISTICS FOR EACH MEASURE

		1 Betweenness	2 nBetweenness
1	Mean	0.727	0.808
2	Std Dev	1.543	1.714
3	Sum	8.000	8.889
4	Variance	2.380	2.938
5	SSQ	32.000	39.506
6	MCSSQ	26.182	32.323
7	Euc Norm	5.657	6.285
8	Minimum	0.000	0.000
9	Maximum	4.000	4.444

Network Centralization Index = 4.00%

Output actor-by-centrality measure matrix

Figure 4. Freeman Node Betweenness Centrality for the Health Care (System Solution) Project

The flow betweenness centrality calculates the role and graph flow betweenness centrality measures. Results for the health care (system solution) project communication network are shown in Figure 5.

By this more complete measure of betweenness centrality, the role of (IMD AD) is clearly the most important change agent (broker). (PM), who was fairly important when we considered only geodesic flows, appears to be less important. While the overall picture does not change a great deal, the elaborated definition of betweenness does give us a somewhat different impression of who is most central in this network.

Dataset is not symmetric.

		1 FlowBet	2 nFlowBet
1	IMD AD	3.000	3.333
2	IMD M	0.000	0.000
3	PM	0.500	0.556
4	TL	0.000	0.000
5	IT SC	0.000	0.000
6	SVP F	0.000	0.000
7	IMD A	0.000	0.000
8	PS	0.000	0.000
9	C PM	0.000	0.000
10	PDT	0.000	0.000
11	FTLS	0.000	0.000

Network Centralization Index = 3.278%

DESCRIPTIVE STATISTICS FOR EACH MEASURE

		1 FlowBet	2 nFlowBet
1	Mean	0.318	0.354
2	Std Dev	0.860	0.956
3	Sum	3.500	3.889
4	Variance	0.740	0.913
5	SSQ	9.250	11.420
6	MCSSQ	8.136	10.045
7	Euc Norm	3.041	3.379
8	Minimum	0.000	0.000
9	Maximum	3.000	3.333

Figure 5. Flow Betweenness Centrality for the Health Care (System Solution) Project

Some roles are clearly more central than others, and the relative variability in flow betweenness of the roles is fairly great (the standard deviation of normed flow betweenness is .86 relative to a mean of .32, giving a coefficient of relative variation). Flow betweenness has a relatively high amount of variation, with a network centralization index of 3.3%. The flow centralization index is slightly lower than the index for the betweenness measure that was based only on geodesic distances.

Summary of results

This paper uses social network analysis (SNA) to map and measure the potential impact of the emerging relationships and flows between stakeholders, change agents, and participants assigned to specific roles in a successful systems solution (ISD project).

SNA provides both a visual and a mathematical analysis of the human relationships in the process of participation. In particular, two-dimensional diagrams called sociograms were used to display the relationships among change agents, participants, and stakeholders in ISD (a bounded social system).

In summary, the results of the social network impact analysis suggest that in successful systems solutions with "goal directed" social network structures, multiple change agents that act as brokers who plan and coordinate activities tend to emerge. The (PM) and (IMD AD) roles are brokers in a goal directed health care setting. They emerge as change agents that act as brokers. They plan and coordinate activities of the network as a whole, thereby accumulating social capital. Successful systems solutions with multiple change agents tend to have more communication in goal directed social structures. The (PM) and (IMD AD) roles are change agent (broker) structures in a goal directed health care setting. But an interesting result was found by testing with a more complete measure of betweenness centrality, the role of (IMD AD) is clearly the most important change agent. (PM), who was fairly important when we considered only geodesic flows, appears to be less important. While the overall picture does not change a great deal, the elaborated definition of betweenness does give us a somewhat different impression of who is most central in this network.

CONTRIBUTION AND CONCLUSION

The purpose of this study was to use SNA to better understand the relationships and interactions between actors in an ISD project and therefore better manage the project. The basic idea behind this study is to map out and explain more fully, the richness and complexity of human behavior (Cohen et al. 1989) during the development of a successful systems solution. This will be useful for future research to create ISD project management models that allow social network structures to be established at the onset of a project that increase the chance of a successful ISD solution. These models may aid the quest to establish ISD participant "best practices" and therefore have better project management occur. This study also contributes to theory by analyzing patterns of relationships that are embedded in a social structure rather than view individual performance in isolation. It is important to note that more studies are needed to confirm our findings and to uncover additional insights that can further this line of research.

Direct findings of this study include that successful system solutions with change agents tend to have more communication than other nodes. That is, performance is better when the communication plan and emerging social structure incorporates the change agent roles effectively. This conclusion is consistent with (Papa 1990) who found that performance following a technological change has been found to be related to interaction frequency, network size, and network diversity (number of ties to other departments and hierarchical levels). It would be expected that a project manager and/or an IMD Associate Director should be a major player is an ISD project, but major players do not always communicate effectively. A good communication plan can be a template for successful communication, but the emerging social network is the implementation of the plan. A social network impact analysis provides better guidance for the project to succeed.

This offers numerous practical applications. For example, an organizations' communication plan should be prepared with the idea that when implemented they emerge as "goal directed" social structures. These planned social structures (project management plans) have change agents that cultivate relationships with others and acquire social capital. Therefore, they can affect performance, especially if those relationships involve the ability to acquire necessary information and expertise.

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