Investigating the Influence of an Individual's Social Network on the Diffusion of Technological Innovations

Sylnovie Merchant

California State University, Sacramento
College of Business Administration
Department of MIS
smerchant@csus.edu

Abstract

In recent years there has been a major increase in research on technological innovations and the variables which would lead to a faster and less disruptive diffusion of these technological innovations. However, few studies have addressed the issue of communication between individuals within their social network and how this communication can influence the adoption decision. The purpose of this paper is to develop a model which explores the relationship between an individual's social network and their decision to adopt a technological innovation. The technological innovation used for this research was Object Oriented Systems Development. Data was collected from individuals in various organizations. Multiple regression analysis was used to examine the data. Results show that the density of an individual's social network does have a significant influence on that individual's adoption decision while the degree of an individual's network does not.

Introduction

Within the last 15 years, there has been a major increase in research dealing with technological innovations and those variables which would lead to a faster and less disruptive diffusion of these innovations within an organization. By necessity, these studies have focused on the adoption of the innovation by individuals within the organization, with some authors suggesting that task characteristics or environmental characteristics (Kwon and Zmud, 1987) are the important variables to understand. Yet, it has been found that it is the individual who plays the significant role in the ultimate adoption of an innovation [10] [9].

Moreover, Rogers [13] has pointed out that communication within an individual's social setting is the important element in the diffusion of innovations. However, few studies have actually addressed the issue of this communication in the adoption of technological innovations and even fewer have looked into the effect of an individual's social network. This research proposes to investigate this phenomenon.

Purpose

The purpose of this research is to develop a model which describes the influence of the social network on an individual's decision to participate in the diffusion of a technological innovation. Specifically, it is recognized that individuals within an organizational setting do not operate independently, but are part of a social system or social network. It is also recognized that the diffusion of any innovation within an organization is an information intensive behavior. Furthermore, the individual's perceptions of an innovation will be conditioned by this network and the type of information received within it.

The research objective is to incorporate the separate and related research of technological innovations and social networking. The technological innovation chosen for this research is Object Oriented Systems Development (OOSD).

The Social System

An individual within an organizational setting does not operate independently, but is a part of a social system or social network. That is, organizations in which individuals operate are social systems comprised of many interrelated sub-systems. Unfortunately, researchers who study innovation solely as a diffusion phenomenon neglect the social structure that produces innovation or

governs its adoption ; that is, the network is itself implicated in the diffusion process [6].

A social system is a set of interconnected units that are involved in joint problem solving to accomplish a common goal. This sharing of a common objective is what binds the system together. For instance, a social system within an organization has the goal of achieving some business objective. In a systems development department, the common goal is to develop systems that meet the users requirements. The members or units of this social system can be individuals, informal groups, or organizations [13].

Although the individual units in the social system behave differently, structure does exist. The structure can be formal, such as an organization defining behavior or information flow in the workplace. This type of formal structure provides stability within the system. However, in addition to the formal structure, an informal structure exists [13] [11].

The formal and informal structure determines who interacts with whom and under what circumstances. This interpersonal structure can predict, in part, the behavior of individual members of a social system, including their innovation adoption decision. The interpersonal structure has been the basis for much of the research in social networks [3] [13] [15].

Social Networks

The study of social networks, or network theory, is gaining attention as an important element in understanding both corporate culture and the adoption of innovations [1]. A social network is defined as a set of actors and the set of ties representing some relationship - or lack of relationship - between the actors. Although we can assign social network measures to individuals, these measures are not the property of isolated actors; rather, they result from an account of the entire

network of relationships. That is, the focus is on the relationships among the individuals rather than the characteristics of the individuals themselves [4]. There are two main types of social networks: socio-centric or global and ego-centric or local [8] [14] [17].

Socio-centric or global networks encompass a particular aspect of social activity such as community ties or relationships within an entire organization [14] [17]. These networks are seldom studied because of the sheer enormity of the data that needs to be collected [14]. For instance, if one wants to study the relationships in an entire organization, then it is often necessary to determine all of those who work in the organization and their interactions with each other. Most researchers focus on ego-centric networks.

Ego-centric or local networks consist of one central actor, identified as the ego, and a set of individuals who have ties to the ego, also known as alters. The researcher typically gathers data from respondents (egos) who report on a set of alters to whom they are tied (degree), and on the ties among these alters (density) [17]. This research is focusing on the ego-centric network by concentrating on individual system developers and their set of alters within their system development area. For this reason, it is important to understand what is meant by degree and density when discussing connections in a network.

Degree of a Network

The degree of a network is related to the number of links that are connected to it. These links are referred to as nodes. The degree of a node is the number of nodes (individuals) that are connected to it. The degree of a node is a count that ranges from a minimum of 0, where no nodes are connected to a given node, to a maximum of g-1 (g=the total number of nodes), where a given node is connected to all other nodes in the network. For example, if an individual is connected to six other individuals, there are a total of seven nodes in the network. Therefore, the degree of the network is 7-1=6. A node with degree equal to 0 is called an isolate. While degree refers to the connections between a central node and others in the network, density refers to the number of lines in the network [14] [17].

Density of a Network

The concept of density measures the completeness of the network and consists of the number of lines connecting the nodes in the network. The maximum number is determined by the number of nodes. Since there are g nodes in a network, there are g(g-1)/2 possible lines that can be present in the network [17]. The higher the density, the more complete the network; that is, the more connected the individuals in the network are to each other. A totally complete network is very rare, even in small networks. However, network density is not a function of its size, and while it is usually related to it, it reflects variations in the quality of the interpersonal relationships [14]. For this reason, researchers need to consider all organizations as embedded in networks of other organizational actors that influence how and when they engage in innovative activities.

Object Oriented Systems Development

Structured development has long been the paradigm for systems development. The fundamental unit of decomposition in structured techniques is a process; the system is represented as a series of processes that transform data. Processes are linked via data flows, which help establish the sequencing of those processes. A complete structured requirements specification consists of a data flow diagram representing data flows and processes, a data dictionary, and a set of detailed process specifications [2].

Object oriented systems development (OOSD) represents a new way of approaching application development. The primary distinction between OOSD and structured development is the concept of process versus data orientation [2]. OO is a way of thinking about problems using models organized around real world concepts. The OO technology aims to identify the elements of the problem to better understand and explain how they interact with one another [5]. OOSD uses the concept of an object as the primary unit of decomposition. An object is a collection of data (attributes) and processes (services) that manipulate the data. It is an entity that is characterized by the actions that are imposed on it and the actions it imposes on other objects. These objects directly map to their real world counterparts [16] [18].

Although object oriented concepts have been around for over 30 years, it is just recently catching the attention of businesses. For this reason OOSD is considered an innovation because the definition of an innovation is that it is perceived as new or is new to the adopting unit [12]. Using the categories discussed earlier, OOSD is considered a radical innovation, while also being a process innovation because it involves new procedures. It is a radical

innovation because it requires serious changes in how software is built. That is, OOSD requires thinking about a problem and its solution in terms of objects rather than the more traditional functional or data approaches [2].

Findings

An instrument on the perceptions of innovations was used to collect data that measures variables that impact on the social network. The instrument was given to individual's who work as systems analysts in various organizations. A total of 239 usable surveys were collected. Participants were asked to list up to five individuals who they most often discussed systems development issues with. These individuals formed the degree of the individual's social network. Participants were then asked whether or not the individuals they listed knew each other. This measured the degree of the individual's social network. Participants were then asked to rate their adoption intention towards OOSD based upon the information which they had received about it.

Multiple regression analysis was used to analyze the data with an alpha of .05. It was discovered that the density of an individual's network had a direct effect on the individual's adoption decision. Interestingly, the degree of the network did not have a significant effect on the adoption decision. Recall from the earlier discussion that the degree of the network refers to the number of nodes in a network while the density refers to how these nodes are related to each other.

Conclusion

This research attempted to develop a model of the influence of communication within a social network on the diffusion of a technological innovation - OOSD. The findings indicate that the density of the social network has a significant relationship with the adoption decision while the degree of the network does not. However, these findings should be viewed with caution. That is, when collecting data on the degree of the social network, individual's were asked to list "up to five" individuals. It is possible that some of the respondents had more than five associates with whom they discussed systems development issues. Limiting the degree to no more than five could have affected the results.

This research, however, is valuable in that it combines two areas that have not previously been investigated together. That is, the influence of the social system on the adoption and diffusion process of technological innovations.. The findings of this research can be used to further advance the knowledge of how the social networks can influence the adoption of OOSD and other technological innovations. In addition, this research could contribute to the advancing theory of diffusion of innovations by taking it into a new arena (social settings) and focusing on sociological rather than psychological aspects of technology use, thereby joining the disciplines of sociology and technological innovations.

References

[1] Abrahamson, Eric and Lori Rosenkopf, "Social Network Effects on the Extent of Innovation Diffusion: A Computer Simulation," *Organization Science*, May-June 1997, (8:3), pp. 289-309.

[2] Agarwal, Ritu and Atish P. Sinha, and Mohan Tanniru, 1996, "Cognitive Fit in Requirements Modeling: A Study of Object and Process Technologies," *Journal of Management Information Systems*, Fall, (13:2), pp. 137-162.

[3] Brancheau, James C. and James C. Wetherbe,"The Adoption of Spreadsheet Software: Testing Innovation Diffusion Theory in the Context of End-User Computing," *Information Systems Research*, June 1990, (1:2), pp. 115-143.

[4] Brass, Daniel J, Kenneth D. Butterfield, and Bruce C. Skaggs,1998, "Relationships and Unethical Behavior: A Social Network Perspective," *Academy of Management Review*, January, (23:1), pp. 14-31.

[5] Eckert, Gabriel and Paul Golder, 1994, "Improving Object-Oriented Analysis," *Information and Software Technology*, (36:2), pp. 67-85.

[6] Greve, H. R., D. Strang and N. B. Tuma, "Specification and Estimation of Heterogenous Diffusion Models," *Sociological Methodology*, P.V. Marsden (ed.), (25), pp. 377-420, Blackwell, Cambridge, MA.

[7] Kwon, Tae. H. and Robert W. Zmud, 1987, "Unifying the Fragmented Models of Information Systems Implementation,"in *Critical Issues in Information Systems Research*, John Wiley & Sons Ltd., New York, pp. 227-251.

[8] Marsden, Peter V., 1990, "Network Data and Measurement," *Annual Review of Sociology*, (16), pp. 435-463.

[9] Moore, Gary C. and Izak Benabasat, 1991, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research*, (2:3), pp. 192-222.

[10] Pierce, Jon L. and Andre L. Delbecq, 1977, "Organization Structure, Individual Attitudes and Innovation" *Academy of Management Review*, January, pp. 27-37.

[11] Rogers, Everett M. and D. Lawrence Kincaid, 1977, *Communication Networks: Towards a New Paradigm for Research*, The Free Press, New York.

[12] Rogers, Everett M., 1983, *Diffusion of Innovations*, 3rd edition, The Free Press, New York.

[13] Rogers, Everett M.,1994, *Diffusion of Innovations*, 4th edition, The Free Press, New York.

[14] Scott, Jordon, *Social Network Analysis*, 1991, Sage Publications, Ltd., Newbury Park, CA.

[15] Shah, Priti Pradhan, 1998, "Who Are Employees' Social Referents? Using a Network Perspective to Determine Referent Others," *Academy of Management Journal*, June, (41:3), ppl 249-268.

[16] Vessey, Iris and Sue A. Conger, 1994, "Requirements Specification: Learning Object, Process, and Data Methodologies," *Communications of the ACM*, May, (13:2), pp. 137-162.

[17] Wasserman, Stanley and Katherine Faust, 1994, *Social Network Analysis*, Cambridge University Press, Cambridge.

[18] Weinberg, Randy, Tor Guimaraes, and Richard Heath, 1990, “Object-Oriented Systems Development,” *Journal of Information Systems Management*, (7:4), pp. 18-26.