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The Effect of Influence Tactics and Contingency Factors on the Adoption and Diffusion of IS/IT Innovations in Social Networks

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TABLE OF CONTENTS

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TABLE OF TABLES

TABLE OF FIGURES

TABLE OF APPENDICES

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Abstract

Despite considerable research on the adoption and diffusion of information systems (IS)/ information technology (IT) innovations by individuals in organizations, very little is known about the processes underlying the adoption of innovations, and how those processes contribute to the diffusion and assimilation of innovations within organizations. Viewing processes as *sequences of actions*, this research conducted two studies to: a) uncover the adoption and influence processes employed by individuals, and b) identify the factors that influence diffusion and assimilation within social networks.

The first study, situated at the individual level, involved field interviews with 27 individuals from ten organizations in a large mid-western city in the United States. Three categories of actions were identified from the interview data: **contextual actions**, **influencer actions**, and **adopter** (pre-adoption) **actions**. The actions from each interview were used to construct two sequences (for adoption and influence), which were then examined using optimal matching and cluster analysis. Taxonomies of three adoption processes (Conscious Quest, Requisite Compliance, and Piloted Trial) and three influence processes (Directed Assistance, Queried Disclosure, and Logical Persuasion) were empirically developed. These processes provide insights into the *adoption of innovations by individuals*.

The second study, situated at the network level, involved an agent-based simulation. Building on the field interviews, the simulation modeled the behaviors of *individuals* within 5000 networks adopting multi-feature IS/IT innovations over 50 time periods. Cross-sectional time-series analyses of the resulting data supported 13 of the 20 hypotheses, and revealed that: a) diffusion was facilitated by: a centralized organization structure, an individualistic cultural orientation, and all three actions, b) assimilation was facilitated by: a centralized organization structure and an individualistic cultural orientation during the early periods but by a decentralized organization structure and a collectivistic cultural orientation during the later periods, and c) all three actions facilitated assimilation in the early periods but only contextual and adopter actions influenced assimilation during the later periods. Overall, this study yielded insights into the *diffusion and assimilation of innovations within networks*.

Together, the two studies provided insights into the complex processes by which individuals within networks adopt IS/IT innovations with multiple features.

Keywords:
Information systems; innovation; individual; social network; adoption; diffusion; assimilation; field interviews; optimal matching; cluster analysis; agent-based simulation; cross-sectional time-series.

1 Introduction

The beginning of knowledge is the discovery of something we do not understand.
Frank Herbert

Individuals in organizations continue to be besieged by a variety of information systems (IS) and information technology (IT) innovations everyday. The ADOPTION[1] of IS/IT innovations has been of enduring interest to information systems research and practice over a considerable period of time. There has been extensive research conducted on the ADOPTION of IS/IT innovations by individuals in organizations (DeLone and McLean 1992; Fichman 1992; Jeyaraj et al. 2006; Prescott and Conger 1995; Rogers 1995; Venkatesh et al. 2003). While prior research has generated valuable findings and insights, there is inadequate understanding of the processes that underlie the ADOPTION of IS/IT innovations by individuals within organizations. This dissertation seeks to address this gap in our knowledge and contribute to our understanding of the ADOPTION of IS/IT innovations.

1.1 Statement of the Problem

The ADOPTION of IS/IT innovations by individuals within organizations has received considerable attention in extant literature. Two broad lines of inquiry may be identified within this extensive body of research: a) technology adoption studies and b) technology diffusion studies.

Technology adoption studies generally focus on the factors that are instrumental or detrimental to the adoption and use of innovations by individuals. These studies deal with an individual's intention to adopt or use the IS/IT innovation (Venkatesh et al. 2003), decision to accept or reject an IS/IT innovation (Rogers 1995), use of an IS/IT innovation (DeLone and McLean 1992), and use of specific features of the IS/IT innovation (Jasperson et al. 2005). The unit of analysis is typically the "individual" and the focus is on the individual adopting innovations. A variety of theoretical models have been proposed and empirically tested in the context of innovation adoption by individuals. These include the Theory of Reasoned Action: TRA (Fishbein and Ajzen 1975), Diffusion of Innovations (DoI) for individuals (Rogers 1983), Social Cognitive Theory: SCT (Compeau and Higgins 1995), Technology Acceptance Model: TAM (Davis 1989), Theory of Planned Behavior: TPB (Ajzen 1991), Perceived Characteristics of Innovating: PCI (Moore and Benbasat 1991), Model of PC Utilization: MPCU (Thompson et al. 1991), Motivational Model (Davis et al. 1992a), Task-Technology Fit: TTF (Goodhue and Thompson 1995), TAM Extended (Jackson et al. 1997), TAM2 (Venkatesh and Davis 2000), and Unified Theory of Acceptance and Use of Technology: UTAUT (Venkatesh et al. 2003). Together, these models have examined contextual factors such as facilitating conditions and voluntariness, individual dispositions such as playfulness and attitudes, individual differences such as age and gender,

[1] ADOPTION is used here for conciseness; it encompasses "adoption," "use," "assimilation," and "diffusion" of IS/IT innovations.

and innovation attributes such as usefulness and ease of use. There is a general consensus that beliefs shape attitudes, which in turn influence intentions, which in turn affect behaviors.

Technology diffusion studies focus on the ways in which an innovation spreads across individuals within an organization. These studies examine the mechanisms by which the IS/IT innovations diffuse across individuals within the organization (Rogers 1995). The unit of analysis is usually the "organization" (or more generally, the social system) but the focus is on the individual adopting innovations. This literature provides several insights into the diffusion process. For instance, this literature informs us that individuals may be classified as early or late adopters based on the time of adoption, that both external and internal information sources are important during innovation diffusion, that external information sources (e.g. mass communication) are more useful in the early stages, that internal information sources (e.g. interpersonal relationships) are more important in the later stages, and that a "critical mass," i.e. a threshold of participants, may be necessary before an explosion in diffusion activity is seen (Brancheau and Wetherbe 1990; Burkhardt and Brass 1990; Liberatore and Breem 1997; Lou et al. 2000; Rogers 1995; Valente 1995). These studies yield an understanding of when, i.e. the time at which, individuals within an organization adopt innovations. There is a general consensus that innovation diffusion closely resembles the S-shaped curve (Astebro 1995; Jurison 2000; Rogers 1995; Rottman 2002; Teng et al. 2002; Zelkowitz 1996).

The above two research streams complement each other and yield unique insights regarding the ADOPTION of IS/IT innovations. However, neither of these research streams delves into the *processes* underlying adoption. Specifically, the processes that contribute to the ADOPTION of IS/IT innovations by individuals within organizations are virtually untouched by prior literature. This research examines the processes that contribute to the ADOPTION of IS/IT innovations.

1.2 Feature-Centric View of Innovation Adoption

ADOPTION refers to different phenomena including adoption, assimilation, and diffusion of IS/IT innovations. While these are related to each other, they also possess distinctive characteristics. Adoption and assimilation, for instance, refer to an individual's acceptance and use of the IS/IT innovation; the former with regard to the entire innovation and the latter with regard to the features of the innovation. Diffusion, on the other hand, refers to the spread of the IS/IT innovation to individuals in a network.

Prior research has traditionally employed adoption and diffusion in the context of the entire IS/IT innovation (Venkatesh et al. 2003). That is, the focal point of the research has been the complete IS/IT innovation, such as computers, decision support systems, software packages, etc. (Davis 1989; Igbaria 1993; Sanders and Courtney 1985). However, individuals reporting on adoption and use behaviors may not have actually used all the capabilities of the IS/IT innovation being examined. Recent research has begun to recognize this particular aspect and shifted attention to the "features" possessed by IS/IT innovations (Fichman and Kemerer 1997; Jasperson et al. 2005).

This research takes a feature-centric view of ADOPTION (Jasperson et al. 2005), thus viewing the underlying phenomenon in terms of the features of the innovation. Accordingly, for the purposes of this research, the following feature-centric definitions are employed. *Adoption is defined as an individual's acceptance of the first feature of the IS/IT innovation. Assimilation refers to an individual's acceptance of multiple features (i.e. the first feature as well as additional features) of the IS/IT innovation. Diffusion represents the spread of the first feature of the IS/IT innovation to individuals within the organization.*

1.3 Research Questions

To address the gaps in research identified in the previous subsection, and taking a feature-centric view of ADOPTION, I developed two distinct sets of research questions. The first set of research questions, shown below, is asked from the perspective of a single individual within the organization. These questions explicitly recognize two aspects of an individual's behavior: a) the individual may engage in adoption and assimilation activities, and b) the individual may also influence other individuals to adopt or assimilate innovations.

Research Question 1A

What are the processes by which individuals are influenced to adopt (and assimilate) IS/IT innovations within organizations?

Research Question 1B

What are the processes by which individuals influence others to adopt (and assimilate) IS/IT innovations within organizations?

The first research question (1A) deals specifically with the *potential adopter*, the individual making the adoption decision. Prior research has focused extensively on the intentions and behavior of the potential adopter (Davis 1989; Venkatesh et al. 2003). There is a considerable base of knowledge on the various factors that explain the behavior of potential adopters. For instance, contextual factors such as top management support and social norms, individual dispositions such as experience and innovativeness, and innovation attributes such as relative advantage and complexity, are instrumental for adoption (Agarwal and Prasad 1998; Rogers 1995; Venkatesh et al. 2003). However, the processes by which potential adopters adopt innovations have not been examined in extant literature.

The second research question (1B) deals with the *influencer*, the individual who influences other individuals to adopt an innovation. Extant research has not directly attended to the role of the influencer. The little that is known regarding the role of the influencer has been examined indirectly from the perspective of the potential adopter. Thus, there is some understanding that internal information sources, i.e. interpersonal influences, are instrumental in innovation adoption (Rogers 1995), that individuals are influenced by others in their social networks (Burt 1997; Granovetter 1973), and that individuals mimic the behavior of other individuals they come in contact with (Jasperson et al. 2005). However, the specific ways in which the influencer influences others have not been explicitly examined in prior literature.

The second set of research questions, shown below, is asked from the perspective of the entire network in which the individuals are situated. These questions explicitly recognize two relevant characteristics of the phenomenon: a) each individual within a network may engage in adoption and influence activities, and b) the behaviors of all individuals, taken together, may reveal insights about patterns at the network level.

Research Question 2A

Given that individuals engage in adoption and influence processes, what are the factors that contribute to the assimilation of IS/IT innovations across individuals within networks?

Research Question 2B

Given that individuals engage in adoption and influence processes, what are the factors that contribute to the diffusion of IS/IT innovations across individuals within networks?

Following up with insights gained from the first set of questions (which examine the adoption and influence processes that shape individuals' response to IS/IT innovations), the second set of questions (2A and 2B) deal with the three innovation-related activities at the level of the population. That is, given that individuals engage in adoption and assimilation activities, the question seeks to find out the overall effects at the population regarding assimilation and diffusion. Prior literature has not generally examined the cumulative effects of diffusion and assimilation at the level of the network. However, there is some evidence in prior literature regarding diffusion, such as the diffusion pattern conforming to an S-shaped curve (Rogers 1995). But extant literature has not explicitly considered or modeled the adoption and influence processes that drive the diffusion of IS/IT innovations.

2 Literature Review

Our knowledge is the amassed thought and experience of innumerable minds.
Ralph Waldo Emerson

The adoption of IS/IT innovations by individuals has received considerable attention in extant literature. Two broad lines of inquiry, quite distinct from one another, may be identified within this extensive body of research: a) technology adoption and b) technology diffusion. While both research streams pursue contrasting research questions, examine different units of analysis, and seemingly lack synergies, they do offer significant insights into the adoption of IS/IT innovations by individuals. However, interplay between these two research streams is virtually non-existent as each stream considers a single view of innovation adoption by individuals. This chapter presents a review of IS/IT innovations and the two research streams.

2.1 IS/IT Innovations

IS/IT innovations generally refer to innovations involving computers and communications technologies and related applications (Swanson 1994). IS/IT innovations generally involve a technological component such as hardware and/or software, and may also bring about changes in work processes, business processes, and organizational structures (Lyytinen and Rose 2003). In fact, IS/IT innovations have the potential to transform organizations and improve business performance (Henderson and Venkatraman 1993; Sabherwal and Chan 2001).

A variety of IS/IT innovations have been examined in prior literature. These include the World Wide Web (Agarwal and Karahanna 2000), inter-organizational systems (Grover 1993), electronic data interchange: EDI (Niederman 1998), object oriented programming languages (Fichman and Kemerer 1997), electronic mail systems (Rottman 2002), database management systems: DBMS (Grover and Teng 1992), telework (Ruppel and Harrington 1995), client/server technology (Subramanian and Lacity 1997), CASE tools (Orlikowski 1993), decision support systems: DSS (Sauter 1996), executive information systems: EIS (Bergeron et al. 1995), IT outsourcing (Loh and Venkatraman 1992), expert systems (Guimaraes et al. 1996), e-commerce systems (Iivari and Janson 2003), computer resource centers (Taylor and Todd 1995), software packages (Venkatesh and Davis 1996), computer-aided design: CAD (Joshi and Lauer 1998), microcomputers (Igbaria 1993), enterprise resource planning (ERP) systems (Mirchandani and Motwani 2001), group support systems: GSS (Chin and Gopal 1995), and teleconferencing (Grover et al. 1997).

IS/IT innovations have been categorized variously over the years. These include technical and administrative innovations (Daft 1978); product and process innovations (Zmud 1982); new product or service, administrative, and technical innovations (Robey 1986); Type 1 (low knowledge burden or user dependencies) and Type 2 (high knowledge burden or user interdependencies) (Fichman 1992); Type I (functional IS), Type II (administrative), and

Type III (business administration) innovations (Swanson 1994); system development, services and IT base innovations (Lyytinen and Rose 2003); and business process applications, communications and collaboration systems, computers, office applications, system software, and world wide web/internet innovations (Jasperson et al. 2005).

2.2 Technology Adoption

The first research stream that deals with the adoption of IS/IT innovations by individuals may be labeled as studies of "technology adoption." Technology adoption studies are by far the more dominant of the two research streams in terms of the number of prior studies conducted over time. Several hundred studies have been conducted over the past 25 years (Jeyaraj et al. 2006; Sabherwal et al. 2006)[2].

Technology adoption studies typically ask the question: "What are the factors that influence the adoption of IS/IT innovations by individuals?" Somewhat infrequently, these studies also pursue the question: "What are the factors that hinder the adoption of IS/IT innovations by individuals?" As can be surmised from these questions, and concluded from the relevant literature, the technology adoption studies generally seek to understand the various factors that are instrumental or detrimental to the adoption of IS/IT innovations by individuals.

The unit of analysis in technology adoption studies is typically the "individual" and the focus is on the adoption behavior of such individuals[3]. A variety of dependent variables have been employed to understand innovation adoption by individuals. These include intention to adopt (Chin and Gopal 1995; Karahanna et al. 1999), adoption (Keil et al. 1995; Sultan and Chan 2000), acceptance (Al-Gahtani 2001; Chau 1996), intention to use (Agarwal and Prasad 2000; Venkatesh and Davis 2000), usage (Moon and Kim 2001; Szajna 1996), continued use (Kim and Malhotra 2005), and post-adoption behavior (Parthasarathy and Bhattacherjee 1998). Table 1 describes the major dependent variables employed in technology adoption research.

Several theoretical models have been proposed and empirically tested in the context of innovation adoption by individuals[4]. These include the Theory of Reasoned Action: TRA (Fishbein and Ajzen 1975), Diffusion of Innovations (DoI) for individuals (Rogers 1983), Technology Acceptance Model: TAM (Davis 1989), Theory of Planned Behavior: TPB (Ajzen 1991), Perceived Characteristics of Innovating: PCI (Moore and Benbasat 1991),

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[2] Jeyaraj et al. 2006 examined 45 studies whereas Sabherwal et al. 2006 examined 121 studies of technology adoption by individuals.

[3] These studies have examined individuals in a variety of settings. For instance, individuals may be members of an organization (Igbaria 1993), members of communities of practice (DeSanctis 2003), members of homes (Venkatesh and Brown 2001), or patrons (e.g. customers, students, etc.) of an organization (Agarwal and Prasad 1999; Gefen et al. 2003). For the purposes of this discussion, and in this research, individuals are considered to be members of organizations. Thus, this research examines the adoption of IS/IT innovations by individuals situated in organizations.

[4] An excellent review of several of these models can be found in prior literature (Venkatesh et al. 2003). Among other things, this study identifies the convergence and divergence between the theoretical models.

Model of PC Utilization: MPCU (Thompson et al. 1991), Motivational Model (Davis et al. 1992a), Social Cognitive Theory: SCT (Compeau and Higgins 1995), Task-Technology Fit: TTF (Goodhue and Thompson 1995), TAM Extended (Jackson et al. 1997), TAM2 (Venkatesh and Davis 2000), and Unified Theory of Acceptance and Use of Technology: UTAUT (Venkatesh et al. 2003).

Dependent variable	Description
Intention to adopt or use	The extent to which the individuals aims to make first use or continued use of the innovation (Venkatesh et al. 2003).
Adoption or acceptance	The indicator of whether or not the individual actually made first use of the innovation (Rogers 1995).
Use or continued use	The degree to which the individual depends on the innovation for accomplishing his or her tasks (Rai et al. 2002).

Table 1. Dependent Variables in Technology Adoption Research

Table 2 summarizes the prominent theories of technology adoption used to examine the adoption of IS/IT innovations over the past 30 years. Several points of interest emerge from the table. First, the table provides a nearly chronological account of the technology adoption theories in IS literature. It is possible to trace the research on technology adoption from back in the mid-1970s and the TRA (Fishbein and Ajzen 1975) to the mid-2000s and the ISSM (Sabherwal et al. 2006). Second, the table shows the extent to which the theories have been examined in empirical research. It can be seen that TAM and its extensions have received considerable attention in research on IS/IT adoption[5]. Third, the table helps appreciate the cumulative research tradition prevalent in the arena of technology adoption. Early theories contributed greatly to the formulation of subsequent theories. For instance, the TPB draws heavily on the TRA but also incorporates the notion of perceived behavioral control (Ajzen 1991; Fishbein and Ajzen 1975). Similarly, the DoI model was elaborated by the PCI Model (Moore and Benbasat 1991; Rogers 1983) as was the TAM by the TAME and TAM2 models (Davis 1989; Jackson et al. 1997; Venkatesh 2000). Finally, it can be seen how the theories have gradually expanded the inquiry net surrounding adoption behavior. For instance, TAM proposed only two constructs: perceived usefulness and perceived ease of use as influencing individual behavior; however UTAUT also proposed additional constructs: facilitating conditions and social influence as well as moderator variables.

[5] In fact, a quick search on the ABI/Inform online database, restricted to some leading IS journals (*MIS Quarterly*, *Information Systems Research*, *Management Science*, *IEEE Transactions n Engineering Management*, *Journal of Management Information Systems*, *Decision Sciences*, *Omega*, *Information & Management*, *Decision Support Systems*, and *European Journal of Information Systems*) revealed 82 studies for "Technology Acceptance Model" and only 15, 14, 13, and 13 studies for "Theory of Reasoned Action," "Theory of Planned Behavior," "Diffusion of Innovations," and "Task Technology Fit" respectively. The other models resulted in less than five studies, except for "Social Cognitive Theory" which showed seven studies.

Theory	Description	Empirical work examining IS/IT innovations
Theory of Reasoned Action (TRA)	TRA proposes that individual behavior may be explained primarily by the individual's behavioral intentions, which in turn, is affected by the individual's attitude toward the behavior and the individual's perception of the subjective norms regarding such behavior (Fishbein and Ajzen 1975).	(Davis 1989; Karahanna et al. 1999; Mathieson 1991; Venkatesh et al. 2003)
Diffusion of Innovations Model (DoI) and extensions such as PCI	DoI proposes that individual behavior may be determined by the individual's perceptions regarding the relative advantage, compatibility, complexity, trialability, and observability of the innovation, as well as social norms (Rogers 1983).	(Agarwal and Prasad 1997; Brancheau and Wetherbe 1990; Hardgrave et al. 2003; Karahanna et al. 1999; Moore and Benbasat 1991; Nilakanta and Scamell 1990; Venkatesh et al. 2003)
Technology Acceptance Model (TAM) and its extensions such as TAM2 and TAME	TAM proposes that individual behavior may be attributed to the individual's perceptions regarding the usefulness and ease of use of the innovation (Davis 1989).	(Adams et al. 1992; Agarwal and Karahanna 2000; Al-Gahtani 2001; Chau 1996; Chau and Hu 2001; Davis et al. 1989; Dishaw and Strong 1999; Gefen and Straub 1997; Jackson et al. 1997; Keil et al. 1995; Lewis et al. 2003; Mathieson 1991; Szajna 1996; Taylor and Todd 1995; Venkatesh 2000; Venkatesh and Davis 1996; Venkatesh and Davis 2000; Venkatesh and Morris 2000; Venkatesh et al. 2003; Venkatesh et al. 2002; Wixom and Todd 2005)
Theory of Planned Behavior (TPB) and its variants such as Decomposed TPB	TPB proposes that individual behavior may be explained primarily by the individual's behavioral intentions, which in turn, is affected by the individual's attitude toward the behavior, the individual's perception of the subjective norms regarding such behavior, and the individual's perception regarding the ease of performing the behavior (Ajzen 1991).	(Chau and Hu 2001; Mathieson 1991; Morris et al. 2005; Taylor and Todd 1995; Venkatesh et al. 2003)
Model of Personal Computer Utilization (MPCU)	MPCU proposes that individual behavior may be determined by the individual's attitudes toward the innovation, perceptions regarding the social norms and facilitating conditions, and the perceptions regarding the benefits and consequences of the behavior (Thompson et al. 1991).	(Igbaria 1993; Igbaria and Iivari 1995; Igbaria and Zviran 1996; Thompson et al. 1994; Venkatesh et al. 2003)

Motivational Model (MM)	MM proposes that individual behavior may be attributed to the individual's perceptions regarding the behavior to lead to positive outcomes such as rewards and the individual desire to perform the behavior (Davis et al. 1992b).	(Igbaria et al. 1996; Venkatesh 2000; Venkatesh et al. 2003)
Social Cognitive Theory (SCT)	SCT proposes that individual behavior may be attributed to the individual's judgment about his or her own ability to use the innovation (Compeau and Higgins 1995).	(Compeau et al. 1999; Gallivan et al. 2005; Igbaria and Iivari 1995; Thatcher and Perrewe 2002; Webster and Martocchio 1992)
Task Technology Fit Model (TTF)	TTF proposes that individual behavior may be explained by the extent to which the characteristics of the innovation are compatible with the characteristics of the tasks to be performed by the individual (Goodhue and Thompson 1995).	(Dishaw and Strong 1999; Goodhue 1998; Mathieson and Keil 1998)
Unified Theory of Acceptance and Use of Technology (UTAUT)	UTAUT proposes that individual behavior may be attributed to the individual's behavioral intention, which in turn, may be influenced by the individual's perception of performance expectancy, effort expectancy, social influence, and facilitating condition; and that these relationships may be moderated by gender, age, experience, and voluntariness of use (Venkatesh et al. 2003).	(Sabherwal et al. 2006)
IS Success Model (ISSM)	ISSM proposes that individual behaviors may be determined by the individual's perceptions regarding the characteristics of the innovation, attitudes towards innovations, and beliefs regarding the extent to which the organizational context contributes to the behavior (Sabherwal et al. 2006).	n/a

Note: Prior studies on IS/IT adoption have also used "unnamed" theoretical models that comprise constructs from a combination of the various "named" models or from elsewhere in the literature (Guimaraes et al. 1996; Schiffman et al. 1992).

Table 2. Theories in Technology Adoption Research

The above theories and models have identified various antecedents that influence innovation adoption by individuals. Table 3 summarizes the different types of antecedent variables employed by studies on technology adoption. The antecedents include innovation attributes such as usefulness and ease of use, individual characteristics such as gender and experience, task characteristics such as variety and newness, and contextual factors such as facilitating conditions and social norms. These are indicative of the rich and diverse set of antecedents that inform technology adoption.

Category	Description	Illustrative Variables	References
Innovation Attributes	The characteristics of the innovation as perceived by the individual	Usefulness, Ease of use, Relative advantage, Compatibility, Complexity, Trialability, Observability, Quality	(Adams et al. 1992; Davis 1989; DeLone and McLean 1992; Rogers 1995; Sabherwal et al. 2006)
Individual Characteristics	The characteristics that describe the individual	Gender, Age, Education, Experience, Attitudes, Playfulness, Innovativeness, Self-efficacy	(Agarwal and Prasad 1997; Compeau and Higgins 1995; Igbaria 1993; Webster and Martocchio 1992)
Task Characteristics	The characteristics of the task performed by the individual	Newness, Difficulty, Variety, Routineness, Importance	(Guimaraes et al. 1992; Igbaria 1990; Sanders and Courtney 1985)
Contextual Factors	The characteristics of the organization context in which the individual is situated	Top management support, Facilitating conditions, Training, User participation, Subjective norms	(Davis et al. 1989; Sabherwal et al. 2006; Thompson et al. 1991; Venkatesh et al. 2003)

Table 3. Antecedent Variables in Technology Adoption Research

However, it should be noted that these antecedents have been typically examined from the perspective of the potential adopter. That is, data on the various antecedents – whether it be the individual characteristics or the contextual factors – are obtained from the research participants, generally assuming the role of the potential adopters. For instance, 215 individuals from four organizations reported on their intentions to use innovations as well as on facilitating conditions and social influence (Venkatesh et al. 2003)[6]. Thus, the extant conceptualizations of technology adoption are heavily dependent on the individuals' views of the contextual conditions influencing behavior. There is virtually no treatment of these contextual factors from the perspective of the respective stakeholders (different from the potential adopter).

[6] The research employed measures such as "I have the resources necessary to use the system" and "I have the knowledge necessary to use the system" for measuring facilitating conditions, and "People who are important to me think that I should use the system" and "People who influence my behavior think that I should use the system" for social influence. These measures capture the individual's beliefs regarding facilitating conditions and social influence.

Extending further, technology adoption research generally deals with individuals' beliefs (regarding contextual factors, for instance), attitudes (regarding the innovation), intentions (regarding future adoption or use of the innovation), and behaviors (i.e. adoption or use). There is a consensus in the literature that beliefs affect attitudes, which in turn, affect intentions, which in turn, affect behaviors. Thus, technology adoption research, for the most part, is about perceptions rather than actual behaviors.

2.3 Technology Diffusion

The other research stream that addresses the adoption of IS/IT innovations by individuals may be labeled as studies of "technology diffusion." Technology diffusion studies have not been as widespread as technology adoption studies. Over time, only a limited number of innovation studies have examined the adoption and diffusion of IS/IT innovations (Jeyaraj et al. 2006).

Technology diffusion studies generally deal with the following research question: "What are the factors that contribute to the diffusion of IS/IT innovations to individuals in social networks (such as organizations)?" To a lesser extent, these studies also ask the question: "What is the shape (or pattern) of the diffusion activity within social networks (such as organizations)?" The technology diffusion studies, thus, attempt to understand the dynamics of innovation adoption with reference to the broader context (i.e. social network or organization) in which individuals are situated.

As may be expected, the unit of analysis in technology diffusion studies is the "organization" (or more generally, the larger social system in which the individuals are situated). Despite the obvious difference in unit of analysis when compared to technology adoption studies, technology diffusion studies examine the individual as well. Specifically, diffusion within the social system is actually a result of technology adoption by individuals. The aggregate analysis of data gathered from individuals may be used to understand technology diffusion. Different dependent variables have been proposed, if not empirically examined, to understand technology diffusion, including rate of adoption, time of adoption, and earliness of adoption (Astebro 1995; Liberatore and Breem 1997; Rogers 1995; Valente 1995). Table 4 summarizes the dependent variables in technology diffusion research.

Several models, although not all of them examining IS/IT innovations, can be seen in the technology diffusion stream of research. These include the relational models of diffusion, threshold models of diffusion, spatial models of diffusion, influence models of diffusion, positional (or structural) models of diffusion, critical mass theories of diffusion, and bandwagon models of diffusion (Abrahamson and Rosenkopf 1993; Bass 1969; Brancheau and Wetherbe 1990; Burkhardt and Brass 1990; Rice 1993; Rogers 1995; Valente 1995).

Dependent variable	Description
Time of adoption	The time periods at which individuals within the social system adopted the innovation (Rogers 1995).
Earliness of adoption	The time periods elapsed since introduction by which individuals within the social system adopted the innovation (Burkhardt and Brass 1990).
Rate of adoption	The proportion of individuals within the social system who adopted the innovation at a given time period (Rogers 1995).

Table 4. Dependent Variables in Technology Diffusion Research

Table 5 summarizes the different types of models used to examine the diffusion of *IS/IT innovations* over the last few decades. Several observations may be extended based on information in the table. First, there are only a limited number of diffusion studies dealing with IS/IT innovations (especially when compared to the number of adoption studies as shown in Table 2). Second, the table provides an understanding of the variety of perspectives that have been proposed for examining diffusion. For instance, the influence models recognized the importance of mass media as well as word-of-mouth influences in mapping technology diffusion. However, later models recognized the importance of including homophily effects such as relational proximity, positional (structural) proximity, and spatial proximity. Finally, it becomes possible to appreciate the maturity of the technology diffusion research arena.

These theories have identified various antecedents that influence innovation diffusion within social networks. Table 6 illustrates the variety of antecedent variables describe by studies in the technology diffusion arena. The antecedents include individual attributes such as centrality and personal network exposure, tie (relationship) characteristics such as strength of tie and spatial proximity, network characteristics such as density and centralization, and contextual factors such as critical mass and external influence. These are indicative of a rich and diverse set of antecedents that influence technology diffusion.

This literature presents several valuable insights into technology diffusion. This literature shows that the pattern of technology diffusion resembles an S-curve, which shows that the rate of adoption by individuals is minimal during the early stages, maximal during the middle stages, and minimal during the late stages (Astebro 1995; Jurison 2000; Rottman 2002; Teng et al. 2002; Zelkowitz 1996). Moreover, this literature (Brancheau and Wetherbe 1990; Burkhardt and Brass 1990; Liberatore and Breem 1997; Lou et al. 2000; Rogers 1995; Valente 1995) demonstrates that: a) individuals may be classified as early or late adopters based on the time of adoption; b) both external and internal information sources are important during innovation diffusion; c) external information sources (e.g. mass communication) are more useful in the early stages; d) internal information sources (e.g. interpersonal relationships) are more important in the later stages; and e) a critical mass of participants may be necessary before an explosion in diffusion activity is seen.

Theory	Description	Empirical work examining IS/IT innovations
Influence Models	Influence models posit that individuals adopt innovations due to mass media (from the context) or "word-of-mouth" (from individuals already using the innovation) influence (Bass 1969).	(Astebro 1995; Burkhardt and Brass 1990)
Homophily Models	Relational models propose that individuals adopt innovations based on their relationships and the extent of communication with other individuals in their social networks (Valente 1995). Positional (structural) models propose that individuals adopt innovations based on the similarity of their positions in the organizational hierarchy (Valente 1995). Spatial models argue that individuals adopt innovations based on their spatial proximity (i.e. closeness in physical locations) to individuals who have already adopted the innovation (Rice 1993).	(Rice and Aydin 1991)
Critical Mass Theories	Critical mass theories argue that there is an explosion in adoption activity by individuals within a social network when a sufficiently large number of other individuals have already adopted the innovation to sustain use (Rogers 1995). Threshold models argue that individuals adopt innovations when their personal thresholds of tolerance are exceeded (Granovetter 1978). Bandwagon models argue that individuals adopt innovations as pressures to adopt increase resulting from adoption by other individuals in the social network (Abrahamson and Rosenkopf 1993).	(Kraut et al. 1998; Rice et al. 1990)

Table 5. Technology Diffusion Theories in IS/IT Innovations Research

However, technology diffusion research does not address the psychological states of the individuals in social networks. In other words, the focus is typically on the structural elements of the dyads and the network, such as the relational proximity and network density. For instance, 25 individuals in one organization reported on their ties with other individuals within the same organization, which was used to construct a measure of network density (Rice 1994). Similarly, 96 individuals from one organization reported on their proximities on several aspects with other individuals in the same organization (Rice and Aydin 1991). Even though the studies obtain information from individuals to understand network-level patterns, there is virtually no reference to the psychological states of individuals.

Category	Description	Illustrative Variables	References
Individual attributes	The characteristics of the individuals who belong to the social network	Threshold, Personal network exposure, Centrality	(Burkhardt and Brass 1990; Granovetter 1978; Valente 1995)
Tie (relationship) characteristics	The characteristics of the relationship shared by pairs of individuals within the social network	Positional (structural) equivalence, Internal influence (interpersonal), Homophily, Strength, Spatial proximity	(Bass 1969; Granovetter 1973; Krackhardt 1992; Rice 1993; Rogers 1995)
Network characteristics	The structural characteristics of the social network being examined	Size, Centralization, Density	(Burkhardt and Brass 1990; Kilduff and Tsai 2003; Wasserman and Faust 1994)
Contextual factors	The characteristics of the organization context in which the social network and its individuals are situated	Critical mass, External influence (mass media)	(Bass 1969; Markus 1990; Rogers 1995)

Table 6. Antecedent Variables in Technology Diffusion Research

2.4 Summary

The technology adoption and technology diffusion research streams, while complementing each other, approach the innovation problem from different angles (See Table 7).

Technology adoption research deals with the individual and explicitly considers the psychological characteristics of the individual, including attitudes, beliefs, and intentions, and how the situational context of the individual, represented by the contextual, task, and innovation characteristics, contributes to, if not determines, behaviors related to innovation adoption. There is a general consensus in this research stream that individual beliefs shape attitudes, which in turn influence intentions, which in turn affect behaviors.

Technology diffusion research, on the other hand, deals with the entire social system in which individuals are situated. These studies examine the system-level patterns related to innovation adoption. As such, individuals are really secondary to the analysis despite the active roles they play in adopting innovations. Understandably, these studies typically disregard the psychological characteristics of individuals within the network and seek to explain adoption and diffusion patterns at the level of the social network.

Characteristic	Technology Adoption Research	Technology Diffusion Research	This Dissertation Research
Unit of analysis	Individual	Social network (with attention to individual)	Individual as well as social network (with attention to individual)
Primary stakeholder	Individual (in the role of the potential adopter)	Individual (in the role of the potential adopter, and indirectly, in the role of the influencer)	Individual (in the role of potential adopter as well as the influencer)
Primary data	Perceptions of individual (even for non-individual factors describing contextual characteristics)	Objective measures of social network and (objectified) perceptions of individuals	Behaviors of individual (objectified from perceptions) and objective measures of social network
Adoption drivers	Utility or normative considerations (implicit)	External or internal influence considerations (implicit)	Actions in the context and by individuals in the roles of potential adopter and influencers (explicit)

Table 7. Summary of Technology Adoption and Diffusion Research

Despite the extensive research evident in these research streams, and the rich body of extant knowledge on technology adoption and diffusion, there are virtually no process explanations in these research streams regarding the adoption of IS/IT innovations. That is, there is very little understanding of the sequence of actions that result in the adoption of IS/IT innovations by individuals. For instance, studies of technology adoption and diffusion collectively reveal that top management support, user participation, training, external information sources and internal information sources are important predictors of adoption by individuals. However, there is no explanation, in either stream, of the sequence or the pattern of enactment of various such activities to foster the adoption of IS/IT innovations by individuals.

Further, there is virtually no interplay or synthesis between the knowledge generated by the two research streams. At the very fundamental level, technology adoption research and technology diffusion research examine the adoption of IS/IT innovations by individuals in networks. However, they take divergent perspectives. Whereas technology adoption research sheds light on the individual-level dynamics, technology diffusion research deals with network-level dynamics. These divergent perspectives prevent knowledge from either research stream to inform the other.

Finally, the drivers of innovation adoption as described in the technology adoption studies are based on utility and/or normative considerations whereas that described in the technology diffusion studies are based on external and/or internal influence considerations. Utility drivers deal with the usefulness of the innovation to individuals (e.g. TAM, which

proposes perceived usefulness as a key driver) whereas normative drivers emphasize the group or organizational norms (e.g. TRA, which posits subjective norms as a key driver). External influence drivers refer to information available to individuals through mass media channels whereas internal influence drivers refer to information available through interpersonal communication channels. However, these drivers are typically implicitly treated, and not explicitly examined, in the technology adoption or diffusion literatures. For instance, subjective norms in the technology adoption literature are an individual's perception of the beliefs of other individuals and not an explicit measurement of the behaviors of the other individuals. Similarly, the technology diffusion literature includes a measure for internal influence but does not explicitly track the interpersonal communication between the individuals in the social networks.

In summary, extant knowledge would seem deficient with regard to processes underlying innovation adoption and diffusion. We have neither a good understanding of the processes underlying innovation adoption by individuals (from technology adoption studies) nor a good understanding of how such processes influence innovation diffusion within the social network (from technology diffusion studies).

This research seeks to contribute to our understanding of the processes underlying innovation adoption and diffusion by undertaking two specific goals. First, this research aims to identify the various activities affecting individuals as they deal with innovations and to determine the sequences and patterns of such activities. Second, using the knowledge gained at the end of the first goal above, this research aims to examine innovation diffusion and assimilation at the level of the social network. Thus, this dissertation research aims to conduct a multi-level analysis, first at the individual level and then at the network level – thereby spanning both the technology adoption and technology diffusion streams of research.

3 Conceptual Model

There is nothing more difficult to take in hand, more perilous to conduct or more uncertain in its success than to take the lead in the introduction of a new order of things.
Niccolo Machiavelli

To address the research questions set forth in Chapter 1, I developed the conceptual model shown in Figure 1. The model depicts three major actors: a) the potential adopter, who accepts an innovation, b) the influencer, who is influencing a potential adopter to accept an innovation, and c) the organizational context, in which the potential adopter and the influencer perform their activities. These three actors determine the adopter's responses and behavior, at least to some extent.

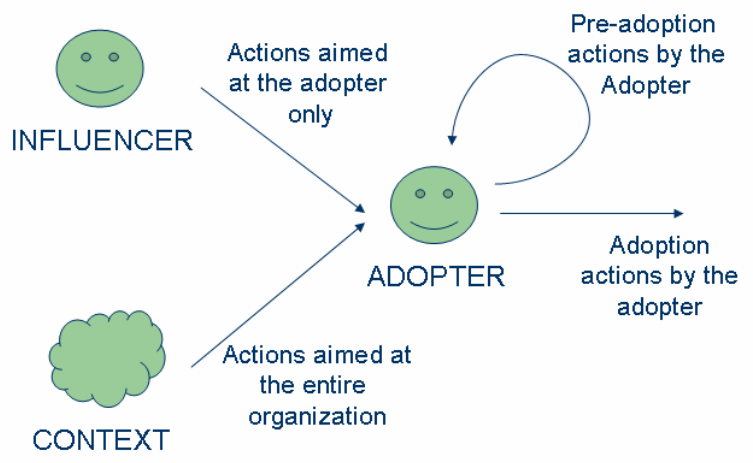

Figure 1. Conceptual Model

This model is generally consistent with other conceptualizations found in the literatures on innovation adoption and diffusion. Prior research has attended to the potential adopter quite extensively by examining such phenomena as the intention to adopt IS/IT innovations, the initial adoption of IS/IT innovations, and use of IS/IT innovations (Adams et al. 1992; DeLone and McLean 1992; Rai et al. 2002). Similarly, the context has also received considerable attention in prior literature, albeit from the perspective of the potential adopter. That is, research has examined the potential adopter's perceptions of the context through factors such as top management support, facilitating conditions, training, user participation, user involvement (Barki and Hartwick 1994; Leonard-Barton and Deschamps 1988; Santhanam et al. 2000; Venkatesh et al. 2003). Finally, the influencer has been given some attention, albeit indirectly, again from the perspective of the potential adopter. Prior research has, for instance, demonstrated that the potential adopters are influenced by others in their personal networks (who have already adopted the innovation, i.e. influencers), and that the potential adopters model their own behavior on similar others in their social networks (i.e. influencers) (Brancheau and Wetherbe 1990; Burkhardt and Brass 1990; Rogers 1995; Valente 1995).

However, the model departs from prior conceptualizations in one important respect. Rather than viewing it as a set of factors, I treat the innovation adoption phenomenon as a *series of actions* enacted by various stakeholders within the organization. This is consistent with prior views of processes (Sabherwal and Robey 1993; Sabherwal and Robey 1995). According to the Webster dictionary, an "action" is an activity performed to towards achieving some objective. In the context of innovation adoption, actions refer to activities aimed at adopting particular IS/IT innovations. Stakeholders performing these actions may include the top management (which institutes the policies related to the IS/IT innovation and its adoption), the IS department (which oversees or manages the process of innovation adoption), the influencers (who are responsible for upholding organizational policies or are themselves early adopters of the innovation), and the potential adopters (who are the target users of IS/IT innovations). In the conceptual model depicted in Figure 1, the "context" accounts for stakeholders such as top management and IS department whereas the "influencer" and the "adopter" represent the influencer and the potential adopter respectively.

3.1 Actions aimed at the Entire Organization

The actions orchestrated in the organizational context are shown in Table 8. These actions are generally the purview of the senior levels of the organizational hierarchy or other entities delegated with responsibility to manage the innovation. In general, these actions affect the entire population of the organization. Prior literature has generally examined these actions as factors from the perspective of the potential adopter. Examples include facilitating conditions, user participation, and training (Jasperson et al. 2005; Venkatesh et al. 2003).

In formulating the actions in the organizational context, I considered the ways in which an organization might attempt to facilitate innovation adoption. Assuming that the eventual outcome of interest to the organization is the adoption of the innovation by its members, the organization can choose to do any or all of the following: create an awareness of the innovation among its members, design and develop or otherwise acquire the innovation, implement the innovation such that it is available for use, establish a clear mandate for the use of the innovation, and provide training to its members on the innovation (Davis 1989; Jasperson et al. 2005; Rogers 1995).

The organization must first obtain the innovation for use by its members. It can use different approaches to acquire the innovation. The organization may design and develop the innovation in-house or it may outsource the design and development of the innovation to external vendors (Sabherwal and Robey 1995). In contrast to this "make" option, the organization may opt to "buy" the innovation as a packaged or commercial off-the-shelf software solution and use it as is or have it customized for the context (Attewell 1992; Janson and Subramanian 1996; Lassila and Brancheau 1999). Subsequent to its acquisition, the organization may implement the innovation so that it is available for use by individuals (Lewis and Seibold 1990). The organization may also set up training sessions to enable potential adopter to become familiar with the innovation (Jasperson et al. 2005). Finally, with an intent to realize maximal use of the innovation, the organization may mandate the use of the innovation by its members (Davis 1989).

Action	Code	Description	Literature
Awareness creation	C1	Refers to the introduction of the innovation by vendors, external consultants, or the IS department through different mechanisms such as sales presentations, announcements, etc.	(Rogers 1995)
Issuing of mandate	C2	Refers to the enforcing of norms for obligatory use of the innovation by organizational members or groups.	(Davis 1989)
Withdrawal of mandate for use	C3	Refers to the retraction of norms for obligatory use of the innovation by organizational members or groups.	(Rogers 1995)
Development	C4	Refers to the design and development of new innovations or customization of existing innovations by vendors, external consultants, or the IS department through formal processes (such as structured development) or informal processes (such as skunk works).	(Sabherwal and Robey 1995)
Implementation	C5	Refers to the placement of the completed or customized innovations in production for use by organizational members or groups.	(Lewis and Seibold 1990)
Training	C6	Refers to the formal instruction on using the innovation given to organizational members or groups by vendors, external consultants, or the IS department.	(Jasperson et al. 2005)
Changes in personnel	C7	Refers to the introduction of new personnel at the senior management levels of the organization such as executives or managers.	(Sabherwal and Robey 1995)
OTHER contextual actions [OCA]	OCA	Bin for contextual actions that do not cleanly fit the actions listed above.	

Table 8. Actions aimed at the Entire Organization

For an innovation to be adopted and used, it must be made known to the relevant individuals within the organization. It is generally believed that individuals can adopt an innovation only if they know about it and that they may not proactively seek out an innovation (Rogers 1995). The organization may employ different techniques to generate awareness of the innovation among its members. Such techniques may include mass communication mechanisms such as memos, flyers, posters, etc. or selective mechanisms such as presentations, meetings, etc. (Nilakanta and Scamell 1990).

3.2 Influencer Actions aimed at the Potential Adopter only

The actions performed by the influencer are shown in Table 9. These are actions aimed by the influencer at only the potential adopter. Both the influencer and the potential adopter, as pointed out earlier, are members of the same organizational context, and are thus subject to the same actions emanating from the organizational context. Hence these influencer actions are over and above the influences the potential adopter may experience from the organizational context.

Action	Code	Description	Literature
Building coalitions	I1	Includes obtaining support of co-workers, requesting action at a formal conference.	(Kipnis et al. 1980)
Appeals to higher authority	I2	Includes making formal appeals to higher levels, obtaining informal support from higher-ups.	(Kipnis et al. 1980)
Bargaining	I3	Includes offering an exchange, reminding past favors, offering to help.	(Kipnis et al. 1980)
Acting in a clandestine manner	I4	Includes threatening to stop working, engaging in work slowdown, distorting or lying.	(Kipnis et al. 1980)
Presenting rational arguments	I5	Includes explaining reasons, justifying ideas, using logic.	(Kipnis et al. 1980)
Applying sanctions	I6	Includes threatening job security, threatening unsatisfactory performance evaluation.	(Kipnis et al. 1980)
Using friendliness and ingratiation	I7	Includes making others feel important, acting in friendly manner, praising, acting humbly.	(Kipnis et al. 1980)
Being assertive	I8	Includes checking, repeatedly reminding, simply ordering, pointing to rules, expressing anger.	(Kipnis et al. 1980)
OTHER influencer actions [OIA]	OIA	Bin for influencer actions that do not fit any other category above.	

Table 9. Influencer Actions aimed at the Potential Adopter only

Extant knowledge of the influencer's role in innovation adoption is limited to indirect accounts provided by potential adopters. For instance, we know that potential adopters are influenced by other individuals in their personal networks (Valente 1995), that they model themselves on similar others in their networks (Burt 1997), and that they ascribe some significance to what important individuals in their networks think (Fishbein and Ajzen 1975). However, such knowledge has typically been accumulated from potential adopters; we do not have direct accounts from the influencers themselves. That is, prior studies have

generally assumed the existence of influencers but have not explicitly examined their role in the adoption process.

I consider the influencers as agents in their own right and explicitly consider their influence in the process of innovation adoption. This begs the question: Who are these influencers and why would they matter when the organizational context can influence the behavior of potential adopters? Prior literature offers some clues on the characteristics of those individuals who may also be known as influencers. Influencers may be those individuals who are responsible for enforcing the mandate for the innovation, or those individuals who function as "champions" of the innovation, or those individuals designated as "change-agents" for the innovation, or those technically-savvy individuals who possess the expertise to assist others with the innovation (Howell and Higgins 1990; Rogers 1995). Influencers are generally enthusiastic about the innovation and would attempt to influence others to adopt the innovation. Influencers are important in the innovation adoption process since they reinforce the innovation and its adoption to specific potential adopters in the organization on a one-to-one basis over and above the communal actions in the context.

Treating the influencers as agents allows for explicitly examining the actions they perform in the adoption process. Since the influencer role has not been explicitly examined in the context of the adoption of IS/IT innovations, I looked to other literatures that may provide a basis for understanding their actions. The influence tactics literature (Kipnis et al. 1980; Yukl et al. 1993) from the organization behavior area proved a promising avenue for the influencer perspective since it deals with interactions between two individuals engaged in an interpersonal relationship, just like the influencer and the potential adopter. Moreover, the influence tactics literature accommodates the individual differences of the persons (e.g. different hierarchical positions) in the relationship and explicitly addresses the direction of influence (e.g. lateral, downward, upward) in a relationship (Yukl et al. 1995). Finally, the influence tactics literature sheds light on the objectives of using influence tactics including "changing behavior," which is consistent with the influencer's objective of changing the behavior of the potential adopter with regard to the innovation (Yukl et al. 1995).

Individuals, as influencers, influence other individuals to change their behaviors using a variety of influence tactics. Different inventories of influence tactics have been proposed and examined in prior literature (Keys et al. 1987; Kipnis et al. 1980; Lee and Sweeney 2001; Yukl et al. 1993). I chose a single inventory of influence tactics (Kipnis et al. 1980) for modeling influencer behaviors. Two reasons guided the choice of this particular inventory: a) this was one of the first inventories found in the influence tactics literature, which has been validated in subsequent research, and b) this was the only inventory previously examined in a technological setting (Howell and Higgins 1990). The specific influence tactics in this inventory were building coalitions, appealing to higher authority, bargaining, acting in a clandestine manner, presenting rational arguments, applying sanctions, using friendliness and ingratiation, and being assertive (Kipnis et al. 1980).

The eight influence tactics provide a range of behaviors for the influencers for influencing the potential adopters. "Presenting rational arguments" and "bargaining," for instance, allow the influencer to logically argue in support of the innovation as well as offer help to potential adopters as they deal with the innovation. Since they do not demand specific responses, these tactics present somewhat more control and choice to the potential adopters. On the

other hand, "being assertive," "building coalitions," "appealing to higher authority," and "applying sanctions" permit the influencer to pressure the potential adopters. These tactics curtail the potential adopters to a greater extent than other tactics since these involve authority, power, and norms.

3.3 Pre-Adoption Actions by the Potential Adopter

The actions performed by the potential adopter prior to adoption of the innovation are shown in Table 10. These actions are helpful to the potential adopter in clarifying the use of the innovation, or use of the specific features of the innovation, or address perceived limitations of the innovation.

Action	Code	Description	Literature
Review	A5	The potential adopter engages in learning through a variety of reference materials such as books, manuals, guides, handouts, etc.	(Jasperson et al. 2005)
Observation	A6	The potential adopter engages in learning by observing other individuals	(Jasperson et al. 2005)
Inquiry	A7	The potential adopter engages in learning by seeking information from other individuals through direct or indirect questions	(Jasperson et al. 2005)
Seeking assistance	A8	The potential adopter engages in learning by seeking assistance from other individuals through joint learning or walk-through sessions	(Jasperson et al. 2005)
Developing own…	A9	The potential adopter develops own solutions to overcome limitations of the innovation.	(McGill et al. 2003)
Requesting for…	A10	The potential adopter requests for new or enhanced solutions to overcome limitations of the innovation.	(Vessey and Conger 1994)

Table 10. Pre-Adoption Actions by the Potential Adopter

To ensure that the pre-adoption actions are mutually exclusive, I developed the framework in Figure 2. The framework is based on two dimensions: "interactivity of intervention" (referred to as interactivity hereafter) and "content of intervention" (referred to as content hereafter) relating to the innovation. The interactivity dimension refers to the extent to which the intervention used by the potential adopter requires interpersonal communication (Rogers 1995). Two possibilities for interactivity are non-interactive (the potential adopter does not communicate with others) and interactive (the potential adopter communicates with others). The content dimension represents the substantive elements or bases of the

intervention used by the potential adopter. From the perspective of the potential adopter, three types of content are possible: information, assistance, and change.

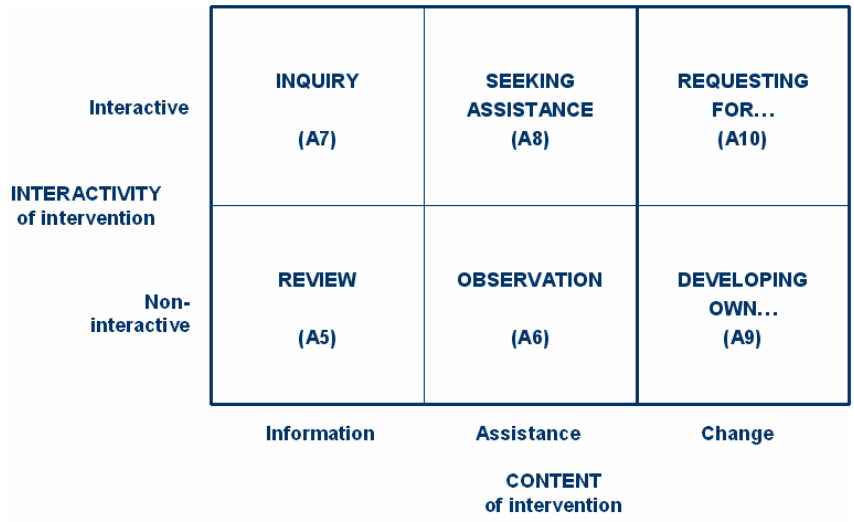

Figure 2. Pre-Adoption Actions of the Potential Adopter

The "information" content gives rise to two pre-adoption actions: "review" for the non-interactive intervention and "inquiry" for the interactive intervention. "Review" represents the potential adopter's efforts to learn the innovation through reference materials such as books, manuals, guides, reports, etc. whereas "inquiry" denotes the potential adopter's attempts to learn by seeking information from other individuals such as peers, experts, etc. (Nilakanta and Scamell 1990). The "assistance" content gives rise to two pre-adoption actions as well: "observation" for the non-interactive intervention and "seeking assistance" for the interactive intervention. "Observation" refers to the potential adopter watching other individuals work with the innovation and modeling own responses similarly whereas "seeking assistance" denotes the potential adopter's effort to learn by specifically asking others to help accomplish certain tasks with the innovation (Jasperson et al. 2005).

The "change" content gives rise to two pre-adoption actions: "developing own" solutions for the non-interactive intervention and "requesting for" solutions for the interactive intervention. "Developing own" solutions refers to the potential adopter's own efforts at designing and creating custom applications so as to overcome the limitations of the organizational innovation. This is somewhat similar to the concept of user-developed applications for which end-users assume responsibility (McGill et al. 2003). "Requesting own" solutions refers to the potential adopter asking for additional solutions to overcome limitations of the organizational innovation. This is somewhat similar to specifying requirements in the traditional system development process (Vessey and Conger 1994).

3.4 Adoption Actions by the Potential Adopter

The actions performed by the potential adopter in adopting the innovation are shown in Table 11. These are actions that generally happen toward the end of the innovation adoption process and may be considered as terminal or outcome actions[7]. In fact, the potential adopter could perform any one of these actions for the innovation adoption process to be completed. However, this research allows for the possibility that the potential adopter could progress from experimentation to partial adoption to full adoption.

Action	Code	Description	Literature
Full adoption	A1	Full adoption refers to the potential adopter using the innovation to its fullest possible extent.	(Jasperson et al. 2005)
Partial adoption	A2	Partial adoption refers to a) use of only a subset of features of the innovation or b) use of the innovation for only a restricted set of tasks.	(Jasperson et al. 2005)
Experimentation	A3	Experimentation refers to the potential adopter a) playing around in it attempting to understand the features and/or functions of the innovation or b) using the innovation for only a limited time.	(Rogers 1995)
Non-adoption	A4	Non-adoption refers to the potential adopter rejecting or not using the innovation.	(Rogers 1995)
OTHER adopter actions [OAA]	OAA	Bin for other adopter actions that cannot be cleanly fit into the categories above.	

Table 11. Adoption Actions by the Potential Adopter

Adoption outcomes have traditionally been captured using two approaches. The first one involves the binary measure of "adoption" which indicates whether or not the individual has adopted an innovation (Agarwal and Prasad 1999; Brancheau and Wetherbe 1990). While this measure of adoption outcomes has been useful, it really does not indicate anything more than the individual's initial decision regarding adoption (Rogers 1995). The individual's behavior regarding initial adoption does not necessarily reflect an enduring behavior that is repeated over time. The second approach is much more reflective of enduring behavior and involves the continuous measure of "system use" which captures the extent to which the individual works with the innovation on a regular basis (DeLone and McLean 1992; Rai et al.

[7] Of the four possible actions for the potential adopter, non-adoption is included only for the completeness of the discussion related to the adoption process. There is always the possibility that the potential adopter may choose to reject the innovation. However, this research assumes that the terminal action will reflect adoption.

2002). A variety of system use measures such as frequency of use, time of use, and length of use have been employed in prior literature (Guimaraes et al. 1996; Sanders and Courtney 1985; Thompson et al. 1991; Venkatesh and Davis 2000). However, system use only indicates the extent to which the individual uses the overall system but does not deal with the individual's use of the different features of the innovation.

I conceptualized adoption outcomes to reflect the extent to which an individual adopted the features of the innovation (Jasperson et al. 2005). Prior literature has generally not examined adoption outcomes in terms of the innovation features except in rare instances (Kay and Thomas 1995) or in specific innovation contexts such as computing technologies (Lee 1986; Winter et al. 1998). Notwithstanding the limited attention, a feature-centric view of adoption outcomes may be valuable in gauging the degree to which the innovation features are used by the individuals. Four possible outcomes can be visualized depending on the extent to which individuals exploit the features of the innovation they are authorized to use for their specific organizational roles (Goodhue and Thompson 1995; Jasperson et al. 2005): a) full adoption; b) partial adoption; c) experimentation; and d) non-adoption.

Full adoption refers to the potential adopter using the innovation to its fullest possible extent in terms of the features available (Fichman and Kemerer 1997). Partial adoption refers to use of only a subset of features of the innovation or use of the innovation for only a restricted set of tasks (Jasperson et al. 2005). Experimentation refers to the potential adopter playing around in it attempting to understand the features and/or functions of the innovation or using the innovation for only a limited time. Non-adoption refers to the potential adopter rejecting or not using the innovation (Rogers 1995).

4 Research Framework

> If we knew what it is we were doing, it would not be called research, would it?
> *Albert Einstein*

The research questions presented in Chapter 1 were pursued using multiple studies. Specifically, two empirical studies were conducted to answer the research questions. The first study, involving a series of field interviews with individuals, was designed to address research questions 1 and 2. The second study, involving a simulation of individuals in a network, was used to deal with research questions 3 and 4. Thus, this research involved multiple levels of analysis.

Figure 3 shows the overall research framework guiding this research. The research framework identifies the research contexts, the levels of analysis, the research models, and the research methodologies. The horizontal dotted line in the figure demarcates the two empirical studies undertaken in this research. In the figure, the section above the dotted line represents with the field interviews at the individual level of analysis whereas the section below the dotted line deals with the simulation at the network level of analysis.

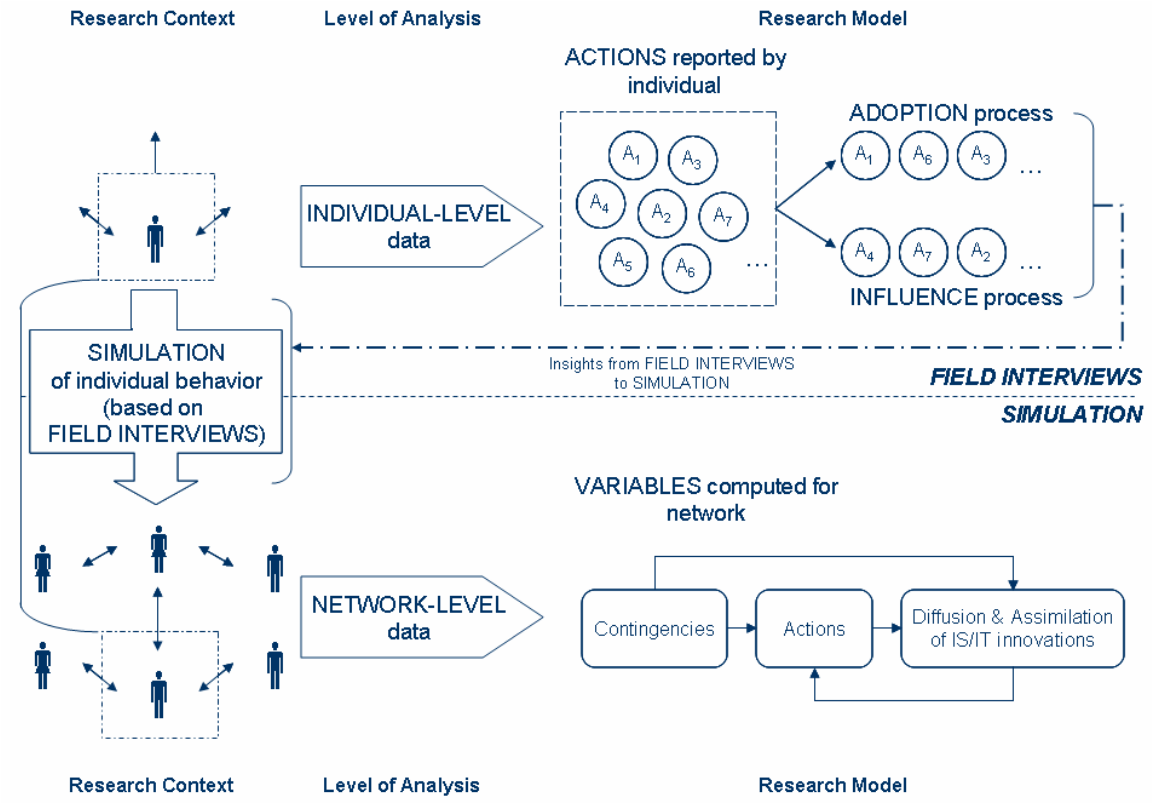

Figure 3. Research Framework

The research contexts relevant for the individual- and network- level analyses are related to each other. As seen from Figure 3, the network-level analysis (and in effect the simulation) will be based on the entire network or organization. Thus, the behaviors of all individuals in the network would be modeled (based on the adoption and influence behaviors identified from the field interviews). The individual-level analysis (and in effect the field interviews), on the other hand, will be based on a single individual belonging to the network or organization. Thus, the behaviors of only one individual will be targeted in the field interviews.

The dotted-dashed line in the figure identifies the connection between the field interviews and simulation, and thus, the connection between the individual and network level of analysis. Specifically, the field interviews provided an understanding of the actions, their frequencies, and their chronological orderings, which were subsequently used to inform the simulation models. A more detailed overview of the individual and network levels of analysis is presented in the following subsections.

4.1 Field Interviews and Individual-Level Analysis

The individual-level analysis is conducted on data obtained from the field interviews with individuals in actual work settings. The individuals, in these interviews, belong to a network of individuals, and hence considered to be situated in a larger context. The interviews focused on understanding the individual's (i.e. interviewee's) experiences in adopting and propagating specific IS/IT innovations, as narrated by the interviewee. Thus, the data gathered through the field interviews are the individual's own interpretation and explanation of the context in which he or she is situated, the innovation itself, the various influences he or she faced, and the adoption-related responses of the individual. The interviewees are encouraged to narrate experiences related to innovation in the roles of the adopter as well as the influencer.

The major goal of the individual-level analysis is to provide a description of the adoption and influence processes reported by the individual during the interview. Since the interview allows individuals to recount their experiences in free form, i.e. not bound by too many rules and considerations, the interview data does not necessarily have the data arranged in chronological order (which is required for describing a process). Thus, one of the tasks associated to this analysis is to organize the individual's descriptions of actions in the order in which they happened, such that the chronology of actions is transparent. (This ordering in chronological order is done for both the adoption and influence processes. These chronological sequences will be available for each individual at the end of this step.)

This process is depicted in Figure 4, which shows the research model adopted for the analysis at the individual level. From the interviews, the actions reported by the individuals (identified as A_1, A_2, A_3, … inside the box in the figure) are gathered, and then analyzed to construct the adoption and influence processes (following the arrows in the figure).

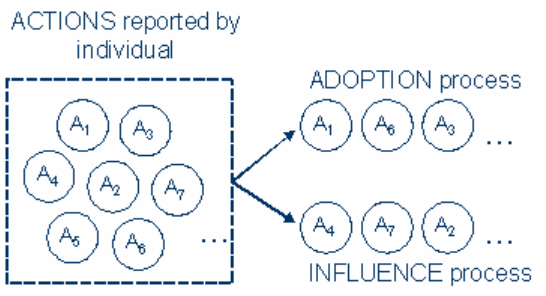

Figure 4. Individual-Level Research Model

Finally, to understand the similarities and differences in the chronological sequences constructed from each interview, and to actually construct generic adoption and influence processes underlying the adoption and diffusion of IS/IT innovations, techniques such as optimal matching (Abbott 1990) and cluster analysis (Hair et al. 1999) may be used (discussed in detail in Chapter 5).

4.2 Simulation and Network-Level Analysis

The network-level analysis is conducted on the data obtained through the simulation. The simulation is conducted for several periods by varying several parameters, some systematically and others randomly, over several trials. At the end of each simulation run (which models the behavior in a single network over different time periods), data representing the simulation parameters as well as other aggregated measures (i.e. network-level measures) are recorded on a data file for analyses later. The major goal of the network-level analysis is to provide an understanding of the various factors that influence the diffusion and assimilation of IS/IT innovations in organizations, given the adoption and influence processes.

The overall theoretical model identifies the constructs and the inter-relationships between the constructs examined in this research (See Figure 5).

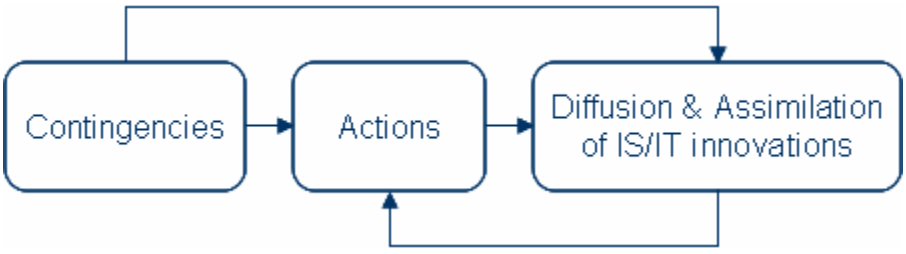

Figure 5. Network-Level Research Model

The construct of **Diffusion and Assimilation of IS/IT Innovations** is a representation of the different variables that characterize the innovation process at the level of the network. **Actions** refer to the variety of innovation-related influences that may impact the individuals within the network regarding adoption, diffusion, and assimilation. **Contingencies**

represent the characteristics of the organization and the network in which the innovation process is being examined.

Contingencies are posited to affect the Actions as well as the Diffusion and Assimilation of IS/IT innovations. Actions are also expected to influence the Diffusion and Assimilation of IS/IT innovations. Further, the Diffusion and Assimilation of IS/IT innovations is also expected to influence Actions.

Finally, cross-sectional time-series regression methods (Hsiao 2003; Wooldridge 2002) were employed to determine the relationships between the independent and dependent variables, and to understand the main and mediating effects on the diffusion and assimilation of IS/IT innovations in social networks.

4.3 Bridging Individual- and Network- Level Analyses

The individual- and network- level analyses are related even when being distinct from each other. The bridging between the field interviews and simulation happens on several fronts, eventually leading to a rich understanding of the adoption, diffusion, and assimilation of IS/IT innovations.

First, the behaviors of all individuals in the network are modeled based on the findings (regarding the various types of actions: contextual actions, influencer actions, and adopter actions) from the field interviews. Based on the chronological order of actions within the adoption and influence processes reported by individuals, the precedence of the various actions were determined. This precedence information was then used to model the behaviors of the individuals in the network (in the simulation).

Second, the field interviews served to determine the set of actions that were prevalent in real-world settings dealing with IS/IT innovations. This was possible because the interviews did enable one of the following: a) supported an action determined *a priori*, b) rejected an action determined *a priori*, and c) uncovered new actions that were not determined *a priori*. These findings were incorporated into the simulation; for instance, *a priori* actions not supported by the field interviews were not included subsequently in the simulation.

Finally, from the field interviews, the frequencies of the different actions and the conditional probabilities of the various actions given the history of prior actions were computed. These weights and probabilities were then incorporated into the simulation such that the simulation models resembled the real-world context.

5 Individual-Level Analysis of Adoption

Be not the first by whom the new are tried, not yet the last to lay the old aside.
Alexander Pope

To understand the processes by which IS/IT innovations are adopted and assimilated within social networks, I conducted field interviews with different individuals in their actual work settings. Field interviews have been recognized as an appropriate research method when the phenomenon being examined is relatively new or understudied (Patton 2002).

5.1 Pilot Interviews

I conducted pilot interviews with four individuals occupying different positions within a public university in the Mid-western region of the United States. I considered the pilot interviews as opportunities to verify the effectiveness of the questions I had included in my interview guide. The stories obtained through the pilot interviews were generally consistent with the major hypotheses of the dissertation, i.e., adoption and diffusion of innovations depend on innovation attributes, individual characteristics, social network factors, and influence tactics employed by individuals. Two of the interviewees, for instance, talked about the adoption of open-source systems and how the adoption process was individualistic and experiential and almost devoid of social influences. The other two interviewees talked about the adoption of a Mac system and how the process was determined by interpersonal influences as well as individual preferences. The pilot interviews provided valuable insights into the adoption process and also served as opportunities to fine-tune the questions that I had on the interview guide.

5.2 Sample and Methods

To identify potential participants for the interviews, I initially contacted 15 organizations located in a major metropolitan area in the Mid-western region of the United States. The sample included organizations in the public sector as well as private for-profit organizations of various sizes operating in different industries. Executives from these organizations were members of an academic advisory board at a public university in the Mid-western region of the United States. The initial request for research access to participants was made to that individual, referred to as the sponsor hereafter, representing the organization on the academic advisory board (See Appendix A). One of the members of my dissertation committee sent out the initial requests to the 15 sponsors on my behalf (See Appendix B). Specifically, the sponsor was requested to identify two or three individuals in his or her organization who had recently adopted information systems. Ten sponsors responded to this initial request and provided contact details of potential participants for the research. Subsequently, I directly contacted these potential participants, requested their participation, and set up interview times.

I conducted 27 interviews with different individuals in actual work settings. The interviews were generally conducted in the respective office locations of the participants or in a conference room located on the interviewee's facility. Each interview lasted for approximately 60 minutes. All interviews were tape-recorded (Patton 2002) with the express permission of the participants. I solicited "stories" of innovation adoption and diffusion from the interviewees. I generally followed the outline of the interview guide illustrated in Appendix C but employed different probes (Patton 2002) depending on the stories recounted by the participants. The interview questions were generally open-ended such that the interviewees recounted their stories with minimal interruption from the interviewer (Rapley 2001). Field notes were taken where necessary to record additional details about the context and the interview (Choudhury and Sabherwal 2003). The interviews focused on topics related to the actions aimed at the entire organization, the influencer actions on the adopter, the pre-adoption actions of the potential adopter, and the adoption actions of the potential adopter. In providing their stories, the interviewees were asked to sequentially assume two roles: potential adopter and influencer. That is, the interviewee first explained how he or she adopted an innovation and then explained how he or she influenced other individuals to adopt the same innovation. I requested the interviewees to provide general explanations as well as specific comments and examples (Choudhury and Sabherwal 2003).

For each interview, I adopted a standard interview protocol (Lacity 1992). I first administered the participant consent form outlining the confidentiality policy (See Appendix D), explained the purpose and nature of the research, and solicited the interviewee's participation (Carmin and Balser 2002). I then set the tone for the interview by establishing a friendly atmosphere and putting the interviewee at ease. I allowed the interviewees to talk about their job, position, and responsibilities within the organization. After these preliminaries, I proceeded with the semi-structured portion of the interview, in which I allowed the interviewees to explain their stories related to the adoption and diffusion of innovations. During the interviews, the participants were requested to explain both the adoption and influence stories for an innovation of their choice, i.e. they typically explained the adoption story followed by the influence story. (However, not all participants recounted both of the stories. This was because some participants had adopted the innovation but not influenced others to adopt the innovation. Thus, the analysis of adoption and influence processes was based on 30 adoption stories and 20 influence stories respectively. I obtained stories of innovation adoption and influence for 30 IS/IT innovations.) Finally, I allowed a debriefing period (Lacity 1992) during which I addressed anxieties or concerns faced by the interviewees.

5.3 Study Characteristics

The 30 IS/IT innovations examined in the research were of various types. The innovations included business process applications (e.g. Peoplesoft), office or personal productivity tools (e.g. Microsoft Visio), and computer operating systems (Microsoft Windows XP). Table 12 displays the different IS/IT innovations belonging to each category of innovations examined in the research.

Group	Count	IS/IT Innovation
Business Process Applications	16	Barcode System; Bentech; ChangePoint; Maintenance and Support System; Oracle Financial System;; Oracle Sales Analyzer; Peoplesoft; Systems Atlanta; Task Tracker; Travel Expense Report System; Travel Manager
Office or Personal Productivity Tools	12	ArcView; Bloomberg; Contact Management System; Document Management System; Microsoft OneNote; Microsoft Visio; Personal Manager; Pilot; Section Reports; Stanford Charts
Operating Systems	2	Windows XP

Table 12. IS/IT Innovations

The participants in the research were from different organizational levels. The participants included executives (e.g. directors), managers (e.g. project managers), and frontline employees (e.g. administrative assistants). Table 13 shows the organizational positions of the various participants. The stories of innovation adoption and influence were obtained from an even number of participants – 15 each – at the managerial and employee levels.

Level	Count	Job Titles
Executives	2	Director, Common Systems Development; Director, System Development
Managers	13	Accounts Payable Manager; Business Development Manager; Category Manager; Information Shared Services Manager; Information Systems Manager; Production and Inventory Control Manager; Project Manager; Purchasing Manager
Employees	15	Administrative Assistant; Bond Trader; Business Analyst; Contracts and Billing Coordinator; Human Resources Associate; Information Risk Management Associate; Information Technology Administrator Specialist; Licensing Specialist; Seed Analyst; Senior Administrative Assistant; Senior Airport Operations Supervisor; Senior Business Analyst; Senior Programmer

Table 13. Participants

The ten organizations in the research were large organizations from both the private and public sectors. Of the eight organizations from the private sector, four were publicly-traded and four were privately-held organizations. The remaining two organizations were from the public sector. Table 14 presents brief descriptions of the ten organizations.

Pseudonym	Description of the organization
Org_One	A large publicly-traded manufacturing organization operating in about 145 countries. The company employed about 153000 people.
Org_Two	A large privately-held financial services organization operating in 3 countries. The company employed about 30000 people.
Org_Three	A large privately-held services organization in about 140 countries. The company employed 6700 partners, 76000 service professionals, and 21000 support staff.
Org_Four	A large publicly-traded retail organization in the United States. The company employed about 112000 people.
Org_Five	A large privately-held financial services organization in about 210 countries. The company employed about 4000 people.
Org_Six	A division of the city government that provided the operating infrastructure for transport connecting the metropolitan area, employing about 1000 individuals.
Org_Seven	A division of the city government that provided transportation services in and around the metropolitan area. The division employed about 2000 people.
Org_Eight	A large publicly-traded technology organization with global operations. The company employed about 64000 individuals.
Org_Nine	A large publicly-traded manufacturing organization in more than 45 countries. The company employed about 12600 people.
Org_Ten	A medium-size privately-held retail organization in the United States. The company employed about 16500 people.

Table 14. Research Sites

5.4 Data Coding

The tape-recorded interviews were transcribed prior to data coding, (Patton 2002). The transcription was done by a professional transcriber. The transcriber created a separate electronic document for each interview conducted for the research. The electronic document was generally organized in a question-answer format. The transcription procedure yielded 450 pages of textual data from all interviews.

To facilitate uniform coding across all interviews, I assigned unique "codes" for each *a priori* action identified in the theoretical development section (Miles and Huberman 1984). When the coding process began, there were seven contextual actions labeled C1 through C7 (See Table 8), eight influencer actions labeled I1 through I8 (See Table 9), six pre-adoption actions of the potential adopter labeled A5 through A10 (See Table 10), and four adoption actions of the potential adopter labeled A1 through A4 (See Table 11). I also created three additional action-categories, one each for the contextual actions, influencer actions, and

potential adopter actions, labeled OCA, OIA, and OAA respectively (See Tables), to collect actions that may not be classified into any of the 25 *a priori* actions.

I conducted a pilot round of coding with my dissertation advisor serving as the second coder. The pilot coding was done as follows. I randomly selected one interview transcript and identified all actions belonging to the context, influencer, and potential adopter, as reported by the interviewee. Using the definitions formulated for all the *a priori* actions, both coders independently coded the 17 actions extracted from the interview transcript. I then compared the coding done by the two coders. There was agreement on 13 of the 17 actions. The resulting Cohen's Kappa coefficient of 0.70 was satisfactory; it was above the conservative recommendations (Koh et al. 2004). The disagreements were resolved through discussion.

The coding of the interview data proceeded as follows. For each interview, I identified the interviewee, his or her position in the organizational hierarchy, the specific IS/IT innovation, the adoption context, and the potential adopter and/or influencer roles assumed by the interviewee in the adoption process. I also identified the different types of actions relevant for understanding the process of adoption including the actions aimed at the entire organization, the influencer actions aimed at the potential adopter only, the pre-adoption actions of the potential adopter, and the adoption actions of the potential adopter. Table 15 shows illustrative examples of the data coding effort for the *a priori* actions that were reported multiple times in the interviews.

Action	**Code**	**Illustrative Text from Interviews**
Awareness creation	C1	"Several months in advance of that we started receiving updates of what was coming to us." [Kevin] "We were notified by communications by the project team through email and said, 'It [ChangePoint] was coming.'" [Veronica]
Issuing of mandate	C2	"We were told this is what we were going to do and this is the way we're going to do it." [Hilda] "It was pretty much enforced when it first came out that everyone had to use it. We all had to use it." [Jake]
Development	C4	"He [the consultant] would come to me and say, 'Here's what we think we can do and that's how it would work.' [I] would say, 'This is what we want.' He would build the system, come and show us, and then work out the bugs." [Raymond] "The meetings that I had with [the IT department head] were generally very informal. I'd be stopping by his office, no appointment… He would say to me, 'What do you think of this? Look at how this works. What do you think of that?'… 'Oh that's great stuff. What about this? Can you do that?'... 'Yeah, we can do that.'" [Brian]

Implementation	C5	"Once it [the software] was done… and we said, 'That's great; That's exactly what we wanted,' they move it into place and everybody has access to it." [Jennifer] He [the consultant] automated that process where there was no process other than sending the documents up to [the accounting department]. [Raymond]
Training	C6	"We had training… We had a four hour time slot for training that we all signed up for through one of the computer labs and picked up our little training." [Veronica] "They [the IT department] had some training class… it was like an hour session showing the features." [Neil]
Building coalitions	I1	The power user and I started [using the system] first and then he and I went to the other team members and said, 'We're going to move to this [Contact Management System].'" [Brad] "We went through [the system]. The other lady -- a procurement clerk -- works with back orders all the time and I do. But [this individual] hadn't. Between the two of us we kind of ganged up on her… She's on board now." [Raymond]
Bargaining	I3	"I told them [other individuals] when they get ready to do their first expense report that I would sit with them and help them through it." [Tim] "'We'll mentor you as you go through this. So, as you have your first one, come to me and I'll show you how to set it up and what I would do.'" [Brad]
Presenting rational arguments	I5	"[My supervisor explained] the useful features [of the system]… in relation to the objectives for the operations center." [George] 'If you want to do this yourself, it would save you a lot of time and we can wait on other people. If you need it you can just come in and get it…' [Robert]
Being assertive	I8	"I would constantly be emailing everybody [in team], 'Your project's set up. You're ready to go in and put your planned hours with you estimates…'" [Veronica] "People get into a mode of doing certain things… A lot of times you almost have to sit them down and browbeat them to death to show them. Yes, [I] had to do that a few times." [Titus]
Review	A5	"I read the book the first couple of weeks to try to figure out [ArcView]." [Helen] "I got a book from the library… I spent quite a few hours just trying to learn it." [Cheryl]

Observation	A6	"I did see how other people were using it and tried to copy that or mirror that." [Keith] "We [my training admin and I] sat together for at least two weeks. I shadowed her the first week and then she shadowed me to see how I was doing." [Melissa]
Inquiry	A7	"[I] just go out and ask them, 'What did you use to tie that report to variances for our cost center?'" [Kevin] "I would send a note or en email, or an instant message, or even a phone call to one of those three people [who knew it]…" [Karen]
Seeking assistance	A8	"I would get emails like… 'Well, if you can come and show me how to make it happen, you're more than welcome to.' So, I am like, 'Fine. I'll be down there in a minute.'" [Veronica] "My boss knew before he had to do his first one [that] I was able, so he asked me to sit with him." [Tim]
Developing own…	A9	"There are some data that it [Peoplesoft] doesn't track and therefore you may have other kind of tool like and Excel spreadsheet that you can use to capture some data." [Teresa] "We had to do some [tasks] elsewhere. We had a spreadsheet or project in our own group. We developed one in Access." [Kevin]
Requesting for…	A10	"We had a need and we all kind of grumbled among ourselves. We wish we could look up this or look up that, grumble, grumble and we'd take it to [the] Systems [Department]…" [Jennifer] "The initial implementation had a lot of short comings in it, so we had to request a lot of updates to support our needs." [Kevin]
Full adoption	A1	"I use all features [of ChangePoint]… I use the entire system." [Veronica] "I pretty much use all the features [of the system] that I am authorized to use." [Cathy]
Partial adoption	A2	"May be of all the things it supported, I probably used 60 to 70% [of the features]" [Elizabeth] "[I use] a reasonable amount of the operating system [Windows XP] features." [Tyler]
Experimentation	A3	"Once you get how you find information on something or how to let it [the system] help you, then you know, 'Okay, it helped me do this time; let's try to go down that same path for other things.'" [Katelin]

	"Instances would come up and I'd just start playing around with it [Personal Manager] and I would find something." [Melissa]

Table 15. Illustrative Examples of Data Coding

5.5 Data Characteristics

I coded a total of 355 actions from all interviews. Of these, 259 actions were classified into the 25 *a priori* actions described earlier. The remaining 96 actions were categorized into the three additional action-categories (OCA, OIA, and OAA) that had been created for gathering unclassifiable actions. Based on an analysis of these unclassifiable actions, 78 actions were recoded into five emergent categories (See Table 16 and Table 17). Three of the emergent actions were for the influencer role: expertise (OI1), demonstration (OI2), and knowledge sharing (OI3). The other two emergent actions were for the potential adopter: favorable response (OA1) and unfavorable response (OA2). The remaining 18 actions remained unclassified and were excluded from further analysis (OCA: 5 actions; OIA: 11; and OAA: 2).

Action	Code	Description
Expertise	OI1	The influencer provides responses or answers to specific questions regarding the innovation posed by the potential adopter.
Demonstration	OI2	The influencer provides a walk-through of the innovation to the potential adopter.
Knowledge sharing	OI3	The influencer transfers special knowledge s/he possesses about the system to the potential adopter.
Favorable response	OA1	The potential adopter reacts positively to the innovation when s/he was introduced to it.
Unfavorable response	OA2	The potential adopter reacts negatively to the innovation when s/he was introduced to it.

Table 16. Definitions of Emergent Action Types

Action	Code	Illustrative Text from Interviews
Expertise	OI1	"With my leader, I think I was trying to find out a screen, I remember going to him in a situation where I wanted to understand… I had the sense that it was somewhere in the database but I couldn't figure out where it was. So he was able to pinpoint where that would be." [Teresa] "It was clarifying what should go in a certain field and how to navigate through the tool. The tool is almost like a wizard. It prompts you through the steps that you had to take and so once you are prompted through, they needed to go back and they didn't know how to get back." [Tim]
Demonstration	OI2	"It was a 15 or 20 minute process for me to show them how to use [Travel Manager]… I just went down there [their office] and walked them through it the first time." [Tim] I'll just walk back to where they're [the new hire] at and sit down with them and I'll do it slowly so that they can take down notes. [Melissa]
Knowledge sharing	OI3	"Sometimes people might be in a meeting and somebody might bring up the specifics of Travel Manager and start complaining about something, and I might say, "Here's how I learned how to solve that problem."" [Tim] I had them set up a room with 12 computers in and I would take our people and do two classes a week, rotate them in the classroom until they thoroughly understood what we were doing. [Titus]

Table 17. Illustrative Examples of Emergent Action Types

Illustrative Text from Interviews	Notes
If I can't find an answer, I'll refer them [directors] to another admin. [Melissa]	Looks like a REFERRAL to someone else and *not* a direct influence by the influencer
Someone was using [ArcView] and he told me about it… because we were looking for a map software [and] I was searching for a map software. [Helen]	Looks like an AWARENESS CREATION action – but *not* by the organization (and hence not a contextual action)
He [the colleague] showed me that system [Contact Management System] and *I got the same permission then to have us do it here.* [Brad]	Looks like OBTAINING PERMISSIONS to use system from the management or representative of the management

Table 18. Illustrative Examples of Unclassified Actions

Thus, 337 classified actions were used the analysis of adoption and influence processes underlying the adoption of IS/IT innovations. As explained earlier, the same participant

told their stories for each role – potential adopter and influencer – and hence the contextual actions were similar to both adoption and influence stories explained by that individual. Thus, the contextual actions were included in both stories. As a result, the adoption processes were extracted from 224 actions and the influence processes were based on 154 actions.

5.5.1 Actions aimed at the Entire Organization

The data revealed 64 actions aimed at the entire organization. These actions generally related to the activities by top management to aid adoption of innovations. Table 19 shows the frequencies of actions aimed at the entire organization.

Action	Frequency	%Frequency
Training	18	28.13
Awareness creation	16	25.00
Development	10	15.63
Issuing of mandate	9	14.06
Implementation	9	14.06
Withdrawal of mandate for use	1	1.56
Changes in personnel	1	1.56
Total	*64*	*100.0*

Table 19. Actions aimed at the Entire Organization

The action most frequently aimed at the entire organization was "training" (18 of the 64 actions). The next set of most frequently used actions were "awareness creation" (16 of 64) and "development" (10 of 64) – actions which provided potential adopters a reason to know about the innovation. The other set of most frequently used actions were "implementation" (nine of 64) and "issuing of mandate" (nine of 64) – both of which deal with the use of the innovation by potential adopters.

5.5.2 Influencer Actions aimed at the Potential Adopter only

I identified 145 influencer actions aimed at the potential adopter only, of which 70 actions fit the eight *a priori* action types and 74 actions were categorized into three emergent actions for the influencer (See Table 20; emergent actions are underlined).

The emergent actions identified for the influencer were demonstration, expertise, and knowledge sharing. Demonstration refers to the influencer giving a walk through of the innovation and its features to the potential adopter. Expertise indicates the influencer providing responses or answers to specific questions posed by the potential adopter. Knowledge sharing refers to the influencer transferring knowledge possessed about the innovation to the potential adopter such that the potential adopter can appreciate the nuances of the innovation. Demonstration was seen in 42 of the 74 emergent actions, expertise in 21, and knowledge sharing in 11 coded actions.

Action	Frequency	%Frequency
Demonstration	42	28.97
Presenting rational arguments	28	19.31
Being assertive	25	17.24
Expertise	21	14.48
Bargaining	12	8.28
Knowledge sharing	11	7.59
Building coalitions	5	3.45
Applying sanctions	1	0.69
Appeals to higher authority	0	0.00
Acting in a clandestine manner	0	0.00
Using friendliness and ingratiation	0	0.00
Total	*145*	*100.0*

Table 20. Influencer Actions aimed at the Potential Adopter only

[emergent actions have been underlined]

The most frequently used action by the influencer was "demonstration" (42 of 145), an action that enabled the potential adopter to model own behavior appropriately. The influencers also used the actions of "presenting rational arguments" (29 of 145) and "being assertive" (23 of 145) quite frequently – both actions serving as reasons for the potential adopters to adopt innovations. The other actions used by influencer to some extent were "expertise" (22 of 145), "bargaining" (12 of 145), and knowledge sharing (11 of 145) – all of which either helped the potential adopter to understand the innovation or pinpointed a resource for the potential adopter. In rare occasions, the influencers also used "building coalitions" (five of 145) and "applying sanctions" (one of 145) to get the potential adopters to adopt innovations. Three *a* priori actions, "appeals to higher authority," "acting in a clandestine manner," and "using friendliness and ingratiation" were not reported by the interviewees in the study, consistent with prior literature (Yukl et al. 1995).

5.5.3 Pre-Adoption Actions of the Potential Adopter

The data yielded 67 pre-adoption actions enacted by the potential adopter, of which 63 actions were consistent with the six *a priori* actions and four actions represented the two emergent actions of the potential adopter (See Table 21; the emergent actions are underlined).

The two emergent pre-adoption actions of the potential adopter were "favorable response" and "unfavorable response". Favorable response refers to the potential adopter responding positively to cues about the innovation. Unfavorable response indicates the potential adopter's negative reactions to cues about the innovation. Favorable response was seen in three of the four emergent actions; the remaining one was an unfavorable response. These two actions are somewhat similar to the positive and negative affect individuals exhibit towards IS/IT innovations. The distinction between responses (in this study) and affect (generally seen in prior literature) is that the former is an observable behavior whereas the latter in an intrinsic feature. Favorable responses are typically more conducive to adoption compared to unfavorable responses.

Action	Frequency	%Frequency
Inquiry	34	50.75
Seeking assistance	13	19.40
Developing own…	5	7.46
Review	4	5.97
Observation	4	5.97
Requesting for…	3	4.48
Favorable response	3	4.48
Unfavorable response	1	1.49
Total	*67*	*100.0*

Table 21. Pre-Adoption Actions of the Potential Adopter

[emergent actions have been underlined]

The pre-adoption action most frequently used by the potential adopter was "inquiry" (34 of 67), an action that enabled the potential adopter to ask someone about the innovation. The next most frequently used action was "seeking assistance" (13 of 67), an action that allowed the potential adoption to seek help with the innovation. Potential adopters also engaged in "review" (four of 67) of the reference materials to know about the innovation. They also used "observation" (four of 67) to understand some of the ways in which other individuals worked with an innovation. Sometimes, they also developed their own solutions (five of 67) when the innovation provided to them was deficient in certain aspects. The potential adopter also requested for new solutions (three of 67) from other individuals or units such as the information systems department.

5.5.4 Adoption Actions of the Potential Adopter

I identified 61 adoption actions by the potential adopter from the data. In general, the potential adopter engaged in four different adoption actions. The potential adopters used "experimentation" (31 of 61) and "partial adoption" (20 of 61) more frequently than the other actions. Both were actions that allowed the potential adopter to use a subset of the innovation features or use the innovation for a subset of the tasks. "Full adoption" was employed only nine out of the 61 times an adoption action was performed. In rare cases, "non-adoption" (1 of 61) was also seen.

Action	Frequency	%Frequency
Experimentation	31	50.82
Partial adoption	20	32.79
Full adoption	9	14.75
Non-adoption	1	1.64
Total	*61*	*100.0*

Table 22. Adoption Actions of the Potential Adopter

5.6 Data Analysis

I employed both qualitative and quantitative data analysis techniques to make sense of the data gathered through the interviews. That is, I first analyzed the interview data using qualitative data analysis techniques, the results of which I further analyzed using quantitative data analysis techniques. Overall, the data analysis involved two major steps. The first step was a textual analysis (Lacity and Janson 1994) of the interview data, in which I identified the four classes of actions introduced earlier. The second step was a combination of optimal matching (Abbott 1990) and cluster analysis (Sabherwal and Robey 1993) of the actions identified through the textual analysis earlier. Thus, the findings of the study are somewhat objectified even though the data was obtained through interviews and may be considered subjective.

5.6.1 Within-Case Analysis

I conducted a within-case analysis for each interview. This entailed the identification of the chronological order of all actions that transpired within the context (in which the interviewee was situated) for each innovation, and building a description of innovation adoption (Miles and Huberman 1984). This process description contained actions reported by the interviewee for the roles of the potential adopter as well as the influencer. I then split the description into two parts: one for the potential adopter, referred to as the "adoption process," and the other for the influencer, referred to as the "influence process." Since the organizational context is the same for both processes – the interviewee functioned in the same organizational context for both potential adopter and influencer roles – I included the actions aimed at the entire organization in both the adoption and influence processes.

At the end of the within-case analyses, I obtained the adoption process and the influence process for each innovation reported in each interview. That is, I ended up with two sets of process descriptions – one based on data for the potential adopter role (i.e. adoption processes) and the other for the influencer role (i.e. influence processes). Table 23 shows an illustration of the accumulated descriptions of adoption processes obtained from different interviews.

Participant	IS/IT Innovation	Actions								
Jake	Task Tracker	c1	i8	i5	c6	i8	a2			
Cathy	M.A.S. System	i8	c5	c1	c6	a3	a7	a8	oi3	a1
Elizabeth	Travel Manager	c2	c6	a5	a7	oi2	a2			

Table 23. Within-Case Analysis Results Illustrated

5.6.2 Cross-Case Analysis

I conducted cross-case analyses on the adoption and influence processes resulting from the within-case analysis phase (See Table 23 for an example). The objective of the cross-case analyses was to classify the action sequences in each process class into different groups such

that sequences between groups are dissimilar while sequences within groups are similar. The resultant groups of sequences would then indicate different processes of adoption and influence enacted in actual settings. To accomplish this objective, I employed a combination of quantitative techniques such as optimal matching, cluster analysis, and crosstabs analysis, explained next.

Optimal Matching

Optimal matching is a technique that can be used to measure the resemblance of two given sequences (Abbot and Hrycak 1990; Sabherwal and Robey 1993). For optimal matching to work, the sequences must be represented by "a string of well-defined elements" that are typically drawn from a "relatively small set" (Abbot and Hrycak 1990). In this study, there are a total of 30 actions identified earlier. A sequence can be defined using a string of actions from that set. For instance, Person C has the following sequence (Table 15): c2, c6, a5, a7, oi2, a2 (referred to as SEQ1 hereafter). SEQ1 represents the following actions: issuing a mandate (c2), training (c6), review (a5), inquiry (a7), demonstration (oi2), and partial adoption (a2). Another sequence may be composed of the following string of actions: c1, c4, c4, c6, a3, a7, a2 (referred to as SEQ2). SEQ2 represents the following actions: awareness (c1), development (c4), development (c4), training (c6), experimentation (a3), inquiry (a7), and partial adoption (a2). What is the extent of resemblance of SEQ1 and SEQ2? This can be answered by computing the "distance" between each other (Abbott 1990; Sabherwal and Robey 1993). The distance is typically defined in terms of the number of substitutions, insertions, and deletions that would be needed to transform SEQ1 to SEQ2. Such transformations can usually be accomplished in different ways. The following (Table 24) are some ways by which to transform SEQ1 into SEQ2 (φ is a "placeholder").

Path	Transformation Steps	Representation								Cost
1	Substitute c2 with c1 Substitute c6 with c4 Substitute a5 with c4 Substitute a7 with c6 Substitute oi2 with a3 Insert a7	SEQ1:	c2	c6	a5	a7	oi2	φ	a2	6
		SEQ2:	c1	c4	c4	c6	a3	a7	a2	
2	Insert c1 Substitute c2 with c4 Substitute c6 with c4 Substitute a5 with c6 Substitute a7 with a3 Substitute oi2 with a7	SEQ1:	φ	c2	c6	a5	a7	oi2	a2	6
		SEQ2:	c1	c4	c4	c6	a3	A7	a2	
3	Insert c1 Insert c4 Substitute c2 with c4 Substitute a5 with a3 Delete oi2	SEQ1:	φ	φ	c2	c6	a5	A7	oi2	a2	5
		SEQ2:	c1	c4	c4	c6	a3	A7	φ	a2	

Table 24. Optimal Matching Example

These possibilities are not exhaustive. However, as can be seen, some paths are more expensive than others. The goal is to determine the closest inter-sequence distance between the two sequences so that their resemblance can be measured. This requires the computing of all possible transformation paths and then assigning of the minimum cost as the distance between the two sequences. That is, the lower the distance the more similar the two sequences.

In general, the number of ways by which sequences can be transformed increase with the lengths of the sequences. As a result, manually determining all possible transformations for any two sequences becomes unmanageable. This process becomes even more problematic when there are multiple sequences. The optimal matching program[8] provides an efficient way of identifying the different transformation paths and the minimum distances between all pairs of sequences in a given set (Abbot and Hrycak 1990).

Figure 6 shows an example of an optimal matching between two sequences. In this example, the optimal matching program identified all possible paths for transforming the sequence on the column (1, 6, 21, 26, 19) to the sequence on the row (1, 15, 17, 12, 6, 18, 26, 27, 27, 25, 26, 19)[9]. The "circles" in the Figure indicate the "cost" of transforming an action in the column sequence to another action in the row sequence. (The different sizes of the circles indicate the different "costs" for transformations: smaller circles involve lower costs and the bigger circles the higher costs.) The "lines" indicate the various transformation paths, from the top left-hand corner (i.e. beginning of the sequence) to the bottom right-hand corner (i.e. end of the sequence). The program then determines the lowest cost from all possible paths and assigns it as the distance between the two sequences.

In computing the inter-sequence distances using the Optimal Matching program, I set all substitution costs, i.e. the cost of substituting one action with another action, as 1.0. That is, the substitution costs assume that all actions in the set are dissimilar to each other (Sabherwal and Robey 1993). I set all indel (i.e. insertion and deletion) costs, i.e. the cost of either inserting an action into a sequence or deleting an action from a sequence, as 0.50. In general, the sum of the insertion and deletion costs should be equal or greater than the substitution costs (Sabherwal and Robey 1993). Otherwise the Optimal Matching program would never choose a substitution over a combination of insertion and deletion (which would always be economical)[10].

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8 The optimal matching program was graciously provided by Dr. Andrew Abbott. More information about the program can be found at http://home.chicago.edu/~aabbott/Om/optprelim.html, accessed 05/01/07.

9 The optimal matching program requires the sequence elements to be "numbers" (as seen in Figure 6). Hence, I assigned numbers for all the 30 actions before conducting the analysis with the optimal matching program.

10 Even though, at the level of individual actions, all 30 actions are dissimilar to each other, and substitution costs of 1.0 across the board may be reasonable, it is possible to recognize the similarities as well. For instance, the 30 actions may be classified into three broad categories based on "the actor" performing those actions: the context (c1 thru c7), the influencer (i1 thru i8, oi1 thru oi3), and the potential adopter (a1 thru a10, oa1 and oa2).

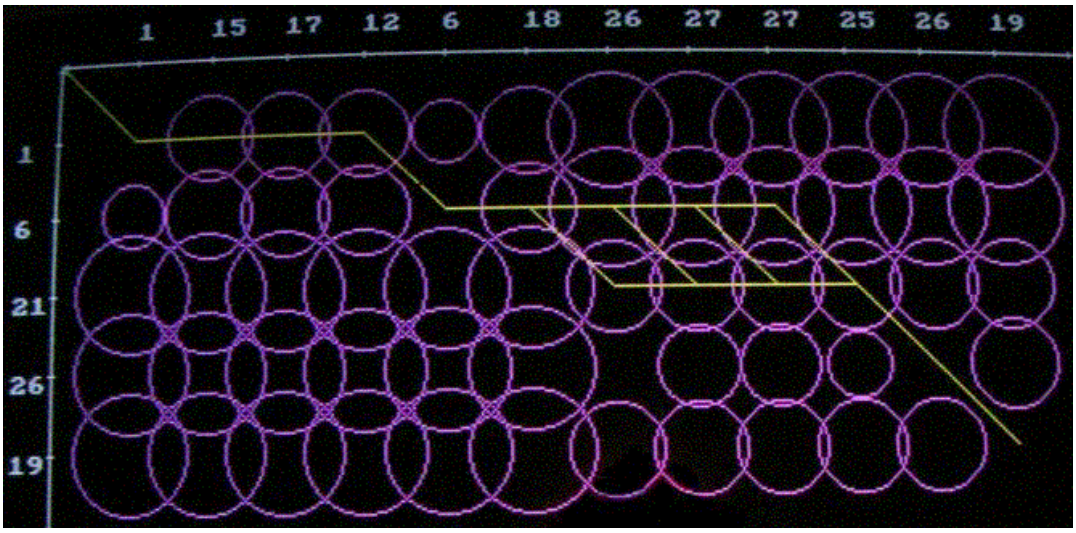

Figure 6. Optimal Matching

Finally, the distances are affected by the length of the sequences to be transformed. That is, the distances increase as the sequence lengths increase. To minimize the disturbances due to sequence lengths, I standardized the distances by the length of the longer sequence (Abbot and Hrycak 1990; Sabherwal and Robey 1993).

The output of the Optimal Matching program was a matrix of distances that contained the minimum distances for all sequences from all other sequences.

The 30 actions may also be classified into four categories (as introduced in the theoretical development section): actions aimed at the entire organization (c1 thru c7), influencer actions aimed at the potential adopter only (i1 thru i8, oi1 thru oi3), pre-adoption actions of the potential adopter (a5 thru a10), and adoption actions of the potential adopter (a1 thru a4, oa1 and oa2).

To exploit these classifications, I constructed two other cost structures with unequal substitution costs between two actions.

For the first case with three possible categories, I set up the costs for each process class from the perspective of its major actor. That is, I considered the substitution costs from the potential adopter perspective for the adoption processes and from the influencer perspective for the influence processes. Thus, a substitution between two categories, one of which was the major actor, cost 0.8 while substitutions between the categories that did not involve the major actor cost 1.0. All substitutions within the same category cost 0.6. All indel costs were 0.5.

For the second case with four possible categories, I set up the costs for each process class according to the actions introduced in theoretical section. All substitutions within the same categories cost 0.5, except in three cases. First, actions that were contradictory (such as adoption and non-adoption, or issuing of mandate and withdrawal of mandate) cost 1.0. Second, substitutions involving pre-adoption actions cost 0.6 if the substitution involved changes on two dimensions. Finally, substitutions between somewhat dissimilar adoption actions cost 0.7. Substitutions between categories cost 0.7. All indel costs were 0.5.

The results obtained using these two cost structures were inferior, compared to the equal substitution cost structures, in some of the diagnostic tests conducted to verify the robustness of the findings. Hence, these findings are not discussed further in the paper.

Cluster Analysis

Cluster analysis is a technique that can be used to classify observations into different categories (Hair et al. 1999). The use of cluster analysis is consistent with the objectives of the study, since the objective is to identify different types of adoption and influence processes. The observations for the cluster analysis procedure were the inter-sequence distances obtained using the optimal matching procedure. I used the SPSS 11.0 software[11] for conducting the cluster analysis.

The cluster analysis procedures typically agglomerate individual observations into small groups based on the extent to which individual observations resemble each other (Hair et al. 1999). Subsequently, the small groups are combined into larger groups until all observations are gathered in a single large group (Sabherwal and Robey 1993). Cluster analysis procedures use a variety of linkage methods such as Ward's linkage, within-group average linkage, and between-group average linkage to join different observations into groups (Hair et al. 1999; Punj and Stewart 1983). I conducted cluster analysis using the Ward's linkage methods for both the adoption and influence processes.

Since cluster analysis procedures eventually combine all observations into a single large cluster, the task of determining the number of clusters in the final solution resides with the researcher. Cluster analysis procedures provide the "fusion coefficients" at each agglomeration stage, which can be used to finalize the number of clusters for the final solution (Hair et al. 1999). In general, major jumps in fusion coefficients indicate significant differences between the clusters in that agglomerative stage. I examined the fusion coefficients and selected the three-cluster solution for both the adoption and influence processes based on the extent of difference between two successive agglomeration stages.

To verify the robustness of the clusters, I compared the within-group distances with the between-group distances for each cluster (Sabherwal and Robey 1993). I first computed the mean distance of each sequence from other sequences in its cluster, and considered the sequence with the smallest mean distance as the "centroid" for that cluster. Subsequently, I conducted a t-test for the mean distance of each sequence from others in its cluster and the mean distance of each sequence from the centroid sequence of the other clusters. A significant t-test indicates that the sequences are more similar to others in their own clusters and more dissimilar to others in the other clusters. In this study, the t-tests were significant for both adoption and influence processes, thus resulting in divergent clusters with convergent sequences.

Interviewee	Actions																			
Jake	c1		i8	i8	i5			c6				i8		a2						
Cathy			i8			c5	c1	c6		a3	a7				a8	oi3	a1			
Elizabeth		c2						c6	a5		a7		oi2	a2						
Ideal Sequence			i8					c6			a7			a2						

Table 25. Cross-Case Analysis Example

[11] SPSS 11.0 is a software program for statistical applications. More information about the program can be found at http://www.spss.com, accessed 05/01/07.

Finally, I conducted several tests for interpreting the clusters obtained through the cluster analysis. First, I inspected the centroid sequences of each cluster to determine the extent of their dissimilarity with each other. Second, I inspected the sequences in each cluster to determine the extent of their similarity with each other (Abbot and Hrycak 1990). Third, beginning with the centroid sequences and through an examination of the sequences, I prepared an "ideal sequence" for each cluster; i.e. a "hypothetical sequence" that best approximates the sequences in a cluster (Sabherwal and Robey 1993). I rearranged, while preserving the chronological order, the actions of the sequences in each cluster to be vertically aligned such that number of sequences that contain a particular action can be obtained. For membership in an ideal sequence, I employed a heuristic of "in at least 40% of the cases;" i.e. an action should appear in at least 40% of the sequences to be included on the ideal sequence. Table 25 shows an illustration of this process. Lastly, I evaluated the extent to which the sequences in each cluster were similar to the ideal sequences for that cluster (Sabherwal and Robey 1993). This was done by computing the distances of each sequence from its ideal sequence and then performing a t-test on the distance of a sequence from its own ideal and the mean distance of the sequence from the other two ideals.

Crosstabs Analysis

I conducted a crosstabs analysis using the clusters to determine the dependence of the adoption and influence processes on each other. These analyses were based on those instances for which data on both the adoption and influence processes were available (by virtue of an interviewee reporting on both the potential adopter and influencer roles). Finally, I analyzed the extent to which the processes of innovation adoption were different or similar across contingencies. Crosstabs analyses were used to understand the extent to which the adoption and influence processes were contingent on the adoption context, organizational positions of the interviewee, the type of organization, gender, etc.

5.7 Adoption Processes

The adoption processes were determined based on the analysis of 224 actions for the 30 adoption stories. The average length of an action sequence was 7.46 actions. The analysis yielded three different processes: Conscious Quest, Requisite Compliance, and Piloted Trial. Table 26 and Appendix H contain descriptive statistics of the adoption processes. From Table 26, it can be seen that all three processes, on average, involved similar number of actions. However, the Conscious Quest process contained fewer actions in its ideal action sequence than Requisite Compliance and Piloted Trial processes. The ideal sequences of the three processes are unique and result in very different adoption processes, explained next.

	Conscious Quest	Requisite Compliance	Piloted Trial
# of stories (% on 30)	8 (26.7%)	12 (40.0%)	10 (33.3%)
# of actions (% on 224)	63 (28.1%)	85 (38.0%)	76 (33.9%)
Average sequence length	7.88	7.08	7.60
Shortest sequence	3	3	3
Longest sequence	13	12	14
Length of ideal sequence	5	6	7

Table 26. Adoption Processes

5.7.1 Conscious Quest

The Conscious Quest process comprised five actions: awareness creation, training, experimentation, seeking assistance, and full adoption (See Figure 7). It was found in 26.7% of the adoption stories (eight stories out of 30). The eight stories that involved the Conscious Quest process contained 63 actions and the average length of an action sequence was 7.88 (See Appendix I for action sequences).

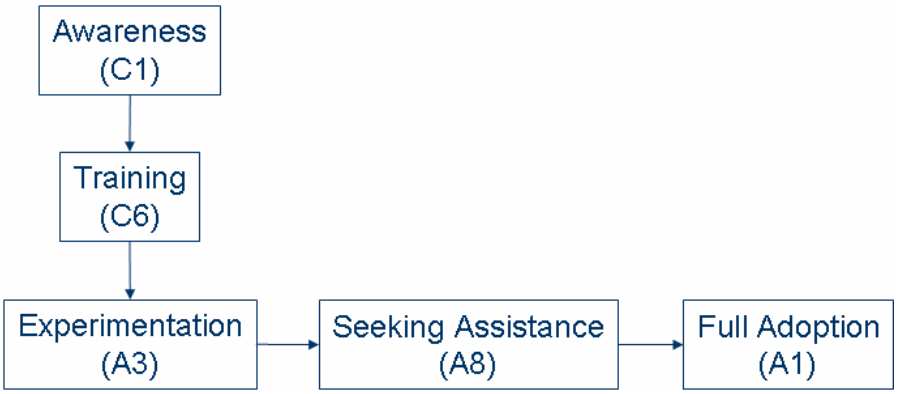

Figure 7. Conscious Quest Process

This process began with awareness creation (i.e. the organization made the innovation known to potential adopters) and was followed by training (i.e. the organization conducted training sessions in which the potential adopter participated). The potential adopter typically engaged in experimentation (i.e. playing around with the system and finding or using more of the system) followed by seeking assistance (i.e. the potential adopter sought someone to help with the system). These actions were followed by full adoption (i.e. the potential adopter typically adopted the innovation in full).

5.7.2 Requisite Compliance

The Requisite Compliance process included six actions: awareness creation, issuing of mandate, presenting rational arguments, training, experimentation, and partial adoption (See Figure 8). It was seen in 40% of the adoption stories (12 stories out of 30). The 12 stories

that involved the Requisite Compliance process contained 85 actions and the average length of an action sequence was 7.08 (See Appendix I for action sequences).

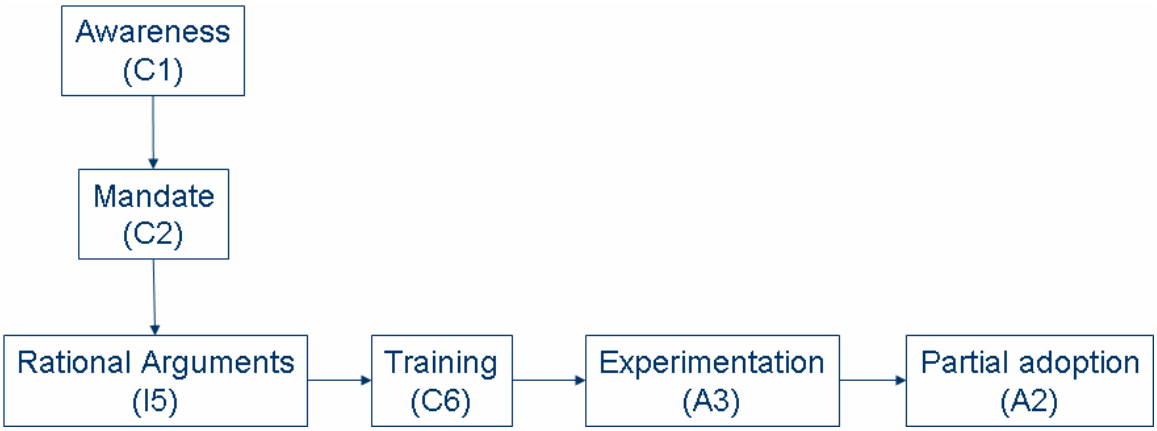

Figure 8. Requisite Compliance Process

This process began with awareness creation (i.e. the organization made the innovation known to potential adopters), which was followed by an issuing of mandate (i.e. the organization required the potential adopters to use of the innovation). These actions were followed by rational arguments (i.e. the potential adopter was presented with reasons for adopting the system). This was followed by training (i.e. the organization conducted training sessions in which the potential adopter participated). This was followed by experimentation (i.e. playing around with the system and finding or using more of the system) and partial adoption (i.e. the potential adopter partially adopted the innovation).

5.7.3 Piloted Trial

The Piloted Trial process encompassed seven actions: being assertive, demonstration, inquiry, experimentation, inquiry, experimentation, and partial adoption (See Figure 9). It was found in 33.3% of the adoption stories (10 stories out of 30). The ten stories that reported a Piloted Trial process comprised 76 actions and the average length of an action sequence was 7.66 (See Appendix I for action sequences).

This process began with being assertive (i.e. someone told the potential adopter to use the innovation) and was followed by a demonstration (i.e. someone provided a walk through of the system for the benefit of the potential adopter). These actions were followed by inquiry (i.e. the potential adopters asked someone specific questions about the innovation) and experimentation (i.e. the potential adopters tried some features of the innovation). These were followed by another round of inquiry and experimentation. This was typically followed by partial adoption (i.e. the potential adopter partially adopted the innovation).

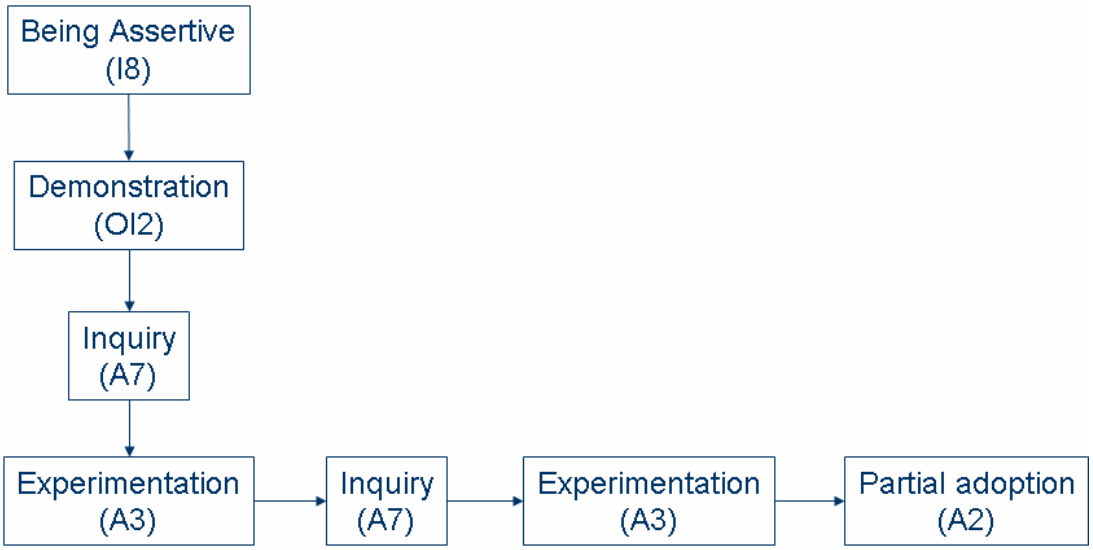

Figure 9. Piloted Trial Process

5.8 Influence Processes

The influence processes were determined from the analysis of 154 actions for the 20 influence stories. The average length of an action sequence was 7.70 actions. The analysis resulted in three different processes: Directed Assistance, Logical Persuasion, and Queried Disclosure. Table 27 and Appendix K contain descriptive statistics of the influence processes. From Table 27, it can be seen that the Logical Persuasion process involved more actions than Directed Assistance and Queried Disclosure processes. Further, the ideal action sequence was much shorter for the Directed Assistance process than the Logical Persuasion or Queried Disclosure processes. The ideal sequences of the three processes are unique and result in very different adoption processes, and are explained next.

	Directed Assistance	Logical Persuasion	Queried Disclosure
# of stories (% on 20)	7 (35%)	5 (25%)	8 (40%)
# of actions (% on 154)	44 (28.6%)	46 (29.9%)	64 (41.5%)
Average sequence length	6.29	9.20	8.00
Shortest sequence	3	6	5
Longest sequence	10	15	15
Length of ideal sequence	6	8	7

Table 27. Influence Processes

5.8.1 Directed Assistance

The Directed Assistance process included six actions: awareness creation, issuing of mandate, training, expertise, being assertive, and demonstration (See Figure 10). It was found in 35% of the influence stories (seven stories out of 20). The seven stories that

reported a Directed Assistance process contained 44 actions and the average number of actions on an action sequence was 6.29 (See Appendix L for action sequences).

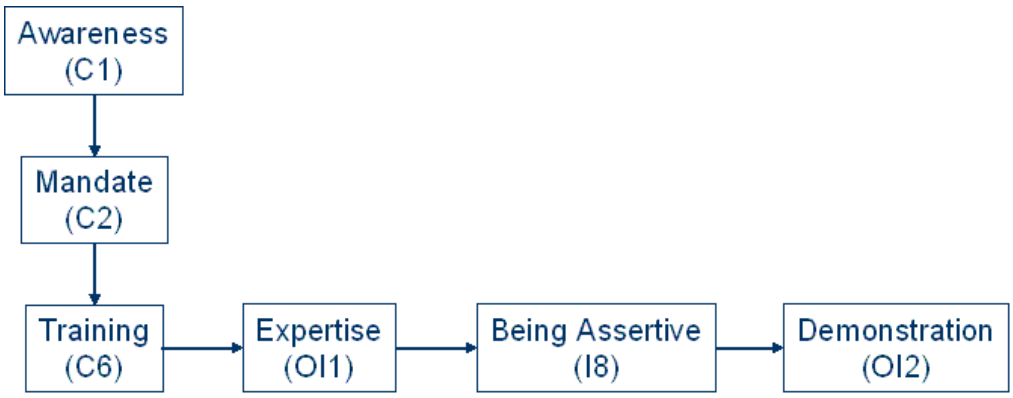

Figure 10. Directed Assistance Process

This process began with awareness creation (i.e. the organization made the innovation known to the potential adopters) and was followed by an issuing of mandate (i.e. the organization required the individuals to use the innovation) and training (i.e. the organization conducted training sessions for the individuals). This was followed by expertise (i.e. the influencer addressed specific questions from potential adopters) and being assertive (i.e. an influencer told the potential adopters to use the innovation). These actions were followed by demonstration (i.e. the influencer provided a walk through of the innovation to the potential adopters).

5.8.2 Logical Persuasion

The Logical Persuasion process contained eight actions: presenting rational arguments, coalition tactics, presenting rational arguments, bargaining, presenting rational arguments, demonstration, expertise, and demonstration (See Figure 11). It was seen in 25% of the influence stories (five stories out of 20). The five stories that reported a Logical Persuasion process accounted for 46 actions and the average length of an action sequence was 9.20 (See Appendix L for action sequences).

This process typically began with presenting rational arguments (i.e. influencer presented some reasons for adopting the system to the potential adopters) and was followed by coalition tactics (i.e. the influencer teamed with someone else to influence the potential adopters). These actions were followed by presenting rational arguments (i.e. more reasons by the influencer) and bargaining (i.e. the influencer told the potential adopters that s/he would be willing to help in adopting the system). This was followed by presenting rational arguments (i.e. more reasons by the influencer) and demonstration (i.e. the influencer provided a walk through of the innovation to the potential adopters). These actions were followed by expertise (i.e. the influencer responded to specific questions about the

innovation) and demonstration (i.e. the influencer provided a walk through of the innovation to the potential adopters).

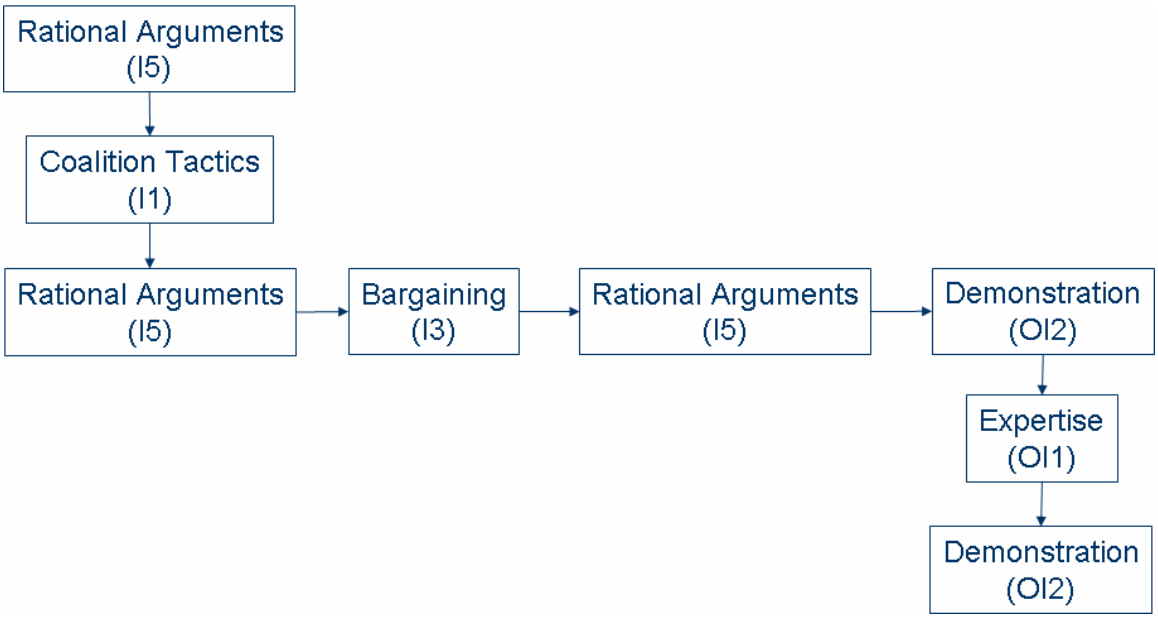

Figure 11. Logical Persuasion Process

5.8.3 Queried Disclosure

The Queried Disclosure process involved seven actions: awareness creation, training, demonstration, inquiry, demonstration, inquiry, and expertise (See Figure 12). It was found in 40% of the influence stories (eight stories out of 20). The six stories that involved a Queried Disclosure process contained 64 actions and the average length of an action sequence was 8.00 (See Appendix L for action sequences).

This process began with awareness creation (i.e. the organization made the innovation known to the potential adopters) and was followed by training (i.e. the organization arranged training sessions for the potential adopters). This was followed by demonstration (i.e. the influencer provided a walk through of the innovation to the potential adopters), and inquiry (i.e. the influencers had questions from the potential adopters). These were followed by demonstration (i.e. more walkthroughs by influencers), inquiry (i.e. more questions for influencers), and expertise (i.e. the influencer responded to specific questions about the innovation).

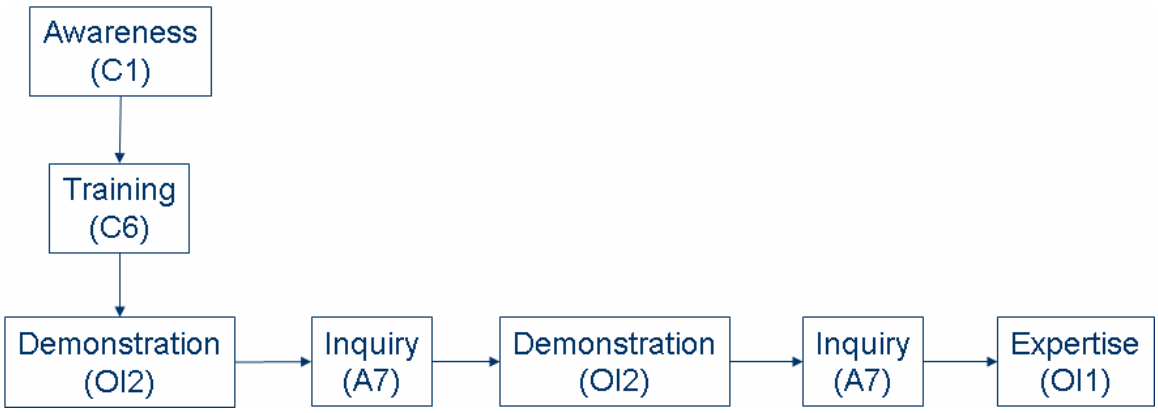

Figure 12. Queried Disclosure Process

5.9 Relationships and Contingencies

The crosstabs analysis for understanding the relationship between adoption and influence processes was based only on the 20 instances that contained both the adoption and influence stories. Thus, there were six Conscious Quest processes, ten Requisite Compliance processes, and four Piloted Trial processes in the 20 adoption stories, and seven Directed Assistance processes, five Logical Persuasion processes, and eight Queried Disclosure processes in the 20 influence processes.

Figure 13 outlines the frequencies of the adoption and influence processes against each other[12]. The Directed Assistance influence process was reported to a greater extent with the Requisite Compliance adoption process: five participants reported both processes. The Logical Persuasion influence process was found to appear more with the Requisite Compliance adoption process as well: three participants reported both these processes. The Queried Disclosure influence process was spread evenly between the Conscious Quest and Piloted Trial adoption processes: three participants reported these processes.

ADOPTION PROCESSES	Directed Assistance	Logical Persuasion	Queried Disclosure
Conscious Quest	2	1	3
Requisite Compliance	5	3	2
Piloted Trial	0	1	3

INFLUENCE PROCESSES

Figure 13. Relationship between Adoption and Influence Processes

[12] I conducted a chi-square test of independence which did not reveal an association between the adoption and influence processes. Hence the discussion is based only on the frequencies.

I subsequently examined the contingencies that determine the particular adoption and influence processes. This analysis was conducted to understand the circumstances under which the adoption and influence processes may be seen in actual settings. Specifically, I examined three contingencies: use context, user roles, and innovation type as explained below. All these analyses were based on 30 adoption stories and 20 influence stories[13].

5.9.1 Use Context

Use context refers to the extent to which the organization bestows choice to potential adopters regarding the adoption and use of an IS/IT innovation. An organization may allow the individuals to make a free choice (i.e. voluntary use) or stipulate the adoption and use of an innovation (i.e. mandatory use).

Of the 30 adoption stories I gathered from the interviews, 17 described processes in a mandatory use context and 13 in a voluntary use context (Figure 14). The Conscious Quest process was reported to a greater extent in the mandatory use context (five out of the 17 stories set in a mandatory context) than the voluntary use context. The Requisite Compliance process was found more frequently in the mandatory use context (nine out of the 17 stories). The Piloted Trial process, on the other hand, was related to the voluntary use context (seven out of the 13 stories set in a voluntary context). This analysis revealed that certain adoption processes are seen more in mandatory use settings while others seem to work better in voluntary use settings.

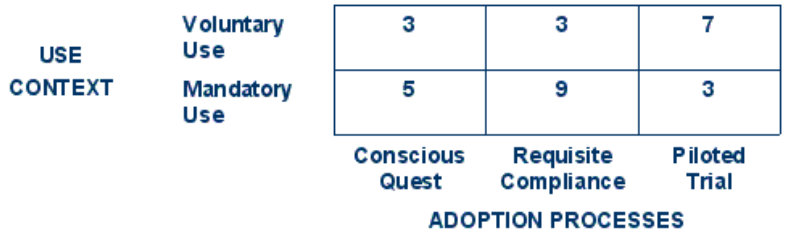

Figure 14. Use Context and Adoption Processes

Of the 20 influence stories available from the interviews, 14 belonged to a mandatory use context and only six were from a voluntary use context (Figure 15). The Directed Assistance and Queried Disclosure processes were seen more frequently the mandatory use context (six each of the 14 stories set in a mandatory context). The Logical Persuasion process was reported more frequently in the voluntary use context (three out of the six stories). This analysis revealed that certain influence processes are more likely in mandatory use settings while others are more likely in voluntary use settings.

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[13] Chi-square tests of independence did not reveal an association between any of the contingencies with the adoption or the influence processes. Consequently, the discussion is based only on frequencies of occurrences of the processes as well as the contingencies.

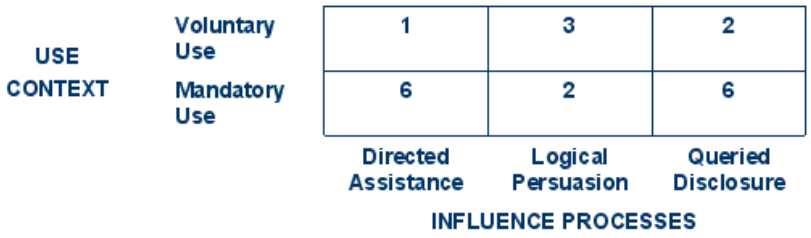

Figure 15. Use Context and Influence Processes

While the association between use context and processes were less clear, this analysis was useful in understanding the role of the use context itself. Only six of the 13 stories (46%) set in the voluntary use context had corresponding influence stories whereas 14 of 17 stories (82%) in the mandatory use context reported influence stories. Mandatory contexts, more than voluntary contexts, seem to sustain adoption and influence activities.

5.9.2 User Role

User role refers to the level of the organizational hierarchy at which individuals perform their organizational activities. An organization typically employs individuals at the (senior) executive, managerial, and (frontline) employee levels, with each level demanding different skills and capabilities from the individuals.

Of the 30 adoption stories obtained from the interviews, 15 were from managers or executives and 15 were from employees (Figure 16). The Requisite Compliance process was related to the manager or executive level (eight of the 15 stories told by participants) and the Piloted Trial process was associated to the employee level (seven of the 15 stories told by participants). However, the Conscious Quest process was evenly distributed between the manager or executive level and the employee level (four stories each). This analysis indicates that adoption processes seem to differ between specific groups or classes of individuals.

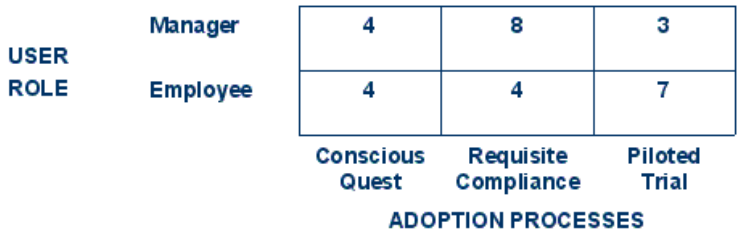

Figure 16. User Roles and Adoption Processes

Of the 20 influence stories from the interviews, 13 were from managers or executives and seven were from employees (Figure 17). The Directed Assistance process and the Logical Persuasion process were reported more by the managers or executives (four and five stories respectively out of 13 stories by participants). The Queried Disclosure process was evenly distributed between the two roles (four stories each). This analysis indicates that the influence processes may differ between specific groups of individuals.

USER ROLE		Directed Assistance	Logical Persuasion	Queried Disclosure
	Manager	4	5	4
	Employee	3	0	4

INFLUENCE PROCESSES

Figure 17. User Roles and Influence Processes

Another result from the analysis revealed the circumstances surrounding the adoption of IS/IT innovations. Only seven out of the 15 individuals (46%) at the employee level reported an influence side to their stories compared to 13 of the 15 (86%) individuals at the executive or manager levels). The executive or manager role, more than the employee role, seemed to sustain the adoption of innovations.

5.9.3 Innovation Type

Innovation type refers to the particular class of information systems that was adopted by individuals in organizational settings. An IS/IT innovation may be classified into different categories such as business process applications, office or personal productivity tools, and computer operating systems.

Of the 30 innovations seen in the adoption stories from the interviews, 16 were business process applications, 12 were office or productivity tools, and two were computer operating systems (OS) (Figure 18). The Conscious Quest process and Requisite Compliance processes were related to business process applications (six and eight stories respectively out of 16 business process applications). The Piloted Trial process was related more to office and productivity tools (seven out of 12 tools). This analysis indicates that the adoption processes would seem to differ by the type of class of the IS/IT innovation.

INNOVATION TYPE		Conscious Quest	Requisite Compliance	Piloted Trial
	Bus apps	6	8	2
	Tools	2	3	7
	OS	0	1	1

ADOPTION PROCESSES

Figure 18. Innovation Type and Adoption Processes

Of the 20 innovations seen in the influence stories from the interviews, 14 were business process applications, five were office or productivity tools, and one was a computer operating system (Figure 19). All three processes – Directed Assistance, Logical Persuasion,

and Queried Disclosure – were strongly related to business process applications. The influence processes seems to differ based on the innovation type.

INNOVATION TYPE	Directed Assistance	Logical Persuasion	Queried Disclosure
Bus apps	6	4	4
Tools	1	1	3
OS	0	0	1

INFLUENCE PROCESSES

Figure 19. Innovation Type and Influence Processes

An additional result of this analysis related to the circumstances that aided the adoption of innovations. Only five out of the 12 stories (41%) involving office or productivity tools had an influence component to it in contrast to 14 of the 16 stories (87%) involving business process applications. Business process applications, more than office or productivity tools, seem to propagate adoption of innovations.

5.9.4 Gender

I also conducted an analysis of the adoption and influence processes using gender as a potential discriminating variable. Of the 30 adoption stories from the interviews, 13 were provided by male participants and 17 by female participants (Figure 20). The Conscious Quest and Piloted Trial process were reported by female participants (five and seven stories respectively of the 17 stories by females). The Requisite Compliance process was reported more by male participants (seven of the 17 stories by males). This analysis indicates that males and females report different adoption processes.

GENDER	Conscious Quest	Requisite Compliance	Piloted Trial
Male	3	7	3
Female	5	5	7

ADOPTION PROCESSES

Figure 20. Gender and Adoption Processes

Of the 20 influence stories from the interviews, 11 were from male participants and nine from female participants (Figure 21). Two processes – Directed Assistance and Logical Persuasion – were reported by males (four stories each). The Queried Disclosure process was reported more by females (five stories). Thus, males and females may engage in different influence processes.

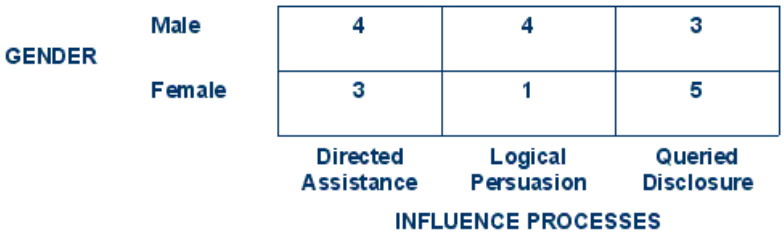

Figure 21. Gender and Influence Processes

Another result of this analysis related to the circumstances that aided the adoption of innovations. Only nine out of the 17 stories (52%) by females had an influence component to it in contrast to 11 of the 13 stories (91%) by males. Males, more than females, seem to aid the adoption of innovations.

5.10 Discussion

Based on an analysis of the data obtained from interviews, I uncovered three processes by which individuals were influenced to adopt innovations, i.e. Conscious Quest, Requisite Compliance, and Piloted Trial, and three processes by which individuals influence others to adopt innovations, i.e. Directed Assistance, Logical Persuasion, and Queried Disclosure. The three adoption processes and the three influence processes were inherently distinctive and worked in very different ways.

5.10.1 Adoption Processes

Table 28 presents an overview of the three adoption processes identified from the interview data. Of the three adoption processes, Conscious Quest and Requisite Compliance were typically seen in mandatory use contexts whereas Piloted Trial was prevalent in voluntary use contexts. Requisite Compliance was reported more by managers or executives whereas Piloted Trial was reported more by employees; Conscious Quest was distributed evenly between the managers or executives and employees. Conscious Quest and Requisite Compliance were associated more with the business process applications whereas Piloted Trial was seen more with office or productivity tools. Conscious Quest and Piloted Trial were explained more by females while Requisite Compliance was reported more by males.

At first glance, it would seem that the three processes have some commonalities. For instance, "experimentation" was seen in all three processes; and "awareness," "training," and "partial adoption" were seen in two of the three processes. However, the three adoption processes were considerably different in the ways in which the actions coalesced over time to drive innovation adoption. Based on the length of the ideal sequences, Piloted Trial seemed to be a somewhat longer process when compared to the other two processes. Further, Piloted Trial was much of an adopter-driven process than Conscious Quest and Requisite

Compliance[14]. That is, the organization context and the influencer had a larger role in the Requisite Compliance and Conscious Quest processes respectively than Piloted Trial.

Dimension	Conscious Quest	Requisite Compliance	Piloted Trial
Typical process	Awareness → Training → Experimentation → Seeking assistance → Full adoption	Awareness → Mandate → Rational arguments → Training → Experimentation → Partial adoption	Being assertive → Demonstration → Inquiry → Experimentation → Inquiry → Experimentation → Partial adoption
Use context	Mandatory	Mandatory	Voluntary
User role	Any	Manager/Executive	Employee
Innovation type	Business process apps	Business process apps	Office or productivity tools
Gender	Female	Male	Female

Table 28. Overview of Adoption Processes

The Conscious Quest and Requisite Compliance processes were seen in mandatory contexts involving business process applications. And both processes began with an "awareness creation" action as well as contained the "training" and "experimentation" actions. Moreover, those three actions happened in the same temporal order in both processes albeit some interspersion with other actions. However, the two processes differed in important respects. For instance, "seeking assistance" was found in Conscious Quest but not in Requisite Compliance, while "mandate" and "rational arguments" were found in Requisite Compliance but not in Conscious Quest. Further, Conscious Quest resulted in "full adoption" whereas Requisite Compliance resulted in only "partial adoption."

It is possible to offer some reasons for the partial adoption of innovations at the end of the Requisite Compliance process. One reason was that individuals in organizations worked under time constraints such that they generally used only those features of the system they needed the most to accomplish any task.

> "I found the ones [features] I thought were useful and I use them. There may be others out there that are useful too. But you get to a point where you get too busy. It's like, "Yeah, this kind of does what I need it to do and I don't have time to figure out the rest of it." [Wanda]

Individuals also had to deal with upgrades to the system that, in all likelihood, introduced new system aspects that individuals had to deal with. In such a case, individuals would have

[14] An index can be used to determine the extent to which an adoption process was driven by the potential adopter, i.e. the index represents the extent to which the potential adopter had to take the initiative to adopt the innovation. The adopter-driven index is given by: (number of actions by potential adopter / total number of actions in the ideal sequence) * 100. The Piloted Trial process received an adopter-driven index score of 71.42% (= (5 actions by the potential adopter / 7 total actions in the ideal sequence) * 100). The same index for the Conscious Quest and Requisite Compliance processes were 60.00% (= 3 / 5 * 100) and 33.33% (= 2 / 6 * 100) respectively.

had to re-learn the new features, which most likely dealt with old functionality, rather than finding new features of the system.

> Some of them are upgraded to new releases, new pieces to get new functionality. And sometimes we know about them and sometimes we don't. Sometimes we open up the machine on Monday morning and have a completely different look to it, and we've lost functionality, we don't know why. [Hilda]

Partial adoption may also have been due to the negative attitudes of the individuals toward the system for different reasons. These reasons may be attributed to the system itself, such as the ease of using the system, or to what the system implied, such as issues related to control.

> It was, in my mind, the most distasteful thing I've ever experienced. It [the Travel Manager system] was awful to use. [Elizabeth]

> I didn't have any concerns about the actual system itself. I think I had concerns like, "I'm a salaried executive and you're wanting me to keep track of my time like I'm an hourly paid [employee]." [Jake]

In contrast, the full adoption of an innovation by individuals at the end of the Conscious Quest process may be explained by a different set of reasons. One possible reason is that the systems pretty much remained stable over time and individuals did not have to deal with changes or upgrades as they got used to the system.

> The more you learn, the more you know how to get in and out of things, but it's [Personal Manager's] basic structure has stayed the same. There's been no upgrade… What's there is there. It has its own little glitches… but no, since I've been here it's never changed. When you learn the system… you've learned it. [Melissa]

Individuals may also be in charge certain responsibilities such as providing technical support for executives that they necessarily had to have a very good understanding of the system and the knowledge to work with it.

> I had a team that was responsible for doing executive support and we wanted to know as much about this system [Travel Manager] as we could before the executive customers had to experience it. [Tim]

With some understanding of the reasons for partial adoption and full adoption, it becomes possible to appreciate the other differences in the two processes. For instance, both processes began with the "awareness creation" action and both processes contained the "training" action; however, the Requisite Compliance process contained two additional actions between awareness creation and training – specifically, "mandate" and "rational arguments" – that were not found in the Conscious Quest process. That is, individuals who reported the Requisite Compliance process, required both mandate and rational arguments

before they experienced training, unlike individuals who reported the Conscious Quest process.

In both processes, "training" was followed by "experimentation," i.e. individuals played around with the new system after they finished their basic training. However, the Conscious Quest process continued with "seeking assistance" and "full adoption" whereas the Requisite Compliance process ended with "partial adoption." Consistent with the particular needs and reactions of individuals in each process, those who reported Conscious Quest sought further assistance with the system and reached full adoption while those who reported Requisite Compliance did not take that additional step and stayed at partial adoption.

The remaining process, Piloted Trial, was typically seen in voluntary use contexts involving office or productivity tools. Unlike the other two adoption processes, Piloted Trial did not contain any contextual actions, i.e. there were no actions aimed at the entire organization; there was no awareness, or mandate, or training. Stated differently, Piloted Trial was a more localized process that generally began with the "being assertive" and "demonstration" actions. That is, individuals were typically not required to use these systems on their regular jobs but were directed to adopt such systems by another individual in their personal networks, who typically provided a "demonstration" or a "walk-through" of the system as well. And, unlike Conscious Quest but much like Requisite Compliance, Piloted Trial resulted in "partial adoption" as well.

Different reasons for "partial adoption" in the Piloted Trial process can be furthered as well. One of the several causes for partial adoption is the lack of time for working with and discovering more features of the system.

> If I had time to sit down with it [Microsoft Visio], you know with some down time, I think I could probably figure out most of the features. [Sue]

Individuals generally used the systems only on an as-needed basis. Thus, if individuals did not face particular needs or tasks or requirements, then there was a good chance that aspects of the system never got used.

> It was mostly need… When I needed to do something, I had to go figure out how to do it… So I never really set out to learn the system; I just did it on a as needed basis. [Tyler]

Further, personal dispositions of individuals played a role in partial adoption. Individuals who possessed more playfulness or innovativeness probably would have breached the stage of partial adoption and gone beyond.

> As a user, I am not the leading edge person who is going out and looking around what the product can completely do. I kind of learn through trial and error and then I am introduced to new features as people kind of make them available to me. [Keith]

Finally, it is entirely possible that individuals have access to other systems that they can access for accomplishing their regular tasks. In such a case, the new system would most likely be used for only those situations in which the old systems were insufficient.

> It [Stanford Chart] will do all kinds of charting… [However, Microsoft] Excel does charting very well also. I know how to use that [Stanford Chart for creating bubble charts] and use Excel for the other kinds. I go to this [Stanford Chart] for the bubble ones, because Excel makes it difficult to do a bubble [chart]. [Janet]

With these insights, it is possible to explicate what happens during the Piloted Trial process. Subsequent to the "being assertive" and "demonstration" actions, and before the "partial adoption" action, individuals engaged in "inquiry" and "experimentation" actions followed by "inquiry" and "experimentation" actions again. When compared to the other two processes, both of which contained "training," Piloted Trial did not. That is, the organization did not arrange training sessions, which is not surprising considering how this process began to unfold. Individuals, in the absence of training, performed the "inquiry" action to gather more information about the system. They then experimented some more with the system. However, they needed follow up inquiry and experimentation actions to continue their interactions with the system. Much like the Requisite Compliance process, these individuals never really moved beyond the "partial adoption" stage, due to the reasons outlined above.

5.10.2 Influence Processes

Table 27 presents an overview of the three influence processes identified from the interview data. Of the three influence processes, Directed Assistance and Queried Disclosure were typically seen in mandatory use contexts whereas Logical Persuasion was observed in voluntary use contexts.

Dimension	Directed Assistance	Logical Persuasion	Queried Disclosure
Typical process	Awareness → Mandate → Training → Expertise → Being assertive → Demonstration	Rational arguments → Coalition tactics → Rational arguments → Bargaining → Rational arguments → Demonstration → Expertise → Demonstration	Awareness → Training → Demonstration → Inquiry → Demonstration → Inquiry → Expertise
Use context	Mandatory	Voluntary	Mandatory
User role	Manager/ Executive	Manager/ Executive	Any
Innovation type	Business process apps	Business process apps	Business process apps
Gender	Male	Male	Female

Table 29. Overview of Influence Processes

Directed Assistance and Logical Persuasion were reported more by managers or executives while Queried Disclosure was distributed evenly between the managers or executives and employees. All three processes were associated more with the business process applications. Directed Assistance and Logical Persuasion were explained more by males while Queried Disclosure was reported more by females.

The Directed Assistance and Queried Disclosure processes were seen in mandatory contexts involving business process applications. And both processes began with an "awareness creation" action as well as contained the "training," "expertise," and "demonstration" actions. Moreover, these four actions were seen in the same temporal order in both processes although other actions were interspersed in between. However, the two processes differed in important respects. For instance, "mandate" and "being assertive" were found in Directed Assistance but not in Queried Disclosure, while "inquiry" was found in Queried Disclosure but not in Directed Assistance. Also, "expertise" followed "training" in Directed Assistance while "demonstration" and "expertise" followed "training" in Queried Disclosure.

It would seem that the three processes have some commonalities. For instance, "expertise" and "demonstration" were seen in all three processes; and "awareness" and "training" were seen in two of the three processes. However, the three influence processes were very different in how the actions combined over time to drive innovation influence. The lengths of the ideal sequences revealed that Logical Persuasion was a somewhat longer process than the other two processes. Further, Logical Persuasion was much of an adopter-driven process than Directed Assistance or Queried Disclosure[15]. That is, the organization context and the adopter had larger roles in the Directed Assistance and Queried Disclosure processes than in the Logical Persuasion process.

The incidence of "demonstration" after "training" in Queried Disclosure may be attributed to different reasons. One possible reason is the lack of "mandate" – which was contained in Directed Assistance. Since there was no organizational mandate, individuals had to employ other actions to influence someone else to adopt the system. In addition, influencers may have been tasked with the responsibility of providing a demonstration or walk-through of the system to other individuals.

> [I] basically show them how to open it and the basic stuff, how to get to it and then how to type in the information and what needs to be typed in. [Melissa]

Sometimes influencers were placed in a "mentoring" relationship with other individuals, i.e. potential adopters, which required that they provide a walk-through of the system for the benefit of the potential adopters.

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[15] An index may be used to determine the extent to which an influence process was driven by the influencer, i.e. the index represents the extent to which the influencer had to be involved in having other individuals adopt the innovation. The influencer-driven index is given by: (number of actions by influencer / total number of actions in the ideal sequence) * 100. The Logical Persuasion process received an influencer-driven index score of 100.00% (= (8 actions by the influencer / 8 total actions in the ideal sequence) * 100). The Directed Assistance and Queried Disclosure processes had an influencer-driven index of 50.00% (= 3 / 6 * 100) and 42.85% (= 3 / 7 * 100) respectively.

> Usually you're assigned someone. A leader would say, "Katelin, you're going to be training Dawn on this… product" or whatever, and whoever gets there first is probably going to end up showing the most functionality when it comes to the systems. [Katelin]

Lastly, individuals may delegate some of their system use requirements to others, typically their assistants or direct reports. Since these other individuals are not necessarily required to use the systems, the influencers may provide a demonstration of the system to them.

> I would perhaps bring my secretary in here or I would sit at her desk with her and I would walk her through the program and show her how to use it… … If I give an assignment to retrieve point-of-sales data from a particular store or a group of stores, they obviously need to know how to do it. [Brian]

Subsequently in the Queried Disclosure process, the influencers performed specific actions based on actions enacted by the adopters. As can be determined from the actions that comprise the three processes, Queried Disclosure is somewhat more adopter-driven (28.57% = 2 / 7 * 100) than the other two processes (0.00% and 0.00% respectively). That is, influencers generally did not undertake much initiative in Queried Disclosure process compared to the other two processes. The adopter-driven nature of Queried Disclosure may be understood in light of their need to use the system now based on the request of the influencer.

The incidence of the "being assertive" action in Directed Assistance can be explained as well. In general, once a mandate had been issued at the organizational level for the use of a particular system, it was really up to the various managers to enforce the mandate.

> I think they sent out an email that it [Task Tracker] was going to be available on this date, when training was, and once it was available, [it was] up to the manager to make sure that everyone had started using it. [Neil]

Influencers also were assertive when they found that individuals were not really using the system and when they felt that the other individuals needed some prompting before they will use the system.

> I would initiate by, "Why haven't you done this? It's due on this date." And then I would get emails back like you can imagine, "Well, if you can come and show me how to make it happen, you're more than welcome to." [Veronica]

Probably due to these reasons, the Directed Assistance process is more influencer-driven than the Queried Disclosure process also seen in similar contexts. Between Directed Assistance and Queried Disclosure, the onus to ensure adoption is certainly on the influencer in Directed Assistance but not as much in Queried Disclosure. In Queried Disclosure, the influencers can afford to design their actions on the actions of the adopter.

The remaining process, Logical Persuasion, was generally observed in the voluntary use contexts involving business process applications. Unlike the other two influence processes, Logical Persuasion did not contain any contextual actions, i.e. there were no actions aimed at the entire organization; there was no awareness, or mandate, or training. Stated differently, Logical Persuasion was a more localized process which generally began with the "rational arguments" action. That is, individuals were typically not required to use these systems on their regular jobs but were "persuaded" to adopt such systems by influencers in their personal networks.

The uniqueness of the Logical Persuasion process may be attributed to different reasons. The influencers, generally in their roles as adopters, had already experienced the system to be able to recognize some of its potential impacts were much more enthusiastic about it and probably wanted others to benefit from the system as well.

> It [the Barcode system] would be a benefit to us and it would improve our organization and that it would [provide] better control of the assets and we would be able to charge the departments for what [products or materials] they take… so that it links back to the budget [and] they would be able to control the costs better. [Robert]

Alternatively, the influencers appreciated the extent to which the system provided benefits for their selves as well as for their teams.

> Every week I have to show what we worked on and if we need help I can go with hard facts and say, "Look, here's all our hours, here's where we are spending them, and you want this done, 'Well, I need another person to help us.'"… With the old way… I had no facts to back that up. [Wanda]

Another element related to new ways of doing things or more efficiently managing tasks and activities. Influencers believed that the new system would be more effective and efficient to accomplish their everyday operations.

> When I came to the department they were running multiple attempts of this: three of four different software systems to try and get at this and it just wasn't working… … I started talking about "contact management" as opposed to "task management." … I could clearly see that [Microsoft] Outlook had these capabilities, and from there, there was a sort of skunk works project. [Brad]

With these insights, the Logical Persuasion process can be explicated. Initially, the influencers, for various reasons, realized the importance of the new systems, and attempted to have others adopt the system as well by presenting rational arguments. However, since the systems were not exactly required to be used, potential adopters may not have been overly enthusiastic. The influencers then engaged in a series of actions with intents to overcome pre-adoption or anxieties such that the long-term benefits can be realized. Such actions included "coalition tactics," "bargaining," "demonstration," and "expertise" – all of which would generally work to ease the concerns of potential adopters. Influencers

repeatedly employed the "rational arguments" to bring home the advantages of using the innovation as they employed the other actions.

5.11 Limitations

The findings should be interpreted in light of the limitations of the research, from company access to data collection.

Single point of reference. First, the organizations that served as research sites were selected from a single point of reference, i.e. their representation on the advisory board of the information systems department. It is conceivable that the individuals representing these organizations participated on the advisory board because of their emphasis or their realization of the importance of information systems on the everyday operations of their organizations. Thus, the research findings can be considered more reflective of organizations that are pro-active in their approach to information systems. However, this particular bias was somewhat mitigated by the fact that the individuals on the advisory board served as "sponsors" (i.e. they referred me to other individuals within their organizations) rather than as "participants." Thus, the participants need not necessarily share the same opinions or beliefs as the sponsors.

Retrospective accounts. The research relied on retrospective accounts of the adoption and influence stories recounted by the participants. Moreover, the individuals reported their perceptions of the innovation adoption and influence processes. Finally, the adoption and influence stories were gathered from a single interview with each participant. Thus, retrospective accounts are based almost entirely on perceptions and may suffer from recall bias (Collopy 1996). Consequently, the findings of the study are dependent on the extent to which the participants were able to accurately explicate their experiences related to adoption and influence. As the researcher, I took some precautions to somewhat mitigate these potential biases in data collection. I allowed the participants to tell their stories in their own words, with minimal interruptions to maintain the storyline, and with appropriate probes to obtain richer descriptions.

Social desirability bias. The research may have suffered from bias associated to considerations by participants for social desirability (Collopy 1996). The interviews allowed the participants to recount "stories" of their adoption and influence behaviors related to IS/IT innovations. It is quite possible that the participants consciously excluded descriptions of their experiences that may have negative connotations or be perceived as negative by other individuals (such as the researcher). For instance, three of the influencer actions were not reported by participants: "appealing to higher authority," "acting in a clandestine manner," and "using friendliness and ingratiation." Further, "applying sanctions" was reported only once across all interviews. While it may be that these actions were not employed for adoption or influence, nevertheless, the findings should be interpreted with caution.

Linear sequencing of actions. The optimal matching analysis employed in the research requires a linear arrangement of the actions in a sequence. The linear arrangement of actions may not entirely capture the variety of actions experienced by individuals. For instance, it is

quite possible that individuals are subject to multiple actions at the same time; the multiple actions then signify concurrent actions. Thus, an individual may experience an action from an influencer (say, rational arguments, I5) and an action from the context (say, awareness creation, C1) at the same time. For the optimal matching algorithm to work, the two actions would have been coded as C1, I5 or I5, C1, neither of which may be entirely accurate. Further, there is always the possibility of an error in identifying the sequence despite best efforts. However, optimal matching methods are found to be robust to such perturbations in the action sequences (Abbot and Tsay 2000; Forrest and Abbot 1990).

6 Network-Level Analysis of Diffusion and Assimilation

Everything is connected… not one thing can change by itself.
Paul Hawken

To address the research questions set forth in Chapter 1, I developed a theoretical model involving the factors that are expected to influence the diffusion and assimilation of IS/IT innovations at the network level. This chapter describes the propositions and hypotheses that will be examined in this research.

6.1 Broad Theoretical Model

The network-level analysis is based on the broad theoretical model shown in Figure 22. The dependent construct in the model is **Diffusion and Assimilation of IS/IT innovations**. Diffusion describes the spread of the innovation to all individuals in a network or organization (Rogers 1995). The feature-centric view of this research implies that diffusion is understood in terms of the acceptance and use of the *first* feature of the innovation by individuals in the network or organization. Assimilation refers to the acceptance and use of multiple features of the innovation by individuals in a network (Fichman and Kemerer 1997). This is also consistent with the feature-centric view undertaken in this research.

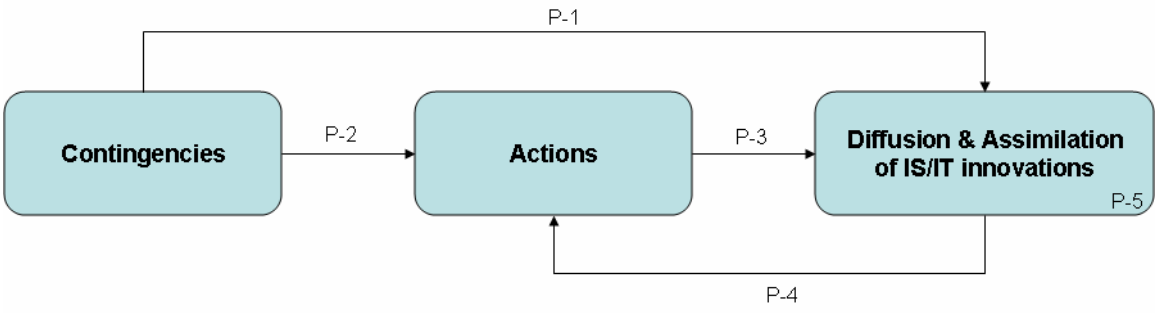

Figure 22. Broad Theoretical Model

Contingencies represent those aspects of the organizational context that directly or indirectly impact the Diffusion and Assimilation of IS/IT innovations. This is consistent with prior literature which has found support for organizational factors such as centralization and top management support on the adoption of innovations (Rogers 1995; Sultan and Chan 2000). The absence of these innovation-supportive conditions may even be detrimental to the diffusion and assimilation of IS/IT innovations. Thus, the contingencies are expected to affect the Diffusion and Assimilation of IS/IT innovations in organizations. Therefore,

P-1:
Contingencies affect the Diffusion and Assimilation of IS/IT innovations within the network

Actions represent contextual actions, influencer actions, and adopter actions performed by different stakeholders within the organization. All three types of actions are enacted within the larger organizational context in which the individuals are situated. Therefore, stakeholders performing these actions are likely to be influenced by the unique characteristics of the context. This is consistent with prior literature that discusses how elements of the larger context such as organizational culture determine individual behavior (Sultan and Chan 2000). Thus, contingencies are expected to affect the actions employed by stakeholders. Therefore,

P-2:
Contingencies affect the Actions employed by individuals within the network with regard to IS/IT innovations

The three types of actions, while different, serve similar purposes. Adopter actions reflect the individual's own actions related to a feature prior to adopting it. The contextual actions are organization-wide actions aimed at all individuals and carried out by, or representatives of, the top management. On the other hand, influencer actions and adopter actions are directed at an individual or a handful of individuals by other individuals in the organization. These actions enable individuals within the organization to know about, learn, and use features of the IS/IT innovations. Moreover, in the absence of such actions, individuals may not even know about the IS/IT innovations. This is consistent with prior literature which demonstrates the importance of facilitating conditions, help desks, training sessions, etc. for adoption (Jasperson et al. 2005; Venkatesh et al. 2003). Thus, all three types of actions are expected to impact Diffusion and Assimilation of IS/IT innovations. Therefore,

P-3:
Actions affect the Diffusion and Assimilation of IS/IT innovations within the network

Whereas the above proposition concerns the impact of Actions on Diffusion and Assimilation of IS/IT innovations, the following proposition deals with the impact of Diffusion and Assimilation of IS/IT innovations on Actions. While contextual actions are not directly dependent on the individuals in the network, the influencer and adopter actions are performed by individuals. More specifically, individuals can engage in influencer actions only when they have already adopted a feature, and they engage in adopter actions for a feature only when they have not already adopted it. Therefore,

P-4:
Diffusion and Assimilation of IS/IT innovations affect Actions (Influencer and Adopter actions) within the network

Diffusion and Assimilation themselves are related to each other. Whereas diffusion deals with the adoption of the first feature, assimilation deals with the adoption of the remaining features of the innovation. However, adoption of the remaining features is possible only when the first feature has been adopted. More fundamentally, an innovation should have diffused through the network to an individual before assimilation is possible. Therefore,

> P-5:
> Diffusion of IS/IT innovations affects the Assimilation of IS/IT innovations within the network

6.2 Detailed Research Model

Figure 23 presents the detailed research model for analysis at the level of the network. The dependent construct is represented by two variables: level of diffusion and level of assimilation. The actions construct includes three variables: contextual actions, influencer actions, and adopter actions. The contingencies are represented by organization structure, cultural orientation, top management support for IS, sourcing of IS solution, network density, network centralization, network strength, innovativeness, and expertise. The control variables in the model include network size, innovation size, and two simulation conditions: feature vs. innovation centric view and contingency or history view (explained in detail in Section 6.2.3).

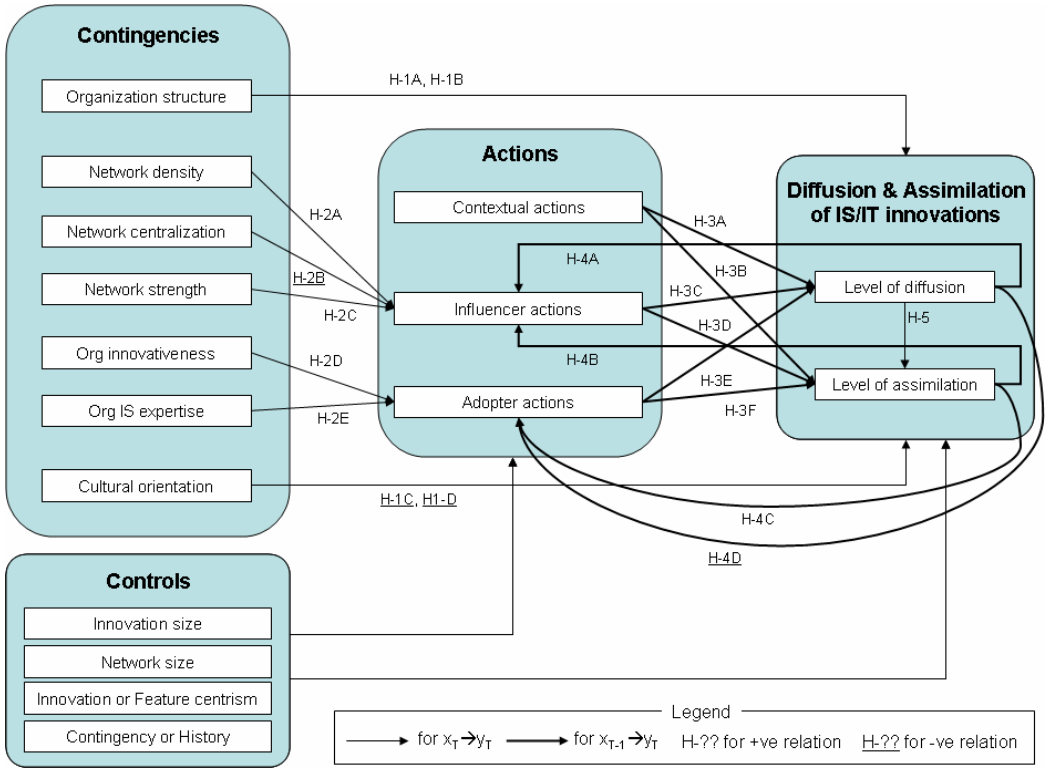

Figure 23. Detailed Research Model

6.2.1 Dependent Variables

Two dependent variables were employed in this research to describe the diffusion and assimilation of IS/IT innovations within the network. These are level of diffusion and level of assimilation. At any point in time, the **level of diffusion** within the network refers to the proportion of the individuals in a network who have adopted the first feature of the innovation by that time. At any point in time, the **level of assimilation** within the network describes the proportion of the total number of available features that have been adopted by all adopters in the network by that time.

Three mediating variables, mediating the relationship between contingencies and diffusion and assimilation of IS/IT innovations, were employed in this research. These are contextual actions, influencer actions, and adopter actions. At any point in time, the three actions represent all relevant actions within the entire network. Moreover, **contextual actions** and **adopter actions** at the network level relate to contextual actions and adopter actions respectively experienced by individuals in the network. On the other hand, **influencer actions** at the network level describe the influencer actions realized through the ties in the network.

6.2.2 Independent Variables

The research model includes seven independent variables, which impact the dependent and mediating variables. **Organization structure** refers to the distribution of the decision-making authority between the top and other levels of the organization hierarchy. **Cultural orientation** represents the extent to which members of the network are expected to exhibit individualistic rather than collectivistic behaviors. **Network density** represents the overall number of ties shared by individuals within a network. **Network centralization** represents the extent to which the ties are evenly or unevenly distributed among members of a network. **Network strength** represents the extent to which the ties shared by individuals in the network may be characterized as weak or strong. **Organizational innovativeness** describes the extent to which individuals within the network are receptive to innovations and which translates into how early individuals would adopt those innovations. **Organizational IS expertise** represents the extent to which individuals within the network possess the skills and knowledge to deal with IS/IT innovations.

6.2.3 Control Variables

Several control variables are included in the model to account for influences that are not hypothesized but may nevertheless impact the dependent and mediating variables. **Network size** refers to the number of individuals in the network. **Innovation size** describes the number of features of the innovation. Two other variables included as controls are the feature vs. innovation centric view and the contingency vs. history view. The **feature vs. innovation centric** variable captures the differences in individuals' consideration of the action histories: specifically, whether individuals consider the action history of the feature being considered or the action histories of all features. The **contingency vs. history** variable captures the differences in the information used to determine actions: specifically,

whether the information is based only on contingencies or only on histories from field interviews.

6.2.4 Hypotheses

The hypotheses examined in this research are presented below in the same order as the propositions presented above (from P-1 through P-5).

P-1: Effects of Contingencies on Diffusion and Assimilation

Organization structure refers to the distribution of the decision-making authority between the top and other levels of the organization hierarchy (Rogers 1995). In centralized structures, decision-making is typically accomplished in the upper levels of the hierarchy, whereas in decentralized structures, decision-making may be relegated to the lower levels of the organization hierarchy as well.

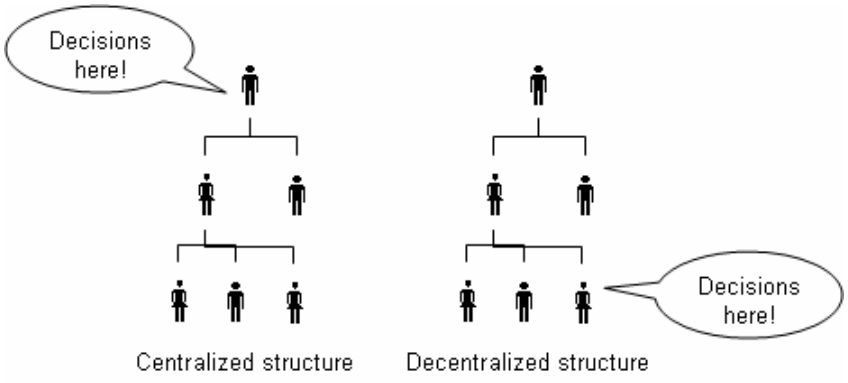

Figure 24. Centralized vs. Decentralized Structures

Organization structure may be viewed as a continuum ranging from completely decentralized to completely centralized structures. In centralized structures, decisions made at the top levels of the hierarchy are communicated to the lower levels of the hierarchy. Stated differently, individuals may not have much control over decisions regarding adoption of innovations. In decentralized structures, however, individuals have greater autonomy over the decisions and have the flexibility to determine their responses to innovations. This is consistent with accounts of mandatory and captive use of IS/IT innovations by individuals (Adams et al. 1992; Davis 1989). Thus, at any given point in time during the innovation adoption process, individuals in centralized structures are more likely to adopt the first feature or subsequent features of the IS/IT innovation as compared to their counterparts in decentralized structures. Therefore,

> H-1A:
> Organization structure (centralization) is positively related to level of diffusion within the network.

H-1B:
Organization structure (centralization) is positively related to level of assimilation within the network.

Cultural orientation represents the extent to which members of the network are expected to exhibit individualistic rather than collectivistic behaviors (Hofstede 1983). Individualistic cultures allow more freedom to individuals to set their own directions and behaviors. Collectivistic cultures, on the other hand, expect the individuals to be more receptive to the larger collective to which they belong and deal with the collective needs.

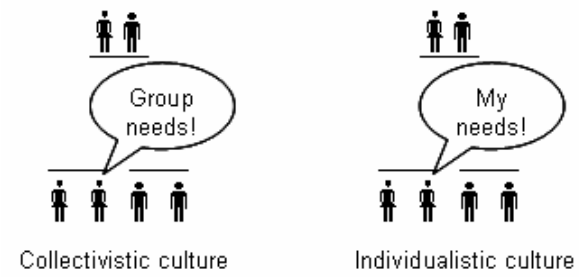

Figure 25. Collectivistic vs. Individualistic Cultures

Cultural orientation may be viewed as a continuum from completely collectivistic to completely individualistic. In individualistic cultures, individuals generally pursue their own interests and determine their own behavior. In such situations, individual characteristics or differences are more likely to be the influential factors in individual decisions regarding adoption of IS/IT innovations (Agarwal 2000). However, in collectivistic cultures, individuals are sympathetic to the needs of the larger group to which they belong. This is consistent with prior literature that argues for the importance of subjective norms in the adoption of IS/IT innovations (Ajzen 1991; Moore and Benbasat 1991). Moreover, individuals in organizations with collectivistic culture would give importance to their co-workers in deciding their own responses to IS/IT innovations (Agarwal 2000; Schmitz and Fulk 1991). Thus, at any given point in time during innovation diffusion and assimilation, individuals in collectivistic cultures are more likely to have adopted the first feature as well as subsequent features of the IS/IT innovation than individuals in individualistic cultures. Therefore,

H-1C:
Cultural orientation (individualistic) is negatively related to level of diffusion within the network.

H-1D:
Cultural orientation (individualistic) is negatively related to level of assimilation within the network.

P-2: Effects of Contingencies on Actions

Network density describes the extent to which ties between individuals are prevalent within a network (Kilduff and Tsai 2003; Valente 1995). Sparse networks possess a lower number of ties and at worst can be a network of isolates (i.e. individuals who do not share ties with others). Dense networks contain relatively large number of ties and at best can be a network of fully-connected individuals (i.e. individuals who are connected to everyone else in the network).

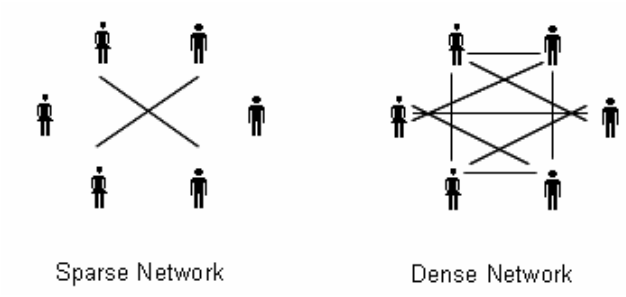

Figure 26. Sparse vs. Dense Networks

In sparse networks, where the number of ties is relatively lower, only a few individuals are connected to others (Rogers 1995). On the other hand, in dense networks, the number of ties is relatively higher, and therefore many individuals are connected to others (Rogers 1995). Moreover, even the individuals who are connected to others are likely to be connected to fewer individuals in sparse networks as compared to dense networks. Consequently, dense networks provide greater avenues for the occurrence of influencer actions, as compared to sparse networks. Thus, network density is likely to impact the influencer actions within the network. Therefore,

> H-2A:
> Network density is positively related to influencer actions within the network.

Network centralization represents the extent to which the ties are disproportionately distributed across individuals in the network (Brass 1995; Kilduff and Tsai 2003; Wasserman and Faust 1994). In centralized networks, for instance, one or two individuals are connected to a large number of other individuals whereas in decentralized networks, the ties are almost evenly distributed across all individuals in the network.

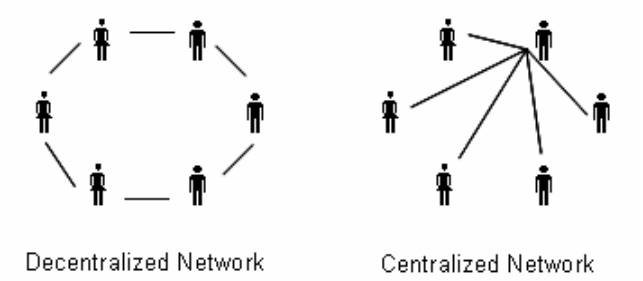

Figure 27. Decentralized vs. Centralized Network

In centralized networks, the central individuals can communicate with several individuals whereas the peripheral individuals can communicate only with the central individuals. Consequently, the central individuals, and not others, become the conduits of knowledge for other individuals in the network (Sparrowe et al. 2001). In decentralized networks, however, each individual can interact with a number of other individuals, and consequently, gain knowledge from multiple sources. There is a greater potential for individuals to gain new information more frequently in decentralized networks. Thus, network centralization is likely to impact the influencer actions within the network. Therefore,

> H-2B:
> Network centralization is negatively related to influencer actions within the network.

Network strength refers to the extent to which ties among individuals in a network are strong or weak. Strength of ties have been defined in terms of the frequency of contact or interaction between individual sharing the ties (Granovetter 1973; Nelson 1989). Strong ties are typically shared by individuals who interact frequently, and have similar interests and behavior (Burt 1997; Krackhardt 1992). Weak ties, on the other hand, are shared between individuals who interact infrequently, and possess different interests and behavior (Granovetter 1973; Hansen 1999). Strong networks contain a larger proportion of strong ties relative to the total number of ties whereas weak networks possess a larger proportion of weak ties.

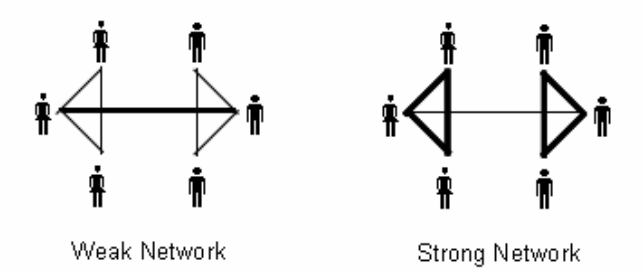

Figure 28. Weak vs. Strong Network

Both strong ties and weak ties are useful in propagating the innovation. Since individuals sharing strong-tie relationships have similar interests and behavior, they are likely to end up with similar knowledge bases (Burt 1997). Therefore, in cases where individuals sharing a

strong-tie relationship do not exhibit similar knowledge bases, corrective interventions would take place. That is, the individual with the new knowledge will share it with his or her partner (who does not possess the new knowledge). Individuals sharing weak-tie relationships have dissimilar interests, which results in new knowledge being transmitted between the individuals (Granovetter 1973). However, the speeds at which such knowledge sharing takes place differs between strong and weak ties. Individuals in strong-tie relationships interact frequently with each other whereas individuals in weak-tie relationships interact infrequently (Granovetter 1973; Hansen 1999). Hence, individuals in strong-tie relationships are more likely to model their self behaviors earlier in time compared to individuals in weak-tie relationships. Thus, network strength is likely to impact the influencer actions within the network. Therefore,

> H-2C:
> Network strength is positively related to influencer actions within the network.

Organizational innovativeness describes the extent to which individuals within the network are receptive to innovations (Agarwal and Prasad 1998; Rogers 1995). Individuals who exhibit innovativeness are more likely to engage in exploring and experimenting with the IS/IT innovations. Within a network, multiple individuals may exhibit innovativeness resulting in behaviors related to exploration and experimentation with the innovation. Consequently, at the network level, the collective innovativeness of all individuals in the network would impact adopter actions within the network. Therefore,

> H-2D:
> Organizational innovativeness is positively related to adopter actions within the network.

Organizational IS expertise represents the extent to which individuals within the network possess the skills and knowledge to deal with IS/IT innovations (Igbaria 1990). IS expertise may be accumulated by individuals in the network over time based on prior experience with similar or other IS/IT innovations, training programs, seminars, etc. (Gatian 1994; Igbaria et al. 1996). Individuals with expertise in IS/IT innovations are more likely to explore the new IS/IT innovation and experiment with the features available. At the network level, the collective expertise of the individuals would impact adopter actions within the network. Therefore,

> H-2E:
> Organizational IS expertise is positively related to adopter actions within the network.

P-3: Effects of Actions on Diffusion and Assimilation

Contextual, influencer, and adopter actions are expected to impact diffusion and assimilation within the network. All three types of actions, in their own unique ways, contribute to the

understanding regarding IS/IT innovations gained by individuals. Collectively, these actions enable the individuals to become aware of the innovation, understand organizational goals regarding the innovation, learn the various features of the innovation, understand the usefulness of the innovation, and make efficient and effective use of the innovation. Thus, all three types of actions would impact the diffusion and assimilation of IS/IT innovations.

Contextual actions represent those actions carried out by the organization and which are aimed at all members of the organization. These include such actions as awareness creation, issuing a mandate, and training that may signal to the individuals the intent of the organization for its members regarding the IS/IT innovation (Davis 1989; Jasperson et al. 2005; Rogers 1995). Contextual actions can influence both the diffusion and assimilation processes. For instance, an action such as awareness creation would allow the individuals in the network to learn about the innovation whereas an action such as training would also introduce different features of the innovation to individuals in the network. Consequently, individuals in the network may be expected to gain knowledge about not only the first feature but also additional features of the innovation. Moreover, contextual actions may be experienced during each time period. However, their impacts on diffusion and assimilation are expected to be lagged by at least one time period to allow for the action to impact behavior of individuals. Therefore,

> H-3A:
> Contextual actions in the previous time period is positively related to level of diffusion of IS/IT innovations at the current time period within the network.

> H-3B:
> Contextual actions in the previous time period is positively related to level of assimilation of IS/IT innovations at the current time period within the network.

Influencer actions refer to those actions performed by individuals and targeted at one individual or a small group of individuals within the network. These include actions such as rational arguments, bargaining, assertiveness, and sanctions (Kipnis et al. 1980; Yukl et al. 1995) that inform the other individuals about the IS/IT innovations, the importance of adopting its features, the usefulness of the innovation, etc. Influencer actions are consistent with championing and disseminating information via broadcasts, presentations, demonstrations, etc. (Howell and Higgins 1990; Rogers 1995)and allow individuals in the network to learn about the innovation as well as its features. Thus, influencer actions can be influential in both diffusion and assimilation of IS/IT innovations with a network. Moreover, influencer actions may be experienced during each time period. But their impacts on diffusion and assimilation are expected to be lagged by at least one time period to allow for the action to impact behavior of individuals. Therefore,

> H-3C:
> Influencer actions in the previous time period is positively related to level of diffusion of IS/IT innovations at the current time period within the network.

H-3D:
Influencer actions in the previous time period is positively related to level of assimilation of IS/IT innovations at the current time period within the network.

Adopter actions are those actions carried out by the individuals themselves in adopting IS/IT innovations. These include such actions as review, observation, and inquiry that enable the individuals to learn more about the innovation (Jasperson et al. 2005; Nilakanta and Scamell 1990). Adopter actions are generally consistent with exploration and experimentation of IS/IT innovations (Rogers 1995). Thus, adopter actions would impact the diffusion and assimilation of IS/IT innovations within the network. Moreover, adopter actions may be experienced during each time period. Their impacts on diffusion and assimilation are expected to be lagged by at least one time period to allow for the actions to impact behavior of individuals. Therefore,

H-3E:
Adopter actions in the previous time period is positively related to level of diffusion of IS/IT innovations at the current time period within the network.

H-3F:
Adopter actions in the previous time period is positively related to level of assimilation of IS/IT innovations at the current time period within the network.

P-4: Effects of Diffusion and Assimilation on Actions

Actions are expected to share a reciprocal relationship with diffusion and assimilation of IS/IT innovations within the network. That is, both diffusion and assimilation are expected to influence Actions. However, the effects of diffusion and assimilation are likely only on influencer and adopter actions and not on contextual actions. This is because diffusion and assimilation inherently describe the adoption of one or more features of the innovation by individuals in the network (Fichman and Kemerer 1997; Rogers 1995) and not anything about the organizational context.

Diffusion describes the adoption of the first feature of an innovation by individuals within the network. Consequently, an increase in diffusion implies that more individuals in the network have adopted the first feature of the innovation. This leads to an increase in the number of individuals who would be able to introduce the innovation to other individuals in the network. This also implies that more individuals would be in a position to examine additional features of the innovation on their own. However, individuals who have adopted one of more features of the innovation in a time period can influence other individuals only during the subsequent time period. Therefore,

H-4A:
Level of diffusion of IS/IT innovations at the previous time period is positively related to influencer actions within the network during the current time period.

H-4B:
Level of diffusion of IS/IT innovations at the previous time period is positively related to adopter actions within the network during the current time period.

Similar explanations may be extended to assimilation of IS/IT innovations, but with one exception. An increase in the level of assimilation implies that more features have been adopted within the network. This may be attributed to features adopted by new adopters or to new features adopted by continuing adopters. Consequently, individuals are equipped to introduce a greater number of features to other individuals in the network (diffusion). However, as the number of features adopted increases, there is a decrease in the remaining number of features that are available for adoption in the network. Furthermore, individuals who have adopted one of more features of the innovation in a time period can influence other individuals only during the subsequent time period. Therefore,

H-4C:
Level of assimilation of IS/IT innovations at the previous time period is positively related to influencer actions within the network during the current time period

H-4D:
Level of assimilation of IS/IT innovations at the previous time period is negatively related to adopter actions within the network during the current time period.

P-5: Effects of Diffusion on Assimilation

The constructs of diffusion and assimilation themselves are expected to share a relationship with each other. Since both diffusion and assimilation deal with features, the former the first features and the latter the remaining features, it is conceivable that both constructs would share a relationship with each other. At the very basic level, an increase in diffusion means that more individuals have adopted their first features, which would automatically signal an increase in the level of assimilation within the network. But even more importantly, the new adopters in the network are now free to explore the innovation and experiment with additional features of the innovation. Further, individuals adopting the first feature in any time period are more likely to adopt other features in later time periods. Therefore,

H-5:
Level of diffusion at the previous time period is positively related to assimilation of IS/IT innovations within the network during the current time period.

6.3 Agent-based Simulation

I employed an agent-based simulation (Gilbert and Troitzsch 2005; Macy and Willer 2002), which is a specific family of simulation techniques, to model the behavior of individuals within networks with regard to the adoption of innovations. Agent-based simulations enable the simultaneous modeling of all individuals within a network, and at the same time enable the combined effects of the individual behaviors at the level of the network. In agent-based simulation, each individual of a social network is viewed as an agent with certain attributes (e.g. IS expertise) and behaviors (e.g. performing an influencer or adopter action). The attribute values for the agents are randomly generated at the beginning of the simulation. The behaviors of the agents are typically specified once and extended to all agents in the simulation. The stochastic nature of the behaviors specified for individuals ensures that the agents in the simulation do not have identical behaviors. Thus, the agents in the simulation are indicative, even if not completely representative, of individuals in real-world networks.

Simulation, including agent-based simulation, allows for phenomena to be examined over time under a series of different parameters representing varying conditions (Law and Kelton 1982; Sastry 1997). Space and time may be compressed in a simulation, as a result of which the long-term effects and implications may be determined in the short-term. Simulation even enables the discovery of not-so-obvious relationships and implications (Repenning 2002). Simulation is particularly useful in situations where the time and resources required to longitudinally examine phenomena in "real-world" settings are prohibitive. The agent-based simulation is an appropriate technique for this research due to several reasons. First, innovation adoption and diffusion processes are multi-level in nature, with some actions occurring in the context, responses and most other actions at the individual level, and the diffusion and assimilation being viewed at the network level. Agent-based simulation enables modeling behaviors and responses at the individual level and testing hypotheses developed at the network level. Second, the agent-based simulation allows examining the evolution of diffusion and assimilation processes at the required level of complexity, wherein the innovation has multiple features and numerous individuals consider and influence the adoption of each specific feature. Third, the agent-based simulation enables examining diffusion and assimilation processes under a variety of contextual and individual circumstances, while also varying the extent to which the effects of actions decay with time. Moreover, the examination of the research model would benefit from a sensitivity analysis that allows findings from the field interviews to be incorporated into the simulation along with other conditions. Agent-based simulation provides an opportunity to address these requirements as well. Finally, and perhaps most importantly, the costs of conducting a longitudinal study of the adoption and assimilation of a multi-feature innovation by multiple individuals in several networks in real-world settings may be prohibitive. The agent-based simulation model for individual behavior and its various components are explained in the following subsections.

6.3.1 Agent-based Modeling

I developed an agent-based simulation model to reproduce behavior of individuals, as both influencing others and considering features for own adoption, as portrayed in the conceptual

model shown in Figure 1. The model was constructed based on insights I gained from the field interviews, from which I obtained stories of both adoption and influence from different individuals, and the cumulative knowledge from the prior literatures on technology adoption, innovation diffusion, social networks, and influence tactics. To mimic actual organizational settings (i.e. one organization can contain multiple individuals), the simulation was carried out at the organization level, using insights from the field interviews conducted at the individual level. That is, the behavior of each individual is modeled based on findings from the field interviews; however, simulation at the network level allows the diffusion and assimilation of innovations to be examined across the entire network.

I allowed the agents to perform both the adopter and influencer role. The agents were programmed for adoption and influence behaviors based on the model specifications explained below. Although the specifications are common to all agents, individual behaviors would vary due to the stochastic nature of the simulation model. The specific behaviors of the individuals were specified to be consistent with the various behaviors depicted in the conceptual model (Figure 1): adopter response, contextual actions, influencer actions, and adopter (pre-adoption) actions. However, the agent-based model does incorporate the following changes. First, the conceptual model is implemented using a feature-centric approach (Jasperson et al. 2005), i.e. the contextual, influencer, and adopters actions as well as the adopter responses are tracked for each feature of the innovation. This allows for the different processes that individuals may have employed in adopting different features. Consequently, the adopter response component had only two actions: adoption and non-adoption. Second, *a priori* actions depicted in the conceptual model were included in the simulation model only if such actions were reported at least three times in the field interviews with individuals in real-world organizations. Two contextual actions (withdrawal of mandate for use and changes in personnel) and three influencer actions (appealing to a higher authority, acting in a clandestine manner, and using friendliness and ingratiation) did not meet this requirement and were excluded from the simulation model. Finally, the emergent actions from the field interviews were included in the simulation model only if such actions were reported at least five times by the interview participants. Two adopter actions (favorable response and unfavorable response) were not included whereas three influencer actions (expertise, demonstration, and knowledge sharing) were included in the simulation model.

The overall model for simulating the behaviors of individuals in social networks is shown in Figure 29. The overall simulation model contains four major components: adopter response, contextual actions, influencer actions, and adopter actions. Mathematical models were developed for each of the four components based on theory from prior literature as well as empirical findings from the field interviews. The collection of all such mathematical models formed the complete specification for the simulation of behaviors related to adoption and influence by individuals. The four components, including the mathematical models, are explained in the subsections below.

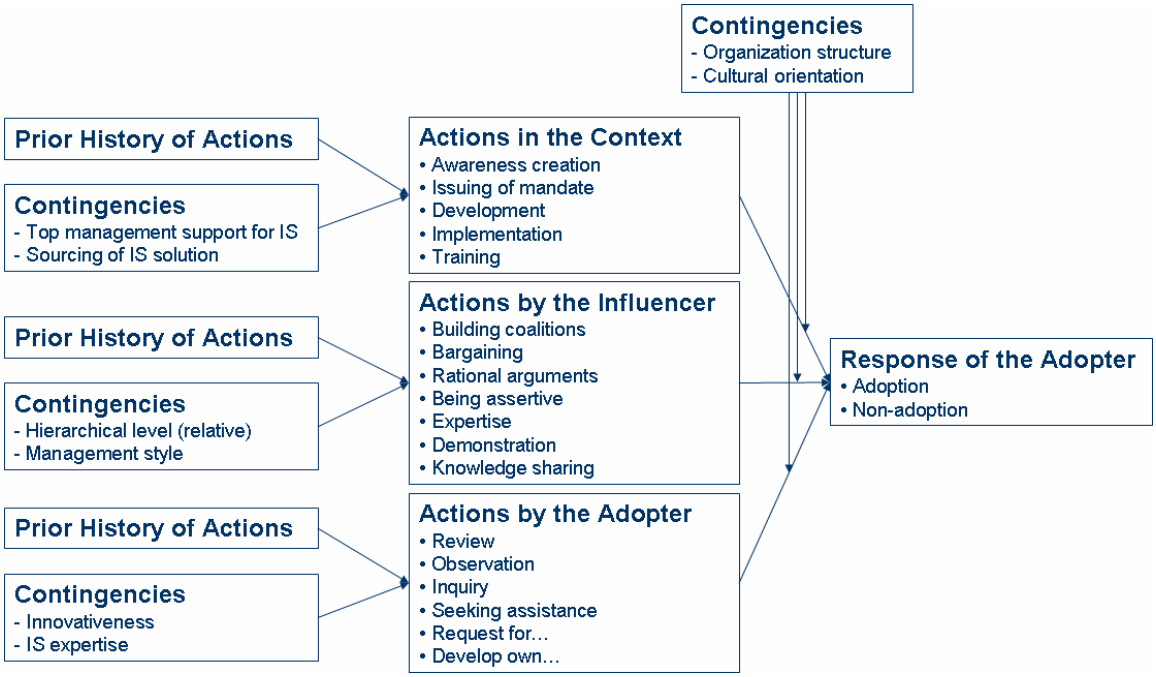

Figure 29. Composite (Adopter Response & Action Selection) Simulation Model

Adopter Response Model

The basic phenomenon underlying the diffusion of innovations within a social network is the adoption of innovations by the individual members of the network. An individual's response behavior (i.e. adoption or non-adoption) may be modeled as a response to the three influences (contextual actions, influencer actions, and adopter actions) experienced by the individual prior to the current time period *T*. This is true for all features of the innovation that have not yet been adopted (F^*) by the individual. The adoption response (i.e. the outcome) exhibited by the adopter, for any feature *F*, $F \in F^*$, at time *T*, is given by:

$$p(ADOPTION_F)_T = \alpha_C(CONTEXT_T) + \alpha_I(INFLUENCER_T) + \alpha_A(ADOPTER_T) \quad \ldots 1$$

α_C, α_I, and α_A are the levels of importance the adopter assigns to the contextual actions, influencer actions, and adopter actions, respectively, and are subject to the following constraints.

$$\alpha_C, \alpha_I, \alpha_A \geq 0 \quad \ldots 2$$

$$\alpha_C + \alpha_I + \alpha_A = 1 \quad \ldots 3$$

The level of importance associated to the three influences by the adopter may be attributed to two conditions: a) organization structure and b) cultural orientation. **Organization structure** represents the extent to which the decision-making responsibilities rest with the upper echelons or dispersed through the lower levels of the organization (Rogers, 1995).

Cultural orientation represents the extent to which individuals in an organization are expected to consider their own interests or are expected to exhibit primary loyalty to their groups (Hofstede, 1983). The particular weights for different combinations of these variables are shown in the following table.

Cultural Orientation	Organization Structure: Centralized	Mixed	Decentralized
Collectivistic	$\alpha_C = 0.45$, $\alpha_I = 0.45$, $\alpha_A = 0.10$	$\alpha_C = 0.30$, $\alpha_I = 0.60$, $\alpha_A = 0.10$	$\alpha_C = 0.10$, $\alpha_I = 0.80$, $\alpha_A = 0.10$
Neutral	$\alpha_C = 0.450$, $\alpha_I = 0.275$, $\alpha_A = 0.275$	$\alpha_C = 0.30$, $\alpha_I = 0.35$, $\alpha_A = 0.35$	$\alpha_C = 0.10$, $\alpha_I = 0.45$, $\alpha_A = 0.45$
Individualistic	$\alpha_C = 0.45$, $\alpha_I = 0.10$, $\alpha_A = 0.45$	$\alpha_C = 0.30$, $\alpha_I = 0.10$, $\alpha_A = 0.60$	$\alpha_C = 0.10$, $\alpha_I = 0.10$, $\alpha_A = 0.80$

The specific values for α_C, α_I, and α_A were determined as follows. The matrix of combinations between three levels of organization structure and three levels of cultural orientation has nine cells. Each cell provides a combination of non-negative values for α_C, α_I, and α_A (satisfying the constraint in Equation 2) such that the sum of the three values equals 1 (satisfying the constraint in Equation 3). In the top-left cell, which refers to a centralized organization structure and a collectivistic cultural orientation, the contextual actions and influencer actions are prominent than the adopter's own actions from the adopter's perspective. Therefore, α_A is given a value of 0.10 (to indicate a minimal effect) whereas the remaining 0.90 is distributed evenly between α_C and α_I. In the bottom-right cell, which refers to a decentralized organization structure and an individualistic cultural orientation, the adopter's own actions are considered more prominent than either the contextual actions or the influencer actions from the perspective of the adopter. Therefore, the contextual actions and influencer actions are assigned 0.10 each (to indicate minimal effects) whereas the adopter actions are assigned the remaining 0.80. Similar arguments are possible for the other cells[16].

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[16] Furthermore, when holding cultural orientation constant at "collectivistic" and varying organization structure from "centralized" through "decentralized", the values for α_A remain constant at 0.10 (minimal effect for adopter actions in collectivistic cultures), whereas the values for α_C decrease from 0.45 to 0.10 (indicating a larger effect for contextual actions in centralized structures and a smaller effect in decentralized structures) and the values for α_I increase from 0.45 to 0.80 (indicating a larger effect for influencer actions in decentralized structures and a smaller effect for influencer actions in centralized structures).
Similarly, holding cultural orientation constant at "individualistic" and varying organization structure from

The values for $CONTEXT_T$, $INFLUENCER_T$, and $ADOPTER_T$ are based on the contextual, influencer, and adopter actions prior to time period *T*, given by:

$$CONTEXT_T = \frac{\sum_{t=1}^{T-1}\left[ContextAction_t \cdot \delta_C{}^{T-t-1}\right]}{(T-1)} \quad \ldots 4$$

$$INFLUENCER_T = \sum_{i=1}^{r}\left[\frac{w_i}{\sum_i w_i}\left(\frac{\sum_{t=1}^{T-1}\left[InfluenceAction_{t,f=F} \cdot \delta_I{}^{T-t-1}\right]}{(T-1)} + \eta \cdot \frac{\sum_{f=1}^{G}\sum_{t=1}^{T-1}\left[InfluenceAction_{t,f\neq F} \cdot \delta_I{}^{T-t-1}\right]}{(G-1)\cdot(T-1)}\right)\right] \quad \ldots 5$$

$$ADOPTER_T = \frac{\sum_{t=1}^{T-1}\left[AdopterAction_{t,f=F} \cdot \delta_A{}^{T-t-1}\right]}{(T-1)} + \eta \cdot \frac{\sum_{f=1}^{G}\sum_{t=1}^{T-1}\left[AdopterAction_{t,f\neq F} \cdot \delta_A{}^{T-t-1}\right]}{(G-1)\cdot(T-1)} \quad \ldots 6$$

$ContextAction_t$, $InfluenceAction_t$, and $AdopterAction_t$ indicate whether or not a contextual action, influencer action, or adopter action was experienced by the adopter in a given time period *t*, prior to the current time period. This is represented by 1 and 0 respectively.

$$ContextAction_t = \{1, \quad 0 \quad \ldots 7$$

$$InfluenceAction_t = \{1, \quad 0 \quad \ldots 8$$

"centralized" through "decentralized", the values for α_I remain constant at 0.10 (minimal effect for influencer actions in individualistic cultures), whereas the values for α_C decrease from 0.45 to 0.10 (indicating a larger effect for contextual actions in centralized structures and a smaller effect in decentralized structures) and the values for α_A increase from 0.45 to 0.80 (indicating a larger effect for adopter actions in decentralized structures and a smaller effect for adopter actions in centralized structures).

Similar arguments could be made when holding organization structure constant (either at "centralized" or "decentralized") and varying cultural orientation (from "collectivistic" to "individualistic"). For instance, α_C remains constant at 0.45 for centralized structures and at 0.10 for decentralized structures whereas α_I and α_A increase or decrease when moving from collectivistic to individualistic cultures.

$$AdopterAction_t = \{1, \quad 0 \qquad \ldots 9$$

Further, greater importance is associated to those actions experienced by the individual in the more recent periods. This is implemented through a decay function for all three types of actions, and which incorporate different levels of decay: 0.1 for fast decay and 0.9 for slow decay, one of which will be randomly selected during the simulation.

$$\delta_C = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 10$$

$$\delta_I = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 11$$

$$\delta_A = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 12$$

The contextual actions are modeled at the level of the innovation since actions such as issuing of mandate (a contextual action) are typically deal with the entire innovation. However, the influencer and adopter actions are modeled at the level of the features since actions such demonstration (an influencer action) and review (an adopter action) generally deal with specific features of the innovation. Consequently, $INFLUENCER_T$, and $ADOPTER_T$ also incorporate an adjustment for the number of features of the innovation, represented by *G*.

In considering the influencer and own actions, the individual is allowed to consider a) only prior actions that relate to the specific feature being adopted ($\eta = 0$), or b) prior actions that relate to all features of the innovation ($\eta = 1$). Thus, η is a dichotomus parameter that represents the individual adopter's cognitive focus – on only the specific feature (i.e., $\eta = 0$), or on the entire innovation (i.e., $\eta = 1$). The adopter response model computes the probabilities of adoption for all features in F^*, which is then used to identify the candidate features for adoption.

Finally, the $INFLUENCER_T$ equation also accommodates the different influencers in the social network who are connected to, and may influence, the adopter. The influencers may be peers, superiors, or subordinates to the adopter, and the adopter likely associates greater importance to the influences from the superiors relative to the peers and lower importance to the subordinates relative to the peers. One of the following three values will be selected during the simulation depending on the relationship between the adopter and the influencers.

$$w_i = \{1, \quad 1/\lambda_R, \quad \lambda_R \qquad \ldots 13$$

The model incorporates different levels of importance that adopters may associate with the different levels of the influencers, one of which will be randomly selected during the simulation.

$$\lambda_R = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 14$$

Contextual Action Selection Model

The contextual actions modeled in the simulation include awareness creation, issuing of mandate, development, implementation, and training. The contextual action selection model describes how a contextual action likely to be performed by the organization during the current time period *T* is determined. One possibility is to treat all five contextual actions equally by assigning equal probabilities and then selecting one action. However, not all contextual actions can be considered equal since they serve different goals and are subject to different contingencies (based on prior literature), and occur with differing frequencies and varying probabilities (based on findings from field interviews). The contextual action model determines the probabilities of the contextual actions using three distinct approaches: a) contingencies only, based on prior literature, b) history only, based on field interviews, and c) a combination of both prior literature and field interviews. Thus, the contextual action seen in the context for the entire innovation at time *T*, is given by:

$$p(ContextAction_T) = \{P_C, \quad P_H, \quad P_{OR} \qquad \ldots 15$$

P_C represents the probability of a contextual action based on contingencies only, P_H the probability based on history only, and P_{OR} the probability based on both contingencies and history. One of these situations will be randomly selected during the simulation.

Prior literature presents two contingencies are salient in determining the contextual actions: a) top management support, and b) sourcing of IS solution.

Top management support for IS refers to the senior management's favorable attitudes towards, and explicit support for, information systems (Sabherwal et al. 2006). Top management support may be reflected in several different ways, including but not limited to, statements of faith, setting examples, allocation of resources, incentives and rewards, and motivation (Igbaria 1993; Igbaria et al. 1995; Jasperson et al. 2005). Depending on whether the top management exhibits high or low levels of support for information systems, all five actions (i.e. awareness creation, issuing of mandate, development, implementation, and training) have a greater likelihood of being seen in the context.

Sourcing of IS solution represents organizational approaches to acquiring IS/IT innovations for use by its members. IS/IT innovations may be designed in-house by the resident IS function, purchased from vendors as off-the-shelf products, or outsourced completely or selectively (Hirschheim and Lacity 2000; Lacity et al. 1996; Subramanian and Lacity 1997; Swanson 1994). Sourcing of IS solution can be viewed as a continuum in which the IS/IT innovation from completely in-house solutions to completely outsourced solutions. Individuals within organizations are likely to be involved more in development and implementation and be more aware of it for in-house solutions rather than outsourced solutions.

The effects of top management support and sourcing of IS solution on the choice of contextual actions may be modeled as:

$$P_C = \prod_C p(ContextAction_j \mid Contingency_{C,l}) \quad \ldots 16$$

The equation above, used to determine the probabilities of the contextual actions given the contingencies, is subject to the following constraints.

$$p(ContextAction_j \mid Contingency_{C,l}) = \frac{\gamma_{C,l}}{\sum_{l=1}^{L}[\gamma_{C,l}]} \quad \ldots 17$$

$$\sum_{l=1}^{L} p(ContextAction_j \mid Contingency_{C,l}) = 1 \quad \ldots 18$$

The values for $\gamma_{C,l}$ are determined using the following table, which outlines the change in probabilities for the contextual actions based on the values for top management support and the sourcing of IS solution.

Contextual Action	$\gamma_{C=1,l}$ Top management support			$\gamma_{C=2,l}$ Sourcing of IS solution		
	Low $l=1$	In-between $l=2$	High $l=3$	Outsourced $l=1$	Mixed $l=2$	In-house $l=3$
Awareness creation	λ_C	1	$1/\lambda_C$	λ_C	1	$1/\lambda_C$
Issuing of mandate	λ_C	1	$1/\lambda_C$	1	1	1
Development	λ_C	1	$1/\lambda_C$	λ_C	1	$1/\lambda_C$
Implementation	λ_C	1	$1/\lambda_C$	λ_C	1	$1/\lambda_C$
Training	λ_C	1	$1/\lambda_C$	1	1	1

The model incorporates different intensities of the effects of the contingencies on the selection of contextual actions, one of which will be randomly selected during the simulation.

$$\lambda_C = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \quad \ldots 19$$

The field interviews resulted in multiple action sequences that yielded insights on the frequencies of the contextual actions and the precedence relationships between the various contextual actions in real-world organizations. The simulation model used this precedence information to determine the contextual action that may be performed during the current time period. This is given by:

$$P_H = p(ContextAction_j \mid HISTORY) \quad \ldots 20$$

HISTORY refers to the set of all contextual actions prior to the current time period. To determine the contextual action for the current time period given the previous *HISTORY*,

the information regarding the precedence of actions from the field interviews are used as follows:

$$p(ContextAction_j \mid HISTORY) = \frac{\sum_{t=1}^{T-1}\left[p(ContextAction_j \mid ContextAction_t)\cdot {\delta_C}^{T-t-1}\right]}{\sum_{j=1}^{k_C}\left[\sum_{t=1}^{T-1}\left[p(ContextAction_j \mid ContextAction_t)\cdot {\delta_C}^{T-t-1}\right]\right]} \quad \ldots 21$$

The precedence of the different contextual actions from the action sequences in the field interviews is given by:

$$p(ContextAction_j \mid ContextAction_t) = \frac{\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{C,pq}\cdot {\delta_C}^{p-q-1}\right]}{\sum_{t=1}^{k_C}\left[\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{C,pq}\cdot {\delta_C}^{p-q-1}\right]\right]} \quad \ldots 22$$

$\varphi_{C,pq}$ specifies whether or not two contextual actions shared a precedence relationship in the action sequences from the field interviews.

$$\varphi_{C,pq} = \{0, \quad 1 \quad \ldots 23$$

Further, in equation 22, n refers to the number of action sequences from the field interviews, m the number of actions in a sequence, and k_C the number of contextual actions available for the simulation model.

The probabilities for the contextual actions computed from the field interviews are subject to the following constraints.

$$\sum_{t=1}^{k_C} p(ContextAction_j \mid ContextAction_t) = 1 \quad \ldots 24$$

Finally, prior actions exert different levels of influence on the action selected for the current time period: recent actions have greater influence than actions in the earlier periods, one of which will be randomly selected during the simulation.

$$\delta_C = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \quad \ldots 25$$

In addition to P_C and P_H, which reflect the effects of contingency and history, respectively, and are computed above, the third option in Equation 15 is P_{OR}, where the probabilities for influencer actions are computed using a combination of the contingencies based on prior literature and the histories based on the field interviews. This is given by the following equation:

$$P_{OR} = P_C + P_H - P_C \cdot P_H \quad \ldots 26$$

Influencer Action Selection Model

The influencer actions modeled in the simulation include building coalitions, bargaining, rational arguments, being assertive, expertise, demonstration, and knowledge sharing. The influencer action selection model describes how an influencer action likely to be performed by an individual in the network during the current time period *T* is determined. One possibility is to treat all seven influencer actions equally by assigning equal probabilities and then selecting one action. However, not all influencer actions can be considered equal since they serve different goals and are subject to different contingencies (based on prior literature), and occur with differing frequencies and varying probabilities (based on findings from field interviews). The influencer action model determines the probabilities for the influencer actions using three distinct approaches: a) contingencies only, based on prior literature, b) history only, based on field interviews, and c) a combination of both prior literature and field interviews. Thus, the influencer action performed by an individual with regard to a feature *F* at time *T*, is given by:

$$p(InfluenceAction_T) = \{P_C, \quad P_H, \quad P_{OR} \quad \ldots 27$$

P_C represents the probability of an influencer action based on contingencies only, P_H the probability based on history only, and P_{OR} the probability based on both contingencies and history. One of the three situations will be randomly selected during the simulation.

Prior literature presents two contingencies are salient in determining the influencer actions: a) management style, and b) hierarchical level (relative).

Management styles are indicative of the ways in which an individual elicits particular behaviors from other individuals. While individuals may adopt different styles, management by direction and management by enablement are particularly relevant in the context of information systems adoption (Kennedy 1991). Management by direction is a style in which an individual elicits compliance behaviors from others through directives and direct requests. Management by enablement, on the other hand, is one in which the individual actually aids others to exhibit specific responses. In the context of influence actions, an influencer who manages by direction is more likely to engage in building coalitions, bargaining, applying sanctions or being assertive in having others adopt information systems. On the other hand, an influencer who manages by enablement is more likely to engage in rational arguments, expertise, knowledge sharing, and demonstration to accomplish the same ends. Thus, the management style is indicative of the extent to which influencers actually facilitate the process of innovation adoption.

Hierarchical level represents an individual's relative position in the organizational hierarchy (Igbaria 1993). The organizational hierarchy establishes the formal lines of command, as a result of which individuals in relatively higher positions possess the formal power to direct

individuals in the lower levels of the hierarchy. However, individuals in the lower levels may have to rely on non-formal powers such as expert power to gain supportive responses from individuals in the higher levels. In the context of influence actions, then, the actions chosen by individuals in the higher and lower levels of the organization hierarchy are likely to differ (Yukl et al. 1993; Yukl et al. 1995). For instance, individuals in higher levels are more likely to apply sanctions or be assertive in dealing with individuals in lower levels. But individuals in lower levels may be more likely to choose rational arguments to interact with individuals in higher levels.

The effects of relative hierarchical level and management style on the choice of influencer actions may be modeled as:

$$P_C = \prod_C p(InfluenceAction_j \mid Contingency_{C,l}) \quad \ldots 28$$

The equation above, used to determine the probabilities of the influencer actions given the contingencies, is subject to the following constraints.

$$p(InfluenceAction_j \mid Contingency_{I,l}) = \frac{\gamma_{I,l}}{\sum_{l=1}^{L}[\gamma_{I,l}]} \quad \ldots 29$$

$$\sum_{l=1}^{L} p(InfluenceAction_j \mid Contingency_{I,l}) = 1 \quad \ldots 30$$

The values for $\gamma_{I,l}$ are determined using the following table, which outlines the change in probabilities for the influence actions based on two contingencies: management style, and relative hierarchical level.

Influencer Action	$\gamma_{I=1,l}$ Management style			$\gamma_{I=2,l}$ Hierarchical level (relative)		
	Direction $l=1$	Mixed $l=2$	Enablement $l=3$	Superior $l=1$	Peer $l=2$	Subordinate $l=3$
Building coalitions	$1/\lambda_I$	1	λ_I	λ_I	1	$1/\lambda_I$
Bargaining	$1/\lambda_I$	1	λ_I	λ_I	1	$1/\lambda_I$
Rational arguments	λ_I	1	$1/\lambda_I$	λ_I	1	$1/\lambda_I$
Being assertive	$1/\lambda_I$	1	λ_I	$1/\lambda_I$	1	λ_I
Expertise	λ_I	1	$1/\lambda_I$	λ_I	1	$1/\lambda_I$
Demonstration	λ_I	1	$1/\lambda_I$	λ_I	1	$1/\lambda_I$
Knowledge sharing	λ_I	1	$1/\lambda_I$	λ_I	1	$1/\lambda_I$

The model incorporates different intensities of the effects of the contingencies on the selection of influencer actions, one of which will be randomly selected during the simulation.

$$\lambda_I = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 31$$

The field interviews resulted in multiple action sequences which yielded insights on the frequencies of the influencer actions and the precedence relationships between the various influencer actions in real-world organizations. The simulation model used this precedence information to determine the influencer action that may be performed during the current time period. This is given by:

$$P_H = p(InfluenceAction_j \mid HISTORY) \qquad \ldots 32$$

HISTORY refers to the set of all influencer actions prior to the current time period. To determine the influencer action for the current time period given the previous *HISTORY*, the information regarding the precedence of actions from the field interviews are used as follows:

$$p(InfluenceAction_j \mid HISTORY) = \frac{\sum_{t=1}^{T-1}\left[p(InfluenceAction_j \mid InfluenceAction_t) \cdot \delta_I{}^{T-t-1}\right]}{\sum_{j=1}^{k_I}\left[\sum_{t=1}^{T-1}\left[p(InfluenceAction_j \mid InfluenceAction_t) \cdot \delta_I{}^{T-t-1}\right]\right]} \qquad \ldots 33$$

The precedence of the different influencer actions from the action sequences in the field interviews is given by:

$$p(InfluenceAction_j \mid InfluenceAction_t) = \frac{\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{I,pq} \cdot \delta_I{}^{p-q-1}\right]}{\sum_{t=1}^{k_I}\left[\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{I,pq} \cdot \delta_I{}^{p-q-1}\right]\right]} \qquad \ldots 34$$

$\varphi_{I,pq}$ specifies whether or not two influencer actions shared a precedence relationship in the action sequences from the field interviews.

$$\varphi_{I,pq} = \{0, \quad 1 \qquad \ldots 35$$

Further, in equation 34, n refers to the number of action sequences from the field interviews, m the number of actions in a sequence, and k_I the number of influencer actions available for the simulation model.

The probabilities for the influencer actions computed from the field interviews are subject to the following constraints.

$$\sum_{t=1}^{k_I} p(InfluenceAction_j \mid InfluenceAction_t) = 1 \quad \ldots 36$$

Finally, prior actions exert different levels of influence on the action selected for the current time period: recent actions have greater influence than actions in the earlier periods. The extent to which the effect of influence decreases with time is modeled using a decay factor, δ_I, which will be randomly assigned one of the following values during the simulation.

$$\delta_I = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \quad \ldots 37$$

In addition to P_C and P_H, which reflect the effects of contingency and history, respectively, and are computed above, the third option in Equation 27 is P_{OR}, where the probabilities for influencer actions are computed using a combination of the contingencies based on prior literature and the histories based on the field interviews. This is given by the following equation:

$$P_{OR} = P_C + P_H - P_C \cdot P_H \quad \ldots 38$$

Adopter Action Selection Model

The adopter actions modeled in the simulation include review, observation, inquiry, seeking assistance, request for…, and develop own…. The adopter action selection model describes how an adopter action likely to be performed by an individual in the network during the current time period *T* is determined. One possibility is to treat all six adopter actions equally by assigning equal probabilities and then selecting one action. However, not all adopter actions can be considered equal since they serve different goals and are subject to different contingencies (based on prior literature), and occur with differing frequencies and varying probabilities (based on findings from field interviews). The adopter action model determines the probabilities for the influencer actions using three distinct approaches: a) contingencies only, based on prior literature, b) history only, based on field interviews, and c) a combination of both prior literature and field interviews. Thus, the adopter action performed by an individual with regard to a feature *F* at time *T*, is given by:

$$p(AdopterAction_T) = \{P_C, \quad P_H, \quad P_{OR} \quad \ldots 39$$

P_C represents the probability of an adopter action based on contingencies only, P_H the probability based on history only, and P_{OR} the probability based on both contingencies and history, one of which will be randomly selected during the simulation.

Prior literature presents two contingencies are salient in determining the adopter actions: a) innovativeness and b) IS expertise.

Innovativeness represents the extent to which an individual is willing to try out new information systems (Agarwal and Karahanna 2000; Agarwal and Prasad 1998). Individuals

who possess higher degrees of innovativeness are more likely to be ready to try new features or interact with the information system in new ways. Consequently, such individuals are more likely to engage in frame-breaking actions such as requesting new features or developing own features. On the other hand, individuals who are not very innovative rely on frame-saving actions such as review, observation, inquiry, and seeking assistance in dealing with information systems than frame-breaking actions.

IS expertise refers to the skills and knowledge possessed by an individual, typically gained through prior experience and interactions with information systems (Ang and Soh 1997; Gatian 1994; Igbaria et al. 1996). Individuals with greater expertise are more likely to engage more freely with information systems and not need extra guidance from other sources. Such individuals are more likely to engage more in non-interactive actions such as review, observation, and developing own features.

The effects of innovativeness and IS expertise on the choice of adopter actions may be modeled as:

$$P_C = \prod_C p(AdopterAction_j \mid Contingency_{C,l}) \quad \ldots 40$$

The equation above, used to determine the probabilities of the adopter actions given the contingencies, is subject to the following constraints.

$$p(AdopterAction_j \mid Contingency_{A,l}) = \frac{\gamma_{A,l}}{\sum_{l=1}^{L}[\gamma_{A,l}]} \quad \ldots 41$$

$$\sum_{l=1}^{L} p(AdopterAction_j \mid Contingency_{A,l}) = 1 \quad \ldots 42$$

The values for $\gamma_{A,l}$ are determined using the following table, which outlines the change in probabilities for the adopter actions based on two contingencies: innovativeness and IT expertise.

Adopter Action	$\gamma_{A=1,l}$ Innovativeness			$\gamma_{A=2,l}$ IT expertise		
	Low $l=1$	Medium $l=2$	High $l=3$	Low $l=1$	Medium $l=2$	High $l=3$
Review	λ_A	1	$1/\lambda_A$	λ_A	1	$1/\lambda_A$
Observation	λ_A	1	$1/\lambda_A$	λ_A	1	$1/\lambda_A$
Inquiry	$1/\lambda_A$	1	λ_A	1	1	1
Seeking assistance	$1/\lambda_A$	1	λ_A	1	1	1
Develop own..	λ_A	1	$1/\lambda_A$	λ_A	1	$1/\lambda_A$
Request for…	$1/\lambda_A$	1	λ_A	1	1	1

The model incorporates different intensities of the effects of the contingencies on the selection of adopter actions, one of which will be randomly selected during the simulation.

$$\lambda_A = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \qquad \ldots 43$$

The field interviews resulted in multiple action sequences which yielded insights on the frequencies of the adopter actions and the precedence relationships between the various adopter actions in real-world organizations. The simulation model used this precedence information to determine the adopter action that may be performed during the current time period. This is given by:

$$P_H = p(AdopterAction_j \mid HISTORY) \qquad \ldots 44$$

HISTORY refers to the set of all adopter actions prior to the current time period. To determine the adopter action for the current time period given the previous *HISTORY*, the information regarding the precedence of actions from the field interviews are used as follows:

$$p(AdopterAction_j \mid HISTORY) = \frac{\sum_{t=1}^{T-1}\left[p(AdopterAction_j \mid AdopterAction_t) \cdot \delta_A{}^{T-t-1}\right]}{\sum_{j=1}^{k_A}\left[\sum_{t=1}^{T-1}\left[p(AdopterAction_j \mid AdopterAction_t) \cdot \delta_A{}^{T-t-1}\right]\right]} \qquad \ldots 45$$

The precedence of the different adopter actions from the action sequences in the field interviews is given by:

$$p(AdopterAction_j \mid AdopterAction_t) = \frac{\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{A,pq} \cdot \delta_A{}^{p-q-1}\right]}{\sum_{t=1}^{k_A}\left[\sum_{s=1}^{n}\sum_{p=2}^{m}\sum_{q=1}^{p-1}\left[\varphi_{A,pq} \cdot \delta_A{}^{p-q-1}\right]\right]} \qquad \ldots 46$$

$\varphi_{A,pq}$ specifies whether or not two adopter actions shared a precedence relationship in the action sequences from the field interviews.

$$\varphi_{A,pq} = \{0, \quad 1 \qquad \ldots 47$$

Further, in equation 46, n refers to the number of action sequences from the field interviews, m the number of actions in a sequence, and k_i the number of adopter actions available for the simulation model.

The probabilities for the adopter actions computed from the field interviews are subject to the following constraints.

$$\sum_{t=1}^{k_I} p(AdopterAction_j \mid AdopterAction_t) = 1 \quad \ldots 48$$

Finally, prior actions exert different levels of influence on the action selected for the current time period: recent actions have greater influence than actions in the earlier periods, one of which will be randomly selected during the simulation.

$$\delta_A = \{0.1, \quad 0.3, \quad 0.5, \quad 0.7, \quad 0.9 \quad \ldots 49$$

In addition to P_C and P_H, which reflect the effects of contingency and history, respectively, and are computed above, the third option in Equation 39 is P_{OR}, where the probabilities for adopter actions are computed using a combination of the contingencies based on prior literature and the histories based on the field interviews, and given by the following equation:

$$P_{OR} = P_C + P_H - P_C \cdot P_H \quad \ldots 50$$

6.4 Implementation

The procedures for the contextual action selection model and the adopter action selection model are implemented using the following approach. At each time period: a) compute the probabilities of each action in the set of actions available, subject to the contingencies and histories, b) determine the candidate actions based on the probabilities, and c) randomly select one of the candidate actions for the time period. For the influencer action selection model, these steps are implemented for all features that are not yet adopted (F^*) by the individual. For the contextual action selection model, these steps are performed for the entire innovation (i.e. no distinction in terms of features).

For the influencer action selection model, a similar procedure is employed, but with two differences. First, the three steps are implemented for all features of the innovation that have already been adopted ($F^{\#}$) by the individual: for each time period: a) compute the probabilities of each action in the set of actions available, subject to the contingencies and histories, b) determine the candidate actions based on the probabilities, and c) randomly select one of the candidate actions for the time period. Second, the steps outlined above are employed only between two connected individuals and only when the tie is considered to be active for that period (determined based on the strength of the tie).

The individuals (i.e. agents) are typically situated in a larger context such as the network or the organization. Prior literature has shown that internal communication sources (as can be found in a network) are influential in diffusion and assimilation of IS/IT innovations (Rogers 1995). Thus, in addition to the specification for the behavior of agents, the specification for the characteristics of the network needs to be defined. The networks may be described using several different characteristics. Network size represents the number of individuals belonging to the network (Brass 1995; Monge and Contractor 2003). Network density is the ratio of the number of actual ties between individuals and the number of the maximum possible ties, when the number of individuals (or the network size) is known

(Kilduff and Tsai 2003; Valente 1995). Network centralization denotes the extent to which a large proportion of ties is concentrated among few individuals in the network (Brass 1995; Kilduff and Tsai 2003; Wasserman and Faust 1994). The most centralized network is the star network in which one individual is connected to all other individuals in the network, whereas the least centralized network is the circle network in which each individual typically has the same number of ties as others(Wasserman and Faust 1994). The ties between individuals may be strong or weak (Burt 1997; Granovetter 1973); strong ties imply greater levels of interaction between the connected individuals whereas weak ties signify lower levels of interaction. Network strength is formulated as the ratio of the number of strong ties to the number of actual ties in the network.

6.5 Pilot Simulation

I conducted pilot simulation runs prior to conducting the main simulation explained below. Specifically, I conducted two different runs, with the same basic approach regarding parameters as explained above, but with varying number of trials in each run. The first pilot generated 200 observations whereas the second pilot generated 1000 observations. The pilot simulations allowed me opportunities to understand the time (for simulation runs) and space (for data storage) constraints that would need to be considered in running the main simulation. It also allowed me to create test datasets (to verify correctness, sufficiency, etc.) and understand the inner workings of the simulation package (such as the use of a random functions to control the behavior of individuals).

6.6 Full Simulation

I adopted the free version of the NetLogo[17] (version 3.2) agent-based modeling system, developed by Wilensky at the Northwestern University, USA, for the simulation. NetLogo allows agent-based modelers to build an interface that can handle multiple concurrently-functioning agents. Further, NetLogo allows modelers to simulate the behavior of each agent individually, and then observe the combined overall effects of the various agents at the aggregate level. Thus, NetLogo is an appropriate tool for implementing the simulation model described above for this research.

[17] More information about NetLogo can be found at http://www.ccl.sesp.northwestern.edu/netlogo/, accessed 05/01/07.

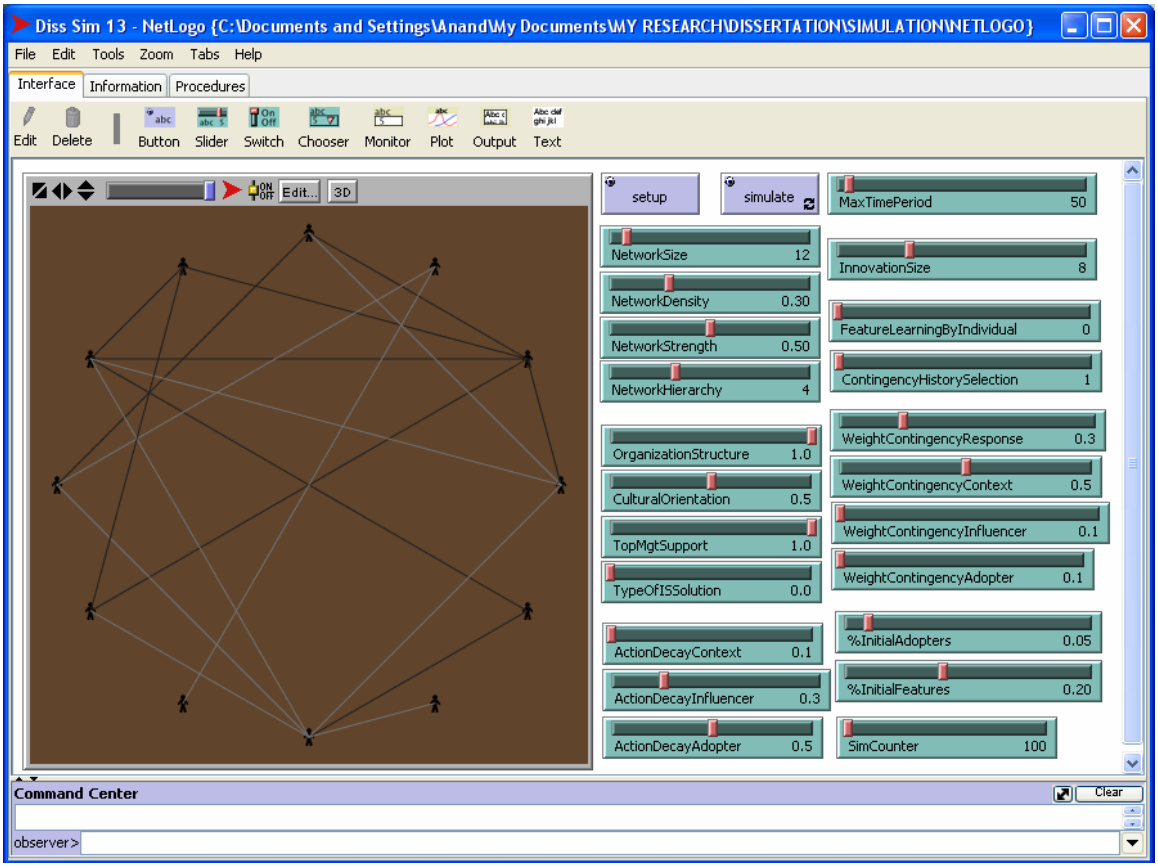

Figure 30. NetLogo Interface

NetLogo automatically manages the concurrent functioning of agents. From the modeler's perspective, what NetLogo requires is a specification of the fundamental behavior of a single agent. NetLogo then propagates the fundamental behavior to all agents belonging to the problem space. NetLogo incorporates stochastic functions that determine the time and order in which such fundamental behavior is transmitted to all agents. Thus, all a modeler needs to do is to specify the behavior and let NetLogo take care of the implementation. A high-level description of the agent behaviors is shown in Figure 31. The set of the parameters varied in the simulation are shown in Table 30.

With the 20 parameters shown in Table 30, and at the number of levels of values for each parameter, more than 2 trillion combinations of parameters are possible. Due to the difficulty in actually running the experiments over this inordinately large number of combinations, I formulated a heuristic by which to more efficiently manage the simulation runs. The heuristic allowed for the random assignment of values to all of the simulation parameters except one. The exception was the feature or innovation centric view of consideration by adopters, represented by $\eta = 0$ and $\eta = 1$ conditions. For each of the two conditions, I repeated the simulation 2500 times for a total of 5000 networks, and network-level data recorded over 50 time periods, the duration of the simulation. The entire

simulation of 5000 networks completed in about 60 hours[18]. The size of the data file at the end of the simulation was about 30 MB and included more than 500 data points (i.e. columns of data) for each of the 5000 networks (i.e. rows of data), including values of variables over time.

```
Set up the "conditions" (parameters) for the simulation run including INNOVATION SIZE,
NETWORK SIZE, INITIAL ADOPTERS, TOP MANAGEMENT SUPPORT, etc.
Construct the initial network using the simulation conditions NETWORK SIZE, NETWORK
DENSITY, NETWORK STRENGTH, and NETWORK HIERARCHY. Set up the attributes for agents:
HIERARCHICAL LEVEL, INNOVATIVENESS, MANAGEMENT STYLE, EXPERTISE, etc. and the
attributes for ties: STRENGTH OF TIE
Repeat the following for ψ time periods OR until the entire network reached 100% assimilation
[
        For each time period, perform behaviors related to all components of the model
        {
                Determine the action, if any, from the context as it relates to the entire
                innovation
                Determine the actions, if any, experienced by each individual sharing ties with
                other individuals, for each feature not already adopted
                Determine the actions, if any, performed by each individual, for each feature
                not already adopted
                Determine adopter response, if any, to any feature not already adopted,
                depending on contextual actions related to the innovation as well as influencer
                and adopter actions related to the feature
        }
]
```

Figure 31. Simulation Algorithm

[18] Two computers were used to run the simulation. One computer was an Acer notebook with an AMD Turion 64MT processor running at 1.60 GHz, 1 GB RAM, and Windows XP. The other computer was a MacBook Pro with a dual-core Intel processor running at 2.16 GHz, 1 GB RAM, and Mac OS X. [NetLogo is available for both Windows and Mac systems and allows the creation of flat data files on both platforms.] Specifically, the $\eta = 0$ condition was run on the Acer notebook and the $\eta = 1$ condition on the MacBook Pro. The run time was about 36 hours for the Acer notebook and 24 hours for the MacBook Pro.

Parameter	Description	Values
Innovation Size	The number of features in the innovation	3, 4, 5, 6, 8, 10, 12, 15
Network Size	The number of agents in the network	10, 12, 16, 20, 26, 32, 40, 50
Network Density	The ratio of the actual number of ties to the maximum possible number of ties in the network	0.01, 0.02, 0.05, 0.10, 0.30, 0.50, 0.70, 0.90
Network Strength	The proportion of strong ties in the network	0 (all weak ties), 0.16, 0.33, 0.5, 0.66, 0.83, 1 (all strong ties)
Network Hierarchy (relative)	The number of distinct hierarchical positions in the organization hierarchy	2, 3, 4, 5, 6, 7, 8
Organization Structure	The extent to which decision making resides with the top echelons	0 (centralized), 0.5, 1 (decentralized)
Cultural Orientation	The extent to which individuals work as a collective	0 (collectivistic), 0.5, 1 (individualistic)
Top Management Support for IS	The extent to which top management is favorable towards innovations	0 (low), 0.5, 1 (high)
Sourcing of IS Solution	The source from which the innovation was obtained	0 (low), 0.5, 1 (high)
Contingency vs. History	Indicator of whether actions were determined only on contingencies based on theory or only on histories based on field interviews or a combination of both	1 (contingency only), 2 (history only), 3 (both)
Feature vs. Innovation centrism	Indicator of whether the adopter response for a feature was based only on prior actions related to that specific feature or all features of the innovation	0 (feature), 1 (innovation)
Initial adopters	The proportion of individuals who had already adopted at least one feature of the innovation (i.e. at time 0)	0, 0.05, 0.10, 0.15, 0.20
Initial features	The proportion of features already adopted by the initial adopters (i.e. at time 0)	0, 0.05, 0.10, 0.15, 0.20
Decays (3 variables)	Relative strengths of the actions from prior time periods	0.1, 0.3, 0.5, 0.7, 0.9
Weights (4 variables)	Relative strengths of the contingencies in determining actions	0.1, 0.3, 0.5, 0.7, 0.9

Table 30. Simulation Parameters

6.7 Data Analysis

The simulated data set was used to examine the research model introduced in the previous chapter. This section outlines the measures constructed for the research variables as well as the empirical models and data analysis techniques to examine the relationships depicted in the research model.

6.7.1 Measures

The variables in the research model were measured through two different methods. Some variables were parameters that were randomly assigned in the simulation. The values of these variables were directly obtained from the simulation. The remaining variables, including all dependent and mediating variables, were computed using data generated by the simulation. These computations are explained below.

Level of diffusion ($LevelDiff_{NET}$) at a point in time t was computed as the ratio of the number of individuals who have adopted the first feature of the innovation ($\#Adopters_{NET}$) by time t, to the total number of individuals in the network ($NetworkSize$).

$$LevelDiff_{NET,t=T} = \frac{\#Adopters_{NET,t=T}}{NetworkSize} \quad \ldots 51$$

Level of assimilation ($LevelAssim_{NET}$) at a point in time t was computed as the ratio of the total number of features adopted by each adopter ($FeaturesAdopted_{IND}$) by time t to the product of the number of individuals in the network ($NetworkSize$) and the total number of features in the innovation ($InnovationSize$).

$$LevelAssim_{NET,t=T} = \frac{\sum_{\forall Adopters} \#FeaturesAdopted_{IND,t=T}}{(NetworkSize \times InnovationSize)} \quad \ldots 52$$

All three actions were operationalized as ratios, standardized using the entity responsible for the actions. That is, contextual actions and adopter actions refer to individuals whereas influencer actions refer to ties. Contextual actions ratio ($ContextAction_{NET}$) at a point in time t was computed as the ratio of the total number of contextual actions experienced by individuals and the number of individuals in the network.

$$ContextAction_{NET,t=T} = \frac{\sum_{\forall Adopters} ContextAction_{IND,t=T}}{NetworkSize} \quad \ldots 53$$

Influencer actions ratio ($InfluencerAction_{NET}$)at a point in time t was computed as the ratio of the total number of influencer actions experienced by all individuals and product of twice the number of ties and the number of features in the innovation. [The denominator accounts for the bi-directional nature of the ties as well as the number of features in the innovation.]

$$InfluencerAction_{NET,t=T} = \frac{\sum_{\forall Ties} InfluencerAction_{IND,t=T}}{2 \times \#Ties \times InnovationSize} \quad \ldots 54$$

Adopter actions ratio ($AdopterAction_{NET}$)at a point in time t was computed as the ratio of the total number of adopter actions experienced by all individuals and the number of individuals in the network as well as the number of features in the innovation. [The denominator accounts for the number of features in the innovation.]

$$AdopterAction_{NET,t=T} = \frac{\sum_{\forall Adopters} AdopterAction_{IND,t=T}}{NetworkSize \times InnovationSize} \quad \ldots 55$$

The independent and control variables do not vary over time. Therefore, their measures were generally retained as is from the simulation. For three variables (organizational innovativeness, organizational expertise, and network centralization), network-level measures were not discussed. Organizational innovativeness and organizational expertise were computed as the average of the innovativeness measures of all individuals in the network.

Network centralization ($NetCentralizaiton$) was computed as the ratio of the sum of the differences between the maximum degree in the network and the individual degrees and the theoretically maximum possible degree for a network with as many actors (typically given by the star network with the same number of individuals).

$$NetCentralization = \frac{\sum_{i=1}^{g} [D_A(n^*) - D_A(n_i)]}{(NetworkSize - 1)(NetworkSize - 2)} \quad \ldots 56$$

where

$$D_A(n_i) = Degree(i.e.\#\_of\_links)\_for\_actor\_i$$

$$D_A(n^*) = Maximum\_of\_all\_D_A(n_i)$$

Finally, two dummy variables were constructed for the contingency vs. history measure obtained from the simulation: the first as a contingency only variable and the second as a history only variable.

Of the 17 variables in the analysis, 12 variables (the seven contingency variables and the five control variables) were treated as time-invariant measures. That is, these values may have been different across the 5000 networks but were constant over the 50 time periods for each network. The five dependent and mediating variables, on the other hand, were time-varying measures and varied across networks as well as over time periods within each network.

6.7.2 Methods

The simulated data set contained data on 5000 networks over 50 time periods, and several measures for each time period. The overall data set was, in effect, time-series data on several cross-sectional units and required cross-sectional time-series analysis techniques (Baltagi 2005; Hsiao 2003; Wooldridge 2002). Data analysis was accomplished using the Stata[19] (version Intercooled Stata 9.2) statistical software package, which provides the cross-sectional time-series family of methods (called as XT methods within Stata, and including several pre-packaged as well as user-written methods starting with "XT," such as XTIVREG, XTABOND, and XTABOND2) for the analysis of cross-sectional time-series data. Prior to executing the XT method on the data, the simulated data set in wide form (i.e. one data row for each network) was converted to long form, i.e. one data row for each network for each time period.

With 50 time-periods and 5000 networks, the simulated data was consistent with the "small T, large N" (i.e. small number of time periods and large number of cross-sectional units) criteria for employing cross-sectional time-series analysis techniques (Certo and Semadeni 2006). Moreover, cross-sectional time-series analysis techniques allowed the data across networks and time periods to be pooled, and to examine effects across the different networks over the different time periods (Hsiao 2003). Since the 5000 networks modeled in the simulation may be considered as randomly drawn units from a larger population and contained both time-invariant and time-varying measures, I employed random-effects models for estimation (Gujarati 2003; Wooldridge 2002). To account for serial correlation in pooled cross-section time-series data, I introduced a lagged dependent variable as an independent variable in the empirical models (Guillen and Suarez 2005). Moreover, since the dependent variables in the research model may depend on their own past history (e.g. level of diffusion in the current time periods may be determined by level of diffusion in the previous time period), and since the independent variables were not strictly exogenous (e.g. influencer actions may be predetermined in the previous time period), I employed the dynamic panel estimators (Arellano and Bond 1991). The specific XT procedure in Stata used for estimating the empirical models was XTABOND2 (Roodman 2006), which is an appropriate procedure for models involving dynamic dependent variables, not strictly exogenous independent variables, and serial correlation of the error terms.

I constructed four different empirical models, as shown below, to examine all hypotheses proposed in the research model. Table 31 identifies the various hypotheses proposed in the research model and the empirical models in which they are examined.

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[19] More information about the Stata statistical software package is available at http://www.stata.com, accessed 05/01/07.

Proposition	Hypothesis	Relationship	Expected	Model
P-1	H-1A	Organization structure (central = 1) → Level of diffusion	+	Diffusion
	H-1B	Organization structure (central = 1) → Level of assimilation	+	Assimilation
	H-1C	Cultural orientation (individual = 1) → Level of diffusion	-	Diffusion
	H-1D	Cultural orientation (individual = 1) → Level of assimilation	-	Assimilation
P-2	H-2A	Network density → Influencer actions	+	Influencer action
	H-2B	Network centralization → Influencer actions	-	Influencer action
	H-2C	Network strength → Influencer actions	+	Influencer action
	H-2D	Org Innovativeness → Adopter actions	+	Adopter action
	H-2E	Org Expertise → Adopter actions	+	Adopter action
P-3	H-3A	Contextual actions @ t=T-1 → Level of diffusion @ t=T	+	Diffusion
	H-3B	Contextual actions @ t=T-1 → Level of assimilation @ t=T	+	Assimilation
	H-3C	Influencer actions @ t=T-1 → Level of diffusion @ t=T	+	Diffusion
	H-3D	Influencer actions @ t=T-1 → Level of assimilation @ t=T	+	Assimilation
	H-3E	Adopter actions @ t=T-1 → Level of diffusion @ t=T	+	Diffusion
	H-3F	Adopter actions @ t=T-1 → Level of assimilation @ t=T	+	Assimilation
P-4	H-4A	Level of diffusion @ t=T-1 → Influencer actions @ t=T	+	Influencer action
	H-4B	Level of assimilation @ t=T-1 → Influencer actions @ t=T	+	Influencer action
	H-4C	Level of diffusion @ t=T-1 → Adopter actions @ t=T	+	Adopter action
	H-4D	Level of assimilation @ t=T-1 → Adopter actions @ t=T	-	Adopter action
P-5	H-5	Level of diffusion @ t=T-1 → Level of assimilation @ t=T	+	Assimilation

Table 31. Hypotheses and Empirical Models

Equations 57 and 58 test the effects of antecedents on the two dependent variables in the research model. Specifically, these equations estimate level of assimilation and level of diffusion respectively for the current time period. Each regression model has three groups of independent variables: a) the three actions: contextual, influencer, and adopter actions, b) contingencies: organization structure and cultural orientation, and c) controls: innovation size, network size, feature- vs. innovation- centric, contingency only, and history only. Additionally, the assimilation model also contains level of diffusion as an independent variable. All independent variables in the two models are assigned the simulation parameter values except for the three actions ratios that were computed at the end of the simulation.

ASSIMILATION MODEL:

$$\begin{aligned} LevelAssim_T = {} & \alpha + \beta_1.LevelAssim_{T-1} + \beta_2.LevelDiff_{T-1} + \\ & \beta_3.\left[InfluencerAction_{T-1} - InfluencerAction_{T-2}\right] + \\ & \beta_4.\left[AdopterAction_{T-1} - AdopterAction_{T-2}\right] + \\ & \beta_5.\left[ContextAction_{T-1} - ContextAction_{T-2}\right] + \\ & \beta_6.OrgStructure + \beta_7.CultOrient + \beta_8.InnovationSize + \beta_9.NetworkSize + \\ & \beta_{10}.FeatInno + \beta_{11}.ContOnly + \beta_{12}.HistOnly \end{aligned}$$

…57

DIFFUSION MODEL:

$$LevelDiff_T = \alpha + \beta_1.LevelDiff_{T-1} + \beta_2.[InfluencerAction_{T-1} - InfluencerAction_{T-2}] + \beta_3.[AdopterAction_{T-1} - \Delta AdopterAction_{T-2}] + \beta_4.[ContextAction_{T-1} - ContextAction_{T-2}] + \beta_5.OrgStructure + \beta_6.CultOrient + \beta_7.InnovationSize + \beta_8.NetworkSize + \beta_9.FeatInno + \beta_{10}.ContOnly + \beta_{11}.HistOnly \quad \ldots 58$$

Equations 59 and 60 test the determinants of the two mediating variables in the research model. Specifically, these equations estimate change in influencer actions ratio and change in adopter actions ratio respectively between the current and previous time periods. Each regression model has three categories of dependent variables: a) the assimilation and diffusion variables, b) contingencies: network variables and organization variables, and c) controls: innovation size, network size, feature- vs. innovation- centric, contingency only, and history only. Moreover, both models included the lagged dependent measure as an independent variable. All independent variables in the two models are assigned the simulation parameter values except for the three actions ratios that were computed at the end of the simulation.

INFLUENCER ACTION MODEL:

$$[InfluencerAction_T - InfluencerAction_{T-1}] = \alpha + \beta_1.[InfluencerAction_{T-1} - InfluencerAction_{T-2}] + \beta_2.LevelDiff_{T-1} + \beta_3.LevelAssim_{T-1} + \beta_4.NetDensity + \beta_5.NetCentralization + \beta_6.NetStrength + \beta_7.InnovationSize + \beta_8.NetworkSize + \beta_9.FeatInno + \beta_{10}.ContOnly + \beta_{11}.HistOnly \quad \ldots 59$$

ADOPTER ACTION MODEL:

$$[AdopterAction_T - AdopterAction_{T-1}] = \alpha + \beta_1.[AdopterAction_{T-1} - AdopterAction_{T-2}] + \beta_2.LevelDiff_{T-1} + \beta_3.LevelAssim_{T-1} + \beta_4.OrgInnovativ + \beta_5.OrgExpertis + \beta_6.InnovationSize + \beta_7.NetworkSize + \beta_8.FeatInno + \beta_9.ContOnly + \beta_{10}.HistOnly \quad \ldots 60$$

Each of the four empirical models was examined under four different conditions (for four models X four conditions = 16 sets of regressions) to understand the impacts over different periods of time. The four conditions differed in the specific time periods included in the analysis, with the following time periods being included: (i) the entire set of time periods relevant to the network; (ii) the first ten time periods relevant to the network; (iii) last ten time periods relevant to the network; and (iv) the middle time periods relevant to the network, i.e., excluding time periods included in (ii) and (iii) above. The time periods were computed based on two criteria: a) adopter stability or feature stability, and b) simulation end time. **Adopter stability** was defined as the time period at which the (first feature of the)

innovation was adopted by all individuals in the network whereas **feature stability** was defined as the time period at which all features of the innovation were adopted by all individuals in the network (Gibbons 2004). Adopter stability is relevant for the diffusion model above whereas feature stability is relevant for the remaining three models. The first set of regressions included the data rows until the relevant stability period or all 50 time periods if stability was not reached for the network (the ALL column on Table 37). The second set of regressions included the data rows for the first 10 time periods or until the relevant stability period if stability was reached before 10 periods (the FIRST 10 column on Table 37). The third set of regressions included the last 10 periods prior to stability or prior to the simulation end time (the LAST 10 column on Table 37). The final set of regressions included the periods after the first ten periods and before the last ten periods (the MIDDLE column on Table 37).

6.8 Results

The results of the data analysis are presented in two segments. The first segment presents the descriptive statistics and the second segment presents the hypotheses tests.

6.8.1 Descriptive Statistics

The preliminary analysis of the simulated data set revealed that 4398 networks (88%) had reached adopter stability whereas only 649 networks (13%) had reached feature stability during the 50 time periods of the simulation. On average, the adopter stability took eight time periods (Minimum: two periods; Maximum: 50 periods) whereas the feature stability took almost 26 time periods (Minimum: four periods; Maximum: 50 periods). These statistics indicate that the adoption of the first feature by individuals is considerably faster than the adoption of all features of the innovation.

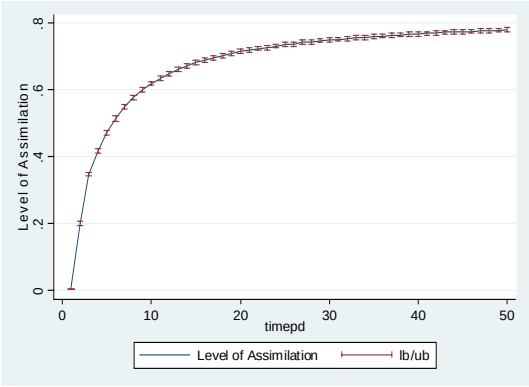

Figure 32. Assimilation Pattern

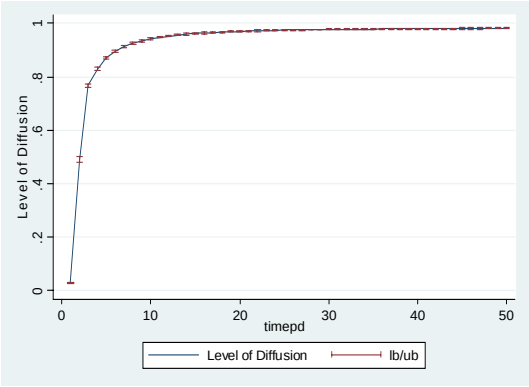

Figure 33. Diffusion Pattern

Figure 32 and Figure 33 depict changes in the level of diffusion and assimilation over time, respectively, for all networks in the sample. Both graphs show increasing rates of change in the early periods and flattening trends in the late periods. However, the slope of the

diffusion curve is much steeper than the assimilation curve during the early periods indicating that diffusion happened quickly during the first 10 periods of the simulation. This is understandable because diffusion (i.e., adoption of first feature by an individual) is a pre-requisite for assimilation (i.e., adoption of multiple features by adopters).

Figure 34, Figure 35, and Figure 36 show the curves for the influencer, adopter, and contextual actions ratios respectively (representing the change in ratios between the current and previous time period) within the networks over time. These graphs exhibit some differences during the early stages; the graphs for adopter and contextual actions show an initial dip before picking up in the early periods whereas the influencer actions revealed a steadily increasing trend during the initial periods. However, all three graphs showed similar trends during later periods of the simulation, with decreasing levels of incremental activity. These patterns seem intuitively appealing. For example, with an increase in the number of adopters during the early time periods, there was an increase in the influencer actions as well (since more adopters can now influence other individuals). However, as more individuals adopted more features, the influencer actions decreased as well (since the number of individuals who can be influenced decreased with time).

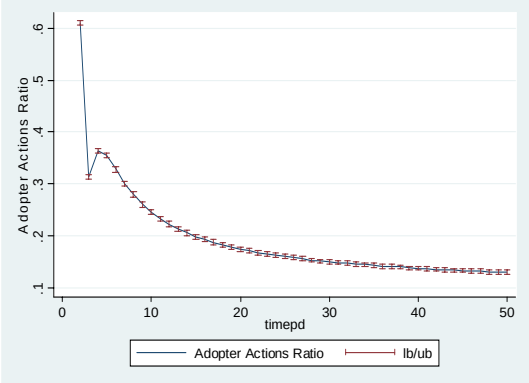

Figure 34. Influencer Actions Patterns

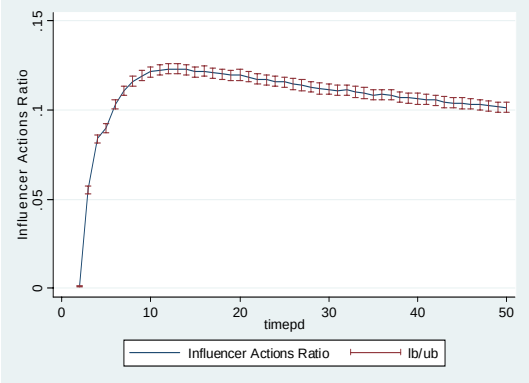

Figure 35. Adopter Actions Patterns

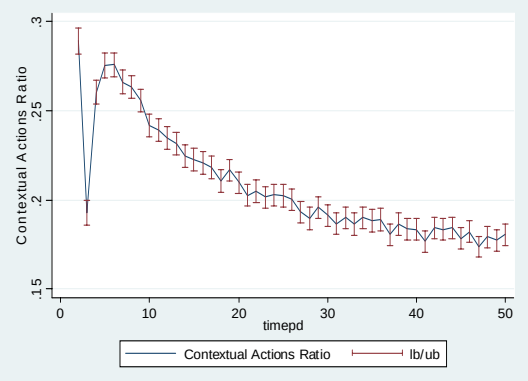

Figure 36. Contextual Actions Patterns

Table 32 provides the descriptive statistics for the two dependent variables, the three mediating variables, and the independent variables. All dependent and mediating variables were normally distributed, based on the criteria of skewness below 2 and kurtosis below 5, and did not require transformations (Akgun et al. 2006; Ghiselli et al. 1981). The correlations among the dependent and mediating variables, computed using the pairwise deletion method, ranged from -0.54 to 0.68. The pairwise computations ensured that the correlations were computed using the maximum number of observations available, since the number of observations for these variables were not the same. The differences in sample sizes are due to different reasons. For instance, when a network reaches feature stability (i.e. all individuals in the network have adopted all features of the innovation) at a given time period, say T, $T < 50$ (i.e. the maximum time periods in the simulation), the data records for the remaining time periods drop out of the sample. Similarly, the influencer actions ratio would be defined when there are no ties in the network, since influencer actions are not possible in a network of individuals who are all isolates. The correlations among independent variables ranged from -0.04 to 0.03 except in one instance: the correlation between network density and network centralization was 0.35, significant at the 0.001 level. The correlations between the dependent or mediating variables and the independent variables ranged between -0.22 and 0.18 except in three c: the correlation between cultural orientation and level of assimilation was 0.51, between cultural orientation and adopter actions -0.52, and between network strength and influencer actions 0.55, all significant at the 0.001 level. The correlations did not reveal multicollinearity problems.

6.8.2 Hypotheses Tests

The complete results of the regression analyses are shown in Table 33 (adopter actions model), Table 34 (influencer action model), Table 35 (diffusion model), and Table 36 (assimilation model). The number of observations used in the regression models was based on the measures of adopter stability (for diffusion) and feature stability (for assimilation, influencer actions, and adopter actions). The Wald chi-square statistic revealed that all four regression models were significant at the 0.001 level. The consolidated results of the regression analyses, based on the ALL periods conditions, are available in Table 37.

Based on the regression analysis of the four different empirical models over ALL 50 time periods, the research model received considerable empirical support (See Table 37, ALL column). All five propositions (P-1 through P-5) were supported. In brief, 13 of the 20 hypotheses associated with the five propositions received empirical support. The results were consistent with the extant literature, i.e. Contingencies impact Diffusion and Assimilation of IS/IT innovations. The results were also consistent with proposed extensions to extant literature, i.e. Contingencies impact Actions which in turn impact Diffusion and Assimilation of IS/IT innovations. Thus, the major hypotheses of this essay in this dissertation are supported. Specifically, Actions mediate the relationship between Contingencies and Diffusion and Assimilation of IS/IT innovations. Further, Actions influence Diffusion and Assimilation of IS/IT innovations and vice versa, modeled in this dissertation as causal relationships using lag measures.

Table 32. Descriptive Statistics

Panel A. Dependent/Mediating Variables

Variable	N	Mean	S.D.	Min	Max	Level of Assimilation	Level of Diffusion	Influencer Actions	Adopter Actions
Level of assimilation @ t=T	234344	0.67	0.27	0	1.00				
Level of diffusion @ t=T	234344	0.92	0.19	0	1.00	0.68***			
Influencer actions from t=T-1 to T	218138	0.10	0.09	0	0.87	0.13***	0.24***		
Adopter actions from t=T-1 to T	229344	0.19	0.17	0	0.87	-0.88***	-0.54***	-0.06***	
Contextual actions from t=T-1 to T	229344	0.20	0.22	0	1.00	-0.29***	-0.09***	0.16***	0.39***

Correlations are computed pairwise
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001
N: # of observations
# of networks: 5000
# of time periods: 50

Panel B. Independent Variables

Variable	Mean	S.D.	Min	Max	Organization Structure	Cultural Orientation	Network Density	Network Centralization	Network Strength	Organization innovativeness
Organization structure	0.50	0.41	0	1.00						
Cultural orientation	0.49	0.40	0	1.00	0.02***					
Network density	0.31	0.31	0.01	0.90	0.003	-0.002				
Network centralization	0.13	0.08	0	0.63	0.004*	-0.01**	0.35***			
Network strength	0.50	0.33	0	1.00	-0.02***	-0.03***	0.01***	-0.01***		
Org Innovativeness	0.50	0.06	0.21	0.77	0.01***	0.01***	0.002	0.01***	0.003	
Org IS Expertise	0.50	0.06	0.21	0.78	0.004*	0.02***	-0.01***	-0.04***	-0.02***	-0.01**

Correlations are computed pairwise
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001
# of observations: 250000
# of networks: 5000
# of time periods: 50

Panel C. Dependent/Mediating Variables and Independent Variables

Independent Variable	Level of Assimilation	Level of Diffusion	Influencer Actions	Adopter Actions	Contextual Actions
Organization structure	0.07***	0.01***	-0.09***	-0.09***	-0.06***
Cultural orientation	0.51***	0.18***	-0.03***	-0.52***	-0.22***
Network density	0.05***	0.01***	0.12***	-0.05***	-0.01***
Network centralization	0.04***	0.02***	0.09***	-0.05***	-0.01***
Network strength	0.05***	0.01***	0.55***	-0.04***	-0.03***
Org Innovativeness	-0.001	-0.003	0.00	0.01**	0.01***
Org IS Expertise	0.02***	0.002	-0.02***	-0.00	-0.00

Correlations are computed pairwise
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001
# of networks: 5000
# of time periods: 50

Table 33. Regression: Adopter Action Model

Predictors	ALL PERIODS [a]		FIRST 10 PERIODS		MIDDLE PERIODS		LAST 10 PERIODS	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Constant	0.586***	0.015	0.525***	0.012	0.565***	0.018	0.472***	0.026
Time-variant measures								
Adopter actions from t=T-2 to T-1	-0.243***	0.010	-0.119***	0.005	-0.001	0.0008	-0.020	0.017
Level of assimilation @ t=T-1	-0.823***	0.008	-0.821***	0.006	-0.634***	0.006	-0.641***	0.012
Level of diffusion @ t=T-1	0.287***	0.006	0.381***	0.003	0.102***	0.016	0.190***	0.024
Time-invariant measures								
Org Innovativeness	-0.010	0.011	-0.015	0.014	-0.008	0.009	-0.003	0.008
Org IS Expertise	0.055***	0.011	0.076***	0.014	0.040***	0.009	0.032***	0.008
Control measures								
Innovation size	-0.002***	0.0001	-0.006***	0.0002	-0.0006***	0.0001	-0.0007***	0.0001
Network size	-0.00005	0.00005	-0.00006	0.00006	-0.00003	0.00004	-0.00005	0.00004
Innovation (=1) vs. Feature (=0) –centric	-0.004**	0.001	-0.012***	0.001	-0.002#	0.001	-0.003**	0.001
Contingency only	-0.136***	0.002	-0.176***	0.002	-0.106***	0.002	-0.077***	0.002
History only	-0.043***	0.001	-0.081***	0.002	-0.027***	0.001	-0.016***	0.001
Wald Chi-square	44621.05***		35318.18***		55788.86***		39508.49***	
Number of observations	224344		39864		135885		49721	
Number of groups	5000		5000		4764		5000	

Notes:
Dependent variable is Change in adopter actions ratio from t=T-1 to t=T
Level of diffusion is computed as #Adopters / Network size
[a]: All periods until feature-stability, i.e. time at which all features were adopted by all individuals (i.e. full assimilation)
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001

Table 34. Regression: Influencer Action Model

Predictors	ALL PERIODS [a]		FIRST 10 PERIODS		MIDDLE PERIODS		LAST 10 PERIODS	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Constant	-0.111***	0.003	-0.053***	0.002	-0.150***	0.008	-0.177***	0.012
Time-variant measures								
Influencer actions from t=T-2 to T-1	0.283***	0.014	0.523***	0.016	0.162***	0.015	0.211***	0.025
Level of assimilation @ t=T-1	-0.038***	0.002	0.004	0.003	-0.046***	0.004	-0.118***	0.006
Level of diffusion @ t=T-1	0.120***	0.003	0.063***	0.001	0.155***	0.010	0.236***	0.015
Time-invariant measures								
Network density	0.024***	0.001	0.010***	0.001	0.032***	0.003	0.030***	0.002
Network centralization	0.080***	0.008	0.035***	0.005	0.103***	0.012	0.105***	0.012
Network strength	0.121***	0.003	0.086***	0.002	0.153***	0.004	0.114***	0.004
Control measures								
Innovation size	0.003***	0.0001	0.001***	0.0001	0.005**	0.0002	0.004***	0.0002
Network size	0.0003***	0.00004	0.0002***	0.00003	0.0004***	0.00006	0.0004***	0.00006
Innovation (=1) vs. Feature (=0) –centric	-0.006***	0.001	0.002**	0.0007	-0.008***	0.002	-0.011***	0.001
Contingency only	-0.025***	0.001	-0.022***	0.001	-0.033***	0.002	-0.018***	0.002
History only	-0.010***	0.001	-0.021***	0.0009	-0.011**	0.002	-0.0008	0.002
Wald Chi-square	14155.29***		28579.02***		6921.28***		4443.34***	
Number of observations	213385		37905		129214		47280	
Number of groups	4753		4753		4532		4753	

Notes:
Dependent variable is Change in influencer actions ratio from t=T-1 to t=T
Level of diffusion is computed as #Adopters / Network size
[a]: All periods until feature-stability, i.e. time at which all features were adopted by all individuals (i.e. full assimilation)
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001

Table 35. Regression: Diffusion of IS/IT Innovations Model

Predictors	ALL PERIODS [a]		FIRST 10 PERIODS		MIDDLE PERIODS		LAST 10 PERIODS	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Constant	0.030*	0.015	0.122***	0.00	0.160***	0.014	0.380***	0.014
Time-variant measures								
Level of diffusion @ t=T-1[b]	0.748***	0.015	0.483***	0.018	0.813***	0.015	0.402***	0.013
Influencer actions from t=T-2 to T-1	0.081***	0.016	0.356***	0.018	0.057***	0.009	0.187***	0.012
Adopter actions from t=T-2 to T-1	0.254***	0.012	0.214***	0.008	-0.048	0.010	0.134***	0.010
Contextual actions from t=T-2 to T-1	0.004**	0.001	0.008***	0.002	0.0004	0.007	0.008***	0.001
Time-invariant measures								
Organization structure (Centralization=1)	0.011***	0.002	0.028***	0.003	0.0002***	0.002	0.017***	0.002
Cultural orientation (Individualistic=1)	0.136***	0.003	0.216***	0.004	0.011***	0.002	0.107***	0.002
Control measures								
Innovation size	0.006***	0.0004	0.015***	0.0004	0.003	0.0003	0.006***	0.0003
Network size	0.0002**	0.00007	0.000	0.000	0.0003***	0.00005	0.0006***	0.00007
Innovation (=1) vs. Feature (=0) –centric	0.052***	0.002	0.085***	0.002	0.008***	0.002	0.041***	0.001
Contingency only	0.020***	0.004	0.000	0.003	-0.022***	0.003	0.003	0.003
History only	0.005	0.003	-0.021***	0.004	-0.013***	0.002	-0.002	0.003
Wald Chi-square	17146.60***		15572.41***		28948.13***		3870.42***	
Number of observations	52541		20356		20656		23162	
Number of groups	4276		4276		918		4276	

Notes:
Dependent variable is Level of diffusion @ t=T
Level of diffusion is computed as #Adopters / Network size
[a]: All periods until adopter-stability, i.e. time at which all individuals adopted the first feature of the innovation (i.e. full diffusion)
#: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001

Table 36. Regression: Assimilation of IS/IT Innovations Model

Predictors	ALL PERIODS [a]		FIRST 10 PERIODS		MIDDLE PERIODS		LAST 10 PERIODS	
	B	S.E.	B	S.E.	B	S.E.	B	S.E.
Constant	0.511**	0.025	0.032***	0.003	-0.029***	0.004	-0.245***	0.030
Time-variant measures								
Level of assimilation @ t=T-1[b]	0.120**	0.041	0.743***	0.004	0.923***	0.008	1.672***	0.048
Level of diffusion @ t=T-1	0.209***	0.015	-0.004	0.003	0.043***	0.0008	-0.401***	0.036
Influencer actions from t=T-2 to T-1	0.090***	0.008	0.105***	0.006	0.019***	0.009	0.007	0.005
Adopter actions from t=T-2 to T-1	-0.687***	0.040	0.100***	0.003	-0.063***	0.009	0.772***	0.052
Contextual actions from t=T-2 to T-1	-0.002*	0.001	0.002***	0.0007	0.0004***	0.0001	0.004***	0.001
Time-invariant measures								
Organization structure (Centralization=1)	0.028***	0.002	0.029***	0.001	0.002***	0.0003	-0.007***	0.001
Cultural orientation (Individualistic=1)	0.144***	0.005	0.152***	0.001	0.007***	0.0007	-0.036***	0.003
Control measures								
Innovation size	-0.001***	0.0002	-0.000	0.000	0.0003***	0.00003	0.0009***	0.0001
Network size	0.000	0.000	-0.000	0.000	0.000006	0.000006	-0.000	0.000
Innovation (=1) vs. Feature (=0) –centric	0.059***	0.002	0.060***	0.001	0.003***	0.0003	-0.014***	0.001
Contingency only	-0.119***	0.006	-0.016***	0.001	-0.009***	0.001	0.072***	0.005
History only	-0.078***	0.003	-0.047***	0.003	-0.002***	0.0005	0.026***	0.002
Wald Chi-square	108744.96***		348562.65***		5920000***		111535.66***	
Number of observations	213385		37905		129214		47280	
Number of groups	4753		4753		4532		4753	

Notes:
Dependent variable is Level of assimilation @ t=T
Level of assimilation is computed as #Features adopted / (Network size * Innovation size)
Level of diffusion is computed as #Adopters / Network size
[a]: All periods until feature-stability, i.e. time at which all features were adopted by all individuals (i.e. full assimilation)
[#]: p≤0.10, *: p≤0.05, **: p≤0.01, ***: p≤0.001

Model	Hypothesis	Relationship	Expected	Results			
				ALL	First 10	Middle	Last 10
Adopter action	H-2D	*Org Innovativeness → Adopter actions*	+	n.s.	n.s.	n.s.	n.s.
	H-2E	Org IS Expertise → Adopter actions	+	+	+	+	+
	H-4C	Level of diffusion @ t=T-1 → Adopter actions @ t=T	+	+	+	+	+
	H-4D	Level of assimilation @ t=T-1 → Adopter actions @ t=T	-	-	-	-	-
Influencer action	H-2A	Network density → Influencer actions	+	+	+	+	+
	H-2B	*Network centralization → Influencer actions*	-	+	+	+	+
	H-2C	Network strength → Influencer actions	+	+	+	+	+
	H-4A	Level of diffusion @ t=T-1 → Influencer actions @ t=T	+	+	+	+	+
	H-4B	*Level of assimilation @ t=T-1 → Influencer actions @ t=T*	+	-	n.s.	-	-
Diffusion	H-1A	Organization structure (central = 1) → Level of diffusion	+	+	+	+	+
	H-1C	*Cultural orientation (individual = 1) → Level of diffusion*	-	+	+	+	+
	H-3A	Contextual actions @ t=T-1 → Level of diffusion @ t=T	+	+	+	+	+
	H-3C	Influencer actions @ t=T-1 → Level of diffusion @ t=T	+	+	+	+	+
	H-3E	Adopter actions @ t=T-1 → Level of diffusion @ t=T	+	+	+	n.s.	+
Assimilation	H-1B	Organization structure (central = 1) → Level of assimilation	+	+	+	+	-
	H-1D	*Cultural orientation (individual = 1) → Level of assimilation*	-	+	+	+	-
	H-3B	*Contextual actions @ t=T-1 → Level of assimilation @ t=T*	+	-	+	+	+
	H-3D	Influencer actions @ t=T-1 → Level of assimilation @ t=T	+	+	+	+	n.s.
	H-3F	*Adopter actions @ t=T-1 → Level of assimilation @ t=T*	+	-	+	-	+
	H-5	Level of diffusion @ t=T-1 → Level of assimilation @ t=T	+	+	n.s.	+	-

Legend (for ALL column): n.s.: not significant, +: positive relationship at 0.05 level, -: negative relationship at 0.05 level
Legend (for RELATIONSHIP column): regular font: relationship as expected, *italic font*: relationship either not supported or opposite from expected

Table 37. Regression Results

More specifically, two of the four hypotheses generated by proposition P-1 were supported. The exceptions were hypotheses H-1C (cultural orientation → diffusion) and H-1D (cultural orientation → assimilation), with the results being in the direction opposite of both the hypothesized effects. For both diffusion and assimilation, I had expected collectivistic cultural orientation to be the influential factor; however, in both cases, the results indicated that individualistic cultural orientation to be the influential factor. Three of the five hypotheses generated by proposition P-2 were supported. The exceptions were hypotheses H-2D (innovativeness → adopter actions) and H-2B (network centralization → influencer actions); H-2D was not supported and H-2B was opposite of expectations. I had expected network centralization to be negatively related to influencer actions but found a positive relationship between the two variables. Four of the six hypotheses generated by P-3 were supported: the results for H-3B (contextual actions → level of assimilation) and H-3F (adopter actions → level of assimilation) were opposite of expectations. I had expected both contextual actions and adopter actions to be positively related to the level of assimilation but the results showed a negative relationship between the two independent variables and the level of assimilation. Three of the four hypotheses generated by P-4 were supported: the results for H-4B (level of assimilation → influencer actions) were significant in the opposite

direction. I had anticipated a positive relationship between level of assimilation and influencer actions but the results indicated a negative relationship between the two variables. Finally, hypothesis H-5 was supported.

All models were also examined under three other conditions (FIRST 10, MIDDLE, and LAST 10), depending on the time periods that were considered for analysis. While the results of these additional models were generally consistent with the results of the main (i.e. ALL model), there were exceptions. Such exceptions were also not consistent across the FIRST 10, MIDDLE, and LAST 10 models, indicating that some of these effects vary over time. These results are discussed in terms of the four empirical models examined.

When tested for all time periods, three of the four hypotheses for the adopter action model were supported. That is, the change in adopter actions, from the previous time period to the current time period, were positively related to organizational IS expertise as well as the level of diffusion until the previous time period, and negatively related to the level of assimilation until the previous time period. The remaining hypothesis (H-2D), concerning the relationship between organizational innovativeness and adopter actions, was not supported. This may have been an artifact of the measurement method employed. Innovativeness was manipulated at the individual level in the simulation, and the network level measure of innovativeness was computed as an aggregate (i.e. average) measure of the innovativeness of all individuals in the network. These results were also consistent with the results of the FIRST 10, MIDDLE, and LAST 10 time periods.

When tested for all time periods, three of the five hypotheses for the influencer action model were supported. Specifically, the change in influencer actions, from the previous time period to the current time period, were positively related to network density, network strength, and level of diffusion until the previous time period. These results were consistent with the results obtained using the FIRST, MIDDLE, and LAST 10 time periods. The results for the remaining two hypotheses were significant in the opposite directions than expected. That is, the influencer actions for the current time period were positively related to network centralization and negatively related to the level of assimilation until the previous time period. While network centralization continued to be positively related in the FIRST 10, MIDDLE, and LAST 10 periods, the level of assimilation was not significant in the FIRST 10 periods.

When tested for all time periods, four of the five hypotheses for the diffusion model were supported. That is, the level of diffusion (at time T, the current time period) was positively related to organization structure (centralization), contextual actions in the previous time period, influencer actions in the previous time period, and adopter actions in the previous time period. These results were also consistent with the results for the FIRST, MIDDLE, and LAST 10 periods. The remaining hypothesis, the relationship between cultural orientation and diffusion was found to be positive, which was different from the expected negative relationship.

Finally, when tested for all time periods, three of the six hypotheses for the assimilation model were supported. Specifically, the level of assimilation (at time T, the current time period) was positively related to organization structure (centralization), cultural orientation (individualistic), influencer actions in the previous time period, and level of diffusion in the

previous time period. Two of the remaining three hypotheses, involving contextual actions and adopter actions, were negatively significant and opposite of expectations. The other hypothesis, between cultural orientation and assimilation, was positively related to assimilation, and contrary to expectations. Furthermore, all the hypothesized effects on the level of assimilation differed over time, as seen from the models for the FIRST, MIDDLE, and LAST 10 periods. Both organization structure and cultural orientation, which were positively related to the level of assimilation for all periods, were negatively related to level of assimilation in the MIDDLE and LAST 10 periods but exhibited a positive relationship with level of assimilation in the FIRST 10 periods. Both adopter actions and contextual, which exhibited a negative relationship with the level of assimilation for all periods, were positively related to the level of assimilation in the FIRST, MIDDLE, and LAST 10 periods. Influencer actions, positively related to the level of assimilation for all periods, were positively related, negatively related, and not related to the level of assimilation in the FIRST, MIDDLE, and LAST 10 periods respectively. Level of diffusion was negatively related to the level of assimilation in each of the FIRST, MIDDLE, and LAST 10 periods, but was positively related to the level of assimilation for all periods.

6.9 Discussion

The overall objective of this study was to examine the diffusion and assimilation of IS/IT innovations with special emphasis on the mediating role of actions in the relationship between contingencies and diffusion or assimilation of IS/IT innovations. To accomplish these objectives, I conducted cross-sectional time-series regressions of four different empirical models using simulated data on innovation adoption in 5000 networks, each over 50 time periods. The results showed support for 13 of the 20 hypotheses when examined using all 50 time periods, as explained in the previous section. Further, the results showed varying effects of several variables over different time periods, as seen from the FIRST 10, MIDDLE, and LAST 10 periods. The following discussion is organized along the several variables examined in this research through different models.

Effects of Contingencies

Organization structure and cultural orientation were examined in two models: diffusion and assimilation. From the diffusion model for ALL periods, it was found that organization structure and cultural orientation significantly affect the level of diffusion within the network. Although the nature of the effect of organization structure was as expected, the effect of cultural orientation was the opposite of the hypothesized effect. More specifically, whereas organizational centralization positively affects level of diffusion (consistent with H-1A), an individualistic culture (and *not* a collectivistic culture, as posited in H-1C) facilitates the level of diffusion. Organization structure and cultural orientation revealed similar effects in the FIRST 10, MIDDLE, and LAST 10 periods models as well. These results suggest that the effects of the two contingencies – organization structure and cultural orientation – are stable over time.

The assimilation model for ALL periods produced results similar to the above findings for the diffusion model. That is, organizational centralization (consistent with H-1B) and an

individualistic cultural orientation (opposite to H-1D) positively affect level of assimilation. The same relationships were also supported in the FIRST 10 and MIDDLE periods, further supporting the positive relationships of organization structure and providing additional indication that an individualistic (and *not* collectivistic, as expected) cultural orientation facilitates assimilation. However, the results for the LAST 10 periods were in the opposite direction. Specifically, a decentralized organization structure and a collectivistic cultural orientation facilitate assimilation in the later periods. These results suggest that the two contingencies: organization structure and cultural orientation are not stable, but exert varying influences, over time.

Together, the above results concerning organizational structure and organizational culture reveal how the effects of these time-invariant contingency variables change over time. *The adoption of the first feature of the innovation (i.e., diffusion) and the early stages of the assimilation (i.e., the adoption of the initial features) seems to benefit from a* centralized *organization structure and an* individualistic *culture. However, the late stages of assimilation (i.e., as individuals adopt the last remaining features of the innovation) benefit from a* decentralized *organization structure and a* collectivistic *culture.* This suggests that individuals within a network adopt initial features of the innovation based either on organizational directives (reflected by a centralized structure) or their own personal interests (reflected by an individualistic culture). However, individuals seem to require additional impetus for the adoption of the last set of features, such as the innovation being relevant for their units (decentralization) or for their affiliated groups (collectivistic).

The three network variables – network density, network centralization, and network strength – were examined in a single model, the influencer action model. All three network variables exhibited significant and positive effects on influencer actions, with the effects of network density and network strength being as expected (H-2A, H-2C, respectively), and the effect of network centralization being the opposite of the expected negative relationship (H-2B). The results were consistent across ALL periods as well as FIRST 10, MIDDLE, and LAST 10 periods. The unexpected result of network centralization indicates that individuals try to influence each other to a greater extent in more centralized networks, perhaps because the influence could come from supervisors, who have greater authority in centralized networks. In decentralized networks, on the other hand, adopter actions – rather than influencer actions – might be more common. This is consistent with the significant negative correlation between network centralization and adopter actions, although network centralization had not been hypothesized to affect adopter actions, and was therefore not included as an independent variable in the regression for adopter actions.

Organizational innovativeness and organizational IS expertise were examined in a single model, the adopter action model. Organizational innovativeness exhibited no relationship with adopter actions whereas organizational IS expertise was positively significant on adopter actions. The lack of support for organizational innovativeness was surprising, but that may be attributed to two reasons. First, organizational innovativeness was measured as an aggregated measure of the innovativeness scores of all individuals in the network. This computation may have neutralized the effects the innovative individuals within the network could have had on adopter actions. [Furthermore, the number of innovative individuals within the network may have been low as well.] Second, while innovative individuals are likely to explore more of the innovation (i.e. more adopter actions), it is also possible that innovative individuals also spend less time on the innovation (i.e. fewer adopter actions).

The combined effects of these two competing forces may have nullified the overall effect of organizational innovativeness on adopter actions. The support for organizational IS expertise is consistent with prior literature on innovation adoption which has showed IS expertise to be associated with adoption.

Effects of Actions

The effects of influencer actions, adopter actions, and contextual actions were examined in two models: diffusion and assimilation. In the diffusion model for ALL periods, influencer actions, adopter actions, and contextual actions were found to positively affect level of diffusion (as posited in H-3A, H-3C, and H-3E, respectively). Thus, the adoption of the first feature of the innovation by individuals within networks is influenced by actions from the context, actions from other individuals, and their own actions. This is consistent with prior literature on innovation adoption that demonstrate the importance of the larger context represented by factors such as mandates, memos, and training; the individuals' proximate context represented by factors such as social norms and internal information sources including interpersonal communication; and individuals' own behaviors such as observation and exploitation of help desks and documentation (Brancheau and Wetherbe 1990; Jasperson et al. 2005; Rogers 1983; Sabherwal et al. 2006; Venkatesh et al. 2003). Further, the results from the FIRST 10, MIDDLE, and LAST 10 periods indicated that thee effects of contextual, influencer, and adopter actions persist over time. Thus, all three actions are positively related to the diffusion of IS/IT innovations throughout the innovation adoption process.

The assimilation model for ALL periods showed different effects for the three types of actions. Whereas influencer actions were positively related to assimilation (as posited in H-3D), the contextual actions and adopter actions were *negatively* related to assimilation within networks (contrary to H-3B and H-3F, respectively). The negative effect of contextual actions on the level of assimilation may be explained as follows. Contextual actions deal with the entire innovation and not the features of the innovation, whereas level of assimilation explicitly deals with the innovation features and not the innovation as a whole. Consequently, contextual actions may positively affect the adoption of the first feature (i.e., the level of diffusion) but negatively affect the adoption of the subsequent features (i.e., the level of assimilation). The negative effect of adopter actions on the level of assimilation may be because greater number of adopter actions reflects that the adopter is struggling with the innovation and therefore adopts *fewer* additional features. Two potentially contributing reasons are the individuals' unfamiliarity or lack of expertise with the innovation and the complexity of the innovation itself.

Results for the FIRST 10, MIDDLE, and LAST 10 periods revealed that the effects of the three types of actions on the assimilation of innovations vary with time. Specifically, influencer actions were positively related to assimilation in the FIRST 10 and MIDDLE periods, but not significantly related to it in the LAST model. Adopter actions were positively related to assimilation in the FIRST 10 and LAST 10 periods, but exhibited a negative relationship with assimilation across ALL time periods and during the MIDDLE periods. Contextual actions, rather surprisingly, were positively related to assimilation in FIRST 10, MIDDLE, and LAST 10 periods, despite showing a negative relationship with

assimilation across ALL time periods. Collectively, *these results indicate that all three types of actions are positively related to assimilation during the early time periods*, much like diffusion. That is, initially during the innovation assimilation process, when few individuals have already adopted the innovation, assimilation depends on contextual actions, actions by adopters to explore new features, as well as influence actions by early adopters. *During the middle stages, influencer actions and contextual actions continue to facilitate assimilation, but adopter actions inhibit assimilation*, with greater number of adopter actions perhaps reflecting the individual's struggle with respect to the innovation, as discussed above. *Even later during the process*, when level of diffusion is high, indicating that a large proportion of the individuals have adopted at least one feature of the innovation, *adoption of additional features is no longer affected by others (i.e., influencer actions), and is instead positively affected by the adopter's own actions and by the contextual actions*. This may be explained to some extent by how the organization or its representatives such as managers may require some features of the innovation to be adopted and not others (Jasperson et al. 2005) or how individuals may adopt only those features on an as-needed basis and not due to the influences of other individuals.

Despite the positive effects of adopter actions on assimilation during FIRST 10 and LAST 10 periods, and the positive effects of contextual actions on assimilation in each of the FIRST 10, MIDDLE, and LAST 10 periods, it is important to emphasize that both actions were negatively related to assimilation of IS/IT innovations across ALL time periods. In addition to reflecting the potential struggle by the adopters, the negative effect of adopter actions on assimilation may be attributed to the following two reasons. First, since innovation features may be considered collections of mandatory and voluntary features (Jasperson et al. 2005), it may be argued that individuals adopted those mandatory features in the early period and looked at the voluntary features in the later periods. [This would be consistent with individuals exploring the innovation and its features (resulting in actions) but not adopting additional features (as they were voluntary). Alternatively, it may be argued that individuals adopted chunks of features in later periods that became relevant for them or that were additionally mandated for individuals. [This would be consistent with the time-variant effects of organization structure and cultural orientation on assimilation.] Second, it is possible that the innovation and its features were sufficiently complex resulting in significantly greater efforts (adopter actions) from individuals prior to adoption (Davis 1989; Moore and Benbasat 1991; Rogers 1995), if not for all individuals, then at least for a significant portion of the individuals in the network. Finally, when the effects of contextual actions and influencer actions are viewed in conjunction with influencer actions, it may be argued that individuals benefit from the experiences, assurances, and assistance of the early adopters (i.e. influencer actions) during the early time periods that may have been fraught with uncertainties regarding the innovation, whereas they are willing and able to explore and exploit the innovation during the later stages (i.e. contextual and adopter actions) as they gain more experience using the innovation and its features.

Effects of Diffusion and Assimilation

Level of diffusion was included as an independent variable in two models: influencer action model and adopter action model. The influencer action model and the adopter action model involving ALL time periods revealed that the level of diffusion exhibited a positive effect on both influencer actions and adopter actions. That is, influencer actions and adopter actions

increased with an increase in the level of diffusion, possibly because increase in the number of individuals who have adopted the first feature of the innovation increases the number of individuals who perform influencer actions as well as adopter actions.

Finally, level of assimilation was included as an independent variable in the same two models as level of diffusion: influencer action model and adopter action model. In the adopter action model for ALL periods, level of assimilation was negatively related to adopter actions, as expected. Level of assimilation was found to have similar effects on influencer actions in the results for FIRST 10, MIDDLE, and LAST 10 periods. However, in the influencer action model for ALL periods, level of assimilation was negatively related to influencer actions, contrary to expectations. The MIDDLE and LAST 10 periods revealed a similar negative relationship between level of assimilation and influencer actions, although the FIRST 10 periods exhibited a non-significant relationship. The negative effect of the level of assimilation on influencer actions during the later periods may be because when individuals have already adopted more features (as indicated by a high level of assimilation), there may be fewer features remaining to be adopted. Such a negative effect of level of assimilation on influencer actions (due to the lower *need* for influencer actions) may offset the expected positive effect (due to individuals who have adopted more features having greater *ability* to influence individuals to adopt more features). During the initial stages, the two effects may offset each other, thereby leading to a non-significant effect of level of assimilation on influencer actions, but during the later stages, the negative effect due to the reduced need might be greater, because of the increased assimilation with time, thereby producing the significant and negative effect of level of assimilation on influencer actions during MIDDLE and LAST 10 periods.

Summary

Overall, this research found both actions (contextual, influencer, and adopter) and contingencies (organization structure and cultural orientation) played important but varying roles on the diffusion and assimilation of IS/IT innovations within networks. Contingencies had a main effect, as well an indirect effect through Actions, on the diffusion and assimilation of IS/IT innovations in networks. Actions mediated the relationship between Contingencies and the Diffusion and Assimilation of IS/IT innovations. Thus, the primary propositions of this research were well supported.

So, what does this all mean for individuals and organizations dealing with IS/IT innovations? As pointed out in the prior literature on innovation adoption and use, two different adoption scenarios are possible. Organizations may either direct the individuals to use an IS/IT innovation (i.e. mandatory adoption) or allow the individuals to make their own decisions regarding use of an IS/IT innovation (i.e. voluntary adoption). Mandatory adoption is common when the innovation is relevant to virtually all members of the organization (such as a corporate electronic mail system) whereas voluntary adoption is the norm when the innovation may not be appropriate or required by all members of the organization (such as a personal productivity system). In either scenario, adoption of the IS/IT innovation may be viewed as the acceptance of its features; initially, the first feature (i.e. diffusion) and subsequently the other features (i.e. assimilation). This is where this

research contributes the most by providing an understanding of how individuals in organizations may progress from diffusion through assimilation.

According to the findings of this research, diffusion takes considerably less time than assimilation (c.f. eight time periods for diffusion vs. 26 time periods for assimilation on average). Regardless of whether individuals decide to adopt an innovation as a result of organizational directives or personal interests, assimilation happens considerably less frequently than diffusion (c.f. full assimilation in 649 networks vs. full diffusion in 4398 networks). These results are consistent with expectations because diffusion precedes assimilation, but together, they imply that individuals are generally prone to adopt the first feature and perhaps some extra features of the innovation much more frequently and painlessly than adopting all features of the innovation. If the organization were to be satisfied with such partial adoption by individuals, then the rest of this discussion may be considered superfluous.

On the other hand, if the organization envisions full assimilation of the innovation by all individuals (to maximize the returns on organizational investments in IS/IT for design, development, and deployment, or acquisition and implementation), different strategies would be needed to make full assimilation a reality. In mandatory adoption contexts, where directives and mandates are initiated at the upper levels of the organization hierarchy at the beginning stages, it becomes important to *cascade the adoption decisions down and give control and authority to implement the mandates or directives to relatively lower levels of the organization hierarchy*. That is, organizations may engage in contextual actions to get the individuals to adopt innovations initially. While contextual actions at the organizational level may be influential in diffusion, they may not be sufficient for assimilation. Managers in the lower levels of the organizational hierarchy need to be tasked with the responsibility of influencing individuals to assimilate innovations. In voluntary adoption contexts, where personal interests determine adoption decisions, *the innovation may be made more relevant for the groups to which individuals belong*. That is, individuals may be enthusiastic about adopting the innovations initially; however, the initial enthusiasm may not be sufficient to achieve assimilation. One possibility is to make the innovation more relevant for the immediate groups to which the individuals belong such that the initial adopters can benefit from externalities associated to the other individuals adopting the innovation as well. These strategies are based on the findings related to both organization structure and cultural orientation, which were centralized and individualistic respectively early on in the assimilation process, changed to decentralized and collectivistic during the later stages.

Furthermore, all three types of actions were influential in the diffusion and assimilation of innovations. The organization may engage in strategies to manage the three types of actions that facilitate diffusion and assimilation of IS/IT innovations. *The organization may periodically engage in one or more contextual actions* since contextual actions affect diffusion and assimilation over time. That is, organizations may have to engage in contextual actions over time rather than only during the initial stages. While the initial efforts may lead to diffusion, the subsequent efforts may lead to assimilation. Organizations and their managers should also recognize the importance of influencer and adopter actions. The influencer and adopter actions may not be directly controllable by the organization since both types of actions are within the purview of the individuals. However, *the organization may find ways to elicit influencer and adopter actions from individuals* through such devices such as motivation, incentives, or

example. This is because adopter actions and influencer actions are also influential in achieving diffusion and assimilation. These strategies are based on the findings related to all three types of actions being related to diffusion and assimilation.

6.10 Limitations

The results of the simulation should be interpreted in the light of several assumptions of the simulation model regarding the network, ties, and agents.

Stability of networks. The model assumed a stable network for the life of the simulation. That is, new individuals never joined the network and/or incumbents never abandoned the network. This may not always be true in real-world settings, especially over long periods of time. Hirings and firings are a prominent part of organizational life. In addition, individuals entering the network have the potential to influence the innovation process under two conditions: a) they may initiate new innovation processes or alter existing innovation processes, thus affecting adoption and diffusion, or b) they may advocate alternative innovations or oppose prevalent innovations, as a result of which innovation processes could be curtailed. Similarly, individuals leaving the network may have an effect on innovation adoption and diffusion processes under two conditions: a) they may have functioned as champions of the innovation, and their departure may actually curtail adoption and diffusion, or b) they may have opposed the innovation and curtailed adoption, and their departure may actually help adoption and diffusion.

Stability of relations. The model also assumed a stable set of relations between individuals in the network for the life of the simulation. That is, the particular configurations of strong and weak ties initially assigned to the individuals remained unchanged until the simulation ended. This may be quite different from what can be observed in real-world settings. Individuals may enter into new relationships and discontinue old relationships over time. This may be attributed to change in formal relationships as a result of reassigned job roles or functions, or to change in informal relationships as a result of new friendships. These shifts can alter the distribution of strong and weak ties in the network, thus ensuring that the innovation adoption and diffusion processes will change as well.

Reciprocal relations. The model further assumed reciprocal relations between individuals in the network for the life of the simulation. This means that, if the first individual reported strong ties with the second individual, then the second individual also reported strong ties with the first individual. This may or may not be true in real-world settings. That is, it is not necessary that both individuals report identical relations with each other. For instance, it is not necessary for two individuals sharing a hierarchical relationship to share similar ties. In this example, it is possible that the individual in a superior position reports strong ties with the other individual just because of the frequency of formal meetings between them. However, the subordinate individual may not necessarily consider these formal meetings as an indicator of strong ties.

Spatial proximities. The model additionally assumed spatial proximities for all individuals in the network for the life of the simulation. This means that all individuals were considered to be operating in the same physical space. This may not necessarily be true in actual

organizational settings. Different groups of individuals may work together in closely packed or adjacently located physical areas. These physical boundaries may actually be instrumental in distinguishing work groups, especially in fostering or alienating innovations. As a result, innovation adoption and diffusion may be heavily dependent on the particular work groups and the ways in which the physical spaces constrain or support innovation adoption and diffusion.

Full information. The model also assumed full information regarding adoption and diffusion between individuals in the network for the life of the program. That is, each individual is knowledgeable about the adoption behaviors or patters of adoption behaviors of the other individual in the network. This particular assumption may not be true in real-world settings since not all individuals share their adoption stories, success or otherwise, with other individuals. In reality, individuals may need to find information from other individuals on their adoption behaviors, before deciding on a course of action to be pursued for influencing other.

Relevance of features. The model assumed that all features of the innovation were relevant for all individuals in the network. While this status is theoretically possible in certain controlled settings (e.g. all individuals in a project team will use the same functionality of the same innovation), it is probably untenable in larger contexts. For instance, if the network being examined is the entire organization, then not all parts of the innovation may be relevant for all individuals since they are likely to have different roles and responsibilities and thus different uses for the innovation (Jeyaraj 2006). Thus, the applicability of features to individuals in the network may be considered in future analyses.

Stability of innovation. The simulation model also assumed that the innovation and its features are stable over time. This would probably be an accurate description of innovations that have been developed for a very specific purpose and whose functionality is fixed. In real-world settings, however, it is not inconceivable that innovation features can change over time due to software upgrades due to periodic updates, requests, or revisions; and software extensions such as add-ons, plug-ins, and on-demand installations (Jeyaraj 2007). It is also possible that certain features may be discontinued in subsequent releases of version upgrades available to individuals.

7 Conclusion

> This is not the end. It is not even the beginning of the end.
> But it is, perhaps, the end of the beginning.
> *Winston Churchill*

This research was initiated with four broad research questions. The first two questions related to the adoption and influence processes employed by individuals in networks as they dealt with the adoption of IS/IT innovations. The remaining two questions were related to the diffusion and assimilation of IS/IT innovations within networks, given the adoption and influence processes (i.e. mechanisms) identified for the first two questions. This chapter provides a summary of the research done and also implications for research and practice.

7.1 Summary

To answer the first two questions regarding adoption and influence processes employed by individuals, data were gathered through a series of field interviews with several individuals in multiple organizations. Textual analysis of the data allowed for the identification of several actions experienced by individuals for adoption of IS/IT innovations or performed by individuals for influencing others to use IS/IT innovations. Optimal matching and cluster analysis techniques on the actions revealed distinctive processes followed by individuals for both adoption and influence. Specifically, three adoption processes (namely, Conscious Quest, Requisite Compliance, and Piloted Trial) and three influence processes (namely, Directed Assistance, Queried Disclosure, and Logical Persuasion) were identified from the interview data.

The remaining two questions, regarding the diffusion and assimilation of IS/IT innovations within networks, were answered in two stages. First, an agent-based simulation was conducted, in which the behaviors of individuals were modeled using findings from the field interviews, specifically, the actions experienced and performed by individuals as they dealt with the adoption of IS/IT innovations. To answer the questions regarding diffusion and assimilation at the network level, data were recorded for the entire network even though behaviors were modeled at the individual level. Further, since diffusion and assimilation are processes that happen over time, the network level data were recorded over several time periods. The network data resulting from the simulation were then analyzed using cross-sectional time-series regression techniques. The analysis revealed that diffusion and assimilation were dependent on contingencies as well as three types of actions (contextual, influencer, and adopter) in the network. However, both contingencies and actions exerted varying influences over time.

This study has several implications for research methodologies, and for future research and practice on innovations in information systems.

7.2 Methodological Contributions

First, this research dealt with two distinct levels of analysis: the field interviews dealt with the individual whereas the simulation dealt with the network. This type of multi-level analysis is fairly uncommon in prior literature, although it seems particularly applicable for studies dealing with the adoption and diffusion of IS/IT innovations. Since adoption and diffusion are phenomena observable at different levels (individual vs. network), and since adoption and diffusion are intertwined by their very nature (i.e. adoption is an individual phenomenon whereas diffusion, which is a collection of adoptions by individuals, is a network phenomenon), multi-level analyses may be an ideal choice.

Second, this research employed multiple methods, including qualitative and quantitative techniques. At the highest level of distinction, both field interviews and simulation methods were used in this research. However, even within the qualitative framework of field interviews, this research made use of quantitative techniques such as optimal matching and cluster analysis. To achieve this, qualitative techniques were used to identify the actions from the textual data, and then the actions were used as input for the optimal matching algorithm, which determines the optimal solution for translating one action sequence given another sequence. A combination of qualitative and quantitative methods may be useful to lend some objectivity to the analysis of qualitative data.

Third, this research utilized agent-based simulation models to simulate the behavior of individuals dealing with IS/IT innovations. Agent-based simulation models are relatively new and considerably newer to information systems research. Agent-based simulation allows the stochastic manipulation of multiple agents at the same time, very similar to individuals in real-world settings, thus enabling a phenomenon to be examined across a collective of individuals such as a network. Further, the simulation component allows phenomena to be examined across space and time, enabling the examinations of patterns over time.

Fourth, the agent-based simulation not only followed up on the field interviews, but also benefited from the field interviews. Specifically, the insights from the field interviews were incorporated into the simulation such that the simulation was not devoid of realism. The methodological contribution to be highlighted is the underlying approach used to integrate two radically different methodologies. This research employed "actions" as the common mechanism between field interviews and agent-based simulation. More specifically, the agents (i.e. individuals) in the simulation were modeled to employ similar actions as their counterparts in the real world (i.e. interviewees).

Finally, the use of cross-sectional time-series analysis for examining longitudinal data generated by the simulation is another contribution of this research. Cross-sectional time-series analyses are fairly unusual in information systems research, perhaps due to the low incidence of longitudinal data to any great scale. But cross-sectional time-series methods have the potential to help understand the varying effects of phenomena over time.

7.3 Implications for Research

First, this study serves as one of the earliest studies to empirically examine the feature-centric view of innovation adoption. This view is a fairly recent exposition and dealt with how innovation adoption may be examined from the perspective of features, since individuals only adopt the features of the innovation. This research expanded on these propositions and modeled the behaviors of individuals in the simulation to be consistent with the feature-centric view. The results are generally supportive of the feature-centric approach to examining the adoption of IS/IT innovations.

Second, this research specifically examined the role of the influencer in the adoption, diffusion and assimilation of IS/IT innovations. Prior research on innovation adoption has generally assumed the role of the influencer in the adoption process. For instance, prior literature has demonstrated the importance of internal information sources (such as interpersonal communication with other individuals in the network) in the adoption process. But prior research generally examined the adoption process from the perspective of the adopter leaving the influencer role unexamined. This research serves as a validation for the importance of the influencers in the adoption and diffusion processes.

Third, the influence tactics literature provided the underpinnings for the actions of the influencer. While this literature has been used extensively in the organization behavior area, it is relatively new to the field of information systems. The findings related to the influence tactics were somewhat consistent with prior literature on influence tactics. However, in the IS/IT innovation context, three new influence actions emerged from the interview data: expertise, demonstration, and knowledge sharing. Further research would be needed to verify the extent to which the influence tactics inventories have to be tailored for the IS/IT innovation context.

Fourth, the pre-adoption actions of the potential adopter were specifically designed for use in this research. Thus, the pre-adoption actions framework is a contribution of the study. While the framework found useful support in this research, it may need validation in future research. Finally, the remaining two sets of actions – actions aimed at the entire organization and the adoption actions of the potential adopters – were also developed for this research. Further work may be needed to validate these inventories.

Fifth, the adoption and influence processes identified from the field interviews are unique to research on the adoption and diffusion of IS/IT innovations. Despite extensive attention in prior research, there is a dearth of process theories that deal with the adoption and diffusion of IS/IT innovations. The adoption processes and the influence processes from this research may serve as a base from which process theories regarding the adoption and diffusion of innovations may be formulated.

Sixth, this research proposed and examined a network-level model of diffusion and assimilation of IS/IT innovations. That is, the focus was on the patterns of diffusion and assimilation at the network level even though adoption is an individual-level phenomenon. In addition, the network-level model proposed and empirically examined how various contingencies and actions influence diffusion and assimilation of IS/IT innovations.

Finally, this study proposed and validated Actions as a new construct in examining the adoption, diffusion, and assimilation of IS/IT innovations. Two points about the Actions construct are particularly relevant for theory. First, Actions was positioned as a mediating construct between Contingencies and Diffusion or Assimilation of IS/IT innovations, a relationship that has considerable support in prior literature. Actions was found to mediate the relationship between Contingencies and Diffusion and Assimilation of IS/IT innovations. Second, Actions was conceptualized as actual behaviors of individuals with regard to IS/IT innovations. This is a significant departure from extant research that typically cast only IS/IT adoption and use as behaviors but their antecedents as perceptions, intentions, or beliefs. This is not to state that perceptions or intentions or beliefs are less important or do not matter, but rather to highlight the fact that individuals do engage in specific behaviors or become targets of specific behaviors regarding IS/IT innovations as they deal with adoption and assimilation of IS/IT innovations.

7.4 Implications for Practice

This research also has some potentially valuable implications for individuals and organizations dealing with the adoption, diffusion, and assimilation of IS/IT innovations.

First, this research uncovered three adoption processes (Conscious Quest, Requisite Compliance, and Piloted Trial) and three influence processes (Directed Assistance, Logical Persuasion, and Queried Disclosure), as reported by the same individual performing different roles (adopter vs. influencer) in dealing with the same innovation. These findings suggest that individuals follow different processes, and thus different paths, in adopting innovations even when they may have similar considerations such as ease of use or usefulness of the innovation. Organizations may need to implement different strategies to get individuals to adopt and assimilate IS/IT innovations.

Second, three categories of actions were identified in this research: contextual actions, influencer actions, and adopter actions. While the three categories of actions were equally important for the overall adoption and diffusion stories, the importance of contextual actions cannot be understated. Since both adopters and influencers are situated in the same context when dealing with IS/IT innovations, that whatever happens in the context is more influential for adoption and diffusion of IS/IT innovations. Specifically, organizations may have to engage in awareness creation, development, implementation, and training to promote the adoption and diffusion of IS/IT innovations.

Third, the influencer and adopter actions were influential in the adoption and diffusion of IS/IT innovations. Next only to contextual actions, influencer and adopter actions need to be performed for adoption and diffusion to happen. Stated differently, an organization would need to encourage individuals to perform both adoption and influence actions to achieve effective adoption and diffusion of IS/IT innovations. Prior literature has reported the role of champions as well as how individuals benefit from internal information sources for adoption and diffusion. This research indicates that organizations need to explicitly engage all individuals to actively promote as well as experiment with the innovation for maximum adoption and diffusion.

Finally, the simulation uncovered the varying effects of several variables on diffusion and assimilation of IS/IT innovations over time. This included different contingencies as well as the three types of actions. For instance, cultural orientation (individualistic) exhibited a positive relationship with assimilation during the early periods but a negative relationship during the later periods, which indicated that cultural orientation (collectivistic) was important during the later periods. This implies that organizations, assuming they want to achieve full diffusion and assimilation, would need to formalize strategies to exploit this change over time. Even assuming that individuals were interested in adopting the innovation in the early stages of the adoption process, such interest may not last until the assimilation is complete. Hence organizations need to find ways in which the innovations may be made more meaningful for the individuals by cascading adoption and assimilation related activities to units or groups to which individuals belong and by encouraging the groups to find ways to adopt IS/IT innovations.

Appendix A. Request for Research Access to Organizations

To: …
…

Subject: One or two dissertation interviews at your organization

Dear …:

Hope you are doing well.

I would like to introduce to you Anand Jeyaraj, a doctoral candidate in the Information Systems area at the College of Business Administration in the University of Missouri - St. Louis (UMSL). I am doing this in my capacity as his dissertation advisor and the Director of UMSL's Ph.D. program in Business Administration (with an emphasis in Information Systems). Drs. Vicki Sauter, Mary Lacity, and Deborah Balser are the other members of Anand's dissertation committee.

Anand is currently working on his doctoral dissertation in the area of information systems adoption by individuals within organizations. His dissertation focuses on how individuals within organizations adopt new information systems, the ways in which their adoption decisions are influenced by other individuals in their social networks, and the extent to which they use the new systems.

As part of the dissertation research, Anand would like to interview one or two individuals in your organization regarding their experiences with a recent information systems innovation they adopted, or discontinued after they adopted. Each interview will last about an hour, and the information obtained during each interview will only be used for academic research. The individuals or organizations participating in the study will not be identified in any presentation of the study's results.

I seek your help in getting Anand the approval to interview one or two individuals in your organization, and your assistance in identifying such individuals -- who have recently adopted an information systems innovation, and who may be willing to participate in the interviews. Please let me know if Anand can conduct interviews at <name of the organization> and I will have Anand contact you directly to set up the interview dates and times.

I appreciate your assistance and time in this matter.

Sincerely,

Appendix B. Request to Individuals for Participation in Research

REQUEST FOR PARTICIPATION IN RESEARCH

You are invited to participate in a research study about the adoption and diffusion of Information Systems (IS) or Information Technology (IT) innovations. This research is conducted by a doctoral student at the College of Business Administration in the University of Missouri–St. Louis. You are being requested to participate in the research since you have dealt with IS/IT innovations and may be eligible to participate. Your participation in this research is voluntary. Your decision whether to participate will not affect present or future relations with the university. If you decide to participate, you are free to withdraw at any time without affecting that relationship. If you have any questions about your rights as a research subject, you may call the Chairperson of the Institutional Review Board at 314.516.5897.

The purpose of the research is to understand the ways in which interpersonal relationships between members in social networks influence the mechanisms by which IS/IT innovations diffuse to members within an organization. If you participate in this research, you will be required to take part in an interview of not more than 60 minutes. During the interview, you will share your *perceptions* of how your relationships with others resulted in you adopting an innovation, or how others adopted an innovation due their relationships with you. You may choose to not answer any questions should you so desire.

There are no potential risks to participating in this study. The research would be beneficial for practitioners as they implement policies for managing innovations in organizations.

Anand Jeyaraj
Principal Investigator
Doctoral Candidate
College of Business Administration
Phone: 314.516.4882

Dr. Rajiv Sabherwal
Principal Investigator's Dissertation Advisor
University of Missouri System Curators' Professor
College of Business Administration
Phone: 314.516.6490

Appendix C. Interview Guide

1. How long have you been with this organization?
2. I will be asking for the interviewee's business card. If a business card is not available, then:
    a. What is your official job title and your job description?
3. How long have you been working with this unit?
4. What is the innovative IT system that you adopted most recently?
5. When did you first adopt this system?
6. Who are the THREE people who influenced you the most to adopt the system?
7. For each of the THREE people,
    a. What did [name of influencer] say or do that made you adopt the system?
    b. Did you or [name of influencer] generally initiate these interactions?
    c. Depending on answer to question b above, one of the following questions:
        i. What about the occasions when you may have specifically solicited [name of influencer]'s help or opinion or input regarding the system?
        ii. What about the occasions when [name of influencer] may have specifically talked or communicated to you about the system?
8. Did you also rely on information from other sources (other than the THREE people) in adopting the system?
9. Overall, what are the reasons due to which you adopted the system?
10. Who are the THREE people you influenced the most to adopt the system?
11. For each of the THREE people,
    a. What did you say or do that made [name of considerer] to adopt the system?
    b. Did you or [name of considerer] generally initiate these interactions?
    c. Depending on answer to question b above, one of the following questions:
        i. What about the occasions when you may have specifically talked or communicated to [name of considerer] about the system?
        ii. What about the occasions when [name of considerer] may have specifically solicited your help or opinion or input regarding the system?

Appendix D. Confidentiality Policy

CONFIDENTIALITY POLICY

Your responses are collected only for the purposes of this research. Interviews are tape-recorded to ensure accuracy of data collection. The audio-tapes are accessible only to the investigator and an individual who will be hired to transcribe the tapes. The transcripts will be available only to the investigator and his dissertation advisor. Audio-tapes will be destroyed after the completion of this research. To protect your organization as well as yourself, identities of participating organizations as well as individuals will remain anonymous throughout this research.

Anand Jeyaraj
Principal Investigator
Doctoral Candidate
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Phone: 314.516.4882

Dr. Rajiv Sabherwal
Principal Investigator's Dissertation Advisor
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Appendix E. Illustrations of Coding of Stories

ADOPTION STORIES

Illustration #1: Hilda

Narrative (including Actions)	**Action Type (Action Code)**	**Researcher Notes**
Hilda worked as an accounts payable manager at her organization. She also acted as manager of the accounting department. She was responsible for managing accounts payable and for implementing projects related to accounts payable or the accounting department, including information systems implementations.		
She recently served as the project lead for implementing the accounts payable unit of the Oracle Financial System – an enterprise-wide system aimed at integrating the various units within the organization. Hilda was concerned with only the specific implementation related to the accounting department.		
The decision to implement the Oracle Financial system was taken by the senior management. However, she participated in the evaluation process when the organization engaged different suppliers to demonstrate their products. Hilda said:		
"We talked to a lot of different software suppliers. I was part of the team that listened to presentations about a lot of different software suppliers."	Awareness creation (C1)	The sessions were arranged by the organization for its members
The senior management arranged for the consultants to talk to Hilda and her team to assist in the transition to the Oracle system. Stated Hilda:		
"We went through an intensive exploration phase where we had consultants come in and talk to me about what we currently did in our [department]."	Development (C4)	Hilda participated in specifying user requirements for the systems development process

Once the senior management decided to go with the Oracle system, they decided to implement all modules at the same time, a total switch to the new system.		
"We did our implementation a little more abruptly than a lot of companies do. We did everything… We decided to do the whole thing at once and go from the old system and totally install the new system. That was an upper management decision."	Implementation (C5)	The organization decided on a full switchover system implementation
Subsequently, the senior management mandated the use of the system as well. However, Hilda was herself enthusiastic about the new system because she felt the old system to be inadequate.		
We were told this is what we were going to do and this is the way we're going to do it.	Issuing of mandate (C2)	The organization mandated the system for employees
Hilda obtained additional information from the consultants regarding how the system would be beneficial to the organization and also to her department.		
"They [the consultants]… talked about what the new system would be able to do for us and how we would get there."	Presenting rational arguments (I5)	Hilda was presented with the advantages of the new system
Hilda attended training sessions that enabled her to understand the system better. The training provided the basic skills necessary for her to implement the system. She also received books that would allow her to gain additional information.		
"Then I went to training… And helped me to get the tools I need to do my module installation."	Training (C6)	Hilda participated in training sessions
"We did have training. It was very high level, very surfaced… and "Here's a book. This will help you figure it out."'	Training (C6) Other Influencer Action (OIA)	A book about the system was given to Hilda for her use… but it is not clear that she used it. Hence that action was not classified

Hilda uses about 20% of the features of the system now. The system was still being implemented and she hoped to adopt more features over time.		
"[I use] may be 20% of the features."	Partial adoption (A2)	Hilda indicated partial adoption of the system

Thus, Hilda's action sequence for adoption contains: C1, C4, C5, C2, I5, C6, C6, A2.

Illustration #2: Katelin

Narrative (including Actions)	Action Type (Action Code)	Researcher Notes
Katelin worked as a bond trader at her organization. She was responsible for conducting online trades, carrying out research about various trading opportunities, providing inventory of trades for their retail brokers, educating and marketing specific investments to their brokers, and assisting with outgoing information to the general public. Her job demanded that she routinely use different information systems. An information system that Katelin adopted when she joined the organization was the Bloomberg system. Bloomberg is a comprehensive system made available by an external provider that can be used for trading bonds. The Bloomberg system came with built-in information on several aspects including bonds, news wires, stock markets, etc. Katelin accessed the Bloomberg system through a computer station the external provider had installed on her desk. The Bloomberg system was actually required for all individuals trading bonds for the organization. The system was already installed and available in place before Katelin joined the organization. She understood, in her initial briefing sessions, that she would have to routinely use the Bloomberg system. A fellow employee introduced her to the Bloomberg system and to the fact that she would need it on her job. Katelin stated:		
"Because it [the Bloomberg System] was considered on the job as well… It wasn't until I actually got on the desk that someone take my hand and say, "You need this system," and that's about how it was initially introduced to me. And I said, 'Okay.'"	Being assertive (I8)	Katelin got to know about the system and its role from a fellow employee
Katelin was not authorized to use the live Bloomberg system until she got the license to trade. However, she benefited from a training system that the organization had in place and learnt the various features and the ways in which the system could be used for trading as well as for research. Katelin said:		

"The organization had a training system in place and I spent a couple of days working through sample entries… and learned all the different commands."	Training (C6)	The training system was put in place by the organization and helped Katelin understand the system
Katelin was assigned to a mentor during her early days on the job, and this mentor showed her the various capabilities of the system.		
She was going through and showing me what I could do… [She] would help find something… She would show me how …	Demonstration (OI2)	Katelin's mentor demonstrated the system to her
Katelin generally talked to her mentor on anything she needed to know about the system. However, she had the flexibility to call on any of her other fellow employees who shared the same floor space in the office.		
"If she [the person assigned] was gone, it was just a matter of [asking] the person across the way."	Inquiry (A7)	Katelin sought answers from her mentor or from other employees
Sometimes, Katelin obtained more information about the system through the periodic updates from Bloomberg representatives on behalf of the organization.		
"Bloomberg sent representatives out here periodically. When they have something new, they'll come out and say, 'Oh, we've got this new thing.'"	Awareness creation (C1)	Information about the new system was made available periodically
Once Katelin obtained the license, she began using Bloomberg for the actual trading transactions. She tried her best to learn the Bloomberg system by herself building off of what she had gained on her previous forays into the system. She even discovered certain aspects of the system by herself.		
I was always finding something new the system could do.	Experimentation (A3)	Katelin experimented with the system and found new features and uses of the system

"Primarily just experience. Until you have a situation [when you have a specific need]. It's like 'I never saw this before.'… I end up discovering [more about the system]."	Experimentation (A3)	Katelin experimented with the system and found new features and uses of the system
"Once you get how you find information on something or how to let it [the system] help you, then you know, 'Okay, it helped me do this time; let's try to go down that same path for other things.'"	Experimentation (A3)	Katelin experimented with the system and found new features and uses of the system
But when she was in unfamiliar territory, however, she solicited the help of her fellow traders who may have experienced similar issues.		
"Or, I would just ask the question out loud on my desk and some one on the desk has already gone down that path, then you get the answer you need."	Inquiry (A7)	Fellow employees may get some questions from Katelin when she was unable to find the solutions to the problems she had
Katelin used about 85% of the features and helped other individuals, perhaps new hires, use the Bloomberg system as well.		
I may be using 85% of it [the system].	Partial adoption (A2)	Katelin indicated partial adoption of the system

Thus, Katelin's action sequence for adoption contains: I8, C6, OI2, A7, C1, A3, A3, A3, A7, A2.

Illustration #3: Kevin

Narrative (including Actions)	Action Type (Action Code)	Researcher Notes
Kevin worked as a business analyst at his organization. He focused specifically on the online authorization systems. He had two major responsibilities: the first was to prepare business requirements for the authorization systems and take it to the systems development staff; the second was to publish information related to the authorization systems for use by members of the organization.		
He was recently involved in the implementation of the ChangePoint system at his organization. ChangePoint is a comprehensive system for time tracking, cost accounting, project management, and a host of other things. The organization used to have independent systems for these different activities before the implementation of ChangePoint.		
Several months prior to implementation, the organization sent out updates and information on the forthcoming ChangePoint system. This provided an opportunity for individuals like Kevin to get used to the idea of working with the new system.		
"Several months in advance of that we started receiving updates of what was coming to us."	Awareness creation (C1)	The message was sent out to all individuals in the organization
However, ChangePoint was made mandatory when the organization switched over.		
"It was mandatory. It's mandatory that we track our time. It's mandatory that we put all of our projects on the tool."	Issuing of mandate (C2)	The organization mandated the use of the system
The organization also set up training classes which provided basic information about the system and how to get started on it.		
"There were training classes for us to attend."	Training (C6)	The organization arranged training sessions

Unfortunately for Kevin and others, the initial implementation of ChangePoint was a turnkey solution which did not really cater well to the particular needs of Kevin's group. Hence, Kevin engaged in activities such as requesting updates or implementing own solutions to overcome the limitations of the system. Stated Kevin:		
"The initial implementation it was product they bought off the shelf… The initial implementation had a lot of shortcomings in it, so we had to request a lot of updates to support our needs… Unfortunately, we had to do some [tasks] elsewhere. We had a spreadsheet or project in our own group. We developed one in Access."	Implementation (C5) Requesting for… (A10) Seeking assistance (A9)	This talks about the implementation, the changes requested by Kevin, and alternate solutions created
Kevin employed a combination of different approaches to effectively work with the ChangePoint system. He experimented with the system as and when there was a specific requirement or task to be completed.		
"I think it was more of a need basis… I had a need to go in and look at certain reports that previously I had no need for."	Experimentation (A3)	Kevin engaged in experimentation with the new system
Kevin also interacted with other individuals in the organization who he knew had accomplished the same tasks before using the system. Sometimes, the other individuals assisted Kevin		
"I went mostly to the person who I knew had done this before."	Inquiry (A7)	Kevin inquired how to accomplish tasks using the system
"[I] just go out and ask them, 'What did you use to tie that report to variances for our cost center?'"	Inquiry (A7)	Kevin inquired how to accomplish tasks using the system
"That [assistance from others] might be necessary in some cases."	Seeking assistance (A8)	Kevin sought assistance on how to use the system

Kevin also accepted the assistance from the help desk to master some of the capabilities of the system.		
"I called the help desk a few times as well."	Seeking assistance (A8)	Kevin sought assistance on how to use the system
In general, Kevin learnt more of the ChangePoint system on a need basis. He used about 50% of the features of the system.		
"I would say… about 50% of the features."	Partial adoption (A2)	Kevin indicated partial adoption of the system

Thus, Kevin's action sequence for adoption contains: C1, C2, C6, C5, A10, A9, A3, A7, A7, A8, A8, A2.

INFLUENCE STORIES

Illustration #1: Brian

Narrative (including Actions)	Action Type (Action Code)	Researcher Notes
Brian worked as a category manager at his organization. Specifically, he was responsible for the pricing, promotion, product assortment, and shelf set and allocation – the collection of activities recognized as category management of the various products in his product categories he managed for the organization. Brian interacted with quite a good number of information systems on his job. One of the systems Brian adopted for his tasks was the Oracle Sales Analyzer. This system was used primarily for analyzing the point-of-sales data of their everyday operations gathered by the organization. Brian was dependent on the system to more effectively run the category management processes for his product categories. Category managers such as Brian were generally expected to use Oracle Sales Analyzer of analyzing data and adjust their actions. Oracle Sales Analyzer was initially suggested as an option by the new head of the information technology department at Brian's organization. The new head came in to the organization at a time when the old sales reporting system was becoming rather old and needing some enhancements. He said:		
"[The IT department head] made it known throughout the organization, the senior management, that [Oracle Sales Analyzer] would be, in his opinion, a suitable substitute for what we had been using."	Awareness creation (C1)	The message was meant for, and introduced the innovation to, the entire organization
He [the IT director] engaged Brian actively and obtained feedback about the system before making it available for use within the organization. Brian also provided feedback as the system was being designed and customized for use by category managers within the organization. He said:		

"I recall [the IT department head] showing me, one of the users, [the Oracle Sales Analyzer] system in his office… The IT department usually talked to [users] when they're considering new applications… I'm involved in that… Just to get the users' perspective and users' feedback whether or not [Oracle Sales Analyzer] would be a suitable replacement."	Development (C4)	This indicates the interactions between users and system developers during the systems development phase
"The meetings that I had with [the IT department head] were generally very informal. I'd be stopping by his office, no appointment… He would say to me, 'What do you think of this? Look at how this works. What do you think of that?'… 'Oh that's great stuff. What about this? Can you do that?'... 'Yeah, we can do that.'"	Development (C4)	This indicates the interactions between users and system developers during the systems development phase
Brian was trained by the information technology department on using the Oracle Sales Analyzer because he was one of the primary users of the system. Brian said:		
"Our IT department provided the training to me recognizing the category management group as the primary user of the system."	Training (C6)	This indicates a training session organized by the organization
Subsequently, Brian actively engaged in experimenting with the system to understand more of the features and capabilities of the system. Brian then introduced the system to his secretary such that some of the reports he needed can be prepared by her. Although he had several secretaries reporting to him, Brian really introduced the system to only one of his secretaries since he did not really need all secretaries to be working on the same needs he had. He showed her the fundamentals of the system. He said:		
"I would bring my secretary in here [my office] or I would sit at her desk with her and I would walk her through the program and show her how to use it [Oracle Sales Analyzer]."	Demonstration (OI2)	This is indicative of a demonstration of the innovation
Brian provided some feedback to his secretary on her usage of Oracle Sales Analyzer and the effectiveness with which she used the system. He stated:		

"Any questions regarding other things that the system can do, 'How can I do this better?', 'Am I doing this right?'… that the person asks me, I provide the feedback… I provide the feedback of how you can do this. 'Yes, you're doing this right. If you do this, if you do such and such report you have to watch for this.'"	Inquiry (A7) Expertise (OI1)	This contains two actions: one seeking assistance and the other providing answers

Thus, Brian's action sequence for influence contains: C1, C4, C4, C6, OI2, A7, O11.

Illustration #2: Brad

Narrative (including Actions)	Action Type (Action Code)	Researcher Notes
Brad functioned as the department leader for the business development team at his organization. His role was designed to help company representatives make actual clients out of potential clients (or leads) they may have identified in their field work. Brad routinely interacted with a variety of information systems. Since assuming the role of department leader, one of the information systems Brad adopted was the Contact Management System. This system is an extension of the Microsoft Outlook application and allows the management of information related to the potential clients (or leads) from the time they make the first contact with the organization to the time when they become full clients of the organization. The process of identifying leads and making clients is typically a long one and involves considerable effort. Brad came to know about the Contact Management System that another department in his organization used for their own tasks. He put together a team from his department to design and develop the Contact Management System for their own specific uses in tracking information about potential clients. Once the system was developed and ready to use, Brad wanted his team to use the Contact Management System. So he informed his team members that they would have to be using the contact system. However, rather than just giving a directive, Brad also explained the potential benefits of the system to his team members.		
"I told them [my team] they were going to use it [Contact Management System]."	Being assertive (I8)	This indicates a directive regarding the innovation Brad issued to the other members of his team
"I told them [my team] the primary benefits for them… They would be able to document what's going on and allow a third party to be there when they're not… [Contact Management System] will allow you to organize from one vantage point as opposed to what you tried to do before."	Presenting rational arguments (I5)	Brad also presented rational arguments regarding the innovation

Brad and another individual began using the Contact Management System first and subsequently talked to the other team members about them using it as well.		
The power user and I started [using the system] first and then he and I went to the other team members and said, "We're going to move to this [Contact Management System]."	Building coalitions (I1)	Brad and another individual functioned as a coalition to influence other individuals on the team
"We'll mentor you as you go through this. So, as you have your first one, come to me and I'll show you how to set it up and what I would do."	Bargaining (I3)	This indicates Brad's offer to assist members on his team if they needed it
Brad also demonstrated the Contact Management System to the members of his team at a department meeting so that they could gain an understanding of the system.		
We had a department meeting… I pulled [the Contact Management System] up and showed it to them and then just sort of demoed it to them, how we're doing it, and what we're doing.	Demonstration (OI2)	Brad demonstrated the innovation to the members of his team
I did have at that time [the department meeting] this power user sort of give a voluntary endorsement because he said, "I couldn't exist without this [Contact Management System]."	Building coalitions (I1)	Brad and another individual operated as a coalition to influence others

Thus, Brad's action sequence for influence contains: I8, I5, I1, I3, OI2, I1.

Illustration #3: Veronica

Narrative (including Actions)	Action Type (Action Code)	Researcher Notes
Veronica worked as a senior business analyst at her organization. She belonged to the authorization strategy group that was responsible for designing and implementing processes related to the authorization of online card transactions. She was responsible for liaison between business groups and systems development groups to understand business needs as well as implementation issues.		
One of the systems Veronica adopted recently was the ChangePoint system. ChangePoint was a comprehensive system for tracking projects undertaken, time spent, budget adherence, and other related components such as variance reporting.		
The project team in charge of the ChangePoint system notified through communications about the impending implementation. Stated Veronica:		
"We were notified by communications by the project team through email and said, 'It [ChangePoint] was coming.'"	Awareness creation (C1)	The message was aimed at the entire organization
When the time arrived, the system was implemented as a complete switchover for the entire organization, and the old systems disappeared during the switchover. The use of Task Tracker was mandated by the organization.		
"It was mandated."	Issuing of mandate (C2)	The organization mandated the use of the system
Even before the implementation, Veronica received hands-on training set up by the organization to familiarize individuals to the ChangePoint system.		
"We had training… We had a four hour time slot for training that we all signed up for through one of the computer labs and picked up our little training. All the training was on line there was no books."	Training (C6)	The organization arranged training sessions for the individuals

Veronica was one of the designated release leads for the ChangePoint system. Hence, she interacted with other individuals to get them started on the new system. She prompted other individuals to begin using the ChangePoint system.		
I would constantly be emailing everybody [in team], "Your project's set up. You're ready to go in and put your planned hours with you estimates…" It took a lot of hand-holding on my side with everybody in my group.	Being assertive (I8)	Veronica informed the team about the new system as well as to get the individuals to use the system
However, she also had to assist individuals use the new system. She showed the individuals different aspects of the system.		
"[I] literally had to walk them through every step of the way. 'Here's how you add icons. Here's your shortcuts.'"	Demonstration (OI2)	Veronica demonstrated aspects of the system to the individuals
"I had to, a lot of times, go show somebody, 'Here's how you do this to enter your estimates.'"	Demonstration (OI2)	Veronica demonstrated aspects of the system to the individuals
Not everyone took to the ChangePoint system immediately. Veronica sometimes had to talk to the other individuals and remind them that they should be using the new system.		
"I would initiate by, 'Why haven't you done this? It's due on this date.'"	Being assertive (I8)	Individuals were directed to the system
But, she also had to help these individuals use the system since individuals had some problems and issues with the system.		
"I would get emails like… 'Well, if you can come and show me how to make it happen, you're more than welcome to.' So, I am like, 'Fine. I'll be down there in a minute.'"	Seeking assistance (A8)	Individuals asked Veronica to assist them in using the system

Thus, Veronica's action sequence for influence contains: C1, C2, C6, I8, OI2, OI2, I8, A8.

Appendix F. Adoption Stories

Brad

Brad functioned as the department leader for the business development team at his organization. His role was designed to help company representatives make actual clients out of potential clients (or leads) they may have identified in their field work. Brad routinely interacts with several information systems.

Since assuming the role of department leader, one of the information systems Brad adopted was the Contact Management System. This system is an extension of the Microsoft Outlook application and allows the management of information related to the potential clients (or leads) from the time they make the first contact with the organization to the time when they become full clients of the organization. The Contact Management System is a valuable tool that supports this process.

When Brad first came to the department, they had different systems attempting to track information related to the leads. But since those disparate systems were not accomplishing the particular tasks, Brad started looking for a new solution that would perhaps be more efficient and effective.

> When I came to the department they were running multiple attempts of this, three or four different software systems to try and get at this and it just wasn't working… They [the systems] didn't communicate… We weren't getting what we wanted.

He came to know about the Contact Management System that another department in his organization used for their own tasks. He found that this system was not supported or sanctioned by the organization and it was up to the individuals to determine the ways in which they can customize and make use of the system. Brad liked what he saw about that system and obtained permission to use that tool at his department as well.

> He [my colleague] showed me that system [Contact Management System] and I got the same permission then to have us do it here [his department].

Brad put together a team from his department to design and develop the Contact Management System for their own specific uses in tracking information about potential clients. The final product possessed the features to enable Brad and his team to manage information about potential clients from the first contact through the last.

> There was sort of a skunk works project, where… two or three individuals within the company and I got together and sort of mentally plotted this out; how we organize, share, access, and export data to reporting.

Brad did not use all the features of the Contact Management System but he used a large percentage of the available features.

Brian

Brian worked as a category manager at his organization. Specifically, he was responsible for the pricing, promotion, product assortment, and shelf set and allocation – the collection of activities recognized as category management of the various products in his product categories he managed for the organization. Brian interacted with quite a good number of information systems on his job.

One of the systems Brian adopted for his tasks was the Oracle Sales Analyzer. This system was used primarily for analyzing the point-of-sales data of their everyday operations gathered by the organization. Brian was dependent on the system to more effectively run the category management processes for his product categories. Category manager such as Brian were generally expected to use Oracle Sales Analyzer of analyzing data and adjust their actions.

Oracle Sales Analyzer was initially suggested as an option by the new head of the information technology department at Brian's organization. The new head came in to the organization at a time when the old sales reporting system was becoming rather old and needing some enhancements. He engaged Brian actively and obtained feedback about the system before making it available for use within the organization.

> I recall him [the head of the information technology department] showing me, one of the users, the system [Oracle Sales Analyzer] in his office… just to get the users' perspective and users' feedback on whether or not it would be a suitable replacement [for the old sales reporting system].

Brian also provided feedback as the system was being designed and customized for use by category managers within the organization.

> He [the head of the information technology department] would say to me, "What do you think of this? Look at how this works. What do you think of that?"… "Oh, that's great stuff. What about this? Can you do that?"… "Yeah, we can do that."

Brian was trained by the information technology department on using the Oracle Sales Analyzer because he was one of the primary users of the system. Subsequently, Brian actively engaged in experimenting with the system to understand more of the features and capabilities of the system.

> After I received the basic training… I started nosing around in the program [Oracle Sales Analyzer]. I started clicking on different areas and said, "Gee, I wonder what that does!" and at that point a lot of my understanding was self-taught.

Brian used about 80% of the features of Oracle Sales Analyzer and was happy with the effectiveness of the system.

Cheryl

Cheryl worked as an information technology administrator specialist at her organization. She was responsible for writing user manuals for the various applications that were being used in her organization. She generally used a variety of software tools provided by the organization for accomplishing her tasks.

One of the software tools she adopted recently was Microsoft Visio – a tool used for preparing graphical illustrations such as flowcharts and organization charts. Cheryl was not really required by the organization to use Microsoft Visio but she ended up using it anyway because her boss requested her to complete a particular task using Visio. Her boss also explained that Visio was a flowcharting tool that can be used to make organization charts.

> [My boss introduced Visio] because he needed me to do a flowchart for him on it.

Cheryl's boss provided a brief introduction to Visio to her such that she can get started on the flowcharts he needed. This introduction doubled up as a training session for Cheryl after which she was on her own with Visio.

> This is how I got trained. "You take your mouse, you go to this, and it goes like that… You just take it and you drag it over here."

Since that time, Cheryl learned to use the system on her own. She employed a variety of techniques to get the most out of the system. For instance, she got a book about Visio from the library and practiced what she learned from the book on the Visio tool.

> I got a book for the library… I spent quite a few hours just trying to learn it [Visio]... and also to have the book and try to do it right then [on the system].

When she needed to do something specific with Visio and she did not quite get help from the book, she talked to another individual who also used Visio.

> When I need something in particular, she [the other individual] would go, "Here's how you do that." … May be two or three questions just trying to not take up a lot of her time and she showed me things that she learned… [Sometimes] she came over and she showed me a couple of things.

Cheryl used only a portion of the features available on Visio. She began using Visio fairly recently and believed that Visio had several other features that she had not yet used.

Cathy

Cathy functioned as a buyer's assistant at her organization. She was responsible for conducting research that would assist her managers with the procurement of products from sellers. She generally used a variety of software tools provided by the organization for accomplishing her tasks.

A system she adopted for her role was the Maintenance and Support System – an information system .used to set up the various Universal Product Codes for the products handled by her organization. The use of this system was mandated for everyone by the organization.

In Cathy's case, she became aware of the system when her manager said that she would be using the Maintenance and Support System.

> The communication about the system [Maintenance and Support System] was from the category manager… as far as we're going to use it.

The information systems department then installed the system on Cathy's computer. She was told that the Maintenance and Support System was somewhat similar to what she had been using before.

> They [the information systems department] put it [Maintenance and Support System] on our computers. They said it was similar to what you were using.

Cathy also participated in training sessions for the Maintenance and Support System that were conducted by the information systems department. Once she understood the basics of the system, her learning was pretty much self-taught as Cathy learnt most of the system on her own.

But she sought the assistance of other individuals when she was not able to figure out aspects of the system. Specifically, she either talked to the systems developers or to her co-workers to overcome any issues she had with the system.

> The developers were kind of the people we'd go to if we didn't understand something. And then amongst ourselves we tried to help each other… Like when we came upon a stumbling block or something… we'd help ourselves to get the answers.

Cathy pretty much used all the features of the Maintenance and Support System she was authorized to use.

Elizabeth

Elizabeth served as a manager of the information systems function in her organization. She performed a variety of roles such as programmer, analyst, etc. before she became a manager of the information systems department. Her responsibilities included liaison between information systems and other functional areas within her organization as well as helping set strategic goals for the information systems function.

She recently adopted a system called Travel Manager – a system used to plan travel and record travel expenses so as to get reimbursed. When it became available, Travel Manager was mandated for all individuals who were required to travel on behalf of the organization. Elizabeth did not have a choice but to adopt Travel Manager since the paper-based system in place prior to Travel Manager was completely eliminated.

> We were told. It was a memo that came out and said, "You are traveling; thou shall use this [Travel Manager]." It wasn't like we had a choice. It was like, "This is the way. You're going to use it if you want your money."

Elizabeth attended a training session where she learnt the fundamentals of using Travel Manager for her needs. The training enabled her to gain a level of understanding of how to do simple things using Travel Manager.

> We went to a class about… may be two or three hours. They walked through what we were going to do and they gave us some handout materials. We went in large groups.

Subsequently, she attempted to use Travel Manager to the best of her ability, and when she faced problems using it, she either referred to help systems or talked to other individuals to find ways in which she can solve the problems she faced with Travel Manager.

> What I did is, when I had to do something, I would see if I didn't know how to do it. I would look at the help and read through that to see if the help would do what I wanted. But if I still didn't know what to do, then I would call my office administrative person and say, "How do I do this?" and she would walk me through it.

Elizabeth was not particularly a fan of Travel Manager. According to her, Travel Manager was "the most distasteful thing she had ever experienced." She was not a frequent traveler at the time Travel Manager came into existence and every time she had to use it she ran into some problems. Part of the problem was that she did not remember how to accomplish certain tasks since she had not used the system in a while.

Despite such experiences, Elizabeth used about 60 to 70% of the features available on Travel Manager. She looks forward to the day when Travel Manager would be made much more intuitive than what she experienced.

George

George performed the role of a senior operations supervisor at his organization. He was responsible for liaison and coordination between the various units or operators within the organization. As part of his job responsibilities, he interacted with a variety of information systems.

One of the systems George adopted for his job tasks was Systems Atlanta – a system used to obtain field reports of current conditions. Systems Atlanta was part of the organization's portfolio of information systems. The use of Systems Atlanta was ultimately mandated for everyone like George who worked for the organization.

Initially, however, the system was introduced into the organization by George's department, specially, George's supervisor, with a little help from other individuals in the department like George. His supervisor was constantly on the lookout for systems that would improve the efficiency and effectiveness of the department.

> She [his supervisor] would bring everybody in as far as the operations specialist and have the monthly staff meetings to say, "Okay, these are some of the ideas I have as far as the systems that I would want to bring online for the operations center." Then she would get our ideas of how we felt about it.

George participated in these meetings and provided feedback on ideas and systems. Also, his supervisor brought in vendors to demonstrate their systems.

> Periodically [my supervisor would] have contractors come in with the new systems… They [the contractors] would sit down and do a little sales pitch with us.

One of such sessions was about Systems Atlanta. In addition to what George understood from the presentation, his supervisor also explained her view of the system.

> [His supervisor explained] the useful features [of the system]… in relation to the objectives of the operations center… it would be a good thing to bring it [Systems Atlanta] online as far as the case of usage for individual people.

After the decision was made to implement Systems Atlanta for the organization, George participated in a training session that provided a basic understanding of the system.

> Our basic training for that [Systems Atlanta] was probably like six hours… for the technician to come in and show us what we needed to do.

George did not have access to some parts of the system but he used pretty much all features that he had access to on the system.

Hilda

Hilda worked as an accounts payable manager at her organization. She also acted as manager of the accounting department. She was responsible for managing accounts payable and for implementing projects related to accounts payable or the accounting department, including information systems implementations.

She recently served as the project lead for implementing the accounts payable unit of the Oracle Financial System – an enterprise-wide system aimed at integrating the various units within the organization. Hilda was concerned with only the specific implementation related to the accounting department.

The decision to implement the Oracle Financial system was taken by the senior management. However, she participated in the evaluation process when the organization engaged different suppliers to demonstrate their products. Once the senior management decided to go with the Oracle system, they decided to implement all modules, and then mandated the use of the system as well.

> We did our implementation a little more abruptly than a lot of companies do. We did everything… We decided to do the whole thing once and go from the old system and totally install the new system. That was an upper management decision.

The senior management arranged for the consultants to talk to Hilda and her team to assist in the transition to the Oracle system. The consultants provided a lot of information about the system and how the accounting department can benefit by using the system. The consultants did not have to sell the system so much since the organization felt the need for the new system as well.

> We were told this is what we were going to do and this is the way we're going to do it. But I also was very enthused about it because our old system was inadequate. So I was very eager to use the new system.

Hilda attended training sessions that enabled her to understand the system. The training provided the basic skills necessary for her to implement the system. She also received books that would allow her to gain additional information.

> We did have training. It was very high level, very surfaced,… and it wasn't as extensive and detailed and repetitive as I would have liked to seen it.

Hilda uses about 20% of the features of the system now. She also assists others on her team and the organization to use the system as well.

Helen

Helen functioned as a data analyst at her organization. She was responsible for analyzing data related to operations and market segments and create various types of reports for use by field workers and product managers. She routinely used different information systems on her job for her various assignments.

One of the tools that she adopted recently was ArcView – a tool to create geographic maps using data available on a data warehouse. Unlike standard graphs (line charts, bar charts, etc.) that display information on a two- or three- dimensional grid, geographic maps allow information to be displayed on the outlines of geographical segments such as countries, states, cities, etc.

Helen initially had access to only the standard graphs that were created by packages such as Microsoft Excel. While the standard graphs were useful for understanding the characteristics of the data, she realized that non-standard graphs such as geographical maps would be much more intuitive for the field workers and product managers to understand the extent to which they had access to the geographical markets.

> We needed to have a map capability... It helps people to visualize where we are heavily penetrated and where we are not. So it helps you geographically... [to understand] problem areas... [as well as] opportunities.

She came to know about ArcView through another individual who had some understanding of what she needed. Helen was essentially on the lookout for a map software that can do geographic graphs of her data.

> Someone was using it [ArcView] and he told me about it... I was out there searching for a map software and he said, "Hey, did you try this one [ArcView]?"

Helen learnt the system primarily on her own. She missed the training sessions provided by the software vendor and relied on a book to understand the basics of using ArcView. She spent several hours with the ArcView system trying to master the different ways in which the maps can be created. She occasionally asked other individuals to help her with some aspect of the system that she couldn't quite figure out on her own.

> I read the book the first couple of weeks to try and figure out things... Later on,... as more people use it, I tend to call up and [say,] "Hey, have you ever tried this? If so, how did you make it happen?"

She has learnt more of the system now although she does not use all of the features. She is happy to introduce ArcView to others if needed; but she is not very hopeful that she can do it very often because she is the only person on her team who has the need to use it.

Jake

Jake worked as a senior programmer at his organization. He was responsible for the technical analysis and design of systems: he obtained and analyzed the functional requirements to determine what needs to be done, design what needs to be done, actually code the system, test it, and then help with the installation. Jake used a variety of information systems on his job.

A system that Jake adopted recently on his job was Task Tracker. Task Tracker was an information system used to track the different tasks Jake was involved in during different phases of a development project and the amount of time he spent on each task. It was a system that was internally developed by the organization to more efficiently track the time spent by individuals on different projects undertaken by the organization.

When it was rolled out, Task Tracker was mandated for all information systems professionals within the organization.

> It was pretty much enforced when it first came out that everyone had to use it [Task Tracker]. We all had to use it.

In the case of Task Tracker, the mandate for use was made known to Jake by his manager. There was not much of a choice but to use Task Tracker.

> It was more of a directive that came down from your director through the manager… and your manager telling you, "Here's this new product and you're going to use it."

Jake was able to participate in a training session that was aimed at introducing Task Tracker and its features to the participants.

> The group that had developed the application… sent down a couple of people for the training sessions… They showed the features of what you could do with it [Task Tracker] and they kind of ran through some examples of how you can use it. They gave us some quick reference cards that you could reference and quickly look at… how to do something.

Jake was not particularly happy with Task Tracker and the implications of using it on his job. He nevertheless used the system as it was mandated.

> I had concerns… I felt I'm a salaried executive and you're wanting me to keep track of my time like I'm an hourly paid [employee].

However, Jake discontinued using the system after a year or so since he had a new manager who did not enforce the use of Task Tracker. In all the time he used Task Tracker, Jake pretty much used the same features he used when he initially adopted it.

Janet

Janet functioned as a category manager at her organization. She was responsible for pricing, promotion, and product procurement of the various products in her product categories. Janet interacted with a variety of information systems on her job. She had some control over the particular information systems she wanted to use for performing her job tasks.

One of the information systems she adopted recently was Stanford Charts. This tool was used to create graphical charts from numerical data, much like Microsoft Excel, which Janet typically used for her graphing needs. However, she adopted Stanford Charts for a specific rendition, i.e. bubble charts, of the point-of-sales data collected by the organization.

Janet came to know about Stanford Charts in one of her many interactions with another category manager working at her organization.

> Just looking over each other's shoulders. We're in each other's offices and talking… He posts his charts and shows what he's working on. We just kind of share how we're doing things to manage our categories.

The other category manager showed Janet what he did as part of managing his categories – creating bubble charts. The bubble charts looked very different from what Janet typically obtained through Microsoft Excel. However, Janet was impressed with the bubble charts and asked how she herself can create bubble charts.

When she found out that Stanford Charts can create bubble charts, she acquired a copy of the program from an outside vendor and installed it on her computer. She subsequently had this other category manager help her with the system such that she can then do it herself.

> He [the other category manager] showed me what he knew and that's all I know.

Janet typically used Stanford Charts only for creating bubble charts since she felt her regular tool, i.e. Microsoft Excel, made that a somewhat cumbersome process. She was sure that Stanford Charts was good for other types of charts but she had not yet used it for her other graphing needs.

Jennifer

Jennifer worked as a category manager at her organization. She was responsible for product procurement, pricing, promotion, and placement of the several products in product categories she managed for the organization. Jennifer interacted with quite a few information systems on her job.

She had access to a variety of information systems and had some choice over the specific information systems she wanted to use on her job. What she needed to be cautious about was, when performing comparisons between different time periods, to use the same information system or database that she had use for the previous time periods as well.

Jennifer recently adopted a system called Data Downloader – an interactive online reporting system that provided consolidated results of point-of-sales data based on the specific criteria outlined by her. The system was actually developed because Jennifer and a few others indicated the need for specific features that were not available on systems they used until then.

> We had a need and we all kind of grumbled among ourselves. We wish we could look up this or look up that, grumble, grumble, and we would take it to [the] Systems [department].

She routinely participated in meetings related to systems development and offered feedback on the various aspects of the system and her needs.

> [The developer] comes in, some of it [the system] is already written, "Take a look at it."… We meet once a week and we say, "Yeah, that is great; No, we don't need that; you don't understand what I wanted," and she [the developer] will go back… she'll call us when she has something to show us.

When the development was done and Jennifer had provided feedback on the acceptability of the system for her needs, the information systems department made the system available for use. Jennifer actually had the program installed on her computer.

> They [the Systems department] installed it here [my computer]. "Here's how you use it; here's how it works."

Once she had the basic understanding, Jennifer spent time with the system attempting to make use of its various features. Jennifer actually used pretty much all the features of the system.

Karen

Karen functioned as contracts and billings coordinator at her organization. She was responsible for end-to-end contracts and billings for the consulting operations, which was considered part of a larger process called engagement management. Karen generally used different systems to manage the contracts and billings.

She recently adopted an information system called ChangePoint. The ChangePoint system was used for contracting, invoicing, and timekeeping activities carried out by the consultants and subcontractors on different projects. The organization made the decision to implement ChangePoint after listening to sales presentations by the vendor. Karen was not party to the actual implementation decision.

Subsequent to the decision to implement ChangePoint, the organization mandated use of the system for everyone. Karen learned about the system and the mandate through a team of managers responsible for the implementation.

> A team of managers said, "This is the decision that has been made, this [ChangePoint] is what you will use."… It was... a group-wide meeting where everybody got on the phone and then they [the managers] showed us… "We're going to utilize this and here are all the wonderful things that it [ChangePoint] does."

Karen participated in the training sessions conducted within the organization by the ChangePoint vendor. During the initial stages after implementation, there was ambiguity about how the system can be used and not everyone understood it. At times, questions had to be forwarded all the way to the ChangePoint vendor to understand solutions to the problems.

> They had a [company] liaison with our ChangePoint team… So everything we needed was funneled to our [company] liaison, like from our team lead to the liaison to the ChangePoint team to get answers.

Karen participated in building a process around this questioning activity such that when information was available from ChangePoint on how to use the system, it was then available to all members of the organization.

> We have an entire process and policy corner on our SharePoint and anything new or different is posted there.

Karen attempted to learn the ChangePoint system by herself. However, when she ran into problems, she benefited from assistance from her team lead as well as from other persons at the organization. Karen used about 80% of the features of the system and helped others to more effectively use the system as well.

Kevin

Kevin worked as a business analyst at his organization. He focused specifically on the online authorization systems. He had two major responsibilities: the first was to prepare business requirements for the authorization systems and take it to the systems development staff; the second was to publish information related to the authorization systems for use by members of the organization.

He was recently involved in the implementation of the ChangePoint system at his organization. ChangePoint is a comprehensive system for time tracking, cost accounting, project management, and a host of other things. The organization used to have independent systems for these different activities before the implementation of ChangePoint. However, ChangePoint was made mandatory when the organization switched over.

> It was mandatory. It's mandatory that we track out time. It's mandatory that we put all of our projects on the tool.

Several months prior to implementation, the organization sent out updates and information on the forthcoming ChangePoint system. This provided an opportunity for individuals like Kevin to get used to the idea of working with the new system. The organization also set up training classes which provided basic information about the system and how to get started on it.

Unfortunately for Kevin and others, the initial implementation of ChangePoint was a turnkey solution which did not really cater well to the particular needs of Kevin's group. Hence, Kevin engaged in activities such as requesting updates or implementing own solutions to overcome the limitations of the system.

> The initial implementation was a product they bought off the shelf… It had a lot of shortcomings on it, so we had to request a lot of updates to support our needs… We [also] had to do some tasks elsewhere. We had a spreadsheet or project in our own group. We developed one in [Microsoft] Access.

Kevin employed a combination of different approaches to effectively work with the ChangePoint system. He relied on the tutorial to become familiar with the capabilities of the system and on other individuals to get information or assistance to solve specific problems he faced with the system.

> You had the tutorial… [but] you just have to use the tool for a while to get familiar with everything is that it can do.

In general, Kevin learnt more of the ChangePoint system on a need basis. He used about 50% of the features of the system.

Keith

Keith functioned as a licensing specialist at his organization. He was responsible for negotiating the terms and conditions of agreements with customers and pricing the different types of products sold to customers. Keith typically accomplished this by being part of the sales teams that directly interfaced with the customers. He made use of various information systems to complete these tasks.

One of the systems that Keith adopted recently was a productivity tool named Microsoft OneNote – a system used for taking, organizing and reusing notes in any form (handwritten, typed, diagrams, audio, etc.). OneNote is a productivity tool available for the desktop computers and typically distributed with the TabletPC. As such, it was up to the individuals to decide if they want to use OneNote.

Keith had several opportunities to become familiar with the OneNote system and its capabilities. He had seen demonstrations of the product several times.

> It occurred several times because there was a number of different events that I had attended. This [OneNote] was a new thing. So, I had seen a number of demonstrations and presentations on it.

He was enthused about OneNote because it looked like a superior product that would replace the functionality of several products. Keith attempted to learn more about OneNote whenever he got a chance. For instance, when other people in his organization began receiving OneNote on their computers, he would take the opportunity to observe how these other individuals used the system and perhaps trial-run the system.

> At some point people began to get them [OneNote] and that's where I got more exposure to how you use it… and "Hey, why don't you try it?" and I would do something like that.

Keith also inquired others about the OneNote system when he got a chance and gain some more understanding of the features of the system. When he received his copy of OneNote, Keith experimented with the system quite a bit to understand its capabilities and determine how best he can use it for his needs.

> Once I got it [OneNote], I spent a little bit time playing with it… trying the applications and then through trial and error learning how to do the handwriting notes, how to copy and paste, and just kind of working through whatever issues or problems I had.

He developed his own strategy of using the OneNote system based on the insights he had gained from observing others and his own understanding of how it can be used. Keith used about a third of the features available on OneNote.

Katelin

Katelin worked as a bond trader at her organization. She was responsible for conducting online trades, carrying out research about various trading opportunities, providing inventory of trades for their retail brokers, educating and marketing specific investments to their brokers, and assisting with outgoing information to the general public. Her job demanded that she routinely use different information systems.

An information system that Katelin adopted when she joined the organization was the Bloomberg system. Bloomberg is a comprehensive system made available by an external provider that can be used for trading bonds. The Bloomberg system came with built-in information on several aspects including bonds, news wires, stock markets, etc. Katelin accessed the Bloomberg system through a computer station the external provider had installed on her desk.

The Bloomberg system was actually required for all individuals trading bonds for the organization. The system was already installed and available in place before Katelin joined the organization. She understood, in her initial briefing sessions, that she would have to routinely use the Bloomberg system. A fellow employee introduced her to the Bloomberg system and to the fact that she would need it on her job.

> It [the Bloomberg system] was considered on the job as well… It wasn't until I actually got on the desk that someone take my hand and say, "You need the system," and that's about how it was initially introduced to me. And I said, "Okay."

Katelin was not authorized to use the live Bloomberg system until she got the license to trade bonds. However, she benefited from a training system that the organization had in place and learnt the various features and the ways in which the system could be used for trading as well as for research.

> The organization had a training system in place and I spent a couple of days working through sample entries… and learned all the different commands.

Once Katelin obtained the license, she began using Bloomberg for the actual trading transactions. She tried her best to learn the Bloomberg system by herself building off of what she had gained on her previous forays into the system. She even discovered certain aspects of the system by herself. But when she was in unfamiliar territory, however, she solicited the help of her fellow traders who may have experienced similar issues.

> Once you get how you find information on something or how to let it [the Bloomberg system] help you, then you know, "Okay, it [the system] helped me do this time; let's try to go down that path for other things."

Katelin used about 85% of the features and helped other individuals, perhaps new hires, use the Bloomberg system as well.

Melissa

Melissa worked as an administrative assistant for several directors at her organization. She was responsible for scheduling appointments, taking phone calls, and writing correspondence for the directors and generally making sure that the directors can function smoothly. A vast majority of her tasks were completed on systems provided by the organization. She worked on a variety of systems depending on the tasks to be accomplished.

One of the systems that she used frequently was Personal Manager – a scheduling tool that allowed her to schedule meetings, include participants for meetings, and reserve conference rooms. Personal Manager was a multi-user system and had different levels of rights for the different individuals in the organization. Melissa, for instance, had the user rights to include meetings on her directors' schedules.

Melissa had been using the system for about 10 years. Her first introduction to Personal Manager was when the administrative assistant she replaced [called Debra hereafter] in the organization told her about it.

> The administrator that was training me -- I was taking her position -- is the one who trained me. She said, "This [Personal Manager] is what we do to do meetings."

Based on what Debra told her, Melissa understood that she would have to use Personal Manager for all scheduling tasks. Before she left for her new position, Debra helped Melissa understand Personal Manager so that she can use it herself. For about a week, Melissa shadowed Debra and learnt how to use Personal Manager.

> I was basically shown by just sitting there and watching [my trainer] do meetings. Then she'd say, "Here, you try the next one."

After the first week, Melissa started to use Personal Manager on her own. Not all was rosy however. Melissa experienced quite a few problems using Personal Manager such as overbooking conference rooms, scheduling the meetings for 2 a.m. instead of 2 p.m., and scheduling the wrong Smith for the meetings. She was able to overcome these problems since she received help from other administrative assistants or even her hiring boss at times. Over time, she gained a lot of experience, and actually learnt little things about Personal Manager herself that no one else had told her.

> With [my training admin] I learned all… the major features and then… on my own, I learned some of the little things that it would do that no one had told me.

Now she is one of the more experienced users of Personal Manager and helps other individuals with questions and problems.

Neil

Neil performed the role a project manager at his organization. He was affiliated to the division of the information technology department that dealt with human resources. Neil was responsible for collecting and tracking all the hours worked by employees, creating schedules related to staffing field locations, and determining eligibilities for vacation and sick time, and computing employee status changes.

As part of his job responsibilities, Neil adopted an information system called Task Tracker. This system can be used to track different tasks undertaken by an individual and the time the individual spent on those tasks. Task Tracker was a multi-user system which allowed simultaneous access to multiple individuals. But the system also had rights management that enabled individuals to access different pieces of the system. As a project manager, Task Tracker enabled Neil to obtain and evaluate the hours put in by various individuals.

The use of Task Tracker was mandated by the organization. Information on the forthcoming availability of Task Tracker was distributed to all individuals via electronic email. However, in Neil's case, his director also specifically asked that he use Task Tracker for tracking times.

> He [my director] definitely wanted us to use it [Task Tracker]… He was the only one who pushed us to use it.

Neil's director also suggested that using Task Tracker would really be good for everyone since it was a good tool. The organization arranged training sessions for anyone interested in getting the basics of using Task Tracker.

> They [the information technology department] had some training class… It was like an hour session showing the features.

Once Neil adopted the Task Tracker system, he was enthused by its capabilities and really wanted to make use of the tool whenever he can. But his director, who initially instructed Neil and similar others to use the system, also monitored the extent to which individuals actually used the system.

> He [my director] can monitor and see his whole pyramid, who has been submitting time sheets, who hasn't. So, if he thought some groups weren't keeping up on it, he'd… send out a reminder to be using it.

Neil used between 80 and 90% of the features of the Task Tracker system and actually ensured that everyone on his team used it as well.

Nancy

Nancy worked as an information risk management associate at her organization. She was responsible for assessing the risks related to the financial statements and the overall financial reporting. She functioned in an advisory role and advised organizations regarding security, fraud, and risk issues while implementing information systems.

She recently adopted Windows XP – an operating system by Microsoft Corporation for the different types of computers such as desktops and notebooks. Windows XP was the result of an organizational initiative to adopt a standard operating system for all computers at her facility. Nancy had received a notebook computer from the organization for performing her tasks on the road and she had the notebook changed to Windows XP.

Nancy came to know about the Windows XP system through communications sent by the organization via a distribution list.

> They [the organization] tell me, "There's an upgrade." They told me to get the upgrade.

The process of upgrading her notebook entailed Nancy to set up an appointment with the information systems department and then drop off her computer with them. The information systems department upgraded her computer to Windows XP. Nancy picked up her notebook from the information systems department after several hours.

Nancy did not receive any training on Windows XP. She, however, received a fold-up brochure from the information systems department on how she should ensure that her data was ported to Windows XP properly and how she can personalize her email and other folders.

While she used several applications on her notebook computer, Nancy really interacted with the Windows XP system only on a need basis. Such needs included altering default setups for the printers, and sometimes, for the mouse and the wireless network.

> Not very many [features], it's just printers and with the mouse if I want to change some little thing… There is nothing else I use in control panel [of the Windows XP operating system].

Nancy did not really need to use much of the features of Windows XP and hence she used only a limited set of features.

Natalie

Natalie worked as an information risk management associate at her organization. She was responsible for advising different organizations on issues related to security and fraud as they expanded their portfolio to include new information systems. She employed different systems to carry out her tasks.

She recently adopted the Document Management System – an extension to the Microsoft Outlook system used to manage documents by specific projects. The document management system enabled an individual or team to assemble all documents belonging to a project in a single repository that can be accessed remotely via electronic mail.

Natalie adopted the document management system by virtue of being on a project team in which the manager wanted all team members to upload the project documents to a central remote location. This worked out be convenient for Natalie and her team because the team members generally worked from multiple site locations in advising their clients about the security and fraud issues.

> My manager said we need to upload our documents to the Outlook database [for the project].

To accomplish that, Natalie asked around and found the name of the central repository and then figured out a way to upload the documents.

> I found out what the Outlook mailbox is called, then I found how to add it. I went in and added it to my bar. I just click on it and then I could go in… and just drop my documents in there.

Natalie did not receive training on using the document management system, but felt that it was not a difficult-to-use system. She only had a very few questions for any one on how to set up the tasks for the repository, but managed the rest of the process on her own. She does not use all features of the document management system.

Paul

Paul served as a director of information systems activities at his organization. His primary responsibilities involved systems development activities for the human resources system as well as other corporate systems internally used by the organization. He was generally more involved with the implementation of enterprise information systems for his organization. He interacted with different information systems on his job.

One of the information systems he adopted as an individual was the Travel Expense Report system. The system may be used to plan official trips and record expenses related to the travel for the purposes of reimbursement. This system was required by the organization of the individuals who traveled on behalf of the organization. When the system was rolled out, the paper-based process was withdrawn and hence individuals who traveled did not have much choice but to adopt the Travel Expense Report system.

> It [the Travel Expense Report system] was installed under the direction of our senior management group. You can no longer use the paper. So, therefore, you will either use the online system or you don't get your money.

Paul benefited from the training sessions that were available for the Travel Expense Report system. Training sessions for individuals using this system was a routine process at Paul's organization.

> We also had [formal] training on how to use it [Travel Expense Report system]… We have a training environment here. We have a training room – what I call my university – and we schedule training for any and all of us who need training in any particular process… Our accounting department provides the training periodically and routinely… They meet in class once a month or so to take care of any new hires who use the system and also anyone who has tended to forget it.

In using the Travel Expense Report system itself, Paul generally likened his difficulties with the system to the "usual transition process": he faced a few issues but he could solicit help when needed and overcome those initial difficulties.

> We've got people that were ready to assist us in going through so I didn't see anything abnormal. It was just a quick transition. Once you use it a couple of times and made a few mistakes, it was quite simple past that point.

Paul uses pretty much all the features of the Travel Expense Report system, a system that served its purpose well.

Raymond

Raymond worked as a manager for the warehousing, inventory, and logistics operations at his organization. He was responsible for maintaining inventories as well as liaising with other functional areas about their requirements. He attempted to standardize and streamline the inventory management process. He interacted with different information systems in imparting his duties.

One of the information systems that he adopted was named Bentech – a system used to monitor inventory, purchasing, and financial activities of the organization. Bentech was a custom-designed system that was built incrementally over time by an external consultant who worked closely with the organization, and specially, Raymond's department.

> We hired a consultant… [He] was a really knowledgeable individual, and he worked closely with our department.

Raymond was very much involved in the design and development of the Bentech system. He routinely participated in group meetings with the external consultant, outlining the specific requirements for the system, providing comments on different aspects of the system, etc.

> He [the consultant] would host a meeting to determine… what we wanted out of the system… I might have my staff; may be two or three people in my staff, two or three from accounting… We'd get a whiteboard… go to the conference room and he'd draw how it was going to all work out… There was a lot of interaction… I had a lot of suggestions because I had come from a very sophisticated system… and I knew exactly what we could do.

Raymond also interacted directly with the consultant and actively contributed his thoughts on translating requirements into the design of the system, verifying intermediate versions of the system as it was designed, etc.

> He [the consultant] would come to me and say, "Here's what we think we can do and that's how it would work." I would say, "That is what we want." He would build the system, come to show us, and then work out the bugs.

Raymond was sold on the Bentech system for all its features and the convenience and efficiencies it brought to the operations of his department. He used about 25% of the features of the system on a daily basis and also helped others to use the system to accomplish their job functions.

Robert

Robert functioned as an inventory and logistics manager at his organization. He was responsible for maintaining as well as distributing inventories to the other functional areas within the organization. He routinely worked with different information systems in completing his various tasks.

A system that Robert adopted for his operations was the BarCode System. The barcode system was useful in tracking inventories in real time. This was possible because all items or item groups in the organization's inventories were tracked using Universal Product Codes. The barcode system was a combination of hardware and software that allowed the products to be scanned using a wireless device and processed at a remote location. Thus, individuals dealing with the inventories did not have to manually key in the Universal Product Codes but rather scan the codes and let the computer do the rest.

Robert was always looking to improve the efficiency of his department and thus became interested in the barcode system. Initially, he did not have much information other than what he had read somewhere. Subsequently, he gained more information about the barcoding system by attending a seminar on barcoding conducted by an external vendor.

> I attended a seminar…about barcoding… and talked to them [the vendor] afterwards.

Robert was pretty enthusiastic about the barcoding system and its potential to improve the efficiencies of his department. So he approached his boss for the amount of money.

> I looked to my manager for the money… [I explained] briefly that it would be a benefit to us and it would improve our organization, that it would be better control of the assets, and we would be able to charge the departments for what they take.

Once his manager approved the system, Robert implemented it within his department and saw some improvements in his operations. He used pretty much all features of the barcode system.

Sharon

Sharon worked a project manager for customer operations at her organization. She was responsible for understanding the needs of the different customers, taking orders from customers, managing the order process, and for evaluating order processes and implementing more efficient solutions for customer operations. She used a variety of information systems in accomplishing her tasks.

One of the tools Sharon adopted recently for her work was the Pilot system. Pilot was an add-on system to Microsoft Excel that can generate reports for *ad hoc* queries with data from a corporate data warehouse. In general, the Pilot system was customized, in terms of the data universe, for different user groups within the organization. The Pilot system was developed and customized by the information systems department within the organization.

For the specific role she performed, Sharon needed more *ad hoc* querying capabilities rather than standard reporting options. The information systems department introduced Sharon to the Pilot system and its superior capabilities.

> The information systems group that working with us on implementation suggested the flexibility that the Pilot tool would offer and that it [Pilot] would give control back to us as business users… The information systems project manager… knew that the tool [Pilot] had been successful for other business groups to help do *ad hoc* reporting.

Sharon was really enthusiastic about the Pilot system once she was introduced to it. She communicated with the information systems project manager and understood the ways in which the Pilot tool can be used.

> One she [the project manager] had mentioned it [Pilot], I was like, "Yeah, yeah, yeah."… Having an *ad hoc* ability in my own control is an important part of what I'm going to need to do… She certainly got me to speed on what was sort of new and different about it [Pilot].

She attended the basic training sessions for Pilot conducted by the information systems group. She interacted quite a bit with the information systems group to more clearly understand the functionality and capabilities of the Pilot system. She also benefited from walk-through sessions given by the information systems project manager.

> They do offer training through our information systems group which pretty much showed you how to drag and drop and sort of explained sorting.

It took a few weeks of practice for Sharon to get comfortable with the Pilot system. She does not use all features of the system but is very satisfied with what she uses. Whenever she gets a chance, she motivates other individuals to use the system as well.

Sue

Sue functioned as a senior administrative assistant at her organization. She was responsible for taking care of the secretarial work for the associates and the professionals who were employed by the organization. She used a variety of information systems in performing her job responsibilities.

She recently adopted an information systems tool named Microsoft Visio. The Visio system allowed the preparation of graphical illustrations such as flowcharts and organization charts. Visio was not mandated by the organization for Sue; however, she adopted it because her boss required Sue to prepare organization charts using Visio.

> I just had Visio put on my computer based on a request I had to do for organization charts. The [conversation with a boss was]: "Do you know Visio?" "No" "Would you like to learn?" "Yes." And I was handed organization charts to prepare.

She considered the possibility of using other packages such as Microsoft Powerpoint since she was familiar with those packages; however, she was instructed to create the organization charts using only Visio. Visio was a tool completely unfamiliar to Sue. Also, since Visio was not part of the organization's standard portfolio, she had to specifically request support services to install Visio on her computer.

The organization did not have any training sessions for Visio that may have benefited Sue. Moreover, Sue found out that none of the other administrative assistants in her organization used Visio and hence she did not have very much choice but to look for help from other individuals such as professionals.

> I basically just asked around and none of the other administrative assistants in our report department were familiar with the software for creating a document. So, I sent the message out to the professional staff…

Fortunately, for Sue, one of the professionals in her organization responded to her message and indicated that she would be able to help Sue.

> She sat down with me and showed me; she let me drive and just kind of told me, "This is what this is, this is what this," and it was very, very easy to move around in once you have that little bit of hands on with someone.

Sue was then able to experiment with the Visio system on her own, and she used about 70% of the features.

Teresa

Teresa worked as a human resources generalist at her organization. On her job, she counseled or coached leaders and associates on the policies and procedures of the human resources operations. She also provided training on team dynamics, relationships and leadership. She also answered questions regarding compensation. She used a variety of information tools and systems on her job.

To accomplish her job responsibilities, one of the systems Teresa adopted was the Peoplesoft system. The Peoplesoft system, relevant for her function, was used for managing human resources within her organization. Specifically, Teresa focused on job information related to the hire, absence, performance, termination, etc. The Peoplesoft system was already in place and mandated for use when she joined the organization. All Teresa received when she joined was a communication that she should contact someone to obtain the necessary user identification and password to use the system.

Teresa initially had someone give her a demonstration of some of the features of the Peoplesoft system. But she experimented with the system quite a bit once she received her access to the system attempting to uncover aspects that may be useful to her.

> Someone spent 30 minutes with me at least getting me through… the key or frequently used screens that I would use and want to go to. Once I had the user ID and password, I just started poking around.

However, there were occasions when Teresa enlisted the help of other individuals in working with the system. The types of responses she needed from these other individuals differed.

> For someone on my team, [I asked,] "I know which area I wanted to get at, but I couldn't remember how to get there." With my leader, I think I was trying to find out a screen… I had the sense that it was somewhere in the database but I couldn't figure out where it was. So he was able t pinpoint where that would be.

She occasionally received help from the information systems specialist dealing with the human resource component of the system. These interactions were aimed more at finding out and understanding how to work with specific reports. For the most part, however, Teresa's interactions with the Peoplesoft system were based on certain needs.

> Questions would come in for my role that would require me to find certain information… It was kind of learn it as you go… There were even moments of discovery.

Teresa used less than 15% of the features of the system since her tasks were repetitive for most of the time.

Tim

Tim occupied the position of a senior manager for the information systems support group at his organization. He managed a team of software professionals who were responsible for development and maintenance of internal information systems. The software professionals on his team were involved in different activities: conversion of legacy systems, maintenance of systems, development of small systems, etc.

One of the systems that Tim adopted recently was the Travel Manager – a system used to plan trips and record expenses for obtaining reimbursement. Initially, Travel Manager was released to a limited number of users who volunteered to test the system. It was mandated for all individuals who had travel needs and wanted to be reimbursed – but that came later.

When Travel Manager was first announced, Tim volunteered to be an early user of the system. It was a general practice for the information support group to "try-out" the new information systems before it was made available to the entire population. This was also important since the support group would have to assist other individuals, including the executives, to effectively use the system.

> I was told it [Travel Manager] was coming and…, because I like to do testing systems, I chose to volunteer to be one of the first users of the system.

Tim did quite a bit of traveling at that time and that gave him several opportunities to interact with the system. He did have some formal training but his interactions with the system were based on more on trial-and-error and self-learning. There were not a lot of other individuals he could talk to since there were not very many individuals using that system in the beginning stages. However, he did get some assistance from the help desk established for helping individuals with Travel Manager.

> I had formal training and then the system had a help desk… Since I was an early adopter, there weren't too many people – too many of my peers – I could lean on. So, it was pretty much the formal training, trial-and-error, and occasionally I would call the help desk and get an answer to a question.

But, over time, the combination of learning and assistance, as well as repeated use of the system enabled Tim to ultimately use all features of the system.

> Like all systems, when you use it for a while, you find some features that make things a lot easier and a lot faster, so eventually I was able to use all the features.

Tim now assists other individuals in his organization to adopt Travel Manager by providing information or showing how to use the system.

Tyler

Tyler was a leader of an information systems support team at his organization. Individuals on the support team generally acted as data testers that they can acquire all the experience they can with new technologies. Such experiences were useful to the support group when they had to assist the executive customers within their organization.

Recently, Tyler was involved with the rollout of the Windows XP operating system at his organization. As was the general rule with the support group, when he came to know about the Windows XP rollout, he volunteered to be one of the data testers. He was willing to get the additional functionality of Windows XP for himself even when the transition to Windows XP may not have been easy.

> The distribution list would say, "Would anybody like to volunteer to be a data tester?" I always liked to be a data tester because once you got through the pain of getting started up then you had something that was supposedly better than what you had before. So, I was willing to go through that pain to get the additional functionality and get it earlier than other people.

His initial interaction with Windows XP was based on the instructions he got on the distribution list regarding how to work with the system, how to do the upgrades, how to get the backups done, and so on. It was a semi-automated process that required Tyler's input off and on. Sometimes Tyler had to figure something out on his own since the organization had not yet codified the process of smoothly moving to Windows XP.

However, Tyler's later interactions with the system were more on a need basis. He did not have to explicitly set goals to learn the system but rather tried new features as and when he needed to accomplish something with the system.

> It was mostly need. Mostly when I needed to do something I had to go figure out how to do it in XP… So I never really set out to learn the system. I just needed it on an as-needed basis.

Tyler did not receive any training on Windows XP but there was a help desk he could rely on and he was given the name of a contact person who would be able to answer questions related to Windows XP.

> I had to call our help desk. I called them on a number of occasions… I am pretty sure the help desk wasn't trained in XP… So when I called up with an XP question, they automatically routed me to a specialist.

Tyler uses a reasonable number of the Windows XP operating system features and continues to work with the system on an as-needed basis.

Titus

Titus functioned as a production and inventory control manager at his organization. He was responsible for setting up and helping to implement information systems for the management and control of inventories. He also conducted reviews of the existing business processes related to inventory management and control and constantly looked to streamline processes to achieve more efficient and effective operations.

He was recently involved in the acquisition and implementation of the Oracle Financial System for the entire organization. The Oracle system was an enterprise-wide system that affected several other functional areas within the organization including accounting, procurement, and maintenance.

Titus was a member of the team that was responsible for evaluating different products available in the market and determining the best offering for their needs. After helping with the initial evaluation of the product, he was involved in actually building and customizing the system for the organization. He was actually authorized by top management to ascertain the best way to implement the system for the organization.

> I was given the responsibility to build this system the way that would best work for the company. I was given full responsibility…

He was fascinated with the process of transferring the processes from the old systems to the Oracle system. He made it his business to get familiar with the system and find different ways in which the information system can be effectively used.

> By using and going in and playing with the system, I was able to reconstruct and better format how our inventories are set up, how the inventories issued to our units… I could tell that we could get more data out of this system now that we would ever dream of doing. So, that really enthused me.

Since he was a pivotal influence in identifying the best way to implement the system for actual use, he spent time with the system attempting to determine the best ways in which to get the most out of the system.

> The more I played with it [the system] and the more I tried different [things] the better it looked for me… I spent a lot of hours… just pounding the system… I play, play, played until I found a way that I liked it to work.

Titus interacted with several individuals in different functional areas to convey his findings related to the Oracle system and the best ways in which the system can be exploited. The system is now in full use at the organization.

Veronica

Veronica worked as a senior business analyst at her organization. She belonged to the authorization strategy group that was responsible for designing and implementing processes related to the authorization of online card transactions. She was responsible for liaison between business groups and systems development groups to understand business needs as well as implementation issues.

One of the systems Veronica adopted recently was the ChangePoint system. ChangePoint was a comprehensive system for tracking projects undertaken, time spent, budget adherence, and other related components such as variance reporting. The use of Task Tracker was mandated by the organization. It replaced a collection of three systems that was in place prior to the time ChangePoint was implemented.

> What it [ChangePoint] does is an all-in-one application for which we had three before. So you replace three with one. And it was supposed to be able to give budget adherence and budget tracking at a group level.

Even before the implementation, Veronica received hands-on training set up by the organization to familiarize individuals to the ChangePoint system.

> We had training… We had a four hour time slot for training that we all signed up for through one of the computer labs and picked up out little training. All the training was online; there was no books.

The project team in charge of the ChangePoint system notified through communications about the impending implementation. When the time arrived, the system was implemented as a complete switchover for the entire organization, and the old systems disappeared during the switchover.

However, the implementation was not smooth. The system could not handle some of the requirements for which it was designed. About two weeks into the implementation, Veronica figured out that she would have to adopt a manual process to overcome the limitations of the system. Veronica and individuals like her had to make stop-gap arrangements to accomplish their tasks despite the inadequate systems. These efforts included requesting for new solutions as well as designing own solutions that may serve to get the tasks done.

> I got together with a group of people and said, "This is what I think we need based on what I've been dealing with."… We started building something else in Access that we thought might be essential.

In response to such demands, the organization implemented two or three patches since the implementation of the system. Veronica used pretty much all features of the system since she also served as one of the release leads for the ChangePoint system.

Wanda

Wanda served as a director in the information systems department of her organization. She managed a team that designed and developed information systems for the organization's local and overseas offices dealing with the conception of merchandise. She also monitored merchandising and compliance operations at her organization. She worked with a variety of information systems on her job.

An information system she adopted on her job was Task Tracker. Task Tracker enabled the organization to track the various project tasks for an individual and the time the individual spent on those tasks. The Task Tracker system was internally developed by the organization using Lotus Notes and the Notes database.

The use of Task Tracker was mandated by the organization for individuals involved in information systems development projects. In Wanda's case, her director told her that she and her team should be using Task Tracker to track project times. He also explained the benefits of using the tracking system.

> It was a company directive that you had to use [Task Tracker]… [My director] was the person who told me.

Wanda benefited from a training class that was conducted by the organization. The training session provided an understanding of the basic features of the system.

> There was a training class… We had an on-site trainer who trained us. The class was hands-on.

Once Wanda began using the Task Tracker system, she was enthused by it and wanted to continue with it.

> I used it because I think it is a good tool… Why I use it is because I found it to be useful once you started using it.

She spent time with the system attempting to understand its capabilities and features such that she could get more benefits out of the system. She also learnt a lot about Task Tracker from the user guide.

> [I] spent a lot of time using [Task Tracker], trying to understand the features it provides.

Wanda did not use all the features of the system, but she continued to use those features she thought were useful.

Appendix G. Influence Stories

Brad

Brad functioned as the department leader for the business development team at his organization. His role was designed to help company representatives make actual clients out of potential clients (or leads) they may have identified in their field work. Brad routinely interacted with a variety of information systems.

Since assuming the role of department leader, one of the information systems Brad adopted was the Contact Management System. This system is an extension of the Microsoft Outlook application and allows the management of information related to the potential clients (or leads) from the time they make the first contact with the organization to the time when they become full clients of the organization. The process of identifying leads and making clients is typically a long one and involves considerable effort.

Brad came to know about the Contact Management System that another department in his organization used for their own tasks. He put together a team from his department to design and develop the Contact Management System for their own specific uses in tracking information about potential clients. Once the system was developed and ready to use, Brad wanted his team to use the Contact Management System. So he informed his team members that they would have to be using the contact system. However, rather than just giving a directive, Brad also explained the potential benefits of the system to his team members.

> I told them [my team] the primary benefits for them… They would be able to document what's going on and allow a third party to be there where they're not… [The contact management system] will allow you to organize from one vantage point as opposed to what you tried to do before.

Brad and another individual began using the Contact Management System first and subsequently talked to the other team members about them using it as well.

> The power user [the other individual] and I started [using the system] first and then he and I went to the other team members and said, "We're going to move to this [Contact Management System]. We'll mentor you as you go through this. So, as you have your first one, come to me and I'll show you how to set it [Contact Management System] up and what I would do."

Brad also demonstrated the Contact Management System to the members of his team at a department meeting so that they could gain an understanding of the system.

> We had a department meeting… I pulled [the Contact Management System] up and showed it to them and just sort of demoed it to them, how we're doing it, and what we're doing… I did have at that time this power user sort of give a voluntary endorsement because he said, "I couldn't exist without this [Contact Management System]."

Brian

Brian worked as a category manager at his organization. Specifically, he was responsible for the pricing, promotion, product assortment, and shelf set and allocation – the collection of activities recognized as category management of the various products in his product categories he managed for the organization. Brian interacted with quite a good number of information systems on his job.

One of the systems Brian adopted for his tasks was the Oracle Sales Analyzer. This system was used primarily for analyzing the point-of-sales data of their everyday operations gathered by the organization. Brian was dependent on the system to more effectively run the category management processes for his product categories. Category manager such as Brian were generally expected to use Oracle Sales Analyzer of analyzing data and adjust their actions.

Oracle Sales Analyzer was initially suggested as an option by the new head of the information technology department at Brian's organization. The new head came in to the organization at a time when the old sales reporting system was becoming rather old and needing some enhancements. He engaged Brian actively and obtained feedback about the system before making it available for use within the organization. Brian also provided feedback as the system was being designed and customized for use by category managers within the organization. Brian was trained by the information technology department on using the Oracle Sales Analyzer because he was one of the primary users of the system. Subsequently, Brian actively engaged in experimenting with the system to understand more of the features and capabilities of the system.

Subsequent to his adoption of Oracle Sales Analyzer, Brian introduced the system to his secretary such that some of the reports he needed can be prepared by her. Thus, the use of Oracle Sales Analyzer was not a mandated activity for the secretaries, but rather based on specific requests by Brian.

> It is required [for the secretaries] only by virtue of the fact if I give them an assignment to retrieve point-of-sales data from a particular store of group of stores, they obviously need to know how to use it.

Although he had several secretaries reporting to him, Brian really introduced the system to only one of his secretaries since he did not really need all secretaries to be working on the same needs he had. He showed her the fundamentals of the system.

> I would bring my secretary in here [my office] or I would sit at her desk with her and I would walk her through the program and show her how to use it [Oracle Sales Analyzer].

Brian provided some feedback to his secretary on her usage of Oracle Sales Analyzer and the effectiveness with which she used the system.

> I provide the feedback of how you can do this. "Yes, you're doing this right. If you do this, if you do such and such report you have to watch for this."

Cathy

Cathy functioned as a buyer's assistant at her organization. She was responsible for conducting research that would assist her managers with the procurement of products from sellers. She generally used a variety of software tools provided by the organization for accomplishing her tasks.

A system she adopted for her role was the Maintenance and Support System – an information system .used to set up the various Universal Product Codes for the products handled by her organization. The use of this system was mandated for everyone by the organization.

In Cathy's case, she became aware of the system when her manager said that she would be using the Maintenance and Support System. The information systems department then installed the system on Cathy's computer. She was told that the Maintenance and Support System was somewhat similar to what she had been using before. Cathy also participated in training sessions for the Maintenance and Support System that were conducted by the information systems department. Once she understood the basics of the system, her learning was pretty much self-taught as Cathy learnt most of the system on her own. Cathy pretty much used all the features of the Maintenance and Support System she was authorized to use.

Cathy typically introduced the Maintenance and Support System to new hires coming in to her department.

> [I] show them [the new hires] now to open it [Maintenance and Support System]… how to get to it and then how to type in the information and what needs to be typed in. So, usually they'd kind of take notes and [I] usually give them something pretty simple to do.

She also answered the questions that these new hires generally asked Cathy subsequent to her introducing the system to them. In some cases, she had just a few questions and in other cases, she had several questions depending on the extent to which the new hires were able to get a grasp on the functionality of the system.

> They [the new hires] keep asking you questions… As long as they're not trying to learn a whole lot of it [Maintenance and Support System], if they're just trying to learn parts of it, they usually catch on.

Sometimes Cathy provided the documentation on how to work with the system so that the new hires can read through and determine the features they need for completing their tasks.

Elizabeth

Elizabeth served as a manager of the information systems function in her organization. She performed a variety of roles such as programmer, analyst, etc. before she became a manager of the information systems department. Her responsibilities included liaison between information systems and other functional areas within her organization as well as helping set strategic goals for the information systems function.

She recently adopted a system called Travel Manager – a system used to plan travel and record travel expenses so as to get reimbursed. When it became available, Travel Manager was mandated for all individuals who were required to travel on behalf of the organization. Elizabeth did not have a choice but to adopt Travel Manager since the paper-based system in place prior to Travel Manager was completely eliminated.

> We were told. It was a memo that came out and said, "You are traveling; thou shall use this [Travel Manager]." It wasn't like we had a choice. It was like, "This is the way. You're going to use it if you want your money."

Elizabeth attended a training session where she learnt the fundamentals of using Travel Manager for her needs. The training enabled her to gain a level of understanding of how to do simple things using Travel Manager.

> We went to a class about… may be two or three hours. They walked through what we were going to do and they gave us some handout materials. We went in large groups.

Elizabeth was not particularly a fan of Travel Manager. According to her, Travel Manager was "the most distasteful thing she had ever experienced." She was not a frequent traveler at the time Travel Manager came into existence and every time she had to use it she ran into some problems. Part of the problem was that she did not remember how to accomplish certain tasks since she had not used the system in a while. Hence when Elizabeth had a chance to introduce Travel Manager to other individuals in her organization, she recommended them to stay away from Travel Manager as much as they can.

> I told them [other individuals] to "stay as far away from it [Travel Manager] as much as you could as long as you could." So I was a bad influence. I was "run and hide when they [the organization] come and talk to you about it [Travel Manager]. You don't want any part of this." But eventually they [the other individuals] got stuck with it. That was only temporary.

However, Elizabeth was more than willing to share knowledge she had gained about Travel Manager with other individuals so that they did not have to face the same issues with the system that she did.

> We were planning a trip. It was a group of us going to it for a specific reason and I mentioned, "You have to do something special about the charge number you put in there because if you don't you get into this loop."

Hilda

Hilda worked as an accounts payable manager at her organization. She also acted as manager of the accounting department. She was responsible for managing accounts payable and for implementing projects related to accounts payable or the accounting department, including information systems implementations.

She recently served as the project lead for implementing the accounts payable unit of the Oracle Financial System – an enterprise-wide system aimed at integrating the various units within the organization. Hilda was concerned with only the specific implementation related to the accounting department.

The decision to implement the Oracle Financial system was taken by the senior management. However, she participated in the evaluation process when the organization engaged different suppliers to demonstrate their products. Once the senior management decided to go with the Oracle system, they decided to implement all modules, and then mandated the use of the system as well. Hilda attended training sessions that enabled her to understand the system. The training provided the basic skills necessary for her to implement the system. She also received books that would allow her to gain additional information. Hilda uses about 20% of the features of the system now. She also assists others on her team and the organization to use the system as well.

Hilda had the responsibility to introduce the Oracle Financial System to the members of her team. She conducted one on one sessions with her team members to get them familiar with the new system.

> I took them [my team members] one by one and we spent an hour to an hour and a half just doing one very simple task, doing it over and over again, until hopefully they have some comfort with that one specific task. I did that with each of them on tow different areas that are key to what they do.

She used the test system installed by the organization to get her team members become familiar with the new system such that they can then use that knowledge to work effectively with the live system.

> She came to me and said, "I don't know how to do this. I have not clue how to do it."… I said, "Let's… play around in the test system."… We did it over and over again until she gained comfort.

Hilda employed a variety of techniques to assist others when they struggled with the Oracle system. Sometimes she would sit with them and show them how to use the system and at other times she would be in a remote location and interact over the phone.

> Sometimes I'll go show them. Sometimes I'll sit at my desk and they sit at theirs and we'll pull up the same screens.

Jake

Jake worked as a senior programmer at his organization. He was responsible for the technical analysis and design of systems: he obtained and analyzed the functional requirements to determine what needs to be done, design what needs to be done, actually code the system, test it, and then help with the installation. Jake used a variety of information systems on his job.

A system that Jake adopted recently on his job was Task Tracker. Task Tracker was an information system used to track the different tasks Jake was involved in during different phases of a development project and the amount of time he spent on each task. It was a system that was internally developed by the organization to more efficiently track the time spent by individuals on different projects undertaken by the organization.

When it was rolled out, Task Tracker was mandated for all information systems professionals within the organization. Jake was able to participate in a training session that was aimed at introducing Task Tracker and its features to the participants. Jake was not particularly happy with Task Tracker and the implications of using it on his job. He nevertheless used the system as it was mandated. However, Jake discontinued using the system after a year or so since he had a new manager who did not enforce the use of Task Tracker. In all the time he used Task Tracker, Jake pretty much used the same features he used when he initially adopted it.

Jake introduced Task Tracker to new hires who were assigned to his team when they joined the organization.

> One guy started recently… and I am not the one who told him he had to use [Task Tracker] but I was there to help him get started in using it as far as explaining what he needed to keep track of an how to enter it into the screen.

He did not have the responsibility of issuing the mandate to these new hires since he typically was a peer to these new hires. However, Jake demonstrated Task Tracker to the new hires.

> I [showed] how to use it [Task Tracker] as far as… a good way for entering time, keeping track with this type of detail, and turning in time. I would say I probably had a little bit of influence on how to use it [Task Tracker], not necessarily to use it.

Jake even used his time sheets that he created to track his time as an example to these new hires on how they can exploit the features of Task Tracker.

> I… demonstrated or showed him my time sheet and… logged in as myself and showed him on mine… walked through the screen.

Kevin

Kevin worked as a business analyst at his organization. He focused specifically on the online authorization systems. He had two major responsibilities: the first was to prepare business requirements for the authorization systems and take it to the systems development staff; the second was to publish information related to the authorization systems for use by members of the organization.

He was recently involved in the implementation of the ChangePoint system at his organization. ChangePoint is a comprehensive system for time tracking, cost accounting, project management, and a host of other things. The organization used to have independent systems for these different activities before the implementation of ChangePoint. However, ChangePoint was made mandatory when the organization switched over.

> It was mandatory. It's mandatory that we track out time. It's mandatory that we put all of our projects on the tool.

Several months prior to implementation, the organization sent out updates and information on the forthcoming ChangePoint system. This provided an opportunity for individuals like Kevin to get used to the idea of working with the new system. The organization also set up training classes which provided basic information about the system and how to get started on it.

Unfortunately for Kevin and others, the initial implementation of ChangePoint was a turnkey solution which did not really cater well to the particular needs of Kevin's group. Hence, Kevin engaged in activities such as requesting updates or implementing own solutions to overcome the limitations of the system.

Kevin was part of the team that was responsible for ensuring that the organizational members moved to ChangePoint. Hence, Kevin interacted with individuals who had problems with the ChangePoint system and showed them how to use the system.

> [I] had to help some of the users... because we were the responsible party in making sure to get their estimates into the tool [ChangePoint]. [I] helped show them how to do it.

In several cases, Kevin's efforts were directed at educating the other users about the ChangePoint system, especially since the initial implementation of the system had several problems that needed attention. In addition, Kevin provided personal assistance to some individuals when they needed such assistance.

> In some cases, [I] would go to their keyboard and help them put in the information they needed to do.

Katelin

Katelin worked as a bond trader at her organization. She was responsible for conducting online trades, carrying out research about various trading opportunities, providing inventory of trades for their retail brokers, educating and marketing specific investments to their brokers, and assisting with outgoing information to the general public. Her job demanded that she routinely use different information systems.

An information system that Katelin adopted when she joined the organization was the Bloomberg system. Bloomberg is a comprehensive system made available by an external provider that can be used for trading bonds. The Bloomberg system came with built-in information on several aspects including bonds, news wires, stock markets, etc.

The Bloomberg system was actually required for all individuals trading bonds for the organization. She understood, in her initial briefing sessions, that she would have to routinely use the Bloomberg system. Katelin benefited from a training system that the organization had in place.

Katelin typically introduced the Bloomberg system to new people hired by the organization and who ended up at her office. In general, Katelin showed demonstrations of the system to the new hires such that they can gain a preliminary understanding of how to use the Bloomberg system.

> I take them [the new hires] step by step how I do it [the Bloomberg system]. They [the new hires] are watching me do it and they do some. It could get more complicated as the days go on. It's a good month before they're completely comfortable looking by themselves… [Sometimes] they [the new hires] get half way and they'll say, "Okay, what was I supposed to do?"… We do have the handbooks in place.

In interacting with the new hires, Katelin generally considered the prior expertise or knowledge possessed by the individuals in tailoring her input to their needs.

> We have a lot of people… who require rotational development, where they have been to a number of different departments before they get to us… A lot of times the rotational people have been a little bit more introductory first. That's going to be different from someone who is brand new… You do have to go in steps, to different mind sets.

However, the new hires may also benefit to some extent from the internal communication system maintained by the organization that contained information on a variety of topics that the new hires may need to know.

> There's some things they [the new hires] may be able to find the answers to through our internal communication system, but pretty much it's going to be based on whatever knowledge they have before, their global resources, and other people.

Melissa

Melissa worked as an administrative assistant for several directors at her organization. She was responsible for scheduling appointments, taking phone calls, and writing correspondence for the directors and generally making sure that the directors can function smoothly. A vast majority of her tasks were completed on systems provided by the organization. She worked on a variety of systems depending on the tasks to be accomplished.

One of the systems that she used frequently was Personal Manager – a scheduling tool that allowed her to schedule meetings, include participants for meetings, and reserve conference rooms. Personal Manager was a multi-user system and had different levels of rights for the different individuals in the organization. Melissa, for instance, had the user rights to include meetings on her directors' schedules.

Melissa had been using the system for about 10 years. Her first introduction to Personal Manager was when the administrative assistant she replaced [called Debra hereafter] in the organization told her about it. Based on what Debra told her, Melissa understood that she would have to use Personal Manager for all scheduling tasks. Before she left for her new position, Debra helped Melissa understand Personal Manager so that she can use it herself. Melissa experienced quite a few problems using Personal Manager such as overbooking conference rooms, scheduling the meetings for 2 a.m. instead of 2 p.m., and scheduling the wrong Smith for the meetings. She was able to overcome these problems, and over time, she gained a lot of experience with Personal Manager.

Just as Debra introduced Personal Manager to her, Melissa introduced the system to other new hires at her organization. Typically she provided an overview of the Personal Manager system so that the new hires can get started on it pretty quickly.

> We hired a few new people in my department and I went over. It took about 15 minutes for a brief overview.

However, the new hires typically came back to Melissa with questions on specific aspects of Personal Manager. In those instances, Melissa demonstrated the system to them and offered to assist with their future questions, if they had any.

> They [the new hires] will call me and say, "How do I do this?"… I'll just walk back to where they're at and sit down with them and I'll do it slowly so that they can take down notes… Then I'll tell them, "If you don't understand it next time, call me, and I will come back; if you want me to come back and have me watch, we can do that too."

As an experienced user of Personal Manager, Melissa actually showed efficient ways of using Personal Manager to the new hires.

> I try to show then [new hires] an efficient way of doing that [scheduling meetings with Personal Manager].

Neil

Neil performed the role a project manager at his organization. He was affiliated to the division of the information technology department that dealt with human resources. Neil was responsible for collecting and tracking all the hours worked by employees, creating schedules related to staffing field locations, and determining eligibilities for vacation and sick time, and computing employee status changes.

As part of his job responsibilities, Neil adopted an information system called Task Tracker. This system can be used to track different tasks undertaken by an individual and the time the individual spent on those tasks. Task Tracker was a multi-user system which allowed simultaneous access to multiple individuals. But the system also had rights management that enabled individuals to access different pieces of the system. As a project manager, Task Tracker enabled Neil to obtain and evaluate the hours put in by various individuals.

The use of Task Tracker was mandated by the organization. Information on the forthcoming availability of Task Tracker was distributed to all individuals via electronic email. The organization arranged training sessions for anyone interested in getting the basics of using Task Tracker. Once Neil adopted the Task Tracker system, he was enthused by its capabilities and really wanted to make use of the tool whenever he can.

Since the mandate was issued to all individuals, Neil did not have to influence others on his team to use the system. However, Neil wanted to ensure that his team members did actually use the Task Tracker system. Moreover, it was general practice for individuals not involved in systems development to only introduce the new system to others.

> I didn't have to [motivate others] to use it [Task Tracker]. I just had to introduce to us [my team] because we didn't write it.

In general, it was up to the individuals to respond to the organizational mandate; however, Neil followed up with his team members if he found that the individuals were not using the system yet.

> It they [my team members] forgot for a week, I reminded them to do it [use Task Tracker].

One of the challenges for Neil was to make sure that his team members did a decent job with the timesheets. In case he thought there were any infractions, he followed up with the team members for compliance.

> A lot of people just put one line, 40 hours this week… My challenge would be, "Okay, I need a little more detail of exactly what you're doing and how many hours on this, how many hours on this, which problem number were you working on, which program, etc.

Paul

Paul served as a director of information systems activities at his organization. His primary responsibilities involved systems development activities for the human resources system as well as other corporate systems internally used by the organization. He was generally more involved with the implementation of enterprise information systems for his organization. He interacted with different information systems on his job.

One of the information systems he adopted as an individual was the Travel Expense Report system. The system may be used to plan official trips and record expenses related to the travel for the purposes of reimbursement. This system was required by the organization of the individuals who traveled on behalf of the organization. When the system was rolled out, the paper-based process was withdrawn and hence individuals who traveled did not have much choice but to adopt the Travel Expense Report system.

> It [the Travel Expense Report system] was installed under the direction of our senior management group. You can no longer use the paper. So, therefore, you will either use the online system or you don't get your money.

Paul benefited from the training sessions that were available for the Travel Expense Report system. Training sessions for individuals using this system was a routine process at Paul's organization.

Due to the mandate for all individuals, Paul did not explicitly instruct individuals to adopt the Travel Expense Report system. However, he worked with individuals on his team to make sure that any problems they had with the system were addressed.

> If people on my team did not complete their travel expense report, if they did not complete it correctly, I worked with them to show them what they had to do.

Most of the problems Paul observed with his team members were related to the "newness" of the system for individuals who did not travel as frequently as some other individuals. It took a while for them to come to terms with the new processes.

> It was a little confusing the way it [the expense report] was presented for some people who didn't do it very often. They tended to forget that they had to enter [some details]… It took a while to get everybody oriented on those changes.

Paul followed up with those individuals on his team who missed or overlooked some aspect of the system that may be important in the reimbursement process.

> Mostly it was with email. The system is set up so that when an individual submits a travel expense report electronically I get an email… If… there's no explanation…, I bounce it back and I usually send that back in an email. Rarely do I bother saying anything verbally; just through the note.

Raymond

Raymond worked as a manager for the warehousing, inventory, and logistics operations at his organization. He was responsible for maintaining inventories as well as liaising with other functional areas about their requirements. He attempted to standardize and streamline the inventory management process. He interacted with different information systems in imparting his duties.

One of the information systems that he adopted was named Bentech – a system used to monitor inventory, purchasing, and financial activities of the organization. Bentech was a custom-designed system that was built incrementally over time by an external consultant who worked closely with the organization, and specially, Raymond's department.

> We hired a consultant… [He] was a really knowledgeable individual, and he worked closely with our department.

Raymond was very much involved in the design and development of the Bentech system. He routinely participated in group meetings with the external consultant, outlining the specific requirements for the system, providing comments on different aspects of the system, etc. Raymond also interacted directly with the consultant and actively contributed his thoughts on translating requirements into the design of the system, verifying intermediate versions of the system as it was designed, etc. Raymond was sold on the Bentech system for all its features and the convenience and efficiencies it brought to the operations of his department.

Raymond really wanted his team to be using the Bentech system as well. Hence he kept updating the group about what the system can do for them and suggested that the team should give the system a try. To make it more attractive, Raymond explained the advantages of using the Bentech system and how the system would be beneficial in their everyday jobs.

> I'd always bring a group together… "Here's where we're headed. Here's what we're going to do, hash it out, explain it… if it doesn't work we can always go back to the way we were; but let's try it."… [I] explained the usefulness of the system… You always want to give the people what it [the system] is going to do for them to make their life easier.

For individuals who were not overly enthusiastic about Bentech, Raymond employed different strategies to get them on board.

> The administrative assistant wasn't using it [Bentech]. So I told her, "I think it would be a lot better if you really use the system."… She had a lot of reasons why it couldn't work… We talked about it. I said, "I'll show you what you can do. You won't have to do this and you won't have to do this."… We went through [the system]. The other lady – a procurement clerk – works with [the system] all the time and I do… Between the two of us, we kind of ganged up on her… She's on board now.

Robert

Robert functioned as an inventory and logistics manager at his organization. He was responsible for maintaining as well as distributing inventories to the other functional areas within the organization. He routinely worked with different information systems in completing his various tasks.

A system that Robert adopted for his operations was the BarCode System. The barcode system was useful in tracking inventories in real time. This was possible because all items or item groups in the organization's inventories were tracked using Universal Product Codes. The barcode system was a combination of hardware and software that allowed the products to be scanned using a wireless device and processed at a remote location. Thus, individuals dealing with the inventories did not have to manually key in the Universal Product Codes but rather scan the codes and let the computer do the rest.

Robert was always looking to improve the efficiency of his department and thus became interested in the barcode system. He gained more information about the barcoding system by attending a seminar on barcoding conducted by an external vendor. Robert looked to his manager for the money to implement the system.

Once his manager approved the system, Robert implemented it within his department and saw some improvements in his operations. He actually kept his team informed and updated on the barcode system.

> I didn't keep anything from them [my team]… I just try to give them a little sales pitch all along the way… "Hey, it's going to be different, but I think it will be better."

Robert waited until the successful implementation of the barcode system to convince individuals who had some trouble understanding the use or importance of the barcode system.

> She really was going to be the one to use this [Barcode System] after we got it running. So what we did was: we told her about it and she wasn't really too happy with it, but we didn't really force it on her. We got it running to where we knew it was really good and then we just talked to her… After she got it, she was fine.

Since the inventories were being distributed to other units within the organization, Robert also demonstrated the system to representatives from other units who came by to pick up inventory.

> [I] just showed them… "If you want to do this yourself, it would save you a lot of time and we can wait on other people. If you need it you can just come in and get it."… We had classes. We actually had to do classes and we brought people over. We have a conference room in our area and we brought people in… just showed them how and trained them.

Sharon

Sharon worked a project manager for customer operations at her organization. She was responsible for understanding the needs of the different customers, taking orders from customers, managing the order process, and for evaluating order processes and implementing more efficient solutions for customer operations. She used a variety of information systems in accomplishing her tasks.

One of the tools Sharon adopted recently for her work was the Pilot system. Pilot was an add-on system to Microsoft Excel that can generate reports for *ad hoc* queries with data from a corporate data warehouse. In general, the Pilot system was customized, in terms of the data universe, for different user groups within the organization. The Pilot system was developed and customized by the information systems department within the organization.

The information systems department introduced Sharon to the Pilot system and its superior capabilities. Sharon was really enthusiastic about the Pilot system once she was introduced to it. She attended the basic training sessions for Pilot conducted by the information systems group. It took a few weeks of practice for Sharon to get comfortable with the Pilot system; however, she was very satisfied with the system.

Since she found the Pilot system to be very useful, Sharon introduced the system to her team and actually trained them on the fundamental aspects of the Pilot system.

> I did train a group of them [my team] at the same time… We went to one of our tech rooms where everyone could have a computer and I helped walk them through."… [The training session] was about two hours and [I] then provided practice exercises for them to work through in the room.

Depending on the particular needs of her team members, Sharon employed different approaches to get the value of the Pilot system across to her team. For instance, she pointed out the Pilot system to her team members as a possible solution to some of their task requirements.

> It was about showing them, pointing out to them the gaps in information that the standardized reports left for them, and helping them see that standardized reports didn't tell them everything… Some of it was waiting for them to bring the question that they had, that they couldn't get to answer because they didn't have it anywhere… "Well, you can get that out of Pilot."

Sharon also volunteered to assist her team members should they ever need to understand or become familiar with aspects of the Pilot system. She was happy to demonstrate the Pilot system to her team members.

> "You go try and when you can't get that, come back" or "Hold on, let's get it together." So I would drive and they would watch, and voila, there was the answer.

Teresa

Teresa worked as a human resources generalist at her organization. On her job, she counseled or coached leaders and associates on the policies and procedures of the human resources operations. She also provided training on team dynamics, relationships and leadership. She also answered questions regarding compensation. She used a variety of information tools and systems on her job.

To accomplish her job responsibilities, one of the systems Teresa adopted was the Peoplesoft system. The Peoplesoft system, relevant for her function, was used for managing human resources within her organization. Specifically, Teresa focused on job information related to the hire, absence, performance, termination, etc. The Peoplesoft system was already in place and mandated for use when she joined the organization. All Teresa received when she joined was a communication that she should contact someone to obtain the necessary user identification and password to use the system.

Teresa initially had someone give her a demonstration of some of the features of the Peoplesoft system. But she experimented with the system quite a bit once she received her access to the system attempting to uncover aspects that may be useful to her. However, there were occasions when Teresa enlisted the help of other individuals in working with the system. For the most part, however, Teresa's interactions with the Peoplesoft system were based on certain needs.

Since the Peoplesoft system was mandated for the organization, Teresa did not have to introduce the system to others. However, when she had new hires join her department or team, she helped set up the user accounts and offered to help if the new hires had any questions regarding the use of the Peoplesoft system.

> When someone joined our team, [I said,] "Here's your login and password, let me know if you have a question."

Teresa provided an initial demonstration of the Peoplesoft system to the new hires and also made herself available if they had any follow-up questions. The initial demonstration typically lasted for a longer duration that the follow-up sessions which may be spread out to different points in time for different periods of time.

> I walk her through some of the key tasks or places where she needed to get information… [I] initially got her through the fundamentals… in about 30 minutes, and then may be 5 minutes here, 10 minutes there, when situations came up.

She also answered specific questions that may come her way from individuals who needed assistance on specific aspects of the system.

> [She asked] just where to go for information, or "How do I find this?" or… "Where do I find that?"… I was once in her cube… and had her in my cube sitting in front of the terminal.

Tim

Tim occupied the position of a senior manager for the information systems support group at his organization. He managed a team of software professionals who were responsible for development and maintenance of internal information systems. The software professionals on his team were involved in different activities: conversion of legacy systems, maintenance of systems, development of small systems, etc.

One of the systems that Tim adopted recently was the Travel Manager – a system used to plan trips and record expenses for obtaining reimbursement. Initially, Travel Manager was released to a limited number of users who volunteered to test the system. It was mandated for all individuals who had travel needs and wanted to be reimbursed – but that came later.

When Travel Manager was first announced, Tim volunteered to be an early user of the system. He did have some formal training but his interactions with the system were based on more on trial-and-error and self-learning. There were not a lot of other individuals he could talk to since there were not very adopters yet. However, he did get some assistance from the help desk established for helping individuals with Travel Manager.

Tim introduced Travel Manager to other individuals in his organization. He basically explained to them the need for Travel Manager and how they can get ready for using the system when it was mandated.

> I introduced it [Travel Manager] to several people and I said, "In order to take this trip you're going to have to get it authorized online and you're going to have to get the expense report online and in order to do that you're going to have to learn Travel Manager… My input to their adoption was, "If you want to travel for [this organization] you will have to use the system."… It was like saying, "You live in the United States, therefore you will pay income tax."

He demonstrated the Travel Manager system to anyone who needed it and also offered to assist them in their first attempts to use the system themselves.

> I told them [other individuals] when they get ready to do their first expense report that I would sit with them and help them through it [Travel Manager]… It was a 15 or 20 minute process for me to show them how to use [Travel Manager]… I just went down there [their office] and walked them through it the first time.

Tim actually assisted individuals with Travel Manager at all levels of the organization. He employed different approaches to deal with the different levels.

> My boss knew before he had to do his first one that I was able, so he asked me to sit with him… [With my peers] I would say, "Just let me know. I've done this for a couple or three years, let me know if you have any questions."… I would sit with [my direct reports] the first time.

Tyler

Tyler was a leader of an information systems support team at his organization. Individuals on the support team generally acted as data testers that they can acquire all the experience they can with new technologies. Such experiences were useful to the support group when they had to assist the executive customers within their organization.

Recently, Tyler was involved with the rollout of the Windows XP operating system at his organization. As was the general rule with the support group, when he came to know about the Windows XP rollout, he volunteered to be one of the data testers. Tyler's initial interaction with Windows XP was based on the instructions he got on the distribution list regarding how to work with the system, how to do the upgrades, how to get the backups done, and so on. It was a semi-automated process that required Tyler's input off and on. However, Tyler's later interactions with the system were more on a need basis. Tyler did not receive any training on Windows XP but there was a help desk he could rely on and he was given the name of a contact person who would be able to answer questions related to Windows XP.

Subsequent to the initial data testing phase, in which Tyler was involved, the organization mandated the use of Windows XP for all individuals in the organization. Exceptions to this general rule were individuals whose work systems were not quite compatible with Windows XP, and whose desktop plans would guarantee their systems to be replaced in a short while. The individuals were actually put on an "upgrade list" – a sequential list that determined the order in which the individuals were instructed to get the upgrade. If, for instance, someone decided not to get an upgrade immediately – because they were in the middle of a project – their name would be placed at the bottom of the list and be contacted again.

By the time these events happened, however, Tyler had been using Windows XP for a while, and this was known to other individuals in his organization. Thus, although Tyler did not have to, and did not, influence others to adopt Windows XP, he had individuals enquire him about the Windows XP systems.

> People come to me and say, "I know you have had [Windows] XP for quite a while; I am about to get the upgrade. What can you tell me? What should I worry about?" So, I am serving as a consultant because I'm one of the first people to use it [Windows XP].

Tyler also provided some assistance to individuals who sought him. He provided answers to some questions as well as demonstrations of the Windows XP system itself.

> [I have had] very short questions and I have shown some people how to do something.

Titus

Titus functioned as a production and inventory control manager at his organization. He was responsible for setting up and helping to implement information systems for the management and control of inventories. He also conducted reviews of the existing business processes related to inventory management and control and constantly looked to streamline processes to achieve more efficient and effective operations.

He was recently involved in the acquisition and implementation of the Oracle Financial System for the entire organization. The Oracle system was an enterprise-wide system that affected several other functional areas within the organization including accounting, procurement, and maintenance. Titus was a member of the team that was responsible for evaluating different products available in the market and determining the best offering for their needs. After helping with the initial evaluation of the product, he was involved in actually building and customizing the system for the organization. He was authorized by top management to ascertain the best way to implement the system for the organization.

Titus interacted with several individuals in different functional areas to convey his findings related to the Oracle system and the best ways in which the system can be exploited. Titus organized several meetings in which he attempted to persuade others.

> Most of the time [I] would have two or three people in [the meeting] just to get the other side of the story, open the door for conversation or anything… Also I wanted to have an ally saying this was a good process.

At times, Titus showed demonstrations of the Oracle system to others. For this purpose, he actually designed and created processes that he could show others in the organization. Titus had to demonstrate how the Oracle system can be used to conduct operations efficiently and effectively in comparison to the old methods.

> By having a defined process to show them I was able to persuade them that may be they need to change their thinking a little bit.
> [I walked them through] demonstrations of how this works and why it would work better… I could show them that I could go in do their process of buying with a more logical process.

However, the process was not always easy. Titus had to literally explain why the new system would be beneficial across different functions in the organization. At times, Titus had to actually be very assertive to get the other individuals on board for the use of the new system.

> I had to basically take them by hand and explain to them why they had to do it a different way.
> People get into a mode of doing certain things… A lot of times you almost have to sit then down and browbeat them to death to show them. Yes, I had to do that a few times… It took – I hate to say it but – stubbornness and shouting and other things to go with it.

Veronica

Veronica worked as a senior business analyst at her organization. She belonged to the authorization strategy group that was responsible for designing and implementing processes related to the authorization of online card transactions. She was responsible for liaison between business groups and systems development groups to understand business needs as well as implementation issues.

One of the systems Veronica adopted recently was the ChangePoint system. ChangePoint was a comprehensive system for tracking projects undertaken, time spent, budget adherence, and other related components such as variance reporting. The use of Task Tracker was mandated by the organization. It replaced a collection of three systems that was in place prior to the time ChangePoint was implemented. Even before the implementation, Veronica received hands-on training set up by the organization to familiarize individuals to the ChangePoint system. The project team in charge of the ChangePoint system notified through communications about the impending implementation. When the time arrived, the system was implemented as a complete switchover for the entire organization, and the old systems disappeared during the switchover.

However, the implementation was not smooth. The system could not handle some of the requirements for which it was designed. Veronica and individuals like her had to make stop-gap arrangements to accomplish their tasks despite the inadequate systems. These efforts included requesting for new solutions as well as designing own solutions that may serve to get the tasks done. In response to such demands, the organization implemented two or three patches since the implementation of the system.

Veronica was one of the designated release leads for the ChangePoint system. Hence, she interacted with other individuals to get them started on the new system. She prompted other individuals to begin using the ChangePoint system.

> I would constantly be emailing everybody [in her group], "Your project's set up. You're ready to go in and put your planned hours with your estimates." … It took a lot of hand-holding on my side with everybody in my group.

Not everyone took to the ChangePoint system immediately. Veronica sometimes had to talk to the other individuals and remind them that they should be using the new system. But, she also had to help these individuals use the system since individuals had some problems and issues with the system.

> I would initiate by, "Why haven't you done this? It's due on this date."… I would get emails like… "Well, if you can come and show me how to make it happen, you're more than welcome to." So I am like, "Fine. I'll be down there in a minute."
> [I] literally had to walk them through every step of the way. "Here's how you add icons. Here's your shortcuts."… I had to, a lot of times, go show somebody, "Here's how you do this to enter your estimates."

Wanda

Wanda served as a director in the information systems department of her organization. She managed a team that designed and developed information systems for the organization's local and overseas offices dealing with the conception of merchandise. She also monitored merchandising and compliance operations at her organization. She worked with a variety of information systems on her job.

An information system she adopted on her job was Task Tracker. Task Tracker enabled the organization to track the various project tasks for an individual and the time the individual spent on those tasks. The Task Tracker system was internally developed by the organization using Lotus Notes and the Notes database. The use of Task Tracker was mandated by the organization for individuals involved in information systems development projects.

> It was a company directive that you had to use [Task Tracker]… [My director] was the person who told me.

Wanda benefited from a training class that was conducted by the organization. The training session provided an understanding of the basic features of the system. Once Wanda began using the Task Tracker system, she was enthused by it and wanted to continue with it. She spent time with the system attempting to understand its capabilities and features such that she could get more benefits out of the system. She also learnt a lot about Task Tracker from the user guide.

Because of the benefits Task Tracker provided, Wanda wanted her team members to use the system as well. Although the organizational mandate was applicable to her team also, Wanda introduced the system to her team and explained the benefits and advantages of using Task Tracker.

> I told them [my team] why it was helpful to me: "Here is why I need this information. Every week I have to show what we worked on and if we need help I can go with hard facts and say, 'Look, here's all our hours; here's where we're spending them; and you want this done; well, I need another person to help us.' It helps me and it will help get things for our team."

Wanda had to prompt her team members to make use of Task Tracker quite a few times before the practice was more accepted.

> If you [the team member] didn't have your thing turned in to me by the time, then I would send you a note [to use Task Tracker].

However, not everyone was amenable to the use of Task Tracker. In such instances, Wanda had to apply the threat of performance appraisals before gaining compliance.

> I had an individual on my team who I had to fight tooth and nail and [I] basically said, "You can either do this [adopt Task Tracker] or not; it will be on your review and you can make that decision."

Appendix H. Actions in the Adoption Processes

CQ, RC, and PT refer to the adoption processes Conscious Quest, Requisite Compliance, and Piloted Trial respectively.

Action	Code	CQ	RC	PT	TOTAL
Awareness creation	C1	5	7	4	16
Issuing of mandate	C2	3	6		9
Withdrawal of mandate for use	C3		1		1
Development	C4	1	9		10
Implementation	C5	4	3	1	8
Training	C6	6	10	2	18
Changes in personnel	C7		1		1
Building coalitions	I1				
Appeals to higher authority	I2				
Bargaining	I3			2	2
Acting in a clandestine manner	I4				
Presenting rational arguments	I5	2	7		9
Applying sanctions	I6				
Using friendliness and ingratiation	I7				
Being assertive	I8	3	5	6	14
Expertise	OI1	1		4	5
Demonstration	OI2	5	3	8	16
Knowledge sharing	OI3	4		1	5
Full adoption	A1	8	1		9
Partial adoption	A2		11	9	20
Experimentation	A3	6	5	19	30
Non-adoption	A4		1		1
Review	A5		2	2	4
Observation	A6	1		2	3
Inquiry	A7	3	6	13	22
Seeking assistance	A8	6	2	1	9
Developing own…	A9	3	1	1	5
Requesting for…	A10	1	2		3
Favorable response	OA1	1	1	1	3
Unfavorable response	OA2		1		1
Total		*63*	*85*	*76*	*224*

Appendix I. Action Sequences of the Adoption Processes

Conscious Quest Process

Person	c1										c6						a3									a8			a1
Cathy				i8			c5		c1		c6						a3				a7					a8	oi3		a1
Jennifer					a10	c4	c5	c5		oi2							a3												a1
Karen	c1			i8						oi2	i5	c6						oi3			a8	a9	a9	a7				a8			a1
Melissa				i8						oi2						a6	oi3	a3		a8				oi1	oi3	oi2	oi2	a8		a3	a1
Paul		c2	c2								c6	c6											a7						a3	a1
Robert	c1																		oa1											a1
Tim	c1										c6						a3									a8				a1
Veronica	c1	c2									c6		i5	a9	c5															a1

Requisite Compliance Process

Person	c1						c2					i5		c6										a3					a2		
Brad																							oi2					a10		a2		
Brian	c1	c4	c4											c6										a3		a7				a2		
Elizabeth							c2							c6					a5			a7	oi2						a2		
George	c1											i5		c6																	a1	
Hilda	c1	c4		c5			c2					i5		c6	c6															a2		
Jake							c2			i8	oa2			c6			c7	c3												a2		a4
Kevin	c1						c2							c6		c5				a10	a9			a3		a7	a7		a8	a8	a2		
Nancy	c1						c2																	a3							a2		
Neil	c1									i8		i5		c6					i8												a2		
Raymond	c1	c4	c4	c4	c5	c4	c4																								a2		
Sharon								i5	i5	oa1			i5	c4		c6						a7	oi2	a7	a3						a2		
Wanda							c2				i8		i5		i8	c6									a3	a5					a2		

Piloted Trial Process

Person		i8					oi2					a7					a3			a7					a3							a2
Cheryl		i8		oi1			oi2	oi2		i3	oi1	a7				oi2							a5		a3	a3							a2
Helen												a7											a5		a3								a2
Janet							oi2		oa1							oi2									a3	a3								a2
Katelin		i8	c6				oi2					a7			c1			a3	a3	a3	a7												a2
Keith	c1																	a3			a7					a3	a3		a6	a6	oi3			a2
Natalie		i8																			a7													a2
Sue		i8			a7	i3	oi2											a3																a2
Teresa		i8					oi2											a3	a3		a7	a7	a7	oi1		a8	a3					a9	c5	c6	a2
Titus	c1	i8																									a3	a3	a3						
Tyler	c1											a7	a7	a7			oi1	a3																a2

Appendix J. Narratives of the Adoption Processes

The three adoption processes – Conscious Quest, Requisite Compliance, and Piloted Trial – are distinctive in character and are instructive of the different ways in which IS/IT innovations are adopted by individuals. The following subsections present illustrations of the three processes.

Conscious Quest

The process typically begins with an "awareness creation" effort that introduces the innovation to potential adopters. Generally meant for the entire organization, this activity allows the potential adopters to know about the innovation that will soon be available for use within the organization.

> We were notified by communications by the project team through email and said, "It [ChangePoint] was coming." [Veronica]

To aid the adoption of innovations, the organization typically arranges formal training sessions for the benefit of the potential adopters. Lasting a few hours, the training sessions generally enable the potential adopters to gain a basic understanding of the innovation such that they can get started with the innovation without too much trouble.

> We got a ChangePoint expert, someone employed by that company, who came to our site and we sat in a room over there for one week, who showed us, demonstrated how to do this. [Karen]

To fulfill their needs as well as to get the maximum out of the innovation, the adopters typically experiment with the innovation. This serves to identify new features of the system, to understand different ways in which the system can be used, or to find better ways to accomplish the same tasks.

> You get the basics and then when you want to run one and say, "Oh you can use those fields," and then next time you know they are there. [Jennifer]

The potential adopters may seek assistance from others to overcome any issues they faced with using the innovation. For this purpose, the potential adopters may interact with any of different resources such as development teams, help desks, technical support, liaisons, or other individuals.

> They had a [company] liaison with our ChangePoint team… So everything we needed was funneled to our [company] liaison, like from our team lead to the liaison to the ChangePoint team to get answers. [Karen]

The potential adopters generally adopt and use all features of the innovation, or at least all features they have access to, or all features that are relevant for them.

> I think I'm using pretty much all features that are available. [Paul]
> I'd say… we probably utilized 80% of the features of the tool. There are probably another 20% available that either don't pertain to us, we don't want to use yet, or we have no need for. [Karen]

Requisite Compliance

This process too begins with an "awareness creation" effort by the organization that introduces the innovation to potential adopters. Generally aimed at the entire organization, this activity allows the potential adopters to know about the innovation that will soon be available for use within the organization.

> They sent out an email that it [Task Tracker] was going to be available on this date. [Neil]

The potential adopters are generally required to adopt the innovations to accomplish the everyday activities on their jobs. The organization typically "issues a mandate" such that the innovation may be accepted by all potential adopters, to whom the innovation would be relevant.

> We were told this is what we were going to do and this is the way we're going to do it. [Hilda]

In addition, the potential adopters get to hear more about the innovation and how they would indeed be better off adopting it. The potential adopters are subject to the "rational arguments" made by other individuals, such as their managers, for instance, who explicate the advantages of using the innovation.

> [My boss said,] "There's this great new application and it's really going to be helpful to keep more accurate time… " [Wanda]

The potential adopters may benefit from formal training sessions arranged by the organization. Typically conducted for a few hours, the training sessions generally enable the potential adopters to gain a basic understanding of the innovation such that they can get started with the innovation without too much trouble.

> The group that developed the application… sent down a couple of people… for the training sessions. [Jake]

To understand the innovation as well as to benefit from using it, the adopters typically experiment with the innovation. This process allows the potential adopters to identify new features of the system, to understand different ways in which the system can be used, or to find better ways to accomplish the same tasks.

> After I received the basic training… I just start nosing around in the program. I start clicking on different areas and say, "Gee I wonder what this does" and at that point a lot of my understanding is self-taught. [Brian]

The adopters typically are in various stages of assimilation and use only a subset of the features of the innovation.

> I don't use the calendar function… I am also not as frequent in task reminders as some of my other colleagues. [Brad]
> I'm probably working on 25% of it [the Bentech system]… on a daily basis. [Raymond]

Piloted Trial

The process typically begins with someone "being assertive" that the potential adopter should adopt the innovation. These assertive behaviors are generally enacted by different types of individuals such as the potential adopter's manager or supervisor, co-worker or team member, etc.

> Because it [the Bloomberg System] was considered on the job as well… It wasn't until I actually got on the desk that someone take my hand and say, "You need this system," and that's about how it was initially introduced to me. And I said, "Okay." [Katelin]

The potential adopters generally benefit from "demonstrations" or "walk throughs" of the innovation, given by their managers or co-workers. This helps the adopters to understand the ways in which the innovation may be exploited to accomplish any tasks that are to be performed by the adopters on their jobs.

> [My boss] explained it was a flow charting tool and then he showed me.... This is how I got trained. "You take your mouse, you go to this and it goes like that... You just take it and you drag it over here." [Cheryl]

The adopters also engage in "inquiry" – querying other individuals they come in contact with, such as their peers or managers. Such inquiry typically helps the adopters to understand aspects of the innovation that would help them in making better use of the innovation.

> I had to call our help desk. I called them on a number of occasions… I'm pretty sure the help desk wasn't trained in XP… So, when I called up with an XP question they automatically routed me to a specialist. [Tim]

When they had access to the new innovation, the potential adopters typically experiment with the innovation. This enables the potential adopters to become familiar with the features of the innovation and the ways in which the innovation can be exploited for their specific needs.

> Once I had the user ID and password, I just started poking around… I… tried to figure out as much as I could on my own. [Teresa]

The adopters also engage in more "inquiry," typically with other individuals they interact with in their networks such as their peers or managers. This allows the potential adopters to obtain specific information about the innovation or the features of the innovation or using the innovation.

> To figure out how to add a task… a question or two about it but not very much. [Nancy]

In addition, the potential adopters engage in more experimentation with the innovation, thereby learning more about the innovation. There are even occasions when the adopters discover aspects of the innovation or specific ways by which to exploit the innovation or more efficient ways to use the innovation.

> Then you figure out… It's just one of those things where it really is outside of the box and the book doesn't tell you. [Helen]

The adopters typically are in various stages of assimilation and use only a subset of the features of the innovation.

> [I use] a reasonable amount of the operating system [Windows XP] features. [Tyler]

Appendix K. Actions in the Influence Processes

DA, LP, and QD refer to the influence processes Directed Assistance, Logical Persuasion, and Queried Disclosure respectively.

Action	Code	DA	LP	QD	TOTAL
Awareness creation	C1	3	2	6	11
Issuing of mandate	C2	6	1	1	8
Withdrawal of mandate for use	C3				
Development	C4		1	3	4
Implementation	C5	1	1	3	5
Training	C6	8	1	6	15
Changes in personnel	C7				
Building coalitions	I1		5	1	6
Appeals to higher authority	I2				
Bargaining	I3	1	4	5	10
Acting in a clandestine manner	I4				
Presenting rational arguments	I5	3	14	1	18
Applying sanctions	I6		1		1
Using friendliness and ingratiation	I7				
Being assertive	I8	6	4	1	11
Expertise	OI1	5	3	8	16
Demonstration	OI2	9	7	10	26
Knowledge sharing	OI3		1	4	5
Full adoption	A1				
Partial adoption	A2				
Experimentation	A3	1			1
Non-adoption	A4				
Review	A5				
Observation	A6			1	1
Inquiry	A7		1	11	12
Seeking assistance	A8	1		3	4
Developing own…	A9				
Requesting for…	A10				
Favorable response	OA1				
Unfavorable response	OA2				
Total		*44*	*46*	*64*	*154*

Appendix L. Action Sequences of the Influence Processes

Directed Assistance Process

Person	c1	c2		c6			oi1	i8	oi2								
Elizabeth		c2		c6			oi1										
Jake		c2		c6			oi1		oi2	oi2							
Kevin	c1	c2		c6		c5	oi1		oi2	oi2							
Neil	c1			c6				i8			i5					i8	
Paul		c2	c2	c6	c6		oi1	i8									
Sharon				c6			oi1		oi2	oi2	i5	i5	i3	oi2	a3	i8	
Veronica	c1	c2		c6				i8	oi2	oi2						i8	a8

Logical Persuasion Process

Person									i5		i1		i5		i3		i5		oi2					oi1				oi2
Brad							i8			i5		i1				i3				oi2			i1						
Raymond	c1	c4	c5					i3		i5		i1		i5		i3		i5							oi1				
Robert														i5		i3		i5		oi2					oi1				oi2
Titus	c1											i1	i1	i5	i5		oi2	i5		oi2	i8	i8		i5	oi1	i5	oi3	oi2
Wanda				c2	c6	i5	i8		i6	i5	i5								a7									oi2

Queried Disclosure Process

Person		c1				c6				oi2					a7				oi2				a7			oi1						
Brian		c1	c4	c4			c6				oi2					a7											oi1						
Cathy	c5	c1					c6				oi2					a7																	
Hilda		c1	c4		c5	c2	c6							oi1		i5	a7	oi3	oi3	i1	oi2	oi2			a7			oi1						
Katelin							c6	c1													oi2			a6	a7								
Melissa									a7		oi2	i3	a8	oi1	i3						oi2												
Teresa					c5		c6			i3	oi2																oi1				a7		a8
Tim		c1					c6		i8						i3						oi2				a7	a8	i3	oi1	oi1	oi3		a7	oi3	
Tyler		c1														a7							oi1		a7						oi2			

Appendix M. Narratives of the Influence Processes

The three influence processes – Directed Assistance, Logical Persuasion, and Queried Disclosure – are distinctive in character and are instructive of the different ways in which individuals influence others to adopt IS/IT innovations. The following subsections provide illustrations of the three processes.

Directed Assistance

The process initially begins with an organization's effort to create "awareness" about the innovation among its members. During this time, the organizational members get a chance to evaluate the innovation and determine the extent to which it can be useful for their everyday activities.

> Several months in advance of that we started receiving updates of what was coming to us. [Kevin]

Subsequently, the organization issues a "mandate" to adopt and use an innovation. It is even possible that the potential adopters have no other way but to adopt the innovation since the organization may discontinue the alternate mechanisms that may have been in vogue previously.

> You can no longer use the paper. So, therefore you will either use the online system or you don't get your money. [Paul]

The organization typically sets up training sessions such that the potential adopters can participate and reap the benefits of being part of such sessions. Despite being only a basic introduction to the innovation, this intervention allows the adopters to appreciate the bare necessities of using the innovation.

> We had training… We had a four hour time slot for training that we all signed up for through one of the computer labs and picked up our little training. All the training was on line there was no books. [Veronica]

The influencers may also assist other potential adopters to use the innovation by sharing their expertise. Through these actions, the potential adopters have a chance to appreciate the different ways in which to more effectively use the innovation or gain operating efficiencies.

> One guy started [recently]… I was there to help him get started in using it [Task Tracker] as far as explaining what he needed to keep track of and how to enter it into the screen. [Jake]

However, it is an individual – typically the person responsible who is enthusiastic about the innovation or the persons responsible for managing the innovation process – who influences

a potential adopter to try out the innovation. These are generally assertive actions by these individuals on potential adopters.

> If they [my team members] forgot for a week, I reminded them to do it [Task Tracker]. [Neil]

Sometimes, the influencers may actually provide demonstrations of the innovation, over and above the training sessions, such that the potential adopters have an easier time migrating to the new innovation. Such demonstrations may also allow the potential adopters to witness different ways in which the innovation may be exploited.

> So I would drive and they would watch, and voila, there was the answer. [Sharon]

Logical Persuasion

The process typically begins with the presenting of "rational arguments," an activity undertaken by influencers. In addition to providing information, this activity allows the potential adopters to also know about the innovation and perhaps get ready to adopt it sometime in the near future.

> I told them [my team] why it was helpful to me. Here is why I need this information. Every week I have to show what we worked on and if we need help I can go with hard facts and say look here's all our hours, here's where we're spending them and you want this done, well I need another person to help us. It helps me and it will help get things for our team... [Wanda]

The influencers, in addition, also had other individuals endorse the innovation such that potential adopters may adopt the innovation. Such "coalition tactics" allowed influencers to set an agenda or a direction of their teams or groups, which would have to be followed by other individuals as well.

> The power user and I started [using the system] first and then he and I went to the other team members and said, "We're going to move to this [Contact Management System]." [Brad]

However, these actions alone may not be sufficient. Potential adopters may actually need further reinforcement. The influencers may engage in further presenting rational arguments to help the potential adopters understand how the innovation would be superior to what they have experienced before.

> [I said,] "If you'd use Task Tracker, you could keep better track of that… and if you needed you could research your facts to figure out based on the numbers you have." [Wanda]

Influencers typically offer to help potential adopters should they need any assistance in making sense of or using the innovation. This allows the potential adopters to realize that

there is some help or resource person available in case there face problems using the innovation; that they are "not alone" in attempting to use the innovation.

> She had a lot of reasons why it couldn't work… We talked about it. I said, "I'll show you what you can do. You won't have to do this and you won't have to do this." [Raymond]

The influencers even provide demonstrations of the innovation to make the potential adopters understand and appreciate the power and usefulness of the innovation. Influencers even show potential adopters ways in which the innovation is superior to the old ways of accomplishing the same tasks previously.

> By having a defined process to show them I was able to persuade them that maybe they needed to change their thinking a little bit. [Tony]

The influencers even provide demonstrations of the innovation to make the potential adopters understand and appreciate the power and usefulness of the innovation. Influencers even show potential adopters ways in which the innovation is superior to the old ways of accomplishing the same tasks previously.

> We had a department meeting… I pulled [the Contact Management System] up and showed it to them and then just sort of demoed it to them, how we're doing it, and what we're doing. [Brad]

The influencers may also assist other potential adopters to use the innovation by sharing their expertise. Through these actions, the potential adopters have a chance to appreciate the different ways in which to more effectively use the innovation or gain operating efficiencies.

> Once in a while, may be someone, may be one or two would need a little help. [Robert]

Additionally, the influencers may also provide further demonstrations of the innovation such that the potential adopters are able to understand additional aspects of the innovation or more ways to use the innovation or the ways in which the innovation could more efficiently accomplish the same tasks as before.

> I would get on the system and show them through the test database that this would work better. [Titus]

Queried Disclosure

The process typically begins with an "awareness creation" action in which the organization makes the innovation known to potential adopters. These efforts may include activities such as information dissemination by the information technology department, which allows the potential adopters to gauge the value of the innovation for their own needs.

> [The IT department head] made it known throughout the organization, the senior management, that [Oracle Sales Analyzer] would be, in his opinion, a suitable substitute for what we had been using. [Brian]

The organizations typically arrange formal training sessions for the benefit of potential adopters. Generally lasting for a few hours, the training sessions enabled potential adopters to gain a basic understanding of the innovation such that they can get started with the innovation without too much trouble.

> Then I went to training… And helped me to get the tools I need to do my module installation. [Hilda]

The influencers even provide demonstrations of the innovation to make the potential adopters understand and appreciate the power and usefulness of the innovation. Influencers provided walkthroughs of the innovation such that potential adopters may be able to replicate that behavior later.

> It was a 15 or 20 minute process for me to show them how to use [Travel Manager]… I just went down there [their office] and walked them through it the first time. [Tim]

The influencers typically face "inquiries" from potential adopters on how to use the innovation or the steps to be followed for accomplishing a task or specific questions about the innovation. This allowed the potential adopters to find some necessary information from influencers, who may be more knowledgeable.

> Then they [the new hire] get half way and they'll say, "Okay, what was I supposed to do?" [Katelin]

It is quite possible that influencers are called to provide more demonstrations or walkthroughs of the innovation as the potential adopters become more familiar with the innovation or different aspects of the innovation. These actions are generally useful for potential adopters.

> I'll just walk back to where they're [the new hire] at and sit down with them and I'll do it slowly so that they can take down notes. [Melissa]

Further, influencers may have to deal with specific questions from potential adopters about the innovation or its features. These inquiries may be beneficial to potential adopters as they get a chance to learn more features of the innovation or more efficient ways of interacting with the innovation.

> [She asked] just where to go for information, or "How do I find this?" or… "Where do I find that?" [Teresa]

Appendix N. NetLogo Source Code

```
;;=============================================================
;;                  The Effect of Influence Tactics and Contingency Factors
;;              on the Adoption and Diffusion of IS/IT Innovations in Social Networks
;;
;;                                    by
;;                                 Anand Jeyaraj
;;                                   2007
;;                              (c) All rights reserved
;;
;;                           Agent-based Modeling with NetLogo
;;
;;                                  committee
;;                              Rajiv Sabherwal, Ph.D., Chair
;;                                 Mary Lacity, Ph.D.
;;                                Vicki Sauter, Ph.D.
;;                               Deborah Balser, Ph.D.
;;=============================================================

;;=============================================================
;; Declarations
;;=============================================================

globals
[
  ;; Defined Constants
  UNDEFINED               ;; Placeholder when some value is not defined
  STRONG                  ;; for strong ties
  WEAK                    ;; for weak ties
  YES                     ;; for 'yes' values
  NO                      ;; for 'no' values
  CONTEXTUALACTIONS       ;; # of action types in context, 5
  INFLUENCERACTIONS       ;; # of action types in influencer's repertoire, 7
  ADOPTERACTIONS          ;; # of action types in adopter's repertoire, 6

  ;; Computed Constants
  maxPossibleTiesInNetwork   ;; # of possible ties in network, computed using NetworkSize
  actualTiesInNetwork        ;; # of actual ties in network, computed using NetworkDensity &
maxPossibleTies
  strongTiesInNetwork        ;; # of strong ties in network, computed using NetworkStrength & actualTies
  actualInitialAdopters      ;; # of initial adopters in network, computed using NetworkSize &
%InitialAdopters
  actualInitialFeatures      ;; # of initial features adopted, computed using InnovationSize &
%InitialFeatures
  contextualActionPrecedence ;; Probabilities of contextual actions, computed from field interviews
  influencerActionPrecedence ;; Probabilities of influence actions, computed from field interviews
  adopterActionPrecedence    ;; Probabilities of adoption actions, computed from field interviews

  ;; Environmental Variables
  contextActionsOverall      ;; Contextual action in each time period, from top management perspective
  NetworkCentralization      ;; computed: network centralization score
  NetworkDegree              ;; computed: Average person centrality (degree: # of ties)
  FirstDecay                 ;; Index of the first decay variable that was assigned a random value
                          ;; 0: contextual, 1: influencer, 2: adopter
  FirstWeight                ;; Index of the first weight variable that was assigned a random value
                          ;; 0: response, 1: contextual, 2: influencer, 3: adopter
  SimSeed                    ;; Random seed for the simulation run

  ;; State and Process Variables
  runNumber                  ;; Simulation run number
  timePeriod                 ;; Current time period
  interval                   ;; Fixed interval at which simulation variables are recorded
  adoptersTime0              ;; Actual # of adopters at time 0
```

```
  featuresTime0            ;; Actual # of features adopted at time 0
  adoptersTimeT            ;; # of adopters at time t
  featuresTimeT            ;; # of features adopted at time t
  sigmaTimeAdptIND           ;; Sum of times at which individuals adopted (i.e. first feature)
  timeDiffNET              ;; Time of diffusion (i.e. first feature) from first adopter to other individuals
  timeAsimNET              ;; Average of time of assimilation by individuals
  chgLevelDiffNET          ;; Change in level of diffusion
  chgLevelAsimNET            ;; Change in level of assimilation
  speedAdptNET             ;; Speed of adoption
  speedDiffNET             ;; Speed of diffusion
  speedAsimNET               ;; Speed of assimilation
  adopterStability         ;; Stability of adopters: Time period at which # adopters = Network size
  featureStability         ;; Stability of features: Time period at which # features adopted = Net size * Inno
size

  ;; State Varibles over Time
  seqAdoptersNET
  seqFeaturesNET
  seqSigmaTimeAdptIND
  seqChgLevelDiffNET
  seqChgLevelAsimNET
  seqTimeDiffNET
  seqTimeAsimNET
  seqSpeedAdptNET
  seqSpeedDiffNET
  seqSpeedAsimNET
  seqCumContextualActions
  seqCumInfluenceActions
  seqCumAdoptionActions
]

;;=================================================================
;; Agent Types and Attributes
;;=================================================================

breed [ persons person ]
breed [ ties tie ]

persons-own
[
  ;; Individual Dispositional Attributes
  orgLevel             ;; Hierarchical level: 1 is the highest level and 3 is the lowest level
  expertise            ;; Individual's expertise with information systems
  innovativeness         ;; Extent to which individual attempts/tolerates frame-breaking changes
  managementStyle        ;; Operating style: management-by-direction, management-by-action

  ;; Adoption-related Attributes
  featureAdopted?        ;; Features adopted by individuals; set up as a LIST; list index refers to feature#
  timeAdopted            ;; Time period at which feature# was adopted by individual
  assimilation         ;; % of features adopted

  ;; Pre-adoption-related Attributes
  featureOdds            ;; Probability of feature# selected by adopter
  actionHistory          ;; Pre-adoption action selected in each time period

  ;; Influence-related Attributes
  inflTies             ;; IDs of ties connected to this person
  inflPartners           ;; IDs of other persons connected (through ties) to this person
  inflActionHistory      ;; Influence action selected in each time period (for #ofTies persons for #ofFeatures)
  inflFeatureOdds        ;; Odds of feature# selected by influencer (for each #ofTies persons)

  ;; Context-related Attributes
  contextHistory         ;; Contextual action selected in each time period, as applicable to this person
  contextOdds            ;; Odds of context action interpreted by person, single value, treated as probability
]
```

```
ties-own
[
  tieType             ;; Type of Tie: Strong, Weak
  tieStrength          ;; Probability of tie being active in a time period: <0.25 for WEAK, >0.75 for STRONG
]

;;=====================================================================
;; Setup Procedures
;;=====================================================================

to setup
  ;; this is a BUTTON-initiated procedure
  ;; it controls the creation of the initial network, including persons, ties, and attributes
  let localRun runNumber
  ca
  set runNumber (localRun + 1)
  set interval 1

  ;; defined general-purpose constants
  set UNDEFINED -1
  set STRONG 1
  set WEAK 0
  set YES 1
  set NO 0

  ;; defined special-purpose constants, i.e. types of actions
  set CONTEXTUALACTIONS 5
  set INFLUENCERACTIONS 7
  set ADOPTERACTIONS 6

  ;; random seed for the simulation
  set SimSeed new-seed
  random-seed SimSeed

  ;; simulation parameters
  ;; 0: Feature-centric, 1: Innovation-centric
  set FeatureLearningByIndividual 0
  ;; 1: Contingency only, 2: History only, 3: Contingency OR History
  set ContingencyHistorySelection one-of (list 1 2 3)
  ;; network characteristics
  set NetworkSize one-of (list 10 12 16 20 26 32 40 50)
  set NetworkHierarchy one-of (list 2 3 4 5 6 7 8)
  set NetworkDensity one-of (list 0.01 0.02 0.05 0.10 0.30 0.50 0.70 0.90)
  set NetworkStrength one-of (list 0 0.16 0.33 0.5 0.66 0.83 1)
  ;; innovation attributes
  set InnovationSize one-of (list 3 4 5 6 8 10 12 15)
  ;; decays
  let allValues []
  set firstDecay one-of (list 0 1 2) ;; three different decay variables, one for each action type
  let firstValue one-of (list 0.1 0.3 0.5 0.7 0.9)
  foreach (list 0 1 2)
  [
    ifelse (? = firstDecay)
    [
      set allValues lput firstValue allValues
    ]
    [
      let nextValue 0
      ifelse (firstValue = 0.1)
      [ set nextValue 0.3 ]
      [
        ifelse (firstValue = 0.9)
        [ set nextValue 0.7 ]
        [ set nextValue one-of (list (precision (firstValue + 0.2) 1) (precision (firstValue - 0.2) 1)) ]
      ]
      set allValues lput nextValue allValues
```

```
    ]
  ]
  set ActionDecayContext item 0 allValues
  set ActionDecayInfluencer item 1 allValues
  set ActionDecayAdopter item 2 allValues
  ;; weights
  set allValues []
  set firstWeight one-of (list 0 1 2 3) ;; four different weight variables, one for each model: selection,
response
  set firstValue one-of (list 0.1 0.3 0.5 0.7 0.9)
  foreach (list 0 1 2 3)
  [
    ifelse (? = firstWeight)
    [
      set allValues lput firstValue allValues
    ]
    [
      let nextValue 0
      ifelse (firstValue = 0.1)
      [ set nextValue 0.3 ]
      [
        ifelse (firstValue = 0.9)
        [ set nextValue 0.7 ]
        [ set nextValue one-of (list (precision (firstValue + 0.2) 1) (precision (firstValue - 0.2) 1)) ]
      ]
      set allValues lput nextValue allValues
    ]
  ]
  set WeightContingencyResponse item 0 allValues
  set WeightContingencyContext item 1 allValues
  set WeightContingencyInfluencer item 2 allValues
  set WeightContingencyAdopter item 3 allValues
  ;; contingencies
  set OrganizationStructure one-of (list 0 0.5 1)
  set CulturalOrientation one-of (list 0 0.5 1)
  set TopMgtSupport one-of (list 0 0.5 1)
  set TypeOfISSolution one-of (list 0 0.5 1)
  ;; initial conditions
  set %InitialAdopters one-of (list 0 0.05 0.10 0.15 0.20)
  set %InitialFeatures one-of (list 0 0.05 0.10 0.15 0.20)
  if %InitialAdopters = 0 [ set %InitialFeatures 0 ]

  ;; computations
  set maxPossibleTiesInNetwork int(NetworkSize * (NetworkSize - 1) / 2)
  ;; compute network characteristics using parameters
  set actualTiesInNetwork int(maxPossibleTiesInNetwork * NetworkDensity)
  set strongTiesInNetwork int(actualTiesInNetwork * NetworkStrength)
  set actualInitialAdopters int(NetworkSize * %InitialAdopters)
  set actualInitialFeatures int(InnovationSize * %InitialFeatures)

  ;; set up the network
  ask patches [ set pcolor 33 ]
  create-persons
  create-ties
  ;; create histories of features, actions, etc.
  create-history

  ;; compute network characteristics for the constructed network
  let personDegrees values-from persons [ length inflPartners ]
  set NetworkCentralization (sum (map [max personDegrees - ?] personDegrees)) / ((NetworkSize - 1) *
(NetworkSize - 2))
  set NetworkDegree (sum personDegrees) / NetworkSize

  ;; compute precedences from field interviews
  set contextualActionPrecedence contextual-action-precedence
  set influencerActionPrecedence influencer-action-precedence
```

```
  set adopterActionPrecedence adopter-action-precedence
  set contextActionsOverall [ -1 ] ;; UNDEFINED for time 0

  ;; set up initial values for process variables
  set seqAdoptersNET []
  set seqFeaturesNET []
  set seqSigmaTimeAdptIND []
  set seqChgLevelDiffNET []
  set seqChgLevelAsimNET []
  set seqTimeDiffNET []
  set seqTimeAsimNET []
  set seqSpeedAdptNET []
  set seqSpeedDiffNET []
  set seqSpeedAsimNET []
  set seqCumContextualActions []
  set seqCumInfluenceActions []
  set seqCumAdoptionActions []

  ;; stability measures
  set adopterStability -1
  set featureStability -1
end

to create-persons
  ;; this is called by the "setup" procedure
  ;; it creates the persons in the initial network, including their attributes
   set-default-shape turtles "person"
   no-display
   create-custom-persons NetworkSize
   [
     ;; position the new agent on the physical space
     fd max-pxcor - 1
     ;; individual attributes for this person
     set expertise random-float 1
     set innovativeness random-float 1
     set managementStyle random-float 1
     ;; hierarchical level (based on the parameter NetworkHierarchy)
     set orgLevel 1
     if NetworkHierarchy > 1 [ set orgLevel ((random NetworkHierarchy) + 1) ]
     ;; adoption related attributes for this person
     set featureAdopted? n-values InnovationSize [ NO ]
     set timeAdopted n-values InnovationSize [ -1 ]
     set assimilation 0
     ;; black indicates no adoption yet, for visual interface
     set color black
     ;; odds for features selected by this person
     set featureOdds n-values InnovationSize [ 1 / InnovationSize ]
     ;; actions selected by this person
     set actionHistory n-values InnovationSize [ [ -1 ] ]
   ]
   ;; incorporate values from simulation parameters
   ;; set up initial number of adopters and initial set of adopted features
   ask n-of actualInitialAdopters persons
   [
     let featureCounter 0
     while [ featureCounter < actualInitialFeatures ]
     [
       ;; randomly select the specific feature already adopted
       let idxFeature random InnovationSize
       set featureAdopted? (replace-item idxFeature featureAdopted? YES)
       set timeAdopted (replace-item idxFeature timeAdopted timePeriod)
       set featureCounter (featureCounter + 1)
       ;; compute assimilation level based on features adopted
       set assimilation ((sum featureAdopted?) / InnovationSize)
       ;; assign 0 prob for already-adopted feature
       set featureOdds (replace-item idxFeature featureOdds 0)
```

```
      ;; revise probs to account for adopted features
      set featureOdds (map [? / sum featureOdds] featureOdds)
    ]
    ifelse (assimilation = 1)
    [ set color white ]
    [ set color round (assimilation * 9.9) ]
  ]
  ;; update actual counts of adopters and features at time 0
  set adoptersTime0 count persons with [ sum featureAdopted? > 0 ]
  set featuresTime0 sum (values-from persons [ sum featureAdopted?])
  display
end

to create-ties
  ;; this is called by the "setup" procedure
  ;; it controls the creation of ties between persons in the network
  ask persons
  [
    ;; find all other persons who are not already connected to this person
    ;; this would form a completely connected network
    let otherPersons persons with [ self != myself and __tie-neighbor? myself = false ]
    __create-ties-with otherPersons
    [
      ;; initially set all ties as weak
      set tieType WEAK
      set color 1
      set tieStrength random-float 0.25
    ]
  ]
  ;; adjust the network to have only that many ties as actualTiesInNetwork
  ;; this would randomly eliminate ties until only actualTiesInNetwork remain
  ask n-of (maxPossibleTiesInNetwork - actualTiesInNetwork) ties [ die ]
  ;; set up the strong ties as strongTiesInNetwork
  ask n-of strongTiesInNetwork ties
  [
    set tieType STRONG
    set color 4
    set tieStrength (random-float 0.25) + 0.75
  ]
end

to create-history
  ;; this is called by the "setup" procedure
  ;; it sets up the history lists for persons based on ties and features
  ask persons
  [
    ;; determine and setup all ties for this person
    set inflTies []
    set inflTies sort values-from __my-ties [ who ]
    ;; determine and setup all partners for this person, based on ties
    set inflPartners []
    without-interruption
    [
      foreach inflTies
      [
        set inflPartners lput (value-from tie ? [ value-from __other-end [ who ] ]) inflPartners
      ]
    ]
    ;; determine and setup influence action histories for all partners for this person
    set inflActionHistory []
    set inflActionHistory n-values (count __tie-neighbors * InnovationSize) [ [ -1 ] ] ;; UNDEFINED for time
0
    ;; determine and setup odds of features selected for influence actions for all partners for this person
    set inflFeatureOdds []
    set inflFeatureOdds n-values (count __tie-neighbors) [ [] ] ;; no odds yet
    ;; odds depends on features adopted currently by both this person and partner, 4 possibilities exist
```

```
    ;; 1. this person (influencer) has adopted feature but partner (adopter) has not -> influence possible
    ;; 2. this person (influencer) has adopted feature and partner (adopter) has as well -> no influence
needed
    ;; 3. this person (influencer) has not adopted feature but partner (adopter) has -> no influence needed
    ;; 4. neither this person (influencer) nor partner (adopter) has adopted feature -> no influence needed
    without-interruption
    [
      foreach inflPartners
      [
        ;; since featureAdopted? mimics a boolean list indicating features adopted by either individual,
        ;; the difference between this person's and partner's featureAdopted? would determine influence
needed
        let revisedOdds ( map [ ?1 - ?2 ] featureAdopted? value-from person ? [ featureAdopted? ] )
        ;; only a difference of 1 is valid for influence; 0 and -1 are no influence; so set -1 to 0 as well
        foreach revisedOdds [ if ? = -1 [ set revisedOdds replace-item position ? revisedOdds revisedOdds 0
] ]
        ;; then, re-compute the sum of all non-adopted features for each partner,
        ;; and divide value associated with each feature by the re-computed sum
        if sum revisedOdds > 0 [ set revisedOdds (map [? / sum revisedOdds] revisedOdds) ]
        ;; reset revised odds as feature odds
        set inflFeatureOdds replace-item (position ? inflPartners) inflFeatureOdds revisedOdds
      ]
    ]
    ;; create context history with UNDEFINED for time 0
    set contextHistory []
    set contextHistory lput -1 contextHistory
    ;; odds of this individual interpreting the context based on the following
    set contextOdds random-float 1
  ]
end

;;=================================================================
;; Simulation Procedures
;;=================================================================

to simulate
  ;; this is a BUTTON-initated procedure
  ;; it controls the simulation runs by repeatedly allowing the following actions until stopping conditions
  ;; 1: contextual actions, for the entire context
  ;; 2: influence actions, for the influencer role
  ;; 3: pre-adoption actions, for the adopter role
  ;; 4: adoption actions, for the adopter role
  ;; since these actions will be allowed for each person, this ensures that relative order of actions
  ;; i.e. influence actions precede pre-adoption actions precede adoption actions

  if not is-stop-simulation
  [
    set timePeriod (timePeriod + 1)
    show (word "TIME PERIOD: " timePeriod)
    show "CONTEXT:"
    contextual-actions
    show "INFLUENCER:"
    influence-actions
    show "ADOPTER:"
    pre-adoption-actions
    show "DECISION:"
    adoption-actions
    show "STATS:"
    compute-stats
  ]
end

to contextual-actions
  ;; this is called by the "simulate" procedure
  ;; it controls the actions in the context
```

```
  ;; contextual actions are implemented using the following approach
  ;; 1. randomly select a contextual action based on prior history and contingencies
  ;; -- selected action is applicable for the entire network, from top management's perspective
  ;; -- however, that action may not apply to all individuals, due to selection issues
  ;; -- e.g. not all individuals may involve in system development or training
  ;; -- whereas all individuals may be made aware of the innovation or implementation
  ;; -- thus, contextual actions for a person dependent on whether or not person interprets it
  ;; 2. randomly determine if person would interpret the contextual action

  ;; if the context will have an action this time period
  ;; then select an action and update history
  let actionSelected one-action-for-context ;; parameters on following line
      revise-action-probabilities-for-context timePeriod contextActionsOverall
  set contextActionsOverall lput actionSelected contextActionsOverall
  ;; propagate the selected context action to individuals in social network
  ;; this is done by randomly deciding if individual will interpret contextual action
  ask persons
  [
    ifelse actionSelected != -1
    [
      ifelse sum featureAdopted? < InnovationSize
      [
        ifelse is-context-interpreted-by-person? contextOdds
        [ set contextHistory lput actionSelected contextHistory ]
        [ set contextHistory lput -1 contextHistory ]
      ]
      [ set contextHistory lput -1 contextHistory ]
    ]
    [ set contextHistory lput -1 contextHistory ]
  ]
end

to influence-actions
  ;; this is called by the "simulate" procedure
  ;; it controls the influence actions by persons
  ask persons
  [
    let idxFeature 0
    repeat InnovationSize
    [
      ;; determine if this person has already adopted at least one feature, else cannot influence others
      ifelse item idxFeature featureAdopted? = 1
      [
        ;; if this person has adopted this feature..
        ;; then some influence is possible during this time period
        ;; to apply the influence, identify tie strengths, and determine if tie will be active this time period
        ;; first, set all ties to be inactive
        let activeTies n-values length inflTies [ FALSE ]
        ;; then, determine which ties may be active based on tieStrength
        without-interruption
        [
          foreach inflTies
          [
            let strength value-from tie ? [ tieStrength ] ;; obtain tieStrength value from tie
            set activeTies replace-item (position ? inflTies) activeTies is-tie-active strength ;; call procedure
          ]
        ]
        ;; initiate influence action by this person
        ;; in general, the influence action is for all ties associated with this person
        ;; however, influence action is possible only when the tie is active
        without-interruption
        [
          let focalTie 0
          foreach activeTies
          [
            ;; determine if this tie is active
```

```
          ifelse ?
          [
            ;; if this tie is active..
            ;; then some influence is possible during this time period
            ;; however, influence may not be necessary if partner has adopted same features as influencer
            ifelse sum (item focalTie inflFeatureOdds) > 0
            [
              ;; if influence is necessary, influencer and partner have not adopted same features
              ;; select an influence action for *this* partner for this person
              ;; done by performing the following:
              ;; 1. assign equal initial probabilities for all influencer actions
              ;; 2. revise initial probs using precedence (from interviews) and contingencies (from theory)
              ;; 3. construct probability distribution based on revised probabilities
              ;; 4. choose a possibility from the probability distribution
              let relOrgLevel (orgLevel - value-from person item focalTie inflPartners [ orgLevel ])
              let newAHistory item (focalTie * InnovationSize + idxFeature) inflActionHistory
              let actionSelected one-action-for-influence ;; parameters on following line
                  revise-action-probabilities-for-influence timePeriod newAHistory relOrgLevel
              set newAHistory lput actionSelected newAHistory
              set inflActionHistory replace-item
                  (focalTie * InnovationSize + idxFeature) inflActionHistory newAHistory
            ] ;; END: if influence is necessary
            [
              ;; if influence is not necessary, influencer and partner adopted same feature
              let newAHistory item (focalTie * InnovationSize + idxFeature) inflActionHistory
              set newAHistory lput -1 newAHistory ;; -1 is UNDEFINED, no action for this feature
              set inflActionHistory replace-item
                  (focalTie * InnovationSize + idxFeature) inflActionHistory newAHistory
            ] ;; END: if influence is not necessary
          ] ;; END: if this tie is active
          [
            ;; if this tie is not active..
            ;; then no influence is possible, so update histories to reflect no influence during this time period
            ;; update histories for each feature for *this* partner for this person
            let pos (focalTie * InnovationSize + idxFeature) ;; indexing into inflActionHistory list
            let newAHistory item pos inflActionHistory
            set newAHistory lput -1 newAHistory
            set inflActionHistory replace-item pos inflActionHistory newAHistory
          ] ;; END: if this tie is not active
          ;; deal with next tie
          set focalTie (focalTie + 1)
        ]
      ]
    ] ;; END: if this person adopted this feature
    [
      ;; if this person has not adopted at least one feature..
      ;; then no influence is possible, so update histories to reflect no influence during this time period
      ;; update histories for this feature for *each* partner for this person
      without-interruption
      [
        let focalTie 0
        foreach inflTies
        [
          let pos (focalTie * InnovationSize + idxFeature) ;; indexing into inflActionHistory list
          let newAHistory item pos inflActionHistory
          set newAHistory lput -1 newAHistory
          set inflActionHistory replace-item pos inflActionHistory newAHistory
          set focalTie (focalTie + 1)
        ]
      ]
    ] ;; END: if this person did not adopt this feature
    set idxFeature (idxFeature + 1)
  ] ;; END: repeat
 ]
end
```

```
to pre-adoption-actions
  ;; this is called by the "simulate" procedure
  ;; it controls the pre-adoption actions by persons
  ask persons
  [
    ;; if this person has at least one non-adopted feature..
    ;; then some pre-adoption action is possible during this time period
    let idxFeature 0
    repeat InnovationSize
    [
      ;; for each of the non-adopted features
      ifelse item idxFeature featureAdopted? = 0
      [
        ;; then, select a pre-adoption action for this person
        let newAHistory item idxFeature actionHistory
        let actionSelected one-action-for-pre-adoption
            revise-probabilities-for-pre-adoption timePeriod newAHistory
        ;; update action history for this action for this feature selected by this person
        set newAHistory lput actionSelected newAHistory
        set actionHistory replace-item idxFeature actionHistory newAHistory
      ]
      [
        ;; else, no action this time period, so record -1
        let newAHistory item idxFeature actionHistory
        set newAHistory lput -1 newAHistory
        set actionHistory replace-item idxFeature actionHistory newAHistory
      ]
      set idxFeature (idxFeature + 1)
    ]
  ]
end

to adoption-actions
  ;; this is called by the "simulate" procedure
  ;; it controls the adoption actions by persons
  ask persons
  [
    ;; determine if this person has at least one non-adopted feature, else cannot perform adoption actions
    ifelse sum featureAdopted? < InnovationSize
    [
      ;; if this person has at least one non-adopted feature..
      ;; then some adoption action is possible during this time period

      ;; first, determine the odds of each non-adopted feature being adopted this time period
      let pos 0
      let odds [ ]
      without-interruption
      [
        foreach featureAdopted?
        [
          ;; if feature already adopted by individual
          ifelse (? = 1)
          [ set odds lput 0 odds ]
          ;; else if feature not already adopted by individual
          [ set odds lput (adoption-odds who pos) odds ]
          set pos (pos + 1)
        ]
      ]
      ;; second, determine whether or not the non-adopted features are candidates for adoption this period
      set pos 0
      let yesNo [ ]
      without-interruption
      [
        foreach odds
        [
          ;; if odds equal 0 then no adoption possible (i.e. feature not a candidate for adoption)
```

```
        ifelse (? = 0)
        [ set yesNo lput -1 yesNo ] ;; store -1, not a candidate
        ;; else if odds are not equal 0 then feature may be a candidate for adoption
        ;; and so determine if feature is a candidate for adoption, if yes store feature# (candidate) else -1
(not)
        [ set yesNo lput (ifelse-value (is-candidate ? > 0) [ pos ] [ -1 ]) yesNo ] ;; store feature# or -1
        set pos (pos + 1)
      ]
    ]
    ;; finally, set candidate features for adoption as adopted features
    without-interruption
    [
    foreach (remove -1 yesNo)
    [
      let featureConsidered ?
      ;; update assimilation attributes for feature adopted this time period by adopter
      set featureAdopted? replace-item featureConsidered featureAdopted? YES
      set timeAdopted replace-item featureConsidered timeAdopted timePeriod
      set assimilation ((sum featureAdopted?) / InnovationSize)
      set featureOdds (replace-item featureConsidered featureOdds 0)
      if sum featureOdds > 0
      [
        set featureOdds (map [? / sum featureOdds] featureOdds)
      ]
      ;; update influencer related attributes for feature adopted this time period by adopter...
      without-interruption
      [
        foreach inflPartners
        [
          ;; ... in adopter's own history
          let revisedOdds ( map [ ?1 - ?2 ] featureAdopted? value-from person ? [ featureAdopted? ] )
          foreach revisedOdds [ if ? = -1 [ set revisedOdds replace-item position ? revisedOdds revisedOdds
0 ] ]
          if sum revisedOdds > 0 [ set revisedOdds (map [? / sum revisedOdds] revisedOdds) ]
          set inflFeatureOdds replace-item (position ? inflPartners) inflFeatureOdds revisedOdds
          ;; ... in partners' history
          let adopter who
          ask person ?
          [
            let partnerOdds ( map [ ?1 - ?2 ] featureAdopted? value-from person adopter [ featureAdopted?
] )
            foreach partnerOdds [ if ? = -1 [ set partnerOdds replace-item position ? partnerOdds
partnerOdds 0 ] ]
            if sum partnerOdds > 0 [ set partnerOdds (map [? / sum partnerOdds] partnerOdds) ]
            set inflFeatureOdds replace-item (position adopter inflPartners) inflFeatureOdds partnerOdds
          ]
        ]
      ]
      ;; update visual
      ifelse (assimilation = 1)
      [ set color white ]
      [ set color round (assimilation * 9.9) ]
    ] ;; END: foreach YesNo
    ] ;; END: without-interruption
   ]
   [
    ;; if this person has adopted all features..
    ;; then no adoption action is possible during this time period
   ]
  ]
end

;;=================================================================
;; Support Functions for Simulation Procedures
;;=================================================================
```

```
to-report revise-action-probabilities-for-context [ currentPeriod history ]
  ;; to report the revised probabilities of actions for the context

  ;; action probabilities for context based on one of the following models:
  ;; 1. contingency only, based on theory and logic, as Pc
  ;; 2. history only, based on actions from field interviews, as Ph
  ;; 3. OR composite, using both contingency and history, as Pc + Ph - Pc * Ph

  ;; array declarations
  let precedence []
  let revisedProbs []

  ;; following is for option 1. above
  ;; relative weights for context contingencies
  let wgtContext WeightContingencyContext
  let wgtHIc 1 / wgtContext
  let wgtLOc wgtContext
  ;; weights for contextual contingency 1, top mgt. support -> 0 (low), 0.5 (mixed), 1 (high)
  let contingency12 n-values CONTEXTUALACTIONS [ 1 ] ;; mixed
  let contingency11 (list wgtLOc wgtLOc wgtLOc wgtLOc wgtLOc) ;; low
  let contingency13 (list wgtHIc wgtHIc wgtHIc wgtHIc wgtHIc) ;; high
  let contingency1D (map [?1 + ?2 + ?3] contingency12 contingency11 contingency13) ;; denominator
  set contingency12 (map [?1 / ?2] contingency12 contingency1D)
  set contingency11 (map [?1 / ?2] contingency11 contingency1D)
  set contingency13 (map [?1 / ?2] contingency13 contingency1D)
  let contingency1 contingency12 ;; default: mixed
  if TopMgtSupport = 0 [ set contingency1 contingency11 ] ;; low
  if TopMgtSupport = 1 [ set contingency1 contingency13 ] ;; high
  ;; weights for contextual contingency 2, inhouse solution -> 0 (outsourced), 0.5 (mixed), 1 (in-house)
  let contingency22 n-values CONTEXTUALACTIONS [ 1 ] ;; default: mixed
  let contingency21 (list wgtLOc 1 wgtLOc wgtLOc 1) ;; outsourced
  let contingency23 (list wgtHIc 1 wgtHIc wgtHIc 1) ;; in-house
  let contingency2D (map [?1 + ?2 + ?3] contingency22 contingency21 contingency23) ;; denominator
  set contingency22 (map [?1 / ?2] contingency22 contingency2D)
  set contingency21 (map [?1 / ?2] contingency21 contingency2D)
  set contingency23 (map [?1 / ?2] contingency23 contingency2D)
  let contingency2 contingency22 ;; default: mixed
  if TypeOfISSolution = 0 [ set contingency2 contingency21 ] ;; outsourced
  if TypeOfISSolution = 1 [ set contingency2 contingency23 ] ;; in-house

  ;; following is for option 2. above
  ;; precedence from actions seen in field interviews
  ifelse currentPeriod > 1
  [
    ;; if there is some history
    ifelse sum(history) = (-1) * length(history)
    [
      ;; if no defined prior action yet, assign overall probabilities from field interviews
      ;; based on 17, 9, 10, 9, 18 actions respectively of 63 contextual actions
      set precedence (list 0.27 0.14 0.16 0.14 0.29)
    ]
    [
      ;; else, compute probabilities based on prior contextual actions, using precedence info from field
interviews
      set precedence n-values CONTEXTUALACTIONS [ 0 ]
      let numerator n-values CONTEXTUALACTIONS [ 0 ]
      let denominator n-values CONTEXTUALACTIONS [ 0 ]
      let DECAY ActionDecayContext
      let idxAction 0
      repeat CONTEXTUALACTIONS
      [
        let idxTime 1
        repeat ((currentPeriod - 1) - 1)
        [
          let oneAction item idxTime history
          if oneAction != -1 ;; if prior action is defined
```

```
        [
          let newNum item idxAction numerator
          let actionProb (item idxAction (item oneAction contextualActionPrecedence))
          set newNum (newNum + actionProb * DECAY ^ (currentPeriod - idxTime - 1))
          set numerator replace-item idxAction numerator newNum
          let newDen item idxAction denominator
          set newDen (newDen + DECAY ^ (currentPeriod - idxTime - 1))
          set denominator replace-item idxAction denominator newDen
        ]
        set idxTime (idxTime + 1)
      ]
      set idxAction (idxAction + 1)
    ]
    ;; compute probabilities using numerator and denominator
    set idxAction 0
    repeat CONTEXTUALACTIONS
    [
      if (item idxAction denominator) != 0
      [
        set precedence replace-item idxAction precedence
            ((item idxAction numerator) / (item idxAction denominator))
      ]
      set idxAction (idxAction + 1)
    ]
  ] ;; END: ifelse sum(history) = (-1) * length(history)
 ]
 [
  ;; if no history
  set precedence n-values CONTEXTUALACTIONS [ 0 ]
 ]

 ;; following is for option 3. above
 ;; no separate computation needed since this is a combination of both 1. and 2. above
 ;; effects included in the final computation depending on what model is selected

 ;; compute final probabilities of actions for contingency/history model selection
 let Pc (map [?1 * ?2] contingency1 contingency2)
 let Ph precedence
 let Pand (map [?1 * ?2] Pc Ph)
 let Por (map [?1 + ?2 - (?1 * ?2)] Pc Ph)
 ;; first, assume a contingency-only model
 set revisedProbs Pc
 ;; if history-only model
 if ContingencyHistorySelection = 2 [ set revisedProbs Ph ]
 ;; if OR composite model
 if ContingencyHistorySelection = 3 [ set revisedProbs Por ]
 report revisedProbs
end

to-report one-action-for-context [ odds ]
 ;; to report one action that will be seen in the context
 ;; done by performing the following:
 ;; 1: construct a probability distribution for each action using the odds
 ;; 2: determine if an action may be selected based on the probability distribution
 let yesNo []
 let pos 0
 repeat length odds
 [
  ifelse random-float 1 <= item pos odds
  [ set yesNo lput pos yesNo ]
  [ set yesNo lput -1 yesNo ]
  set pos (pos + 1)
 ]
 ;; return action# if action selected, otherwise return -1
 ifelse length remove -1 yesNo > 0
 [ report one-of remove -1 yesNo ]
```

```
  [ report -1 ]
end

to-report is-context-interpreted-by-person? [ odds ]
  ;; to report if the context action will be intepreted during this time period
  ;; done by performing the following:
  ;; 1: construct a probability distribution using contextOdds
  ;; 2: randomly pick a possibility from the probability distribution
  let idx 0
  let interpretProbDist n-values 100 [ NO ]
  repeat int(odds * 100)
  [
    set interpretProbDist (replace-item idx interpretProbDist YES)
    set idx (idx + 1)
  ]
  ;; pick one from the probability distribution
  set idx random 99
  ifelse item idx interpretProbDist = YES
    [ report TRUE ] [ report FALSE ]
end

to-report is-tie-active [ strength ]
  ;; to report if a tie will be active during this time period
  ;; done by performing the following:
  ;; 1: construct a probability distribution using tieStrength
  ;; 2: randomly pick a possibility from the probability distribution
  let idx 0
  let activeTieProbDist n-values 100 [ NO ]
  repeat int(strength * 100)
  [
    set activeTieProbDist (replace-item idx activeTieProbDist YES)
    set idx (idx + 1)
  ]
  ;; pick one from the probability distribution
  set idx random 99
  ifelse item idx activeTieProbDist = YES
    [ report TRUE ] [ report FALSE ]
end

to-report revise-action-probabilities-for-influence [ currentPeriod history relOrgLevel ]
  ;; to report the revised probabilities of actions for influence

  ;; action probabilities for context based on one of the following models:
  ;; 1. contingency only, based on theory and logic, as Pc
  ;; 2. history only, based on actions from field interviews, as Ph
  ;; 3. OR composite, using both contingency and history, as Pc + Ph - Pc * Ph

  ;; array declarations
  let precedence []
  let revisedProbs []

  ;; following is for option 1. above
  ;; relative weights for influencer contingencies
  let wgtIndividual WeightContingencyInfluencer
  let wgtHIi 1 / wgtIndividual
  let wgtLOi wgtIndividual
  ;; weights for influencer contingency 1, management style -> < 0.25 (direction), > 0.75 (action), else
(mixed)
  let contingency12 n-values INFLUENCERACTIONS [ 1 ] ;; weight = 1 -> no change in initial probabilities,
default
  let contingency11 (list wgtHIi wgtHIi wgtLOi wgtHIi wgtLOi wgtLOi wgtLOi)
  let contingency13 (list wgtLOi wgtLOi wgtHIi wgtLOi wgtHIi wgtHIi wgtHIi)
  let contingency1D (map [?1 + ?2 + ?3] contingency12 contingency11 contingency13)
  set contingency12 (map [?1 / ?2] contingency12 contingency1D)
  set contingency11 (map [?1 / ?2] contingency11 contingency1D)
  set contingency13 (map [?1 / ?2] contingency13 contingency1D)
```

```
  let contingency1 contingency12
  if managementStyle < 0.25 [ set contingency1 contingency11 ]
  if managementStyle > 0.75 [ set contingency1 contingency13 ]
  ;; weights for influencer contingency 2, relative org level -> +ve (superior), 0 (peer), -ve (subordinate)
  let contingency22 n-values INFLUENCERACTIONS [ 1 ] ;; weight = 1 -> no change in initial probabilities,
default
  let contingency21 (list wgtLOi wgtLOi wgtLOi wgtHIi wgtLOi wgtLOi wgtLOi)
  let contingency23 (list wgtHIi wgtHIi wgtHIi wgtLOi wgtHIi wgtHIi wgtHIi)
  let contingency2D (map [?1 + ?2 + ?3] contingency22 contingency21 contingency23)
  set contingency22 (map [?1 / ?2] contingency22 contingency2D)
  set contingency21 (map [?1 / ?2] contingency21 contingency2D)
  set contingency23 (map [?1 / ?2] contingency23 contingency2D)
  let contingency2 contingency22
  if managementStyle < 0.25 [ set contingency2 contingency21 ]
  if managementStyle > 0.75 [ set contingency2 contingency23 ]

  ;; following is for step 2. above
  ;; precedence from actions seen in field interviews
  ifelse currentPeriod > 1
  [
    ;; if there is some history
    ifelse sum(history) = (-1) * length(history)
    [
      ;; overall probabilities from field interviews
      ;; based on 9, 7, 18, 11, 16, 26, 5 actions respectively of 92 influence actions
      set precedence (list 0.10 0.08 0.20 0.12 0.17 0.28 0.05)
    ]
    [
      set precedence n-values INFLUENCERACTIONS [ 0 ]
      let numerator n-values INFLUENCERACTIONS [ 0 ]
      let denominator n-values INFLUENCERACTIONS [ 0 ]
      let DECAY ActionDecayInfluencer
      let idxAction 0
      repeat INFLUENCERACTIONS
      [
        let idxTime 1
        repeat ((currentPeriod - 1) - 1)
        [
          let oneAction item idxTime history
          if oneAction != -1 ;; if prior action is defined
          [
            let newNum item idxAction numerator
            let actionProb (item idxAction (item oneAction influencerActionPrecedence))
            set newNum (newNum + actionProb * DECAY ^ (currentPeriod - idxTime - 1))
            set numerator replace-item idxAction numerator newNum
            let newDen item idxAction denominator
            set newDen (newDen + DECAY ^ (currentPeriod - idxTime - 1))
            set denominator replace-item idxAction denominator newDen
          ]
          set idxTime (idxTime + 1)
        ]
        set idxAction (idxAction + 1)
      ]
      ;; compute probabilities using numerator and denominator
      set idxAction 0
      repeat INFLUENCERACTIONS
      [
        if (item idxAction denominator) != 0
        [
          set precedence replace-item idxAction precedence
              ((item idxAction numerator) / (item idxAction denominator))
        ]
        set idxAction (idxAction + 1)
      ]
    ] ;; END: ifelse sum(history) = (-1) * length(history)
  ]
```

```
  [
    ;; if no history
    set precedence n-values INFLUENCERACTIONS [ 0 ]
  ]

  ;; following is for option 3. above
  ;; no separate computation needed since this is a combination of both 1. and 2. above
  ;; effects included in the final computation depending on what model is selected

  ;; compute final probabilities of actions for contingency/history model selection
  let Pc (map [?1 * ?2] contingency1 contingency2)
  let Ph precedence
  let Pand (map [?1 * ?2] Pc Ph)
  let Por (map [?1 + ?2 - (?1 * ?2)] Pc Ph)
  ;; first, assume a contingency-only model
  set revisedProbs Pc
  ;; if history-only model
  if ContingencyHistorySelection = 2 [ set revisedProbs Ph ]
  ;; if OR composite model
  if ContingencyHistorySelection = 3 [ set revisedProbs Por ]
  report revisedProbs
end

to-report one-action-for-influence [ odds ]
  ;; to report one action that will be used by individual
  ;; done by performing the following:
  ;; 1: construct a probability distribution for each action using the odds
  ;; 2: determine if an action may be selected based on the probability distribution
  let yesNo []
  let pos 0
  repeat length odds
  [
    ifelse random-float 1 <= item pos odds
    [ set yesNo lput pos yesNo ]
    [ set yesNo lput -1 yesNo ]
    set pos (pos + 1)
  ]
  ;; return action# if action selected, otherwise return -1
  ifelse length remove -1 yesNo > 0
  [ report one-of remove -1 yesNo ]
  [ report -1 ]
end

to-report revise-probabilities-for-pre-adoption [ currentPeriod history ]
  ;; to report the revised probabilities of actions for pre-adoption

  ;; action probabilities for context based on one of the following models:
  ;; 1. contingency only, based on theory and logic, as Pc
  ;; 2. history only, based on actions from field interviews, as Ph
  ;; 3. OR composite, using both contingency and history, as Pc + Ph - Pc * Ph

  ;; array declarations
  let precedence []
  let revisedProbs []

  ;; following is for option 1. above
  ;; relative weights for individual attributes
  let wgtIndividual WeightContingencyAdopter
  let wgtHIi 1 / wgtIndividual
  let wgtLOi wgtIndividual
  ;; weights for influencer contingency 1, innovativeness -> < 0.25 (low), > 0.75 (high), else (medium)
  let contingency12 n-values ADOPTERACTIONS [ 1 ] ;; weight = 1 -> no change in initial probabilities,
default
  let contingency11 (list wgtLOi wgtLOi wgtHIi wgtHIi wgtLOi wgtHIi)
  let contingency13 (list wgtHIi wgtHIi wgtLOi wgtLOi wgtHIi wgtLOi)
  let contingency1D (map [?1 + ?2 + ?3] contingency12 contingency11 contingency13)
```

```
  set contingency12 (map [?1 / ?2] contingency12 contingency1D)
  set contingency11 (map [?1 / ?2] contingency11 contingency1D)
  set contingency13 (map [?1 / ?2] contingency13 contingency1D)
  let contingency1 contingency12
  if innovativeness < 0.25 [ set contingency1 contingency11 ]
  if innovativeness > 0.75 [ set contingency1 contingency13 ]
  ;; weights for influencer contingency 2, IT expertise -> < 0.25 (low), > 0.75 (high), else (medium)
  let contingency22 n-values ADOPTERACTIONS [ 1 ] ;; weight = 1 -> no change in initial probabilities,
default
  let contingency21 (list wgtLOi wgtLOi 1 1 wgtLOi 1)
  let contingency23 (list wgtHIi wgtHIi 1 1 wgtHIi 1)
  let contingency2D (map [?1 + ?2 + ?3] contingency22 contingency21 contingency23)
  set contingency22 (map [?1 / ?2] contingency22 contingency2D)
  set contingency21 (map [?1 / ?2] contingency21 contingency2D)
  set contingency23 (map [?1 / ?2] contingency23 contingency2D)
  let contingency2 contingency22
  if expertise < 0.25 [ set contingency2 contingency21 ]
  if expertise > 0.75 [ set contingency2 contingency23 ]

  ;; following is for option 2. above
  ;; precedence from actions seen in field interviews
  ifelse currentPeriod > 1
  [
    ;; if there is some history
    ifelse sum(history) = (-1) * length(history)
    [
      ;; overall probabilities from field interviews
      ;; based on 3, 3, 22, 9, 5, 3 actions respectively of 45 pre-adoption actions
      set precedence (list 0.07 0.07 0.48 0.20 0.11 0.07)
    ]
    [
      set precedence n-values ADOPTERACTIONS [ 0 ]
      let numerator n-values ADOPTERACTIONS [ 0 ]
      let denominator n-values ADOPTERACTIONS [ 0 ]
      let DECAY ActionDecayAdopter
      let idxAction 0
      repeat ADOPTERACTIONS
      [
        let idxTime 1
        repeat ((currentPeriod - 1) - 1)
        [
          let oneAction item idxTime history
          if oneAction != -1 ;; if prior action is defined
          [
            let newNum item idxAction numerator
            let actionProb (item idxAction (item oneAction influencerActionPrecedence))
            set newNum (newNum + actionProb * DECAY ^ (currentPeriod - idxTime - 1))
            set numerator replace-item idxAction numerator newNum
            let newDen item idxAction denominator
            set newDen (newDen + DECAY ^ (currentPeriod - idxTime - 1))
            set denominator replace-item idxAction denominator newDen
          ]
          set idxTime (idxTime + 1)
        ]
        set idxAction (idxAction + 1)
      ]
      ;; compute probabilities using numerator and denominator
      set idxAction 0
      repeat ADOPTERACTIONS
      [
        if (item idxAction denominator) != 0
        [
          set precedence replace-item idxAction precedence
              ((item idxAction numerator) / (item idxAction denominator))
        ]
        set idxAction (idxAction + 1)
```

```
    ]
   ] ;; END: ifelse sum(history) = (-1) * length(history)
  ]
  [
   ;; if no history
   set precedence n-values ADOPTERACTIONS [ 0 ]
  ]

  ;; following is for option 3. above
  ;; no separate computation needed since this is a combination of both 1. and 2. above
  ;; effects included in the final computation depending on what model is selected

  ;; compute final probabilities of actions for contingency/history model selection
  let Pc (map [?1 * ?2] contingency1 contingency2)
  let Ph precedence
  let Pand (map [?1 * ?2] Pc Ph)
  let Por (map [?1 + ?2 - (?1 * ?2)] Pc Ph)
  ;; first, assume a contingency-only model
  set revisedProbs Pc
  ;; if history-only model
  if ContingencyHistorySelection = 2 [ set revisedProbs Ph ]
  ;; if OR composite model
  if ContingencyHistorySelection = 3 [ set revisedProbs Por ]
  report revisedProbs
end

to-report one-action-for-pre-adoption [ odds ]
  ;; to report one action that will be used by individual
  ;; done by performing the following:
  ;; 1: construct a probability distribution for each action using the odds
  ;; 2: determine if an action may be selected based on the probability distribution
  let yesNo []
  let pos 0
  repeat length odds
  [
   ifelse random-float 1 <= item pos odds
   [ set yesNo lput pos yesNo ]
   [ set yesNo lput -1 yesNo ]
   set pos (pos + 1)
  ]
  ;; return action# if action selected, otherwise return -1
  ifelse length remove -1 yesNo > 0
  [ report one-of remove -1 yesNo ]
  [ report -1 ]
end

to-report adoption-odds [ pid feature ]
  ;; to report the odds of this feature being adopted by individual this time period

  ;; adoption odds determined based on the following approach
  ;; since individuals influenced by contextual, influencer, and own actions..
  ;; all three influences included to determine adoption decision
  ;; default is equal weightage for all three influences in computing probabilities
  ;; however, differential weightage assigned based on contingencies
  ;; finally, individual's own adoption history is given weights

  ;; initially, all three influences have equal weightage
  let wgtContext 0.30
  let wgtInfluencer 0.35
  let wgtAdopter 0.35
  ;; default weights changed based on contingencies
  if CulturalOrientation = 0 ;; collectivistic
  [
   set wgtContext 0.30
   set wgtInfluencer 0.60
   set wgtAdopter 0.10
```

```
]
if CulturalOrientation = 1 ;; individualistic
[
  set wgtContext 0.30
  set wgtInfluencer 0.10
  set wgtAdopter 0.60
]
if OrganizationStructure = 0 ;; centralized
[
  set wgtContext 0.45
  set wgtInfluencer 0.275
  set wgtAdopter 0.275
]
if OrganizationStructure = 1 ;; decentralized
[
  set wgtContext 0.10
  set wgtInfluencer 0.45
  set wgtAdopter 0.45
]
if CulturalOrientation = 0 and OrganizationStructure = 0 ;; collectivistic and centralized
[
  set wgtContext 0.45
  set wgtInfluencer 0.45
  set wgtAdopter 0.10
]
if CulturalOrientation = 0 and OrganizationStructure = 1 ;; collectivistic and decentralized
[
  set wgtContext 0.10
  set wgtInfluencer 0.80
  set wgtAdopter 0.10
]
if CulturalOrientation = 1 and OrganizationStructure = 0 ;; individualistic and centralized
[
  set wgtContext 0.45
  set wgtInfluencer 0.10
  set wgtAdopter 0.45
]
if CulturalOrientation = 1 and OrganizationStructure = 1 ;; individualistic and decentralized
[
  set wgtContext 0.10
  set wgtInfluencer 0.10
  set wgtAdopter 0.80
]

;; compute effects of contextual, influencer, and adopter actions
;; effects computed using history of contextual actions
;; recent actions given higher weightage thru DECAY ^ (T - t - 1)
;; contextual and adopter own action histories are unique to individual and used as is
;; however, influencer action histories may vary due to multiple influencers, hence need special handling

;; first, the contextual actions
let DECAY ActionDecayContext
let idxTime 1
let ctxtActionNum 0
let ctxtActionRatio 0
if timePeriod > 1
[
  ;; if not first time period
  repeat ((length contextHistory - 1) - 1)
  [
    if item idxTime contextHistory != -1
    [
      set ctxtActionNum (ctxtActionNum + (DECAY ^ (timePeriod - idxTime - 1)))
    ]
  ]
  set ctxtActionRatio (ctxtActionNum / (timePeriod - 1))
```

```
  ]

  ;; next, the adopter actions
  set DECAY ActionDecayAdopter
  let idxFtr 0
  let adptActionNumThis 0
  let adptActionNumOther 0
  let adptActionRatioThis 0
  let adptActionRatioOther 0
  if timePeriod > 1
  [
    ;; if not first time period
    repeat InnovationSize
    [
      let curHistory item idxFtr actionHistory
      ifelse idxFtr = feature
      [
        ;; if this is the feature being currently considered
        set idxTime 1
        repeat ((length curHistory - 1) - 1)
        [
          if item idxTime curHistory != -1
          [
            set adptActionNumThis (adptActionNumThis + (DECAY ^ (timePeriod - idxTime - 1)))
          ]
          set idxTime (idxTime + 1)
        ]
      ] ;; if idxFtr = feature is true
      [
        ;; else if this is not the feature being currently considered
        set idxTime 1
        repeat ((length curHistory - 1) - 1)
        [
          if item idxTime curHistory != -1
          [
            set adptActionNumOther (adptActionNumOther + (DECAY ^ (timePeriod - idxTime - 1)))
          ]
          set idxTime (idxTime + 1)
        ]
      ] ;; if idxFtr = feature is false
      set idxFtr (idxFtr + 1)
    ]
    set adptActionRatioThis (adptActionNumThis / (timePeriod - 1))
    set adptActionRatioOther (adptActionNumOther / ((InnovationSize - 1) * (timePeriod - 1)))
  ]

  ;; finally, the influencer actions
  set DECAY ActionDecayInfluencer
  ;; first determine relative importance of various influencers using (relative) hierarchical level
  ;; assume all influencers connected to this adopter are peers, revise this later for superiors and
subordinates
  let newWgtInfluencer n-values length inflPartners [ 1 ] ;; equal weights
  ;; identify set of influencers for this adopter
  let influencers value-from person who [ inflPartners ]
  ;; extract set of actions by influencers for this feature for this adopter
  let inflActionRatioThis [ ]
  let inflActionRatioOther [ ]
  without-interruption
  [
    foreach influencers
    [
      ;; identify the appropriate action history by this influencer on this adopter
      let idx position pid value-from person ? [ inflPartners ]

      let inflHistory value-from person ?
        [ sublist inflActionHistory (idx * InnovationSize) (idx * InnovationSize + InnovationSize) ]
```

```
    set idxFtr 0
    let inflActionNumThis 0
    let inflActionNumOther 0
    ifelse timePeriod > 1
    [
      ;; if not first time period
      repeat InnovationSize
      [
        let curHistory item idxFtr inflHistory
        ifelse idxFtr = feature
        [
          ;; if this is the feature being currently considered
          set idxTime 1
          repeat ((length curHistory - 1) - 1)
          [
            if item idxTime curHistory != -1
            [
              set inflActionNumThis (inflActionNumThis + (DECAY ^ (timePeriod - idxTime - 1)))
            ]
            set idxTime (idxTime + 1)
          ]
        ] ;; if idxFtr = feature is true
        [
          ;; else if this is not the feature being currently considered
          set idxTime 1
          repeat ((length curHistory - 1) - 1)
          [
            if item idxTime curHistory != -1
            [
              set inflActionNumOther (inflActionNumOther + (DECAY ^ (timePeriod - idxTime - 1)))
            ]
            set idxTime (idxTime + 1)
          ]
        ] ;; if idxFtr = feature is false
        set idxFtr (idxFtr + 1)
      ] ;; end: repeat InnovationSize
      set inflActionRatioThis lput (inflActionNumThis / (timePeriod - 1)) inflActionRatioThis
      set inflActionRatioOther
          lput (inflActionNumOther / ((InnovationSize - 1) * (timePeriod - 1))) inflActionRatioOther
    ]
    [
      ;; if first time period
      set inflActionRatioThis n-values length inflPartners [ 0 ]
      set inflActionRatioOther n-values length inflPartners [ 0 ]
    ]

    ;; identify the relative hierarchical level of this influencer compared to this adopter
    ;; and revise influencer action weights, >0: subordinate influencer, 0: peer, <0: superior influencer
    let inflRelLevel (orgLevel - (value-from person ? [ orgLevel ]))
    ;; revision needed only for subordinate and superior influencers, default for peers
    if inflRelLevel < 0 ;; superior influencer
    [
      set newWgtInfluencer replace-item (position ? influencers) newWgtInfluencer (1 /
WeightContingencyResponse)
    ]
    if inflRelLevel > 0 ;; subordinate influencer
    [
      set newWgtInfluencer replace-item (position ? influencers) newWgtInfluencer
WeightContingencyResponse
    ]
  ]
]

;; compute overall probability, using context, influencer, and adopter weights and action ratios
let odds (wgtContext * ctxtActionRatio)
```

```
  set odds (odds + (wgtAdopter * (adptActionRatioThis + FeatureLearningByIndividual *
adptActionRatioOther)))
  let SIGMAnewWgtInfluencer sum newWgtInfluencer
  set newWgtInfluencer map [?1 / SIGMAnewWgtInfluencer] newWgtInfluencer
  set odds (odds + (wgtInfluencer * (sum (map [ (?1 * (?2 + FeatureLearningByIndividual * ?3)) ]
     newWgtInfluencer inflActionRatioThis inflActionRatioOther))))

  report odds
end

to-report is-candidate [ odds ]
  ;; to report if a feature is a candidate for adoption
  ;; done by performing the following:
  ;; 1: construct a probability distribution using the odds
  ;; 2: randomly pick a possibility from the probability distribution
  let idxDist 0
  ;; construct probability distribution for all actions
  let adoptionProbDist n-values 100 [ NO ]
  repeat round (odds * 100)
  [
    set adoptionProbDist (replace-item idxDist adoptionProbDist YES)
    set idxDist (idxDist + 1)
    if idxDist = 100 [ set idxDist (idxDist - 1) ] ;; to prevent overflow at 100 due to rounding
  ]
  ;; pick one from the probability distribution
  set idxDist random 99
  report item idxDist adoptionProbDist
;;  report ifelse-value (random-float 1 < odds) [ 1 ] [ 0 ]
end

to-report occurrences [ key domain ]
  ;; to report the number of times a particular value is seen in a list
  report reduce [ifelse-value (?2 = key) [?1 + 1] [?1]] (fput 0 domain)
end

to-report all-contextual-actions-count
  ;; to report the number of contextual actions interpreted by individuals, across all persons
  let actionCounter []
  ask persons [ set actionCounter lput (length remove -1 contextHistory) actionCounter ]
  report actionCounter
end

to-report all-contextual-actions
  ;; to report the contextual actions interpreted by individuals, across all persons
  let actions []
  ask persons [ set actions lput (remove -1 contextHistory) actions ]
  report actions
end

to-report all-contextual-action-types
  ;; to report the number of times each contextual action type was interpreted, across all persons
  let actionsByPersons all-contextual-actions
  let actionTypes n-values CONTEXTUALACTIONS [ 0 ]
  foreach actionsbyPersons
  [
    set actionTypes replace-item 0 actionTypes ((item 0 actionTypes) + (occurrences 0 ?))
    set actionTypes replace-item 1 actionTypes ((item 1 actionTypes) + (occurrences 1 ?))
    set actionTypes replace-item 2 actionTypes ((item 2 actionTypes) + (occurrences 2 ?))
    set actionTypes replace-item 3 actionTypes ((item 3 actionTypes) + (occurrences 3 ?))
    set actionTypes replace-item 4 actionTypes ((item 4 actionTypes) + (occurrences 4 ?))
  ]
  report actionTypes
end

to-report all-influence-actions-count
  ;; to report the total number of influence actions across all persons
```

```
  let actionCounter n-values NetworkSize [ 0 ]
  ask persons
  [
    foreach inflActionHistory
    [
      set actionCounter replace-item who actionCounter (item who actionCounter + length remove -1 ?)
    ]
  ]
  report actionCounter
end

to-report all-influence-actions
  ;; to report the influence actions across all persons
  let actions[]
  ask persons
  [
    foreach inflActionHistory
    [
      set actions lput (remove -1 ?) actions
    ]
  ]
  report actions
end

to-report all-influence-action-types
  ;; to report the number of times each influence action type across all persons
  let actionsByPersons all-influence-actions
  let actionTypes n-values INFLUENCERACTIONS [ 0 ]
  foreach actionsbyPersons
  [
    set actionTypes replace-item 0 actionTypes ((item 0 actionTypes) + (occurrences 0 ?))
    set actionTypes replace-item 1 actionTypes ((item 1 actionTypes) + (occurrences 1 ?))
    set actionTypes replace-item 2 actionTypes ((item 2 actionTypes) + (occurrences 2 ?))
    set actionTypes replace-item 3 actionTypes ((item 3 actionTypes) + (occurrences 3 ?))
    set actionTypes replace-item 4 actionTypes ((item 4 actionTypes) + (occurrences 4 ?))
    set actionTypes replace-item 5 actionTypes ((item 5 actionTypes) + (occurrences 5 ?))
    set actionTypes replace-item 6 actionTypes ((item 6 actionTypes) + (occurrences 6 ?))
  ]
  report actionTypes
end

to-report all-adoption-actions-count
  ;; to report the total number of pre-adoption actions across all persons
  let actionCounter n-values NetworkSize [ 0 ]
  ask persons
  [
    foreach actionHistory
    [
      set actionCounter replace-item who actionCounter (item who actionCounter + length remove -1 ?)
    ]
  ]
  report actionCounter
end

to-report all-adoption-actions
  ;; to report the pre-adoption actions across all persons
  let actions []
  ask persons
  [
    foreach actionHistory
    [
      set actions lput (remove -1 ?) actions
    ]
  ]
  report actions
end
```

```
to-report all-adoption-action-types
  ;; to report the number of times each influence action type across all persons
  let actionsByPersons all-adoption-actions
  let actionTypes n-values ADOPTERACTIONS [ 0 ]
  foreach actionsbyPersons
  [
    set actionTypes replace-item 0 actionTypes ((item 0 actionTypes) + (occurrences 0 ?))
    set actionTypes replace-item 1 actionTypes ((item 1 actionTypes) + (occurrences 1 ?))
    set actionTypes replace-item 2 actionTypes ((item 2 actionTypes) + (occurrences 2 ?))
    set actionTypes replace-item 3 actionTypes ((item 3 actionTypes) + (occurrences 3 ?))
    set actionTypes replace-item 4 actionTypes ((item 4 actionTypes) + (occurrences 4 ?))
    set actionTypes replace-item 5 actionTypes ((item 5 actionTypes) + (occurrences 5 ?))
  ]
  report actionTypes
end

to-report one-person-influence-action-types [ personID ]
  ;; to report the influence actions on this individual by other individuals in network
  ;; first gather all influence actions used by other individuals on focal individual
  let actions []
  foreach inflPartners
  [
    ask person ?
    [
      let focalFeature 0
      repeat InnovationSize
      [
        let itemPos ((position personID inflPartners) * InnovationSize + focalFeature)
        set actions lput (remove -1 item itemPos inflActionHistory) actions
        set focalFeature (focalFeature + 1)
      ]
    ]
  ]
  ;; then determine the particular action types used by other individuals on focal individual
  let types n-values INFLUENCERACTIONS [ 0 ]
  foreach actions
  [
    if length ? > 0
    [
      set types replace-item 0 types ((item 0 types) + (occurrences 0 ?))
      set types replace-item 1 types ((item 1 types) + (occurrences 1 ?))
      set types replace-item 2 types ((item 2 types) + (occurrences 2 ?))
      set types replace-item 3 types ((item 3 types) + (occurrences 3 ?))
      set types replace-item 4 types ((item 4 types) + (occurrences 4 ?))
      set types replace-item 5 types ((item 5 types) + (occurrences 5 ?))
      set types replace-item 6 types ((item 6 types) + (occurrences 6 ?))
    ]
  ]
  report types
end

to-report one-person-adoption-action-types [ personID ]
  ;; to report the adoption actions by this individual in network
  ;; first gather all adoption actions used by focal individual
  let actions []
  let focalFeature 0
  repeat InnovationSize
  [
    set actions lput (remove -1 item focalFeature actionHistory) actions
    set focalFeature (focalFeature + 1)
  ]
  ;; then determine the particular action types used by other individuals on focal individual
  let types n-values ADOPTERACTIONS [ 0 ]
  foreach actions
  [
```

```
    if length ? > 0
    [
      set types replace-item 0 types ((item 0 types) + (occurrences 0 ?))
      set types replace-item 1 types ((item 1 types) + (occurrences 1 ?))
      set types replace-item 2 types ((item 2 types) + (occurrences 2 ?))
      set types replace-item 3 types ((item 3 types) + (occurrences 3 ?))
      set types replace-item 4 types ((item 4 types) + (occurrences 4 ?))
      set types replace-item 5 types ((item 5 types) + (occurrences 5 ?))
    ]
  ]
  report types
end

;;=====================================================================
;; Support Procedures for Simulation Procedures
;;=====================================================================

to compute-stats
  ;; to compute dependent and independent variables before recording to data file
  ;; first, the dependent variables

  set adoptersTimeT length (remove 0 values-from persons [ sum featureAdopted? ])
  set featuresTimeT sum (values-from persons [ sum featureAdopted? ])

  let minTimes []
  let maxTimes []
  foreach sort-by [ size-of ?1 < size-of ?2 ] persons with [ sum featureAdopted? > 0 ]
  [
    set minTimes lput value-from ? [ min remove -1 timeAdopted ] minTimes
    set maxTimes lput value-from ? [ max remove -1 timeAdopted ] maxTimes
  ]

  set sigmaTimeAdptIND -1
  let timeDiffIND -1
  set timeDiffNET -1
  ifelse adoptersTime0 > 0
  [
    set sigmaTimeAdptIND ifelse-value (length remove 0 minTimes > 0) [ sum minTimes ] [ -1 ]
    set timeDiffIND ifelse-value (length remove 0 minTimes > 0) [ map [ ? - 0 + 1 ] minTimes ] [ "" ]
    set timeDiffNET ifelse-value (length timeDiffIND > 1)
      [ ((sum timeDiffIND) / (adoptersTimeT - adoptersTime0)) ] [ -1 ]
  ]
  [
    set sigmaTimeAdptIND ifelse-value (length minTimes > 0) [ sum minTimes ] [ -1 ]
    set timeDiffIND ifelse-value (length minTimes > 0) [ map [ ? - min minTimes + 1 ] minTimes ] [ "" ]
    set timeDiffNET ifelse-value (length timeDiffIND > 1)
      [ ((sum timeDiffIND) / (adoptersTimeT - 1)) ] [ -1 ]
  ]

  let asimTimes values-from persons with [ sum featureAdopted? > 0 ] [ remove -1 timeAdopted ]
  foreach asimTimes
  [
    let curPerson ?
    let revAsimTimes []
    ifelse (sum curPerson = 0)
    [
      ;; no new assimilation, i.e. all features were adopted at time 0
    ]
    [
      ;; some new assimilation, i.e. at least some features were adopted after time 0
      ifelse (min curPerson = 0)
      [
        ;; if at least one of those features were adopted at time 0
        set revAsimTimes remove 0 curPerson
      ]
      [
```

```
        ;; if all of those features were adopted after time 0
        set revAsimTimes (map [ ? - min curPerson + 1 ] curPerson)
      ]
    ]
    set asimTimes replace-item position ? asimTimes asimTimes revAsimTimes
  ]
  let timeAsimIND []
  foreach asimTimes
  [
    set timeAsimIND lput ifelse-value (length ? > 0) [ mean ? ] [ [] ] timeAsimIND
  ]
  set timeAsimIND remove [] timeAsimIND
  set timeAsimNET ifelse-value (length timeAsimIND > 0) [ (sum timeAsimIND) / adoptersTimeT ] [ -1 ]

  set chgLevelDiffNET ((adoptersTimeT - adoptersTime0) / (NetworkSize - adoptersTime0))
  set chgLevelAsimNET ifelse-value (adoptersTimeT > 0)
    [ ((featuresTimeT - featuresTime0) / (adoptersTimeT * InnovationSize - featuresTime0)) ] [ 0 ]

  set speedAdptNET ifelse-value (sigmaTimeAdptIND > 0)
    [ (adoptersTimeT - adoptersTime0) / sigmaTimeAdptIND ] [ -1 ]
  set speedDiffNET ifelse-value (timeDiffNET > 0) [ chgLevelDiffNET / timeDiffNET ] [ -1 ]
  set speedAsimNET ifelse-value (timeAsimNET > 0) [ chgLevelAsimNET / timeAsimNET ] [ -1 ]

  ;; next, the independent variables
  let cumContextualActions sum all-contextual-actions-count
  let cumInfluenceActions sum all-influence-actions-count
  let cumAdoptionActions sum all-adoption-actions-count

  ;; update process variables
  if timePeriod mod interval = 0
  [
    ;; build during-simulation periodic data
    ;; dependent variables
    set seqAdoptersNET lput adoptersTimeT seqAdoptersNET
    set seqFeaturesNET lput featuresTimeT seqFeaturesNET
    set seqSigmaTimeAdptIND lput sigmaTimeAdptIND seqSigmaTimeAdptIND
    set seqChgLevelDiffNET lput chgLevelDiffNET seqChgLevelDiffNET
    set seqChgLevelAsimNET lput chgLevelAsimNET seqChgLevelAsimNET
    set seqTimeDiffNET lput timeDiffNET seqTimeDiffNET
    set seqTimeAsimNET lput timeAsimNET seqTimeAsimNET
    set seqSpeedAdptNET lput speedAdptNET seqSpeedAdptNET
    set seqSpeedDiffNET lput speedDiffNET seqSpeedDiffNET
    set seqSpeedAsimNET lput speedAsimNET seqSpeedAsimNET
    ;; independent variables
    set seqCumContextualActions lput cumContextualActions seqCumContextualActions
    set seqCumInfluenceActions lput cumInfluenceActions seqCumInfluenceActions
    set seqCumAdoptionActions lput cumAdoptionActions seqCumAdoptionActions
  ]

  ;; finally, other measures
  if adopterStability = -1 ;; if not defined yet
  [ if adoptersTimeT = NetworkSize [ set adopterStability timePeriod ] ]
  if featureStability = -1 ;; if not defined yet
  [ if featuresTimeT = (InnovationSize * NetworkSize) [ set featureStability timePeriod ] ]
end

to write-sim-end-network-level-data
  ;; this is called by the "simulation" procedure
  ;; it writes the network-level data to file at the end of a simulation run

  ;; first, compute some necessary values for writing to file
  ;; dependent variables done in compute-stats procedure
  ;; independent variables done here
  let contextActionsCount all-contextual-actions-count
  let contextActions all-contextual-actions
  let contextActionTypes all-contextual-action-types
```

```
  let influenceActionsCount all-influence-actions-count
  let influenceActions all-influence-actions
  let influenceActionTypes all-influence-action-types
  let adoptionActionsCount all-adoption-actions-count
  let adoptionActions all-adoption-actions
  let adoptionActionTypes all-adoption-action-types
  let totalActionsCount (sum contextActionsCount + sum influenceActionsCount + sum
adoptionActionsCount)

  ;; next, pad list will empty cells for time-varying data if simulation ends before alloted time
  repeat (MaxTimePeriod / interval - length seqAdoptersNET)
    [ set seqAdoptersNET lput -1 seqAdoptersNET ]
  repeat (MaxTimePeriod / interval - length seqFeaturesNET)
    [ set seqFeaturesNET lput -1 seqFeaturesNET ]
  repeat (MaxTimePeriod / interval - length seqSigmaTimeAdptIND)
    [ set seqSigmaTimeAdptIND lput -1 seqSigmaTimeAdptIND ]
  repeat (MaxTimePeriod / interval - length seqChgLevelDiffNET)
    [ set seqChgLevelDiffNET lput -1 seqChgLevelDiffNET ]
  repeat (MaxTimePeriod / interval - length seqChgLevelAsimNET)
    [ set seqChgLevelAsimNET lput -1 seqChgLevelAsimNET ]
  repeat (MaxTimePeriod / interval - length seqTimeDiffNET)
    [ set seqTimeDiffNET lput -1 seqTimeDiffNET ]
  repeat (MaxTimePeriod / interval - length seqTimeAsimNET)
    [ set seqTimeAsimNET lput -1 seqTimeAsimNET ]
  repeat (MaxTimePeriod / interval - length seqSpeedAdptNET)
    [ set seqSpeedAdptNET lput -1 seqSpeedAdptNET ]
  repeat (MaxTimePeriod / interval - length seqSpeedDiffNET)
    [ set seqSpeedDiffNET lput -1 seqSpeedDiffNET ]
  repeat (MaxTimePeriod / interval - length seqSpeedAsimNET)
    [ set seqSpeedAsimNET lput -1 seqSpeedAsimNET ]
  repeat (MaxTimePeriod / interval - length seqCumContextualActions)
    [ set seqCumContextualActions lput -1 seqCumContextualActions ]
  repeat (MaxTimePeriod / interval - length seqCumInfluenceActions)
    [ set seqCumInfluenceActions lput -1 seqCumInfluenceActions ]
  repeat (MaxTimePeriod / interval - length seqCumAdoptionActions)
    [ set seqCumAdoptionActions lput -1 seqCumAdoptionActions ]

  ;; write end-of-simulation network data to text file
  file-open "end-net.txt"
  file-write runNumber
  file-write SimSeed
  file-write timePeriod

  ;; dependent variables for the network-level analysis
  ;; end of simulation process
  file-write adoptersTime0
  file-write featuresTime0
  file-write adoptersTimeT
  file-write featuresTimeT
  file-write sigmaTimeAdptIND
  file-write timeDiffNET
  file-write timeAsimNET
  file-write chgLevelDiffNET
  file-write chgLevelAsimNET
  file-write speedAdptNET
  file-write speedDiffNET
  file-write speedAsimNET

  ;; independent variables (computed) for the network-level analysis
  ;; contextual actions, interpreted
  file-write (sum contextActionsCount)
  file-write item 0 contextActionTypes ;; action 0
  file-write item 1 contextActionTypes ;; action 1
  file-write item 2 contextActionTypes ;; action 2
  file-write item 3 contextActionTypes ;; action 3
  file-write item 4 contextActionTypes ;; action 4
```

```
;; influence actions
file-write (sum influenceActionsCount)
file-write item 0 influenceActionTypes ;; action 0
file-write item 1 influenceActionTypes ;; action 1
file-write item 2 influenceActionTypes ;; action 2
file-write item 3 influenceActionTypes ;; action 3
file-write item 4 influenceActionTypes ;; action 4
file-write item 5 influenceActionTypes ;; action 5
file-write item 6 influenceActionTypes ;; action 6
;; pre-adoption actions
file-write (sum adoptionActionsCount)
file-write item 0 adoptionActionTypes ;; action 0
file-write item 1 adoptionActionTypes ;; action 1
file-write item 2 adoptionActionTypes ;; action 2
file-write item 3 adoptionActionTypes ;; action 3
file-write item 4 adoptionActionTypes ;; action 4
file-write item 5 adoptionActionTypes ;; action 5

;; actions, overall
file-write totalActionsCount

;; tie-related variables
ifelse count ties > 0
[ file-write sum values-from ties [tieStrength] / count ties ]
[ file-write 0 ]

;; individual-related variables
file-write sum values-from persons [ innovativeness ] / NetworkSize
file-write length values-from persons with [ innovativeness >= 0.75 ] [ innovativeness ]
file-write length values-from persons with [ innovativeness <= 0.25 ] [ innovativeness ]
file-write sum values-from persons [ expertise ] / NetworkSize
file-write length values-from persons with [ expertise >= 0.75 ] [ expertise ]
file-write length values-from persons with [ expertise <= 0.25 ] [ expertise ]
file-write sum values-from persons [ managementStyle ] / NetworkSize
file-write length values-from persons with [ managementStyle >= 0.75 ] [ managementStyle ]
file-write length values-from persons with [ managementStyle <= 0.25 ] [ managementStyle ]
file-write sum values-from persons [ orgLevel ] / NetworkSize

;; independent variables (assigned) for the network-level analysis
file-write NetworkSize
file-write actualTiesInNetwork
file-write NetworkHierarchy
file-write NetworkDensity
file-write NetworkStrength
file-write NetworkCentralization
file-write NetworkDegree
file-write InnovationSize
file-write TopMgtSupport
file-write TypeOfISSolution
file-write OrganizationStructure
file-write CulturalOrientation
file-write FirstDecay
file-write ActionDecayContext
file-write ActionDecayInfluencer
file-write ActionDecayAdopter
file-write FirstWeight
file-write WeightContingencyResponse
file-write WeightContingencyContext
file-write WeightContingencyInfluencer
file-write WeightContingencyAdopter
file-write %InitialAdopters
file-write %InitialFeatures
file-write ContingencyHistorySelection
file-write FeatureLearningByIndividual

;; other computed measures
```

```
  file-write adopterStability ;; full diffusion
  file-write featureStability ;; full assimilation
  file-write count persons with [ assimilation = 0 ]
  file-write count persons with [ assimilation > 0 ]
  file-write count persons with [ assimilation >= 0.10 ]
  file-write count persons with [ assimilation >= 0.25 ]
  file-write count persons with [ assimilation >= 0.50 ]
  file-write count persons with [ assimilation >= 0.75 ]
  file-write count persons with [ assimilation >= 0.90 ]
  file-write count persons with [ assimilation = 1 ]

  ;; end-of-record marker and close file
;  file-print " $"
;  file-close
;
;  ;; during simulation process, periodic data
;  file-open "seq-dv1.txt"
;  file-write runNumber
  file-write seqAdoptersNET
  file-write seqFeaturesNET
  file-write seqSigmaTimeAdptIND
  file-write seqChgLevelDiffNET
  file-write seqChgLevelAsimNET
;  file-print " $"
;  file-close
;  file-open "seq-dv2.txt"
;  file-write runNumber
  file-write seqTimeDiffNET
  file-write seqTimeAsimNET
  file-write seqSpeedAdptNET
  file-write seqSpeedDiffNET
  file-write seqSpeedAsimNET
;  file-print " $"
;  file-close
;  file-open "seq-dv3.txt"
;  file-write runNumber
  file-write seqCumContextualActions
  file-write seqCumInfluenceActions
  file-write seqCumAdoptionActions
  file-print " $"
  file-close

;  show sentence "adopters:" seqAdoptersNET
;  show sentence "features:" seqFeaturesNET
;  show sentence "sigma time adopt:" seqSigmaTimeAdptIND
;  show sentence "chg level diff:" seqChgLevelDiffNET
;  show sentence "chg level asim:" seqChgLevelAsimNET
;  show sentence "time diff:" seqTimeDiffNET
;  show sentence "time asim:" seqTimeAsimNET
;  show sentence "speed adopt:" seqSpeedAdptNET
;  show sentence "speed diff:" seqSpeedDiffNET
;  show sentence "contextual:" seqCumContextualActions
;  show sentence "influence:" seqCumInfluenceActions
;  show sentence "adoption:" seqCumAdoptionActions
end

;;=============================================================================
;; Global Support Procedures
;;=============================================================================

to show-all-attributes
  ;; this is called by the "setup" and "simulation" procedures, on demand
  ;; it displays the randomly generated values for all persons in the network
  ask persons
  [
    show sentence "PERSON: " who
```

```
    show sentence "org level: " orgLevel
    show sentence "expertise: " expertise
    show sentence "innovativenss: " innovativeness
    show sentence "management style: " managementStyle
    show sentence "feature adopted: " featureAdopted?
    show sentence "time adopted: " timeAdopted
    show sentence "assimilation: " assimilation
    show sentence "adoption feature odds: " featureOdds
    show sentence "adoption action history: " actionHistory
    show sentence "influence ties: " inflTies
    show sentence "influence partners: " inflPartners
    show sentence "influence feature odds: " inflFeatureOdds
    show sentence "influence action history: " inflActionHistory
    show sentence "context history: " contextHistory
    show sentence "context odds: " contextOdds
  ]
end

;;=================================================================
;; Global Support Functions
;;=================================================================

to-report contextual-action-precedence
  ;; this is called by the "setup" procedure
  ;; it computes the probabilities of contextual actions based on precedence info from field interviews

  ;; this is done by looking at all sequences, and the order in which the actions happened
  ;; higher weightage given to more recent actions, implemented as DECAY^(T-t-1)

  ;; 4 contextual actions possible, indexed in the following order
  ;; 0. creating awareness, 1. issuing of mandate, 2. development, 3. implementation, 4. training

  ;; action sequences from field interviews
  let fieldSeq [ [0 4] [0 1 4 3] [0 4] [0 4] [1 4] [0 2 3 1 4 4] [1 1 4 4] [3 0 4] [0 1 3 4] [0 1 4 3] [1 4]
                 [1 4] [4 0] [0 1] [2 3 3] [0] [0 4] [0] [0 2 2 2 3 2 2] [0] [2 4] [0 2 2 4] [0] ]
  let numSeqs length fieldSeq
  let numerator n-values CONTEXTUALACTIONS [ n-values CONTEXTUALACTIONS [ 0 ] ]
  let denominator n-values CONTEXTUALACTIONS [ 0 ]
  let DECAY ActionDecayContext
  let idxSeq 0
  repeat numSeqs ;; look through all sequences obtained from field interviews
  [
    let numActions length item idxSeq fieldSeq
    ;; using this action as A in p(A|B)..
    let idxActionA 1 ;; since first index begins at 0
    repeat (numActions - 1)
    [
      ;; ..and using this action as B in p(A|B)
      let idxActionB 0 ;; since first index begins at 0
      repeat (idxActionA)
      [
        let actionA item idxActionA (item idxSeq fieldSeq)
        let actionB item idxActionB (item idxSeq fieldSeq)
        let tmpList item actionA numerator
        set tmpList replace-item actionB tmpList (item actionB tmpList + DECAY ^ (idxActionA - idxActionB -
1))
        set numerator replace-item actionA numerator tmpList
        set denominator replace-item actionA denominator (item actionA denominator + DECAY ^
(idxActionA - idxActionB - 1))
        set idxActionB (idxActionB + 1)
      ]
      set idxActionA (idxActionA + 1)
    ]
    set idxSeq (idxSeq + 1)
  ]
  ;; compute probabilities for precedence of actions in field interviews
```

```
  let precedence n-values CONTEXTUALACTIONS [ n-values CONTEXTUALACTIONS [ 0 ] ]
  foreach numerator
  [
    let num ?
    let den item (position ? numerator) denominator
    if den != 0 [ set num map [?1 / den] ? ]
    set precedence replace-item (position ? numerator) precedence num
  ]
  report precedence
end

to-report influencer-action-precedence
  ;; this is called by the "setup" procedure
  ;; it computes the probabilities of influencer actions based on precedence info from field interviews

  ;; this is done by looking at all sequences, and the order in which the actions happened
  ;; higher weightage given to more recent actions, implemented as DECAY^(T-t-1)

  ;; 7 influencer actions possible, indexed in the following order
  ;; 0. building coalitions, 1. bargaining, 2. rational arguments, 3. being assertive,
  ;; 4. expertise, 5. demonstration, 6. knowledge sharing

  ;; action sequences from field interviews
  let fieldSeq [ [3 2 0 1 5 0] [2 3 2 2 5] [3 2 3] [3 1 5 1 4 4 6 6] [5] [4 2 6 6 0 5 5 4] [3 5 5 3]
               [4 5 5] [4 3] [1 5 4] [4 5 5] [5 1 4 1 5] [4] [5] [0 0 2 2 5 2 5 3 3 2 4 2 6 5] [2 1 2 5 4 5]
               [4 5 5 2 2 1 5 3] [4 5] [1 2 0 2 1 2 4] [5 4] ]
  let numSeqs length fieldSeq
  let numerator n-values INFLUENCERACTIONS [ n-values INFLUENCERACTIONS [ 0 ] ]
  let denominator n-values INFLUENCERACTIONS [ 0 ]
  let DECAY ActionDecayInfluencer
  let idxSeq 0
  repeat numSeqs ;; look through all sequences obtained from field interviews
  [
    let numActions length item idxSeq fieldSeq
    ;; using this action as A in p(A|B)..
    let idxActionA 1 ;; since first index begins at 0
    repeat (numActions - 1)
    [
      ;; ..and using this action as B in p(A|B)
      let idxActionB 0 ;; since first index begins at 0
      repeat (idxActionA)
      [
        let actionA item idxActionA (item idxSeq fieldSeq)
        let actionB item idxActionB (item idxSeq fieldSeq)
        let tmpList item actionA numerator
        set tmpList replace-item actionB tmpList (item actionB tmpList + DECAY ^ (idxActionA - idxActionB -
1))
        set numerator replace-item actionA numerator tmpList
        set denominator replace-item actionA denominator (item actionA denominator + DECAY ^
(idxActionA - idxActionB - 1))
        set idxActionB (idxActionB + 1)
      ]
      set idxActionA (idxActionA + 1)
    ]
    set idxSeq (idxSeq + 1)
  ]
  ;; compute probabilities for precedence of actions in field interviews
  let precedence n-values INFLUENCERACTIONS [ n-values INFLUENCERACTIONS [ 0 ] ]
  foreach numerator
  [
    let num ?
    let den item (position ? numerator) denominator
    if den != 0 [ set num map [?1 / den] ? ]
    set precedence replace-item (position ? numerator) precedence num
  ]
  report precedence
```

```
end

to-report adopter-action-precedence
  ;; this is called by the "setup" procedure
  ;; it computes the probabilities of adopter actions based on precedence info from field interviews

  ;; this is done by looking at all sequences, and the order in which the actions happened
  ;; higher weightage given to more recent actions, implemented as DECAY^(T-t-1)

  ;; 6 adopter actions possible, indexed in the following order
  ;; 0. review, 1. observation, 2. inquiry, 3. seeking assistance, 4. request for..., 5. develop own...

  ;; action sequences from field interviews
  let fieldSeq [ [3 4 4 2 3] [4] [0] [2] [2 3] [1 3 3] [2 2 2 3 4] [5 4 2 2 3 3] [0 2] [2 2] [2]
               [2] [2] [5] [2 2 2] [2 0] [3] [2 1 1] [5] [2 2] [2] ]
  let numSeqs length fieldSeq
  let numerator n-values ADOPTERACTIONS [ n-values ADOPTERACTIONS [ 0 ] ]
  let denominator n-values ADOPTERACTIONS [ 0 ]
  let DECAY ActionDecayAdopter
  let idxSeq 0
  repeat numSeqs ;; look through all sequences obtained from field interviews
  [
    let numActions length item idxSeq fieldSeq
    ;; using this action as A in p(A|B)..
    let idxActionA 1 ;; since first index begins at 0
    repeat (numActions - 1)
    [
      ;; ..and using this action as B in p(A|B)
      let idxActionB 0 ;; since first index begins at 0
      repeat (idxActionA)
      [
        let actionA item idxActionA (item idxSeq fieldSeq)
        let actionB item idxActionB (item idxSeq fieldSeq)
        let tmpList item actionA numerator
        set tmpList replace-item actionB tmpList (item actionB tmpList + DECAY ^ (idxActionA - idxActionB -
1))
        set numerator replace-item actionA numerator tmpList
        set denominator replace-item actionA denominator (item actionA denominator + DECAY ^
(idxActionA - idxActionB - 1))
        set idxActionB (idxActionB + 1)
      ]
      set idxActionA (idxActionA + 1)
    ]
    set idxSeq (idxSeq + 1)
  ]
  ;; compute probabilities for precedence of actions in field interviews
  let precedence n-values ADOPTERACTIONS [ n-values ADOPTERACTIONS [ 0 ] ]
  foreach numerator
  [
    let num ?
    let den item (position ? numerator) denominator
    if den != 0 [ set num map [?1 / den] ? ]
    set precedence replace-item (position ? numerator) precedence num
  ]
  report precedence
end

to-report is-stop-simulation
  ;; to report if it is time to stop the simulation
  ;; a simulation run may be stopped if one of the following two conditions are met
  ;; 1: a pre-specified number of time periods has been reached OR
  ;; 2: ALL individuals have adopted ALL innovation features
  ifelse timePeriod = MaxTimePeriod or PopulationASSIMILATION >= 1
    [ report TRUE ] [ report FALSE ]
end
```

```
to-report PopulationASSIMILATION
  ;; to report if all individuals have adopted all innovation features
  ;; done by accumulating the assimilation values of all individuals and dividing by the number of
individuals
  let poptot 0
  ask persons [ set poptot (poptot + assimilation) ]
  report (poptot / NetworkSize)
end
```

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