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Information Technology Implementation and Sustainment Model: Data Collection Instrument

Walter K. Yazzie

INFORMATION TECHNOLOGY IMPLEMENTATION AND SUSTAINMENT MODEL: DATA COLLECTION INSTRUMENT

THESIS

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AFIT/GEM/ENV/05M-15

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Abstract

The goal of this research was to develop a data collection instrument for an existing information technology implementation and sustsinment model. In 2003, a unique system dynamics model was developed at the Air Force Institute of Technology to predict the behavior of information technology implementation and sustainment (Fonnesbeck, 2003). However, no empirical data was used during the model development. In order to collect the needed empirical data, this research develops a data collection instrument for the model. The instrument was sent to 60 Air Force community planners who are currently implementing a geographical information system (Air Force GeoBase) into their planning process. The reliability analysis of the instrument resulted in reliability coefficients exceeding the recommended Cronbach's alpha in all but one factor.

The implementation of the model for the first time with empirical data showed promising results. The model output indicated steady increase to implementation completion and solid sustainment there after.

Acknowledgments

I would like to express my sincere appreciation to my faculty advisor, Dr. Alfred Thal, for his guidance and support throughout the course of this thesis effort. In addition to academic guidance, Dr. Thal also provided personal and military advice. His insight and experience has changed the course of my career and life; his sincere concern is greatly appreciated. I would also like to thank the other members of my committee, Dr. Michael Shelley and Major Kent Halverson, for their insight and guidance.

My deepest appreciation goes out to my wife and children. Their endless support, understanding, and sacrifice made it possible for me to complete this thesis effort. The children have been most understanding while I attended AFIT and my wife completed her masters at The Ohio State University.

Walter K. Yazzie

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INFORMATION TECHNOLOGY IMPLEMENTATION AND SUSTAINMENT MODEL: DATA COLLECTION INSTRUMENT

I. Introduction

1.1 Background

"Understanding why people accept or reject computers has proven to be one of the most challenging issues in information systems research" (Davis, Bagozzi, and Warshaw; 1989). The primary reason for this difficulty is that the implementation of new technology is related to human behaviors – behaviors which are influenced by external factors such as the characteristics of the new technology, the ways in which it is introduced to the individual/organization, and individual involvement in the implementation process (Davis et al., 1989). Human behaviors regarding computer usage are also influenced by the overall diffusion of the new technology (or innovation) in a population.

Rogers (2003:5) defines diffusion as "the process in which an innovation is communicated through certain channels over time among the members of a social system." He places emphasis on four main factors: innovation, communication, time and the social system. Understanding the dynamic interactions of these factors is important because they govern the success or failure of innovation diffusion

To help better understand the diffusion process, the literature is replete with theories and models developed to measure the implementation and sustainment of new information technology. Kukafka, Johnson, Linfante, and Allegrante (2003) identified six dominant models within the literature and observed that the models are typically focused on only one of three factors: organizational, technological, or individual. However, without addressing these factors in a holistic fashion, strategies to change acceptance behavior could be ineffective (Kukafka et al., 2003).

In unrelated work, Fonnesbeck (2003) observed the same tendencies after reviewing the literature in the fields of innovation and information technology adoption, diffusion of innovation, organizational change, and organizational learning. He subsequently identified four areas in which managers can influence the implementation of technology: operating capability, adoption, integration, and organizational inertia. These areas are similar to the three factors identified by Kukafka et al. (2003). Fonnesbeck (2003) subsequently used system dynamics theory to capture the combined behavior of the four areas he identified. This was based on Meadows' (1980) conclusion that "the persistent dynamic tendencies of any complex system arise from its causal structure." Thus, the system dynamics methodology allows one to simultaneously model the relationships between many dependent variables with the use of feedback loops. Fonnesbeck (2003) referred to the model he developed as the Information Technology Implementation and Sustainment (ITIS) model, which he designed to specifically predict organizational behavior associated with information technology implementation and sustainment.

Fonnesbeck's (2003) model could be a powerful tool for any organization interested in improving their business processes; the insight gained through the use of the model would be invaluable and would help identify the factors critical to the successful implementation of new technology. As Laudon and Laudon (2004) point out, businesses today are built around information systems and the technology driving them. In order to stay competitive in the fast changing global economy, organizations will have to ensure the latest information technology systems are implemented and sustained.

Similar to the private sector, the Department of Defense (DoD) is continually implementing new technology in their operations. In fact, a current technological movement across the armed services is the implementation of geographical information systems (GIS) to improve information management. The GIS is a technology that has been evolving since the 1960s. With a GIS, data are spatially related to objects depicted on a map or photograph; this relationship combines the power of database manipulation with the visual effects of mapping and photography (Davis, 1990).

The United State Air Force began its centralized initiative to adopt GIS in 1995, calling the system GeoBase. The goal of GeoBase implementation goes beyond the acceptance of a new technology; it is a transformation in the way information is shared and used across each installation (National Geospatial Intelligence School, 2003a). This transformation will have a direct impact on many functions in the Air Force. Among other things, GeoBase supports daily and crisis operations across all base functions and organizations; it improves base planning activities and raises command and control situational awareness; and it integrates numerous nonspatial information systems with mapping capability to provide a single point of access to base information (Feinberg and Cullis, 2005).

To maintain an appropriate scope, this research will focus on the use of GeoBase in the base planning activities. Community planners ensure appropriate and comprehensive plans are developed, maintained, and implemented to optimize facility investments in support of their installation's mission requirements (Department of the Air Force, 1997). Since the planning function interacts with numerous other activities, the accuracy and timeliness of information generated by community planners are important. Therefore, the incorporation of new technology such as GeoBase is imperative.

In fact, the Air Force leadership recently emphasized the integration of GeoBase for general plans, which are abridged versions of comprehensive plans produced by the civil engineer function. Air Force guidance identified four portions within the general plan for which GeoBase should be used: land use plans, composite constraints and opportunities map, existing facilities maps, and five-year capital improvement plan (Fox, 2003). The GeoBase system lends itself to the realization of these planning goals because it is capable of taking many individual plans and integrating them into a general plan, which is subsequently used as a decision tool for Air Force leadership. GeoBase was specified because it will aid in-house updating of maps and databases, conserve limited resources, and increase accuracy.

1.2 Research Objective

During the development of the ITIS model, no empirical data were collected. As Fonnesbeck (2003) states, "Unfortunately in this system, there are no empirical data available, so other ways must be used to link variables together and define each variable range." Because of this drawback, the next step in implementing the model is to develop a survey instrument to collect empirical data which can be used as inputs to the model. This survey instrument will be based on the variable definitions in the ITIS model. By providing a tool that can be repeatedly and consistently used in many locations, the survey will also increase the reliability of the data collected.

The overarching goal of this research is to gain a better understanding of the factors impacting the implementation of new technology in an organization. With that in mind, there are four primary objectives associated with the research.

(1) Develop a survey instrument to collect empirical data which can be used as inputs to the ITIS model.

(2) Run the ITIS model with empirical data and compare the behavior predicted by the model with behaviors previously generated with hypothetical data.

(3) Evaluate the state of GeoBase implementation in the Air Force community planning function. Referring back to Rogers' (2003) four factors emphasized (innovation, communication, time and the social system) in his definition of diffusion, this research asks the following questions to determine the state of GeoBase implementation:

   a. Is the cultural environment of the community planner conducive to accepting new technology?

   b. Are community planners satisfied with the communication within their squadron?

   c. Do community planners have a positive perception of GeoBase?

   d. What is the percentage of community planners using GeoBase?

1.3 Methodology

To design the content of the survey, Fonnesbeck's (2003) ITIS model was reviewed to identify all input variables. The purpose of this review was to determine the theory and rationale supporting each variable. The review consisted of each variable's definition, range, and identification of any unique characteristics. Existing measures were then culled from the literature to evaluate the theory supporting each variable. The resulting survey instrument was administered to the entire population of Air Force community planners. Analysis of factor reliability will be conducted on the new instrument. Survey results will be aggregated through statistical analysis. A developed utility function will be used to covert the aggregated results into the appropriate value for the variables in the ITIS model. Because the survey is made from existing questionnaires, separate sections of the survey can be evaluated and indicate a qualitative values correlating to research objective 3.

1.4 Limitations and Assumptions

The first limitation in this research is building a survey of reasonable length. The ITIS model contains numerous inputs, combining full length questionnaires for each input into one survey would result in an unreasonably long survey, which could decrease response rates. Consequently, only those inputs from existing questionnaires that were deemed to be most significant in the ITIS model were captured in the survey. After survey results are obtained, it is important to remember, this research is only one step toward building confidence in Fonnesbeck's ITIS model. The model will require additional testing before the model can be considered operational. Generally, to achieve reliable survey results, large sample sizes are desirable. However, this research is limited by the size of the Air Force. The target population will consist of the community planners in all of the 60 main operating bases within the continental United States. It is safe to assume this research will not achieve 100% response rate. Consequently, the number of responses will be less than 60 which is considered a small sample for statistical analysis. Because system dynamics models require a general understanding of both system thinking and system dynamics software operations, use of a model based on system dynamics will be limited.

II. Literature Review

2.1 Introduction

This chapter briefly discusses the development of the Information Technology Implementation and Sustainment (ITIS) model (Fonnesbeck, 2003); this includes a review of various theories regarding the implementation of new technology as well as a description of the systems dynamics methodology. With the structure of the ITIS model established, the chapter then explores various measures reported in the literature and the suitability of those measures for use in this research. Finally, the general application area for this research is presented, which consists of the geographical information systems (GIS) field. This is followed by a discussion of the specific application area: GeoBase software used in the community planning function within Air Force civil engineering organizations.

2.2 ITIS Model Development

The ITIS model development was based on current theories and models that attempt to explain the likelihood, rate, and success of new information technology acceptance. As mentioned in Chapter 1, Kukafka et al. (2003) concluded that many of the current theories focused on one of three factors: organizational, technological, or individual. This conclusion was reached after review of the following theories and models: Diffusion of Innovation, Theory of Reasoned Action, Theory of Planned

Behavior, Technology Acceptance Model, Social-Cognitive Theory, and Task-Technology Fit Model. Diffusion of Innovation (Rogers, 2003) and Technology Acceptance Model (Davis, 1989) are introduced below because they play a major role in the ITIS model. The ITIS model was developed with all three factors in mind, thus it combined theories addressing individual, technological, and organizational influences on information technology acceptance. A brief discussion of these theories and models will be presented, followed by a review of the ITIS model.

2.2.1 Influential Theories

Rogers' (2003) Diffusion Theory was developed while studying Iowa farmers and their acceptance of new agricultural products. The diffusion theory is built on four main factors: innovation, communication channels, time, and social system. It was found that the diffusion of innovation followed an S-shaped curve, whether studying agriculture, education, public health, or a whole host of other areas. "The multidisciplinary nature of diffusion research cuts across various scientific fields. A diffusion approach provides a common conceptual ground that bridges these divergent disciplines and methodologies" (Rogers, 2003:103).

Kotter (1995) studied corporate change efforts for more than ten years and developed a short list of eight items which he considers necessary in transforming an organization. Attempting to skip any one of these steps will lead to failure for the organization. The eight items are: establishing a sense of urgency, forming a powerful guiding coalition, creating a vision, communicating the vision, empowering others to act on the vision, planning for and creating short-term wins, consolidating improvements and producing still more change, and institutionalizing new approaches.

Reengineering the corporation sounds like a thing of the past; however, Hammer and Champy (2001) revisit it and present contemporary examples of its use. Reengineering is the process of reviewing your fundamental processes, identifying the root of any problem, making dramatic change, and being process-oriented. Reengineering may appear very risky; but if the rules are followed, mistakes can be avoided and success is very likely (Hammer and Champy, 2001).

2.2.2 Influential Models

"A model specifically tailored for modeling user acceptance of information systems is the Technology Acceptance Model" (TAM) (Davis et al., 1989:985). This model is useful in tracking the impact of external forces on internal beliefs, attitudes, and intentions. Two main information systems acceptance behaviors influenced are perceived usefulness and perceived ease of use (See Figure 2.1). Perceived usefulness is the belief that using the system will increase job performance, while perceived ease of use is the degree the user expects the system to be free of effort.

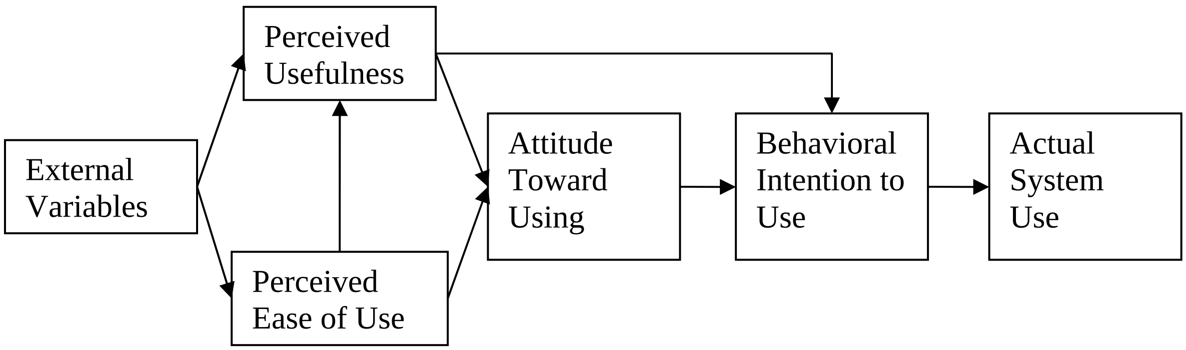
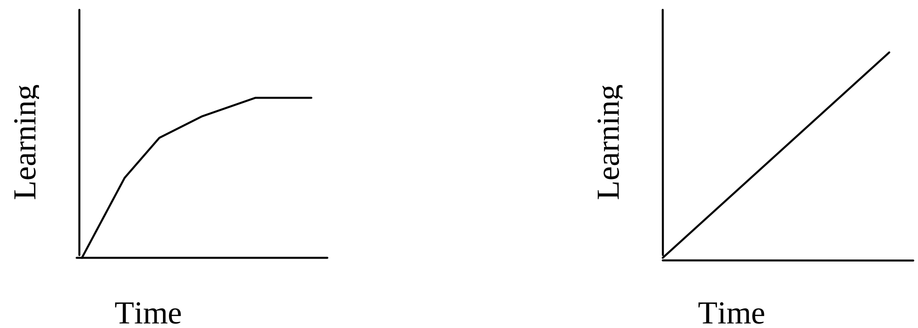


Figure 2.1: Technology Acceptance Model (Davis et al., 1989:985)

An organization can and should learn as it ages. Cunningham (1999) presents the learning problem common in Western companies and models it as shown in Figure 2.2. In the Western mindset, it is assumed an employee will learn when he is new and his learning plateaus in the future. Organizations can overcome this model of learning, but it is a tricky task. The Japanese, on the other hand, have a Zen-basis perspective of learning which views learning as a perpetual process.



Western Model (Cunningham, 1999:48) Japanese Model (Fonnsebeck, 2003:66)

Figure 2.2: Western and Japanese Learning Models

As organizations accept new technology and processes, there is initial momentum influencing the change. This momentum can be positive or negative, and both can exist at the same time. Huff et al. (1992) illustrates this concept in Figure 2.3. They refer to the positive momentum as inertia and the negative momentum as stress. Inertia and stress are not exact opposite of each other because they are influenced by many different factors. Inertia can come from the fact that an organization has committed time and resources to a process. Inertia is not always maintained by a conscious effort. Stress on the other hand is more often associated with specific events and it captures the attention of individuals in close proximity to it. “Stress accumulating over time is likely to lead more and more people in an organization to perceive the benefits of strategic renewal, in contrast to the processes that increase commitment to current strategy" (Huff et al., 1992:59).

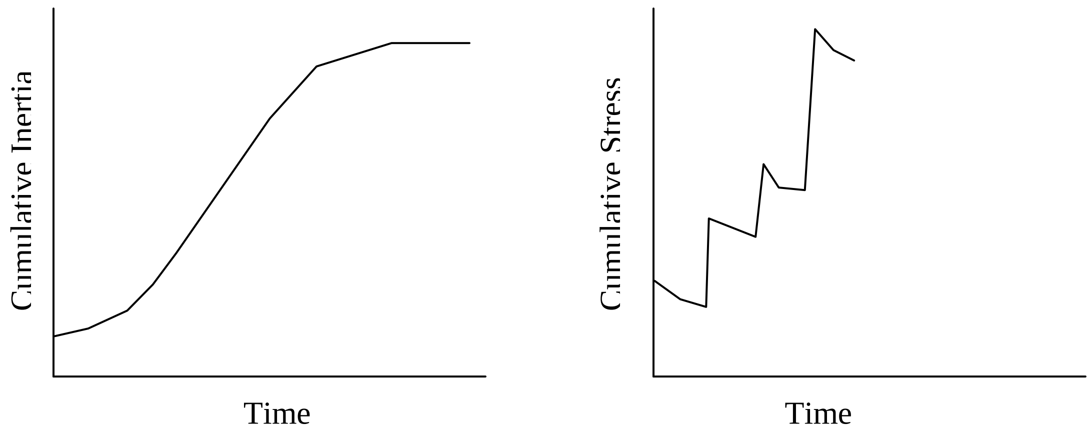


Figure 2.3: Inertia and Stress with Dissipation (Huff et al, 1992:57,59)

2.3 The Information Technology Implementation and Sustainment (ITIS) Model

The Information Technology Implementation and Sustainment model (Fonnesbeck, 2003) capitalizes on the capability of system dynamics modeling to take many different theories and combine them within one model (system dynamics modeling will be introduced in the next section). Characteristics from theories in organizational change, information technology implementation, and management intervention are incorporated in the ITIS model shown in Figure 2.4. The theories mentioned above have a common link: time. Each has a characteristic behavior over time and this is the element which makes each a good candidate for modeling in System Dynamics.

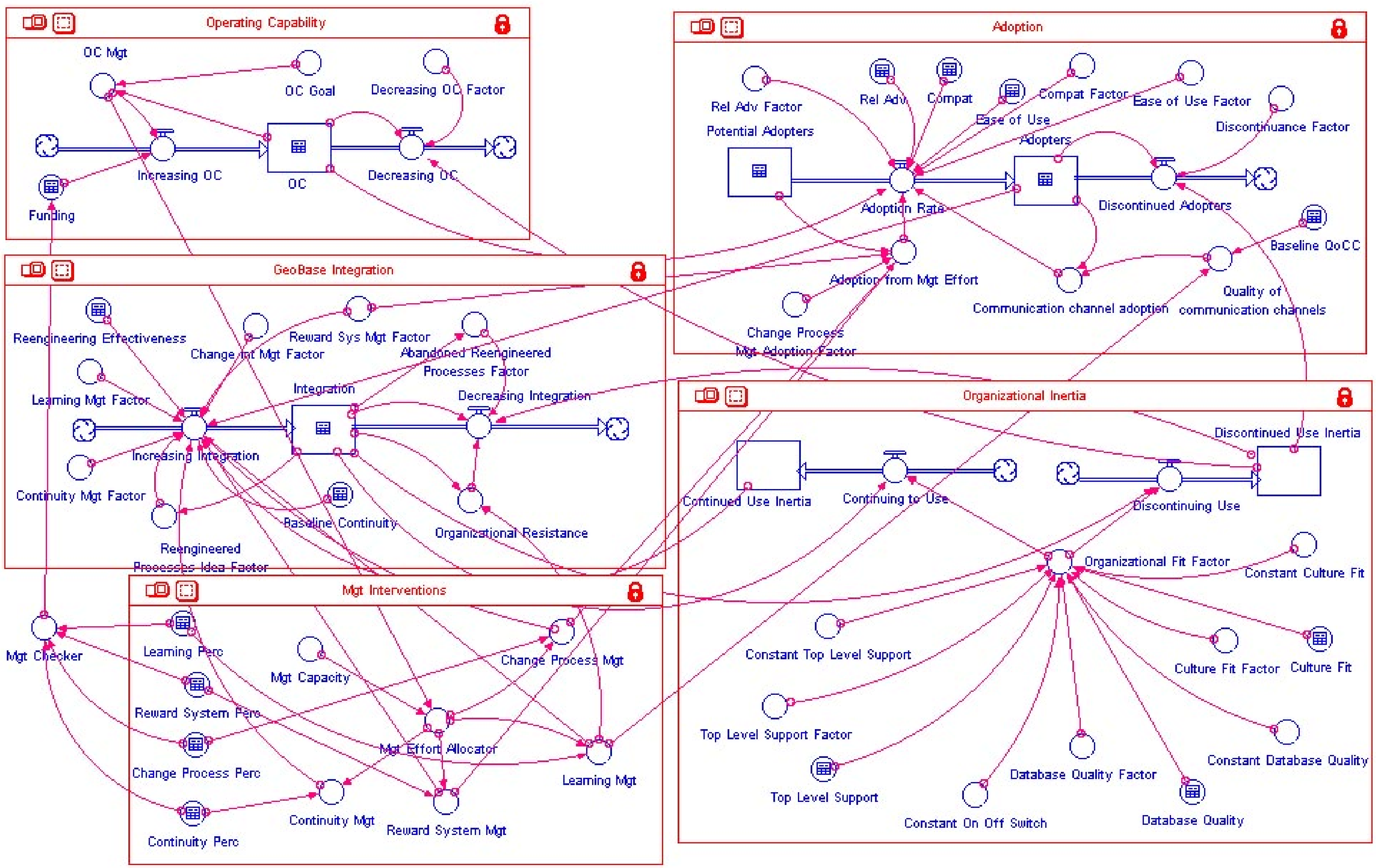


Figure 2.4: Information Technology Implementation and Sustainment (ITIS) Model (Fonnesbeck, 2003)

As can be seen in Figure 2.4, the ITIS model is very complex. However, the model does have logical divisions and relationships. Each major concept and its defining variables are contained in a logical grouping or sector of the model as indicated by the rectangular borders. These sectors help organize the remaining literature review. Taking the model one sector at a time, the significant literature influencing the development of each sector will be reviewed. The review starts with operating capability and progresses through adoption, GeoBase integration, organizational inertia, and management interventions.

2.3.1 Operating Capability

This sector of the model represents the operating capability of the organization (see Figure 2.5). Overall capability is defined by the amount of funding and the operating capability goal set by management. The operating capability is focused on tangible items such as software, hardware and printers or plotters.

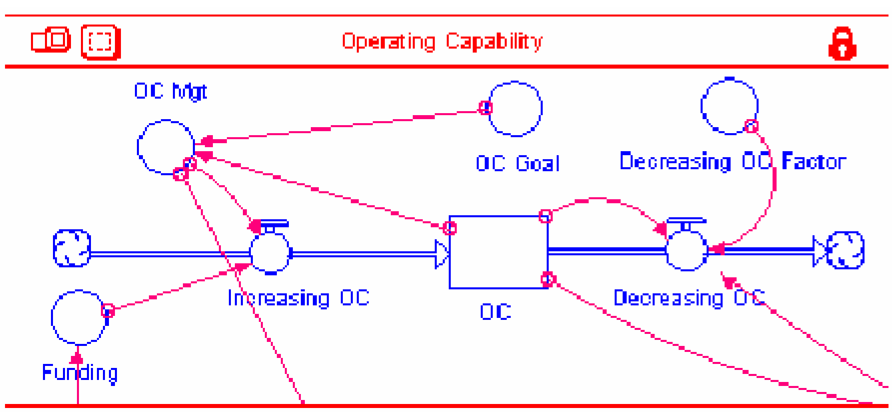


Figure 2.5: Operating Capability Sector (Fonnesbeck, 2003)

Funding and the operational capability goal (OC Goal) define the level at which operating capability starts and, in time, how fast it increases or decreases. These cause-and-effect relationships can be seen clearer in the accompanying causal diagram shown in Figure 2.6. The influences of the circles labeled Operating Capability Goal and Operating Capability converge on the Operating Capability Management Effort circle. Within the Operating Capability Management Effort circle, the two inputs are compared and a positive or negative value is generated. This value influences the Increasing Operating Capability circle. Also influencing the Increasing Operating Capability circle is the Funding circle. The Increasing Operating Capability circle combines the values from the two inputs and increases the value of Operating Capability. Because Operating Capability has a natural tendency to decrease when neglected by funding and management, the compensating loop for Decreasing Operating Capability exists. The boxes in Figure 2.6 show other sectors interacting with the Operating Capability sector. These sectors will be discussed as the literature review progresses.

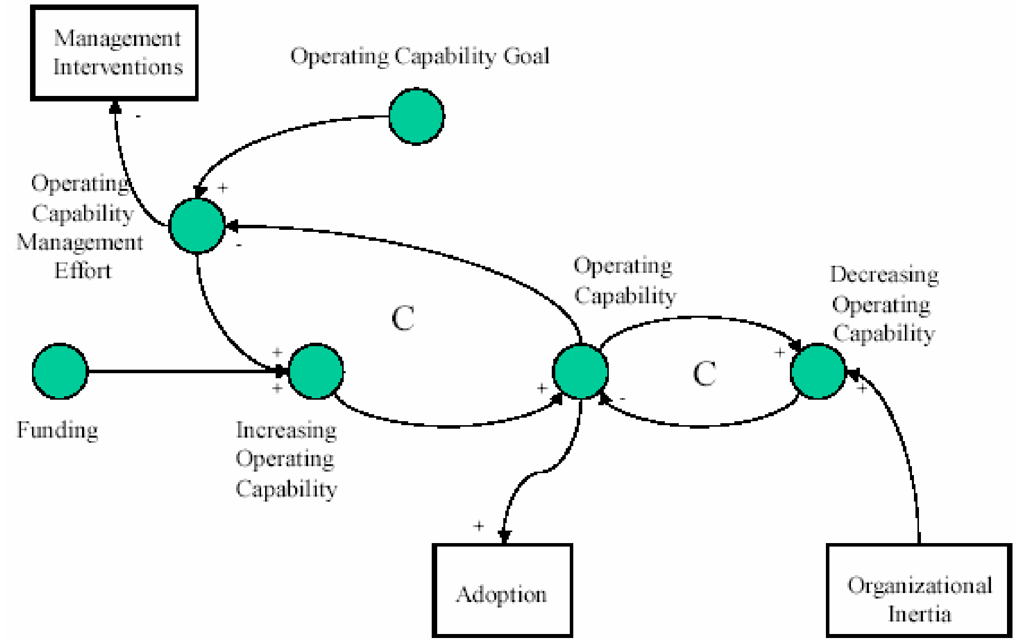


Figure 2.6: Causal Diagram, Operating Capability Sector (Fonnesbeck, 2003)

Geo InSight, a consulting company for businesses interested in implementing GIS, identifies several important managerial aspects common to information technology implementation. Throughout the implementation process of GIS, the manager has to be involved with many of the decision points; such as the decision to investigate GIS, the decision to proceed with detailed planning and design of the database, and the decision to acquire the GIS hardware and software. All of these decisions have to be backed by the necessary funds (*Geo InSight*, 2004). These critical factors are generic across the field of information technology implementation. Kotter (1995) in his list of "Eight Steps to Transforming Your Organization," also points out the importance of leadership behind organizational change. In the first step, he mentions the need to have or hire "real leaders" in senior-level jobs. These leaders are key in spreading the vision and setting the appropriate goals for the organization. The goals set and funding provided by the organization's leaders will set the stage for operating capability and influence the future increase or decrease of it.

2.3.2 Adoption

This sector of the model is focused on individual perception and acceptance of technology. Rogers (2003) places individuals in three categories during the implementation of technology: potential adopters, adopters, and discontinued users. The rate at which the potential adopters move to adopters is influenced by many factors. These factors are identified in Rogers (2003:11) definition of diffusion, "The process by which an innovation is communicated through certain channels over time among the members of a social system." The perception of the innovation, communication, and the social system factors, are reflected in the Adoption sector shown in Figure 2.7. To help interpret this sector of the model, the accompanying causal diagram is shown in Figure 2.8.

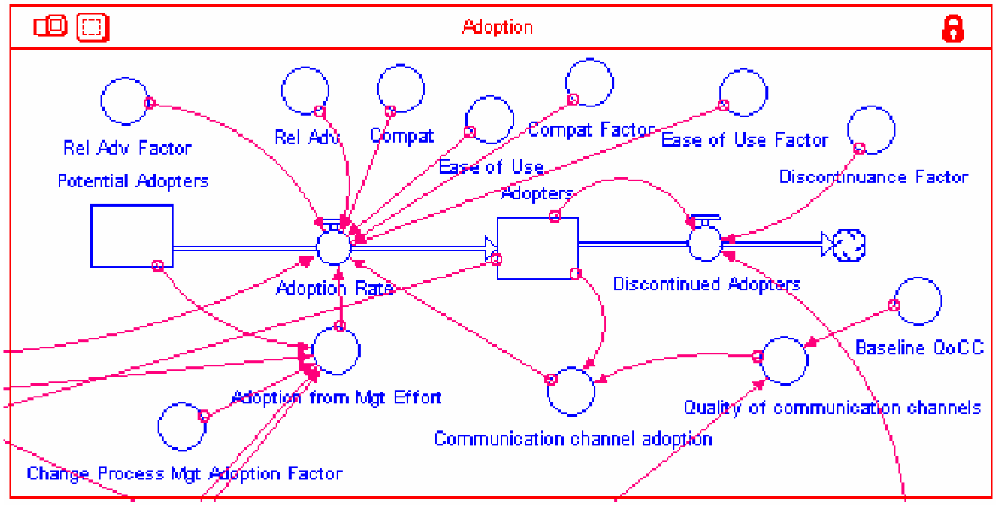


Figure 2.7: Adoption Sector (Fonnesbeck, 2003)

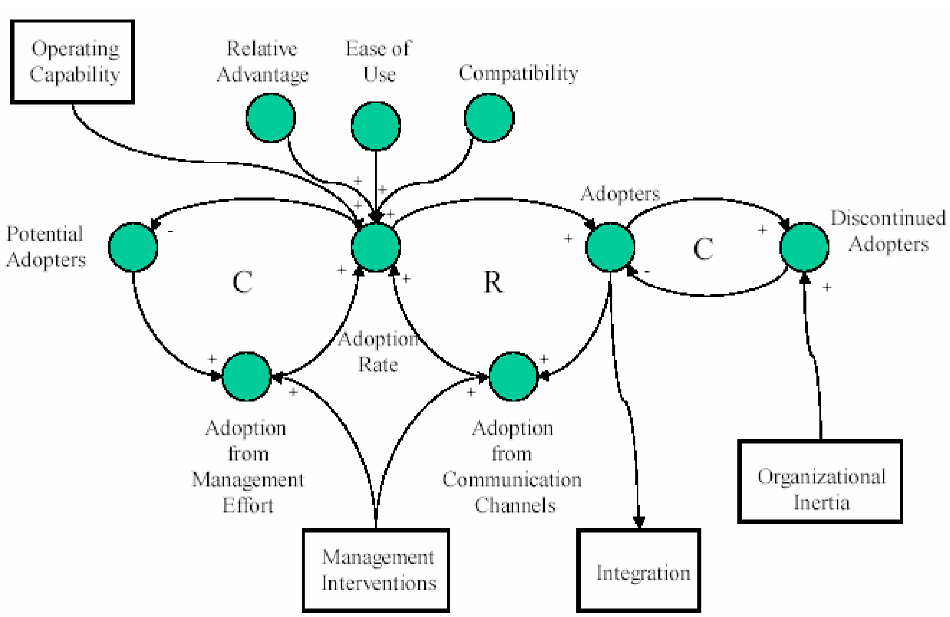


Figure 2.8: Causal Diagram, Adoption Sector (Fonnesbeck, 2003)

Overall perception of innovation is comprised of several perceptions: relative advantage, ease of use, and compatibility. Relative advantage, "the degree to which an innovation is perceived as being better than the idea it supersedes" (Rogers, 2003:229), is not necessarily an objective measure. What matters is the perception of the potential adopter. Relative advantage is not just an economical issue to the adopter; it can also be a status indicator. Adopters may be inclined to us the new technology because it projects an image they desire.

The Ease of Use factor comes from Davis' (1989) Technology Acceptance Model (TAM). This model was developed by Davis in 1986 specifically for the acceptance of computers (Davis, 1989). The TAM is based on two major constructs, perceived usefulness and perceived ease of use. Results from a study of MBA students' use of a new computer program during their four-semester program at the University of Michigan (Davis, 1989:997) indicate the model explained 45% of the variance at the beginning of the program and 57% by the end of the program. Davis (1989:997) states, "This is promising for those who wish to evaluate systems very early in their development and, cannot obtain extensive user experience with prototypes in order to assess its potential acceptability."

In information technology implementation, communication cannot be overlooked. When talking about communication, Rogers (2003) distinguishes between the source and the channel. The source is where the message is authored while the channel is the means in which the message is transferred. There are two basic types of channels, mass media and interpersonal. Mass media is most important at the start of information technology implementation. Mass media gets the message out far and wide. As technology implementation matures, interpersonal communication becomes the more important channel. At this interpersonal level, details and convincing testimonials are passed along between individuals who trust each other's opinions (Rogers 2003). Individuals also influence the organization as a whole; the next sector addresses the dynamics of the organization and integration of an information technology into the organizations processes.

2.3.3 GeoBase Integration

In this sector of the model, the focus is on the organization and its ability to change and accept a new technology. This is the heart of the model and the most aggregated part, combining many concepts such as business process reengineering, organizational learning and organizational resistance (Fonnesebeck, 2003) (see Figure 2.9). Turning to the causal diagram in Figure 2.10 will help guide the literature review covering this sector of the model.

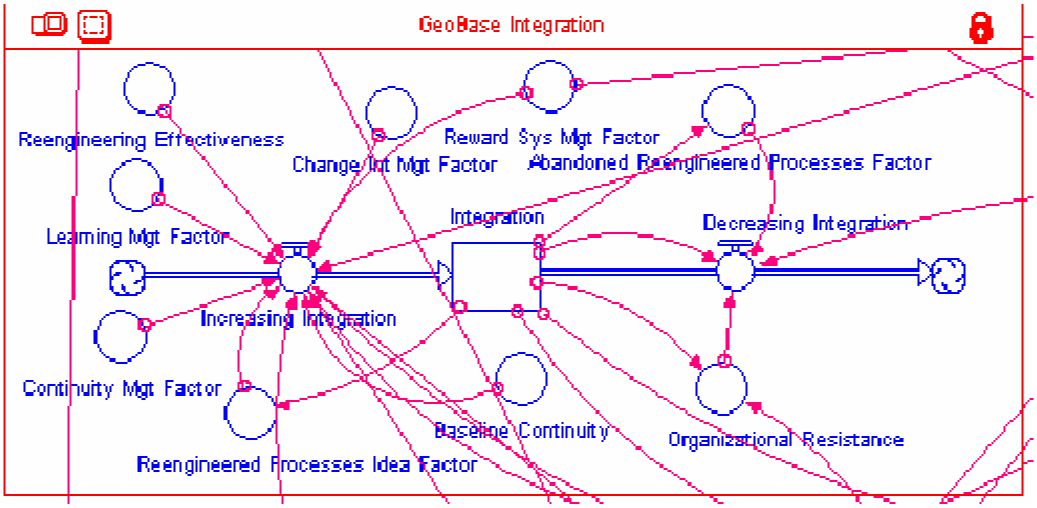


Figure 2.9: GeoBase Integration Sector (Fonnesbeck, 2003)

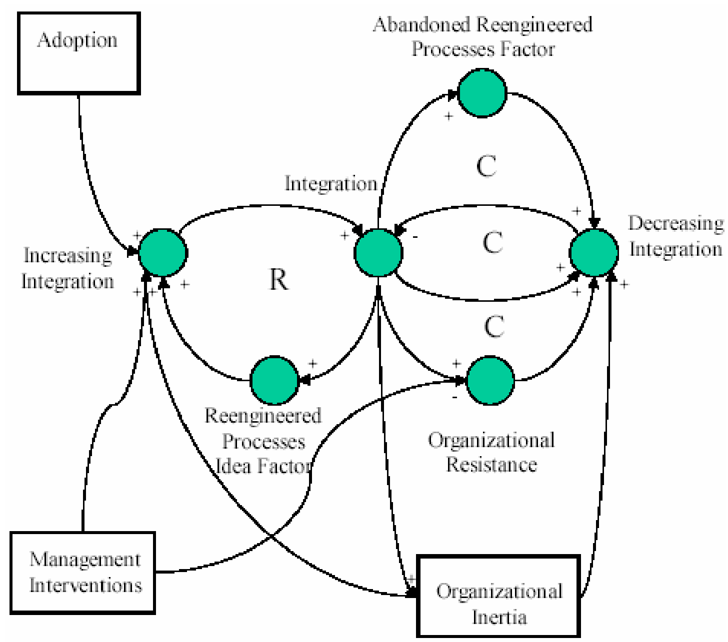


Figure 2.10: Causal Diagram, GeoBase Integration Sector (Fonnesbeck, 2003)

In general, the causal diagram for GeoBase Integration shows two influences acting on Integration, Increasing Integration and Decreasing Integration. There are many different ways to define and view these influences. Kotter (1995) observed both influences over a ten year period and concluded, of the many businesses attempting to change business processes, only few are successful. He also noted that the successful companies followed a systematic process with phases over long periods of time. It is critical for management to ensure their companies complete each phase. Skipping phases in an attempt to shorten the time needed to change can be fatal and render the implementation attempt unsuccessful.

In Hammer and Champy's 2001 book, "Reengineering the Corporation," they define the concept of reengineering as "the fundamental rethinking and radical redesign of business processes to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed" (Hammer and Champy, 2001:35). Within this definition, four points are key: addressing the fundamental question or problem; thinking in terms of radical gains, not merely modifications, or enhancements; seeking dramatic improvements because of need or foresight; and most importantly thinking in terms of processes not tasks or structure. Thinking in terms of process is very important because it can eliminate much of the supervision and overhead needed to keep a process running. Most companies today are influenced by Adam Smith's notion of breaking work into is simplest task and assigning a specialist to the task (Hammer and Champy, 2001). With new information technology, this notion can be reversed and simple tasks can be combined and one person, enabled by information technology, can handle a process just as efficiently as several specialist assigned to individual tasks.

Resistance to integration, represented in Figure 2.10 by the Decreasing Integration circle, is influenced by two forces, the resistance of organizational change and the abandonment of reengineering process. Organizational change is like trying to change the direction of a dense, moving object. The momentum and the direction the mass is traveling are not easy to change. Many articles have been written on steps and phases that need to be taken to change an organization. Armenakis and Bedeian (1999) reviewed theories and research accomplished on organizational change performed during the 1990s. In their review of process research, the articles reviewed focus on overcoming the resistance inherent to changing within an organization. According to Armenakis and Bedeian (1999), most of the theories they reviewed are loosely based on the work of Lewin in 1947 and include the phases introduced by Lewin: unfreezing, moving, and freezing. In literature, the many theories and their phases have a common goal: to overcome resistant to change. One of the most important elements each theory emphasizes is communication, at the individual level and at the organizational level. All the models Armenakis and Bedeian (1999) reviewed pertaining to process research included at least one phase focusing on communication.

Within organizational change is also resistance to continual learning; organizations have a tendency to decrease learning as they meet status quo. Cunningham (1999) compares the behavior of western learning to a curve with a gradual increase to steady state. This is because learning is viewed as a temporary process. For example, when new employees are hired, they will seek learning until they reach a point were they are comfortable with their knowledge and job performance. The decrease in learning results in resistant to change across the organization. Another influence on decreasing integration is the fact that not all information technology integration efforts are successful. Rogers (2003) identifies two types of rejection in the diffusion of innovations, active rejection and passive rejection. Active rejection is characterized by first considering the adoption, even to the point of a trial, then deciding not to move forward. Passive rejection is never seriously considering adoption. Once an innovation is adopted and implemented, the abandonment of the adoption is called discontinuance. The influence of resistance to change and abandonment of reengineering combine to decrease integration and in some cases can drive to the discontinuance of integration.

2.3.4 Organizational Inertia

In the ITIS model (Fonnesbeck, 2003), the concept of inertia in an organization is an aggregate of the environmental forces acting on it. Huff, Huff, and Thomas (1992) define organizational inertia as "the level of commitment to current strategy, reflecting individual support for a given way of operating, institutional mechanisms used to implement strategy, monetary investments and social expectations." In the ITIS model (Fonessebck, 2003), all these elements are represented. The previous three sectors have addressed the monetary commitment, individual perceptions, and organizational acceptance. This sector, shown in Figure 2.11, addresses how well the new technology fits the organizational culture and the influence of time and dedication the organization gives to the new information technology.

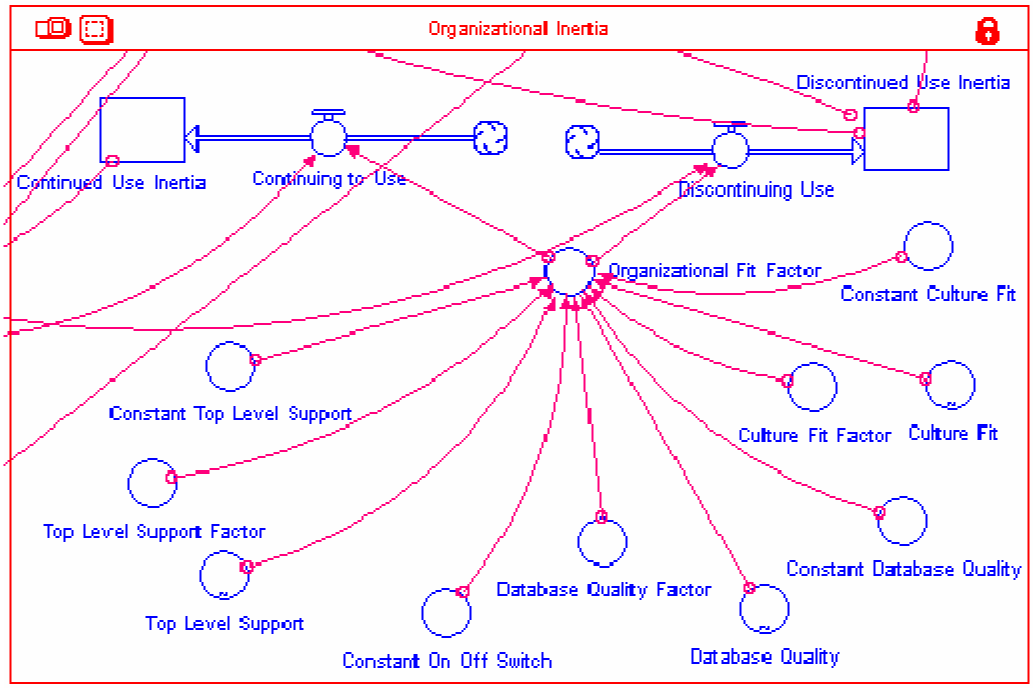


Figure 2.11: Organizational Inertia Sector (Fonnesbeck, 2003)

The commitment to strategy and monetary investment increases in time. In terms of technology implementation, as a new technology is used in an organization, it becomes the status quo. Individuals that may not particularly like the new technology, but are out-numbered by those that do, find themselves committed to it due to the fact they have become accustomed to the technology (Huff, Huff, and Thomas, 1992). The inertia behind a new technology has a tendency to continually increase simply because the organization is using it. In the causal diagram, Figure 2.12, the factors influencing Continued Use inertia and Discontinued Use inertia are identified.

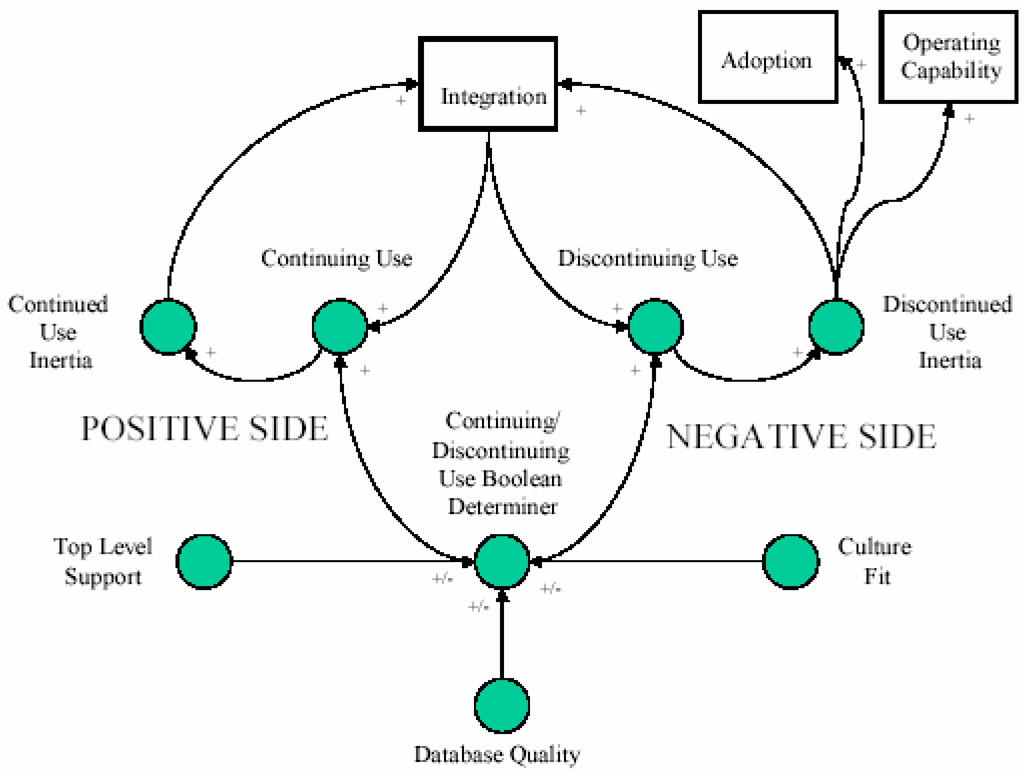


Figure 2.12: Causal Diagram, Organizational Inertia (Fonnesbeck, 2003)

In the Organizational Inertia causal diagram, there are three factors influencing inertia: culture fit, top level support, and database quality. The better the technology fits the organizational culture the more inertia that will be gained. It would seem there are some organizational cultures that would be more accepting of new information technology and its implementation. Fonnesbeck (2003) suggests that organizations can be rigid or innovative. Depending on the organization's cultural characteristics, they are more or less apt to gain continual use inertia.

Top level support from management is also a factor in inertia. The management in an organization can influence the inertia by their support given to implementation of new technology. Managers can range from antagonists to champions of the new technology. As literature indicates, a change process or diffusion of innovation cannot succeed without the support of leadership (Rogers, 2003; Kotter, 1995; Hammer and Champy, 1994).

Particular to the implementation of GeoBase is the quality of the data base. The use of a geographical information system cannot hope to gain inertia until the database is reliable. The better the database is constructed and populated with relevant information, the higher the quality of the database and the user is less apt to discontinue use of it. *Geo InSight* (2003) states that "database planning is the single most important activity in GIS development." Also emphasized by *Geo Insight* is the maintenance of the database once it is operational.

In the causal diagram shown in Figure 2.12, the three factors (cultural fit, database quality, and top level support) are combined and a determination is made whether the combined effect constitutes a positive inertia or a negative inertia. Depending on the determination, value is added to either the continue use inertia, indicating the technology implementation is gaining acceptance, or to the discontinue use inertia, indicating technology implementation is failing and headed to discontinuance. The separation of continue use inertia and discontinue use inertia is based on the fact that they can exist simultaneously (Huff, Huff, and Thomas, 1992).

Within the dynamics of the entire model's sectors, there is one area that can be directly influenced by design. This area is management intervention. Managers within the system have to identify the areas they can influence to obtain the most benefit for the organization. Because mangers have limited time and resources, a careful allocation of their time and efforts are needed. The following sector of the model provides the means to allocate management influence.

2.3.5 Management Interventions

Within the literature covered to this point, there have been many types of management strategies mentioned. All of the strategies have a common goal: to reduce the resistance to change, either as an organization or an individual. The model includes five factors to account for these management strategies: operational capability, learning, reward system, change process, and continuity. Operational capability was discussed in the first sector (see Figure 2.5). The remaining four are discussed in this sector (see Figure 2.13). For simplicity sake, we turn to the Management Interventions' causal diagram to review the literature for this sector (see Figure 2.14).

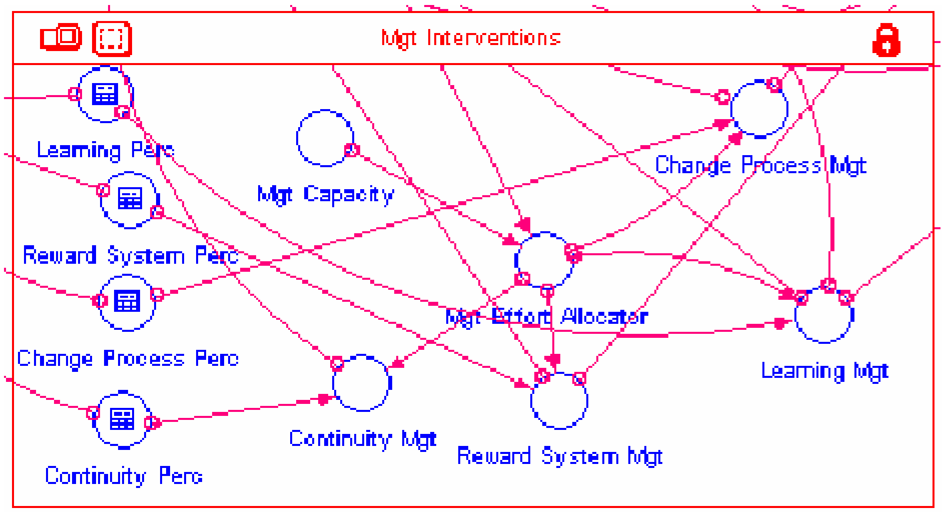


Figure 2.13: Management Interventions Sector (Fonnesbeck, 2003)

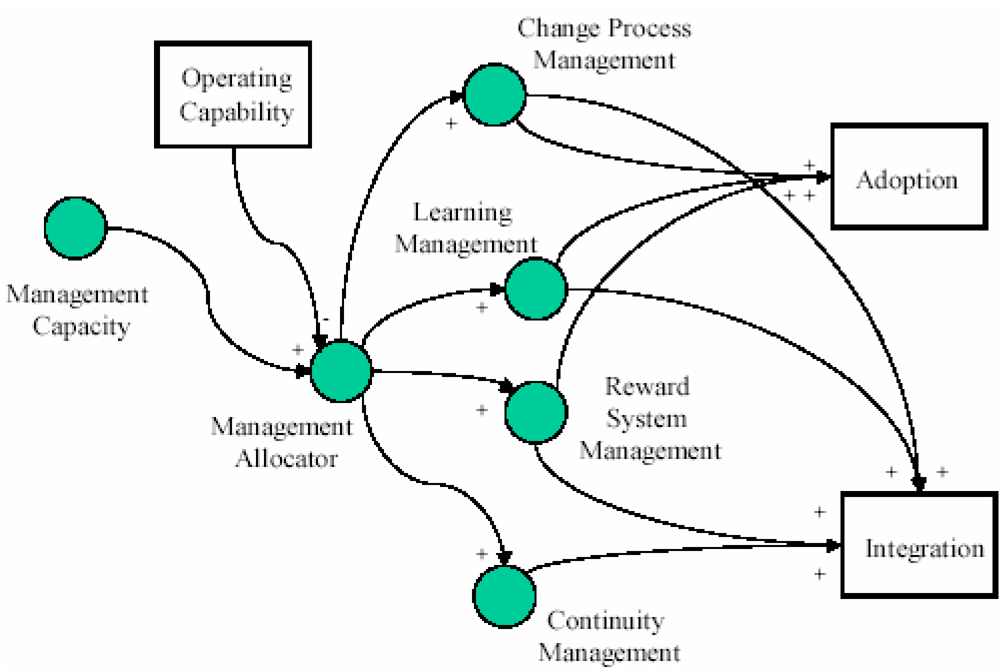


Figure 2.14: Causal Diagram, Management Interventions (Fonnesbeck, 2003)

In Figure 2.14, time is accounted for by the Management Capacity and Management Allocator factors. The modeler can capture the division of time a manager spends on each management strategy, not allowing the total time to exceed the management capacity. In the ITIS model (Fonnesbeck, 2003), the concept of change strategy comes from Hammer and Champy (2001), Kotter (1995), Rogers (2003), and Kim (1993). The time a manger spends in preparing the organization for change and breaking down the resistance to change is captured in this variable.

Learning management strategies are found in Kim (1993) and Cunningham (1999). Managers have to spend time ensuring the knowledge gained by individuals is passed onto the organization in some form. They also have to ensure the individual continues to learn; because it is possible for an individual to learn without the organization, but organizations cannot learn without the individual (Kim, 1993).

Another management strategy is the offering of rewards to encourage desired behavior. Reward system management is a short term, quick result type of management. The benefit of a reward program depends on the perceived benefit for the reward to an individual or organization. "Most organisms seek information concerning what activities are rewarded, and then seek to do (or at least pretend to do) those things, often to the virtual exclusion of activities not rewarded (Kerr, 2001)." In setting up a rewards system, the manager should seriously ponder the behavior desired then evaluate the organization and determine if the existing reward system is focused on these behaviors. In many cases, a reward system can unknowingly reward an undesirable behavior (Kerr, 2001). For example, the tendency for doctors to diagnose a healthy patient as being sick is more common than a sick patient being diagnosed as healthy. Doctors can be punished for diagnosing a sick person as healthy. Law suits will be brought against the doctor if serious illness occurs. On the other hand, if a doctor diagnosis a healthy person as sick, the medical industry will benefit from the profit on the cost of health care (Kerr, 2001). The bottom line is, reward programs can be beneficial. However, careful evaluation of their effectiveness is essential.

Moving on to the next management strategy, continuity management strategy is very common throughout the Air Force. In each office, a continuity folder is created. The extent of the information contained in the folder depends on the attention of the individual creating it and the manager's requirements. Unfortunately, continuity folders are seldom used to their full extent. Commonly, the folder is glanced over when a new individual is assigned to the office or during a desperate attempt to avoid "recreation of the wheel." Mangers must take time to address the continuity of information within their organization to avoid loosing ground in information technology implementation and sustainment.

2.4 System Dynamics Modeling

System dynamics, initially known as industrial dynamics and then managerial dynamics, has been around since the early 1970s; the name changes over the years reflect the expanding fields included in the discipline. Forrester and his colleagues at the Massachusetts Institute of Technology (MIT) have been the driving force behind this discipline and its expansion (Towill, 1993). "System dynamics is a method of dealing with questions about the dynamic tendencies of complex systems, that is, the behavioral patterns they generate over time" (Meadows, 1980:31), For example, the graph in Figure 2.15 shows both the desired and undesired behavior patterns of information technology implementation.

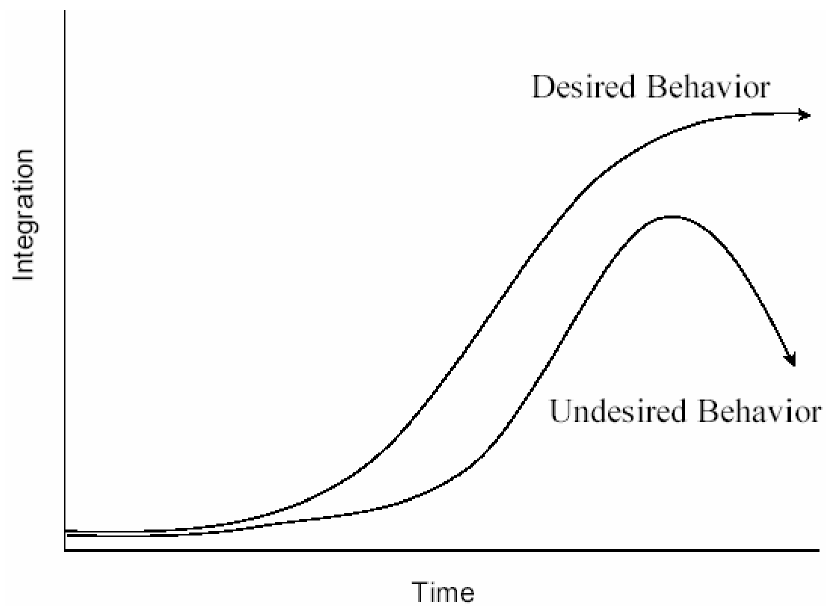


Figure 2.15: Integration Behavior Graph (Fonnesbeck, 2003)

In general terms, system dynamics models are developed by starting with a reference mode, "graphed behavior" as shown in Figure 2.15. Then the system to be modeled is considered, and boundaries are defined around significant factors (see Figure 2.16) which have cause-and-effect relationships. The cause-and-effect relationships are illustrated in a causal diagram. Finally, the relationships are programmed into a system dynamics software program; resulting in a functioning model. As this system dynamics discussion progresses, it will cover boundary setting and three necessary thinking skills, causal, operational, and closed-loop.

System dynamics models are best suited for investigating the long term behavior of a system. To produce the projected behavior, the methodology focuses on feedback loops and cause-and-effect relationships instead of the various statistical methods used in other research. This characteristic makes it possible to use simulations to identify the elements in a system having the most influence on the system's behavior. Towill (1993) states, "We should be aiming to use the simulation tools of system dynamics for ...exploring limiting behavior in scenarios beyond the experience of the 'problem owner.'"

To better understand the structure and advantages of system dynamics modeling, system thinking is required (An Introduction to Systems Thinking, 1997). An important component of system thinking is having the right vantage point or perspective (An Introduction to Systems Thinking, 1997). The goal is to avoid being too close, where the view of the system is lost, while not backing too far out, where the details of the individual factors are no longer discernable. The correct perspective is a bifocal one so that an individual can clearly see the trees while simultaneously being able to see the forest (An Introduction to Systems Thinking, 1997). In other words, a system can be simplified by drawing boundaries around significant factors to help eliminate unnecessary "noise." Choosing a perspective and boundary is an iterative effort leading to the simplest representation of the system. As shown in Figure 2.16, the systems boundaries for the ITIS model (Fonnesbeck, 2003) have been limited to the dynamics within an Air Force squadron, thereby eliminating the influence from higher headquarters organizations and the overall organizational culture within the Air Force.

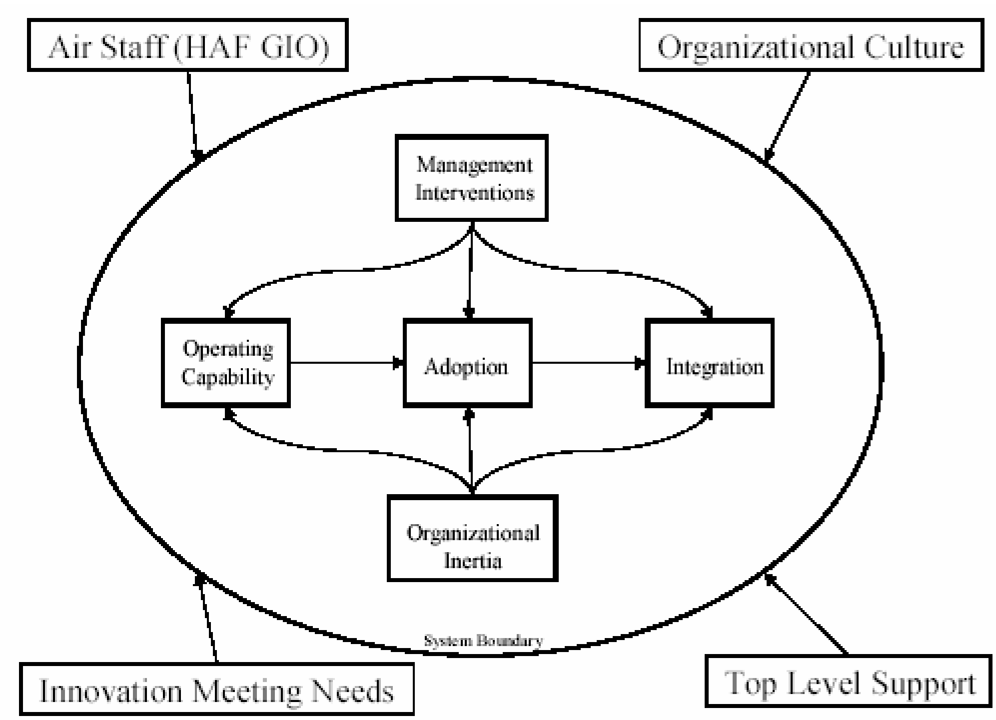


Figure 2.16: System Boundaries (Fonnesbeck, 2003)

Another important aspect of system thinking is the incorporation of three thinking skills: causal, operational, and closed-loop (An Introduction to Systems Thinking, 1997). Causal thinking helps one better understand the relationships between factors in the system being explored and determine which factors to include in the model. Once boundaries have been drawn, the dynamics of the model are driven solely by the factors inside the boundary. "It is unnecessary to invoke any forces from outside the boundary in order to 'drive' the system's dynamics" (An Introduction to Systems Thinking, 1997).

The second important skill in systems thinking is operational thinking, which is the ability to look at a system and view it as it really works. For example, the production of milk is not caused by technology but by cows. Technology may effect the farmer's interaction with his cows, but the cows actually produce the milk and have to be represented in the system's model (An Introduction to Systems Thinking, 1997). Operational thinking focuses on structures that reflect the physical operation of the system and does not use econometric explanations, such as historical regression models or abstract relationships, to describe the system. The goal of operational thinking is to gain a deeper understanding of causal relationships and their influence in a system. With this deeper understanding, there is a better chance of making effective changes to the modeled system.

The third thinking skill, closed-loop thinking, helps ensure that "no absolute distinction is maintained between cause and effect" (An Introduction to Systems Thinking, 1997:2-11). In a closed-loop system, no single factor dominates all the time; as time passes, the dominant factor can shift and change. To illustrate this concept, a simple closed-loop system is shown in Figure 2.17. In this closed-loop system, it is possible for the Increasing Integration loop to dominate Integration, and with a change in time the combination of the Organizational Resistance and Decreasing Integration loops may become dominant. Each loop is designated an R or C to indicate its characteristic effect on Integration. R indicates a reinforcing of Integration; if Integration increases, a reinforcing loop will respond by adding to integration. C indicates a counteracting loop; as integration increases, the counteracting loops will respond by subtracting from Integration.

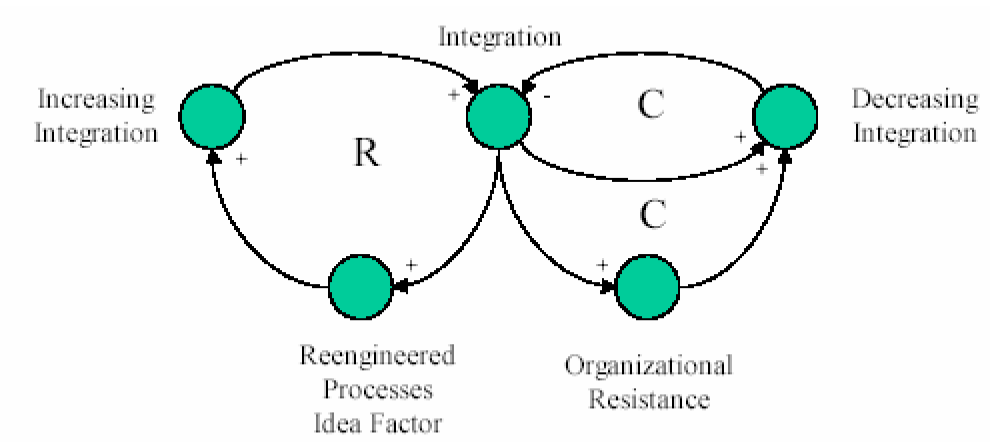


Figure 2.17: Simple Closed-loop System (Fonnesbeck, 2003, 125)

Referring back to Figure 2.15, the desirable integration behavior depicts the compensating loops, over time, countering the reinforcing loop and approaching steady state. If the compensating loops overpower the reinforcing loop, the undesirable behavior is produced.

2.5 Measures and Constructs

The review of the theories and questionnaires for building the ITIS data collection instrument will follow the same format as followed in the ITIS model review; relevant literature will be covered sector-by-sector. However, operational capability is not included because there was no additional literature reviewed for the sector. Chapter 3 will cover the origin of the measures for operational capability. Therefore, this review starts with adoption followed by GeoBase integration, organizational inertia, and management interventions.

2.5.1 Adoption: Data Collection

In 1991, Moore and Benbasat developed an instrument to measure the perceptions of adopting an information technology innovation. Their final instrument included the following constructs: voluntariness, relative advantage, compatibility, image, ease of use, result demonstrability, visibility, and trialability. The development of their instrument was motivated by the fact that over the past twenty five years many instruments have been used but most fall short when it comes to reliability (Moore and Benbasat, 1991). Their instrument was developed by starting with five characteristics of innovation derived by Rogers in 1983: relative advantage, compatibility, complexity, trialability, and observability. Moore and Benbasat (1991) note others have used Roger's five perceived characteristics of innovation (Ostlund, 1969; Bolton, 1981; Holloway, 1977); however, all of their instruments needed further development to increase their reliability. The other model used in the development of Moore and Benbasat's (1991) instrument is the Technology Acceptance Model developed by Davis (1989). Davis' model includes two constructs, perceived usefulness and perceived ease of use. Moore and Benbasat (1991) choose to use relative advantage from Rogers instead of usefulness because it is more generalizable and the new innovation has to be considered relative to the old technology it is replacing. Ease of use was added to Moore and Benbasat's instrument as well as image and voluntariness. Moore and Benbasat developed their instrument by identifying perceived characteristics of innovation; then a panel of judges sorted the items into similar categories; and finally an instrument was developed for testing. Table 2.1 below shows the final number of items in the instrument and their corresponding alpha values.

Table 2.1: Alpha Coefficients of Short Scales (Moore and Benbasat, 1991:211)

CONSTRUCT	ITEMS	ALPHA
Relative Advantage	5	0.90
Compatibility	3	0.86
Ease of Use	4	0.84
Result Demonstrability	4	0.79
Image	3	0.79
Visibility	2	0.83
Trialability	2	0.71
Voluntariness	2	0.82
Total Number of Items	25	

In information technology implementation, communication cannot be overlooked. To measure the quality of communication in both the organization and between individuals, a long used instrument can be depended on. The Communication Satisfaction Questionnaire has been the basis for 30 PhD dissertations and MA theses; it has also been administered in several foreign countries (Clampitt and Downs, 2004). Downs and Hazen (1977) developed the Communication Satisfaction Questionnaire consisting of eight dimensions of communication satisfaction: (1) Satisfaction with communication climate encompasses both the organizational and individual level of satisfaction. Communication climate indicates how the level of communication motivates the workers to meet established goals as well as the health of employees' attitudes toward communication within the organization. (2) Satisfaction with the communication with supervisors includes both upward and downward communication. It indicates how accepting supervisors are of information coming from subordinates, and if information is being distributed from the supervisor downward. (3) Satisfaction with organizational integration is built on the degree of information an individual is getting about their immediate environment, such as plans within the department and other personal news. (4) Satisfaction with media quality addresses the amount of communication present and the quality of the communication channels, such as meetings, written directives, etc. (5) Satisfaction with horizontal and informal communication concerns how well the "grapevine" is developed and accurate. (6) Satisfaction with organizational perspective is based on the receipt of information about the organization as a whole; this includes information on financial standings, strategic plans, and missions. (7) Satisfaction with communication with subordinates focuses on the subordinates' abilities to anticipate and pass needed information to the supervisor. (8) Satisfaction with personal feedback includes the subordinate's need to know how he or she is doing and how the supervisor is judging their performance.

Downs and Hazen (1977) concluded that communication satisfaction was a multidimensional construct, the factor analyses in different organizations indicated stability among the factors, and "the various dimensions of communication satisfaction can provide a barometer of organizational functioning, and concept of communication satisfaction can be a useful tool in an audit of organizational communication" (Downs and Hazen, 1977:72). Downs and Hazen (1977) administered their questionnaire twice, one week apart to the same twenty subjects, and report the reliability on the Communication Satisfaction questionnaire as 0.94. Gray and Laidlaw (2004) also concluded, after evaluating the content adequacy of the instrument, the Communication Satisfaction Questionnaire is a "valid measure of communication satisfaction."

2.5.2 GeoBase Integration: Data Collection

Recently, an instrument to measure the readiness of an organization to change was developed by Holt (2003). Lawin (1947) identified three phases of change readiness, adoption, and institutionalization. Holt (2003) reasons, although all three stages are important, readiness has been underemphasized in literature. His review of existing instruments measuring readiness for change lead him to believe they needed further development to ensure their reliability and validity. A reliable instrument can be helpful to leaders; it can help them understand the readiness of their organization for change and focus their efforts, within the change process, on the areas in most need of their attentioin. Holt's instrument looks at many disciplines, captures their perception of readiness to change, and submits them to the rigorous process examining content validity, construct validity, predictive validity, and reliability. In the development of his instrument, over 900 practitioners participated from a wide range of disciplines, both the public and private sector (i.e., educational, human resource, management, and engineering). Practitioners were involved through four studies accomplished during the instrument development: (1) inductive identification of the themes related to individuals' readiness for change, (2) empirical identification of the most influential readiness for change themes, (3) item development and content validity assessment, and (4) questionnaire administration and refinement. Holt (2003:222) defines readiness for change as "a comprehensive attitude that is influenced simultaneously by these factors; that is, it is influenced by the content (i.e., what is being changed), the process (i.e., how the change is being implemented), the context (i.e., circumstances under which the change is occurring), and the individuals (i.e., characteristics of those being asked to change) involved that collectively reflect the extent to which an individual or a collection of individuals is cognitively and emotionally inclined to accept, embrace, and adopt, a particular plan to purposefully alter the status quo." Through his research, he identifies four factors: (1) appropriateness, (2) management support, (3) change efficacy, and (4) personal valance. During the first distribution of the questionnaire, Holt reports achieving alphas of 0.93, 0.86, 0.81, and 0.64, respectively. On the second distribution of the questionnaire, alphas were reported at 0.80, 0.79, 0.79, and 0.65, respectively. Holt identifies the fact that this instrument was developed during an ongoing change in the organization to which some of the practitioners belong. There may be some error introduced due to the fact that managers within the organization were taking steps to promote organizational change. However, the factors still effectively measure readiness for change and should not be discarded.

Another aspect of organizational change in the ITIS model (Fonnesbeck, 2003) is organizational learning. Organizations cannot learn without the individual. Individuals gain new knowledge and share it throughout the organization. If the organization's system in which the knowledge gained by an individual is incapable of passing it on or storing it, the organization will not learn (Kim, 1993). Continuity within the organization will be lost and much effort will be spent learning things over and over again. Templeton et al. (2002:189) define organizational learning as "the set of actions (knowledge acquisition, information distribution, information interpretation, and organizational memory) within the organization that intentionally and unintentionally influence positive organizational change." Their definition was synthesized from 78 definitions identified through ontological specifications. Through Templeton's et al. (2002) research, three objectives were met: (1) a conceptual definition of organizational learning as stated above, (2) an empirically reliable and valid measure, and (3) norms for benchmarking. The instrument development was approached by using a common paradigm used in Management Information Systems and proposed by Churchill (1979), which include four phases: (1) Construct domain specification, (2) construction of items, (3) data collection, and (4) measure purification. These four phases insure validity and reliability of the instrument. In addition to Churchill's paradigm, the instrument development was augmented by Malhotra and Grover's (1998) Ideal Survey Attributes (ISA) as shown in Table 2.2.

Table 2.2: Ideal Survey Attributes (Malhotra and Grover, 1998)

General	
ISA-1	Is the unit of analysis clearly defined for the study?
ISA-2	Does the instrumentation consistently reflect that unit of analysis?
ISA-3	Is the respondent(s) chosen appropriate for the research question?
ISA-4	Is any form of triangulation used to cross-validate results?
Measurement Error	
ISA-5	Are multi-item variables used?
ISA-6	Is content validity assessed?
ISA-7	Is field-based pretesting of measures performed?
ISA-8	Is reliability assessed?
ISA-9	Is construct validity assessed?
ISA-10	Is pilot data used for purifying measures?
ISA-11	Are confirmatory methods used?
Sampling Error	
ISA-12	Is the sample frame defined and justified?
ISA-13	Is random sampling used from the sample frame?
ISA-14	Is the response rate over 20 percent?
ISA-15	Is nonresponse bias estimated?
Internal Validity Error	
ISA-16	Are attempts made to establish internal validity of the findings?
Statistical Conclusion Error	
ISA-17	Is statistical power sufficient?

The final survey instrument has eight constructs, all but one showing acceptable levels of validity and reliability (alpha above 0.5 for exploratory research): (1) awareness, (2) communication, (3) performance assessment, (4) intellectual cultivation, (5) environmental adaptability, (6) social learning, (7) intellectual capital management, and (8) organizational grafting. Templeton et al. (2002:199) report alphas of 0.86, 0.85, 0.76, 0.69, 0.74, 0.66, 0.52, and 0.46, respectively. Some of the limitations of this research are the fact that participants were mainly top level managers and the data comes from only the Hunstville, Alabama, area.

2.5.3 Organizational Inertia: Data Collection

In the ITIS model (Fonnesbeck, 2003), organizational inertia is driven by three main factors: top-level support, cultural fit, and database quality. There has been research on organizational culture and instruments developed to gauge the characteristics of organizational culture and its relation to organizational behaviors. In 1991, Quinn and Spreitzer studied the psychometrics of the competing values culture instrument (Denison and Spreitzer, 1991) and analyzed the impact of organizational culture on quality of life. In their research, they compare two instruments used to evaluate organizational culture. The first instrument, developed by Cameron (1978), uses four scenarios correlated with Group Culture, Developmental Culture, Hierarchical Culture, and Rational Culture. Respondents are asked to divide 100 points between the four quadrants indicating their organization's characteristics. This method is a fixed-choice method and the measures are perfectly correlated with each other. Because each measure is dependent on the other, this method is not suitable for factor analysis or regression analysis. The second instrument contains the same constructs as the first but is designed to use a Likert scale. The second method, developed by Quinn and Spreitzer (1991), maintains the independence of each measure and traditional statistical analysis can be performed on the gathered data. This method also captures a more realistic culture description; the four quadrants can be high, low or any combination in-between (Quinn and Spreitzer, 1991). Reliabilities for the second instrument (Likert scale) are: Group Culture (0.84), Developmental Culture (0.81), Hierarchical Culture (0.77), and Rational Culture (0.78) (Quinn and Spreitzer, 1991). In 1999, McDermott and Stock's research on

"Organizational Culture and Advanced Manufacturing Technology Implementation" (AMT) was published. They use the competing values framework to evaluate organizational culture in the success of AMT implementation. McDermott and Stock (1999) refer to Schein for the definition of organizational culture, "a pattern of basic assumptions-invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration—that has worked well enough to be considered valid and, therefore, to be taught to new members as the correct way to perceive, think, and feel in relation to those problems" (Schein, 1985:9). Using the questionnaire published in Quinn and Spreitzer (1991), McDermott and Stock (1999) collected data from eleven different industries to increase the generalizability of the research. They hypothesize that organizations that are characterized to have a developmental culture or rational culture will be positively related to AMT implementation satisfaction. Surprisingly, neither are positively related and results show it is the group culture that is positively related to implementation satisfaction. They explain that developmental culture and rational culture, although externally focused, may be looking for quick tangible results from AMT implementation and will not be satisfied if results are not quickly realized. On the other hand, group culture is characterized with attributes such as concern, commitment, morale, discussion, participation, and openness. Many of these attributes go along with a long term implementation of new technology which may have a time lag between implementation and visible results (McDermott and Stock, 1999). Kalliath et al. (1999) performed additional analysis of the competing values instrument developed by Quinn and Spreitzer (1991) using structural equation modeling (SEM). Kalliath et al. (1999) altered the original model (see Table 2.3), resulting in the model shown in Figure 2.18.

Table 2.3: Competing Values Framework Comparison

Quinn and Spreitzer (1991:118)	**Kalliath et al. (1999:146)**
Group Culture	**Human Relations Model**
- Participation, open discussion	- Teamwork
- Empowerment of employees to act	- Participation
- Assessing employee concerns and ideas	- Empowerment
- Human relations, teamwork, cohesion	- Concern for ideas
Developmental Culture	**Open System Model**
- Flexibility, decentralization	- Flexibility
- Expansion, growth, and development	- Growth
- Innovation and change	- Innovation
- Creative problem solving processes	- Creativity
Hierarchical Culture	**Internal Process Model**
- Control, centralization	- Centralization, control
- Routinization, formalization and structure	- Routinization, formalization
- Stability, continuity, order	- Stability, continuity, order
- Predictable performance outcomes	- Predictable performance outcomes
Rational Culture	**Rational Goal Model**
- Task focus, accomplishment, goal achievement	- Task focus
- Direction, objective setting, goal clarity	- Goal clarity
- Efficiency, productivity, profitability	- Efficiency
- Outcome excellence, quality	- Performance

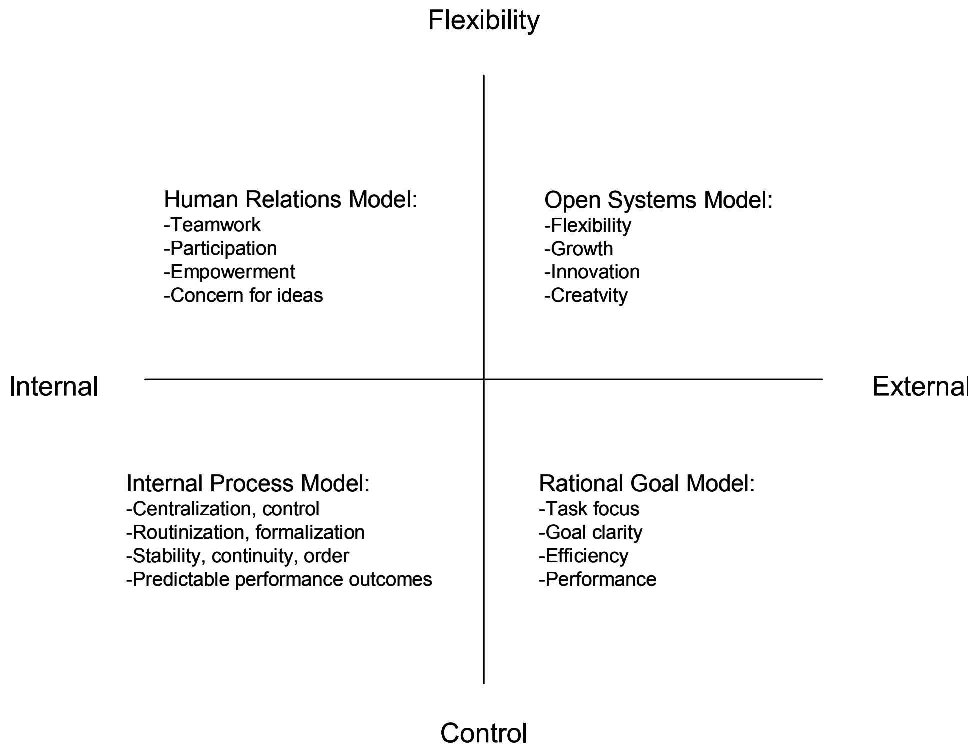


Figure 2.18: Competing Values Framework (Kalliath et al., 1999:146)

The result of their research increased the reliability of the instrument and provided additional confidence in the competing value framework. They report Cronbach's (1951) alphas of internal process (0.80), open systems (0.83), rational goal (0.83), and human relations (0.90) (Kalliath et al., 1999). As the literature review shows, culture is important for an organization and its acceptance of new technology. The leaders of the organization also have to be effective in motivating the organization. In Holt's (2003) development of the Readiness for Change instrument, he included a construct on management support. On this particular construct, he reported a Cronbach's (1951) alpha of 0.86.

On the hardware side, it is important for the system to be available and dependable when introducing a new information technology. *Geo InSight* (2004) states that "database planning is the single most important activity in GIS development." Also emphasized by *Geo Insight* (2004) is the maintenance of the database once it is operational. These factors are considered in chapter 3 as measures were developed for database quality.

2.5.4 Management Interventions: Data Collection

One study that captures the different areas of management as discussed in Fonnesbeck's (2003) ITIS model (i.e., learning, change, reward, and continuity), and provides a way to measure them is the "Employees' Perception of the Learning Organization" by Thomsen and Hoest (2001). Their research is based on the 11 characteristics of a learning organization identified by Pedler et al., (1997). They develop an instrument that managers can use to help develop their organization into a learning organization. By identifying which construct is most influential in developing a learning organization, a manager can be guided and focus his efforts where he will gain the most benefits. The final instrument developed through structural equation modeling has 11 constructs: participative policy making, internal exchange, inter-company learning, learning climate, environmental scanners, informating, reward system, self-development opportunities for all, enabling structures, and learning approach to strategy. Thomsen and Hoest (2001) test their instrument on four Danish service firms and conclude a reward system has a high effect on the learning environment of an organization. The reliability of their instrument is not reported. The benefit of using the 11 characteristics in this research will be covered in chapter 3.

2.6 Information Technology

With the current effort to implement a common Geographical Information System (GIS) across the United States Air Force, an opportunity to demonstrate the usefulness of the ITIS model (Fonnesbeck, 2003) presents itself. Because the community planners of the Air Force will be directly affected by the implementation of GIS, this research has chosen to use them as a case study to aid in the development of the ITIS data collection instrument. The rest of this chapter will provide background information on GIS, Air Force GeoBase, and Air Force community planning.

2.6.1 Geographical Information System

Geographical information system (GIS) is a term coined by Roger Tomlinson also known as the "Father of GIS" (*GIS World*, 2004). In the 1960s, as GIS was in its infancy stage, computer capability was a limiting factor. Tomlinson used computers with magnetic tape as the storage device and computers with no graphical capability to display his work. This limitation was eliminated during the 1970s as computers became more capable of handling large amounts of data and graphical displays improved.

GIS in the United States during the 1970s was also under development. At Harvard University, a structure called "vector" was developed which decreased the required storage space needed for a GIS system and all its associated data. In 1988, The National Center for Geographic Information and Analysis (NGIA) was founded with funds from the National Science Foundation. The NGIA was instrumental in introducing curriculum for higher education and academic research related to GIS. Today, United States government agencies have increased their production of special data and are making it available to GIS users (Wing and Bettinger, 2003).

A GIS is a computerized system for spatial (geographically-referenced) data management (Davis and Schultz, 1990:3). The major functions of a GIS are collection, storage, retrieval, transformation, analysis, modeling and display or output of data. All these functions must be present to classify a system as a GIS. The power of a GIS system comes from its ability to aggregate these functions into one system. Perhaps most visible of these functions is the graphical display, but the function most critical in the GIS is the ability to geographically reference and manipulate data. Geographically referenced refers to the fact that all data in the system is connected to a coordinate on the globe. In a simple illustration, Figure 2.19 shows the combining of data and geospatial attributes. An actual display of this combination from a GIS can be seen in Figure 2.20; a map showing location is combined with descriptive attributes from a linked database.

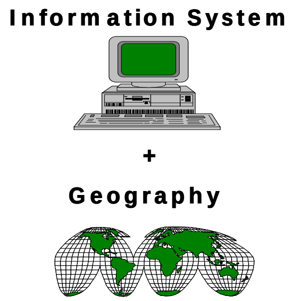


Figure 2.19: Geospatially Located Data (National Geospatial Intelligence School, 2003b)

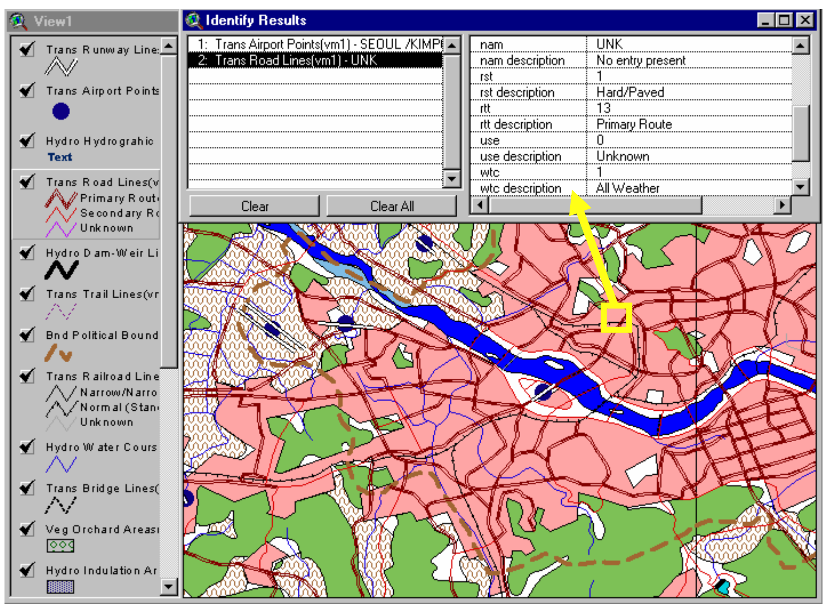


Figure 2.20: GIS Screen Shot (National Geospatial Intelligence School, 2003b)

The graphical display of a GIS can be stored in two different formats, raster or vector. Raster format is similar to a bit map or mosaic. Vector format is made up of points, lines, and polygons, as shown in Figure 2.21. Each format has its benefits and disadvantages.

Raster format make it easy to calculate areas, calculate data storage space, and is good for continuous type data with fuzzy boundaries, for example a large forested area. One of the major drawbacks for raster format is the storage space needed. Another problem is related to the size of each cell; when scaling a drawing, accuracy is lost because cells cannot be split; they can only have one attribute. Vector format's advantages are its accurate representation of map features, compact data storage, and unlimited amount of attributes assigned to a feature. Its disadvantages are the complex data structure, inability to represent features with fuzzy boundaries, and difficulty in determining data storage size (National Geospatial Intelligence School, 2003b).

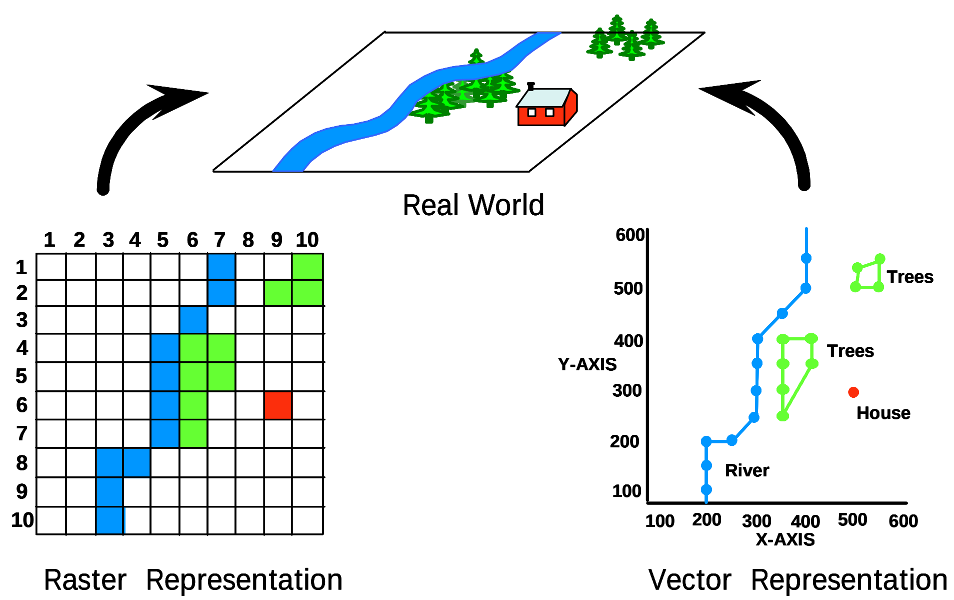


Figure 2.21: Difference Between Raster and Vector Representation (National Geospatial Intelligence School, 2003b)

The usefulness and capability of GIS is illustrated in the following example. Morey, Niemeier, and Limanond (2004) built a model to estimate the amount of PM_{10} (particulate matter <10µm in aerodynamic diameter) caused by vehicle miles traveled along the roads in California's San Joaquin Valley (SJV). The issue of PM_{10} was very important because it was estimated, in the state of California, that 32% of the total PM_{10} came from vehicle travel on unpaved roads. It was suspected the old method of determining PM_{10} was not accurate and the new model using GIS would give better results. SJV consists of a high percentage of agricultural land and unpaved roads. To begin with, Morey et al. (2004, 84) collected three sets of data: "land use and roadway network characteristics; harvest and nonharvest vehicle activity; and precipitation data." Using popular GIS software, Arc/INFO and Arc/View, they performed data analyses and developed graphical displays. With GIS, the researchers were able to assign classes and characteristics to each road and then calculate the length of total unpaved roads within the area studied. The use of GIS was significant because the results, from the powerful analysis capabilities of GIS, provided the statistical values needed in their model. In conclusion, Morey et al. (2004) found their model predicted 30% to 40% less PM_{10} emission from vehicle traffic on unpaved roads than did the old method. This is significant for policy makers attempting to lower the overall PM_{10} emissions for the state. This example shows the results enabled by GIS and creative thinking.

The usefulness of GIS is not questionable; however, successful implementation of GIS is not a sure thing. A case study by Nedovic-Budic and Godschalk (1996) shows the complexity of implementing GIS inside four North Carolina county government agencies. Using a human-factors framework, they evaluated eight factors: (1) perceived relative advantage of the innovation, (2) personal values and beliefs about computerized technology, (3) computer experience, (4) perceived complexity of the innovation, (5) exposure to the innovation, (6) computer/GIS-related anxiety, (7) attitude toward work-related change, and (8) communication behavior. They found perceived relative advantage and compatibility were the major determinants in individuals deciding to use GIS. Computer experience and exposure to GIS were also significant factors. Perceived complexity was not a significant factor in users deciding to use GIS. Finally, the support of management increased the likelihood of GIS implementation success.

2.6.2 GeoBase

The power of GIS has been recognized by the United State Air Force for some time. However, it has only been recently the US Air Force has made a centralized effort to implement it in daily operations. The Air Force has recognized the implementation of GIS is not just a software issue but an all encompassing issue including management, organization, and culture. The Air Force's initiative to implement GIS and a sustaining organizational structure is called GeoBase. According to United State Air Force Headquarters, "The USAF GeoBase is an information management initiative that extends the application of geospatial intelligence and associated tools to address the many challenges airmen face in managing complex infrastructures, both forward and rear, in this era of decreasing resources and increasing threats" (Department of the Air Force, HQ USAF/IL, 2004). In the resent past, each Air Force installation had its own tools to create maps and correlate data. Even within the same installation different squadrons kept their own base map and each squadron updated their maps with an array of information. This caused problems during operations and created hours of duplicated work. The vision of GeoBase is "One installation…One Map" (Department of the Air Force, HQ USAF/IL, 2004) or a common installation picture (CIP). With computer aided drafting a common map could be created but the associate data was nonexistent. With GIS, not only are the graphics and data available, but the capability to link and analyze data is provided. Figure 2.22 is a graphical representation of information from installation squadrons aggregated to produce the CIP.

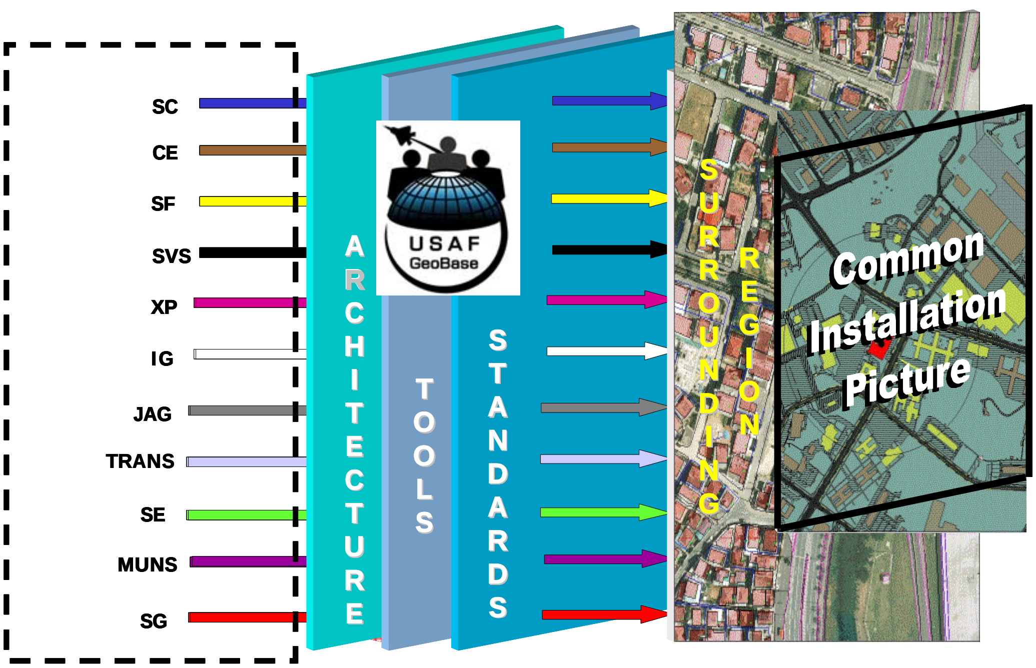


Figure 2.22: Building of a Common Installation Picture
(National Geospatial Intelligence School, 2003a)

2.7 Air Force Community Planning

Today's Air Force bases are similar to small cities and require careful planning. Air Force Instruction 32-7062, Air Force Comprehensive Planning, delineates the planning responsibilities at all levels within the Air Force. It defines comprehensive planning as an "ongoing, iterative, participatory process addressing the full range of issues affecting or affected by an installation's development" (Department of the Air Force, 1997). As a whole, the comprehensive plan consisted of "cumulative data sources in the form of documents and graphics that provide pertinent information used in the planning and decision-making processes" (Department of the Air Force, 1997). The comprehensive plan spans current, short-range, and long-range planning.

There are four divisions within the comprehensive plan: General Plan, Component Plans, Special Plans and Studies, and Maps. The General Plan is an executive summary of the most important information from each of the other divisions presented in a concise way to aid in the planning and decision making process. The General Plan should be easily updated and provide a flexible and accurate response to changes within the base. Component plans are broken down into four documents: Composite Constraints and Opportunities, Infrastructure, Land Use and Transportation, and Capital Improvements Program. These four documents go into further detail and provide an extended level of information to support the General Plan. Special Plans and Studies are for special items of interest, such as natural resources management and housing community plans. Maps provide the graphical and spatial dimension to the planning process and support the narrative parts of the plan.

The typical community planning process at each Air Force base begins with collecting data from many organizations across the base. Collecting current and accurate data is probably the biggest problem for the community planner. Once the data is collected, the community planner develops the many plans mentioned above, (i.e., The General Plan). The implementation of an information system, such as GIS, would aid the community planner in collecting data, consolidating data, and developing the necessary plans. Air Force Instruction 32-7062, Air Force Comprehensive Planning (1997), cites digital electronic systems available to aid in the planning process. To reinforce this, the Air Force leadership recently cited GeoBase as a digital electronic system which would benefit base planners in their development of General Plans (Fox, 2003).

2.8 Summary of Literature Review

A wide range of literature has been reviewed in this chapter. Literature in areas like technology acceptance, organizational behavior, system dynamics, GIS, Air Force GeoBase, and community planning. Because the ITIS model (Fonnesbeck, 2003) encompasses all of these subjects, it was necessary to introduce them all so Chapter 3 can focus on the development of the data collection instrument.

III. Methodology

3.1 Introduction

This chapter summarizes the methodology used to conduct this research. Since a survey was required, this chapter explains how the survey was administered and discusses the various statistical techniques used to evaluate the survey results. It also explains how existing measurements reported in the literature were used to support required constructs and which survey items were developed specifically for this research. The survey results were then used in an existing system dynamics model. Therefore, the chapter also explains how the survey results were transformed into meaningful units that were used as inputs into the Information Technology Implementation and Sustainment (ITIS) model (Fonnesbeck, 2003).

3.2 Survey Administration

To collect the empirical data needed for this research, a survey instrument was developed and distributed over the web. According to Leedy and Ormrod (2001), data collection by survey is very common; in written form or over the web, it can reach a large population in a short amount of time and at little cost to the researcher. Additionally, the collected data can be statistically manipulated and inferences can be drawn. The drawbacks to written and web-based surveys are that they provide only a snapshot in time, a majority of the target population do not respond to or return surveys, and the questions may be misinterpreted by the participants (Leedy and Ormrod, 2001).

The survey was sent to the entire target population, which consisted of the Air Force community planning career field at bases in the continental United States. There are 60 such bases, and it was assumed that each base had only one community planner. Therefore, the expected response to the survey will be less than 60, which is a known limitation that will be discussed in Chapter 5.

The web-based survey was distributed by sending an e-mail to the target population; this e-mail briefly explained the purpose of the survey and contained an electronic link to the survey. The target population was generated from the list of main operating bases in the 2004 Airman Magazine. The survey was available for two weeks; however, for one week the server was taken off-line. Thus, the participants had only one week to take the survey. Two e-mails were sent out notifying the participants of the status of the server. One reminder e-mail was also sent out two days before the survey was terminated.

3.3 Statistical Analysis of Survey Results

Following data collection, the reliability of the instrument was evaluated. A majority of the survey instrument consisted of all or part of existing measurements reported in the literature. Therefore, it was expected that the Cronbach's alpha values would be close to the reported values. A portion of the instrument was developed specifically for this research, for which Cronbach's alpha values were also calculated. Nunnally (1994) recommends that 0.70 be achieved on instruments used for basic research. Statistical Package for the Social Sciences (SPSS) software will be used for all statistical analyses performed in this research.

3.4 Survey Development

This section of the chapter identifies and discusses the variables used in the ITIS model. It also provides a detailed explanation of how the survey instrument was constructed. This is accomplished by describing how existing measurements were used to support the variables in the ITIS model.

3.4.1 Model Variables

Within the ITIS model (Fonnesbeck, 2003), there are five sectors: (1) Operating Capability, (2) Adoption, (3) Integration, (4) Organizational Inertia, and (5) Management Interventions. The description of each of these sectors is provided in Table 3.1. Each sector also contains multiple factors, which are defined in Table 3.2. These factors serve as inputs to the model; as such, they also represent the areas for which empirical data must be collected in order to implement the model.

Table 3.1: ITIS Model Construct Description (Fonnesbeck, 2003)

CONSTRUCT	DESCRIPTION
Operating Capability	The physical capabilities of the organization, supported by funding and management, (i.e., computers, printers, software).
Adoption	Focused on the individual and the rate at which an individual accepts or rejects new information technology.
Integration	The organization as a whole and the level of integration it reaches with a new information technology.
Organizational Inertia	The inertia built up in the organization which drives the continued use or discontinued use of a new information technology.
Mgt Interventions	The amount of time spent and management styles used to influence the implementation of a new information

Table 3.2: ITIS Model Factor Definitions (Fonnesbeck, 2003)

CONSTRUCT	FACTOR	DEFINITION
Operating Capability	Operational Capability	Pg 24: OC represents the technology and technological system management portion of GeoBase. Initial operating capability will occur when all of the hardware, software, and management elements are in place to satisfy the users, doers, and viewers of GeoBase
	Operational Capability Goal	Pg 281: The organizational manager's desired level of GeoBase Operability
	Funding	Pg 279: The level of funding provided to support the GeoBase program
Adoption	Potential Adopters	Pg 283: The pool (number) of individuals who have not adopted the new information technology
	Adopters	Pg 285: The number of individuals who have adopted the new information technology
	Relative Advantage	Pg 287: Perceived adopting and using GeoBase will give advantages in job performance and potential rewards based on that performance.
	Ease of Use	Pg 289: Perceived difficulty in learning and using GeoBase
	Compatibility	Pg 290: Perceive GeoBase is in line with the existing values, needs, and past experiences of potential adopters
	Base Line QoCC	Pg 285: The adequacy of organization communication channels
Integration	Integration	Pg 291: The initial level at which the organization has supported, accepted and utilizes GeoBase
	Reengineering Effectiveness	Pg 293: The organizations level of reengineering experience
	Baseline continuity	Pg 295: The process of storing and passing on organizational information to new members
Organizational Inertia	Top Level Support	Pg 299: The support given form organizational leaders to the integration of GeoBase
	Database Quality	Pg 300: The quality of the database such as availability, updated, and correct
	Culture Fit	Pg 301: The organization's culture in terms of rigidness or acceptability to change
Mgt Interventions	Learning	Pg 305: The time a manager devotes to increasing both the individual's and organization's learning
	Reward	Pg 307: The time a manager devotes to rewarding individuals for desired behavior
	Change Process	Pg 308: The time a manager devotes to change process techniques to make GeoBase integration a success
	Continuity	Pg 309: The time a manager devotes to encouraging a continuity program within the organization

3.4.2 Survey Constructs

This section steps through each sector of the ITIS model (Fonnesbeck, 2003) to elaborate on variable definitions and discuss the development of the survey pertaining to each particular section. The complete data collection instrument, shown in Appendix A, consisted of 110 questions. Definitions for variables used in the instrument are shown in Appendix B.

3.4.2.1 Operating Capability Sector

Within the Operating Capability sector, there are three factors: operational capability, operational capability goal, and funding. Based on the definitions of these factors provided in Table 3.2, 12 questions were developed to collect the associated empirical data. Survey items 2.1 through 2.10 were used to measure operational capability and items 2.11 and 2.12 for funding. Operational capability goal was assumed to be at a high level and no items were included. The survey questions were intended to determine if an organization was striving to reach, had reached, or had surpassed initial operating capability (in terms of capability and funding). Existing measures were not found for these factors; thus, there are no reported Cronbach's alpha values against which to compare.

3.4.2.2 Adoption Sector

Within the Adoption sector, there are six factors for which data needs to be collected. The first two factors require empirical data on how many potential adopters and adopters were in the target population. Potential adopters are the pool of individuals who have not accepted the new information technology. Adopters are the individuals who have already accepted the new information technology. Two items (1.5 and 1.6) were used in the instrument to collect this data.

This research refers to Moore and Benbasat's (1991) instrument to measure individuals' perceptions towards adopting an information technology innovation. Their instrument contains eight constructs, of which three correspond to the factors within the ITIS model (Fonnesbeck, 2003). These three factors are relative advantage, compatibility, and ease of use. Moore and Benbasat (1991) also provided a shortened version of their instrument from which this research borrows. The reported alpha scores for the three factors are: relative advantage, 0.90; compatibility, 0.86; and ease of use, 0.84. Moore and Benbasat (1991) recommend their instrument to researchers and suggest that the wording be changed to reflect the information technology innovation being studied. For the current research, the wording of the original questions was modified by replacing PWS (Personal Work Station) with GeoBase. Survey items 3.4 through 3.8 were used to measure relative advantage, items 3.9 through 3.11 for compatibility, and items 3.1 through 3.3 for ease of use.

The final factor under the Adoption sector references quality of communication between individuals and throughout the organization. To gather empirical data in this area, this research borrowed from the Communication Satisfaction Questionnaire by Clampitt and Downs (2004); it consists of 46 questions and seven factors. However, only five of the factors were considered relevant to the current research. These factors, and the corresponding survey items in Appendix A, were communication climate (items 6.2, 6.4, 6.6, 6.9, 6.10), supervisory communication (items 6.3, 6.5, 6.8, 6.12, 6.17), media quality (items 6.7, 6.16, 6.18, 6.19, 6.21), co-worker communication (items 6.11, 6.13, 6.14, 6.15, 6.20), and personal feedback (item 6.1). No alpha values were given for the individual factors; however, Down and Hazen (1977) report the overall reliability of the original questionnaire, after administering it twice in two weeks, as 0.94. The original wording of the questions was changed to make them more relevant to the current research; for example, (ACME) was changed to Squadron.

3.4.2.3 Integration Sector

In the Integration sector, there are two factors for which data needs to be collected: reengineering effectiveness and baseline continuity. The Reengineering Effectiveness factor was defined in Table 3.2 as "the organization's level of reengineering experience" (Fonnesbeck, 2003). However, true reengineering does not happen very frequently in the Air Force. Therefore, this factor was based on an organization's "readiness for change." Holt (2003:223) defined readiness for change as,

> "… a comprehensive attitude that is influenced simultaneously by these factors; that is, it is influenced by the content (i.e., what is being changed), the process (i.e., how the change is being implemented), the context (i.e., circumstances under which the change is occurring), and the individuals (i.e., characteristics of those being asked to change) involved that collectively reflect the extent to which an individual or a collection of

> individuals is cognitively and emotionally inclined to accept, embrace, and adopt, a particular plan to purposefully alter the status quo."

Holt (2003) developed a survey instrument to measure readiness for change which consisted of 142 questions and 19 factors. Only the following four factors were used from his research: appropriateness, efficacy, valence, and management support (discussed in the following sector). The reliability coefficients for these factors were 0.91, 0.73, 0.64, and 0.82, respectively. Holt's survey instrument was developed for participants preparing for an organizational change; thus, the tense of the questions were focused on a future change. Since the population in the current research may be in different stages of change (contemplating change, in the midst of change, or well into the change), Holt's original survey questions were reworded. For example, "I think that the organization will benefit from this change" was rephrased as, "I think that organizational change has benefits for the organization." Eleven questions were used from Holt's instrument; these factors, and the corresponding survey items in Appendix A, were appropriateness (items 4.1 through 4.4), efficacy (items 4.5 through 4.8), and valence (items 4.9 through 4.11).

The baseline continuity factor is the last one considered in the Integration sector. During the literature review, key ideas associated with this factor included continuity, knowledge management, and organizational memory. Templeton et al. (2002) developed an organizational learning instrument in which one of the factors was Organizational Memory. The items under this factor captured the concepts of storing data, retrieving data, managing data, strategic human resources turnover, electronic storing, electronic documenting, human memory, and other memory. These concepts reflect the ideas of continuity within an organization as previously defined in Table 3.2. Templeton et al. (2002) used a Lawshe procedure to assess content validity which included a panel of 24 information technology management professionals who scored the questions as Essential (3), Important (2), or Not relevant (1). The resulting mean and Content Validity Ratio (CVR) are shown in Table 3.3. The CVR is calculated with the following formula:

$$CVR=(n-N/2)/(N/2)$$

were n is the frequency with which a question was scored as 2 or 3 and N is the total number of respondents. If the CVR was over 0.5, it indicated the item was valid (Templeton et al., 2002). Since the validity was established with the CVR, alpha values were not reported.

Table 3.3: Validity Results (Templeton et al. 2002:196)

Organizational Memory	Mean	CVR	n
The company stores detailed information for guiding operations.	2.47	0.76	17
Employees retrieve archived information when making decisions.	2.41	1.00	18
There is a formal data management function in the company.	2.18	0.53	17
The company maintains a certain mix of skills among its pool of employees.	2.17	0.67	18
The company makes extensive use of electronic storage (such as, databases, data warehousing, scanned documents).	2.24	0.76	17
Employees use electronic means to communicate.	1.88	1.00	18
The company develops experts from within.	2.28	0.67	18
The company makes extensive use of information from other firms (suppliers, partners, customers, and son).	2.06	0.38	16

In this research, six of the original eight questions are used. The last item in Table 3.3 was eliminated because its CVR was below 0.5. Since the Air Force assigns members to specific squadrons and the local manager does not have a significant influence on the mix of skills and expertise in the organization, the fourth question was considered invalid and was also eliminated. The six questions, items 4.12 through 4.17 in the survey in Appendix A, included in this research were reworded to correlate with the Air Force by changing the word company to squadron.

3.4.2.4 Organizational Inertia Sector

In the Organizational Inertia sector, there are three factors for which data needs to be collected: Top Level Support, Database Quality, and Cultural Fit. For the Top Level Support factor, three items from Holt's (2003) survey instrument were used; these items had a reported alpha of 0.82. As with the readiness for change factor, the tense of the questions was modified to span all states of organizational change (before, during, and after). The questions are included as items 4.18 through 4.20 in the survey at Appendix A.

Questions for the Database Quality factor were specifically developed for this research. Based on the definition given in Table 3.2, four questions were formulated to encompass the concepts of periodic updates, accuracy, completeness of information, and accessibility of the existing GeoBase database. These four questions are shown as items 4.21 through 4.24 in the survey at Appendix A.

The last factor in this sector is Cultural Fit. The model presented by Kalliath et al. (1999) provides a way to identify various characteristics existing within an organization. Once these characteristic are identified, the organization can be evaluated in four areas: Human Relations, Open Systems, Internal Process, and Rational Goal. The model by Kalliath et al. (1999) consisted of a 16-item survey instrument with four questions per quadrant. The reported Cronbach's alpha values were 0.90, 0.83, 0.80, and 0.83, respectively. The items corresponding to these four factors are: human relation (items 7.3, 7.7, 7.10, 7.15), open systems (items 7.2, 7.6, 7.11, 7.14), internal process (items 7.1, 7.5, 7.9, 7.13), and rational goal (items 7.4, 7.8, 7.12, 7.16) as shown in the survey at Appendix A.

3.4.2.5 Management Intervention Sector

The last sector of the ITIS model (Fonnesbeck, 2003) is the Management Intervention sector. There are five factors in this sector for which data needs to be collected: Management Capacity, Learning, Reward, Change Process, and Continuity. Management capacity was defined as the amount of time a manager spends on information technology issues. However, this survey is from the subordinate perspective so management capacity will be assumed to be 100% when the ITIS model (Fonnesbeck, 2003) is implemented.

For the other four factors, Thomsen and Hoest's (2001) survey instrument on Learning Organization was used. Their survey consisted of 20 questions which were divided into eleven factors; for the purposes of this research, these factors were grouped into four constructs correlating to the four factors identified in the ITIS model (Fonnesbeck, 2003). The learning factor emphasizes a learning approach to strategy, internal exchange, boundary workers as environmental scanner, inter-company learning, learning climate, and self-development opportunities. The reward factor consists of reward flexibility, while the change factor consists of participative policy making and enabling structures. Finally, the continuity factor consists of making better decisions and higher information awareness. The wording of the questions from Thomsen and Hoest's (2001) survey instrument was slightly changed to make them more compatible with the Air Force. For example, "your company is quick to learn from other companies" was changed to "our squadron is quick to learn from other squadrons." The items corresponding to the four factors in this sector are: learning (items 5.5 through 5.10), reward (items 5.13 through 5.15), change (items 5.1 through 5.4), and continuity (items 5.11 and 5.12) as shown in the survey at Appendix A.

3.5 System Dynamics

Since the data collected with the survey instrument will serve as inputs to a system dynamics model, it needs to be aggregated and transformed to an appropriate range required by the model's variables. Most of the survey items were based on a 5-point Likert scale. However, most of the variables within the system dynamics model have unit-less values ranging from 1 to 10 or percentages from 0 to1. Therefore, the survey data were converted to the necessary range through a simple linear equation as shown in Table 3.4.

The exception to this conversion process is the data within the Organizational Inertia sector which has a range from -1 to 1 in the system dynamics model. Two of the factors, Top Level Support and Database Quality, are simple linear conversions as described above. However, the Cultural Fit factor in the survey is categorical. The categories are based on a structural equation test by Kalliath et al. (1999:153) to quantify the relationships between the four factors: Human Relations (HR), Open Systems (OS), Internal Process (IP), and Rational Goal (RG). McDermott and Stock (1998) concluded that the Human Relations factor, in the competing values model, had the highest relationship to satisfaction of new technology implementation. Table 3.5 shows the value assigned to Cultural Fit factor depending on the dominant combination of competing values.

Table 3.4: ITIS Variable Ranges (Fonnesbeck, 2003)
***Factor from Holt (2003)**

	Theoretical Values		Data Conversion
Operating Capability	**Min**	**Max**	
Operational Capability	0	1	(Mean-1) / (5-1)
Operational Capability Goal	0	1	
Funding	0	1	

Adoption	**Min**	**Max**	
Potential Adopters (PA)	0	1	(PA) / (PA+A)
Adopters (A)	0	1	(A) / (PA+A)
Relative Advantage	0	10	[(Mean-1) / (5-1)]*10
Ease of Use	0	10	
Compatibility	0	10	
Quality of Communication	0	1	(Mean-1) / (5-1)

Integration	**Min**	**Max**	
Integration	0.01	N/A	((Mean BC + Mean RFC)/2)-1) (5-1)
Baseline Continuity (BC)	0	1	(Mean-1) / (5-1)
*Readiness for Change (RFC)	0	10	[(Mean-1) / (5-1)]*10

Organizational Inertia	**Min**	**Max**	
Top Level Support	-1	1	(2*Mean-5)/5
Database Quality	-1	1	(2*Mean-5)/5
Culture Fit	-1	1	See Table 3.5

Mgt Interventions	**Min**	**Max**	
Mgt Capacity	0	1	Set at 1
Learning	0	1	(Mean-1) / (5-1)
Reward	0	1	
Change Process	0	1	
Continuity	0	1	

Table 3.5: Culture Fit Data Conversion
Human Relations (HR), Rational Goal (RG)
Open Systems(OS), Internal Process (IP)

Competing Values	Data Conversion
(HR,OS)	1
(HR,IP), (HR,RG)	0.5
(RG,OS), (RG,HR)	0
(RG,IP)	-0.5
(IP,OS)	-1

IV. Analysis and Results

4.1 Introduction

This chapter provides the results of this research effort. It begins with a review of the demographic data resulting from the survey and analyzes the reliability of the survey measurements. The chapter then presents the results of implementing the Information Technology Implementation and Sustainment model (Fonnesbeck, 2003) using the survey results as inputs. For more insight into the community planning environment and its acceptance of GeoBase, the survey results are discussed specifically in relation to the third primary objective of this research.

4.2 Survey Demographics

The survey was sent by electronic mail to 64 addresses, with 4 e-mails being returned as non-deliverable. From the remaining population size of 60 community planners, there were 56 responses to the survey. Invalid responses were considered to be incomplete surveys or blank data; after these were eliminated, there were 31 responses available for analysis. Therefore, the response rate to this survey, in spite of technical difficulties noted in Chapter 3, was 52%. This response rate was considered quite respectable; typical rates are often less than 50% (Leedy and Ormrod, 2001). Table 4.1 provides the standard demographics for the survey respondents; note that four categories of demographics are represented in the table. An additional demographic, which provides the age distribution of the respondents, is shown in Figure 4.1. Figures 4.2 and 4.3 provide the years of Air Force community planning experience and the years of total community planning experience, respectively.

Table 4.1: Survey Demographics

Demographics						
Gender				Type of Community Planners		
80%	24	Male		3%	1	Military
20%	6	Female		60%	18	Civilian
100%	30	Total		10%	3	Contract
				27%	8	Civil Service
				100%	30	Total
Race				MAJCOMs Representation		
93%	28	White		30%	9	ACC
3%	1	Hispanic		23%	7	AETC
3%	1	Native Am		13%	4	AFMC
0%	0	Black		0%	0	AFSOC
0%	0	Asian		17%	5	AFSPS
0%	0	Other		17%	5	AMC
100%	30	Total		100%	30	Total

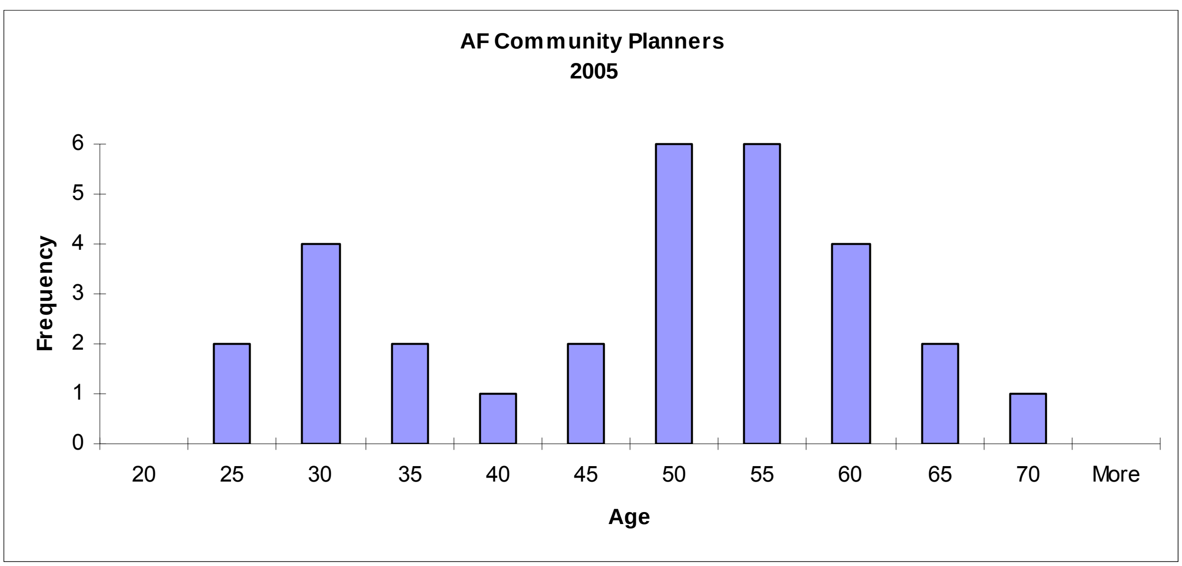


Figure 4.1: Age Distribution

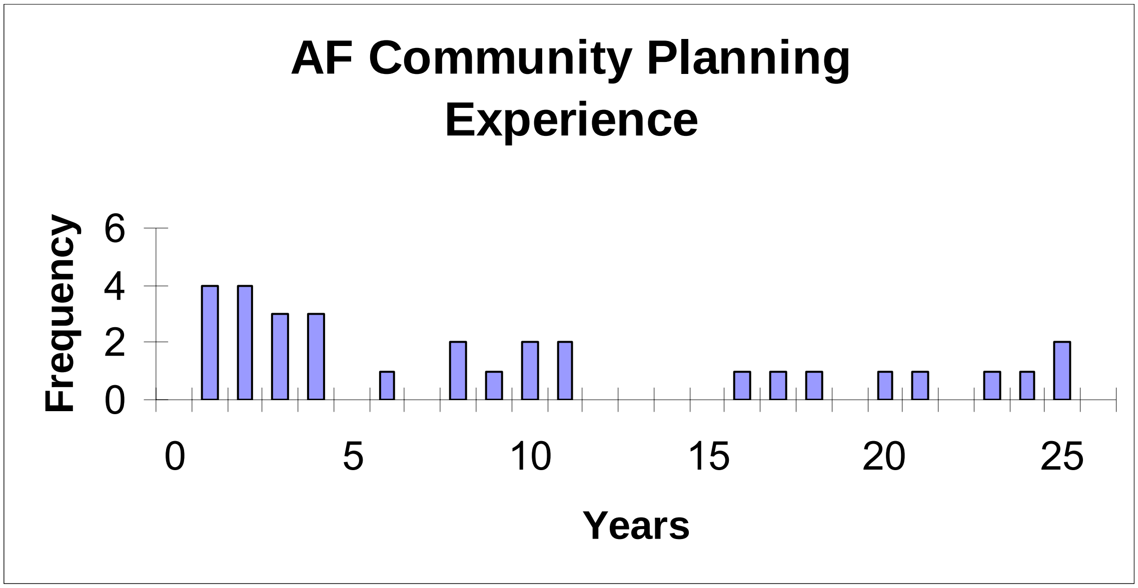


Figure 4.2: Air Force Community Planning Experience

Figure 4.3: Total Community Planning Experience

According to Figure 4.1, 61% of the community planning career field is at least 50 years old. According to these demographics, the typical Air Force community planner is a white male civilian in his late 40s with over 14.3 years of planning experience (9.4 years experience in the Air Force). Of the six Major Commands initially included in the survey, only the Air Force Special Operations Command did not have any respondents. Somewhat surprisingly, the community planning function has very little military representation.

4.3 Instrument Reliability

The researcher's original intent was to perform factor analysis on each of the factors used in this research. As a general rule of thumb, the subjects-to-variables ratio should be no lower than 5 to conduct reliable factor analysis (Bryant and Yarnold, 1995). However, this rule of thumb could not be achieved. With only 31 survey responses, there was not sufficient data to conduct the factor analysis and obtain reliable results.

Although factor analysis could not be performed, the reliability coefficient, also known as Cronbach's alpha, was determined for each factor using the Statistical Package for the Social Sciences (SPSS) 12.0 software. These values are shown in Table 4.2 along with the values reported in the literature for the respective factors. All but one of the factors meet the minimum Cronbach's alpha of 0.70 recommended for basic research (Nunnally, 1994); the Funding factor's alpha value was 0.46. However, there were only two survey items used for this factor; therefore, the relatively low value was not surprising. Two options are available for possibly increasing the alpha value: increase the number of items in the factor and examine the content of the survey items to remove ambiguities.

Table 4.2: Reliability Alphas

Factor	Cronbach Alpha	Alphas from Literature
Operational Capability	0.85	*
Funding	0.46	*
Ease of Use	0.92	0.84[a]
Relative Advantage	0.98	0.9[a]
Compatibility	0.89	0.86[a]
Readiness for Change: Appropriateness	0.87	0.91[b]
Readiness for Change: Efficacy	0.88	0.73[b]
Readiness for Change: Valence	0.84	0.64[b]
Baseline Continuity	0.81	*
Top Level Support	0.89	0.82[b]
Database Quality	0.82	*
Change Leadership	0.83	*
Learning Leadership	0.88	*
Continuity Leadership	0.90	*
Reward Leadership	0.93	*
Quality of Communication: Communication Climate	0.86	*
Quality of Communication: Supervisory Communication	0.93	*
Quality of Communication: Media Quality	0.87	*
Quality of Communication: Co-Worker Communication	0.79	*
Cultural Fit: Internal Process	0.79	0.8[c]
Cultural Fit: Open System	0.93	0.83[c]
Cultural Fit: Human Relations	0.93	0.9[c]
Cultural Fit: Rational Goal	0.82	0.83[c]

a. (Davis, 1989)
b. (Holt, 2003)
c. (Kalliath et al., 1999)
* Alphas not reported
Note: In Appendix C, the complete correlation table is presented.

4.4 ITIS Model Implementation

Since its reliability was validated with the Cronbach's alpha values, the survey instrument was used to collect data for the ITIS model (Fonnesbeck, 2003); it should be noted that this was the first attempt at using empirical data with the model. In the long term, implementation of the ITIS model using empirical data is the most significant result of this research. For this research, the survey and model were used to examine the behavior of GeoBase implementation and sustainment throughout the Air Force community planning function. However, the ITIS model was developed at an organizational level and the results of this model across the USAF community planning function may be stretching the use of the model beyond its boundaries. The researcher assumes that the community planning function as a whole acts as an organization but acknowledges there will be variance unaccounted for because each planner is influenced by his or her own organization.

If sufficient time series data were available, Rogers' (2003) Diffusion of Innovation theory predicts that the diffusion of innovation in an organization follows an S-shaped curve similar to the one shown in Figure 4.4. Such a curve can be validated only by administering a survey instrument at various points in time, i.e., only through longitudinal surveys. However, the administration of the survey in the current research is simply a snapshot in time and is represented by the "data gathering 2" line as illustrated in Figure 4.4. To determine the shape of the curve prior to the "data gathering 2" line in Figure 4.4, it is necessary to look at the past 15 years of GeoBase integration in the community planning function. Using data collected from this research's survey, Figure 4.5 represents this 15-year history. Not surprisingly, the shape of this curve is similar to the lower portion of the curve in Figure 4.4.

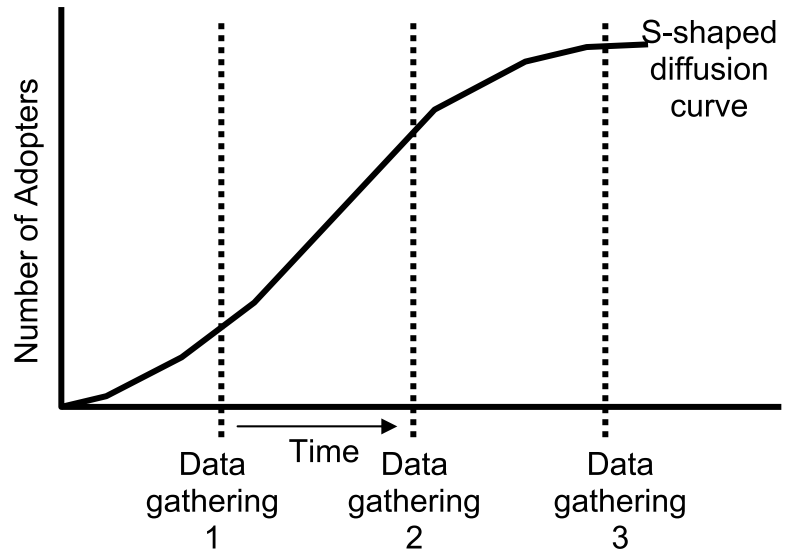


Figure 4.4: S-shape Diffusion Curve (Rogers, 2003:113)

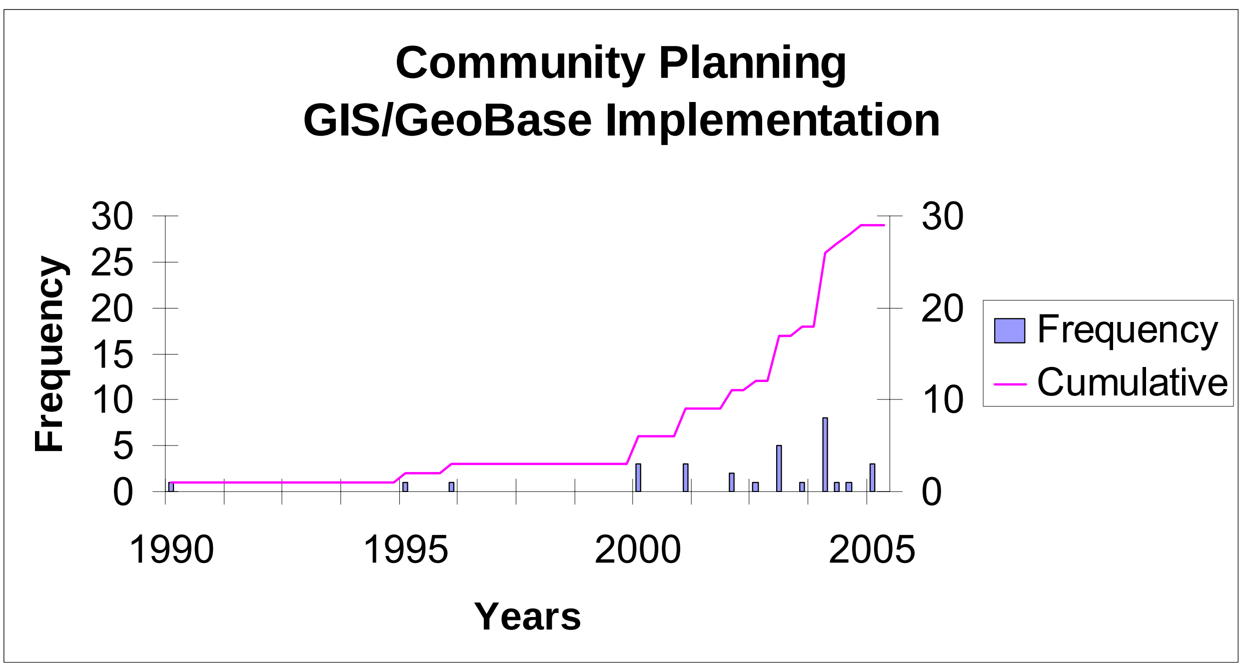


Figure 4.5: GIS/GeoBase Implementation in Community Planning

To examine the behavior of GeoBase implementation past the "data gathering 2" line, the ITIS model (Fonnesbeck, 2003) was implemented using the collected empirical data. Table 4.3 shows the converted variable values derived from the collected data and subsequently used as inputs to the model. Figure 4.6 shows the results from the ITIS model, which models the projected behavior of GeoBase implementation throughout the Air Force community planning function.

Table 4.3: ITIS Model Variable Inputs

Empirical Data	
Adopters	0.64
Integration	2.2
Potential Adopters	0.36
Baseline Continuity	0.57
Baseline QoCC	0.56
Change Process Perc	0.27
Compat	6.1
Continuity Perc	0.22
Culture Fit	-0.5
Database Quality	0.1
Ease of Use	5.3
Learning Perc	0.28
Reengineering Effectiveness	5.3
Rel Adv	7.2
Reward System Perc	0.23
Top Level Support	0.14
OC	0.58
Funding	equation on

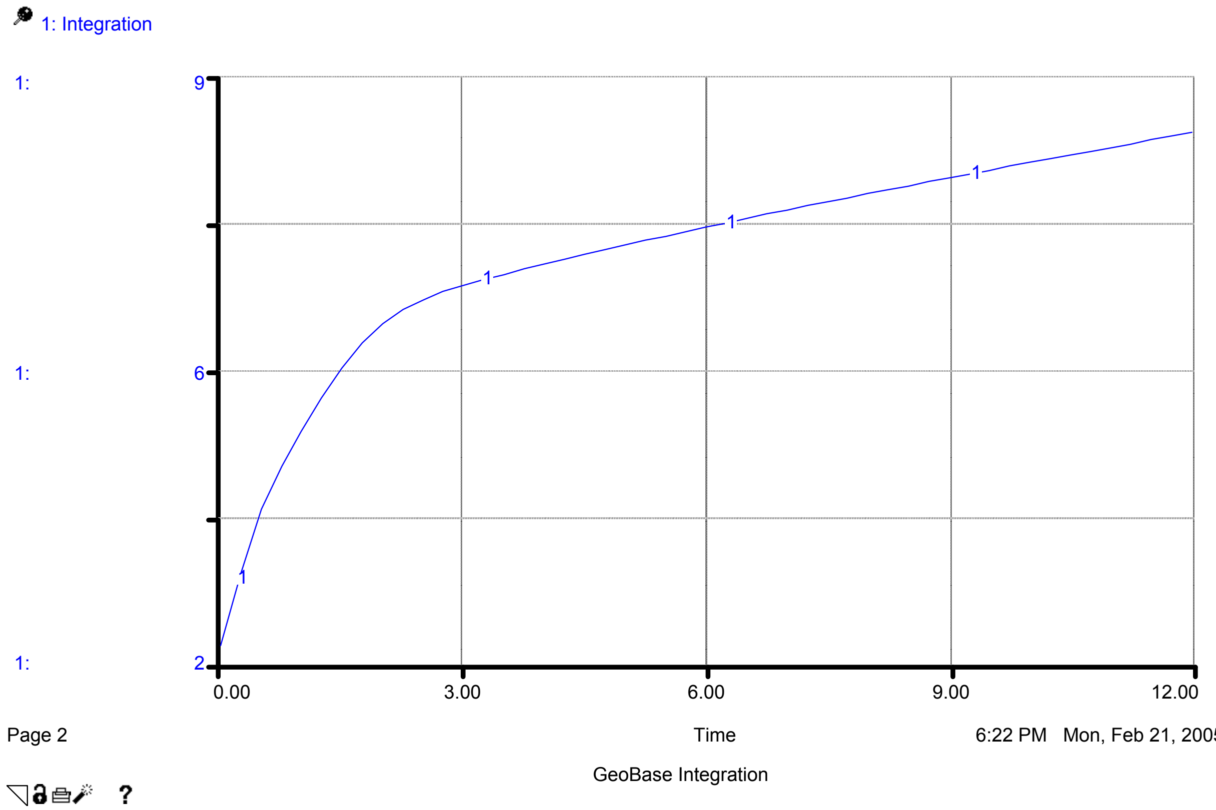


Figure 4.6: ITIS Model Output

The behavior in Figure 4.6 was comparable to the two best hypothetical cases produced by Fonnesbeck (2003). In that it indicates a completion of integration followed by stustainability. In 2003, Fonnesbeck produced 420 different hypothetical curves by entering combinations of adopter levels, operation capability, organizational context, and management styles. Not surprisingly, this research's empirical data did not neatly fit into any of the hypothetical combinations developed in 2003. Empirical data showed higher scores in the operating capability and Adopters area than hypothetical data. When considering the organizational context, empirical data spans baseline organizational context and positive organizational context. See Tables 4.4 and Table 4.5 for a comparison of hypothetical data to empirical data.

Table 4.4: Hypothetical Variable Values (Fonnesbeck, 2003;192)

Operating Capability & Adopters		Poor Organizational Context		Baseline Organizational Context		Positive Organizational Context	
High		Top Level Support	0	Top Level Support	0	Top Level Support	0.4
OC	0.5	Database Quality	-0.4	Database Quality	0	Database Quality	0.4
Pot Adop	0.5	Culture Fit	-0.4	Culture Fit	0	Culture Fit	0.4
Adop	0.5	Rel Adv	5	Rel Adv	9	Rel Adv	9
Low		Ease of Use	2	Ease of Use	3	Ease of Use	3
OC	0.05	Compatibility	3	Compatibility	5	Compatibility	7
Pot Adop	0.98	Baseline QoCC	0.3	Baseline QoCC	0.5	Baseline QoCC	0.7
Adop	0.02	Baseline Continuity	0.1	Baseline Continuity	0.25	Baseline Continuity	0.5

Table 4.5: Empirical Variable Values

Operating Capability & Adopters		Poor Organizational Context		Baseline Organizational Context		Positive Organizational Context	
High		Top Level Support		Top Level Support	0.14	Top Level Support	
OC	0.58	Database Quality		Database Quality	0.1	Database Quality	
Pot Adop	0.36	Culture Fit	-0.5	Culture Fit		Culture Fit	
Adop	0.64	Rel Adv		Rel Adv	7.2	Rel Adv	
Low		Ease of Use		Ease of Use		Ease of Use	5.3
OC		Compatibility		Compatibility		Compatibility	6.1
Pot Adop		Baseline QoCC		Baseline QoCC	0.56	Baseline QoCC	
Adop		Baseline Continuity		Baseline Continuity		Baseline Continuity	0.6

Historical data from the past 15 years showed that the integration of GeoBase has achieved a level higher than zero (see Figure 4.5). It is not surprising then that the projected behavior from the ITIS model starts at 2.2 in Figure 4.6. Since the scales in Figures 4.5 and 4.6 are relative, the research cannot address the values in absolute terms. Additionally, since the curve in Figure 4.6 is produced with data beyond the boundaries of one organization, no true comparison can be drawn. However, system dynamics modeling focuses on trends. Therefore, when the historical data and projected data are combined, the result is shown in Figure 4.7. Note that the trend is similar to the desirable behavior presented earlier in Figure 2.15. Evaluating the hypothetical curve, it appears as though GeoBase integration has passed the point of critical mass, which is "the point at which enough individuals in a system have adopted an innovation so that the innovation's further rate of adoption becomes self-sustaining" (Rogers, 2003:344). Only time will tell if the hypothetical curve is correct and integration of GeoBase in the Air Force community planning function will be successful.

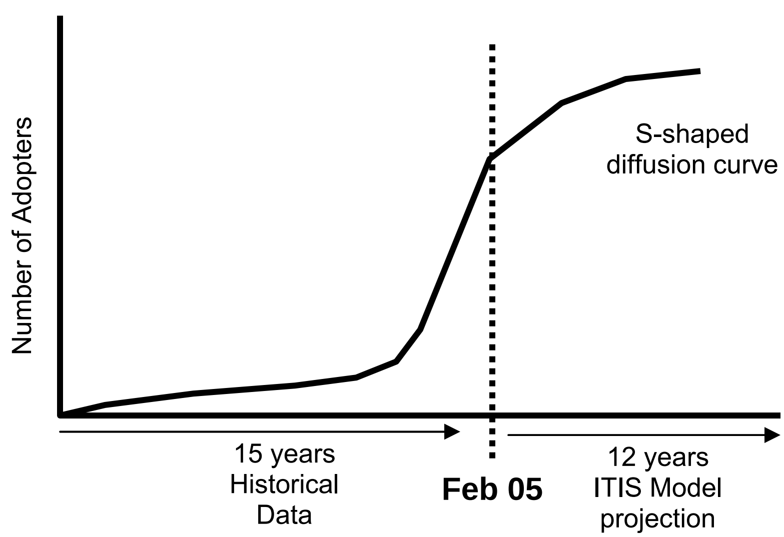


Figure 4.7: Hypothetical GeoBase integration Curve

4.5 State of GeoBase Implementation

To gauge the current state of GeoBase implementation by community planners, this research also focused on several aspects identified in Rogers' (2003) definition of diffusion: social system, communication, and innovation. The number of adopters and potential adopters throughout the community planning function were also examined; this will help identify the progress of GeoBase implementation to date. These areas were explored by analyzing the empirical data that was collected.

4.5.1 Social System

Rogers (2003) identifies social systems as an important factor in diffusion; in Fonnesbeck's (2003) ITIS model, social system was referred to as culture. Using the Competing Values model developed by Kalliath et al. (1999), Figure 4.8 was created. The survey responses were measured on a five point Likert scale with scores ranging from 1 (not valued at all) to 5 (highly valued). The Air Force community planners scored higher on the Control side of the model, both internally and externally; this corresponds to the higher scores in the Rational Goal and Internal Process factors. This was not surprising considering the strict structure within Air Force organizations. In Chapter 2, it was stated that organizations scoring high in Human Relations are more inclined to accept new technology (McDermott and Stock, 1999). Although this research found that the community planners did not score highest in Human Relations, this does not mean they are not receptive to new technology. In fact, they are well balanced in all of the areas.

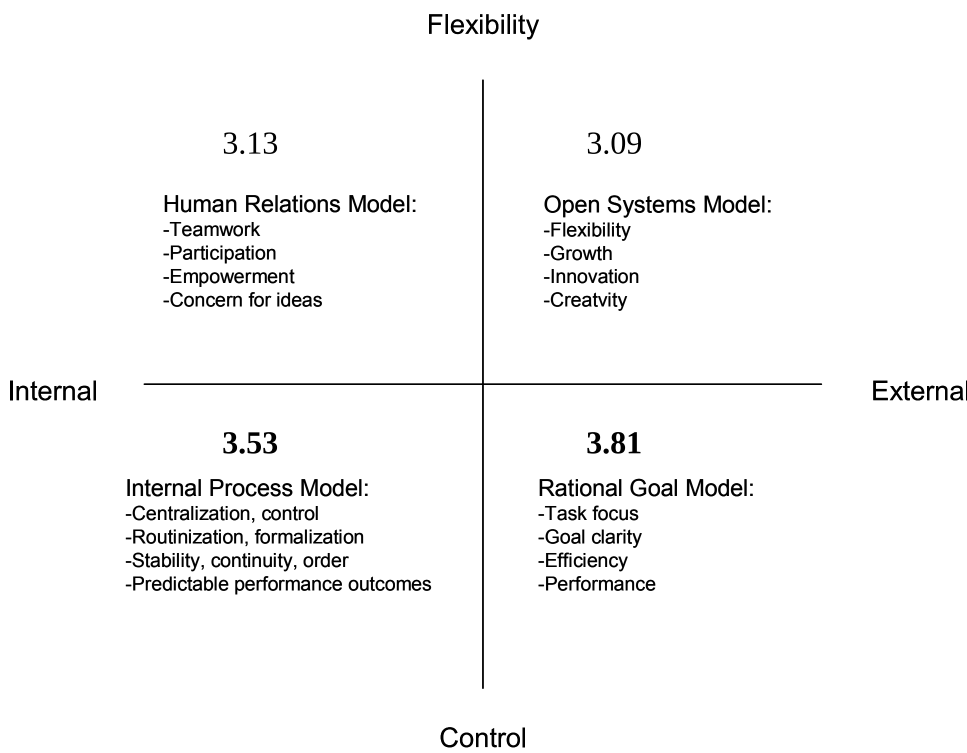


Figure 4.8: Community Planner's Competing Values

4.5.2 Communication Satisfaction

To gain a better understanding of communication satisfaction at the planning level, the average score of the 21 survey items related to communication satisfaction are shown Figure 4.9. There are no dominant areas in the figure, and the averages range from 2.84 to 3.97. All scores are above 2.5, indicating that planners are generally satisfied with their communication environment. There appears to be three major groupings of responses in the graph. Additional insight can be gained by referring to the survey items represented in each grouping, see Table 4.6. The grouping on the left in Figure 4.9 indicates that the highest communication satisfaction among planners is with their supervisors and co-workers. Planners are satisfied with the flow of communication both up and down the chain. Planners can openly communicate with their supervisors and feel the supervisors understand their needs. Communication with co-workers is also good; indicating that lateral communication is healthy and active within the planning community. The middle grouping in Figure 4.9 is dominated with survey items related to the satisfaction of information transfer; this includes meetings, written communications, and the amount of information being conveyed. Thus, the planners appear satisfied with the amount of information they receive and the means by which it is conveyed to them. The last grouping in Figure 4.9 deals with communication on the personnel and organizational level. This grouping had the lowest scores, indicating that planners are almost neutral when identifying with their organization. They are also neutral in terms of the level and quality of communication received from the organization.

In general, communication appears to be active and positive for the community planners. However, if an area needs to be focused on, it may be communicating the value of a planner to the organization. It is important for planners to understand the important role they play in providing the leadership with concise and vital information upon which decisions are based. Communicating the organization's goal to community planners could also be emphasized more.

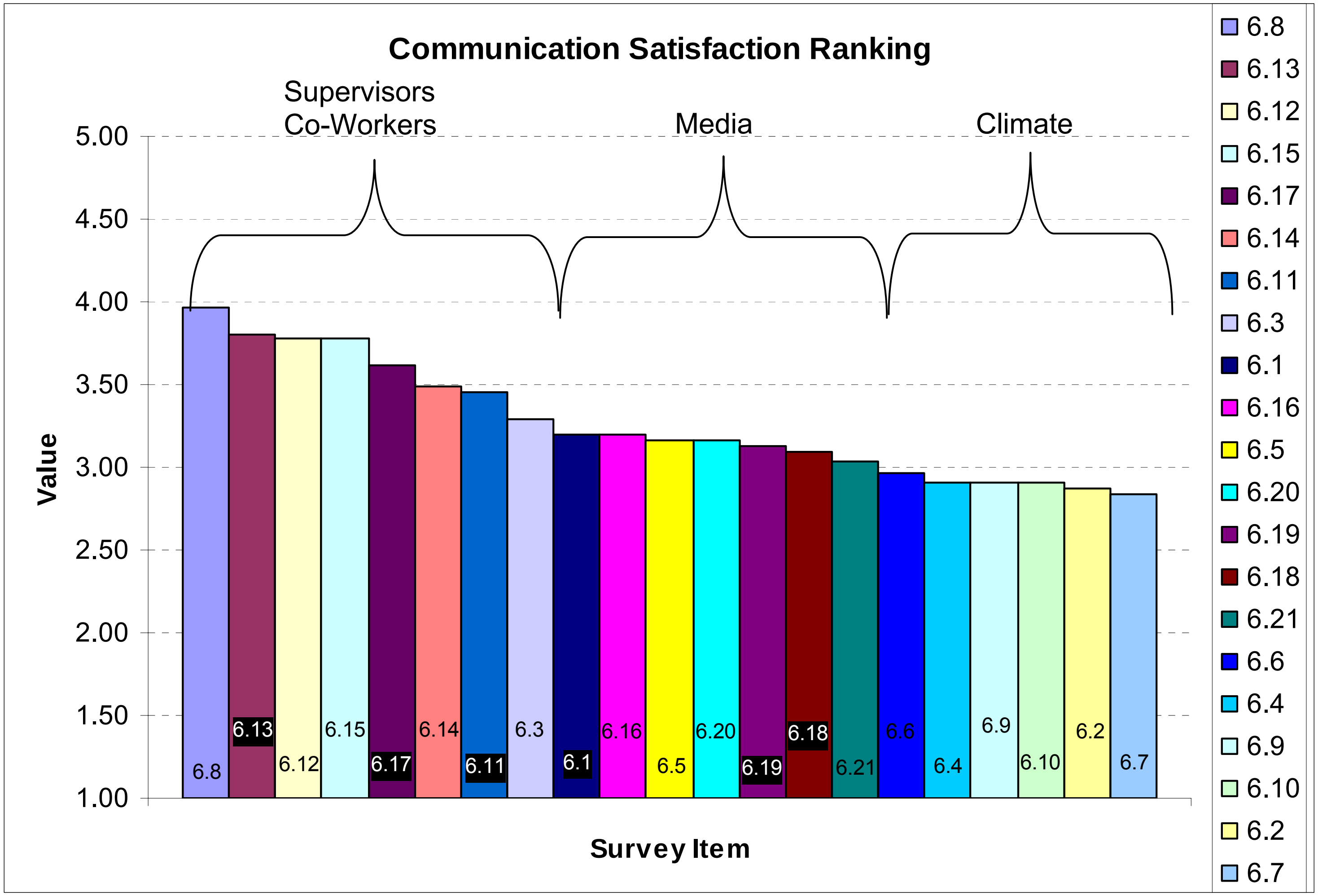


Figure 4.9: Communication Satisfaction Ranking

Table 4.6: Communication Satisfaction Groupings

Item	Average Score	Question
6.8	3.97	Extent to which my supervisor trusts me.
6.13	3.81	Extent to which communication with other employees at my level is accurate and free-flowing.
6.12	3.77	Extent to which my supervisor is open to ideas.
6.15	3.77	Extent to which my work group is compatible.
6.17	3.61	Extent to which the amount of supervision given me is about right.
6.14	3.48	Extent to which communication practices are adaptable to emergencies.
6.11	3.45	Extent to which the grapevine is active in the squadron.
6.3	3.29	Extent to which my supervisor listens and pays attention to me.
6.1	3.19	Extent to which my managers/supervisors understand the problems faced by staff.
6.16	3.19	Extent to which our meetings are well organized.
6.5	3.16	Extent to which my supervisor offers guidance for solving job-related problems.
6.20	3.16	Extent to which informal communication is active and accurate.
6.19	3.13	Extent to which the attitudes toward communication in the squadron are basically healthy.
6.18	3.10	Extent to which written directives and reports are clear and concise.
6.21	3.03	Extent to which the amount of communication in the squadron is about right.
6.6	2.97	Extent to which communication in the squadron makes me identify with it or feel a vital part of it.
6.4	2.90	Extent to which the people in the squadron have great ability as communicators.
6.9	2.90	Extent to which I receive in time the information needed to do my job.
6.10	2.90	Extent to which conflicts are handled appropriately through proper communication channels.
6.2	2.87	Extent to which the squadron's communication motivates me to meet its goals.
6.7	2.84	Extent to which the squadron's communications are interesting and helpful.

4.5.3 Planner's Perception of GeoBase

Several factors identified by Moore and Benbasat (1991), and included in the ITIS model (Fonnesbeck, 2003), are considered good predictors of acceptance of new technology: Ease of Use, Relative Advantage, and Compatibility. The average scores for these factors are depicted in Figure 4.10, which appears to indicate that community planners are generally positive about GeoBase and that acceptance of GeoBase is probable.

As with any new technology, its acceptance can be made or broken by its ease of use. Planners perceive GeoBase to be somewhat easy to use; however, the lower score for this factor indicates there is some level of extra effort that has to be exerted to use GeoBase. The highest scoring factor is relative advantage; planners perceive that GeoBase will give them an advantage in performing their work. Compatibility is a more complex concept because it is related to the values, needs, and past experiences of the planner. Although it is a little more abstract, the planners are positive about GeoBase compatibility.

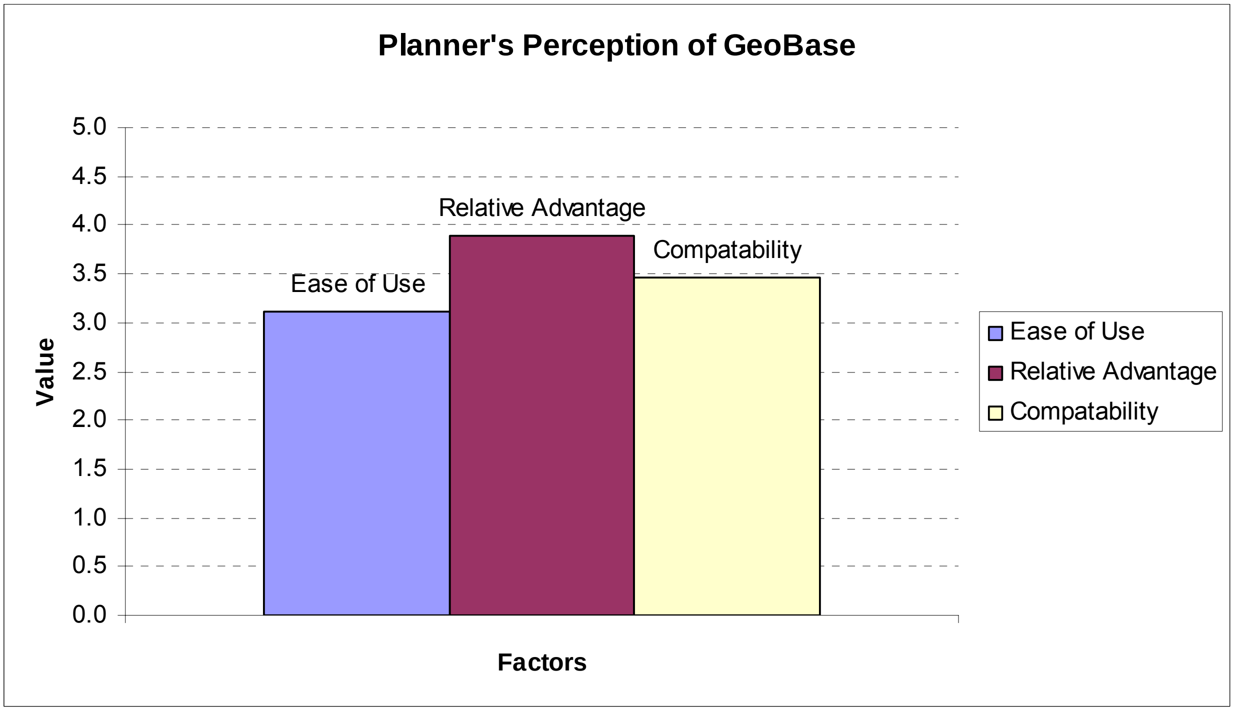


Figure 4.10: Technology Acceptance Predictors

4.5.4 GeoBase Adopter

A direct indicator of how wide-spread GeoBase has been is the number of planners who have accepted GeoBase and the number of planners who have not. Therefore, an examination of adopters and potential adopters is warranted. Of the 31 individuals responding to the survey, 27 community planners reported using GeoBase; these individuals are referred to as adopters. The 31 individuals also identified 11 more community planners, at their bases, who do not use GeoBase; so individuals not using GeoBase add up to 15. The 15 planners, who presumably do not use GeoBase, are referred to as potential adopters. According to the central limit theorem, normality can be reached if the number of samples collected reach or exceed 25 (McClave, Benson, and Sincich, 2001). Since there were 31 respondents to the survey, this survey's results can be considered a good representation of the entire population. With 64% of the community planners being considered adopters, the integration of GeoBase in the community planning function can be considered well underway. At some point in the future, it will begin to taper off and reach the steady state condition depicted by Rogers' (2003) S-shape curve.

4.5.5 State of GeoBase Summary

After examining various aspects of diffusion, it appears as though the implementation of GeoBase in the Air Force community planning function is well underway and over 50% complete. The culture within the planning function is balanced and somewhat focused on control, but not to the point of hindering technology implementation. Planners are satisfied with communication between co-workers and supervisors; the means by which the communication is conducted is also satisfactory. The climate in which communication is carried out received a neutral response and indicated the role of the planner and the organizational goals could be communicated better. Furthermore, the perception of GeoBase by planners is generally positive and its benefits are recognized. Additionally, the implementation of GeoBase is progressing and it supports the behavior projected by the ITIS model (Fonnesbeck, 2003).

4.6 Summary

The data collection instrument developed for this research resulted in all but one reliable factor. With a reliable instrument developed to collect empirical data for the first time, the ITIS model (Fonnesbeck, 2003) was implemented. Combining historical data from the past 15 years and the projected behavior produced by the ITIS model (Fonnesbeck, 2003), an S-shaped curve was produced. This was in agreement with predictions in Rogers' (2003) innovation diffusion studies. Confirming the desirable nature of the S-shape curve in technology implementation, the state of GeoBase was reviewed by studying individual aspects identified in Rogers'(2003) definition of diffusion. Each of the aspects was positive and indicated that the community planning environment and personnel are a fertile grounds for the implementation of GeoBase.

V. Conclusions and Recommendations

5.1 Introduction

In this chapter, the three research objectives proposed in Chapter 1 will be reviewed and discussed. Additionally, research limitations will be identified and recommendations for future research will be made.

5.2 Conclusions

Several factors came together to formulate the idea for this research. The first was the current implementation of Geographical Information System in the Department of Defense, more specifically in the Air Force. The Air Force's implementation effort, known as GeoBase, started in the mid 1990s and is well underway. Second, Fonnesbeck (2003) developed a system dynamics model to predict the future behavior of GeoBase implementation or more generally information technology implementation. Finally, the last factor behind this research is General Fox's November 2003 letter encouraging Air Force Community Planners to use GeoBase in the planning process. These factors provided the subject, tool, and sample population to examine the thesis objectives identified in Chapter 1.

5.2.1 Objective 1.

The development of the data collection instrument required the review of the ITIS model (Fonnesbeck, 2003), the theories it was based on, and consideration of the 18 identified input variables. Once the variables were identified, the instrument was constructed using existing questionnaires which corresponded, as closely as possible, to the identified variables. In areas where questionnaires did not exist, questions were developed to collect the needed data. The developed data collection instrument was web-based and consisted of 110 questions. A 52% response rate was achieved. Confirmatory factor analysis was not accomplished because not enough responses were collected to achieve the recommended subjects-to-variables ratio. However, reliability analysis was accomplished for each factor and the results were very successful. Only one of the factors, Funding, fell below the recommended 0.70 reliability value. Therefore, the principal objective of this research has been successfully achieved -- a reliable data collection instrument has been developed for repeated use with the ITIS model (Fonnesbeck, 2003).

5.2.2 Objective 2.

The developed survey was released for two weeks and empirical data was collected from the Air Force community planners. The raw data was adjusted to fit the ranges defined by the variables of the ITIS model (Fonnesbeck, 2003). For the first time, the ITIS model (Fonnesbeck, 2003) was implemented with empirical data. The resulting behavior projected a successful implementation of GeoBase and strong sustainment once GeoBase is fully implemented. The projected behavior from the model did not exactly fit the hypothetical behavior produced by Fonnesbeck in his research; however, all hypothetical models were run with the assumption of low beginning integration. Since integration of GeoBase in the Air Force is about 64% complete, this may account for some of the differences. An even more interesting result was found when the historical implementation behavior from the past 15 years was combined with the ITIS model's projected behavior. The combined behaviors produced the S-shaped curve common in Rogers' (2003) Innovation Diffusion studies. This objective has been successfully met and one step more has been accomplished in building confidence in the ITIS model.

5.2.3 Objective 3.

Evaluation of the cultural environment indicated that the Air Force community planners perceive their environment as well balanced. They scored the factors in the control quadrants higher, which is not unexpected in a military environment. Because the culture is balanced, there does not appear to be any major hindrance to information technology implementation. The community planners are satisfied with the communication within their organization. They are very satisfied with supervisory and co-worker communication. However, the survey showed that the goals of the organization and the planners' importance in the overall mission were areas in which communication could be strengthened.

The community planners' perception of GeoBase was also positive. Ease of use was scored the lowest; however, it was still on the positive side of the scale and indicates no resistance to accepting GeoBase. The community planners recognize the advantage of using GeoBase and are positive about it being compatible with their work needs and past experience. The survey identified 64% of the community planners are now using GeoBase.

5.3 Limitations

The primary limitation identified in this research is the size of the population used for data collection. The population of Air Force community planners at main operating bases in the continental United States is 64. In order to perform a confirmatory factor analysis on the developed data collection instrument, a much larger population will have to be accessed. Additionally, surveys are only a snap shot in time and a through examination of the implementation of information technology requires a longitudinal study involving time series data.

5.4 Recommendations for Future Research

There are numerous opportunities for future research with the ITIS model (Fonnesbeck, 2003) and this research's data collection instrument. Confidence has to be built in the ITIS model before it can be used in information technology implementation and sustainment projections and policy setting. The first items in the model that could be looked at are the conversion factors. Each input into a flow valve needs to be multiplied by a conversion factor to define the relationship to the flowing units. The ITIS model also needs to be evaluated against existing data to verify its output behaviors are following reality. This takes a longitudinal survey and collection of data over time.

The data collection instrument developed in this research was developed to aid in the longitudinal survey. However, this instrument also needs refining. The items in the Funding factor need to be examined so the factor achieves a 0.70 reliability coefficient. Additionally, a larger sample is needed to conduct a confirmatory factor analysis on each factor of the survey. Finally, the use of the data collection instrument and the ITIS model should be expanded beyond GeoBase into other information technologies.

5.5 Final Comments

The development of the data collection instrument is a critical step in the process of building confidence in the ITIS model (Fonnesbeck, 2003). Many models are developed and forgotten, with no further work accomplished to verify and build confidence in them. It is important to recognize the ITIS model's unique capability to forecast future implementation behavior. This research has developed a reliable instrument specifically to aid in the further development and use of the ITIS model (Fonnesbeck, 2003). The researcher hopes this instrument will not be placed on the shelves of a library, but used to benefit the United States Air Force's implementation and sustainment of information technology.

Appendix A

IT Implementation and Sustainment: Data Collection Instrument

Purpose: To develop a survey tool that will collect data needed to implement an Information Technology Implementation and Sustainment Model.

Participation: We would greatly appreciate your participation in our data collection effort. Your participation is completely voluntary. Your decision to not participate will not jeopardize your relationship with the Air Force Institute of Technology, the U.S. Air Force, or the Department of Defense.

Confidentiality: Although the survey asks for some demographic information, this information is only used to describe the population from which the data was collected. All answers are anonymous. No one other than the research team will see your completed questionnaire. Findings will be reported in an aggregated form at the group level only. Reports summarizing trends in large groups may be published.

Contact information: If you have any questions or comments about the survey contact Major Walter Yazzie. You may want to save the cover sheet with the contact information for future reference.

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PRIVACY NOTICE

In accordance with AFI 37-132, Paragraph 3.2, the following information is provided as required by the Privacy Act of 1974:

Authority: 10 U.S.C. 8012, Secretary of the Air Force; powers and duties; delegation by; implemented by AFI 36-2601, Air Force Personnel Survey Program.

Purpose: To develop a survey tool that will collect data needed to implement an Information Technology Implementation and Sustainment Model. .

Routine Use: No analysis of individual responses will be conducted and only members of the research team will be permitted access to the raw data.

No individual will be identified to anyone outside of the research team.

Participation: Participation is VOLUNTARY. No adverse action will be taken against any member who does not participate in this survey or who does not complete any part of the survey.

INSTRUCTIONS

- Base your answers on your own thoughts and experiences. This survey is from the base community planner perspective.
- All items are answered by choosing the appropriate circle on the survey or typing a response in the space provided.
- If, for any item, you do not find a response that fits your situation exactly, use the one that is the closest to the way you feel.

Information Technology Implementation and Sustainment Survey

In this survey, "GeoBase" is used as a general classification which includes all of the Geographical Information Systems used by the US Air Force, for example ArcInfo and ArcView. Please respond to each item by either choosing the most appropriate circles or typing in the requested information.

1.1. How many years have you been in Air Force community planning?

Years:______

1.2. How many total years of experience do you have in community planning, (both in and out of the Air Force)?

Years: ______

1.3. In your best estimate, how long has your base been using GeoBase software to aid in planning tasks?

Years:______

1.4. How many years have you worked directly with Geographical Information Systems and/or Air Force GeoBase?

Years:______

1.5. How many community planners are at your base?

Number of planners:______

1.6. In your judgment how many of the planners identified in question 1.5 use GeoBase on a daily basis to accomplish planning tasks?

Number of Planners using GeoBase:_____

The term "GeoBase" is used as a general classification which includes all of the Geographical Information Systems used by the US Air Force, for example ArcInfo and ArcView.

Using the scale below, rate the extent to which you agree with the following statements.

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

2.1. We have GeoBase software installed in my squadron.

2.2. I have access to GeoBase at my desktop computer terminal.

2.3. I can view GeoBase maps on my computer.

2.4. I can input data into GeoBase on my computer.

2.5. I can print full size plots (i.e. C or D size) from GeoBase.

2.6. The common installation picture (one GeoBase map used across all squadrons in the wing) is available to me.

2.7. The base uses GeoBase as a base planning tool.

2.8. I can get GeoBase technical support from personnel in the squadron.

2.9. I can get GeoBase technical support from the software vendor/supplier.

2.10. I can get GeoBase technical support within one day.

2.11. I have all the software, hardware, and training I need to use GeoBase effectively.

2.12. My squadron has sufficiently funded our Geobase program.

The term "GeoBase" is used as a general classification which includes all of the Geographical Information Systems used by the US Air Force, for example ArcInfo and ArcView.

Using the scale below, rate the extent to which you agree with the following statements.

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

3.1. I believe that it is easy to get GeoBase to do what I want it to do.

3.2. Overall, I believe that GeoBase is easy to use.

3.3. Learning to operate GeoBase is easy for me.

3.4. Using GeoBase enables me to accomplish tasks more quickly.

3.5. Using GeoBase improves the quality of work I do.

3.6. Using GeoBase makes it easier to do my job.

3.7. Using GeoBase enhances my effectiveness on the job.

3.8. Using GeoBase gives me greater control over my work.

3.9. Using GeoBase is compatible with all aspects of my work.

3.10. I think that using GeoBase fits well with the way I like to work.

3.11. Using GeoBase fits into my work style.

Using the scale below, rate the extent to which you agree with the following statements.

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

4.1. I think that organizational change has benefits for the organization.

4.2. There are legitimate reasons for organizational change.

4.3. There are a number of rational reasons for organizational change.

4.4. The time we spend on organizational change should be spent on something else.

4.5. I do not anticipate any problems adjusting to the work I will have when organizational change is adopted.

4.6. When my organization changes, I feel I can handle it with ease.

4.7. When I set my mind to it, I can learn everything that is required when my organization changes.

4.8. My past experiences make me confident that I can perform successfully after organizational change is made.

4.9. I am worried I would lose some of my status in the organization when my organization changes. ®

4.10. Organizational change would disrupt many of the personal relationships I have developed. ®

4.11. My future in this job would be limited because of organizational change. ®

4.12. The squadron stores detailed information for guiding operations.

4.13. Employees retrieve archived information when making decisions.

4.14. There is a formal data management function in the squadron.

4.15. The squadron makes extensive use of electronic storage (such as, databases, data warehousing, scanned documents).

4.16. Employees use electronic means to communicate.

4.17. The squadron develops experts from within.

4.18. Our senior leaders have encouraged all of us to embrace GeoBase.

4.19. Our organization's top decision-makers have put all their support behind the implementation of GeoBase.

4.20. Every senior manager has stressed the importance of GeoBase implementation.

4.21. The data in GeoBase is up to date.

4.22. The data in GeoBase is accurate.

4.23. The data in GeoBase is complete.

4.24. Access (i.e., connectivity) to the GeoBase data is reliable.

Using the scale below, rate the extent to which you agree with the following statements.

1	2	3	4	5
Strongly Disagree	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**

5.1. Several people from my department are currently discussing new ideas to develop our squadron's policies.

5.2. The employees in my department respect each other's different points of view.

5.3. My department is discussing cross-section problems openly with other flights in our squadron.

5.4. My department exchanges knowledge and experience with other departments in our squadron.

5.5. The employees in my department have regular meetings with other squadrons to exchange experiences.

5.6. Our squadron is quick to learn from other squadrons.

5.7. My colleagues and I learn from each other's mistakes.

5.8. The environment in my department is characterized by learning new things and by questioning the way things are done.

5.9. My colleagues and I often discuss news from the outside environment that may influence our squadron’s development.

5.10. The customers' views and ideas are currently being used to develop our squadron's products and services.

5.11. The continuity system is a help in making better decisions in my department.

5.12. The continuity system is a help in providing a higher information awareness in my department.

5.13. Our squadron has several ways of rewarding good work performance.

5.14. Our squadron’s reward system is considered fair.

5.15. My department offers good opportunities for personal development.

Note: Notice the change in scale definition in this section.

Using the scale below, rate the extent to which you agree with the following statements.

1	**2**	**3**	**4**	**5**
Very Dissatisfied	**Dissatisfied**	**Neutral**	**Satisfied**	**Very Satisfied**

6.1. Extent to which my managers/supervisors understand the problems faced by staff.

6.2. Extent to which the squadron’s communication motivates me to meet its goals.

6.3. Extent to which my supervisor listens and pays attention to me.

6.4. Extent to which the people in the squadron have great ability as communicators.

6.5. Extent to which my supervisor offers guidance for solving job-related problems.

6.6. Extent to which communication in the squadron makes me identify with it or feel a vital part of it.

6.7. Extent to which the squadron's communications are interesting and helpful.

6.8. Extent to which my supervisor trusts me.

6.9. Extent to which I receive in time the information needed to do my job.

6.10. Extent to which conflicts are handled appropriately through proper communication channels.

6.11. Extent to which the grapevine is active in the squadron.

6.12. Extent to which my supervisor is open to ideas.

6.13. Extent to which communication with other employees at my level is accurate and free-flowing.

6.14. Extent to which communication practices are adaptable to emergencies.

6.15. Extent to which my work group is compatible.

6.16. Extent to which our meetings are well organized.

6.17. Extent to which the amount of supervision given me is about right.

6.18. Extent to which written directives and reports are clear and concise.

6.19. Extent to which the attitudes toward communication in the squadron are basically healthy.

6.20. Extent to which informal communication is active and accurate.

6.21. Extent to which the amount of communication in the squadron is about right.

The following might be values reflected in your squadron. Please use the following scale to describe the extent to which each of the following possible values are operating and emphasized in your squadron.

Using the scale below, choose the appropriate circle.

1	2	3	4	5
Not valued at all	**Not valued**	**Some what valued**	**valued**	**Highly Valued**

7.1. Predictable outcomes (being confident about knowing what will happen if certain actions are taken)

7.2. Innovation and change

7.3. Participation and open discussion

7.4. Outcome excellence and quality

7.5. Stability and continuity

7.6. Creative problem solving

7.7. Employee concerns and ideas

7.8. Getting the job done

7.9. Order

7.10. Human relations, teamwork, and cohesion

7.11. Decentralization (where many people have a say in decision making)

7.12. Goal achievement

7.13. Dependability and reliability

7.14. New Ideas

7.15. Morale

7.16. Doing one's best

Please respond to each item by either choosing the most appropriate circles or typing in the requested information. If, for any item, you do not find a response that fits your situation exactly, select the one that is the closest to the way you feel.

8.1. What is your gender?

◯ **Male** ◯ **Female**

8.2. What is your race?

◯ **White** ◯ **Hispanic** ◯ **Native American**

◯ **Black** ◯ **Asian** ◯ **Other________________**

8.3. What is your age?

Years:______

8.4. What is your Major Command (MAJCOM), for example ACC, AETC?

MAJCOM:________

8.5. What is your current status?

◯ **Military** ◯ **Civilian** ◯ **Contractor** ◯ **Civil Service**

Reassurance of Anonymity

ALL ANSWERS ARE ANONYMOUS. No one other than the research team will see your completed questionnaire. Findings will be reported at the group level only. We asked for some demographic information in order to interpret results more accurately. Reports summarizing trends in large groups may be published.

Questions/Concerns

If you have any questions or concerns please feel free to contact the research team members listed on the third page of the questionnaire. We appreciate your participation and would be happy to address any questions you may have regarding the questionnaire or our research in general.

Feedback

If you are interested in getting feedback on our research results, please provide us with the following personal information so we can reach you at a later date:

Name: ___________________

Address:_________________

____

____

Phone:___________________

Appendix B

Data Collection Instrument
Factor Definitions

FACTOR **- SUB FACTOR**	**DEFINITION**
Operational Capability[a]	The technology and technological system management portion of GeoBase.
Operational Capability Goal[a]	The organizational manager's desired level of GeoBase operability.
Funding[a]	The level of funding provided to support the GeoBase program.
Potential Adopters[a]	The pool (number) of individuals who have not adopted the new information technology.
Adopters[a]	The number of individuals who have adopted the new information technology.
Relative Advantage[b]	The degree to which an innovation is perceived as being better than its precursor.
Ease of Use[c]	The degree to which an individual believes that using a particular system would be free of physical and mental effort.
Compatibility[b]	The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters.
Quality of Communication[a]	The adequacy of organization communication channels.
- Communication Climate[d]	The extent to which communication motivates and stimulates workers to meet organizational goals.
- Supervisory Communication[d]	The upward and downward aspects of communicating with superiors.
- Media Quality[d]	The extent to which meetings are well organized and written directives are short and clear.
- Co-Worker Communication[d]	The extent to which informal communication is accurate and free flowing and includes perceptions of the grapevine.
- Personal Feedback[d]	Information concerning how worker performance is being appraised.
Integration[a]	The initial level at which the organization has supported, accepted, and utilized GeoBase.

a. (Fonnesbech, 2003)
b. (Rogers, 2003)
c. (Davis, 1986)
d. (Gary and Laidlaw, 2004)
e. (Holt, 2003)
f. (Kalliath et al., 1999)

Appendix B

Data Collection Instrument
Factor Definitions
Continued

FACTOR - SUB FACTOR	DEFINITION
Readiness for Change$_e$	A comprehensive attitude that is influenced simultaneously by these factors; that is, it is influenced by the content (i.e., what is being changed), the process (i.e., how the change is being implemented), the context (i.e., circumstances under which the change is occurring), and the individuals (i.e., characteristics of those being asked to change) involved that collectively reflect the extent to which an individual or a collection of individuals is cognitively and emotionally inclined to accept, embrace, and adopt, a particular plan to purposefully alter the status quo.
- Appropriateness$_e$	The extent to which one feels that the change effort was legitimate and appropriate for the organization to meet is objectives.
- Efficacy$_e$	The extent to which one feels that he or she has the skills and is able to execute the tasks and activities that are associated with the implementation of the change.
- Valence$_e$	The extent to which one feels that he or she will benefit from the implementation of the change.
Baseline Continuity$_a$	The process of storing and passing on organizational information to new members.
Top Level Support$_e$	The extent to which one feels that the organization's leadership and management are committed to and support implementation of the change.
Database Quality$_a$	The quality of the database such as availability, updated, and correct information.
Culture Fit$_a$	The organization's culture in terms of rigidness or acceptability to change.
- Internal Process$_f$	Include the following characteristics: Centralization, control, routinization, formalization, stability, continuity, order, and predictable performance outcomes.
- Open System$_f$	Include the following characteristics: Flexibility, growth, innovation, and creativity.
- Human Relations$_f$	Include the following, characteristics: Teamwork, participation, empowerment, and concern for ideas.
- Rational Goal$_f$	Include the following characteristics: Task focus, goal clarity, efficiency, and performance.
Learning$_a$	The time a manager devotes to increasing both the individual's and organization's learning.
Reward$_a$	The time a manger devotes to rewarding individuals for desired behavior. a
Change Process$_a$	The time a manager devotes to change process techniques to make GeoBase integration a success.
Continuity$_a$	The time a manager devotes to encouraging a continuity program within the organization.

a. (Fonnesbech, 2003)
b. (Rogers, 2003)
c. (Davis, 1986)
d. (Gary and Laidlaw, 2004)
e. (Holt, 2003)
f. (Kalliath et al., 1999)

Appendix C
Correlation Table

Variable	Mean	S.D.	OC	FUN	EOU	RA	COM	RBPA	RBPE	RBPV	BC	TLS	DBQ
OC	2.75	0.94	**(0.85)**										
FUN	2.44	1.09	0.743**	**(0.46)**									
EOU	3.11	1.09	0.602**	0.533**	**(0.92)**								
RA	3.90	1.20	0.628**	0.425*	0.785**	**(0.98)**							
COM	3.46	0.83	0.498**	0.434*	0.545**	0.731**	**(0.89)**						
RBPA	3.51	0.86	0.315	0.317	0.593**	0.602**	0.440*	**(0.87)**					
RBPE	3.59	0.82	0.537**	0.515**	0.637**	0.664**	0.415*	0.701**	**(0.88)**				
RBPV	3.30	0.77	0.314	0.215	0.217	0.322	0.404*	0.351	0.458**	**(0.84)**			
BC	3.29	0.79	0.543**	0.566**	0.495**	0.514**	0.385*	0.481**	0.584**	0.365*	**(0.81)**		
TLS	2.85	1.19	0.467**	0.656**	0.253	0.214	0.259	0.214	0.527**	0.374*	0.569**	**(0.89)**	
DBQ	2.79	0.98	0.702**	0.525**	0.506**	0.545**	0.447*	0.220	0.426*	0.155	0.480**	0.641**	**(0.82)**
CHAL	3.06	0.83	0.259	0.256	0.331	0.365*	0.376*	0.344	0.471**	0.505**	0.728**	0.493**	0.387*
LEL	3.07	0.82	0.346	0.328	0.245	0.287	0.316	0.316	0.423*	0.344	0.700**	0.595**	0.489**
CONL	2.63	0.88	0.329	0.218	0.354	0.392*	0.210	0.383*	0.298	0.044	0.606**	0.411*	0.507**
REWL	2.69	1.19	0.347	0.328	0.270	0.196	0.028	0.221	0.310	0.357*	0.583**	0.446*	0.355*
QOC_CC	2.91	0.91	0.143	0.185	0.139	0.050	-0.019	0.042	0.121	0.118	0.497**	0.401*	0.270
QOC_SC	3.56	1.11	0.23	0.274	0.084	0.033	-0.115	0.053	0.226	0.235	0.316	0.236	0.132
QOC_MQ	3.06	0.88	0.338	0.394*	0.244	0.104	0.021	0.077	0.159	0.181	0.617**	0.538**	0.444*
QOC_WC	3.54	0.73	0.374*	0.505**	0.436*	0.367*	0.335	0.463**	0.568**	0.347	0.699**	0.634**	0.472**
CF_IP	3.53	0.75	0.127	0.104	0.123	0.126	-0.1119	0.003	0.011	-0.009	0.482**	0.386*	0.350
CF_OS	3.09	1.14	0.172	0.255	0.138	0.124	0.072	0.021	0.213	0.226	0.606**	0.540**	0.394*
CF_HR	3.13	1.11	0.14	0.240	0.075	0.076	0.033	0.001	0.082	0.22	0.588**	0.468**	0.351
CF_RG	3.81	0.83	0.262	0.288	0.177	0.176	-0.065	0.066	0.235	0.09	0.533**	0.483**	0.367*

Variable	CHAL	LEL	CONL	REWL	QOC_CC	QOC_SC	QOC_MQ	QOC_WC	CF_IP	CF_OS	CF_HR	CF_RG
CHAL	**(0.83)**											
LEL	0.856**	**(0.88)**										
CONL	0.560**	0.671**	**(0.90)**									
REWL	0.716**	0.739**	0.528**	**(0.93)**								
QOC_CC	0.658**	0.689**	0.495**	0.815**	**(0.86)**							
QOC_SC	0.506**	0.531**	0.267	0.684**	0.703**	**(0.93)**						
QOC_MQ	0.645**	0.710**	0.606**	0.853**	0.905**	0.677**	**(0.87)**					
QOC_WC	0.764**	0.766**	0.531**	0.703**	0.661**	0.615**	0.744**	**(0.79)**				
CF_IP	0.395*	0.467**	0.599**	0.560**	0.602**	0.327	0.681**	0.416*	**(0.79)**			
CF_OS	0.769**	0.754**	0.567**	0.703**	0.804**	0.650**	0.811**	0.701**	0.709**	**(0.93)**		
CF_HR	0.737**	0.751**	0.570**	0.793**	0.799**	0.664**	0.855**	0.673**	0.716**	0.887**	**(0.93)**	
CF_RG	0.511**	0.611**	0.627**	0.739**	0.606**	0.516**	0.734**	0.604**	0.797**	0.721**	0.742**	**(0.82)**

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

(Boldfaced) diagonal elements are Cronbach's α's.

n=31

Appendix D
Variable and Item Key

® Reversed Questions		Data Collection Instrument															
KEY		Section 1		Section 2		Section 3		Section 4		Section 5		Section 6		Section 7		Section 8	
DEM	Demographics	Item Number	Designator	Item Number	Designator	Item Number	Designator	Item Number	Designator	Item Number	Designator	Item Number	Designator	Item Number	Designator	Item Number	Designator
OCS	Operational Capability System	1.1	DEM	2.1	OCS	3.1	EOU	4.1	RBPA	5.1	CHAL	6.1	QOCPF	7.1	CLFI	8.1	DEM
OCD	Operational Capability Database	1.2	DEM	2.2	OCS	3.2	EOU	4.2	RBPA	5.2	CHAL	6.2	QOCCC	7.2	CLFO	8.2	DEM
OCT	Operational Capability Tech Support	1.3	DEM	2.3	OCS	3.3	EOU	4.3	RBPA	5.3	CHAL	6.3	QOCSC	7.3	CLFH	8.3	DEM
OCG	Operational Capability Goal	1.4	DEM	2.4	OCS	3.4	RA	4.4®	RBPA	5.4	CHAL	6.4	QOCCC	7.4	CLFR	8.4	DEM
FUN	Funding	1.5	DEM	2.5	OCS	3.5	RA	4.5	RBPE	5.5	LEL	6.5	QOCSC	7.5	CLFI	8.5	DEM
EOU	Ease of Use	1.6	DEM	2.6	OCS	3.6	RA	4.6	RBPE	5.6	LEL	6.6	QOCCC	7.6	CLFO		
RA	Relative Advantage			2.7	OCS	3.7	RA	4.7	RBPE	5.7	LEL	6.7	QOCMQ	7.7	CLFH		
COM	Compatibility			2.8	OCT	3.8	RA	4.8	RBPE	5.8	LEL	6.8	QOCSC	7.8	CLFR		
RBP-A	Reengineering Business Process Appropriateness			2.9	OCT	3.9	COM	4.9 ®	RBPV	5.9	LEL	6.9	QOCCC	7.9	CLFI		
RBP-E	Reengineering Business Process Efficacy			2.10	OCT	3.10	COM	4.10 ®	RBPV	5.10	LEL	6.10	QOCCC	7.10	CLFH		
RBP-V	Reengineering Business Process Valence			2.11	FUN	3.11	COM	4.11 ®	RBPV	5.11	CONL	6.11	QOCWC	7.11	CLFO		
BC	Baseline Continuity			2.12	FUN			4.12	BC	5.12	CONL	6.12	QOCSC	7.12	CLFR		
TLS	Top Level Support							4.13	BC	5.13	REWL	6.13	QOCWC	7.13	CLFI		
DBQ	Database Quality							4.14	BC	5.14	REWL	6.14	QOCWC	7.14	CLFO		
CHAL	Change Leadership							4.15	BC	5.15	REWL	6.15	QOCWC	7.15	CLFH		
LEL	Learning Leadership							4.16	BC			6.16	QOCMQ	7.16	CLFR		
CONL	Continuity Leadership							4.17	BC			6.17	QOCSC				
REWL	Reward Leadership							4.18	TLS			6.18	QOCMQ				
QOC-PF	Quality of Communication Personal Feedback							4.19	TLS			6.19	QOCMQ				
QOC-CC	Quality of Communication Communication Climate							4.20	TLS			6.20	QOCWC				
QOC-SC	Quality of Communication Supervisory Communication							4.21	DBQ			6.21	QOCMQ				
QOC-MQ	Quality of Communication Media Quality							4.22	DBQ								
QOC-WC	Quality of Communication Co-Worker Communication							4.23	DBQ								
CLF-I	Cultural Fit Internal Process							4.24	DBQ								
CLF-O	Cultural Fit Open System																
CLF-H	Cultural Fit Human Relations																
CLF-R	Cultural Fit Rational Goal																

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Vita

Major Walter Yazzie grew up on the Navajo reservation in Northeast Arizona. In his senior year of high school he moved to Mesa, Arizona and graduated from Dobson High School. He attended Brigham Young University, graduated with a Bachelor of Science degree in 1992. In June 1992 he was commissioned through the 855th AFROTC Detachment at Brigham Young University.

Major Yazzie's first assignment was at Laughlin AFB, TX assigned to the 47th Civil Engineer Squadron. While at Laughlin, he was assigned to the contracts element followed by assignment as SABER Chief. His next assignment was the 99th Civil Engineer Squadron, Nellis AFB, NV where he worked as a mechanical engineer, chief of the technical support team, and Readiness Flight Commander. In 1999 he headed south for his remote assignment to Soto Cano Air Base, Honduras. He spent the year as Chief of Operations. In 2000, Major Yazzie reported to HQ USAFE, Civil Engineer Directorate. While at HQ USAFE he was assigned to the Operations division and completed his tour in the Plans and Requirements division. In August 2003, he entered the Graduate School of Engineering and Management, Air Force Institute of Technology. His follow-on assignment is Flight Commander in the 366th Training Squadron, Sheppard AFB, TX.

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14. ABSTRACT

The goal of this research was to develop a data collection instrument for an existing information technology implementation and sustsinment model. In 2003, a unique system dynamics model was developed at the Air Force Institute of Technology to predict the behavior of information technology implementation and sustainment (Fonnesbeck, 2003). However, no empirical data was used during the model development. In order to collect the needed empirical data, this research develops a data collection instrument for the model. The instrument was sent to 60 Air Force community planners who are currently implementing a geographical information system (Air Force GeoBase) into their planning process. The reliability analysis of the instrument resulted in reliability coefficients exceeding the recommended Cronbach's alpha in all but one factor.

The implementation of the model for the first time with empirical data showed promising results. The model output indicated steady increase to implementation completion and solid sustainment there after.

15. SUBJECT TERMS

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