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Understanding Organizational Adoption Theories Through the Adoption of a Disruptive Innovation: Five Cases of Open Source Software

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Understanding Organizational Adoption Theories through the Adoption of a Disruptive Innovation: Five Cases of Open Source Software

by

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Dedication

To my wife, Adrian, whose patience and support knows no bounds.

To my parents, who listened and spoke at the right time.

To Helen, unconditional love changes people.

To Blanche, knowing that courage is in my blood.

To John Chan, showing me how it should be done.

To Ali, 21 miles.

To Saturday night dinners, sanity is undervalued.

To Evan Duggan, Shane Sharpe and David Hale, for inspiration to influence others.

To myself, I thought I could.

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Walter Nord, thank you. Talking over burgers and fries was a nice change of pace. Don Hardaway, thank you. Your insight into open source software is exemplary. So is your patience with my understanding and perception of the subject. I feel as though my understanding grew and has more room to grow. Manish Agrawal, thank you. Your attention to detail has helped me understand where this work fits into a larger picture. Richard Will, thank you. Your support and assistance meant much to me. Charles Kroncke, reassurance comes from unexpected places. Thank you for your help. To Cathy Slagle, one day each summer is not enough time to spend with you. You are an expert who can navigation the intricacies of the administration. Your kindness and help will not be forgotten. To Judy and Nadia. Thank you for your help and your company.

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The Adoption of Disruptive Technologies: The Case of Open Source Software

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ABSTRACT

This dissertation seeks to understand how organizations adopt a disruptive technology, open source software. Five cross-sectional case studies at municipal governments were performed using a theoretical model based off of eight organizational adoption theories. Results of the case studies highlight how each construct from each theory was present at the organizations. However each construct was of variable influence based upon organizational characteristics and the time or stage of adoption.

Chapter 1.

Introduction

Organizational adoption decisions concerning disruptive technologies are complicated as disruptive technologies are not easily identified ahead of time (Daneels 2004). A seemingly incremental change to an innovation in one domain can be applied to a new context with disruptive results (Christenson 2000, Christensen and Raynor 2003). This has led researchers who investigate disruptive technologies to believe that an innovation's impact on an adopting organization can be disruptive in some settings and absorbed as routine in others (Christenson 2000, Christensen and Raynor 2003). Because of the challenge of identifying a disruptive technology many technology adoption theories have overlooked the nature, incremental or disruptive, of an innovation when examining the organizational adoption of new innovations (Lyytinen and Rose 2003).

The few studies that examined the adoption of disruptive innovations have focused on organizational factors, like technical knowledge, administrative intensity and internal communication, and how they influence the adoption of these innovations (Bucher, Birkenmeier, Brodbeck, and Escher 2003, Srinivasan, Lilien and Rangaswamy 2002, and Dewar and Dutton 1986). This focus on organizational factors stems from a rejection of technological determinism; that the technology itself does not influence an organization's adoption of the innovation.

However focus on organizational characteristics discounts other organizational adoption research and theories that propose that environmental factors, such as vendors and technical communities, as well as innovation characteristics, such as relative advantage and compatibility, influence the adoption of new technologies (Rogers 1995, Zhu, Kraemer, Gurbaxani, and Xu 2006).

This lack of research examining how disruptive innovations are adopted by organizations appears to reveal two gaps in technology adoption research. The first gap centers on the nature of disruptive innovations. When an innovation is considered disruptive does its adoption create a disruption in the adopting organization? Second, what characteristics, organizational, environmental, or innovation related drive the adoption of new disruptive technologies?

The purpose of this study was to help close these two gaps in existing organizational adoption research. The study first sought to understand if and how the adoption of a disruptive innovation caused disruptions in adopting organizations. Second the study examined the three different technology adoption perspectives, environmental, organizational and innovation, to better understand how constructs from these three different areas influence the organizational adoption of a disruptive technology.

The disruptive technology examined by this study is open source software (OSS). This type of software is widely acknowledged as a disruptive innovation and provides a context for this study. For a detailed discussion of what this study considers OSS, and how OSS is disruptive, please see appendix item B.

Research Questions

The driving questions of this study seek to understand how the adoption of a disruptive innovation causes disruptions in adopting organizations and how environmental, organizational and innovation factors interact during the organizational adoption of a disruptive innovation. To answer these questions the adoption of OSS, a well established disruptive innovation, was used as a disruptive innovation to answer these questions. Consequently the research questions were revised to account for open source software, changing the first research question to:

1. How does the adoption of open source software result in disruptions to adopting organizations?

With the addition of OSS the second research question was altered to:

2. How do environmental factors, organizational characteristics and innovation characteristics interact during the organizational adoption of open source software?

Dissertation Format

The remainder of this dissertation is organized as follows: Chapter two reviews prior organizational adoption literature. It is divided into two sections which cover organizational adoption theories and prior research examining the organizational adoption of a disruptive innovation, open source software.

Chapter three covers the methods used by this study. The chapter is broken down into sections describing the research approach, data collection, and data analysis. The next chapter, chapter four, describes the findings of this study. This is followed by chapter five which discusses the findings, while chapter six highlights the contributions and limitations of this research and provides future direction for subsequent studies.

Chapter 2.

Literature Review and Research Model Development

The literature review for this study covers two areas of prior research. First, the research model for this study is proposed by reviewing existing organizational adoption theories. Second, literature investigating open source software adoption is reviewed to understand how these studies fit into this study's research model. Further literature examining the nature of OSS and disruptive technologies can be found in appendix item B which discusses disruptive technologies and OSS in detail.

Organizational Adoption Theories

Prior research into the organizational adoption of innovations has resulted in several theories that model organizational adoption of technologies. Most of these theories draw from innovation diffusion literature as opposed to studies examining the individual adoption of innovations. Individual technology adoption research has traditionally focused on the individual while diffusion research has centered upon groups of people. Because organizations are groups of people, diffusion theories appear to align better with the organizational context (Rogers 1995, Fichman 2000).

This section begins by reviewing the differences between adoption and diffusion research, then provides an overview of eight organizational adoption theories. This is followed by an examination of how external entities affect organizational adoption. The next section identifies organizational characteristics and is followed by an examination of how innovation characteristics influence organizational adoption. Finally, a model combining these three factors is then described.

Organizational Adoption and Diffusion

There are differences between technology adoption and technology diffusion. The first part of this section identifies what adoption is and how it differs from diffusion. The second part of this section contextualizes adoption to the open source phenomenon.

Traditional Adoption Stages

Adoption in an organizational context has traditionally referred to a level of awareness and commitment by an individual organization towards a specific technology or idea (Rogers 1995). Meanwhile diffusion is the stage in which the technology has spread through a population of, or group of, entities, be they people, groups or organizations (Rogers 1995). The terms are not independent as diffusion of a technology relies upon individuals, groups and organizations within a population to adopt the innovation. Prior studies have found that adoption may occur at different stages (Rogers 1995, Zahara and George 2002, Cooper and Zumd 1990, Meyer and Goes 1988, and Fichman and Kemerer 1997). If this body of research is combined, five different adoption stages can be identified. Table 1 highlights these stages.

Table 1. Technology Adoption Stages

Adoption Stage	Reference
Knowledge/Awareness	Meyer and Goes (1988), Cooper and Zmud (1990), Rogers (1995), Fichman and Kemerer (1997), Zahra and George (2005)
Evaluation/ Choice/Interest	Meyer and Goes (1988), Rogers (1995), Fichman and Kemerer (1997)
Adoption	Meyer and Goes (1988), Cooper and Zmud (1990), Rogers (1995), Fichman and Kemerer (1997), Zahra and George (2005)
Assimilation/ Routinization	Cooper and Zmud (1990), Fichman and Kemerer (1997), Zahra and George (2005)
Infusion	Cooper and Zmud (1990) Zahra and George (2005)

The first stage of adoption that researchers have found is that of knowledge or awareness. At this stage an organization or individual becomes attuned to the existence of the innovation. This does not mean that the potential adopter is interested or curious about the innovation; they simply know that the technology exists.

Curiosity of how the innovation could integrate into an organization is the second stage of adoption. Organizations and individuals enter this stage of adoption when they begin to gather information about how an innovation might affect existing processes or operations. This stage is characterized by an evaluation of some kind as potential adopters attempt to determine if the technology would be a good fit for their context.

The results of the organizational evaluation determine if the party advances to the third stage, that of actual adoption. Many researchers consider organizations to be adopters once they have purchased or implemented the new technology. However this definition of adoption allows for a broad scope of organizational adoption as organizations can adopt in many different several forms: from pilot programs and stand-alone implementations to organization-wide deployment. These different types of adoption are far from equal, and can easily be confused with evaluation as pilot programs.

The fourth stage of organizational adoption, or assimilation and routinization, is much clearer. Not only is an innovation or technology adopted, but it has been widely integrated into work processes. This indicates that the innovation has become a reliable tool for the adopter to accomplish specific tasks. Therefore the major differences between this stage, routinization, and the third stage, adoption, are the scope of adoption and the time that an innovation has been adopted. Not only is wide-spread adoption needed to reach this stage, but time and some familiarity and comfort with the innovation is necessary.

Following assimilation and routinization is the stage of infusion. At this stage of adoption researchers advocate that the innovation has gone beyond being used as an individual technology. Not only has it become an integral part of a business processes; the adopter has learned how to apply the technology to other uses. This focuses on going beyond the intention or scope of the original implementation to meet other duties that the organization performs.

The five stages of organizational adoption are closely related to another technology adoption phenomenon, technology diffusion. While related to organizational adoption, technology diffusion differs as it is a phenomenon that examines the stage of adoption of a technology by a specific population. This causes the two phenomenons, organizational adoption and technology diffusion, to differ on the unit of analysis. For a technology diffusion study, multiple units of a population need to be examined to determine the adoption stage, or the technology diffusion, of an innovation as their aggregated adoption stage will determine how the innovation has diffused. Meanwhile an organizational adoption study would focus on individual organizations. Based on these definitions, this study is an organizational adoption study as it examined five different organizations, too small a sample size to identify any diffusion trends of a population, but large enough to draw conclusions about individual organizations.

OSS Adoption Levels

Traditionally adoption literature has referred to the different stages of adoption as stages or levels interchangeably. This study separates the terms because OSS appears to be an unusual innovation in that there are different levels of adoption. Grand, von Krogh, Leonard and Swap have proposed that OSS can be adopted at four different levels of adoption (2004). Therefore this study will differentiate adoption stages from OSS adoption levels to better understand how this innovation is being adopted and used by organizations.

Grand et al proposed that OSS has multiple adoption levels after examining a series of business case studies. They concluded that organizations can use open source software as an end product (i.e., as a software package), as a complementary asset (i.e., as a component of a larger product), as a design choice (i.e., as a software design), or as a business model. These adoption levels are different from the traditional technology adoption levels of awareness, interest, adoption, routinization and infusion.

Grand, von Krogh, Leonard and Swap propose that the first level of adoption, using OSS as an end product, involves little organizational commitment to OSS beyond implementation and support. This includes deploying the application, training end users and maintaining the program over time. Organizations can perform these duties internally, or where available, can outsource these tasks to other firms.

The second level of adoption, that of using open source as a complementary asset, focuses on integrating OSS with proprietary software or hardware to create a hybrid product. This level of commitment is thought to increase organizational commitment to include open source development as organizations at this level need to integrate OSS with proprietary products. The need to integrate the two technologies implies that organizations need to be proficient enough with open source development to integrate OSS with proprietary technologies.

Commitment to OSS is taken a step further with the decision to utilize an open source design. This third level of adoption proposes that organizations fully abandon the proprietary paradigm and rely extensively on open source communities to supplement development and innovation. It is not quite clear if there are situations where organizations can adopt an open source design and not adopt an open source business model, the fourth level of adoption.

Open source business models constitute the last level of adoption. This includes selling implementation, support, training, customization, and proprietary add-ons. However if the sale of proprietary add-ons is an open source business model, then perhaps the identification of the complementary asset level is not a stand alone level of adoption. Regardless, Grand et. all identify unique characteristics of OSS adoption and highlight how this technology differs from traditional software.

Because organizations appear to have different adoption stages and OSS adoption levels these variables are used to refine this study's model. OSS adoption levels are thought to moderate the disruptive effect of OSS adoption based upon the level of OSS adoption. These ideas are incorporated into the model and are highlighted in Figure 1.

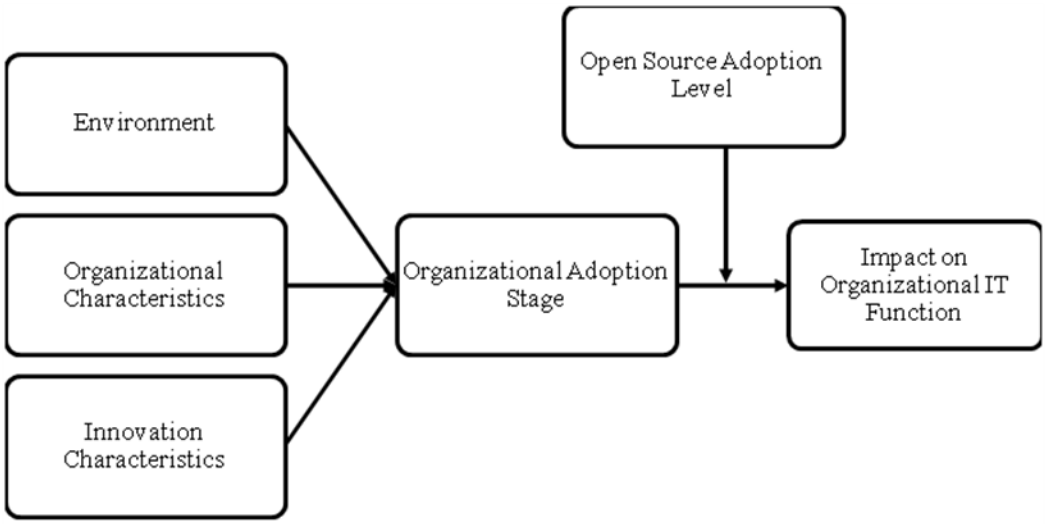

Figure 1. Study Model Overview

Organizational Adoption and Diffusion Theories

Nearly all adoption and diffusion theories can trace their origin to elements of Everett Rogers' (1995) landmark work, The Diffusion of Innovations. This ground-breaking research compiled hundreds of case studies on innovation adoption and resulted in Rogers' Innovation Diffusion Theory. However, as important as the Innovation Diffusion Theory is, researchers have yet to create an overarching theory explaining technology diffusion (Fichman 1992). Theoretical work in this area generally focuses on a specific construct identified in Rogers' Theory, i.e. the innovation, the adopter, or the environment surrounding the innovation (Fichman 2000).

This study examining the adoption of OSS uses eight organizational adoption theories to develop a preliminary model to examine the adoption of OSS. Table 2 highlights these theories, describing their constructs and how they relate to the preliminary model.

Table 2. Organizational Adoption Theories

Theory	Reference	Main Assertions	Factor Described
Innovation Diffusion Theory	Everett and Rogers (1995)	The characteristics of the innovation, how innovative the adopter and the communication channels influence adoption	Innovation, Organizational Characteristics and Environment
Technical Knowledge and Know-How	Attewell (1992)	Organizational knowledge and know-how determines the adoption of an innovation	Organizational Characteristics, Environment
Organizational Resources	Damanpour (1991)	Organizational resources and characteristics determine the adoption of an innovation	Organizational Characteristics
Managerial Fashion	Abrahamson (1991)	Organizational adoption is influenced by peer adoption	Environment
Network Externalities	Katz and Shapiro (1986)	Technical network externalities and third party sponsorship determine the adoption of an innovation	Environment Innovation
Critical Mass	Markus (1987)	Information technologies need to have a critical mass of adopters before they achieve widespread adoption	Environment
IT Context	Swanson (1994)	Innovations are adopted based upon a contextual purpose	Innovation
Routine vs. Radical	Nord and Tucker (1987)	Innovations are adopted based upon how similar or different they are relative to other organizational technologies	Innovation

Environmental Constructs

Of the eight theories identified in Table 5, five identify constructs relate to external parties that influence the adoption of innovations. These constructs focus on communication channels, peer adoption and third party sponsorship. Table 3, Environmental Constructs, summarizes these external organizational variables thought to influence the adoption of OSS.

Table 3. Environmental Constructs

Construct	Theory	Reference	Description
External Communication	Innovation Diffusion Theory	Rogers (1995)	The different methods of communicating with external organizations
Peer Adoption	Critical Mass, Managerial Fad and Fashion	Markus(1987), Abrahamson (1991)	Innovation utility becomes increasingly effective based on peer adoption Peer adoption influences organizational adoption
Vendor Relations	Network Externalities, Technical Knowledge	Katz and Shapiro(1986), Attewell (1992)	Vendors supply services and technology standards to organizations
Technical Community	Technical Knowledge	Attewell(1992)	Communities surrounding technologies supply technical knowledge

External communication, or how adopters communicate the benefits of an innovation between one another, are identified by Innovation Diffusion Theory (Rogers 1995). They are important because they influence how adopters become aware of the benefits of new innovations, influencing the first two levels of adoption, awareness and curiosity. Rogers found that communication channels can be formal, or based on relationships that are clearly defined, or informal, those relationships that are not clearly defined (Rogers 1995). Subsequent research into the adoption of innovations has verified the importance of these channels in generating awareness about innovations (Ball, Dambolena and Hennessey 1986, Nilakanta and Scamell 1990). Because communication channels appear to be critical in building the awareness and curiosity of the first two stages of adoption they will be included in the model at the external organizational level.

Communication channels are closely linked to another construct: peer adoption. Peer adoption appears to be important for two main reasons. First, some innovations, like the telephone and email are considered critical mass innovations; they become increasingly effective as more parties adopt the innovation (Markus 1987). This implies that organizations are more likely to adopt an innovation with critical mass characteristics if their peers also adopt the innovation. Therefore this study will examine if organizations believe that OSS adoption becomes more effective if their peers also adopt the innovation.

Secondly peer adoption may influence organizational adoption of innovations as a technology can become fashionable to adopt (Abrahamson 1991). Abrahamson stated that fashion may influence adoption in two ways. First organizations may adopt an innovation to imitate another organization or for original reasons. Secondly the origin of the adoption may come from within the organization or from outside of the organization. This implies consultants or other external organizations can influence the adoption of an innovation by sponsoring the innovation, which is the third construct identified by examining theories focusing on external organizations.

In addition to Abrahamson's, two other theories indicate that third parties influence the adoption of innovations. Katz and Shapiro's Network Externalities theory proposes that technology vendors are one such organization (1986). They influence the adoption of an innovation in two ways. First vendors sponsor a technical standard. This determines how innovations integrate and ultimately which innovations can work together (Katz and Shapiro 1986). Secondly vendors provide services for their innovation. They create support structures for their innovations that increase the awareness of, and facilitate the use of, their innovations (Katz and Shapiro 1986).

This is closely related to Attewell's theory of technical knowledge and know-how (1992). Attewell claims that innovations are not only adopted because of the awareness of their benefits, but also because of organizational knowledge and know-how relating to the application and use of that innovation. Innovation knowledge is thought to go through a cycle in which technical knowledge about a specific innovation is known by a select few innovators who created the invention. These individuals are thought to then form an organization through which they can then sell their expertise on the innovation to other organizations. These adopting organizations are then thought to internalize the technical knowledge and know-how of the innovation, creating an organizational learning cycle.

Because three theories, Abrahamson's Fad and Fashion, Katz and Shapiro's Network Externalities, and Attewell's Knowledge and Know-how, focus on the roles of external organizations this study will also examine their influence in the adoption of OSS. How these organizations help set managerial trends, set technical standards, and supply technical knowledge will be examined. The constructs identified by reviewing organizational adoption theories conceptually develop variables identified by the organizational level definition of disruptive technologies.

Organizational Constructs

Like studies examining the organizational adoption of disruptive innovations, organizational adoption research has often focused on organizational characteristics. These studies have highlighted many factors outside of environmental scanning and capability building as affecting the organizational adoption of innovations. When looked at in aggregate, three groups of organizational characteristics appear to influence the adoption of innovations: structure, knowledge, and size. Table 4 highlights the organizational constructs identified in this section that will be examined by this study.

These factors are categorized into three groups, structure, knowledge and size, to theoretically develop this study's adoption model.

Table 4. Organizational Constructs

Construct	Theory	Reference	Description
Structure • Internal Communication • Administrative Intensity	Innovation Diffusion Theory, Organizational Resources	Rogers(1995), Damanpour (1991)	How organizations are organized to accomplish their tasks determines adoption
Knowledge • Environmental Sensing • Technical Knowledge	Organizational Resources, technical knowledge	Damanpour (1991), Attewell(1992)	Pre-existing organizational knowledge and how organizations sense and absorb new information determines adoption
Size • Wealth • Slack resources	Organizational Resources	Damanpour (1991)	The amount of organizational resources are thought to determine adoption

In his meta-analysis of organizational adoption factors Damanpour examined many of these factors from all three groups, structure, knowledge and size (1991). With regards to organizational structure Damanpour highlighted that prior studies examining organizational adoption had identified the following structural factors: communication, centralized/decentralized decision making, formalities, and administrative intensity to determine how organizational structure affects the adoption of innovations (Damanpour 1991). When he tested his meta-analysis, Damanpour found that of these factors only communication and administrative intensity were statistically significant structural factors that explained organizational innovation adoption when the radicalness of innovations was taken into account as a moderating factor (1991). Therefore this research will examine these two structural factors when investigating the adoption of OSS by organizations.

Organizational knowledge has also been tested and accepted as a factor determining the adoption of innovations (Fichman and Kemerer 1997). This factor appears to have three components which include the ability to sense new information in the environment, the ability to apply and internalize this information and existing technical knowledge (Cohen and Levinthal 1990, Damanpour 1991, Attewell 1992, Fichman and Kemerer 1997, Zahara and George 2002). Prior research into the adoption of disruptive innovations has highlighted the importance of environmental sensing and the ability to internalize this information (Srinivasan et. al 2002, and Bucher et. al 2003). These aspects, environmental scanning and technical knowledge will also be examined to better understand how these constructs effect the adoption of OSS by organizations.

Finally the third organizational characteristic that studies have examined is organizational size. Size is thought to be a proxy for variables such as scale, wealth, specialization and slack resources, factors found to have a positive impact on organizational adoption of innovations (Tornatzky and Fleischer 1990, Damanpour 1991). In keeping with these prior studies, this research will also examine organizational size.

Innovation Constructs

Fundamentally organizations adopt an innovation to get some kind of intended benefit. These benefits are not always straightforward, as there are several characteristics that have been found to influence an innovation's overall utility. Four theories of organizational adoption focus on innovation characteristics. Innovation Diffusion Theory provides the foundation for the other three theories by identifying five classic characteristics: relative advantage, compatibility, complexity, trialability and observability (Rogers 1995). These characteristics are highlighted in Table 5.

Table 5. Innovation Diffusion Innovation Characteristics

Characteristic	Description	Effect on Adoption
Relative Advantage	The degree to which it is perceived to be better than what it supersedes	Positive
Compatibility	consistency with existing values	Positive
Complexity	difficulty of understanding and use	**Negative**
Trialability	The degree to which it can be experimented with on a limited basis	Positive
Observability	The visibility of its results	Positive

However the importance of all five characteristics has been called into question as trialability and observability were not found to be significant by a meta-analysis of innovation characteristics, but were found to be important in a subsequent study (Tornatzky and Klein 1982, Moore and Benbasat 1991).

To simplify this study only the relative advantage, compatibility and complexity of OSS will be examined. This is done as the goal of this research does not center on clarifying the importance of trialability and observability but rather how these different groups of theories, environmental, organizational and innovation interact. To this end this study will focus on characteristics that have been consistently proven important with organizational adoption, relative advantage, compatibility and complexity. These characteristics are present in three other theories, Network Externality Theory, Routine vs. Radicalness Theory, and IT Context Theory.

Network Externalities Theory, as proposed by Katz and Shapiro, stresses the importance of technical standards and innovation integration. This is very similar to

Innovation Diffusion Theories compatibility construct which has traditionally focused on consistency with existing organizational values.

Nord and Tucker also extended the compatibility construct with their theory of Routine vs. Radicalness. Their extension focuses on prior activities taken by the organization. How similar an innovation's characteristics and purpose are relative to what an organization has already performed is thought to constitute a degree of radicalness which is thought to influence the adoption of an innovation.

Finally Swanson's theory of technical context proposes that innovation characteristics can have differential effects depending on the use of the innovation. This appears to be similar to Roger's relative advantage construct which has traditionally meant the degree to which an innovation is perceived to be better than what it supersedes (Rogers 1995). Swanson extends this characteristic to include the context in which an innovation is used as opposed to a pre-determined relative advantage of a given innovation.

This study will examine modified versions of Roger's innovation characteristics of relative advantage, compatibility and complexity to examine the organizational adoption of OSS. Table 6 reviews the innovation level constructs that this study will investigate.

Table 6. Innovation Constructs

Construct	Theory	Reference	Description
Relative Advantage	Innovation Diffusion Theory, IT Context	Rogers (1995), Swanson (1994)	The degree to which an innovation is perceived to be better than what it supersedes within a task context
Compatibility	Innovation Diffusion Theory, Network Externalities Theory, Routine vs. Radical	Rogers (1995), Katz and Shapiro (1986), Nord and Tucker(1987)	The degree to which an innovation is perceived to be compatible with existing organizational values, activities and technologies
Complexity	Innovation Diffusion Theory	Rogers(1995)	The degree to which an innovation is difficult to understand

A Combined Model of OSS Adoption

This chapter has reviewed adoption literature to identify specific constructs and variables that will be examined by this study to understand both the adoption of OSS and its effect on the IT function of organizations. A combined model identifying all of the factors this study will examine is shown in Figure 2.

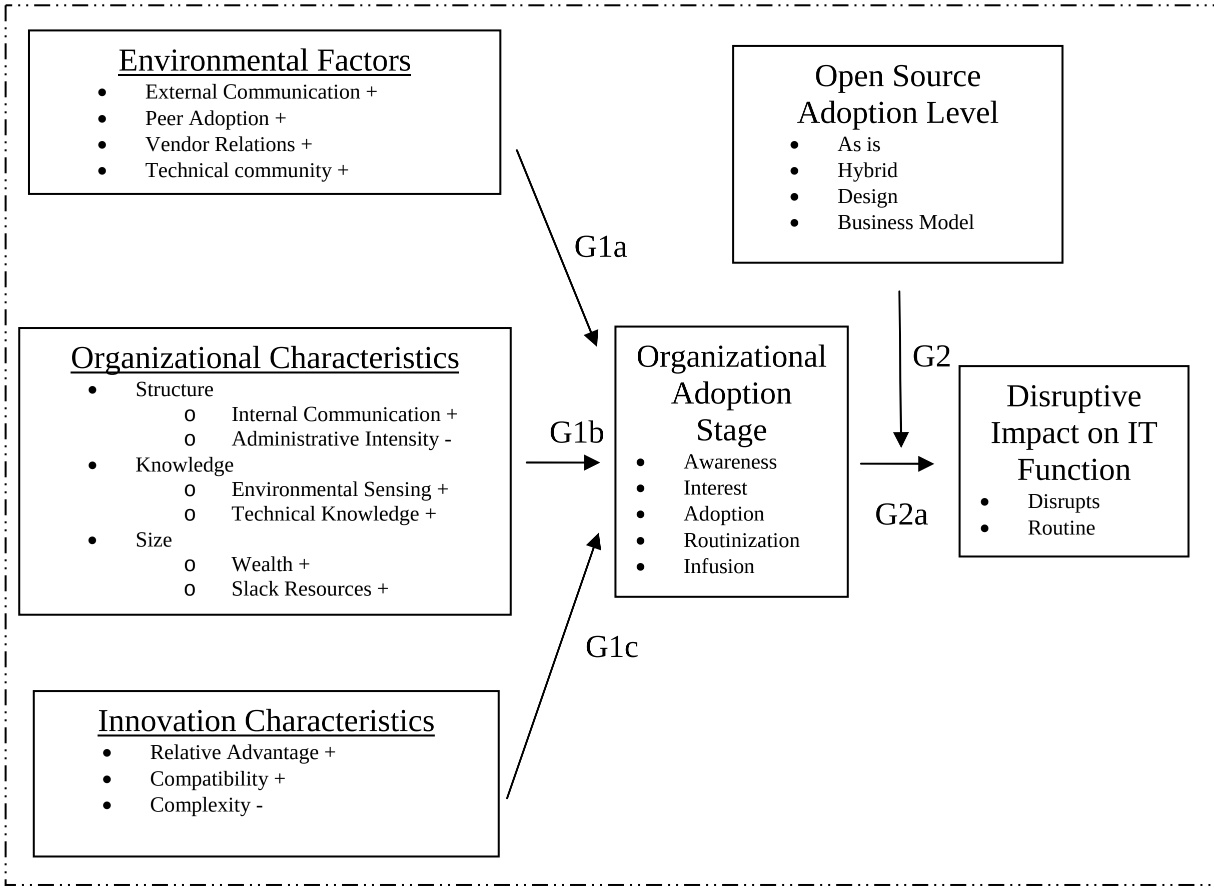

Figure 2. Study Model – Constructs Identified

The model highlights the relationships of the constructs examined by this literature review. But more importantly the model provides a theoretical foundation to investigate the research questions. Relationships G1a, G1b, and G1c allow for testing of the second research question investigating the adoption perspective. Meanwhile G2a and G2b address the disruptive nature of the adoption of OSS.

Open Source Software Adoption

The final section of this literature review examines existing research investigating OSS adoption and how this research fits into the adoption model. To date there have been four studies examining OSS adoption. They are summarized in Table 7, Prior Research into Open Source Adoption. Three of the four studies focus on the adoption of Linux, an open source operating systems, rather than OSS adoption in general. The fourth study, while examining multiple open source applications focused on adoption barriers rather than the adoption of OSS.

Table 7. Prior research into open source adoption

Reference	Theory	Findings	Constructs Tested
Chau and Tam's (1997)	Innovation diffusion theory	Perceived barriers, internal technical standards, compatibility and satisfaction with existing systems were found to be statistically significant factors for open systems adoption.	Technical Knowledge +, Technical Standards +
Goode's (2004)	Exploratory research	Perceived lack of relevance, lack of support, lack of resources, commitment to Microsoft and a perception that open source software was not commercial were the driving factors of firms to reject open source software.	Technical Knowledge +, Vendor Services +, Technical Standards +
Peng (2005)	Innovation diffusion theory	Linux adoption by software service providers followed a bell-shaped curve as predicted by innovation diffusion theory.	Peer Adoption +
West and Dedrick (2006)	Inductive theory	Internal technical standards and organizational uses that limited the scope of the OSS were found to be significant factors in determining adoption.	Vendor Standards +, Technical Standards +, Administrative Intensity -

Chronologically, the first study, Chau and Tam's, examined factors affecting the adoption of open systems (1997). The phenomenon that they investigated would be officially named open source a year later in 1998. Because of this Chau and Tam spent a portion of their research in identifying what open systems were and they accurately described an open source operating system like Linux. They based their adoption model for organizational off of elements of Innovation Diffusion Theory (Rogers 1995).

To test their model they conducted eighty-nine interviews of both technical and non-technical managers. They found that the perceived barriers to adoption, internal technical standards, compatibility and satisfaction with existing systems were all statistically important factors determining the adoption of open systems. These factors are captured in this study's model and should be validated by this research.

In 2004 Sigi Goode's examined why organizations reject OSS. By surveying 500 of Australia's top public companies, Goode found that there were seven main reasons why organizations did not use open source software. These reasons include a lack of relevance, a lack of technical support, minimal or no business requirements, insufficient resources, a commitment to Microsoft, a belief that open source software was not commercial and no time. Goode's findings appear to highlight technical knowledge, technical standards and vendor support, or the availability of technical knowledge and services from vendors. This study captures these factors in the research model and should validate them.

The first study to specifically examine Linux adoption was conducted by Zheshi Peng (2005). Peng used Innovation Diffusion Theory to investigate how adoption stage, the number of suppliers and supplier partnerships impacted the adoption of Linux and Linux product offerings at an industry level. Peng created a research model that integrated Roger's Innovation Diffusion Theory with Moore's Technology Adoption Life Cycle and the Density-Dependence Model. He then tested this model by performing a secondary data analysis of over 3,300 business articles starting from 1993 and ending in 2003.

His had three main findings, those concerning new suppliers, new product offerings and new Linux partnerships. Peng found that while new suppliers followed a bell-shaped pattern proposed by Innovation Diffusion Theory, new product offerings and new Linux partnerships did not. Instead new product offerings experienced a slow steady increase that had, at the time of the study, yet to plateau or slope downward. New Linux partnerships followed a similar trend, slowly increasing over time. These findings are incorporated into this study's model in the vendor relations construct.

The final adoption study examined in this literature review also investigates Linux adoption. Conducted by West and Dedrick (2006), this research focused on OSS adoption in the context of being a technical standard. Linux was proposed as a new standard, i.e. open source as opposed to proprietary, and they sought to understand how it might be adopted in the presence of both network effects and switching costs that favor incumbent technologies.

Taking an interpretive approach, West and Dedrick interviewed twenty-one MIS managers or executives at fourteen different MIS departments. They then refined aspects of inductive theory and constructs from Network Externality Theory (Katz and Shapiro 1986) and Chau and Tam's (1997) work in open standards adoption to arrive at three main conclusions. Their first conclusion was that standards adoption was influenced by vendor support of for a standard. Organizations appear to rely upon vendors standards to facilitate the integration of different systems.

This was followed by evidence that the technical standards of innovations were also important for Linux adoption. West and Dedrick found that systems that had reduced scope and hardware requirements increased the likelihood of Linux adoption.

Finally the authors found that administrative intensity of an organization in setting standards and practices also effected the adoption of Linux. Organizations that focused on a single standard, either through employee certifications or legal commitments, appeared to focus on those standards. This decreased the likelihood of Linux adoption unless Linux was the organizational standard that organizations adhered to.

These three factors, vendor standards, technical standards and administrative intensity are accounted for in the research model. Additionally West and Dedrick’s study gives credibility for adoption studies to examine all three factors, environmental, organizational and innovation, when determining the adoption of OSS. Existing literature examining the adoption of OSS provides confirms how a number of factors from this study’s research model have already been examined in the context of open source software adoption. Collectively these studies serve to validate the research model, as these studies highlight environmental, organizational and innovation specific factors as influencing adoption. However none of these prior works highlight any disruptive consequences, if any, of adopting OSS, nor do they identify a specific theory or group of theories as being influential in understanding the adoption of OSS.

Chapter 3.

Research Design

This chapter describes the methods and philosophical perspective used for this study. First the research questions and theoretical model guiding the study are reiterated. Next an appropriate research method, case studies, is identified to answer these questions. After this a section highlights how the data were collected, analyzed, and interpreted. Finally the chapter is summarized, highlighting the methods used by the study.

Research Questions

The research questions asked in this study seek to close two gaps in organizational adoption literature. First, does the adoption of a disruptive technology, like OSS, cause disruptions in adopting organizations. This gap in organizational adoption research drives the first research question:

1. Does and if so how does the adoption of open source software result in disruptions to adopting organizations?

The second gap in organizational adoption literature concerns factors impacting the organizational adoption of innovations. Technology adoption researchers have identified environmental constructs, like vendors and third parties, organizational constructs, like administrative intensity and technical knowledge, and innovation constructs, like relative advantage and compatibility, that influence the adoption of new innovations. How these constructs interact during organizational adoption is unclear. This creates a theoretical gap that the second research question seeks to answer.

2. Do, and if so how do environmental factors, organizational characteristics and innovation characteristics affect the organizational adoption of open source software?

The literature review conducted in chapter 2 identified eight different organizational adoption theories. These theories were combined with research about OSS adoption to create a theoretical model for this study. However, because existing literature does not provide direction or evidence of how these factors interact or when these factors influence organizational adoption, there is a great deal of uncertainty as to how these factors affect the adoption of innovations like OSS.

Because different organizational theories propose constructs that influence organizational adoption, but do not integrate these different constructs, no single theory or group of theories is available to guide this study. Instead there is an abundance of competing organizational adoption theories that do not account for one another. This lack of organization between organizational adoption constructs leaves a gap in theory. Because of this gap in understanding how these constructs interact, a case study methodology was selected.

Appropriateness of Case Study when lacking theoretical guidance

According to Yin (2002) a case study is useful for inquiring about a contemporary phenomenon within its real-life context and is especially suited when the boundaries between the phenomenon and context are not clear (Yin 2002). Benbasat et al. (1987, p.

370) agree with Yin in his assessment of the appropriateness of case studies. They claim that they are appropriate when “The boundaries of the phenomenon are not clearly evident at the outset of the research and no experimental control or manipulation is used” (Benbasat et. al 1987).

Furthermore Benbasat et. al promote case studies for IS research at an organizational level. They claim that the object of management information systems (MIS) as a discipline focuses on understanding information systems within organizations. Therefore the case study is of special importance because “interest has shifted to organizational rather than technical issues” (Benbasat et al. 1987).

These researchers advocate the use of case studies in the absence of theory. This study will use case studies not because of an absence of theory, but because of a lack of theory linking together the constructs of extant theories that affect the same phenomenon, organizational adoption of OSS.

Research Methods – Case Study

According to Orlikowski and Baroudi (1991) the case study is the most common qualitative method used in IS research. The case study has multiple definitions as it can be used as either a unit of analysis, as in an individual case, or as a research method, through a case study (Stone 1978, Benbasat 1984, Yin 1984, Bonoma 1985 and Kaplan 1985). This research uses case studies in both ways; by using semi-structured interviews with individuals who work in IT departments, the case study methodology is employed. By analyzing five different case sites the study also uses cases as a unit of analysis.

Criticism of Case Studies

Critics of case studies often point out that case study researchers have problems making controlled observations and deductions. Their proximity to the phenomenon, when combined with potential biases and prejudices often leads to conclusions that are difficult for others to replicate. Because of difficulty in replicating studies, it is also difficult to generalize findings to larger populations (Lee 1989). This research examined a series related organizations, which, according to Lee this should reduce these short-comings, allowing for a better description of the phenomenon (Lee 1989).

Research Lens – Organizational Adoption Model

Because the literature review conducted in Chapter 2 resulted in a research model that provides a starting point for this study. Rather than start with a blank sheet, constructs from established theories serve as a guide for this study. This model grounds this research by providing points of inquiry based upon existing constructs. The constructs from the eight theories were used to create a list of interview questions that were asked in semi-structured interviews. These questions can be found in Appendix D, Interview Questions, while the research model, Figure 3 is shown below.

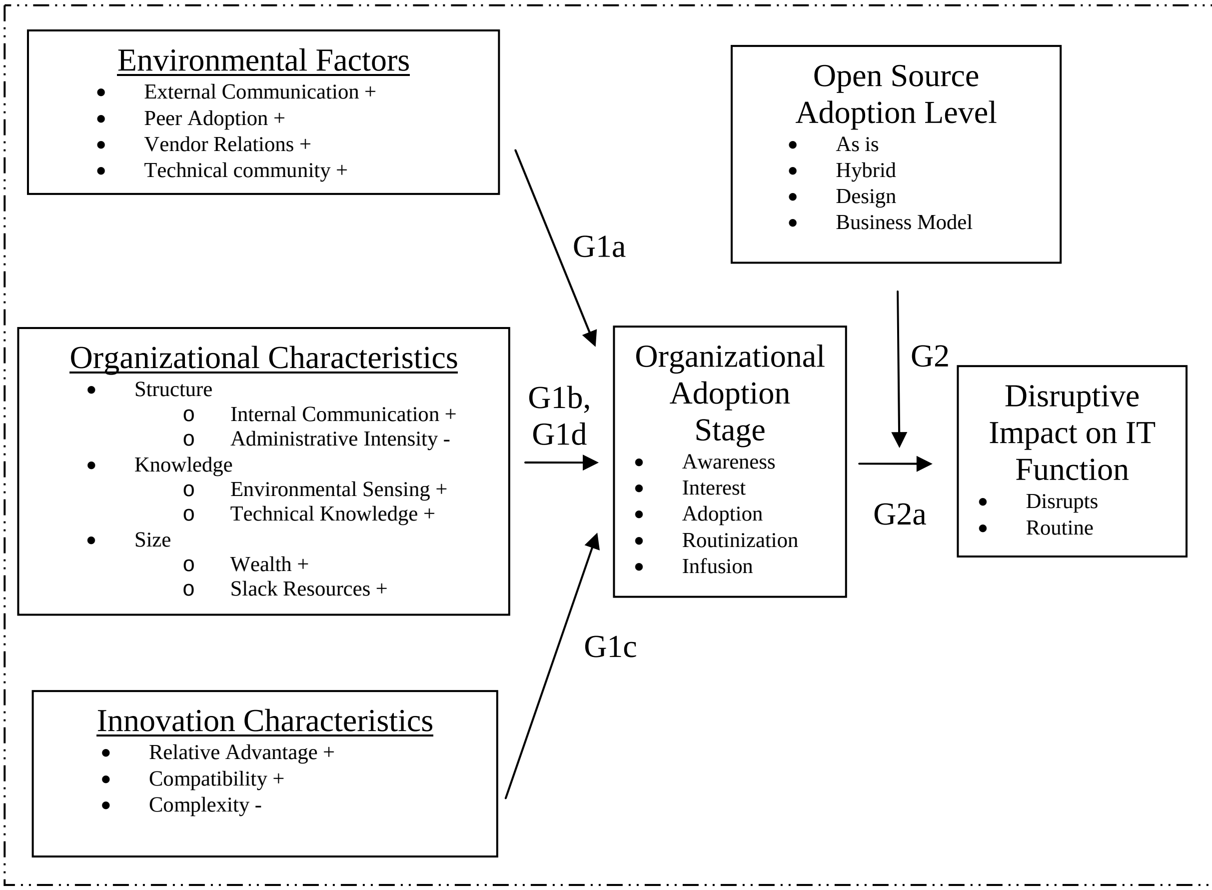

Figure 3. Study Model - Restated

The study uses a model to provide a framework through which the case studies can be conducted. This allows for a starting point, as prior research has already identified the constructs. However, because prior research does not identify the relationships between constructs, the relationships between the different groups of constructs, seen in the model as relationships G1 (a-d) and G2 (a-b) became the focus for the semi-structured interviews conducted during this study. Model relationships, G1 (a-d) and G2 (a-b), created guiding research questions that supplemented the study's research questions, leading to the examination of relationships between model factors.

For example, in response to the second research question, ‘How do environmental factors, organizational characteristics and innovation characteristics interact during the organizational adoption of open source software?’ four guiding questions G1a, G1b, G1c and G1d are asked.

G1a – How do environmental adoption constructs operate during OSS adoption by organizations?

Or more specifically,

G1a – How do external communication, vendor relations, peer adoption and technical communities affect OSS adoption by organizations?

G1b – How do organizational constructs operate during OSS adoption by organizations?

Or more specifically,

G1b – How does internal communication, environmental sensing, technical knowledge, wealth, slack resources, and administrative intensity affect OSS adoption by organizations?

G1c – How do innovation constructs operate during OSS adoption by organizations?

Or more specifically,

G1c – How do the relative advantage, compatibility, and complexity of OSS affect OSS adoption by organizations?

And finally guiding question G1d follows existing literature by placing an emphasis on the different groups of different organizational factors driving adoption by asking:

G1d – Is the adoption of open source software is better explained by organizational characteristics as opposed to environmental factors or innovation characteristics?

The model also addresses the first research question, ‘How does the adoption of a disruptive innovation result in disruptions to the adopting organization?’ For OSS to be disruptive to organizations, it must first be adopted by an organization. Once adopted, organizational adoption stage of OSS is then anticipated to affect the organizational IT function. Prior research proposes that adoption stages of adoption, routinization and infusion are thought to disrupt the IT function while adoption stages of awareness and interest are not. This provides a foundation for G2a, the second guiding question:

G2a – Do OSS Adoption stages of adoption, routinization and infusion disrupt an organization's IT function in terms of implementation, operation, and support?

As the model highlights, disruptions caused by the adoption of OSS are thought to be moderated by the level of OSS adoption. Organizations that adopt OSS at all levels are thought to be disrupted, but the disruptions are proposed to be larger at higher levels of OSS adoption. This relationship provides another guiding question for this study, formally ask in G2b:

G2b – Does open source adoption level moderate the disruptive impact of OSS on the organizational IT function, with lower levels of adoption having less disruptive effects?

These guiding questions created a list of questions that were applied in semi-structured interviews to study participants. Study participants, both the case sites and individuals interviewed, and questions asked during the semi-structured interviews are more fully covered in the next section, Data Collection.

Study Participants

To increase the likelihood that this study's results would be generalizable to similar organizations a comparative case study method was selected. This involved recruiting five different municipal IT departments which makes the research method and the unit of analysis a case study method.

The five that participated were out of a group of eleven that were contacted. This group was formed as these eleven municipal governments were of similar size, serving over 75,000 citizens.

Municipal IT departments were invited by contacting the head of the municipal IT department by telephone. During the telephone conversation an invitation to participate in this study was offered. As part of the conditions site anonymity was assured. Additionally participants were given access to study's results and a review of other IT department practices including training, knowledge management and cost cutting measures. Five of the eleven municipal IT departments agreed to participate.

Municipal IT departments of cities having more than 75,000 residents were selected for a variety of reasons. First, the governments of cities this size mirror medium to large size organizations in terms of budget and personnel. As table 1 in appendix item E shows, the smallest of the participating municipalities had a city budget over 125 million dollars while the largest municipalities had city budgets over 725 million dollars.

Second, because municipal governments are in the same industry; that of local government, use of multiple local government cases appears to increase the likelihood of study results being applied within the industry.

Third, municipal IT departments were selected because the researcher had no prior connection to the municipal IT context. This was done to limit biases or preconceived notions about the context, especially when interpreting the interviews.

Finally municipal IT departments, like most organizations, are not in the IT industry. Although these departments focus on information technology, they, like most businesses, do not create, manufacture or sell technology to customers. This makes municipal IT departments less likely to be cutting edge innovators or early adopters of new, disruptive information technologies like OSS, and follow technology adoption patterns more common to other business industries.

Participation by the municipal IT department members was not random. Study participants were chosen by the municipal IT department. Additionally the municipal IT department scheduled the interviews, determining the ordering of when the interviews were conducted.

Data Collection

In this study two main methods were used to collect data, face to face semi-structured interviews and site documents. Face to face interviews followed a semi-structured approach because the interviews lasted between thirty minutes and an hour. In this brief time the researcher sought to understand the different factors surrounding OSS adoption, the disruptions the technology possibly created and the relationship between the constructs. The interview script, Appendix Item C, provided a basis for the questions asked study participants, but, it should be noted that not every question was asked of every participant as the time allotted for the interviews was limited. Rather, as the semi-structured format allows, the researcher focused on understanding the relationships between the study constructs and the drivers of OSS adoption. This is a well accepted form of data collection as premier journals in several fields have published work based upon semi-structured interviews (Repenning and Sterman 2002, Brusoni, Prencipe and Pavitt, 2001, Levina and Ross 2003, Pinsonneault and Rivard 1998).

Questions were asked of participants from the interview script which was based upon the study model. Follow up questions were then asked to understand the relationships between study constructs and effects caused by the adoption of OSS. These questions varied by participant. Some interviews followed the script; other interviews resulted in unusual responses that led to unique follow up questions that were not asked of other individuals.

Interviews were conducted by the primary researcher at the participating municipal IT departments between October of 2007 and April of 2008. The interviews were digitally recorded and then transcribed for analysis which will be discussed in the data analysis section.

Rather than interviewing individuals of similar organizational role, it should be noted that study participants were of varying organizational role and level within their municipal IT department. Participants included executives, such as Chief Information Officers or Directors of Information Technology, as well as area managers, such as Managers of the Database Area or Managers of the Networking Area, as well as operations personnel within these different areas, such as Database Analysts or Programmer Analysts. The variation in participation at each site allowed for a spectrum of evidence to be collected from the study participants.

The second method of data collection was an examination of site documents. These documents included city websites, budgets, organizational structure, reports and other documentation. These documents supplemented the interviews and helped flesh out an understanding of the five participating IT departments. Documents included organization charts, organization mission statements, statements of individual responsibilities, job descriptions, lists of equipment and other details of the participating departments.

Data Analysis and Interpretation

Data collected from this study were analyzed at two levels. The first level of analysis was the individual case study. At this level of analysis individual interviews were examined by coding the interview transcripts according to the interview script. Questions asked study participants can be found in Appendix item C. The coding schema used to code the interviews is also in the appendix, Appendix item A.

Because coding was done in alignment with the study model, selective coding was used. Selective coding was done by two coders who were trained by the researcher. The coders had an initial coding accuracy of 92%, or 92% of their codes matched both the other coder and the study's coding schema. The coders were later able to agree on 98% of the total codes when they reconciled the research codes with the primary researcher of the study.

Coding was done according to strips or segments of interviews that mentioned study constructs. Because strips or segments could mention several topics, the same strip or segment could be coded for multiple constructs as the dialogue could contain more than one meaning. For example:

> *"We started transitioning into Linux because when it came out – and it just kind of like caught on. There was so much more software available on it. It wasn't like SCO was expensive and SCO was really stable, but I mean things like when*

Mozilla would come out, you would get like all the new ones on Linux right way, and there would be like one version that came out on SCO you'd have to wait a year and a half to get the one that came out and handled whatever you wanted to do." – Roswell - Systems Administrator A

This strip was given multiple codes as it identifies several constructs in the study model. As the interviewer states, the department transitioned to Linux, an OSS. Because the technology was routinely used at the time of the study, it received an adoption stage code of routinization. This also included the adoption stages of awareness, interest, and adoption as the organization needed to progress through these levels to achieve a routinization adoption stage. Additionally the strip highlights an innovation construct, relative advantage as the participant identified more frequent updates as being superior or more desirable than less frequent updates. Therefore the strip was also coded for identifying a relative advantage of OSS.

Because the interview script contained questions focusing on the different constructs used in the study model, coding of the interviews confirmed that the constructs existed at the site. Coding transcripts according to the model constructs also facilitated a general understanding of how the constructs affected OSS adoption stages, adoption levels and disruptive effects. However coding the interviews to the study model did not clarify the relationships between the constructs, the relative effects of the constructs, or what drove the constructs within the organization.

Rather, this understanding, how constructs were related to one another and what drove the constructs in the organization, was interpreted by the researcher. Understanding how the constructs were related to one another was done by interpreting both model constructs and contextual themes at the participating site. To do this, the researcher asked further questions of himself, such as:

"What drives OSS adoption here?"

"How is the organization adopting OSS?"

"Why is the organization adopting OSS?"

By asking these secondary questions case themes, or contextual drivers associated with an IT department's adoption of OSS, were able to be identified. These themes appeared to provide an explanation of what drove the factors at each site. Additionally, like other case studies, more than just facts related to the model constructs were discovered. Rich data about the context and how the model constructs interacted revealed how model constructs interacted with one another and how the context of the municipal IT department affected the constructs themselves.

Analysis was also conducted across the cases. By examining the different site themes and contrasting them with organizational factors, a deeper understanding of the OSS adoption patterns of local government was interpreted by the researcher. This interpretation was based upon re-occurring trends and themes as characterized by the adoption of OSS by study participants. The product of this interpretation was insight into the nature of the municipal IT department, understanding of how organizational adoption theories interacted with one another, and the identification of two additional constructs that appear to integrate or facilitate existing organizational adoption constructs.

After the cases were analyzed, the constructs were assigned an impact value, high, medium or low. This value was based upon the researcher's interpretation of the construct during OSS adoption. Furthermore constructs were interpreted as having an overall impact value on OSS adoption as well as having impact values during different adoption stages. This allowed for a relative comparison of the importance of different constructs during the process of OSS adoption.

Research methodology: Summary

This chapter has outlined the methodology employed to gather and analyze the data for this research. A case study method using semi-structured interviews which based questions on a theoretical model was used to gather data. Five municipal government IT departments provided a setting for the study. Their participation set the context outside of the IT industry in organizations similar to medium sized businesses.

The theoretically generated model was used as a basis for the semi-structured interviews which allowed for a deeper understanding of constructs and the forces driving the model constructs. Data were analyzed as individual cases and across cases. Analysis of individual cases centered on first coding strips from the transcripts. These coded totals were then interpreted, along with contextual information from the interviews, by the researcher to interpret driving themes for OSS adoption at each case site. The five case sites were then interpreted by the researcher, allowing for the identification of overarching trends between the cases.

Chapter 4.

Results

The five case studies are divided into ten sections. The first section provides an overview of the case study. This is followed by a brief description of the municipality in which the participating IT department is located. The third section is a brief description of the participating IT department, while the fourth section describes the individuals interviewed. Meanwhile the fifth section provides an overview of open source adoption by the organization. The sixth section begins to delve deeper into the case by examining the organizational open source adoption themes. This is followed by the seventh section which provides observations of model factors, while the eighth section interprets how model factors were influenced by the site. The ninth section provides an interpretation of OSS adoption at the site, and the tenth and final section is a summary of the case. Synthesis of the cases, or observations and trends from the five cases, are discussed in Chapter 5, Discussion.

Roswell – Network Integration

Overview of Roswell's Case Study

Roswell's adoption of OSS was heavily influenced by the city's network. Because the city had implemented thin client/thick server technologies in the 1980's, transition to OSS technologies was incremental as these technologies used similar technical standards.

This allowed Roswell to pursue vendors that offered OSS products, further facilitating adoption. However the factor that stood out concerning Roswell's OSS adoption was the municipality's commitment to the existing municipal network.

This meant that the city sought to implement IT in a manner that balanced function with the cost of integrating the technology into the existing municipal network. For example the CIO said that department heads regularly requested popular technologies, like BlackBerries, to which he would respond, 'what do you need it for?' If the need was instant communication, the IT department would search for technologies that integrated with the existing network that provided similar functionality. This affected how Roswell adopted OSS and other technologies as the IT department would search for IT that not only met end user needs but also integrated with the existing infrastructure of the city. Because OSS was an incremental advance in thin client architectures, a large portion of the city's network ran on OSS technologies. This alter how the IT department adopted technologies as the department sought to integrate new technologies with the existing network which was comprised of many OSS innovations. This altered the organizational perspective of how OSS fit into the city's technology.

The network integration approach within the IT department affected the administrative intensity, or how technologies were searched for, within the department. Because the network was heavily implemented through OSS technologies, the IT department routinely decentralized search activities to search for alternative technologies. This approach, network integration, influenced model factors of technical communities, vendors, technical knowledge and environmental scanning. Where OSS aligned with the network and end user requirements, Roswell's IT department implemented OSS over proprietary software. However, where OSS alternatives lacked functionality, the department did not hesitate to implement proprietary technologies. Figure 4 highlights how the OSS integration of the department affected Roswell's model factors. The remainder of the case more fully expands on how the environmental, organizational and innovation factors operated within the IT department.

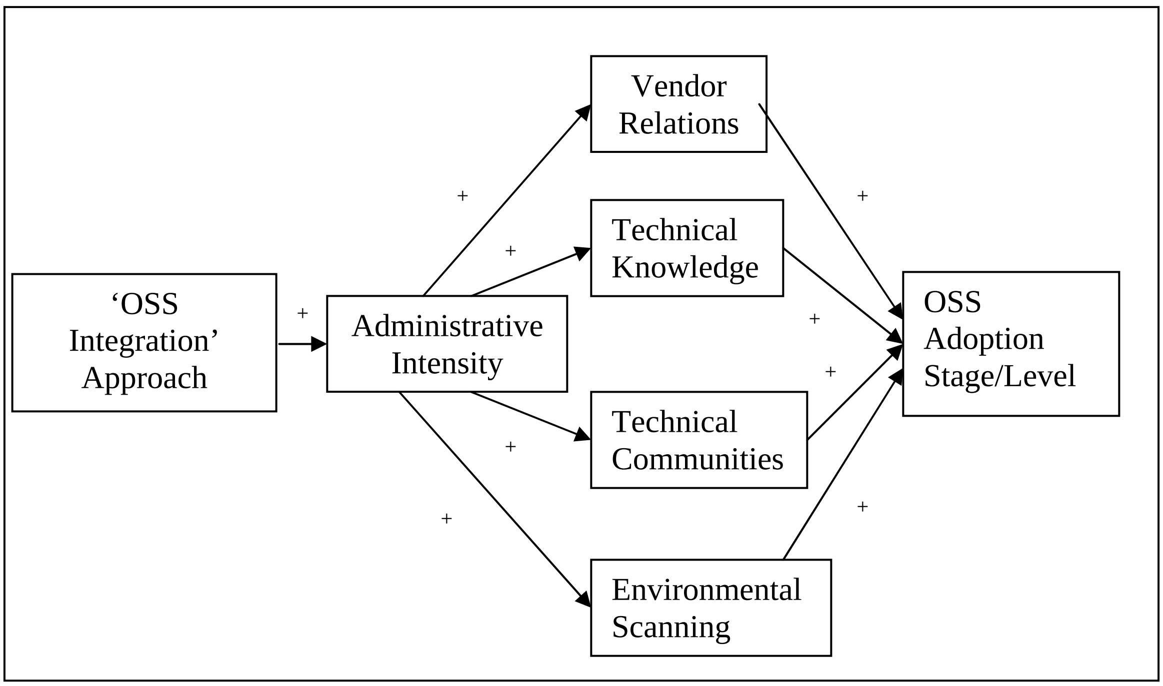

Figure 4. Roswell's OSS Adoption

Description of Roswell

With a population slightly more than 75,000 citizens, Roswell is the smallest of the participating cities in this study. It is often described as a bedroom community, as most of the residents work in nearby areas. Those residents who do work within Roswell are often employed in the retail and service sectors, as these are the largest sectors of Roswell's local economy. While Roswell is primarily residential, its notable local industries include electronics and light manufacturing. Since Roswell is part of, and geographically-contiguous with a larger metropolitan area of well over one million, its feel is more urban than rural.

As an organization, the city has more than fifteen departments that employ more than 900 people. These departments are funded by a city budget that was in 2007, over 125 million dollars. The majority of this revenue, more than 69%, was collected from property taxes. See appendix D for a comparison of the size of the different municipalities.

The mission of the municipal government is to “provide superior services that enhance the quality of life and community pride”. The city’s vision is to “be recognized as a vibrant, distinctive community with a dynamic, diverse, innovative, and high-performance workforce that provides superior services through responsible stewardship.” This focus on quality goals and an understanding of the need for dynamism and innovation to provide services guide the municipal government and these efforts have not gone unnoticed.

Leading Roswell is a professional city manager. This full-time employee of the city reports to an elected commission of citizens. These citizens who comprise the elected commission set goals for the city manager and indirectly guide municipal activities.

Description of Roswell’s IT Department

With just over a two million dollar budget and slightly more than twenty employees, Roswell’s IT department is the smallest in this study. See appendix item E, table 2, for a comparison of participant sizes. Although it is smaller than the other participating departments, Roswell's IT department had areas that corresponded to the other participating IT departments. These areas included administration, operations, development and end user support.

Roswell's IT department has been the only IT resource the city has known. As the only IT resource within the city, the IT department has had a major influence on the IT adopted by the city. By influencing which technologies are chosen by the city, Roswell's IT department has been able to showcase its ability to help save the city money, for example, the department's use of open source software is heralded on the city's website for saving taxpayer money. This has increased the importance of the department, giving the department autonomy and eliminating bureaucratic levels of government between the city manager and the IT department. This is significant because this IT department has a direct link to city leadership to support or hinder projects that do not align with their goals.

Roswell Participants

Data for this study were gathered by conducting nine interviews, nearly half of the IT department, during the fall of 2007. Table 8 highlights the role and responsibilities of the individuals interviewed. What was remarkable about the personnel at Roswell is that there had been almost no turnover in employees during the last fifteen years. The administrator of the IT department said that only two people had left the department during his time in the department. Both individuals more than doubled their government salaries, and even with this extra money, one of the individuals had asked to come back to the IT department.

Table 8. Role and Responsibilities of Roswell IT department members interviewed

Interviewee	Responsibilities
Administrator of the IT department	Responsible for overseeing all technology purchases, the operation of the IT department, strategic planning, project management, and departmental budgeting. Participates in departmental hiring process.
Administrator of Operations and Support	Responsible for managing operations and support personnel. Assists municipal employees with day to day operations of IT. Participates in departmental hiring process.
Administrator of Operations Servers A	Responsible for the city's networks, servers and applications on the servers. Perform research and development. Participates in daily administration of city networks. Participates in project planning. Manages network personnel. Focuses on Linux servers and applications.
Administrator of Operations Servers B	Responsible for the city's networks, servers and applications on the servers. Perform research and development. Participates in daily administration of city networks. Participates in project planning. Manages network personnel. Focuses on Windows servers and applications.
End User Support Specialist	Responsible for supporting end-user computing and infrastructure within the city. Focus on security and security applications.
Development Programmer	Responsible for supporting source code, business processes and database management for select city applications.
Operations Specialist A	Responsible for supporting end-user computing and infrastructure within the city. Focus on Windows servers and systems.
Operations Specialist B	Responsible for supporting end-user computing and infrastructure within the city. Focus on networking.
Development Systems Analyst	Responsible for translating business requirements into software requirements. Expected to positively contribute to end user relationships.

Overview of Open Source Adoption by Roswell

According to members of the IT department, 40%-60% of all software used by the city is open source. OSS used by Roswell is both purchased from vendors and freely downloaded from OSS projects. Software sourcing, purchased OSS, downloaded OSS or proprietary software, while influenced by the city's architecture also appears to depend on meeting contextual end user needs. For example the department had recently implemented a proprietary police department software solution when it was aware of two open source alternatives. The proprietary system was chosen because it provided functionality that neither of the open source solutions could deliver. Therefore software sourcing appears to be complex at Roswell as the department takes both end user requirements and existing technical infrastructure into account when making technology adoption decisions. Table 9 highlights the many areas and applications adopted by Roswell IT department.

Table 9. Roswell's Adoption of OSS

Departmental Area	Applications Adopted	Influential Model Factors	Adoption Stage	Adoption Level	Impact on IT Function
Security	Linux Variants, Nessus*, NMap, John the Ripper, Backtrack	Internal communication, administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage,	Routinization	Business Model**	Routine
Server	Linux Variants	Internal communication, administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage,	Routinization	Business Model**	Routine
Network	GroupWise, Evolution, Beagle, Linux Variants	Internal communication, administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage,	Routinization	Business Model**	Routine
End User Applications	Open Office, PREPS, GIMP	Internal communication, administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage,	Routinization	Business Model**	Routine
Database	PostgreSQL	Internal communication, administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage,	Routinization	As-is	Routine

*Open Source modules
** These areas either placed 'bounties' on specific functionality or coded it themselves

Security

The security area of Roswell had adopted a wide variety of OSS. Many of these applications come in distributions of other open source applications like server software or operating systems. Because members of the security area have issued 'bounties' to get functionality the department desires into base packages, the adoption level is classified as at a business model. The security area's adoption of OSS appears to be heavily influenced by the thin-client, thick-server architecture. Security personnel in Roswell spent time in either the network or server area before moving into the security area, increasing their exposure to OSS technologies used in these areas.

Server

Central to Roswell's IT infrastructure is the department's server area. This group implemented the technologies that ran most of the city's software, as the thin-client, thick-server technology focused on terminals linked to servers. Persons in the server group routinely used OSS and participated in the development of OSS applications, either by placing 'bounties' on functionality desired by the department, or by creating appropriate code and offering it to the OSS project. Because of its involvement with OSS development, the server group can be described as having a routinization adoption stage and a 'business model' adoption level of OSS.

Networking

Like the server area in Roswell's IT department, the networking area was heavily involved with OSS adoption. This group implemented the technologies that linked the city's servers together. Persons in the server group routinely used OSS, participating in the development of select OSS applications. This participation came in one of two forms, either by placing 'bounties' on functionality desired by the department, or coding the desired functionality into the program and sharing it with the OSS project. Like the server group the networking group can be described as having a routinization adoption stage and a 'business model' adoption level of OSS.

End User Applications

End user applications at Roswell are mostly OSS. These applications were found and installed specifically to integrate with the thin-client, thick-server environment that Roswell employs. Like the security, server and networking areas, the end user applications area has placed 'bounties' on OSS functionality. However unlike many of these areas the end user applications area does not participate in the development of software. Because of the routine use of OSS, and because the end user applications area indirectly modifies the development of the software, classifying it as a business model adoption level.

Database

The final area in Roswell's IT department to have adopted OSS applications is the database area. This area purchased a distribution of an open source database to routinely store municipal information, giving this area a routinization adoption stage. Because members working in the database area did not contribute to the OSS, either by coding functionality or by placing 'bounties' on software features, the adoption level of this area is considered 'as-is'.

Roswell's Open Source Adoption Themes

Two main themes appear to have influenced model adoption factors at Roswell. First the city has a history of using a technology associated with OSS; thin-client UNIX based information technology architectures. In the early 1990's the city chose a thin client infrastructure rather than personal computers for city computing. When the organizations providing the operating systems for the thin-client environment had difficulties, the city began searching for alternative operating systems. As the city was accustomed to a UNIX based environment, this evolved into Linux, an OSS closely related to UNIX.

The second major theme at Roswell that appears to drive OSS adoption is a commitment to employee training and development. As per the Administrator of the IT department,

> *"I've cut capital programs before I cut training." – Administrator of the IT department*

Roswell's IT department support of employee training is evident in a $1,000 training budget for every department member, which they are allowed to spend as they see fit. This allows for Roswell IT personnel to grow their skill sets according to how they believe they can best serve the municipality.

Roswell's Model Factors

Environmental Factors

Both the commitment to thin-client technologies and employee development appear to influence the environmental factors at Roswell. The commitment to thin client technologies started in the early 1990's. According to Systems Administrator A, who has been with the city for more than twenty five years:

> *"(If we had adopted Personal Computers as opposed to thin client servers) We would have ended up replacing disk drives and video cards and power supplies all day. And that's all you would ever do, run around and fix people's PCs (Personal Computers). So we started looking at different things and we settled on*

X-terminals…So everybody wanted the X-terminals and we basically got all the stuff out probably within two or three years and we kind of avoided the whole PC thing in that way." – Systems Administrator A

Systems Administrator B, who has a similar tenure to Systems Administrator A, verified this commitment to thin-client technologies.

"It's (Roswell's IT framework) always been server-centric type of computing rather than locally." - Systems Administrator B

Much of the IT department's **external communication** centers on sources that help provide thin client technologies. However external communication, primarily looking at new technologies, is promoted within Roswell's IT department. In the CIO's words

"(Looking at new technology benefits us) because I guarantee that in 6 months there's going to be a vendor sitting in my office trying to sell it to me! I can then say "Well what about this, how does it address this, it doesn't handle this…" So I can have these intital frank conversations with these sales people and I know when they're bullshitting and when they really know what they're talking about. So that benefits the city immediately." – CIO

External communication with **vendors** is routine as vendors help provide services, such as training, technology implementation and external validation for the city. Several members of the department commented on the use of vendors in these functions:

"We hired a consultant for two days. He gave me like a crash course on MAC OSX and how to manage the server and what not and then from there I just kind

of pretty much taught myself. Got some books, did some reading and you know, just took off with it." - IT Support Specialist II A

"I've got consultants working with me on the creation of it (strategic plan), okay? Only because I don't have the time nor the resources on staff to do a strategic plan." – CIO

"Four different consultants over about a year and a half. All four of them said "Leave them alone." How they're doing what they're doing on the budget that they have, leave them alone. So finally the city said "Okay you guys know what your doing." But every three or four years it comes back up and we have to start defending why we're doing open source." – Programmer/Analyst/DBA A

Because the city has a history of using thin client technologies the city mainly worked with UNIX providers. But during the late 1990's, when Linux became an alternative to UNIX technologies, the city migrated to Linux.

"We used to use STL UNIX which was kind of like a Linux, but it was prior – back when computers were really ahead of their time." – Systems Administrator A

"Its a financial system that was originally purchased running on UNIX using a proprietary database and programming language. (The vendor) is currently migrating that over to Linux and they have a web browser interface on an open source database…people love it." - CIO

“We started transitioning into Linux because when it came out – and it just kind of like caught on. There was so much more software available on it. It wasn’t like SCO was expensive and SCO was really stable, but I mean things like when Mozilla would come out, you would get like all the new ones on Linux right way, and there would be like one version that came out on SCO you’d have to wait a year and a half to get the one that came out and handled whatever you wanted to do.” – Systems Administrator A

Because they have a history of working with OSS, Roswell’s IT department utilizes their external communication with its vendors to get customizations put into base OSS packages.

“We actually work with our vendors to customize code. Like for instance one of the applications that we have – Evolution or OpenOffice for instance, we work very closely with the vendors and they help us customize code and what not and if we need to you know have problems upgrading it or moving it over to another machine or what not, they’re always able to help us.” - IT Support Specialist II A

“We try to stay away from (on-site) customizations. Because any time you have to run a patch or do anything you run into problems.” - Systems Administrator B

“Open source you can buy the product and you can customize it based on your needs, so you can generic, you know like say operating system. You can get like

Redhat or something like that and then you can add packages or add features as you see fit based on your current need within your organization. Which you know it's fantastic, I mean it's infinitely customizable for your situation. Because everybody's setup is a little bit different. Their networks are different; you know their needs are different." - IT Support Specialist II A

Interacting with **open source vendors** appears to alter Roswell's IT department's expectations when dealing with vendors. They appear to expect their vendors to be responsive and move quickly.

"We get patches on some things (OSS) like the same day, next day." – Systems Administrator A

"We had an (Vendor X) server here we wanted to upgrade the disk drives in it. That took like six months. Six to nine months to basically make a purchase and have the guy come out here, image the system, put drives in and image it back." – Systems Administrator A

"If you get in with some of the people, and you know you do testing for them and they know you run it and they take some pride in it. I mean if you find something bad in there I mean they'll basically drop what they're doing and go fix it. Which is you know if you ever try to get a patch out of Microsoft or one of the commercial vendors – it might be two years before the version comes out." – Systems Administrator A

Use of OSS vendors does not mean that the city has abandoned proprietary applications; rather they look to meet end user functionality within their existing architecture as opposed to focusing on a vendor name or product. For example the city recently implemented a proprietary police system. After evaluating several software packages, some of which were open source compatible, the city decided to purchase and implement a proprietary police information system.

"There are two open source police systems out there. And when I say open source, they're proprietary packages written in an open source language using open source databases which runs on an open source platform. But the software is proprietary, which is fine. I don't have an issue, but they're very selective. They either do just CAD or just records management, or one or the other. And both of those are just not mature enough with the features that we were looking for...they're both years away from being anywhere near as mature as the package that we've purchased. It is a matter of meeting a certain service level." – CIO

Because Roswell focuses on thin client technologies their reliance upon their **peer relations** appear to be almost non-existent. Most municipalities in the state rely on personal computers rather than thin client technologies. This difference appears to encourage Roswell to largely ignore their peers when searching for new technologies.

"I couldn't tell you anybody else who is doing what we're doing here." - IT Support Specialist II B

Perhaps this focus on thin client technology has encouraged Roswell's IT department personnel to shift from their peers to **technical communities**. Because employees are encouraged to examine, or 'play with', new technologies, Roswell IT department members seem to look for technical communities that help provide them with this information.

> *"I really encourage my staff to enhance their skills constantly through either seminars, lectures, online training. Just spending time at their desk. Something they want to go learn about? Take it apart, work with it, just go play with it, you know?" – CIO*

> *"But they'll (IT department members) go out and play with stuff and that carries over to their private life a lot too. Because what they'll do is they'll go play with it at home. And then they play with it here and you know if it costs a few bucks to go buy something that they need, I'll fund it for them. Because more than likely, the city is going to get a benefit out of it." – CIO*

Roswell's interaction with **technical communities** also appears to be affected by the IT department's focus on thin-client technologies and employee training. Two of the three Systems Administrators at the city are active members of open source communities.

> *"(Systems Administrator C) will find all these toys and all these great little things and he'll bring them in. Normally (Systems Administrator A) is the one that installs and tunes them." – Programmer/Analyst/DBA A*

> *"(Systems Administrator C) is our open source interface. He talks with the open source world all the time. He's done quite a bit, he's well respected because he*

knows when Roswell gets something that we've asked for, that we will literally go test it and give them feedback. And that's part of participating in the open source community." – CIO

This involvement with **open source communities** appears to focus around getting customizations or requests put into base OSS packages. Although the city's IT department members rarely develop software for these communities they commonly pay technical communities to develop their customizations for open source projects through a practice called 'bounties'.

"We don't do that much customization unique to our state, or Roswell. What we do is we get in enough on the ground floor in the development of it (an open source application) and make suggestions as to what the software should do. So we usually get all the features and functions that we want right into the base software that's supported by the open source community." – CIO

"We'll have software, they'll be packages that might be more mature where we haven't been on the ground floor and we see something. We'll actually put a bounty out, and what that is, is your asking for a software change. You put a bounty out, you say "Here, we're willing to pay this much money for it." And somebody out in the open source world will pick it up, write it, and deliver it for you. You don't pay them until it is right. So we do that periodically, so he'll (Individual X) put the bounties out and we'll get the changes to the software that we need and we pay them through Paypal." - CIO

"Now when I say a bounty, we're talking about anywhere from $200-$500. I mean we're not talking a lot of money here. You know I mean, you know if you probably break down the hours that they have to work, they'll probably be charging you $10 an hour." – CIO

This alters how Roswell interacts with its **technical communities**. In addition to using these communities as an online resource to solve day-to-day problems, Roswell leverages technical communities to help develop software to meet current and future city needs. For example Roswell's IT department had worked with the developers of a scheduling system to get their customizations implemented into the standard package of the software, ensuring that they would not need customizations or special support for their specified functionality.

Organizational Factors

Within Roswell the focus on a thin-client architecture and employee development not only affected environmental factors, but also affects organizational model factors. For example Roswell's commitment to employee development seems to facilitate high **technical knowledge, environmental scanning** and **internal communication** as employees are encouraged to learn new things and share this information with one another.

"The knowledge that we learn, we share it amongst everybody in IT. You talk to my staff, we share everything between us. We don't have anybody that hordes information." – CIO

"It is inconceivable to me that somebody would work in an IT department and not want to share their knowledge with a fellow employee. But I guess people are trying to protect their jobs so they'll be like "Oh, well I'll keep this to myself and I'll know how to do it and nobody else will so they won't get rid of me!"" - IT Support Specialist II A

"We don't have like "Well you're a developer, you can never do this – network management or you're a support person you can never do network management." And sometimes if somebody comes in and has the skill for stuff they will informally become your network person." – Systems Administrator A

"I know it sounds crazy but everybody has ideas and everybody puts their two cents in and everybody you know contributes." - IT Support Specialist II B

Perhaps this attitude of knowledge sharing stems from a desire to be prepared for employee turnover or to allow for departmental redundancy.

"(The CIO) would like everybody to do everybody else's job." - Manager for Operations and Support…"It took me twelve years to learn this and you can take twelve years, so I'm not going to tell you what I learned in twelve years. It doesn't exist here. So in other words you feel collective. Everyone shares what they know. So you're as smart as everybody else in that sense." - Manager for Operations and Support

"You gotta wear many hats." - IT Support Specialist II A

"Everyone here wears a lot of hats. Everybody here does a lot of different things." - IT Support Specialist II B

"I work with everybody. Everybody works with everybody." – Programmer/Analyst/DBA A

Or perhaps this attitude towards knowledge sharing stems from a desire to, as the CIO said, 'stay ahead'.

"I allow time to do that (environmental scanning) as part of my program here. I call it R&D, research and development, because that's how we kind of stay ahead of what I feel is, we stay ahead of people because my staff is out there looking for things to go play with, and I allow them time." – CIO

Regardless of the motivation for allowing for knowledge acquisition, the employees appear to genuinely enjoy the department. This has resulted in very little turnover within the department, increasing the average tenure of the department members.

"I like the challenge. It is always something different, there's always something new going on, and they're (the IT department) very much about training and upgrading your skills and they give us a training budget every year so we can continually you know learn." - IT Support Specialist II A

"We think of her as the new person, she's probably been here ten years." – Systems Administrator A

The department furthers this commitment to **technical knowledge, environmental scanning** and **internal communication** by encouraging employee training and internal discussions. Each employee has their own training budget, which at the time of this study was $1,000. Additionally the employees themselves decide how to use their training dollars.

"I've cut capital programs before I cut training." – CIO

"They (IT department) need to keep their skills up. They need to understand that we want to invest in them. Normally what happens is, that's what people look for, because its a turnover issue. First thing that normally happens is that organizations cut out the training. Then what happens? Everybody gets upset. People start leaving, you know because they want to go learn. They want to see other things. So I don't cut that (training)." – CIO

"We have a budget for every person in IT for training…It changes based upon what projects they're working on." - Manager for Operations and Support

As departmental members are allowed to develop and specialize in different IT areas, the city has rewarded these members by promoting them. For example a new network administrator and security lead have come from the IT support area.

"Right now we have just moved him (newer hire) in less than two years he just is now the – network administrator for the city of Roswell! He started out in the entry level position." - Manager for Operations and Support

"I didn't have a lot of experience but I really ran with it and have been very happy and now they're moving me up. They've moved me up twice in less than three years." – IT Support Specialist II A

"I don't just do security right now, despite all I do I still do pretty much everything I used to do." - IT Support Specialist II B

Internal recognition of achievements appears to encourage IT department members to refine or extend projects that they have previously accomplished.

"They just figured out something…so that our broadcast guy who runs our TV station when he's home, after something gets hosed up with the TV. He doesn't have to come down here at three in the morning to broadcast from the straights up now. They got him so that he can remotely access everything from home through a little notebook. And they even simplified, they already accomplished that about a year ago with him. But they just found a new open source, some kind of a VPN open sourced software that's going to even make, instead of using the three IPs to get all this done we can save two IPs and its going to be more robust. Its got better compression, they've figured it out! He wasn't complaining that he needs something, they just said "You know we can do this better for you!" - Manager for Operations and Support

"They (my staff) always look to see how things are working, not broke, now of course we have things that break and we have to fix it. But they try to find out better and more efficient ways to get things done." - Manager for Operations and Support

"(In response to 'You had solved the problem, why did you take a solution a step further') Because it was to do it better. You know the initial setup was just to get him access and we revisited it because we knew we could do it in a better way." - IT Support Specialist II A

Because the IT department has a history of collaboration to, not only complete projects and solutions, but to also extend them, the administration appears to trust the department. This trust appears to result in a lower overall **administrative intensity**. The CIO said:

"I built a trust level with people – people like dealing with me and I still have all of my staff here that were here when I started, and I mean their longevity here, that core of people is over 20 years on average…I let my staff do their job. I don't micromanage them, I don't tell them they need to go and do this. They need to go out and do their job." – CIO

However this does not mean that the administrative intensity of the technology adoption process has been removed. Rather it has shifted to select parts of the technology adoption process, the beginning, or requirements analysis, and the ending, the implementation.

"When we look at a new application we actually go in and do a full analysis of the department or division that the software is going in for. We do a needs analysis, we interview everybody in the department. We put together a document, or and I say we – it is a joint venture between the department and IT. If it is large enough we'll get an outside consultant to come in and validate the needs analysis. They'll do spot checks through it to make sure everything looks like it is in order."- CIO

"What we've done is we're looking, we're trying it (new innovations) and the way we work it is before I usually let it out to other people in the city I do my review of it. And my deal with them is I'm going to play devil's advocate – bad user. You're the techy guy, so I'm going to try everything in my power to break it (new innovations) do anything wrong with it, and when it passes all of that, then I'll let it go out to the field, because I don't want the typical user here in the city to be exposed to that type of unnecessary training or problems." – CIO

This appears to alter the administrative processes around OSS technologies.

"You know it doesn't change your policy just because it says open source. It doesn't mean the rules don't apply anymore, as a matter of fact the rules are even tighter, if you want to know the truth. But its the same process, you know for selection." – CIO

"I mean there's lots of open source software out there, most of it I probably wouldn't even put in here. Either it doesn't fit well, doesn't work well, its not intuitive; it would cause more trouble than it would be worth type things. We looked at a lot of things, or the licensing is not right on it. So I looked at a lot of different things when we looked at software. And actually its the same things I look at when I buy proprietary software. You know just because it says open source, you don't go and forget all the things you normally look at you know? When you look at open source you gotta do the same thing!" - CIO

One organizational construct that appears to drive OSS adoption is the **wealth** construct. However unlike existing theory Roswell's **wealth** construct works opposite to theory, a lack of wealth appears to motivate adoption. Rather than increased levels of wealth spurring adoption, decreased levels of wealth appear to be encouraging the adoption of OSS. Because the IT department has been able to demonstrate cost savings to the city management the IT department personnel believe that they have good relations with the executives of the city.

"We've had good support from the city management." – Systems Administrator A

"I mean we usually get whatever we – because we have a record of not wasting money. If we want something we usually get the money for it." – Systems Administrator A

“We’re always aware that Roswell isn’t one of the richest cities in the world and we try to keep that in mind when we do our work.” – IT Support Specialist II C

“We’re trying to save them (the taxpayers) money. I mean that’s part of our goal, but we want to get the right product. It’s going to cost money, I don’t care how much it costs, I want the right product. We yea, we have a budget, but our budget is always generous when it comes to getting the right product. We don’t skimp on quality. We want the best, most stable, highest quality product to get the job done. In other words that’s going to demand less of our interaction. That means its going to cost 20% more we budget for that 20% because it will actually save us people and time. Here we don’t suffer from tunnel vision.” - Manager for Operations and Support

“From a management point of view – I mean we’ve saved the city you know I think millions of dollars.” – Systems Administrator A

The construct of **slack resources** was the only organizational construct that appeared to be absent. No employee reported having slack hours. However the department did have a test system that allowed them to test new technologies before implementing them into the city’s architecture.

Innovation Factors

Roswell’s commitment to thin client architecture also appears to affect how the city perceives innovation related model factors. The interviews highlighted several areas where the thin-client OSS architecture appears to influence the department's perceived relative advantage, compatibility and complexity of OSS.

Roswell's perception of OSS **relative advantage** seems to be present in the IT areas of security, licensing, maintenance, extension and resource consumption. Roswell department members believed that information system security was enhanced due to the thin-client OSS network. According to Roswell personnel:

> *"All those viruses that have come out, they're all on Windows executable basically. And so we run email and we run our storage on Linux so we run, I mean so basically the people that and we run browing on Linux so basically when someone gets, downloads something, gets it in email, it has now way to execute because its a Windows executable." – Systems Administrator A*

> *"We've never had a virus tear through our mail server and take us down for six days or something like some other cities have. So we've saved a lot of employee hours." – Systems Administrator A*

> *"You can't launch an .exe on a Linux machine so I feel like we are a lot more secure in that aspect as well." - IT Support Specialist II B*

The thin client architecture also increases physical security of the city's computer network. There are a select few CD drives and other external hardware interfaces in the thin-client architecture. This encourages Roswell personnel to use email and electronic means to communicate and relay work. This electronic paper trail can be used to quarantine the city's network if an attack does occur, again providing a perceived relative advantage to the city.

> *"We don't have CD drives, the floppy drives at the desk. I mean we tell people to work electronically so if they need to send something to somebody they do it by email, they don't walk around with floppies and bring in stuff from home and install their own programs. So from an IT point of view it's a really manageable environment. It's really stable and cost effective. But we do fight with people." – Systems Administrator A*

Licensing appears to be another area where OSS has a **relative advantage** over proprietary equivalents. Not only do the licenses themselves cost less, but the man-hours needed to track and keep the licenses current appear to be greater for proprietary technologies. This seems to decrease the attention that Roswell personnel pay to a non-technical, non-functioning attribute of the technology, increasing the relative advantage of OSS to the city.

> *"I've had to keep track of some of the Microsoft licensing in the past back when we used to use some Office around the city and we're talking just a couple of hundred licenses and it just seemed like a huge chore just to keep track of that end of it, let alone you know, if you're talking all these other applications you have to keep track of." - IT Support Specialist II B*

> *"Running on Linux, you don't have to worry about licensing considerations, all we do is license the product, and that's an ideal scenario for a city." – CIO*

A third area of perceived **relative advantage** appears to be the maintenance of OSS in Roswell's thin-client architecture. Personnel are convinced that OSS has superior performance to proprietary equivalents, needing less attention. Like the relative advantage of licenses, this perceived performance seems to decrease employee time spent on maintenance activities.

> *"It's nice having the server run for weeks and weeks and weeks without having to reboot it or touch it or do anything with it." - IT Support Specialist II A*

> *"if you go up to our help desk, the phones aren't ringing and it's not very busy or anything and when people call it's usually 'I forgot my password.' Or 'Can I get access to this other application?' It's not like 'This is broken…' and you know that kind of thing." – Systems Administrator A*

> *"Other than the Microsoft stuff, I mean that's – they're always doing stuff to keep that going. But on our side, our databases never go down. Linux never shuts down. I mean so we're never caught in the day to day. We have time to do R&D and the things that we need to do, we're not having to focus on "Oh my god, whatever…" – Programmer/Analyst/DBA A*

Finally, according to Roswell IT department members, the thin-client OSS architecture uses far less resources than proprietary PC technologies. The thin-client environment appears to need fewer servers and less processing power than proprietary PC based technologies.

“1 server runs the entire thing (ERP system) for the city. Unlike the police system that we bought requires 11 servers. Its Microsoft based, that in of itself is not necessarily the whole reason, but it just being Microsoft – the vendor does not like to put more than one application on a server. So having multiple applications on a server they feel causes degradation and potentially have conflicts. You know we’re going “Well, you’re saying exactly what I say, which is the reason why we like Linux!” and they can’t understand why people want to do it on Linux, they’d rather do it on Microsoft and make everybody buy more servers. Which means you need to buy more Microsoft licenses, which means you need to buy more Microsoft operating systems, which means you need to buy more Microsoft this and that and everything else.” - CIO

“We got enough Microsoft in here for about 15% of the users and we doubled our staff.” – Programmer/Analyst/DBA A

Roswell’s thin-client architecture also impacts the network’s **compatibility**. Because the city uses both OSS and proprietary technologies the city has two separate technical standards. While proprietary and OSS technologies can interface through proper mediums, such as the Internet or program emulators, proprietary and OSS technologies do not have the same commands or actions needed to perform day-to-day tasks. This appears to decrease the compatibility of OSS technologies with the processes Roswell personnel are accustomed to.

"Every so often we'll get somebody that came in here and you know they're just determined that they want to have you know Excel or something and we go through battles with them and we actually have meetings and they'll say…we'll say "Give us the thing that you can't do in OpenOffice that you could do in Excel." And they'll start talking and talking and basically it comes down to like "Well its two clicks in Excel and three clicks in OpenOffice." And we're like "Okay, but we're not going to change our architecture because you have to say insert row from an extra click." You know?" – Systems Administrator A

"They call it third world software." - IT Support Specialist II A

"They (other departments) hate us! They hate and they blame us for them not being able to do things the way they've always done them." - Systems Administrator B

However within the IT department, the commands and technical skills associated with OSS or proprietary, appear to be compatible with one another. Systems Administrator A remarked the following:

"We're using Linux, different flavors of it, and it really doesn't matter what flavor you use once you get used to one you can pretty much work with another." – Systems Administrator A

However within the broader contextual areas of security, licensing, maintenance and resource consumption both proprietary and OSS technologies appear to have the same meta-processes. At a high level they seem to be highly compatible as both standards need to address similar areas.

"Really operating systems are operating a system. It doesn't matter what it lies on, it's how does the application work. That's all it is. A lot of people just don't want to take the time to learn the differences." – IT Support Specialist II C

Finally the **complexity** of Roswell's thin-client OSS architecture appears to influence how the IT department personnel learn how to use the technology.

"I'll tell you open source was new to me, so it was a learning curve for me. I went out and I spent a lot of time studying it and understanding what it was. I felt comfortable with it after about 1 year." - CIO

"Client technology was radical. You know, not to have a PC on everybody's workstation, run everything through the servers." – Manager for Operations and Support

"I admit we have one of the most sophisticated warehouse environments in the whole country." - Manager for Operations and Support

"Coming into a Linux environment was a bit of a culture shock at first." - IT Support Specialist II A

OSS Disruption within Roswell's IT Department

Roswell's IT department did not appear to be disrupted by OSS. OSS technologies were routinely adopted by each of the IT department areas. Additionally departmental processes of support, implementation, and training appeared to align with OSS technologies as OSS technical communities and vendors were fit where appropriate.

For example, according to the Director of the IT Department, every week the city had classes on common open source applications, like Open Office, that city staff could take to learn the technology. Additionally many members of the department referred to using online communities through bounties to have OSS communities perform maintenance and extension activities associated with technologies used by the department. Finally the System Administrators interviewed were accustomed to providing feedback on programs to OSS communities in exchange for new features or designs, integrating them into OSS practices.

Interpretation of Roswell's Model Factors

Coding the interviews resulted in the identification of 522 instances of model constructs. These codes related to twenty one of the twenty two codes in the study model. Coding can be seen in Figure 3, Roswell Interview Codes, which shows the model constructs, such as adoption level and adoption stage, and the role of the individual within the IT department who identified the construct. The only construct that was not readily identified was the disruptive construct relating to OSS. However some codes, associated with knowledge or complexity, appeared to be related to disruptive as they implied a change in skills or routines for other members of the city government. For example:

> *"They (other departments) hate us! They hate and they blame us for them not being able to do things the way they've always done them." - Systems Administrator B*

> *"They call it third world software." - IT Support Specialist II A*

> *"Thin Client technology, it was radical. You know not to have a PC on everybody's workstation. Run everything through the servers…It was just so cutting edge…I studied trends a year in advance."- Administrator of Operations and Support*

These quotes indicate that, while OSS was not disruptive to the IT department, as it was routinely used by every IT area, it was perceived as disruptive to members of other municipal departments.

	Development Systems Analyst	Operations Specialist A	Operations Specialist B	Development Programmer	Administer of Operations Servers A	Administer of Operations Servers B	End User Support Specialist	Administrator of Operations and Support	Administrator of the IT Department	**total**
As is		1	1	1	1	1	1	1	1	8
Design		1		1	1	1			1	5
Awareness	1	1	1	1	1	1	1	1	1	9
Interest	1	1	1	1	1	1	1	1	1	9
Adoption	1	1	1	2	2	3	4	1	2	17
Routinization		1	1	2	2	3	4	1	1	15
Infusion		1	1	1	1	1	1	1	4	11
Complexity			1					1	1	3
Compatibility		1	1		1	1	1	1	1	7
Disruptive										0
Routine		1	1	1	1	1	1	1	1	8
External Communication	1	3	1		2	1	4	2	5	19
Peer Adoption	2	2								4
Environmental Sensing	3	3	2	3	1	1	1	2	3	19
Technical Knowledge	8	7	3	12	3	3	8	7	7	58
Relative Advantage			3	1		4	1		2	11
Administrative Intensity	9	32	8	17	5	5	13	19	32	140
Internal Communication	19	21	8	25	11	10	26	15	13	148
Slack Resources		1		7	3	2	4			17
Wealth		3	1						3	7
Technical Community			1		1	1	1		3	7
Vendors	1	3	1	1	2	1	6		2	17
Total	45	81	36	75	37	40	72	54	82	522

Figure 5. Roswell Interview Codes

As covered in the methodology section, coding of the constructs verified the constructs but did not provide insight as to how the constructs were related. Rather, because the interviews were conducted within the municipal context, city themes were interpreted from the interviews that were used to understand the constructs within the context of the city.

Environmental Factors

Roswell's environmental factors appeared to influence all of the study's stages of OSS adoption. **External communication**, **vendor relations** and **technical communities** appeared to influence OSS adoption throughout the innovation's adoption process as they were used to facilitate awareness and interest in the technologies. By communicating with vendors and technical communities that used thin client networks, Roswell IT department members appeared to be well versed in thin client technologies and their capabilities. External communication with vendors and technical communities appeared to increase the awareness of both proprietary and open source technologies.

These factors, **external communication**, **vendor relations** and **technical communities**, also appeared important during adoption and later stages as Roswell used vendors and technical communities as third parties for training, support, and other services. This appears to integrate vendors and technical communities into Roswell's IT department processes, increasing the importance of these factors during the latter stages of adoption.

The only environmental factor at Roswell that did not appear to play a significant role in technology adoption was **peer adoption**. This factor did not seem to be relevant because of Roswell's uses of thin client technologies. Other municipal IT departments, as observed by this study, do not have extensive use of thin client servers. Rather Roswell's peers appear to adopt personal computers (PCs), a different type of computing architecture. This architectural difference appears to affect the software adopted by the institutions for specific organizational functions, and, because Roswell's IT department members do not believe that they common infrastructures, they do not access their peers for information. Table X highlights how Roswell's Environmental Factors appeared to influence OSS adoption, the relative strength of the factor, and which adoption stages appeared the factor seemed to influence.

Table 10. Roswell's Environmental Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
External Communication	Facilitate adoption by creating awareness and interest in OSS	Facilitated the adoption of both OSS and proprietary applications as departmental members were aware of multiple versions of contextually applied software. Influenced later stages by connecting departmental members to OSS communities for activities such as development or support.	High	Awareness, Interest, Adoption, Routinization and Infusion
Peer Adoption	Facilitate adoption by creating awareness and interest in OSS	Roswell was largely unaware of other government adoption of OSS. However Roswell was aware of other organizations within industry who adopted OSS.	Low	Awareness
Vendor Relations	Hinder adoption through switching costs and other mechanisms	Roswell's vendors were influential in technology adoption so much as their product met organizational needs. One of those needs was integration with the thin-client architecture which appeared to decrease switching costs. Additionally Roswell seemed to work with OSS vendors to get functionality implemented into the base offerings of their software.	Moderate	Awareness, Interest, Adoption, and Routinization
Technical Community	Facilitate adoption by creating awareness and interest in OSS	Facilitated adoption as technical communities not only increased awareness and interest of OSS, but also participated in software development	High	Awareness, Interest, Adoption, Routinization and Infusion

Organizational Factors

Like Roswell's environmental factors, Roswell's organizational factors appeared to be present during the entire adoption process. **Internal communication** and **technical knowledge** appeared to affect every stage in the adoption process. Perhaps these factors, along with **environmental scanning** and the environmental factors of **external communication**, **vendor relations** and **technical communities**, influenced every stage in the adoption process because of the organizational culture of the IT department.

Because Roswell's CIO encouraged his personnel to learn about new technologies and share this information with other departmental members, Roswell's culture appeared to focus on acquiring new knowledge and disseminating it throughout the IT department. Consequently the culture appeared to influence how these model factors were used during the adoption process.

Roswell's organizational culture also appeared to affect **administrative intensity**. The CIO appeared to have a great deal of trust in his department and only bounded IT department personnel during technology searches by placing use requirements when he 'played devils advocate of a bad user.' By taking up this role to test technologies that were selected by IT department members the CIO allowed IT personnel to choose technologies that they thought would best fit into Roswell's architecture.

Without objective evaluations and testing it is difficult to determine if the technologies chosen by IT department personnel were optimal fits into the network. But what this study does show is that this freedom during the technology selection process was not only appreciated by Roswell personnel, but also considered fun. At the time of the study, turnover in the department was almost non-existent as two members had left during the last ten years. Therefore limiting the administrative intensity of technology selection to the adoption process appeared to reinforce the department's use of internal and external communication as well as environmental scanning, technical knowledge and use of vendors and technical communities.

The only model factor that was observed to operate contrary to theory was **wealth**. Instead of excess wealth facilitating the adoption of a new technology it appeared that a dearth of wealth facilitated the adoption of OSS. This is in keeping with theory about disruptive innovations, as there are both new market and low end disruptive innovations. As OSS can be identified as a low end disruptive innovation, or an innovation that enters a market by providing low cost services, cost savings or cost pressures, i.e. low levels of wealth, appear to motivate its adoption.

This appears to be in keeping with one of Roswell's organizational goals, that of reducing the cost of government. The city even touts its use of OSS to save taxpayer dollars, highlighting the alignment between the adoption of OSS and the organizational goal of reducing cost.

While wealth was the only model factor to operate outside of technology adoption theory, **slack resources** was the only model factor that was not observed. Although the IT department did have a test system in place, extra computers and software that mimicked Roswell's live system, personnel did not report slack time to search for new technologies. Rather these activities appeared to be included in their weekly schedule and not considered slack time.

One possible explanation for the lack of slack time is that IT department members did not want to appear to have slack time to the researchers. This perception, that of IT department members having slack time, could negatively affect IT department members either through reprimands by their organizational leaders or by the assignment of additional duties. However, the activities performed by the IT department do not appear to back this perspective as the IT department appeared to try and continually improve their operations. Table 11 highlights how Roswell's Organizational factors influenced OSS adoption and adoption stages.

Table 11. Roswell's Organizational Model Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Internal Communication	Facilitate adoption by building consensus around potential new technologies	Roswell had high levels of internal communication that appeared to build consensus around new technologies. As a senior programmer said	High (Adoption)	Awareness, Interest, Adoption, Routinization and Infusion
Environmental Scanning	Facilitate adoption as scanning should increase awareness of OSS	Roswell had high levels of environmental scanning. These activities appeared to be part of routine work processes as opposed to slack activities. In the words of the CIO:	High (Adoption)	Awareness, Interest, and Adoption
Administrative Intensity	Hinder adoption as decision making is consolidated into a few individuals	Administrative intensity appeared to fluctuate based upon the stage in the adoption process. There were high levels of administrative intensity at the requirements gathering and testing phases, but low levels of administrative intensity in idea generation and physical design.	Moderate (Adoption)	Adoption
Technical Knowledge	Facilitate adoption as increased knowledge is associated with flexibility and greater capabilities	Roswell's adoption of OSS appeared to rely heavily on technical knowledge. Their understanding of open source communities, open source standards and open source software seemed to form the basis of their open source adoption.	High (Adoption)	Awareness, Interest, Adoption, Routinization and Infusion
Wealth	Facilitates adoption	Facilitated adoption as the department sought out technologies that reduced costs associated with IT.	High (Adoption)	Awareness, Interest, Adoption, and Routinization
Slack Resources	Facilitate adoption as employees can search for and experiment with new technologies	Roswell seemed to have low levels of slack resources. This did not appear to affect search and testing activities as they appeared to be part of routine work activities.	Low (Adoption)	Awareness

Innovation Factors

Innovation factors appeared to be extremely important in determining the adoption of OSS by Roswell. These factors appeared to be essential in the determination of Roswell's awareness and interest of an OSS. **Relative advantage**, or the degree to which OSS was perceived to have contextual superiority to an equivalent technology, appeared to be limited to three areas: security, licensing and maintenance which ultimately appeared to affect Roswell's IT costs.

Compatibility appeared to be more important, as the thin-client architecture, or the technical standard that Roswell chose to implement, appeared to drive many technology adoption decisions, whether or not a technology could be implemented into this architecture, whether the technology was proprietary or open source, appeared to be a key driver for its adoption.

In addition to technical compatibility it appeared that the compatibility of OSS to align with what Roswell city users expected to use IT impacted the latter stages of adoption around the city, the routinization and infusion stages. As IT personnel said, Roswell's use of OSS appeared to have earned the disdain of Roswell city employees as other department employees referred to the software as 'third world' or they tried to get proprietary equivalent applications, such as Microsoft Excel, installed. However, the adoption by the municipality as a whole was outside of this study's scope, but would be an avenue of future research.

Complexity also appeared to influence Roswell's IT department's adoption of OSS. However rather than hinder the adoption of OSS by the IT department, high levels of complexity appeared to facilitate the adoption of OSS as the CIO filtered out technologies deemed to complex or difficult to use by Roswell's average user. This provided Roswell's IT department with general guidelines for what OSS could be adopted by the municipality.

Within the IT department complexity appeared to be mitigated by high levels of technical knowledge. No IT department area claimed that OSS technologies were too complex or radical, and as summed up by IT Support Specialist II C,

> *"Really operating systems are operating a system. It doesn't matter what it lies on, it's how does the application work. That's all it is. A lot of people just don't want to take the time to learn the differences."*

Indicating that Roswell's IT personnel have learned the differences and reduced the complexity associated with OSS technology.

Table 12. Roswell's Innovation Factors

Factor	Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Relative Advantage	Facilitate adoption through superior performance	Perceived relative advantages in security, licensing, maintenance, and resource consumption facilitated adoption.	High	Awareness, Interest, Adoption, Routinization and Infusion
Compatibility	Facilitate adoption by working with other technologies	Integration with other OSS applications facilitated adoption. High level activities were similar with proprietary equivalents, but actual commands and execution were substantially different.	High	Awareness, Interest, and Adoption
Complexity	Hinder adoption by erecting barriers to adoption	Complexity appeared to facilitate adoption as it created a knowledge barrier or filter surrounding what technologies they would implement.	Moderate	Interest, Adoption, Routinization and Infusion

Interpretation of Roswell's OSS Adoption

OSS adoption by Roswell's IT department appears to be a conscious, strategic decision taken by the leadership of the department. It appears to have been done to align the IT department with the city mission, that of "provide(ing) superior services that enhance the quality of life and community pride". By utilizing OSS Roswell appears to reduce IT costs associated with standardized IT department functions. This does not mean that Roswell adopts OSS technologies at every opportunity; rather it seems that the IT department weighs application functionality with associated costs to determine technology sourcing. The selection of a proprietary police application, which necessitated the adoption of other proprietary technologies, illustrates how Roswell's IT department searches for optimal functionality in the programs that they choose.

Roswell's IT department appears to substitute OSS applications for proprietary ones when the functionality of the OSS applications is comparable or better to the functionality of proprietary programs. As stated earlier in the case, 40%-60% of the city's software has transitioned to OSS applications. This helps to reduce IT costs, not only through the licensing of the technology, but also through the maintenance and operation of the technologies. The OSS technologies selected integrate into the thin-client, thick server architecture used by the city, allowing the city to avoid using personal computers (PCs), enabling the use of dummy terminals. Dummy terminals cost significantly less than their PC counterparts. Therefore Roswell's use of OSS does not appear to be linked solely to the benefits of OSS applications themselves, but also to the thin-client, thick-server architecture which appears to compound the cost reduction of OSS by allowing for changes in hardware.

Interpretation of OSS Disruption within Roswell's IT Department

Roswell's integration of OSS into departmental processes did not appear to disrupt the IT department. This integration seems to center around the thin client architecture and technical knowledge of the department.

Roswell's thin client architecture appears to allow the IT department to align their external forces, such as technical communities and vendors, with internal drivers, such as goals of cost reduction and levels of functionality, by limiting technology switching costs. Because the thin client technology allows the IT department to incorporate both an OSS framework and proprietary technologies, I.E. the proprietary police department system running side-by-side open source applications, the department does not appear to be committed to specific technology standards. This allows the department to find 'best fit' technologies that allows IT department personnel to pursue multiple goals, such as ideal functionality and cost reduction, at the same time. The department appears able to do this because of the superior technical knowledge of the IT department.

This superior technical knowledge seems to flow through the organization, from the top to the bottom, as the Director of the IT department would rather cancel physical projects than cut training. At the bottom of the organization IT department personnel appear to take genuine interest in the functionality of their technologies, making proactive modifications, even when they are not called for. This attitude of improving the IT function through the best fit technology appears to encourage the adoption of new innovations which seems to create a virtuous cycle that makes adopting the next technology easier.

Disruptions caused by OSS appear to be focused around individuals who are new to the environment, who are accustomed to a single technical standard, or who do not have the associated technical knowledge or who are not accustomed to switching and learning new standards. These disruptions appear to last between six and twelve months, as individuals familiarize themselves with the technology.

Summary of the Roswell Case

Roswell's adoption of OSS appears to be influenced by many model factors, especially environmental and organizational factors associated with searching for and learning about new technologies. However the model factors appeared to be heavily influenced by city themes of thin-client architecture and employee development.

Roswell's commitment to these two factors appears to be driven by two further factors: a pair of visionaries in the IT department and an employed city manager rather than an elected mayor. Roswell's IT visionaries, Systems Administrator A and Systems Administrator B have been with the city for over twenty years. Apparently these two individuals played a major role in adopting the city's thin client architecture that eventually migrated to open source technologies. According to other members of the department:

> *"I think a lot of that you know probably has to do with (Systems Administrator A) and (Systems Administrator B). I would give them credit for how our network is set up." - IT Support Specialist II B*

"It's like they (Systems Administrator A and Systems Administrator B) think for themselves and try to think rationally about the whole situation. They try to think about the future and they you know try to be objective...they don't take any salesman's complete story...They're real gurus." - IT Support Specialist II B

"I will say that I was not the instigator of that, it was actually being looked at and they had some open source stuff in place when I started here." – CIO

Additionally the city has a city manager, an employee who implements the elected representative's initiatives. Although the city manager position has turned over several times in the last twenty years, each manager has valued the cost efficient operation of IT through the use of the thin-client architecture. Their support for IT operations has resisted several initiatives to migrate from the thin client architecture to personal computer technologies.

These factors seem to be at the root of Roswell's OSS adoption and appear to leave a footprint in model factors associated with searching for and acquiring new technical knowledge. But without strong organizational factors, internal communication, environmental sensing and technical knowledge, it is doubtful that the city would have implemented so much of their technology through open source applications.

Columbus – ‘The Need to Succeed’

Overview of Columbus’s Case Study

Columbus’s adoption of OSS was greatly affected by the department’s need for IT project success. Because the department was trying to consolidate IT resources within the city it was trying to maximize political goodwill through IT project successes. Consequently it was paramount for the IT department to appear successful in new IT projects. This influenced IT department areas and operations, including their adoption of OSS. Administrative intensity, or the consolidation of decision making, was correlated to the success rates of the various IT department areas. Those areas with successful track records were given more freedom to search for and implement new technologies so long as these technologies furthered the success of the department. This was especially apparent with OSS adoption as these technologies were often implemented to optimize proprietary technologies.

The need for IT department success encouraged the department to utilize vendors who could increase the likelihood of IT success. This approach to IT operations increased the use of vendors for primary IT department functions, increasing the likelihood that the department would adopt proprietary technologies. However successful IT department areas were free to search for and implement technologies so long as these technologies furthered IT area success. In these areas, OSS was adopted that optimized existing proprietary technologies. Figure 6 highlights the relationships between model factors and the need for IT department success in Columbus. The remainder of the case highlights how the 'need to succeed' influenced environmental, organizational and innovation factors leading to OSS adoption within Columbus.

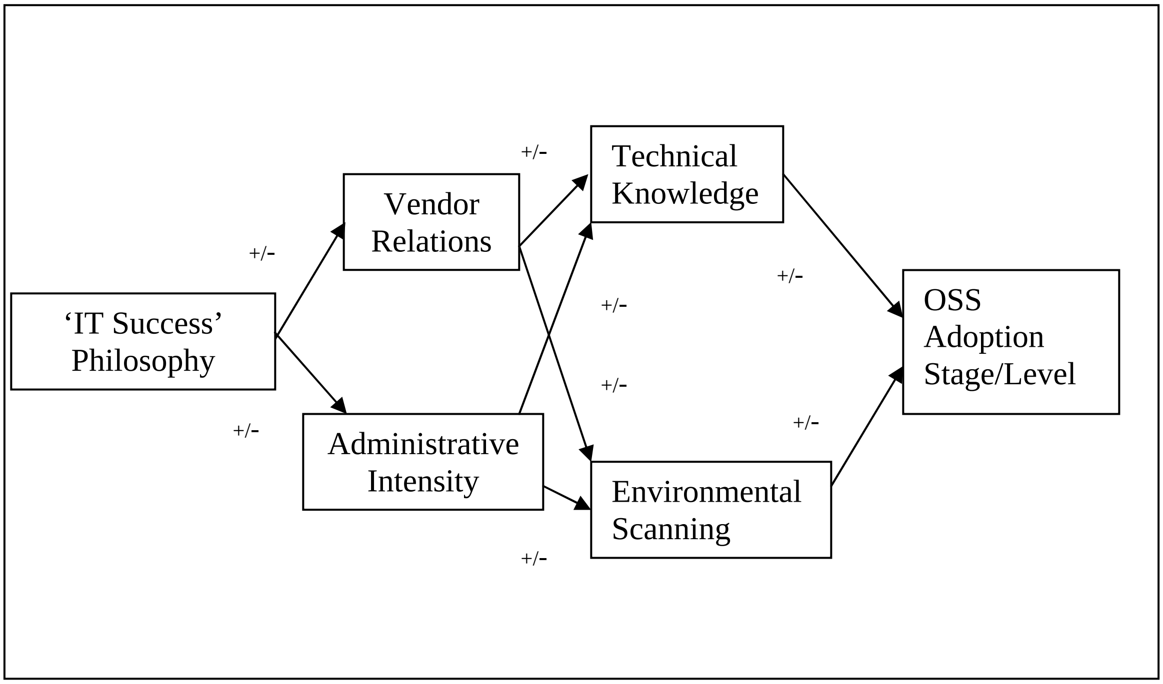

Figure 6. Columbus's OSS Adoption

Description of Columbus

With a population just under 250,000 citizens, Columbus is the second largest municipality to participate in this study. It is often described as 'built out' community; the city itself has spread out and developed all of the area between other municipalities, leaving no more room to grow. The citizens of Columbus work in a variety of industries including tourism, financial services, manufacturing, medical technology, information technology and marine sciences.

As an organization, the city has more than thirty municipal departments that employ more than 3,000 people. These departments are funded by a city budget that was in 2007, over 550 million dollars. In 2007 the majority of this revenue, 43%, was collected from ad-valorem taxes. See appendix item E for a comparison of the size of the different municipalities.

The mission of the municipal government is to “provide efficient and effective public services that protect and enhance sustainability of our environment and the quality of life” within Columbus. Following this guideline, Columbus has received numerous awards for sustainability and ‘green’ initiatives. National awards and recognition have also been earned by public safety and utility departments for improved operations.

An elected mayor leads Columbus. The current mayor, who is serving his second and final term, has been nationally recognized as an outstanding leader. The mayor acts as CEO, Chief Executive Officer, for the municipality. Assisting the mayor in governance activities is an elected city council. These citizens who comprise the elected commission set goals for the city manager and indirectly guide municipal activities.

Description of Columbus’s IT Department

Columbus’s IT department is well established within the city, having been a formal city department for over ten years. Despite this tenure, the IT department is not the only IT resource in the city; at least two other municipal departments have their own IT areas. These IT areas work with the central IT department to implement, support and maintain the information technologies used by the city. Perhaps the city has not consolidated all IT resources into a single IT department because of city politics: the central IT department is two bureaucratic layers away from the elected officials of the city, one level further than the other departments with IT areas. However it does appear that the city is consolidating IT resources and will eventually have a single IT department.

Despite two other municipal IT resources, Columbus's IT department has a budget over ten million dollars and more than sixty employees. The size of the budget and number of personnel ranks Columbus's IT department as the fourth largest or second smallest municipal IT department to participate in this study. See appendix item E for a description of all participating municipal IT departments.

The main duties of the central IT department at Columbus focus on integrating and supporting a wide variety of information technologies that the city uses. These technologies include geographic information systems (GIS), enterprise resource planning (ERP) systems, legacy applications and other information technologies used by the city.

With the implementation of the ERP system, a cross-functional IT, the role of the IT department appears to be changing. As the ERP system crosses multiple city departments the IT department has been given ownership of this application. Consequently the IT department has been making more decisions regarding the ERP including work-flow, business process redesign and technology adoption. To date these decisions have been made with input from other municipal departments, as the city has ERP analysts that work as boundary spanners to ensure that both departments are working together. But the increased responsibilities of coordinating city IT appears to also increase the influence of the IT department itself.

Columbus Participants

The main source of data for this study was gathered through seventeen interviews of IT department members. These members came from each area in the IT department, and from varying organizational levels, both administrative and operations. Personnel within the city had varying tenures with the city, with most area administrators having more than ten years of city experience. Meanwhile operations employees greatly varied in their experience, from new hires to twenty year veterans. Interviews were conducted during the fall of 2007. Department member roles and duties are generalized to those used by this study as many of their job titles appeared to be unique to the city. Table 13 highlights the role and responsibilities of the individuals interviewed.

Table 13. Columbus IT Department Member Role and Responsibilities

Interviewee	Responsibilities
Administrator of Network Operations	Responsible for the city's network, personal computers running on the network and the enterprise applications running on the PC's.
Administrator of Telecommunications	Responsible for the city's telecommunications network, personnel and all telephone equipment (hardwired and cellular) used by the city.
Development, Programmer A	Responsible for maintaining payroll applications and computer processes. Additionally responsible for all programmers involved with the city's ERP.
Development, Programmer B	Responsible for mid-range servers and the applications that run on these servers.
Development, Programmer C	Responsible for maintaining contextual specific applications and the individuals who use, and maintain these applications.
Administrator of Development Programmers (ERP)	Responsible for the city's enterprise resource planning system. Manages developers and analysts who implement and maintain the system.
Operations, Security	Responsible for implementing security on the city's network and servers.
Administrator of IT for External Department	Ultimately responsible for managing over twenty employees who maintain and implement the applications used by the Police Department in the city of Columbus.
Administrator of GIS Development	Responsible for managing GIS employees as well as providing GIS services to other customer departments.
Administrator of Communication Operations	Responsible for the radio and television technology used by the city.
Developer, Systems Analyst A	Responsible for ensuring that business needs of the Human Resources (HR) department are being implemented in information technologies, primarily the city's ERP, used by the HR department.
Administrator of Application Operations	Responsible for computer applications, excluding the ERP and desktop applications, run by the city.
Developer, Systems Analyst B	Responsible for ensuring that business needs of the accounting department are being implemented in information technologies, primarily the city's ERP, used by the accounting department.
Administrator of Server Operations	Ultimately responsible for the server and database functions of the city. Manages city employees who maintain and implement server and database technologies for the city of Columbus
Operations, Network	Responsible for maintaining and monitoring the city's networks
Administrator of Security Operations	Responsible for city information technology security, including establishing security policies, implementing physical security and monitoring network activity
Operations, Server	UNIX Administrator

Open Source Adoption at Columbus

Four areas within Columbus's IT department have adopted OSS applications. Because these applications were commonly used to accomplish work tasks the adoption of OSS can be characterized as being at the routinization stage. Additionally departmental members did not participate in the development of these OSS, characterizing the adoption level as 'as-is'. Finally the OSS did not appear to create any disruptions within the IT department as implementation, maintenance and work processes were not altered by the technology. Because the technology did not appear to disrupt department factors the adoption of OSS by Columbus' IT department can be classified as routine, not disruptive. Table 14 summarizes the departmental areas adopting OSS. The remainder of this section discusses each areas adoption in greater detail.

Table 14. Columbus's Adoption of OSS

Departmental Area	Applications Adopted	Influential Model Factors	Adoption Stage	Adoption Level	Impact on IT Function
Security	Linux, Apache, Netsys, Snort, PERL, MySQL	Administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage	Routinization	As-is	Routine
Server	Bash, Nagios, PERL	Technical knowledge, relative advantage, compatibility	Routinization	As-is	Routine
Network	Bash, C-FTP, Nagios	Administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage	Routinization	As-is	Routine
End User Applications	Open Office, Firefox	Peer adoption, relative advantage, compatibility	Routinization *	As-is	Routine*

*Parallel to proprietary applications

Security

Columbus's IT Security area has adopted OSS for many of the area's functions. Not only does the area use OSS for contextual applications, i.e. security activities like port scanning or threat assessment, it also uses OSS to store and organize area applications and data. Members of the security area routinely used these technologies, but did not participate in their development, classifying the adoption as 'as-is'. Additionally the implementation of these technologies did not cause disruptions to security activities, classifying the adoption as routine. Finally these OSS technologies were limited in scope, as only the security personnel needed to interact with the OSS adopted.

Server

The server area in Columbus adopted OSS utilities to help monitor and optimize servers. Server personnel appear to have adopted these OSS utilities to supplement vendor technologies. Like the security area in Columbus's IT department, the adopting members of the server area did not participate in the development of these utility programs. Consequently the adoption stage is routine while the adoption level is 'as-is'. Additionally because the adoption of these applications did not cause disruptions to server area activities the adoption itself can be considered routine. Finally the OSS adopted by server personnel was only used by members of the area. This appeared to limit the scope of OSS to within the server area.

Networking

Similar to the server area in Columbus's IT department, the networking area has routinely adopted many OSS utilities to monitor and optimize the city's network. Because the networking area did not participate in the development or testing of these technologies the adoption stage is considered routine while the adoption level is considered 'as-is'. Additionally the use of OSS applications did not appear to alter departmental processes or technologies as the OSS adopted were specifically designed to work with the vendor standards that Columbus's networking area used. Consequently the OSS did not appear to disrupt area operations. Finally the OSS technologies used by the networking area were limited to networking personnel, reducing the number of Columbus employees who used the technology and decreasing the scope, or impact of the OSS applications.

End User Support

The fourth area adopting OSS within Columbus's IT department is the end user support area. Two open source applications have been deployed alongside existing proprietary equivalents, Open Office and FireFox. This adoption of OSS is different from the other areas as these OSS applications are widely deployed throughout the city. But these OSS applications were deployed parallel to proprietary software that performed similar functions. However, because these applications were routinely used by some members of the city while ignored by others it is difficult to specifically classify these technologies as either being routinely used or not used at all. Additionally classifying the disruptive effects of these applications is also difficult because of end user use. Do the end users use these technologies or do they ignore them in favor of applications that they are more accustomed to? Clearly the adoption level, 'as-is', is much easier to identify than the adoption stage as the end user area did not participate in the development of these technologies. However for the purposes of this study the adoption stage will be classified as adoption, as it is unclear if a majority of Columbus employees used the applications. Additionally because the OSS did not cause any disruptions to work processes or IT support, the classification of the adoption can be routine, not disruptive.

Open Source Adoption Themes at Columbus

Columbus's adoption of OSS appears to be affected by one major departmental theme, the need for IT department success. IT success, or the successful implementation and maintenance of new and existing IT without disruption of work processes or departmental knowledge, appears to be critical because Columbus's IT department is not the only IT resource in the city. At least two other municipal departments had their own IT areas. IT department success was stressed by all area managers because it is critical to further consolidate IT resources within the city.

The IT department, as well as other IT areas within Columbus, recognizes that IT consolidation into one department will eventually happen. The administrator of an external IT department succinctly captured this sentiment when he said:

"You know we probably really need to begin, we probably are going to have to take a look at that holistically (city IT) and say 'Ok, how many people do we really have doing that type of work in this organization?' You know if we all of a sudden have to begin to constrict financially, you know can we really begin to reduce some of those positions and let central IT provide desktop support?" – Administrator of IT for External Department.

IT department consolidation has been pursued in two different ways. First, in the past the IT department 'took over' struggling IT projects or other IT areas within the municipality. For example the Administrator of Application Operations, who has been with the city for more than twenty years, indicated that in the past the IT department did not hesitate to 'takeover' struggling IT areas, even if it or resulted in ill will among the departments.

> *"We had a hostile takeover, we took GIS and moved down here and they (the other department) weren't happy…They (other municipal departments) call us the evil empire. Because for a long time it was whatever we say, that's the way it's going to be. But it's not like that anymore. You know we have to work with the*

departments and say 'What would you like?'" – Administrator of Application Operations

This strategy of 'hostile takeovers' or absorbing failing areas into the central IT department does not seem to have consolidated all IT resources within the city. Rather larger departments appear to have resources or skilled personnel that ensure successful operation of IT within these areas. Consequently the IT department seems to have changed their approach to consolidation.

The second strategy towards consolidating IT resources focuses on providing IT services as opposed to 'taking over' projects. This was reflected in the current attitudes of several area leaders:

"I look at my team as a service." – Administrator of Development Programmers (ERP)

"(The CIO) is very aware that (the IT department) doesn't want to be viewed as pushing on the user… (The CIO) is very people aware and politically in the city it's hard for us as an IT department because we are the support, then to tell everybody what they are going to do is bad…We want to be invisible, but at the same time help everybody achieve their job and do it as efficiently as possible." – Administrator of Network Operations

"My philosophy always has been: my customers are the other departments and users within the city. So my approach has always been that I want to keep my

users happy, and if I keep my users happy then my boss is happy." – Development, Programmer C

This change in tactics to consolidate municipal IT resources appears to have altered the IT department's priorities. Rather than focusing on efficient or effective technical aspects of IT projects, the IT department now seems more concerned about meeting end user needs and not interfering with existing business processes.

Meeting external department needs has resulted in changes to the central IT department policies when making technology adoption decisions. Other departments are more involved in technology adoption decisions, often suggesting the use of specific vendor technologies.

This theme, IT success, appears to affect OSS adoption and the model factors. It appears to result in higher levels of administrative intensity, which appears to be a proxy or a substitute for organizational power or control. The next section describes how this theme of IT success influences each of the model factors.

Columbus's Model Factors

Columbus's model factors appear to be heavily influenced by the department's need for IT project success, or successfully completing IT projects without causing changes to existing processes or organizational skills. The interviews reveal that all three groups of model factors, environmental, organizational and innovation were present at Columbus and influenced the adoption of OSS.

Coding of the interviews identified 812 instances of model factors. The codes can be seen in Figure 7 and Figure 8. Of these identified factors more than half, 422, were related to internal communication and administrative intensity. These instances were not all positive, as there appeared to be several communication barriers and administrative processes that impacted IT operations. However the sheer number of identified codes within these areas highlights how IT department members focused on the success of IT projects. Additionally every other construct was identified in coding the interviews, however, as the figures show, not every participant identified every construct.

Role	Administrator of Network Operations	Administrator of Telecommunications	Development Programmer A	Development Programmer B	Development Programmer C	Administrator of Development Programs (ERP)	Security Operations	Administrator of External IT Department	Administrator of GIS	Total
As is			1	1			1		1	4
Design	1						1			2
Awareness	1	1	1	1					2	6
Interest	6		1	1			2		2	12
Adoption	3		1	2			2		1	9
Routinization	3		1	1			2		1	8
Infusion										0
Complexity		2					2			4
Compatibility	1		1	2			11		2	17
Disruptive		1								1
Routine	1		1	1			1		1	5
External Communication	4	3	1	1		6	2		1	18
Peer Adoption		1				1				2
Environmental Sensing	5	2	2	1		2		1		13
Technical Knowledge	4	1	8	11	3	1	2	1	8	39
Relative Advantage	1		1	2			3		2	9
Administrative Intensity	23	6	14	23	14	12	10	13	9	124
Internal Communication	26		11	21	6	8	11	5	7	95
Slack Resources	4	1	2	5	2	2	5	2	5	28
Wealth	1			2		2	1			6
Technical Community	3	4	4	2		6	2	1	2	24
Vendor Standards	6	1	8		5	8		3	4	35
Total	93	23	58	77	30	48	58	26	48	461

Figure 7. Columbus Codes

Role	Administrator of Communication Operations	Developer Systems Analyst A	Administrator of Application Operations	Developer Systems Analyst B	Administrator of Server Operations	Operations Network	Administrator of Security Operations	Server Operations	Total
As is					1	1	1	1	4
Design									0
Awareness						2	2	1	5
Interest					1	1	1	1	4
Adoption					1	2	2	1	6
Routinization					2	1	2	1	6
Infusion						1			1
Complexity							1		1
Compatibility							2		2
Disruptive					1		1		2
Routine							1		1
External Communication	1	3	2	1	4		1		12
Peer Adoption			1						1
Environmental Sensing	1		2		4	1	2	2	12
Technical Knowledge	2	2	10	4	6	5	4	2	35
Relative Advantage					1	1	1	1	4
Administrative Intensity	4	14	29	8	12	3	14	8	92
Internal Communication	1	19	24	19	13	16	14	5	111
Slack Resources	1	2	1	2	4	1	1	2	14
Wealth			1	2	1				4
Technical Community	4	3	6	4	3		3	3	26
Vendor Standards	8	2	12						22
Total	22	45	88	40	54	35	53	28	365

Figure 8. More Columbus Codes

The following sections expand each model factor and discuss how Columbus' IT department's philosophy, that of successfully supporting the city's business departments, influences the construct.

Environmental Factors

Because Columbus's IT department is focused on successfully implementing IT projects, the department tries to repeat what was successful in the past, implementing vendor technologies. The administrator of another municipality's IT department appeared to capture this sentiment when he said:

> *"One of our key issues there is that we are not going to modify software, we are going to modify business processes. And so most of the project teamwork isn't involved with rewriting software or redoing code, it is with changing peoples minds about how they go about doing their job and saying 'Ok, you know instead of you wanting me to change the software, I'm not going to do that. We're going*

to change the way we do business.'". – Administrator of IT for External Department.

Consequently Columbus's IT department has a history of successfully implemented **vendor** technologies into their work processes. For example a large ERP (Enterprise Resource Planning) implementation was successfully completed in just over a year. Now many municipal departments rely on this software to accomplish their functions. The administrator of application operations described the relationship between the IT department and their vendors, saying:

"We work with corporate America; I deal with all of my companies. I have, I communicate with the CIO's of all of them…This is years of building relationships, going through some heartache, talking to them (vendors) getting mad with them (vendors)…We've done that (worked with our vendors) a lot, but it has built respect with them (our vendors) and we have relationships with them that a lot of their customers don't have." – Administrator of Application Operations

However this attitude of working with vendors as partners was not consistent among the IT areas. For example the Administrator of Network Operations did not have such close relationships with Columbus's networking vendors.

"Right now we're in tight with (Vendor X). We've bought lots of software from them. We probably buy a lot of software because it's convenient and the contracts are in place…We don't hesitate to say 'Hey vendor, let's set something up and

look at your product.' Before we even think about buying it." – Administrator of Network Operations

Other members of the department indicated that the reliance upon vendor technologies created switching costs, preventing the city from moving away from their vendors.

"We cannot get rid of (Vendor X) because (Vendor X) is synchronized with their time clocks in the police department and all the other departments where in they have time clocks. And the (Vendor Y) time function doesn't work with the time clocks so we have to have (Vendor X), and (Vendor X) doesn't interface with the (Vendor Y) products and so…it is a complicated thing." – Development Programmer A

"Well there would be a lot of switching costs involved for us. That way you're changing what you're currently doing, you've got to look at the switching cost. For us to go to (open source application A) would be a huge switching cost. Number one we own all these (Vendor X) licenses, all of our staff are trained to support (Vendor Y) environments. So they've have to be completely retrained. The cost would be huge." – Lead Security Officer

Reliance upon vendors and their technologies appeared to focus environmental factors, such as **external communication** and **technical communities,** on existing vendors and their technologies.

"I wouldn't say that I've gone to the blogs or whatever. I spend a lot of time on (Vendor X's) site." – Development Programmer B

"Keeping up with (Vendor X) is 50% of our work, and keeping up with the user is the other 50%. Apply all the patches, test all the patches, things like that." – Development Programmer A

"(Vendor X) is the only technology that I use." - Development Programmer A

By focusing external communication and technical communities on vendor technologies, Columbus IT department personnel appeared to be biased towards vendor technologies. Many IT department members viewed alternative applications, like OSS, as 'buggy'. For example the Administrator of GIS development said the following:

"We don't want to implement something that's going to be buggy or troublesome to get support on, you know open-source is a little dangerous in that way. You have to depend on a user community to help you and sometimes they don't respond so you know versus purchased support that you can get with the purchased version of their software." – Administrator of GIS Development

However this bias seemed to be linked to specific IT areas. For example the networking area, seemed much more open to alternative technologies like OSS.

"If we can find an open source that is as/or as close to the effectiveness then yea, we are definitely open to that… I mean I have to say from my own experience I've

found it (OSS) pretty good. You know you call up and you get some help, and you can fudge through it and get through it." – Administrator of Network Operations

Unlike vendor relations and technical communities, which focused on vendors, **peer adoption** was an environmental factor that had identified alternative technologies for the department to adopt. Because Columbus was aware of the success of another municipality's adoption and subsequent cost reduction, they implemented OSS applications with the idea of trying to emulate these savings. However Columbus implemented these OSS, Open Office and Firefox, parallel to existing proprietary technologies. It appears that the city will eventually switch over exclusively to Open Office in the future and is using the parallel deployment to build user familiarity with the technology.

Organizational Factors

Organizational factors were also focused on IT project success. **Administrative intensity** was especially important because it heavily influenced organizational processes. Area leaders were quick to state that their opinions or recommendations, while considered by the department CIO, were secondary to the CIO's. This reflected how administrative intensity affected the decision making processes within the IT department. For example:

"I can make recommendations, but the department administrator makes all of the decisions." – Administrator of Communication Operations

"(Our) CIO understands technology. Now he may not be an engineer, but he knows enough of it…he understands the business process as well…it's easy to push new initiatives or initiatives that can bring value to the city. If we convince him it has value, that means maybe reduce cost, or an equal cost that gets better performance on something, then that's a big hurdle for us…He scrutinizes everything, like "Why this? This? This? We have to justify and part of my job is to explain the technology on why I want, desire or need that." – Administrator of Network Operations

Administrative intensity also appeared to impact work processes within the IT department. However not all IT department areas had the same levels of administrative intensity. Because the IT department pursued IT project success over other departmental goals, administrative intensity appeared to be moderated by IT area project success rates. IT department areas with a history of IT project success had lower levels of administrative intensity than IT areas that were less proven. This seems to account for the varying levels of administrative intensity throughout the IT department.

For example the networking and security areas appeared to display lower overall levels of administrative intensity than the other IT areas as the security and networking areas had a history of successfully implementing new projects. For example the network area had completed an overhaul of the city's networking equipment, replacing 100% of the networking equipment, without causing a minute of the network's downtime.

As administrative intensity varied within the department, areas with high levels of administrative intensity focused on their work tasks. This had the effect of reducing

environmental scanning as high levels of administrative intensity compartmentalized IT department areas, to increase IT department success rates. But this concentration on work tasks created stress between areas in the IT department affecting **internal communication**. This impact on internal communication was reflected in the interviews:

> *"There's also little kingdoms within the IT department. Okay and sometimes people, because they are in a specific modality such as networking or such as (Vendor X) or Email systems, they don't want to have anything to do with the other parts...they want to focus on what they do and not really willing to learn things around themselves." – Systems Programmer I*

In some instances IT area compartmentalization has resulted in conflicts between IT department areas as many area technologies overlap common software and hardware. These conflicts appeared to be especially prominent between areas of varying administrative intensity. For example the security officer, an area with low levels of administrative intensity, has had problems with areas with high levels of administrative intensity modifying software firewalls without her consent or knowledge.

> *"Oh my god! In the server area there is such a cowboy culture. We used to have a software firewall. Now we have a hardware firewall. That's my change control." – Lead Security Officer*

Additionally the database administrators, DBA's, and enterprise resource planning, ERP, developers, two areas within the department with high levels of administrative intensity, seemed to have miscommunications and differing priorities.

"I think sometimes the DBA's don't understand the prioritization when there is a production issue. It's something we really need to be dealing with because of not talking to the user group. They don't understand how high level a problem it may have become." – Developer, Systems Analyst B

Low IT project success rates and high levels of administrative intensity reinforced IT area compartmentalization as members focused on their own function. This was especially apparent in IT department areas that used multiple standards.

"I will say that there's a culture difference between the (Vendor X) side of the house and the (Vendor Y) side of the house…I have so little to do with the (Vendor X) side of the house it's pathetic." – Development Programmer C

Compartmentalization and the ability to focus on specific tasks allow some personnel to largely ignore other IT areas within the department.

"I can only really speak of the GIS work I do." – Administrator of GIS Development

However areas with high IT project success rates and low administrative intensity appeared to interact with one another regularly. For example the networking and security areas, areas of high IT project success and low administrative intensity, routinely talked with one another, discussing technology options.

"We do our research and find out what's the best solution and things like that. Then we all group up and try brainstorming. We work really well together." – Security Operator

“If a problem comes in we toss it out onto the table and we look at whose skills will best fit it and we generally have somebody who can take it on.” – Development Programmer C

Meanwhile other departmental areas, like the ERP (Enterprise Resource Planning) area and the server area, areas with lower success rates and higher levels of administrative intensity, had lower levels of communication that appeared to extend into area rivalries.

“I think sometimes the DBA’s don’t understand the prioritization when there is a production issue. It’s something we really need to be dealing with because of not talking to the user group. They don’t understand how high level a problem it may have become.” – Developer, Systems Analyst B

“We’ve tried to set up some formal times for our teams to spend time together, to learn with each other. Our teams are working really well together now but there was a time when that wasn’t true. There was a lot of ‘They don’t know what they’re doing…’ Going back and forth. So we thought ‘Ok, you know what, lets have them sit down so they can see how different their jobs are and kind of gain respect for each others responsibilities.’ So we did that, but I also try to encourage my team to go out in the business department and learn about what businesses our customers are conducting.” – Administrator of Server Operations

"Oh they've tried things such as they wanted some cross training done between the business analysts and our DBAs, and they wanted these individuals to sit with us for eight hours a day and learn what we do. That ticked most of us off." – Development Programmer B

Another factor that appeared to be affected by administrative intensity was **technical knowledge** as the hiring process of the IT department sought out extremely skilled individuals. This appeared to be done to increase the likelihood of IT department success. For example, the latest hire in the server area had outstanding credentials, including multiple degrees from an Ivey League University, and experience with a large fortune 500 organization. According to the server area administrator the department waited more than six months to fill this position and passed over several qualified applicants.

Meanwhile **slack resources**, a construct long associated with technology searching, did not appear to be present. Rather the high levels of administrative intensity focused personnel on their immediate work tasks as opposed to looking for new technologies. Additionally slack resources were in short supply as the department was short three members, as three positions were unfilled, and these responsibilities were doled out among the remaining IT members in addition to their regular duties.

Finally Columbus's **wealth** or the department's budget was being reduced, as all areas were asked to look for areas to trim their budgets. Within this cost cutting environment the department sought out alternative technologies that could reduce costs, like OSS, not increase them. Perhaps the lower-end, disruptive nature of OSS appeals to organizations with lower wealth that cannot purchase or maintain proprietary applications.

Innovation Factors

IT personnel appeared to be interested in OSS because of a perceived **relative advantage**, the cost of OSS, and how OSS applications fit with existing technologies, or the **compatibility** of the innovation. Personnel were also aware of the **complexity** of OSS, as this was a major point of rejecting OSS.

Columbus's IT department personnel consistently perceived OSS to have one common **relative advantage**, its cost. Because OSS was perceived to reduce costs it was considered an option only when effectiveness, or IT project success, would not suffer.

> *"If we can find an open source that is as/or as close to the effectiveness then yea, we are definitely open to that." – Administrator of Network Operations*

While several individuals in the department were comfortable learning new technologies or using OSS, many personnel perceived OSS to be **incompatible** with existing technologies or very **complex**.

> *"I have people who have experience with other operating systems and my team is very open to learning new things. They would do anything for a new toy." – Administrator of Server Operations*

> *"It would be radical to shift over to (Open Source Application X). That migration would, just, there would be so much complexity in a migration like that. It would be a huge undertaking. It would be something that we could not accomplish*

without downtime which means we could not do without our customers noticing something happening and just the amount of planning." – Administrator of Server Operations

"A lot of the things that are open-source or that are free, you know it's complicated to set up a learning curve that's really big. Learning how to use it and if there's an issue I mean who's going to support that?" – Security Operator

IT department members thought that OSS versions of existing proprietary technology would be perceived as extremely **complex** by non-IT department members.

"Take Microsoft Office. Just moving away from that in itself would be a big deal for all the users (outside the IT department) because now they have to relearn where everything is, how to highlight this. I know like in Excel cut and paste is different, things like that. Little things here and there they'll have to relearn and the tendency for someone to, you know if you already have something that you know why relearn something?" – Security Operator

"A good example is Microsoft Office. Just moving away from that in itself would be a big deal for all the users because now they have to relearn where everything is, how to highlight this. I know like in Excel cut and paste is different, things like that. Little things here and there they'll have to relearn and the tendency for someone to, you know if you already have something that you know why relearn something?...I personally run Linux at home and have Open Office. It's just not

like I said the users here, at least with the city of St. Pete, it's like we always want the users, to get them what they want. Don't force them to change or anything like that. Even though the cost benefit is huge. It's like pushing our own agenda." – Security Operator

OSS Disruption within Columbus's IT Department

OSS adoption by Decatur's IT department did not disrupt IT department operations. It did not change processes or core IT skills beyond the learning of new syntax, as the adoption was limited to select projects and contextual applications. While OSS adopted in this manner reduced the scope of OSS within the organization, the adoption by project teams for their IT projects allowed the technologies to reduce IT costs without sacrificing functionality or changing organizational processes throughout the department.

Interpretation of Columbus's Model Factors

Model factors concerning OSS adoption were heavily influenced by the ongoing theme of IT project success at Columbus. IT project success appeared to be the highest priority so that the IT department could build credibility within the city to consolidate municipal IT resources within the city. Consequently, IT project success appeared to influence all the factors in the study model. Administrative intensity appeared to proxy for IT project success as it appeared to moderate other model factors.

Environmental Factors

Columbus's environmental factors appeared to play a large role in both adoption and rejection of OSS in Columbus. These factors seemed to be influenced by the IT department's **administrative intensity** as departmental member activities and organization was highly regulated. This limited how environmental factors were utilized, primarily to increase IT project success.

For example, due to departmental success with implementing vendor solutions, **external communication**, **vendor relations** and **technical communities** appeared to focus on vendor technologies. This appeared to create network effects surrounding existing IT vendors that served to hinder OSS adoption. By hindering the adoption of new technologies, external communication, vendor relations and technical communities appear to go against commonly accepted theory. In terms of the model, the network effects caused by focus on vendor technologies had the outcome of decreasing the awareness and interest in OSS.

Of these three environmental factors that seemed to hinder OSS adoption, t**echnical communities** also appeared to facilitate OSS adoption. Individual departmental members who had low levels of administrative intensity, appeared to use technical communities to adopt OSS. These individuals appeared more likely to search for alternative technologies, and their searches led them to technical communities that facilitated the adoption of OSS. Technical communities not only appeared to increase IT department member awareness, and interest in OSS, but also facilitated adoption and routinization as the communities supplied knowledge and support for the continued use of OSS.

Peer adoption was the only environmental factor at Columbus that consistently facilitated OSS adoption. This factor was instrumental in the adoption and deployment of two OSS, Open Office and FireFox. Although these actions were done in parallel to existing proprietary technologies, which appears to reduce the adoption level from routinization to adoption, departmental members appeared certain that eventually these applications would replace their proprietary equivalents. Most likely this would occur to highlight the cost savings of these technologies, perhaps once the different IT resources within the city were consolidated. Regardless of motivation, peer adoption seemed to affect the awareness, interest and adoption stages at Columbus. Table 15 highlights Columbus's Environmental Factors.

Table 15. Columbus's Environmental Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
External Communication	Facilitate adoption by creating awareness and interest in OSS	External communication focused on vendors. This appeared to create network effects or switching costs that hindered the awareness of OSS within the department.	High (Rejection)	Awareness & Interest
Peer Adoption	Facilitate adoption by creating awareness and interest in OSS	Peer adoption facilitated adoption by creating an awareness and interest in achieving similar benefits as recognized by Columbus peers.	Moderate (Adoption)	Awareness, Interest, and Adoption
Vendor Relations	Hinder adoption through switching costs and other mechanisms	Vendor Relations hindered adoption of OSS by creating network effects that tied organizational work process to vendor technologies. This created switching costs to pursue OSS technologies.	High (Rejection)	Awareness & Interest
Technical Community	Facilitate adoption by creating awareness and interest in OSS	**Hindered** OSS adoption when technical communities were linked to vendor sites. **Facilitated** OSS adoption when individual technical knowledge, or environmental scanning were high or when administrative intensity was low.	Moderate (Adoption and Rejection)	Awareness, Interest, Adoption, & Routinization

Organizational Factors

Columbus's **administrative intensity** appeared to have a great deal of influence over OSS adoption within the IT department as it appeared to serve as a proxy for IT department authority or control. This focused the department on IT success, dictating organizational structure and area activities. This resulted in administrative intensity directly moderating how organizational constructs of **internal communication**, **environmental scanning**, **slack resources,** and **technical knowledge** influenced OSS adoption.

IT department areas with successful track records, or areas with lower overall administrative intensity, appeared to have increased the **internal communication** and **environmental scanning**. Increased internal communication and environmental scanning appeared to facilitate OSS adoption as IT department areas were able to search for new technologies, like OSS, and become aware of, interested in and apply OSS within their departmental areas.

Unsuccessful track records, or IT areas that had higher levels of administrative intensity, resulted in IT departmental areas with lower levels of internal communication and environmental scanning. This resulted from these IT areas having their duties specifically outlined. Operations personnel were expected to focus on completing their work tasks while administrators of these areas were expected to manage the IT function. Lowered **internal communication** and **environmental scanning** decreased awareness and interest in OSS as departmental members focused on existing technologies and associated work tasks.

Additionally administrative intensity of all levels appeared to eliminate **slack resources** within the IT department. This appears to be supported as the IT department had three positions that were unfilled. Perhaps these duties were unfilled due to the stringent skill and knowledge requirements that the IT department exacted from new members. But more likely slack resources were eliminated as a part of overall budget reductions within the city.

High levels of **technical knowledge** appeared to facilitate OSS adoption. For example the highly skilled server operator who was recently hired routinely used OSS applications to optimize proprietary software.

"I use a lot of the open source tools because there was very little monitoring of the (Vendor X) structure here. It seems like the admins they had before were either not as much experienced or they just neglected to do certain things that I would consider basic." – Systems Programmer I

It appears that higher levels of technical knowledge were positively correlated to higher levels of environmental scanning as personnel with high technical knowledge seemed to scan the environment to be aware of technical trends and available functionality.

Meanwhile the **wealth** construct appeared to play a role in facilitating the adoption of OSS. Because Columbus's IT department was experiencing budget reductions, it appeared that opportunities to reduce costs, such as substituting OSS applications for proprietary ones, were gaining momentum within the department. Perhaps this explains the parallel deployment of Open Office beside Microsoft Office. Wealth and the other organizational factors are more fully described in Table 16 below.

Table 16. Columbus Organizational Model Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Internal Communication	Facilitate adoption by building consensus around potential new technologies	Columbus's internal communication appeared to facilitate OSS adoption within IT areas as they could build consensus and agreement about the value of the technology.	Moderate (Adoption)	Awareness, Interest, and Adoption
Environmental Scanning	Facilitate adoption as scanning should increase awareness of OSS	Environmental scanning appeared to facilitate OSS adoption as individual department members could identify OSS that could optimize other technologies.	Moderate (Adoption)	Awareness, Interest, and Adoption
Administrative Intensity	Hinder adoption as decision making is consolidated into a few individuals	**Adoption** – where administrative intensity was low, IT areas were likely to identify and adopt OSS. **Rejection –** where administrative intensity was high, IT areas focused on work tasks, reducing the likelihood of the area adopting OSS.	High (Adoption and Rejection)	Awareness, Interest, Adoption and Routinization
Technical Knowledge	Facilitate adoption as increased knowledge is associated with flexibility and greater capabilities	Appeared to be linked with environmental scanning. Higher levels of technical knowledge also allowed individuals to identify how OSS could be used within their areas.	Moderate (Adoption)	Awareness, Interest, Adoption, and Routinization
Wealth	Facilitates adoption	An absence of wealth appeared to facilitate OSS adoption as the organization looked to reduce costs.	Moderate (Adoption)	Awareness, Interest, Adoption, and Routinization
Slack Resources	Facilitate adoption as employees can search for and experiment with new technologies	Columbus's high levels of administrative intensity appeared to reduce slack resources and technology search activities.	Low (Adoption)	Awareness

Innovation Factors

Columbus's IT department areas appeared to adopt OSS applications primarily because of the **compatibility** of the innovation. Compatibility appeared to be more important than the **relative advantage** of the software as most OSS applications appeared to optimize proprietary technologies rather than provide unique functionality. Even when a substitute was adopted, like Open Office, it was adopted parallel to vendor technologies.

By focusing on highly **compatible** OSS the **complexity** of OSS appeared to be reduced. Not only were Columbus employees given proprietary alternatives to OSS, but where OSS was solely adopted, it was limited to areas within the IT department. This seemed to further reduce the overall complexity of OSS as only individuals with technical skills that could use OSS were exposed to the technology. Consequently, while the relative advantage of OSS was important, cost savings or optimization functionality appeared to play a major role in OSS adoption, **compatibility** appeared to be the innovation factor that aligned with the department theme of IT project success. Table 17 highlights Columbus's Innovation factors.

Table 17. Columbus's Innovation Factors

Factor	Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Relative Advantage	Facilitate adoption through superior performance	Cost appeared to be the main perceived relative advantage OSS had over proprietary technologies.	Moderate (Adoption)	Awareness, Interest, Adoption, Routinization and Infusion
Compatibility	Facilitate adoption by working with other technologies	Compatibility with existing technologies and skills seemed to drive OSS adoption more than the relative advantage of the software.	High (Adoption)	Awareness, Interest, and Adoption
Complexity	Hinder adoption by erecting barriers to adoption	Complexity appeared to limit the scope of adoption to the IT department or to OSS deployments alongside proprietary equivalents.	Moderate (Rejection)	Interest, Adoption, Routinization and Infusion

Interpretation of Columbus's OSS Adoption

OSS adoption at Columbus appeared to align with the IT project success at Columbus. In most instances this appeared to be the result of good fortune or serendipity as the IT department focused on proprietary vendor technologies to increase IT project success. This drive for IT project success appeared to reflect through the IT department's administrative intensity. Within this setting OSS adoption seemed to be limited to applications that did not adversely affect IT area success, meaning that they enhanced proprietary technologies, were limited in scope (i.e. primary users were contextual experts within the IT department) or were deployed alongside proprietary equivalent technologies.

Interpretation of OSS Disruption within Columbus's IT Department

OSS did not appear to cause disruptions within Columbus's IT department. Rather the IT department's theme of IT project success appeared to ensure that, where adopted, OSS applications caused as little change in work processes or knowledge as possible. This appears to be supported as the primary OSS applications adopted were contextual programs limited to highly knowledgeable IT areas. In the instances of OSS adoption outside of specific IT areas, OSS was deployed alongside traditional proprietary technologies.

Summary of Columbus Case

Columbus's adoption of OSS appeared to be driven by the goals of the IT department to consolidate IT resources within the city. Consequently the departmental theme of increasing IT project success seemed to drive the administrative intensity at the site, which in turn moderated model factors. Vendor technologies appeared to be preferred to OSS applications to increase the likelihood of IT project success. However, even within a highly regulated environment like this OSS was adopted. Contextual applications that complemented proprietary technologies were adopted by multiple IT areas, sometimes as conscious decisions by the IT areas and at other times as individual initiatives. Regardless of how it is adopted, it appears that OSS adoption will likely increase at Columbus if it can be shown to increase IT departmental goals, that of successfully implementing IT projects.

Decatur– 'Cultural Divide'

Overview of Decatur's Case Study

Decatur's adoption of OSS was greatly influenced by a cultural divide resulting from a new organizational structure that originated in the department because of reduced resources. Rather than follow a traditional IT department structure which focused on the functional areas of the IT department, Decatur's IT department had both the traditional functional areas and a projects division. The projects division was responsible for analyzing, designing, and implementing new information systems (IS) within the city while the functional departments were responsible for maintaining the municipalities existing systems.

The new organizational structure resulted from the department's budget. Because the IT department had had the same budget for the last two years, but had increased responsibilities over this time period, the department essentially experienced a net cut in funding. Consequently the department changed structure to allow for the implementation of new IS that could help reduce costs like OSS. However because the IT department is heavily unionized, new activities and technologies can be difficult to implement when union rules are invoked. To work around union rules the department formed a new projects division that focused on using new technologies.

Once new IS were implemented in the projects area, these projects were transitioned to the traditional functional areas to support. This affected the adoption of OSS as the projects division actively used these technologies in many new IS projects. Consequently model factors were mixed in their facilitation or hindrance of OSS. If examined through the traditional IT department functions, the factors of technical knowledge, environmental scanning and vendor relations acted to hinder OSS adoption as they were linked to existing proprietary vendor technologies; however if viewed through the projects division, these same factors acted to promote OSS adoption. Figure 9 highlights the model factor relationships at Decatur. The remainder of the case delves deeper into how environmental, organizational and innovation factors were influenced by cultural divide at Decatur.

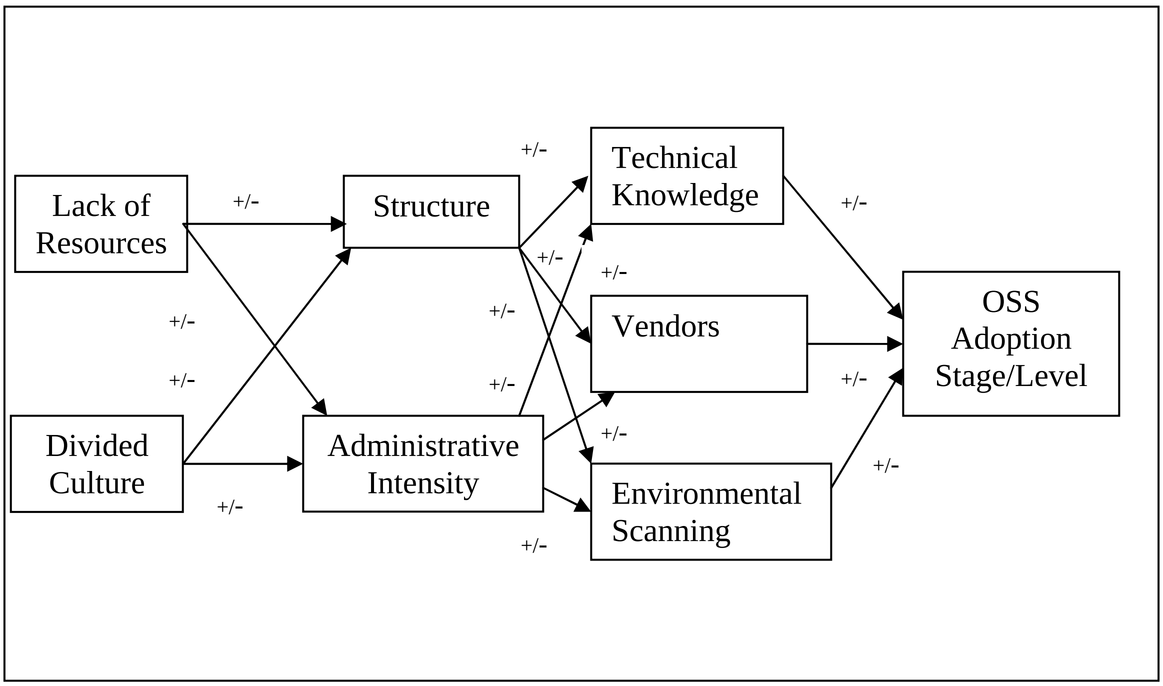

Figure 9. Decatur's OSS Adoption

Description of Decatur

Providing services to the more than 150,000 residents in Decatur is a city government with more than twenty five municipal departments and three thousand employees. These departments and civil servants are led by a 'weak' mayor, or a mayor without veto power, and a city commission of seven individuals. This leadership structure provides direction for a professional city manager who is responsible for managing the city government.

Economically Decatur is diverse as it has ties to agriculture, manufacturing and information technology industries. This economic diversity has grown the community over the last decade, and without large neighboring communities, the city government of Decatur is considering merging with the county to form a single municipal government for the areas residents.

Description of Decatur's IT department

The Information Technology (IT) Department at Decatur, which has more than sixty personnel, is responsible for supporting most of the city's information technology. However there are multiple IT providers within the municipality. Larger municipal departments have their own departmental IT staff. Perhaps this structure is in place as the current central IT department is located three bureaucratic layers away from the elected officials of the city.

A lack of organizational power may also be a contributing factor as to why Decatur's IT department was the only participating IT department in this study not to have an increasing budget. Over the three year period that included the year this research was conducted, the IT department had the same budget. Meanwhile the responsibilities of the department appeared to grow every year, resulting in a net budget cut.

The increase of responsibilities coupled with a static budget resulted in the IT department altering its structure. Unlike other municipal IT departments, Decatur had two distinct divisions within the IT department: project teams and traditional IT areas. These two groups performed different tasks as project teams implemented new IT projects, often working with other departments within the city. Meanwhile the traditional IT areas supported traditional IT functions. For example the database area was concerned only with support and operation of databases while project teams were more involved in taking user requirements, identifying technology needs and implementing technology solutions.

Decatur's Participants

Twelve IT department members were interviewed for this study during the spring of 2008. Table 18 highlights the role and responsibilities of the IT personnel interviewed.

Table 18. Decatur IT Department Member Role and Responsibilities

Interviewee	Responsibilities
Administrator of IT Department	Responsible for the operation of the IT department. Participates in project planning, project management, and departmental budgeting.
Administrator of Hardware Operations	Responsible for the operation of the city's hardware. This includes the city's networks, servers, and personal computers. Participates in project planning, project management and departmental budgeting. Manages personnel associated with infrastructure.
Administrator of Software Operations	Responsible for the city's applications. This includes enterprise as well as personal applications. Participates in project planning, project management and departmental budgeting. Manages personnel associated with applications.
Operations Manager B	Responsible for planning and managing projects associated with the city's geographic information systems. Additionally responsible for managing the geographic information systems used by the city's management and administrative departments.
Operations Manager C	Responsible for planning and managing projects associated with the city's utility departments. Additionally supported and managed several applications used by the city's utility departments.
Operations Manager A	Responsible for planning and managing projects associated with information systems used by the city's management and administrative departments.
Operations Technical Support Specialist	Responsible for supporting the email systems used by the city.
Administrator of Network Operations	Responsible for the security and operations of the city's networks.
Development Systems Analyst	Responsible for integrating business requirements with existing information systems.
Operational Database Specialist	Responsible for daily administration of select city databases.
Applications Systems Administrator	Responsible for the support of end user applications throughout the city.
Database Administrator	Responsible for the operations, maintenance, and implementation of Decatur's databases.

Open Source Adoption at Decatur

Five areas within Decatur's IT department had adopted OSS at the time of the study. Table 19 highlights Decatur's IT department's OSS adoption. Most OSS was adopted by project teams rather than IT areas. However, once the project teams had implemented a new IT, the responsibility of supporting or maintaining the IT was given to the traditional IT areas.

Table 19. OSS Adopted at Decatur

Departmental Area	Applications Adopted	Influential Model Factors	Adoption Stage	Adoption Level	Impact on IT Function
Networking	Cold-Fusion*, Smith Projects	Wealth, environmental scanning, technical knowledge, technical communities, internal communication, relative advantage, compatibility	Routinization	As-is, Hybrid	Routine
Database	MySQL	Wealth, environmental scanning, technical knowledge, technical communities, internal communication, relative advantage	Routinization	As-is	Routine
Server	Linux variants, Apache	Wealth, environmental scanning, technical knowledge, technical communities, internal communication, relative advantage	Routinization	As-is	Routine
End User Applications	Open Office	Wealth, environmental scanning, relative advantage	Routinization	As-is	Routine
Security	N Map	Wealth, Relative Advantage, technical knowledge, environmental scanning	Routinization	As-is	Routine

*While Cold-Fusion itself is a proprietary application it has several open source packages/extensions which were used

Networking

The networking area's adoption of OSS was heavily influenced by the wealth of Decatur.

> *"…we have been using a lot of open source in doing some of our application development because budgets are tight these days and there's really hardly any funding to do the things that we'd like to do." – Operations Manager A*

Two open source applications, Cold Fusion and Smith Projects, appear to help the area 'do the things that they'd like to do.' While Cold-Fusion itself is a proprietary application, the department used several open source packages or extensions for Cold-Fusion. These open source packages appear to have been adopted by an Operations Manager A and her team who report to the Administrator of Network Operations.

Because these open source packages integrated into a proprietary framework, Cold-Fusion, this adoption was classified as having a hybrid adoption level and at the routinization stage.

This project team also uses Smith Projects, an open source application released under the GPL. Although released under the GPL, Smith Projects was specifically developed for the Cold-Fusion engine. This increased the compatibility of Smith Projects with existing technologies and appears to be a moderating factor in its adoption. Because the IT department did not participate in the development of the OSS and used existing releases of the technology, adoption can be classified at the 'as-is' level and at the routinization stage.

Database

Like the networking area, the database area's adoption of OSS has been largely due to new Operations Managers, a project team leader. Two of the three Operations Managers, A & B, had implemented MySQL databases as the data store for small scale projects that they were in charge of. These Operations Managers used OSS databases to reduce costs associated with proprietary database technologies used by the city.

This is in contrast to the technologies that the database area was accustomed to using, two proprietary databases. However the database area was aware of open source databases, as the Operational Database Specialist identified several of them,

> *"I have (considered OSS databases), MySQL, PostgreSQL, EnterpriseDB which is a commercial version of PostgreSQL that has a wrapper that essentially imitates Oracle." – Operational Database Specialist*

The adoption of OSS by the project teams as opposed to the database area highlighted cultural differences within the IT department. The IT areas appeared to reject OSS adoption even when they knew about it while the IT project teams readily adopted this technology.

Server

While the majority of Decatur's servers ran on proprietary applications, a growing number of the municipality's servers utilized OSS as several variations of Linux and Apache Tomcat were used.

> *"Oh yes, we use Linux, RedHat, Suse, you know people have played with Ubuntu." – Administrator of Hardware Operations*

> *"Well the servers in our area are Linux based, basically it's on a light Linux." - Operations Technical Support Specialist*

> *"I have other servers that are running some of my security stuff, and they're more appliances than servers, but I have one server and its run Linux, even though a licensed copy." - Administrator of Network Operations*

> *"There are a few Tomcat servers around." - Development Systems Analyst*

These OSS were either purchased from a distributor like RedHat or SUSE, or freely downloaded. Software sourcing depended upon the context in which the applications were applied. Server personnel reported that servers were classified as supporting either high risk or low risk operations, based upon this classification OSS sourcing changed. For high risk applications, where the department used OSS, it purchased supported versions of the software. Applications deemed low risk that used OSS were sourced by downloading the OSS. These differences appeared as personnel discussed the different versions of Linux that the IT department utilized. For example the Administrator of Network Operations purchased a supported version of Linux when the OSS was critical for supporting several servers at the same time.

"RedHat Enterprise Server 3. Because it's running on a Blade, so better safe than sorry." – Administrator of Network Operations

End User Applications

Use of open source end user applications was very limited at Decatur. Apparently public schools in Decatur had adopted Open Office as an office suite as opposed to purchasing proprietary equivalents to reduce costs.

"We've used for community services – the open source Office type package for the schools." – Administrator of Hardware Operations

However the use of Open Office appears to be limited to these schools and, at the time of the study, did not extend to other municipal departments. Reasons for this adoption were unclear as the IT department was not the primary IT support for these schools. Rather the schools had their own IT support within the education administration. But the Administrator of Hardware Operations was aware of this adoption as he was responsible for hardware interoperability throughout the city, and this included the IT used by education.

Security

Like the other municipalities, Decatur used several OSS in their security area. An open source application, N Map, provided an array of security tools that the city used to identify and address security risks. N Map was used because the network administrator responsible for security identified it as having superior performance and cost to many of its peer applications.

> *"…because the guys that are maintaining it (N Map) and keeping it up take pride in the product. And they're not selling it, they want people to use it, they want to be known as one of the best scanners or one of the best interrogators or whatever they call it. And that's why the products are usually better. Also we don't have the budget to buy a lot of stuff, so you look for tools that are free, and do what you need. And there's a few – we've bought a couple real cheap software packages to do a couple of things but for the most part we use free – I use free tools. Different groups use different things, so you have to ask them." – Network Administrator*

Open Source Software Adoption Themes at Decatur

Decatur's adoption of open source software (OSS) appears to be affected by two main themes, the departmental budget and a changing culture. The more important of the two themes was the department's budget as it seemed to drive the cultural change. The departmental budget not only affected the department's wealth construct, but also appeared to influence other model factors as the department looked to cut costs. Model factors like environmental scanning, technical communities and vendor relations took on a new focus, from IT functionality to IT costs. For example:

"I said I could take a freeware software and do the same thing that you're doing, that you're spending $50,000 a month, why would I do it any other way." – Operations Manager B

The second theme at Decatur, the departmental culture, appeared to not only influence OSS adoption, but also seemed to influence departmental structure. Apparently there are two cultures within the IT department, new hires and experienced IT members.

"Now don't get me wrong, our city government is a great place to work, and here's what happens. You have a lot of people that come into the city that are gung-ho, ready to hit the ground running, and then they get sucked into what I call the government mentality, where 'Okay, don't worry about it. Get it done when you get it done!' and then they get sucked into that, ten years down the road, 15 years down the road, 20 years down the road, okay, their looking at "Hey, I need 10 more years to retire." And they're really not trying to do anything else, they just fix the day to day things and don't think outside the box, they're not trying to do anything different." – Operations Manager C

New hires appeared to have 'business' experience and approached IT tasks in a fundamentally different way than established IT personnel. Employees with significant IT department experience, or more than eight years, appeared to be members of established IT areas and 'just fixes the day to day things'. These employees preferred to follow the traditional role of municipal IT departments and integrate existing technologies to concentrate on tasks assigned by the administration.

The traditional IT department employees were also accustomed to following IT guidelines set by the municipal administration. These guidelines encouraged the IT department to implement and support vendor technologies and not to code or develop software.

> *"You can't use the word 'developer' or 'programmer' around here. We're integrators and we're implementers." - Operations Manager A*

> *"We go in the mentality here in our IT shop is that we don't do any development. Okay, which I've tried to get my management to say that's not true. We do development, so now I say we are going to enhance the system. Same word! But it's easier to accept that word." – Operations Manager B*

Meanwhile newer employees appeared eager to reduce city costs, even if this meant coding or refining technologies. This was a different perspective and facilitated the adoption of OSS by newer employees.

Not only did the cultural divide affect OSS adoption, but it also affected the IT department's structure. Decatur recently re-organized the IT department structure, shifting the planning and management of new projects from traditional IT areas to project teams. Apparently this was done to enable new 'gung-ho' employees to 'think outside of the box'. Meanwhile the traditional IT areas were staffed by employees who had more experience within the city. In the traditional IT areas personnel became responsible for the supporting existing projects, allowing them to 'just fix the day to day things'.

This structure also influenced OSS adoption as project teams actively interacted with one another. They shared experiences, both good and bad, and one such experience was OSS adoption. Apparently one good implementation of an OSS had a high probability of leading to the adoption of the same OSS technology by another project group.

Decatur's Model Factors

Environmental Factors

Decatur's culture influenced environmental factors. On one side tenured city employees appeared to believe that the department should strive to meet the traditional role of an IT department, by providing technical support to the other departments of the city. In this capacity, Decatur's IT department's traditional IT area employees leveraged their **vendor relations** to integrate vendor technologies as opposed to developing applications or coding software.

Perhaps city leadership encouraged this mentality that the department should focus on integrating vendor technologies, because of past IT project success rates. Apparently Decatur's IT project success rate may not have met organizational expectations. The Development Systems Analyst, a newer employee, said

> *"The impression that I get is historically our IT department in the central section, hasn't always done the greatest of jobs in meeting the needs of the business units out in the field"*

Consequently Decatur's veteran IT personnel have moved away from software development or coding activities and instead focus on maintenance and support. Instead

IT areas rely on vendors to provide both packaged technologies and occasional IT services for the city. Every area head declared that their area was a specific vendor shop. For example Operations Manager B said

"The city made a decision to be a (Vendor X) shop, and we hired and trained up some very skilled individuals."

This reliance upon vendor technologies focused established IT personnel on vendor offerings. This affected model factors like **external communication** and **technical communities** as these factors focused on vendors and their support sites.

"We have a list of vendors that we can contact" – Administrator of Hardware Operations

"They (Company X) provide me a warm body from 8 to 5 every day that works in my room, works on my SAN (Storage Area Network), makes sure my servers are updated" – Administrator of IT Department

"We use (vendor site X), which is part of the support that we pay for every year." – Operations Manager C

Meanwhile newer employees on IT project teams appeared to have a different culture that affected their environmental factors. Rather than focusing on the traditional role of IT departments, support for other municipal departments, they sought to apply technologies for best fit solutions in the department. This focused on reducing costs and lead to several projects adopting OSS. Newer IT personnel on project team members seemed to have wider **external communication**, no loyalty to established **vendors** and a diverse set of **technical communities** that they used.

"They love that (searching for technology options), again I'm talking you know this is the new kids on the block if you will (the project team). They (the project team) want to get in and get things done, and I don't want them to get stagnated where they get in that city mentality where they're just "Oh well, this is my job, in fact it's all I'm doing." And I don't teach them that, and I don't want them to be taught that way. So I try to keep them challenged and think outside of the box and think about how they can change things and make our government a better government, because in reality there's a lot of things we could be doing, city wide that we're not doing." – Operations Manager C

Organizational Factors

Organizational factors were also affected by the organizational culture in Decatur's IT department. But the cultural change was driven by the **wealth** of the department. The Administrator of the IT Department appeared to follow the experienced employee's philosophy and IT department approach when:

"The business – the functional units are really running the business and IT is supporting that with infrastructure." - Administrator of IT Department

This philosophy appeared to stress how the department was not supposed to code or develop software, a theme repeated by every experienced employee. However the Administrator of the IT Department implied that this approach to IT work resulted in a culture of mediocrity.

“Lifetime city employees don’t seem to have a sense of urgency.” – Administrator of IT Department

Apparently enough IT department members lacked substantial urgency as the IT department had an eighteen month backlog on projects.

“Now I happen to think that an 18 month backlog isn’t bad at all.” – Administrator of Software Operations

Consequently the Director of the IT department was quick to point out that his newer hires all had short tenures within the city. Most new hires had corporate IT experience which altered their world view. Most new hires were put onto project teams that focused on Decatur’s IT projects.

“I think it helps if they’ve (our staff) had private sector experience because they understand what we called earlier the sense of urgency.” - Administrator of IT Department

Operations Managers A, B and C, the Administrator of Software Operations, and the Development Systems Analyst all had corporate experience and were all hired within the last five years. These individuals confirmed that there was a cultural divide between older city employees and newer hires and that this divide impacted **technical knowledge**, **internal communication** and **environmental scanning**.

“When you’re working inside of a government industry you see just what’s inside those four walls. You don’t see what’s on the outside.” – Operations Technical Support Specialist

"I don't know, most of the staff are fairly compartmentalized in what they do. They have one specific job role, one specific task…Before I arrived I guess my predecessor was not as comfortable with doing a lot of the system updates and stuff themselves so they used to bring the vendor on-site and then he would literally, the vendor, would patch the servers, upgrade the software, go around every client PC and change out scanners and stuff like that. But (employee X) and I have taken over that responsibility and we do probably 90-95% of the maintenance and upgrades ourselves, which definitely allows us to save some budget dollars." – Development Systems Analyst

"This is yours, that's mine. We have a lot of that even internally. (Department A) doesn't want to share with (Department B), well that's yours, that's mine. The two shouldn't cross., now we force that from an IT level." – Administrator of Software Operations

Statements like these indicate that many lifetime city employees, while ready and willing to perform work tasks, were not willing to 'look outside their four walls' or try something new that changed or altered existing work process. Differences in attitude among IT department employees, the long term employees and the recent hires, appeared to have distinct effects on organizational factors that resulted in differing effects on OSS adoption and adoption stage. For example tenured employees appeared to have reduced **environmental scanning**, **technical knowledge** and **internal communication** while newer employees seem to have higher levels of these characteristics.

But differing levels of these organizational factors did not appear to be the only differences between the new hires and lifelong city employees. New hires appeared to have a fundamentally different philosophy about what the IT department should do. They seemed to believe that the IT department performs software development activities when they integrate and customize vendor software and should not ignore these activities where feasible as it could reduce department costs and reliance on IT vendors.

"Vendors are very important to our arena. Personally I think we use vendors too much for some of the things." – Operations Manager A

"Any time we have any new development, if you will, (the city) has it contracted out with a third party vendor. And I don't agree with it, I think we could do that. Because we understand all the city business rules, we have the relationships with the customers, because all we're doing is bringing a vendor in, having them number one to do a fit gap session, sit with us. Which means they're going to sit with us for a week or two, depending on the project, they're going to spend $30-50,000 right there. And we will be the ones who end up doing the 'enhancements' to these new apps. " – Operations Manager B

"When I first came here it seemed that we hired consultants to do everything. Now what we do is we buy a lot of stuff off of the shelf. If you find something that does 80% of what you need you buy it and you make the other 20." – Operations Manager C

"My folks pretty much do all the back end programming of the applications." – Operations Manager A

One factor that was consistent between both the newer and older employees at Decatur was slack resources. Both groups indicated that they did not have slack time. Like other IT departments in this study, there were several positions in Decatur's IT department that were unfilled. The responsibilities of these vacant positions were divided among the remaining IT department members, adding to their tasks and decreasing the amount of slack time individuals reported.

Innovation Factors

Decatur's adoption of OSS was clearly influenced by one innovation characteristic: the cost of OSS.

"they (OSS) may not be better than some of the stuff you can buy, but if you have to make a choice by going with the $15,000 best or the free second best in the industry, I'll take the free second best." – Administrator of Network Operations

Cost was clearly a fundamental motivator for OSS adoption, but it was not the only **relative advantage** perceived by IT personnel. Because OSS can be freely loaded, OSS seemed to circumnavigate purchasing bureaucracies and allow project teams more freedom to source technologies. Decatur, like the other city governments, has many purchasing reviews and processes in place to ensure that taxpayer monies are not wasted. These additional steps in the purchasing process create layers of bureaucracy that slow down the pace of work within the IT department. Consequently, when Decatur IT department members download an OSS for free, they bypass these organizational steps.

"(On using an OSS) That was a big change for the city because it felt like you had your own and have control over everything we do." – Operations Manager B

"The open source stuff helps us get around the purchasing bureaucracy. As long as we don't degrade our network we're pretty much open." – Operations Manager C

Where adopted, Decatur's OSS adoption was **compatible** with existing hardware and software.

"Nobody has had a problem. Not in the Linux OS but on the open source and Office platform type systems. They really don't know the difference and it doesn't cost anything per se." - Administrator of Hardware Operations

Finally departmental members did not perceive OSS to be more technically **complex** than proprietary applications. They seemed to think that to implement OSS they would simply need to learn another standard or language.

"There is some reticence (towards OSS). Has been for a number of years, seems to be of using open source solutions. And my staff, having just geared up to be experts in (technology X) as well as (technology Y), hesitate to learn another system. The skill sets are much the same, it's primarily syntax, but when the rubber hits the road, you need to be able to get the exact syntax to recover from a disaster situation." – Administrator of Software Operations.

"(On adopting OSS) Its like getting out of a comfortable chair…Here people like the comfortableness of Office under Microsoft." - Administrator of Hardware Operations

While the technical **complexity** of OSS appeared to be minimal, the complexity surrounding organizational support of OSS was more confusing. Several IT area personnel expressed concerns about organizational support for the software and the Administer of Software Operations summed up these sentiments by saying:

"The problem is that it changes so quick and so fast that it is almost impossible to look at it on a long term basis. You look at it and it's great today, but where is it going to be in a year?" – Administrator of Software Operations

OSS Disruption within Decatur's IT Department

Columbus's IT department was not disrupted by OSS adoption. Adoption did not change processes or skills as the adoption had limited scope, being contextual applications within specific IT department areas or being deployed alongside proprietary applications. While these adoption patterns reduced the scope of OSS, the adoption patterns also allowed the technologies to further IT project success without changing organizational processes or needed skills.

Interpretation of Decatur's Model Factors

Coding of the interviews with Decatur's IT department identified 371 instances of model constructs. The only constructs not identified were the design adoption, infusion level of OSS adoption and peer adoption of OSS. The absence of these constructs is consistent with Decatur’s OSS adoption of ‘as-is’ technology and the external communication activities of the IT department. Figure 10 highlights the coding of Decatur’s interviews.

	Administrator of IT Department	Administrator of Software Operations	Development Systems Analyst	Application Systems Administrator	Database Administrator	Administrator of Hardware Operations	Operations Manager A	Operations Technical Support Specialist	Operations Manager C	Administrator of Network Operations	Operations Manager B	**Total**
As is		1	1	1	1	1	1			1		7
Design												0
Awareness		1	1	1	1	1	1	1		1	1	9
Interest		4	1	1	1	1	1			1	1	11
Adoption		3	1	1	1	2	1			1		10
Routinization		5	1	1	1	2	1			1		12
Infusion												0
Complexity								1			1	2
Compatibility		5		4	1	2						12
Disruptive								1			1	2
Routine		1	1	1	1	1	1			1		7
External Communication	2	1	1			1	3			3	4	15
Peer Adoption												0
Environmental Sensing	2	1		1		1					2	7
Technical Knowledge	6	3	6	1	2	3	8	5	5	3	4	46
Relative Advantage		3		1		1				2		7
Administrative Intensity	13	5	16	2	5	4	17		4	8	5	79
Internal Communication	4	6	13	3	2	4	11	5	4	6	4	62
Slack Resources	2	1	1	5	3		5	3	1	2		23
Wealth	3	3	2	1		1	2	2	1	1	1	17
Technical Community	2				1	1	4				3	11
Vendors	7	3	2	1	2	3		4	3	4	2	31
Total	41	46	47	25	22	29	56	22	18	35	29	370

Figure 10. Decatur’s Codes

Environmental Factors

While Decatur’s environmental factors appeared to play an essential role in generating awareness and interest in OSS, the organizational culture of Decatur’s IT department seemed to drive the environmental factors. Again culture was divided based upon tenure within the municipal government and prior business experience.

Most veteran members of the IT department, or individuals who had more than eight years of municipal government experience and little prior business experience, were in established IT areas, and focused on their immediate IT related tasks. These IT department members followed municipal guidelines towards IT as they did not code or write new software. Rather these individuals relied heavily on **vendor** technologies, as most IT areas declared themselves a vendor shop of one kind or another. Consequently veteran IT department members focused their **external communication** and use of

technical communities surrounded these vendor technologies. This had the effect of lowering the awareness and interest in OSS because proprietary technologies were preferred by the municipal guidelines. Additionally established business policies and existing skills encouraged the use of these innovations.

Alternatively newer hires within the IT department, or individuals who had fewer than eight years of experience within the IT department and some IT experience in other industries, appeared to focus on meeting departmental needs as opposed to municipal guidelines. These newer hires had little or no loyalty to established **vendors** and actively sought out alternative technologies like OSS to meet departmental goals of reducing costs. This increased the awareness and interest in OSS through **external communication** and **technical communities** related to OSS. **Technical communities** also appeared to influence later stages of adoption as Decatur's IT department members relied on these communities for support and insight into OSS.

The affect that Decatur's organizational culture had on the environmental factors are summarized in Table 20: Decatur Environmental Factors. The table highlights how several factors both facilitated and hindered the adoption of OSS.

Table 20. Decatur Environmental Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
External Communication	Facilitate adoption by creating awareness and interest in OSS	**Adoption:** Newer hires appeared to focus on finding technologies that would fit within the existing architecture regardless of their sourcing. This increased sources, serving to facilitate OSS adoption by creating awareness and interest in the technology. **Rejection**: Older employees appeared to focus on integrating vendor standards. This limited their external communication to vendor related sites and sources.	Moderate (Rejection and adoption)	Awareness, Interest, and Adoption
Peer Adoption	Facilitate adoption by creating awareness and interest in OSS	Neither IT areas nor IT project teams were aware of other municipalities' use of OSS.	Low (Adoption)	Awareness, Interest, and Adoption
Vendor Relations	Hinder adoption through switching costs and other mechanisms	IT area use of vendor technologies appeared to focus those areas on vendor offerings. This seems to have limited many OSS implementations to new projects or technologies like Smith Projects that seamlessly integrated with existing vendor standards.	High (Rejection)	Awareness and Interest
Technical Community	Facilitate adoption by creating awareness and interest in OSS	**Adoption:** Like external communication, newer hires appeared to focus on technical communities that would accomplish a task or provide a service, regardless of its fundamental source. This had the effect of increasing OSS adoption by facilitating awareness and interest in the technology. **Rejection**: Older employees appeared to focus on vendor communities to solve established work routines. This served to limit their external communication to vendor related sites.	Moderate (Rejection and Adoption)	Awareness, Interest, Adoption and Routinization

Organizational Factors

Decatur's organizational factors seemed critical for OSS adoption as they influenced the awareness, interest, adoption and routinization stages of adoption. Like the environmental factors, organizational factors also appeared to be driven by the organizational culture of the department and varied between IT department veterans and new hires.

Because IT department veterans followed municipal guidelines and focused on integrating established vendor technologies rather than code or create software, their organizational factors were heavily influenced by their vendors. Perhaps this reflects a high level of **administrative intensity** towards established IT areas. It is quite probable that established IT areas, such as the networking or database areas were held to rigid standards to minimize downtime or other unforeseen errors. This would allow the IT department to provide consistent support for IT applications used by other municipal departments. However this had a side effect, limiting **internal communication**, **environmental scanning** and **technical knowledge** to established vendor products. This reduced the awareness and interest in OSS among veteran IT department members as they focused on vendor offerings. **Internal communication** appeared reduced as IT department areas had little to interact about, as each area used their own technologies to accomplish their work tasks.

Meanwhile newer IT department members, who were primarily on IT project teams, appeared to focus on departmental priorities, primarily reducing IT costs, as opposed to municipal IT guidelines, of integrating vendor technologies. This allowed project teams comprised of mostly new hires to pursue technologies like OSS that reduced IT costs.

Perhaps this reflected lower levels of **administrative intensity**, as project teams were encouraged to think ‘outside the box’ as they worked on new projects. This differed from the established IT areas that supported existing projects rather than implementing new projects.

Or maybe newer hires more readily adopted OSS as they had higher levels of **internal communication**, **environmental scanning** or **technical knowledge**. Project teams regularly met to discuss their tasks and gather insight and information from one another. Communication among project team leaders was much more frequent; sometimes project leaders would meet multiple times a day, reflecting higher levels of **internal communication**.

Environmental scanning was also encouraged. Project team members were encouraged to find technologies that could reduce costs. Apparently guidelines for reducing costs were an 80/20 rule. As long as an application performed 80% of the requirements it would be adopted.

Finally **technical knowledge** among newer hires seemed to be of higher levels. Perhaps not the execution of individual technologies but the scope or breadth of new higher knowledge appeared to be much higher than veteran IT department members. Maybe this is a result of their IT experience outside of the municipal government context. Several new members in the IT department remarked that the change of pace or the rate of change within the municipal government was much slower than what they were accustomed to in other industries. These newer hires indicated that they were accustomed to frequently learning new technologies, which appeared to increase their comfort level in searching for, and using new technologies like OSS.

Two organizational factors that were constant, regardless of employee tenure or organizational culture, were **wealth** and **slack resources**. Because Decatur's budget was held constant for the last two years while responsibilities increased, the department had a low **wealth** construct, or reduced resources. This was reflected in the hiring and staffing of the department, as there was an 18 month backlog on IT projects. To compensate for this backlog on IT projects, **slack resources** were reduced. Employees did not have free time to search for new technologies. Rather technology searches were formal activities that were part of IT projects. Slack resources and other organizational adoption factors are summarized in Table 21.

Table 21. Decatur Organizational Adoption Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Internal Communication	Facilitate adoption by building consensus around potential new technologies	**Adoption:** New hires that formed project teams had moderately high levels of communication within their teams. This served to build consensus around OSS technologies, facilitating OSS adoption. **Rejection:** Traditional IT areas with more established personnel seemed to have internal communication that focused on work tasks, reinforcing existing technology standards, hindering OSS adoption.	Moderate (Adoption and rejection)	Awareness, Interest, Adoption and Routinization
Environmental Scanning	Facilitate adoption as scanning should increase awareness of OSS	Project teams had moderately high levels of environmental scanning as they looked for lower cost alternatives to city technologies. This appeared to increase awareness of OSS within these teams, increasing the likelihood of adoption. Meanwhile IT areas seemed to have limited environmental scanning as they focused on work tasks.	Moderate (Adoption)	Awareness, Interest, Adoption
Administrative Intensity	Hinder adoption as decision making is consolidated into a few individuals	**Adoption:** Project teams appeared to have lower levels of administrative intensity as they discussed and experimented with a wide variety of technologies. This appeared to increase adoption. **Rejection:** Established IT areas appeared to have set IT standards to reinforce task completion. This seemed to hinder OSS adoption as these IT areas focused on existing standards and technologies.	Moderate (Adoption and Rejection)	Awareness, Interest, Adoption and Routinization
Technical Knowledge	Facilitate adoption as increased knowledge is associated with understanding how to use and apply OSS	**Adoption:** Project teams displayed a wide breadth of technical knowledge that appeared to facilitate the adoption of OSS. **Rejection:** IT areas appeared to focus on technical knowledge concerning vendor technologies and work routines within these technologies. This appeared to reinforce vendor standards, hindering the adoption of OSS.	High (Adoption) Moderate (Rejection)	Awareness, Interest, Adoption and Routinization
Wealth	Positively facilitates adoption as organizations having higher levels of wealth are thought to have more resources to implement new technologies	Decatur's wealth appeared instrumental in the adoption of OSS as the department looked for options to reduce costs. Although the departments' budget was held constant for two years the department was asked to take on more IT projects, essentially resulting in a net budget cut. In most instances where OSS was adopted it was selected to reduce IT costs.	High (Adoption)	Awareness, Interest, Adoption and Routinization
Slack Resources	Facilitates adoption as employees can search for new technologies	Slack resources had little impact on technology adoption as most employees reported no slack time. Rather environmental scanning appeared to be a part of new IT projects.	Neutral	Not Applicable

Innovation Factors

The characteristics of OSS were the primary drivers for OSS adoption. However adoption appeared more likely where OSS characteristics aligned with departmental values and cultural attitudes than the merits of the technology itself. Consequently the cultural divide between the IT departments appeared to influence how OSS innovation characteristics were perceived by the two different groups.

New hires were quick to identify three **relative advantages** of OSS. First the technology was cheaper, or cost less. Second the ability to simply download several OSS applications allowed IT department members to circumvent organizational purchasing procedures. Finally several IT department members, primarily involved with networking and IT security, identified OSS applications as being cutting edge, or industry leading applications. These characteristics were apparent to newer hires as they sought to meet departmental goals of reducing costs and had much more active environmental scanning and communication than veteran IT department members. Regardless of motivation, the **relative advantage** of OSS applications drove the adoption of the technology at Decatur.

IT **compatibility** appeared to be much more important to veteran IT department members than to IT project teams. Because veteran IT department members sought to adhere to municipal IT standards of integrating established technologies, if an OSS did not readily integrate with a proprietary application, or if an OSS application caused undue learning, or the need to learn a new procedure for an existing task, then the likelihood of rejection appeared to be almost certain.

Meanwhile IT project teams did not appear to allow compatibility to drive their adoption of technologies. Rather they sought to meet the departmental goals and would work around most inconveniences, learning or technology integration, caused by the technology.

Finally the perceived **complexity** of OSS seemed to vary between the two groups. Veteran IT employees, charged with supporting existing projects, perceived the organizational support of the technology as being complex. Key to this perception was the belief that these technologies did not have established vendors; rather a common belief was that all OSS was created and supported by volunteers or hobbyists.

Meanwhile newer IT department members were more aware of which OSS applications had vendors and which technologies were supported by volunteer groups. Perhaps this difference in perception can be traced back to the communication and environmental scanning habits of the two groups, as newer IT department hires more actively sought out new technologies. Regardless of the perception of complexity, Table 22, Decatur Innovation Characteristics, summarizes the effect that complexity and other innovation characteristics had on Decatur's adoption of OSS.

Table 22. Decatur Innovation Characteristics

Factor	Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Relative Advantage	Facilitate adoption through superior performance	Decatur personnel highlighted the reduced cost of the innovation. However another relative advantage, the ability to circumvent technology purchasing procedures and high quality were mentioned by several members.	High (Adoption)	Awareness, Interest, Adoption and Routinization
Compatibility	Facilitate adoption by working with other technologies	OSS adopted at Decatur seamlessly integrated with other technologies, no modifications or customizations were needed for the software.	Moderate (Adoption)	Awareness, Interest, and Adoption
Complexity	Hinder adoption by erecting barriers to adoption	**Rejection:** IT areas considered OSS applications as being complex, changing work processes and activities, hindering OSS adoption. IT project teams did not considered OSS to be complex as their perceptions of what IT department members varied from their IT area peers.	Moderate (Rejection)	Awareness, and Interest

Interpretation of Decatur's OSS Adoption

Decatur's adoption of OSS appeared to be driven by a cultural shift that may be the result of decreased departmental budgets. It was apparent that IT department employees fit into a spectrum, from veteran employees to newer hires and were placed in either traditional IT areas or in project teams. The IT project teams were comprised of newer hires who sought to implement new IT projects. These teams seemed to prioritize departmental goals over municipal IT guidelines, allowing them to consider technologies that veteran IT departmental members, who focused on integrating vendor technologies, were either unaware of or had no desire to use.

Interpretation of OSS Disruption within Decatur's IT Department

OSS did not cause disruptions within Decatur's IT department. Rather OSS, where adopted, caused little change in work processes or knowledge. Where OSS did cause changes the IT project teams readily sought to master the technology and integrate them into existing business processes. Perhaps this highlights the temporal nature of disruptions caused by disruptive innovations.

Summary of the Decatur Case

The culture of the IT department appeared very influential to OSS adoption. Newer IT employees had corporate experience and were put onto IT project teams. These IT department members appeared to be willing to adopt OSS for segments of their IT infrastructure in their projects. Meanwhile more experienced employees were assigned to IT areas for IT support. These IT department members focused on specific groups of technologies, such as databases or servers. Their adoption of OSS appeared to focus on the IT department's drive to reduce IT costs.

This split in IT department culture combined with resource shortfalls to influence many model factors including vendor relations, technical communities, internal communication, environmental scanning, and technical knowledge which appeared to be instrumental for Decatur's OSS adoption. Slack resources were almost non-existent as IT personnel scrambled to address an 18 month backlog in IT projects.

Decatur's long term use of OSS seems to be uncertain. IT project teams are implementing select OSS applications to reduce costs within the department. However, as they move on to other projects it seems unlikely that the existing IT areas will be eager to support these applications. As project teams complete more projects it will be interesting to see how the department balances support needs with the need to implement new functionality.

Jackson – 'Hero Driven Adoption'

Overview of Jackson's Case Study

Jackson's adoption of OSS was greatly affected by individual actions, or as one IT area manager said, 'area heroes'. Because the IT department had had four different leaders in the last five years, the IT department lacked a vision or goal to guide the department. Consequently external departments had a large voice in IT operations as they often decided the technologies that they would use; many times these technologies did not align with existing infrastructure, increasing costs and creating technical problems within the city.

Without departmental leadership to provide guidance for the department, most department members strictly adhered to unionized duties and rules. This allowed IT department members to insulate themselves from drastic changes sought by external departments. However, performing tasks that were outside of job descriptions, such as scanning for new technologies, were rare among IT department members. Consequently OSS that was adopted by the IT department was adopted by 'heroes', or individuals who took initiative to change IT operations within their areas. Not only did these individuals have greater technical knowledge and more environmental scanning than their peers, they were also in administrative or managerial positions. This gave the heroes some authority over their operations, allowing them to navigate union rules. Figure 11 highlights how Jackson's lack of leadership influenced model factors. The remainder of the case delves deeper into the environmental, organizational and innovation factors at Jackson.

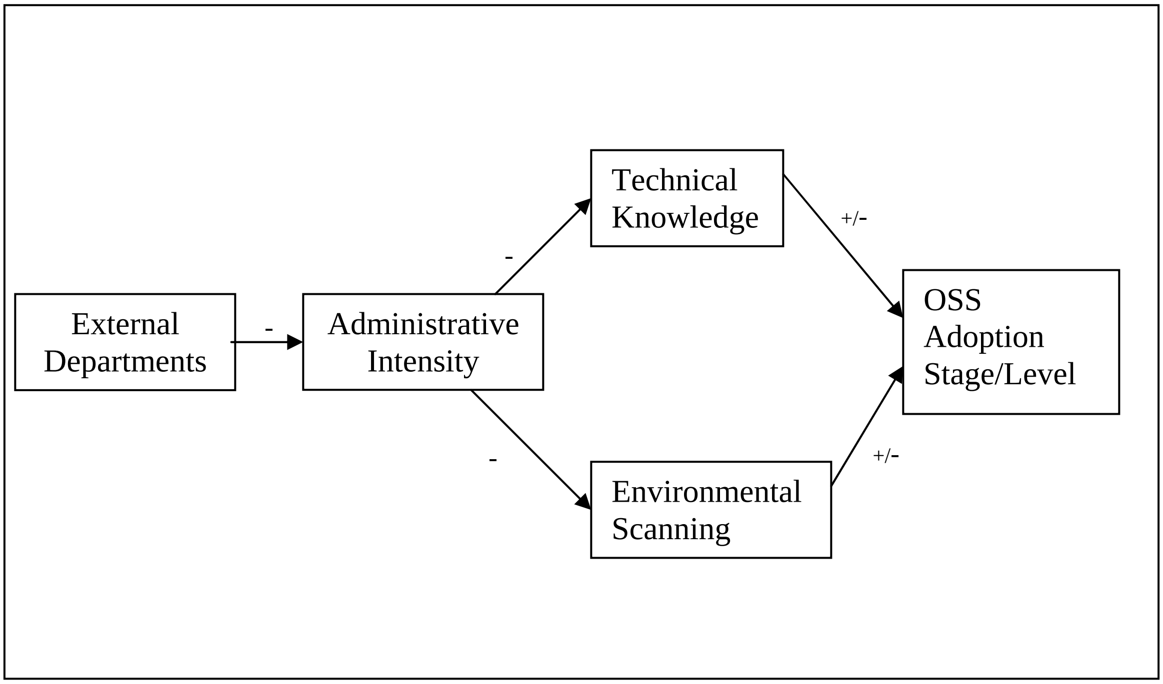

Figure 11. Jackson's OSS Adoption

Description of Jackson

The city of Jackson is a large municipality, having over 250,000 citizens. Providing services to these citizens are more than 4,000 municipal employees who are employed by over twenty municipal departments. Leading the city is an elected city council of seven members which is headed by an elected mayor. The mayor is considered a 'strong' mayor as the mayor can veto city council initiatives.

Economically Jackson is diverse; it has strong ties to service, retail, finance, insurance, and real estate industries. Grounding these industries in Jackson are several Fortune 1000 corporate headquarters.

Description of Jackson's IT department

Jackson's central IT department is large, having more than 80 members. However it is not the only IT resource in the city. Other municipal departments have their own IT resources, and if these individuals were included the number of IT personnel in the city would nearly double.

> *Administrator of Infrastructure – "The city is not truly IT centralized. The city has little groups of people that aren't IT people but they are departmental liaisons…if we counted them all up we wouldn't have the (80+) members of our department, but I'd bet you we'd have more than 130 personnel…there are positives and negatives in that these people don't report to the central IT department."*

There are many possible reasons as to why Jacksons' IT resources are not more consolidated; the IT department is located three organizational layers away from elected city management, there has been high turnover in IT department leadership, the city is divided into operational silos that do not communicate well with one another, and/or the city has displayed a short term perspective to IT operations.

> *Administrator of Infrastructure – "I think our biggest weakness is that our central point of IT authority is nowhere near the city's central point of authority."*

Administrator of Business Applications – "The department has been through about five to seven years of some pretty bad turnover at leadership…and when they failed they bolted. The department is still dealing with this."

Administrator of Data Operations – "They're all over the place. Parking department is their own fiefdom. Police department is definitely their own fiefdom. Fire department's their own fiefdom."

Network Administrator – "I guess there's been a very open philosophy around the city for several years as far as, you know, 'Buy whatever you need, install it, and we'll figure it all out later.' So now all that stuff has really snowballed and we're starting to get a lot of systems that are old. You know, the vendor doesn't exist anymore, the employee that knows how to fix it is gone…so that is a lot of the stuff I deal with on a daily basis."

Complicating matters the city of Jackson, including the IT department, was undergoing budget cuts at the time of the study. Although the IT budget was 13 million dollars, it was being cut during the time of the study. This has resulted in reduced staffing and compounded the use of aging equipment as resources are not available to replace old infrastructure. See Appendix Item E for a description of Jackson's employees and budget.

Jackson's Participants

Sixteen IT department members were interviewed for this study during the fall of 2007. Table 23 highlights the role and responsibilities of the IT personnel interviewed.

Table 23. Jackson IT Department Member Role and Responsibilities

Interviewee	Responsibilities
Administrator of Telecommunication Operations	Responsible for planning municipal telecommunications needs, and the implementation and support of municipal telecommunications.
Operations Lead D	Responsible for a team in charge of infrastructure and software associated with several business applications.
Operations Lead C	Leader of a team responsible for supporting end user computing and examining how end user technologies fit into the work practices of municipal employees.
Network Administrator	Responsible for the operations of select subsystems of the city's network.
Administrator of End User Applications	Responsible for the support and maintenance of municipal end user applications.
Administrator of Infrastructure	Responsible for all the information technology hardware used by the city. Coordinates with other area administrators to plan for city needs.
Network Operations Personnel	Responsible for the operations of the city's servers.
Administrator of Data Operations	Responsible for all data communications within the city of Jackson. This includes the selection, implementation, maintenance and training of Jackson personnel involved in the operations of data communications within the city.
Administrator of Business Applications	Responsible for the selection of, implementation, maintenance and training of Jackson personnel on the business applications used by the city.
Operations Lead A	Responsible for gathering requirements for an integrated ERP (Enterprise Resource Planning) system for city use.
Operations Lead B	Responsible for the requirements gathering and implementation of an ERP (Enterprise Resource Planning) human resources module.
Security Operations Personnel	Responsible for user administration on city servers and cross-functional applications
Development Programmer	Responsible for maintaining and developing custom computer applications used by the city.
Database Development Administrator	Responsible for day to day operations and development of select municipal databases.
Administrator of Web and GIS Development	Responsible for the operation and development of Jackson's web site. Additionally responsible for the operation and development of the city's geographic information systems (GIS).
Administrator of Security Operations	Responsible for the security of the city's electronic information. Participates in project planning. Manages security personnel

Open Source Adoption at Jackson

Two areas within Jackson's IT department had adopted OSS at the time of the study. Both of these areas appear to have management 'heroes' who had adopted these technologies. These area leaders seemed to have little interaction with one another. While they had both adopted the Linux operating system they had adopted different versions of the program as well as other contextual applications. Table 24 highlights Jackson's IT department's OSS adoption.

Table 24. OSS Adopted at Jackson

Departmental Area	Applications Adopted	Influential Model Factors	Adoption Stage	Adoption Level	Impact on IT Function
Networking	Ethereal, Suse Linux	Relative advantage, compatibility, environmental sensing, technical knowledge	Routinization	As-is	Routine
Security	Redhat Linux, NMap, Airsnort	Relative advantage, compatibility, environmental sensing, technical knowledge	Routinization	As-is	Routine

Networking

At the time of the study, Jackson's networking area had adopted two OSS programs. These applications were adopted because they were compatible with the eclectic components comprising Jackson's network. The networking area was responsible for integrating many different technologies, some outdated and others current, and the area manager sought out applications that could bridge the different technical standards. As per the Network Operations Personnel,

Network Operations Personnel – "Everything, right now, is kind of just in silos. Our servers, well, they're really not tied together. We've made that recommendation and they've gone out and bought some products, but they're not implemented as of yet, that's what we're doing."

Ethereal, an open source multi-platform networking analysis tool, was adopted because it provides functionality that allows users to easily troubleshoot networks comprised of different technologies. This relative advantage appears to have been identified by the Network Administrator who needed an application that would allow the networking area to 'shoehorn' together networking equipment that operated on different standards.

Network Administrator – "I'm up at night, cruising the blogs and message boards for new ways to shoestring everything together."

The other OSS adopted by the networking area, a Linux variant, SUSE, was purchased from a vendor. This vendor supplied the various departments with networking software and hardware, and SUSE Linux was a natural extension of these offerings. This Linux variant was compatible with the other offerings of the vendors and appeared to have a lower total cost of ownership than other offerings.

Because OSS applications used by the networking area did not change business processes or the skills needed to perform work, the adoption of these technologies is routine. Meanwhile the technologies themselves were used 'as-is' on a regular basis, characterizing the adoption as 'routinization'.

Security

Jackson's security area had adopted three OSS applications, Redhat's Linux, NMap and Airsnort. The initiative to adopt these applications appears to have been led by the administrator of security operations as he believed these applications were leading technologies.

Administrator of Security Operations – "Open source tools, like NMap, are critical for security. I mean, they're developed by open source communities before going commercial. I guess if I wanted to pay for something that's behind the curve I could, but I prefer getting my tools at the source, so to speak."

However these tools were not used by everyone in the security area. When asked about OSS the security operations personnel interviewed responded that they were 'not aware of' any open source software used by the area. Evidently the security area in Jackson's IT department compartmentalized tasks as the administrator of security operations routinely used OSS tools to scan Jackson's network for vulnerabilities, allowing his personnel to perform other tasks like user administration.

Because the administrator of security operations did not develop the OSS that the area used, the adoption level for the area can be classified as 'as-is'. Meanwhile the adoption stage can be considered as routinization as these technologies were commonly used to perform area tasks. Additionally the technologies seamlessly integrated with the other applications used by the area, having a routine impact on the area's function.

Open Source Software Adoption Themes at Jackson

The major theme behind Jackson's adoption of open source software was the fragmentation of IT resources within the municipality. Because Jackson's central IT department was located several layers below city leadership, it appeared that other, more prominent city departments had more organizational power within the city. This allowed these departments to choose their own technologies, staff their own IT personnel and override or undercut the central IT department's decisions.

Apparently city revenues played a major role in establishing organizational power at Jackson, as municipal departments were divided into 'enterprise' and 'general fund' departments. This influenced organizational power at Jackson as 'enterprise' departments, such as Public Safety and Water Management, held sway over 'general fund' departments, like the central IT department.

Administrator of End User Applications – "Yea, there is a big disparity between the departments here. Some are general fund departments, maybe doing code enforcement, and they don't have a lot of money. Then you have other departments that are revenue generating like parking and traffic monitoring. The disparity is pretty evident with the equipment."

Operations Lead A - "I mean we have enterprise departments like water and sewers basically make their own money so to speak. And they have to spend their own money."

The IT department is a general fund department, and as such, budgets rarely meet fundamental needs, let alone allow for major overhauls of IT infrastructure.

Administrator of Infrastructure – "Management will come back to me and say 'Okay, you've asked for $500,000 worth of equipment, but we have $250,000 worth of money that you and three other supervisors can share." So we get together in a room and negotiate with each other."

Network Administrator – "I think if we had more freedom to implement the service in the way that we thought made the most sense to make, you know most cost effective sense, the city (network) would look a lot different."

The lack of funding or organizational power affects the central IT department. Because the IT department is beholden to 'enterprise' departments, they need to be very careful about how they operate. This has resulted in clearly defined roles and responsibilities for IT department personnel. For example, new innovation adoption was almost entirely directed by IT area managers as their operations personnel focused on performing area tasks.

> *Administrator of End User Applications* – *"Most new ideas and things come from my superior and the managers, and how they want to see things."*

> *Operations Lead D– "I don't do it (look at new technologies) much now, my supervisors and managers do it more than I do now. I just do the work now."*

Consequently area managers who thought that new technologies could improve operations were the individuals within the department who looked for new innovations like OSS. But of the IT department's six area managers, only two actively sought out new technologies. The Administrator of Business Applications summed up the search for new innovation within the department as:

> *Administrator of Business Applications* – *"Our innovation is unfortunately hero driven…The culture is status quo. So it's up to an individual to drive a train for new innovations like an ERP or changing our methodologies."*

> And OSS technologies were no exception. Consequently, the two area managers who had searched for OSS were the only individuals to have adopted OSS technologies.

Jackson's IT department's new leader was focused on consolidating IT resources within the city.

Network Operations Personnel – "Our new director, what he's trying to do is bring them (outside IT personnel) under our umbrella, and maybe even bring them into the department."

Database Development Administrator – "Our IT department head is trying to reign in the other departments. He's trying to bring all these IT people from the departments…so they will actually be working for IT which will be helpful because I tend to believe that they're still going to be in the departments where the departments need them. But because they will actually work for IT, things will have at least standards and policies and procedures and things. Which they don't have right now."

Operations Lead A - *"One of the areas that our department head is looking at is a consolidation of technology people into the central IT department."*

Operations Lead B – "This (department consolidation) isn't rocket science, it's just a matter of sitting down and documenting everything that there is and defining the needs and say "Okay, here's the options. Okay Mr. city councilman, you make the call."

Perhaps the consolidation of IT resources within the city would allow for more IT planning, as this was a major theme within the department. Apparently decentralization of IT resources and turnover in leadership has left area managers 'putting out fires', responding to immediate problems that interrupt daily operations as opposed to planning courses of actions. Many individuals interviewed thought that a five or ten year plan could greatly reduce the number of different IT standards used by the department and consolidate IT work processes.

> *Network Administrator – "I would say on a daily basis the thing that makes my job difficult is there's no such thing as long term planning beyond four years for obvious reasons. We get changes in administrations. If we wanted to do something massive like move the city from (Vendor X) to (Vendor Y) – I mean, that's not even a four year project. So you show somebody the price tag for that, even though the total cost of ownership is lower over 8-12 years…nobody wants to have to be the administration that paid for that."*

> *Administrator of Infrastructure – "I think if we had a true 10-year plan that I wouldn't have (vendor X) type-1 cabling with token ring on it. It's not in the interest of the city for the dollars – yes it costs money to replace it. But I have an engineer that has never worked with token ring before in his life, the technology is outdated."*

> *Administrator of Web and GIS Development – "We have some databases that are 20 years old and still chugging along. To flush those databases now is problematic without having an over-arching enterprise architecture. When we*

have that architecture in place we'll be able to be more responsive to that particular exemplar of the different rates of development."

However, the consolidation of IT resources is no simple task. Apparently the different municipal departments were very conscious about organizational power and the ability to decide for themselves the technologies they would use. Consequently the city had a departmental IT adoption focus rather than a municipal IT adoption focus, which led to the adoption of conflicting technologies.

Administrator of Data Operations – "It's hard to make all these independents work together. Because we weren't involved in the selection at all, and part of the reasons is because we take so long to do it, considering all the options, so we end up trying to shoehorn things into the network because the money's already been spent."

In summary, Jackson's IT department was very similar to other IT departments that participated in this study. The department divided responsibilities among their personnel, had a clearly defined hierarchical structure, and had well defined personnel roles. However this division of task roles limited environmental sensing to management; operations personnel were encouraged to focus on their work tasks. This appeared to facilitate 'hero' driven adoption of new technologies or ideas within the central IT department.

Jackson's Model Factors

Environmental Factors

Because Jackson's IT department limited search activities for new technologies to IT department area management, area management sought out sources to help them reduce their scanning activities. Consequently existing IT vendors were very important for IT department operations. Extensive use of **vendors** created network effects, which interacted with other environmental factors, such as peer adoption and technical communities, to reinforce the importance of vendor technologies. For example vendors influenced the **technical communities** used by Jackson IT employees.

> *Database Development Administrator – "I go online a lot and use a lot of the (vendor X) groups."*

There did not appear to be any departmental processes that limited which vendors Jackson interacted with. Because technology adoption was fragmented within the city, Jackson used 'almost every municipal vendor'.

> *Administrator of Business Applications* – *"We use almost every municipal vendor, we have an eclectic group of applications. You can label them all legacy if you want. Some of them are pretty good. Some are pretty moderate. But we have what we have. We're finishing up our inventory and there's well over 100 core applications that don't talk to each other."*

This reliance upon vendors created a standards fragmentation as vendor technologies often didn't 'talk to each other'. This added to the work load of the IT department and often dictated IT department actions. For example vendor influence was particularly strong in the telecom as work processes, technical skills and equipment were heavily influenced, if not dictated, by Jackson's vendor.

Administrator of End User Applications – "Our telecom rides the vendor. So we always have to manage our process when they change how they do business. We have to adjust on our end. Takes a little bit of my time."

In addition to supplying technologies, vendors were also used to complete work tasks. Some vendors had become extensions of the IT department as they had gained expertise in select operations, resulting in these IT vendors being critical to several IT work processes.

Network Administrator – "Well the contractor I regularly use, he's intimately familiar with the Police Department and supports a lot of their more legacy'd systems."

Operations Lead A - "We have over seven different standards running our operations…We use quite a bit of contract labor. Mainly because to acquire and keep the skill set needed is really expensive."

Environmental factors were also influenced by the fragmentation of Jackson's IT resources as other municipal departments, especially 'enterprise' departments with IT staff, chose their own technologies, often to the detriment of the municipal IT infrastructure. For example Operations Lead B statement about the Human Resource Department's influence in technology adoption decisions appears to supersede the IT department's wishes.

Operations Lead B – "That's because management here doesn't want it (Vendor X implementation). But the (HR department) carries more weight than the people you've talked to and have already endorsed it and then recommended it to the governance committee. I was there in the meeting and they voted, one person against and the other twelve for."

IT department personnel did not have objections with outside municipal departments choosing technologies that the central IT department would need to integrate with other applications and support.

Administrator of telecommunications operations – "Because right now they never had telecom up till a couple years ago. A year, two years ago at best. Never, they've outsourced everything. That's why all of the departments were doing their own thing."

Operations Analyst – "We'd like people to use (Software X) but it's not – they can use any tool, as long as it works for their project. We're ok with that."

IT department managers often limited themselves to looking at proprietary technologies that were used by other municipalities. **External communication** that was not with IT vendors focused on peer institutions. When talking with peer institution, **peer adoption** of vendor technologies was of great interest to Jackson's IT department. Personnel from multiple IT areas have gone to other municipal governments to observe and evaluate proprietary technologies before making innovation adoption decisions.

Administrator of End User Applications – "We've kind of gone down to (municipality X), met those folks, see how they do business."

Administrator of Infrastructure – "(City X) has some very good programs in place. Excellent, we've seen a few of them and we know their director."

Network Operations Personnel – "We talk to other people, we go to trade shows like the storage networking world they had over in (City X)…Once in a while I talk to (County X) and I just met with (County Y) yesterday on a project. Kind of a joint project we have together."

Operations Lead B – "I know what (city X) did, I know what their requirements were and I know what many other public sector organizations have had. It's not any different."

Network Administrator – "I looked around nearby municipalities and then counties…so I was able to glean a lot of knowledge from them."

Operations Lead D– "If we are looking at the possibility of picking like a package or something like that, that other governments might be using; we go to the other government and we take a look at what they've got and how they use it. We do that, in fact some of the projects that I've been on over the years – I've actually *made trips to California and New Jersey and different places looking for the package that we were considering buying and seeing – because we didn't want something that you know they come in and give you a demo and that's what it is. I mean you don't ever accept that."*

Organizational Factors

Jackson's theme of IT fragmentation impacts the organizational factors of the city. **Administrative intensity** is particularly affected as the IT department has little authority or power within the city. For example, the central IT department does not have the authority to consistently dictate standards to other municipal departments.

Operations Analyst – "We'd like people (other departments) to use (Software X) but it's not – they can use any tool, as long as it works for their project. We're ok with that."

Even when standards are successfully passed, municipal departments resist their adoption.

Database Development Administrator – "When I was at the water department, the water department is an enterprise department. Meaning they make their own money, and if we wanted something we got it. I mean we didn't check with IT. It IT said 'No, you can't have it.' We had it anyway, I know. When I was there (at the water department), that's when Win 3.1 first came out. And this department did not bless that. They did not want to use that. We had this old menu called Marks Menu and it was horrible. I mean it was just awful. So what we all did on our PCs, we had somebody there who was like a hacker. And he put 3.1 on *everybody's PCs and then we all had a hotkey and if anybody from IT came in you hit the hotkey, the Marks Menu came up. That's what we – and I know in my heart that they are still out there doing that kind of thing. Because I mean we still have people out there that are working on Office 97, you know and that's just ludicrous. But unfortunately because we (the IT department) don't have a whole lot of people and we don't have the manpower to change it."*

Active resistance of IT standards seems to stem from the history of departmental independence within Jackson.

Administrator of telecommunications operations – "I think it's (the relationships between the city departments) got a long ways to go. I think that it (the city) was so siloed in the past and it was so decentralized that trying to get their arms back around it and not having the other departments have their own ability to do what they want is a major change."

The independence municipal departments have had in the past also influence the **internal communication** of the city.

Network Administrator – "I mean we've had a lot of interaction with departments that have typically been silo'd completely from a technological point of view. They've just been allowed to do their own things. Their computers are completely off the network, you know basically we buy them a new computer and slide the pizza under the door."

Lack of inter-departmental communication within Jackson appears to be a contributing cause to incompatible technology standards.

Operations Lead C - "Simple case, not too long ago, this one department bought a new printer. And all they wanted to do was print mainframe reports. Well they bought a low end printer that did not accept PCL language. That's the only thing the mainframe sends out. So it would not work for the one purpose they wanted it to, you know?"

Low levels of **internal communication** and **administrative intensity** also affect Jackson's IT operations. For example city operations appeared to have an excessive number of databases.

Operations Lead B – "Here we have over 23,000 (vendor x) databases scattered around the city…That's still about 15, 16, 17,000 too many. Our departments just can't grasp the concept. We've got disparate islands of information strewn throughout the city."

Different departments are free to create and implement new databases as they see fit. Data are put into silos and kept from others even when multiple departments use the same information. Not only does this create independent islands of data, but it also questions which department's data is correct.

The **internal communication** problems between municipal departments appear to carry over to the IT department areas. While the IT areas within the central IT department cooperate with one another, it seems that they do not coordinate their area activities or technologies.

Development Programmer – "We have so many standards because, well, the teams are somewhat independent."

Development Programmer – "Initially I was pretty much on my own. This is a fairly immature shop. We really don't have strict version control."

Operations Lead A - "We have very solid cooperation. Very patient because everyone works a little short handed or has six #1 priorities. So every once in a while you get someone to raise an eyebrow or something like but we just get together and say 'We're all on the same team, so lets resolve it and make sure it doesn't go outside the four walls of the department."

The lack of standards planning and enforcement within the city has affected the **technical knowledge** of the municipality. IT area employees appear to have high levels of knowledge about the technologies that they work with on a day-to-day basis, but seem to be falling behind on general trends within their IT area.

Operations Lead B – "Yes, I'm slipping behind. In the (Vendor X) world, no, because we pretty much stay on top of the latest releases and things like that."

Staffing shortages appear to contribute to the reduced levels of technical knowledge as IT department staff members specialize in specific parts of their IT area.

Administrator of End User Applications – "Here we are so short staffed that people get pigeonholed into certain areas of responsibility."

Operations Lead C - "Sure seems like certain people get stuck in certain areas for a long period of time. And then they get so depended upon, while in that area. People can't really spare them."

While this allows individuals to specialize to get work tasks accomplished, it has a side effect, it limits organizational change.

Operations Lead B – "There's very little documentation, it's in peoples heads. That's very important, just knowing what you have. I'm trying to get a total cost of ownership number put together for all software. I don't think anybody has any idea of how much software there is out there and what the total cost of it is. I mean you know we pay annual renewal and maintenance cost as well just for the limited few items I've got and I'm up to a million and a half! Just on renewal."

Specialization, while apparently necessary due to staff shortages, appears to contribute to limiting **environmental scanning** to IT area managers.

Administrator of Web and GIS Development – "Innovation typically comes from the managers. There's a group of us that…are plugged into (Vendor X) at a high level, so we draw on them for ideas, we brainstorm with them about every 6 weeks."

Administrator of Business Applications – "Our innovation is unfortunately hero driven…The culture is status quo. So it's up to an individual to drive a train for new innovations like an ERP or changing our methodologies."

While many managers seem to be open to information about new technologies and new opportunities, IT area personnel do not appear to be looking for these technologies. Many operations personnel are content to use the technologies assigned to them by their area heads.

Network Operations Personnel – "Management is pretty open, really, to finding the best ideas to fix problems. We're open to anything that's out there. There's so much change in this area. To shut things out and not look at things would not be wise."

Development Programmer – "A lot of what we do is dictated by management and you know where their goals and values are."

Perhaps the lack of **internal communication** at Jackson reinforces this behavior, allowing operations personnel to rely upon the 'hero' driven process of adopting new innovations or change.

Innovation Factors

IT area managers that had adopted OSS thought that the applications had **relative advantages** over their proprietary equivalents in performance and cost. However this appeared to depend on organizational factors as the context and the environmental scanning of the individuals influenced their perception of the technology.

Operations Lead B – "Open source technology is good, but it depends on the environment and the application that you're looking for."

Administrator of Web and GIS Development – "GAO did an analysis last year studying open source security. They found that open source software is typically safer, more secure than proprietary code…because you did have hundreds of hackers working to break it over and over again."

What appeared to be more important was the **compatibility** and **complexity** of OSS as an organizational technology. This meant that OSS needed to not only function with the other technologies used by Jackson but also needed to have support and training for organizational staff. These were characteristics that IT area managers were concerned with.

Administrator of Business Applications – "It's not about whether or not we could use open source applications. We could do that, learning new technologies is the same regardless of where they come from. It's about getting the support and training for these technologies to let the city use them. Where will that come from? Volunteers? Hobbyists? Who knows?"

Consequently the innovation characteristics of OSS appeared to stand out to some IT area managers, those who could limit the scope of OSS. For example within the security area only the security area manager used OSS technologies.

Security Operations Personnel – "I'm not familiar with open source software…My manager does most of the research in our area…I mean he has an open door policy, if I see something I can take it to him, but you know for the most part I'm so bogged down in day to day stuff that I don't have a whole lot of time *to go through the stuff on the web or go through the latest magazine and see the latest trends and stuff like that."*

IT area managers seemed more focused on organizational characteristics of the software that they would adopt, or the availability of IT vendors to provide additional services related to specific technologies.

OSS Disruption within Jackson's IT Department

Jackson's IT department was not disrupted by OSS adoption. Where adopted, OSS technologies did not change processes or skills as the adoption had limited scope, often being used by single members of an IT area. The adoption of the technologies focused on meeting specific, contextual needs, being applied to networking and security tasks.

Interpretation of Jackson's Model Factors

Coding of Jackson's interviews found 740 instances of all but two constructs infusion and peer adoption. The construct infusion was not found as the adoption of OSS at Jackson was limited to the 'as-is' level and routinization stage. Departmental members simply used OSS technologies they did not participate in development activities. Additionally peer adoption of OSS was not recorded as the departmental relations with other municipalities seem to have focused on proprietary technologies. Figures 12 and 13 highlight the coding of the interviews.

	Administrator of Telecommunications Operations	Database Development Administrator	Security Operations Personnel	Administrator of End User Applications	Administrator of Infrastructure	Network Administrator	Lead Systems Analyst	Administrator of Business Applications	Operations Lead D	Project Management Analyst	Total
As is		1	1					1			3
Design						2					2
Awareness		2	1			1		2			6
Interest		1	1			1		1			4
Adoption			1			2		1			4
Routinization			1			2		2			5
Infusion											0
Complexity											0
Compatibility											0
Disruptive											0
Routine		1	1			1		1			4
External Communication	2	2	1	3		2	2	4		4	20
Peer Adoption											0
Environmental Sensing	3	1	1	1	1	2	1	5	1	7	23
Technical Knowledge	6	5	4	1		4	4	2	1	6	33
Relative Advantage											0
Administrative Intensity	10	12	14	13	7	9	6	4	17	8	100
Internal Communication	8	9	7	9	2	6	3	5	11	4	64
Slack Resources	3	1	6	7	4		8	2	2	1	34
Wealth			1	2	1		4	1	1	2	12
Technical Community	2			1		1	2			6	12
Vendors	1	1	4	1	1	2	4	2	6	1	23
Total	35	36	44	38	16	35	34	33	39	39	349

Figure 12. Jackson's Codes

As is	Administrator of Security Operations	Development Programmer	Operations Lead B	Database Development Administrator	Operations Lead A	Operations Lead C	Administrator of Web and GIS Development	Total
Design	1						1	2
Awareness								0
Interest	1		3				3	7
Adoption	1						1	2
Routinization	1						2	3
Infusion	1						2	3
Complexity								0
Compatibility			2					2
Disruptive							2	2
Routine			1					1
External Communication	1						1	2
Peer Adoption			1	3	2			6
Environmental Sensing								0
Technical Knowledge	2		2		1		3	8
Relative Advantage	12	8	4	6	20	2	2	54
Administrative Intensity			4				2	6
Internal Communication	9	15	23	19	23	11	12	112
Slack Resources	10	13	12	27	26	11	9	108
Wealth	12	1	6	12	1	1	1	34
Technical Community	2		1		2	1	1	7
Vendors	1		1	3	2	1	1	9
Total	3		2	10	2	3	3	23
	57	37	62	80	79	30	46	391

Figure 13. More Jackson Codes

Environmental Factors

Jackson's environmental factors appeared to both facilitate and hinder the adoption of OSS. The effects of these factors appeared to vary based upon the perspective IT area managers took when looking for new technologies.

When IT area managers searched for new technologies based upon the functionality or the capabilities of the technology, **environmental communication** and **technical communities** appeared to facilitate the awareness and interest of OSS. These factors followed theory as they informed the managers about the functionality and capabilities of OSS. However, when area managers sought technologies based upon organizational characteristics, or the availability of support, training and help implementing technologies, environmental communication, technical communities and vendor relations appeared to hinder the adoption of OSS.

Network effects appeared to be created, as the organization's existing technologies, skill sets, and ability to justify a technology adoption decision influenced the use of vendor technologies. Consequently, when managers sought out vendor technologies or were closely aligned to existing vendor technologies, the awareness and interest in OSS were reduced. Table 25 captures how environmental factors affected OSS adoption at Jackson.

Table 25. Jackson Environmental Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
External Communication	Facilitate adoption by creating awareness and interest in OSS	**Rejection:** IT areas that focused on specific vendor technologies communicated with other municipalities and vendors about these technologies, reducing awareness or interest in OSS. **Adoption:** IT managers that focused on functionality communicated with a variety of sources, increasing the awareness and interest in OSS.	Moderate (Rejection and Adoption)	Awareness and Interest
Peer Adoption	Facilitate adoption by creating awareness and interest in OSS	IT personnel consulted with peers about their proprietary technology implementations, hindering awareness or interest in OSS.	Moderate (Rejection)	Awareness, and Interest
Vendor Relations	Hinder adoption through switching costs and other mechanisms	IT area use of vendor technologies appeared to focus on vendor offerings. This seems to have focused IT areas on the use of vendor technologies.	High (Rejection)	Awareness and Interest
Technical Community	Facilitate adoption by creating awareness and interest in OSS	IT department members appeared to use technical communities to complete work tasks. **Rejection:** Those tasks implemented through vendor systems appeared to focus departmental members on vendor technical communities. **Adoption:** individuals that did not focus on specific vendor technologies appeared to use a variety of technical communities, including those that advocated OSS use.	Moderate (Rejection and Adoption)	Awareness, Interest, Adoption and Routinization

Organizational Factors

Jackson's organizational factors were influenced by the organizational power of the IT department. Because the IT department was a 'general fund' department, it was beholden to, or responsible for providing services for 'enterprise' departments. Consequently the IT department divided responsibilities to clarify processes and responsibilities. This resulted in a hierarchical division that separated IT area managers from operations personnel when selecting new technologies.

This separation of duties implies a high level of **administrative intensity** as the responsibilities of organizational roles were clearly defined. However the number of technical standards adopted by the municipality highlight how little **administrative intensity** other areas or functions of the IT department had. This contextual variation of administrative intensity, clearly defining roles while not defining technology adoption standards, appears to be a direct result from the weak position of the IT department within the municipality.

Other organizational factors were directly influenced by the variations in administrative intensity: **environmental scanning, internal communication, technical knowledge,** and **slack resources**. **Environmental scanning** was specifically outlined by the administrative intensity of the department. Operations personnel were expected to focus on work tasks while area managers, who had the initiative to lead change, were expected to search for and implement new technologies.

This division in technology search process directly influenced **internal communication**, **technical knowledge** and **slack resources**. As operations personnel were encouraged to focus on their duties it limited what they communicated about, discussing work tasks, and what they learned, how to do the different work tasks. It shifted technology search activities to IT area management, to more efficiently allocate operations tasks to operations personnel, all but eliminating slack resources.

Adoption of OSS and other new technologies appeared to be characterized as ‘hero’ driven because of the numerous responsibilities of IT area managers. In most IT areas IT managers worked alongside IT personnel to complete work tasks, and as the department was short-staffed, technology search activities, such as environmental scanning, appeared to be second to completing work assignments. The pressure to complete work tasks appeared to focus technical knowledge on existing standards, as this was how work tasks were completed. It also encouraged static technical knowledge as it would require effort to learn new technologies.

OSS adoption appeared to be facilitated by lower levels of organizational **wealth**. As the department suffered from personnel shortages and reduced budgets, technologies that could reduce costs or bridge technical standards became highly sought after, encouraging area managers with high need to look beyond their traditional vendors. Wealth and other organizational adoption factors are summarized in table 26.

Table 26. Jackson Organizational Adoption Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Internal Communication	Facilitate adoption by building consensus around potential new technologies	Division of area responsibilities limited internal communication to operations. Area managers did not use internal communication to build consensus about OSS.	Moderate (Rejection)	Awareness and Interest
Environmental Scanning	Facilitate adoption as scanning should increase awareness of OSS	Environmental scanning was limited to area managers and varied based on individual initiative. Manager's individual initiative determined OSS adoption as high initiative resulted in adoption while low initiative resulted in the maintenance of the status quo.	Moderate (Adoption)	Awareness, Interest, and Adoption
Administrative Intensity	Hinder adoption as decision making is consolidated into a few individuals	**Adoption:** Low levels of administrative intensity towards technology standards facilitated OSS adoption by IT area managers. **Rejection:** clear division of personnel responsibilities focused other organizational factors on existing vendor technologies.	Low (Adoption) Moderate (Rejection)	Awareness and Interest
Technical Knowledge	Facilitate adoption as increased knowledge is associated with understanding how to use and apply OSS	**Adoption:** The technical knowledge of area managers allowed them to identify how OSS could align with area needs and to implement and use the technologies. **Rejection:** Focus on work tasks encouraged IT area personnel to continue to use existing technologies.	High (Adoption) Moderate (Rejection)	Awareness, Interest, Adoption and Routinization
Wealth	Facilitates adoption as organizations with more resources can encourage adoption	Lack of departmental wealth encouraged IT area managers to look for technologies that would help reduce costs.	Low (Adoption)	Awareness and Interest
Slack Resources	Facilitates adoption as employees search for new technologies	Lack of slack resources resulted in fewer technology searches.	Low (Adoption)	Awareness

Innovation Factors

Jackson's adoption of OSS was strongly influenced by the innovation characteristics of OSS. The **relative advantages** of contextual applications, networking and security applications were crucial for adoption. These applications were perceived to have superior functionality within the related IT function. However it was difficult to determine where the relative advantages in functionality were separated from **compatibility**, as the areas of networking and security needed to interact with many different technology standards.

Compatibility with other technologies appeared to be essential functions in the areas of networking and security as the responsibilities of these areas focused on the communication between different technologies. Because the compatibility with other applications was an essential function of these areas it questions the nature of the relative advantage of the technologies. Does the relative advantage of a technology focus on the main functionality of the program, and if the main functionality of a program is communication, does this make compatibility a form of relative advantage? Perhaps this

OSS **complexity** appeared to hinder OSS adoption. However Jackson's perception of OSS **complexity** focused on organizational issues, such as support and training, rather than individual use or knowledge of the technology. This differs from theory as complexity traditionally refers to the need for individuals to learn a new standard. Table 27 highlights how complexity and the other innovation characteristics affected the adoption of OSS at Jackson.

Table 27. Jackson Innovation Characteristics

Factor	Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Relative Advantage	Facilitate adoption through superior performance	The relative advantage of OSS facilitated adoption through superior performance in the security and networking areas.	Moderate (Adoption)	Awareness, Interest, Adoption and Routinization
Compatibility	Facilitate adoption by working with other technologies	Technical compatibility was essential for the OSS adopted by Jackson's Security and Networking areas as these areas interacted with multiple standards.	High (Adoption)	Awareness, Interest, and Adoption
Complexity	Hinder adoption by erecting barriers to adoption	Complexity of OSS appeared to be low to many Jackson IT personnel. What was complex were the organizational attributes of OSS such as support and training.	Moderate (Rejection)	Awareness and Interest

Interpretation of Jackson's OSS Adoption

Jackson's adoption of OSS appeared to focus on individual managers who were aware of, and who could recognize superior functionality, in OSS applications. Adoption of OSS was limited to managers as the operations personnel within the department were discouraged from searching for new technologies. Rather personnel were encouraged to focus on work tasks that seemed to stem from day-to-day maintenance and support issues rather than a longer term IT plan.

The managers of the networking and security areas, two areas that focus on integrating multiple technologies, identified OSS applications as being superior to proprietary equivalents. Perhaps OSS applications were superior at integrating the proprietary applications used by Jackson as the open source applications were not owned by an organization that sought to create network externalities through technical standards.

Regardless of the ownership of the OSS applications, the OSS adopted by Jackson's IT department appears to be 'hero' driven. Without individual managers, or ‘heroes’ who could search for and identify OSS and recognize the contextual application of these programs, Jackson’s IT department apparently would not have adopted OSS.

Interpretation of OSS Disruption within Jackson’s IT Department

Jackson’s IT department was not disrupted by the adoption of OSS. Because the department’s adoption of the technology was at the ‘as-is’ level and the routinization stage, the department did not contribute to OSS development or testing nor did the department apply the technologies in unusual or new ways. This allowed the department to adopt OSS without making changes to processes or existing skill sets.

It should be noted that the adoption of OSS was limited to programs of limited scope. OSS was used by managers of the network and security areas. If adoption were to have been more widespread within these areas, or if OSS had been adopted in substitution for established proprietary applications, Jackson personnel would needed to have learned new technology standards which, in all likelihood, would cause disruptions within the department.

Summary of the Jackson Case

Jackson’s adoption of OSS appeared to rely heavily on individual managers who could recognize and implement OSS technologies into their IT areas. Additionally these technologies appeared to be limited in their scope, as most of the OSS adopted by Jackson was well established or purchased from OSS providers. ‘Hero’ driven adoption of OSS appeared to require area managers to have higher levels of technical knowledge and environmental scanning. Manager technical knowledge was needed to learn how to apply the innovation into the work context while environmental scanning was necessary to identify the innovations themselves.

Jackson’s adoption of OSS appeared to be ‘hero’ driven because a number of factors that appeared to interact. These factors included multiple technology standards that most assuredly came from decentralized municipal IT resources. Municipal IT resources seem to be fragmented because of a number of reasons that include the low organizational power of the central IT department, high turnover of central IT department leadership and other municipal departments with their own IT resources that are resistant to change.

Bowling Green – 'Best of Breed'

Overview of Bowling Green's Case Study

Bowling Green's adoption of OSS was greatly influenced by the department's 'Best of Breed' approach to IT. According to the Administrator of IT, being 'Best of Breed' meant that the department looked for and adopted recognized industry leading IT products. The Assistant Administrator of IT described this as focusing the department on 'cutting edge' technologies, or hardware and software that was recognized by industry as leading technologies, as opposed to 'bleeding edge' technologies, which were emerging software and hardware that are unproven, but may have great potential.

Being 'Best of Breed', or implementing industry recognized IT, consolidated IT adoption activities into the hands of select managers. Because these managers adopted industry leading technologies, their adoption tied the department very closely to their vendors. This influenced many model factors, including administrative intensity, technical knowledge, technical communities and environmental scanning.

Of these factors, administrative intensity and technical communities acted to reinforce vendor influence on Bowling Green's IT adoption by focusing technical knowledge and environmental scanning on vendor technologies. Figure 14 highlights these factors and their relationships towards OSS adoption. What is remarkable about this case is that these factors, traditionally associated with IT adoption, acted to hinder OSS adoption as they focused the IT department on established vendors. Only when an OSS was recognized by industry as being 'cutting edge', or the flagship technology for that IT area, was it adopted. And in the case there is only one such technology, in the security area. The remainder of the case highlights how the ‘Best of Breed’ approach influenced environmental, organizational and innovation level factors in the IT department.

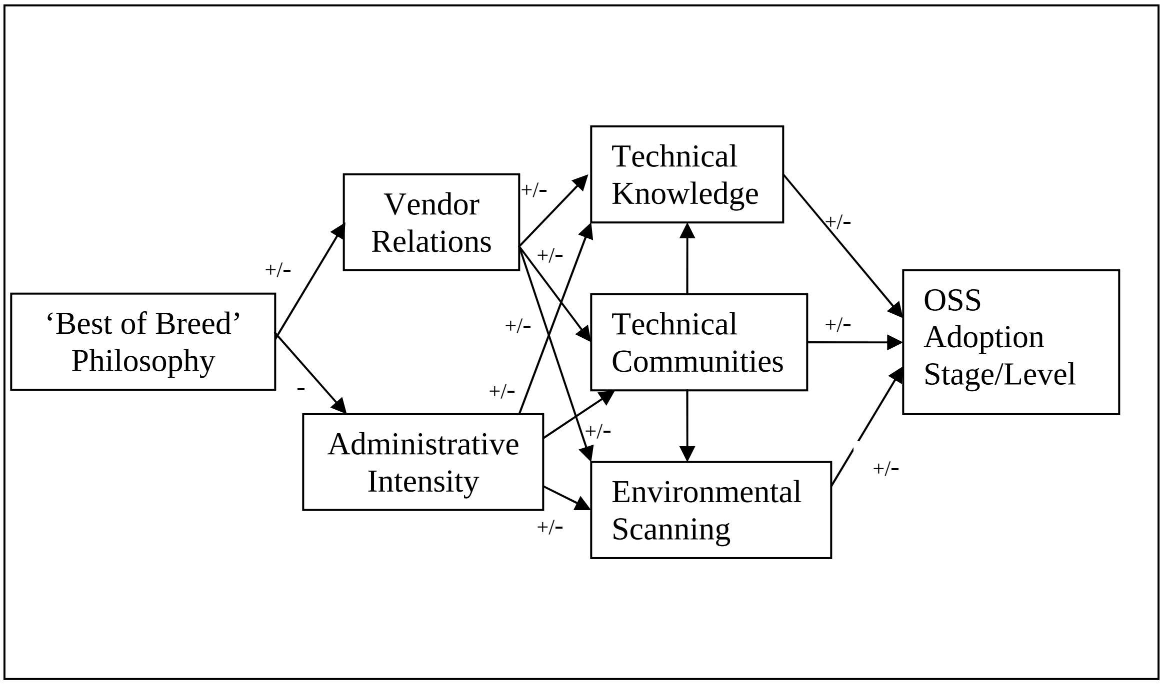

Figure 14. Bowling Green’s OSS Adoption

Description of Bowling Green

Bowling Green, an economically diverse community of over 75,000 citizens, is a growing community. Economically Bowling Green is a recognized leader in citrus and phosphate production with strong ties to regional and national light manufacturers, distribution centers, and corporate centers.

The city itself is comprised of more than fifteen departments. In 2007 these departments spent over 535 million dollars on the salaries of more than 2000 employees, as well as the goods and services needed to provide local government to the residents of the municipality. See appendix item E for a comparison of Bowling Green to the rest of the case participants.

Five key area goals, an economic, communication, fiscal management, growth management and quality of life, guide the city management, which is led by a hired city manager and a professionally hired staff. In turn, the professional city management staff is directed by an elected board of officials, the leader of which is called the city mayor.

Description of Bowling Green's IT department

One of Bowling Green's departments is the information technology department, which recently became the sole IT resource in the city. Located two bureaucratic layers away from the mayor and city commission, the IT department consists of more than 70 members and has had increasing revenues over the last three years. The main duties of the IT department focus on supporting 'best of breed' technologies which are used by the functional departments of the city. The 'best of breed' approach to IT is more fully explained in the section Open Source Adoption Themes at Bowling Green, as it was a key driver of department activities as well as OSS adoption.

Bowling Green Participants

Ten members of Bowling Green's IT department were interviewed for this study. IT department personnel came from every area within the IT department and had varying levels of tenure. The majority, seven, of the individuals interviewed had more than fifteen years of departmental experience while the other three individuals had been with the organization for under three years. Personnel titles and responsibilities are generalized so as to not identify the individuals.

Table 28. Bowling Green IT Department Member Role and Responsibilities

Interviewee	Responsibilities
Administrator of Database Operations	Responsible for the city's databases. Participates in daily administration of city database. Participates in project planning. Responsible for database budget. Manages database personnel.
Assistant Administrator of IT	Responsible for oversight of IT operations. Participates in project planning, project management and departmental budgeting.
Administrator of Network Operations	Responsible for the city's networks. Participates in daily administration of city networks. Participates in project planning. Responsible for networking budget. Manages network personnel
Administrator of Security Operations	Responsible for the security of the city's electronic information. Participates in project planning. Manages security personnel
Senior Database Operations Personnel	Responsible for daily administration of select city databases.
Program Operations Personnel	Responsible for programming and supporting select city applications.
Development Systems Analyst	Responsible for gathering business requirements and presenting them to programmers. Responsible for managing a group of programmers and the applications that they support.
Administrator of Technical Support	Responsible for supporting end-user computing outside of the IT department. Participates in project planning. Manages the city's support specialists.
IT Support Operations Specialist	Responsible for assisting municipal employees with day to day operations of IT. Responsible for trouble-shooting computer problems/bugs.
Administrator of IT	Responsible for the operation of the IT department. Participates in project planning, project management, and departmental budgeting.

Open Source Adoption at Bowling Green

Of the IT departments participating in this study, Bowling Green's IT department had adopted the least amount of OSS. The adopting areas within Bowling Green's IT department are summarized in Table 29.

Table 29. Bowling Green's adoption of OSS by area

Departmental Area	Applications Adopted	Influential Model Factors	Adoption Stage	Adoption Level	Impact on IT Function
Security	Nessus*, Nopix, Backtrax, Airsnort, Nmap	Administrative Intensity, technical knowledge, environmental scanning, compatibility, relative advantage	Routinization	As-is	Routine
Server	Linux variants	Slack resources, technical knowledge, environmental scanning	Evaluation, choice, interest	As-is	Routine

Security

The security area at Bowling Green had adopted several open source security applications. These applications were perceived to be cutting edge or outstanding applications in the security context and therefore fit with the departments ‘best of breed’ IT philosophy, which is covered in the next section. Because these open source applications were routinely used by the security area without modifications or contributions to the OSS, the area’s adoption of OSS was classified as having a routinization adoption stage and an ‘as-is’ adoption level. The effect these computer applications had on the department was routine as they did not alter or disrupt departmental processes.

Server

The server area at Bowling Green had adopted Linux variants at the evaluation/choice/interest adoption level. Perhaps this is due to the timing of the areas experimentation with OSS technologies. The server personnel reported experimenting with Linux and other OSS server platforms before the city consolidated municipal IT resources into a single IT department three years ago. However, during the last three years the server area personnel had not progressed with their adoption of OSS. Perhaps this is because of a lack of slack time, a changing of duties or because of the second major theme in Bowling Green’s IT department, human resources turnover. This theme is also discussed in the next section.

Open Source Adoption Themes at Bowling Green

Bowling Green's adoption of OSS technology appeared to be influenced by two departmental themes. The first theme is the IT department's 'best of breed' philosophy the second is a high rate of human resources turnover.

The 'best of breed' approach to IT led the city to adopt computer applications that were perceived to be industry leading technologies wherever possible. Consequently OSS was routinely adopted by only one IT area, the security area, which identified select open source applications as industry leaders.

The other theme that appears to influence OSS adoption at Bowling Green is employee turnover. Because Bowling Green trains its IT departmental members on industry leading applications many of them leave after a short time in the department. This has left the department in a hiring cycle as the IT department is continually hiring, training, and then watching personnel leave the city. However this hiring cycle seems to be ending as the department has adopted new policies towards training new employees. At the time of the study

Bowling Green's Model Factors

Coding of Bowling Green's model factors revealed that three constructs, design level adoption, infusion stage adoption and awareness of peer adoption were not identified at the site. Figure 15, highlights the 352 codes found in the interview transcripts.

	Administrator of Database Operations	Assistant Administrator of IT	Administrator of Network Operations	Administrator of Security Operations	Senior Database Operations Personnel	Program Operations Personnel	Development Systems Analyst	Administrator of Technical Support	IT Support Operations Specialist	CIO	Total
As is				1							1
Design											0
Awareness	1		1	1	2	1		1		1	8
Interest	1		1	1	2						5
Adoption				1							1
Routinization				1							1
Infusion											0
Complexity		1						1			2
Compatibility		1		1				4			6
Disruptive								1			1
Routine				1							1
External Communication	1	1	2	2	2	2	5	2	1		18
Peer Adoption											0
Environmental Sensing		5		1	1	2	2	1	1		13
Technical Knowledge	1	5	3	2	5	8	3	2	4	1	34
Relative Advantage	1		1	1		1		2		1	7
Administrative Intensity	11	22	10	9	5	12	6	4	2	7	88
Internal Communication	6	7	8	3	7	8	15	10	6	7	77
Slack Resources	4	8	3	3	6	3	1	2	1	1	32
Wealth	1						1			1	3
Technical Community	2	1	1	3	3	2	6		2		20
Vendor Standards	6	6	4	3	1	3	2	4	3	2	34
Total	35	57	34	34	34	42	41	34	20	21	352

Figure 15. Bowling Green's Codes

Environmental Factors

Bowling Green's environmental factors appeared to be heavily influenced by the department's 'best of breed' philosophy. Because the department looks for industry leading applications, or 'the best' IT to meet city needs, Bowling Green's IT department focuses on **vendors** technologies. Consequently IT department personnel appeared to have the largest amount of **external communication** with **IT vendors** and vendor related **technical communities**. Vendor relations affected which websites and Internet resources IT personnel used, as Bowling Green IT personnel almost exclusively used vendor related sites to troubleshoot problems or find solutions to work tasks.

The importance that Bowling Green's IT department places on their relationship to **vendors** appeared to be summed up by the Assistant Administrator of IT when he said:

"We're an active member with FLGISA (Florida Local Government Information Systems Association), because of our relationship with some of our vendors, we

are a targeted site for participation and other government agencies coming to us and talking to us about what we're doing with our vendors."

This statement highlights how important Bowling Green's vendors are to the IT department. It also stresses that the relationships between Bowling Green's IT department and IT vendors are stronger than their municipal IT department peers. Strong enough that other municipal governments ask Bowling Green's IT department for advice when selecting vendor technologies.

Meanwhile **peer adoption** played little role in Bowling Green's technology adoption decisions. The IT department had little interest in what technologies their peers were using and, according to the Assistant Administrator of IT, Bowling Green was accustomed to having peer governments approach Bowling Green for assistance with IT vendors. Not the other way around, with Bowling Green's IT department approaching other municipalities for help with IT projects.

Organizational Factors

Bowling Green's organizational themes had a strong impact on the organizational factors in the model. The 'best of breed' approach reflected high levels of **administrative intensity** regarding technology adoption. This philosophy was enacted to reassure other municipal departments that municipal IT resources would have industry leading functionality.

This reassurance was necessary because of the origin of Bowling Green's IT department. Like most municipalities, Bowling Green did not create a centralized IT department when the city began using IT. Instead city departments, like the Water or the

Police department independently purchased and implemented information technologies. Consequently these departments had their own IT areas that provided support, training and implementation for these technologies. The 'best of breed' philosophy was critical for the consolidation of IT resources as it reassured municipal departments of receiving industry leading functionality.

High levels of **administrative intensity** were required to implement the 'best of breed' technology adoption philosophy. Consequently searches for new technologies were highly formal, involving multiple parties and centered on providing industry leading IT functionality for the municipality. This cultivated an attitude of IT as a service within the IT department.

> *"We're a service. We are servants to the business areas that we serve." – Administrator of IT.*

> *"We never say 'You can't have that.'(to other city departments) We say 'That's one option, let me show you a couple of others." – Assistant Administrator of IT*

Organizational **wealth** appeared to be a major focus for the IT department. However the focus on wealth was the conservation of resources by finding cost savings through IT consolidation within the city. The Director believes that this is

> *"…the low hanging fruit is getting some efficiency in how we go through identifying (software) … (this allows us to) keep costs as low as I can. It is pretty easy for me to demonstrate (savings)…Hey we've got eight different departments in the city that need to cut work orders. I can buy eight different systems and try*

to support them all, and give everybody exactly what they want. Your costs are going to go way up. Or we can buy one system, everybody gets 80% of what they need, but I keep the cost down." - Administrator of IT

This perspective was supported by the Assistant Administrator of IT who said:

"We try to stay very consistent. We stay with, you know two operating systems, one being for risk based processors – HP UNIX and the other being Intel based processors – being Windows, and we stay with, on the server side one set of hardware."

Because the city relied on vendor technologies for 'best of breed' standards organizational model factors appeared to be biased towards vendor technologies as opposed to OSS. **Environmental scanning** and **technical knowledge** seem to focus on vendor offerings to reduce costs and increase the perceived quality of the technologies implemented by the department.

"We…go to third party vendors for training." – Administrator of Database Operations

"…on site internal training and sending them (our staff) to training – paid professional training." – Assistant Administrator of IT

"We had a pretty informal relationship with the sales rep for XX. A lady named Michelle, I've talked with her on quite a few occasions and she's pointed me in

good directions to get some input and some ideas of where to get some information." – Program Operations Personnel

Being 'best of breed' also indirectly influenced departmental **wealth** and **slack resources** by increasing employee turnover. Because Bowling Green employs industry leading IT, new employees, after completing their training, have opportunities to leave the municipal IT department to chase higher salaries in industry. The Administrator of IT appeared to summarize this when he said

"We get someone in, they get them trained up, they go elsewhere. So you always have somebody who is being trained up, and always have somebody who's trained them, it leaves just a handful of people to actually get the job done, and you got work that starts to pile up."

Employee turnover was echoed by many other individuals in the department.

"If I keep a programmer three to five years – if I get them five years I'm really happy…Somewhere between two and three years they're going somewhere for more money…The last two or three years we averaged 20-25% vacancies in the application development and DBA environment." – Assistant Administrator of IT

"…one guy that left here in October and I took over his projects" – Program Operations Personnel

"When I came here we had six DBA's, we were down to two, but now we're up to three." – Senior Database Operations Personnel

This seems to have created the organizational cycle that the Administrator of IT talked about, experienced departmental members spend their time training new hires. This leaves few individuals to perform the work within the department. Consequently, "work…starts to pile up." According to the Assistant Administrator of IT, at last estimation the department had a thirty six (36) month backlog on IT projects.

This affects organizational wealth and slack resources. Because the department has committed itself to being 'best of breed' it spends large portions of its budget licensing proprietary technologies. Wealth available to experiment with new technologies is reduced, decreasing the effect of wealth on technology adoption decisions like those made to adopt OSS.

Additionally **slack resources** are greatly reduced. Because some senior employees appear to be training newer employees their environmental scanning seems to be reduced. They focus on completing their work tasks and training new hires 'up to speed'. However slack resources appeared to be responsible for an experimental implementation of OSS. Members of the server area had implemented an instance of Linux to determine if the technology would work in their environment. Unfortunately the members of the server area reported that they had not had time to experiment with the technology due to employee shortages and new work tasks.

The human resources cycle at Bowling Green also appears to reinforce existing **technological knowledge** and standards as there appeared to be an underlying sense of urgency to complete existing projects. Employees felt stretched thin and were reluctant to experiment or learn new technologies.

Within this environment of employee turnover and backlogged projects, **internal communication** within the department appeared to focus on these tasks as opposed to discussing new ideas or technical options. Rather, individual areas and personnel in these areas focused on completing their work tasks. Often areas did not communicate and in extreme circumstances personnel within the same area did not know what each other were doing. For example:

> *"Because we forget – we have to handle so many databases a lot of times we don't see one – really have to address one for a year or more, then all of a sudden they have a problem with it, we have to get our cheat sheets out to find out who owns it, you know and how it ties in to other things." – Administrator of Database Operations*

This appeared to reinforce existing work processes, narrowing down the responsibilities for individual IT department personnel. Narrowed responsibilities seem to compound reduced environmental scanning, internal communication, and technical knowledge as personnel focused on their tasks and duties within their area.

Innovation Factors

Innovation factors appeared to be the only model factors that influenced the adoption of OSS, and this only where OSS was perceived to be the 'best' technology available. The **relative advantage** and **compatibility**, as predicted by theory, facilitated adoption, while perceived **complexity** hindered adoption. For example, the Administrator of Security Operations, the only area at Bowling Green that had adopted OSS at a routinization level, stressed that he used OSS only when the tool was considered to be the best and aligned well with existing technologies.

> *"a lot of those tools (OSS) still exist and a lot of them still… maintained their status as being the best thing still to use…You run it (OSS) when it has a lot of tools already built on there, already so you don't have to do any configuring, you don't have to build your own Linux workstation and stuff, you pretty much boot up to it." – Administrator of Security Operations*

This statement stressed the importance of using the technology, not developing it or learning new skills. Therefore, only where there was high **relative advantage** and **compatibility** was OSS adopted.

Complexity also followed existing theory as it decreased the likelihood of adoption and adoption stage. Nearly everyone within the department was concerned about changing technical standards to OSS as they believed it would alter processes within the department. It was summed up by the administrator of technical support who said:

> *"It would definitely be a change, and one that I don't know that I would necessarily see happen here." – Administrator of Technical Support*

OSS Disruption within Bowling Green's IT Department

OSS adoption by Bowling Green's IT department did not result in any disruptions to the department. Skills sets, maintenance, and implementation of the technologies did not require new knowledge or processes. The 'best of breed' philosophy integrated industry leading technologies within the municipal framework. This approach downplayed the need to acquire new skill sets or optimize specific functionality in favor of standardized technologies. As previously said by the security administrator,

> *"a lot of those tools (OSS) still exist and a lot of them still… maintained their status as being the best thing still to use…You run it (OSS) when it has a lot of tools already built on there, already so you don't have to do any configuring, you don't have to build your own Linux workstation and stuff, you pretty much boot up to it." – Administrator of Security Operations*

This statement appears to capture the sentiment of how the IT department would adopt technologies that meet the 'best of breed' philosophy while minimizing the configuration and customization of software.

Interpretation of Bowling Green's Model Factors

Environmental Factors

Bowling Green's environmental factors appeared to be heavily influenced by the department's 'best of breed' philosophy which focuses environmental factors on vendor technologies. Because Bowling Green implements industry leading technologies their **external communication** and use of **technical communities** focus on vendor technologies. This focus on vendor technologies caused external communication, vendor relations and technical communities, to adversely affect OSS adoption and adoption stages as Bowling Green's IT department did not consider OSS solutions.

Not only does this reliance upon vendors focus Bowling Green's IT department on vendor offerings, but it also appears to have a side effect: suspicion of OSS. For example, the Administrator of Network Operations admitted:

"I'm not real comfortable with open source applications, operating systems, things like that."

Even the Chief Security Officer, the head of the one area that had adopted OSS, expressed concerns about OSS technologies in the following statement:

"GLBA, (Gramm-Leach-Bliley Financial Services Modernization Act of 1999) will not allow it (OSS). They don't want you running open source like Open Office as your desktop productivity and it's simply not allowed and I do agree and I do see where it's coming from."

This perception is in stark contrast to the many open source companies, like Symbiot and MailArchivia, which offer open source solutions for organizations to become GLBA compliant.

Even **peer adoption** seemed to focus on vendor technologies. Again, the Assistant Director of IT indicated that Bowling Green was accustomed to being contacted by peer municipalities for references about their vendors. This seemed to indicate that the awareness of the IT department was squarely focused on their vendors and their vendor technologies.

Consequently Bowling Green's focus on vendors through the 'best of breed' philosophy appeared to focus environmental factors on vendor technologies. This seemed to create network effects, opportunity costs, or sunk costs that linked Bowling Green to their vendors and negatively impacted the adoption of OSS. A summation of how the environmental factors at Bowling Green affected OSS adoption is summarized in Table 30.

Table 30. Bowling Green Environmental Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
External Communication	Facilitate adoption by creating awareness and interest in OSS	As opposed to facilitating adoption by building awareness, external communication appeared to hindered OSS adoption. Employees appeared to focus on vendors and resources associated with vendor technologies as opposed to searching for new technology options	Moderate (Rejection)	Awareness and Interest
Peer Adoption	Facilitate adoption by creating awareness and interest in OSS	Appeared to facilitate interest as one departmental area was aware of another municipality's use of OSS.	Low (Adoption)	Awareness, Interest, and Adoption
Vendor Relations	Hinder adoption through switching costs and other mechanisms	Appeared to hinder adoption of OSS as strong vendor relations seemed to focus the department on vendor technologies and standards.	High (Rejection)	Awareness and Interest
Technical Community	Facilitate adoption by creating awareness and interest in OSS	Seemed to hinder OSS adoption as the department interacted with technical communities that focused on proprietary technologies. This appeared to reinforce the use of vendor standards as opposed to creating awareness and interest in other technologies like OSS.	Moderate (Rejection)	Awareness and Interest

Organizational Factors

The 'best of breed' philosophy appeared to manifest in the **administrative intensity** within Bowling Green's IT department. It influenced the technology adoption process, focusing organizational factors related to technology adoption on vendor technologies. This focus on industry leading applications appeared to not only overlook most OSS applications, but also create human resources shortage at Bowling Green, as employees gained experience with industry standard applications they would leave for better paying positions in industry. Consequently Bowling Green's IT department appeared caught in a human resources cycle in which new hires would be trained by experienced staff members and then leave. This left few personnel available to complete work tasks, and appeared to be a primary cause of the 36 month backlog in IT projects.

This human resources cycle reinforced departmental **technical knowledge, environmental scanning,** and **internal communication** on **vendor** technologies as Bowling Green IT staff struggled to train new hires and complete existing work tasks. Shifting to a new standard, like OSS, appeared to be a secondary, or unpleasant idea, as the staff would be required to learn new technical standards on top existing backlogged projects. When asked about such a shift, the Administrator of Technical Support responded:

> *"…an open source Linux type system, the best place to start would be something very small and like an island type thing, like a small business. Okay and then grow it out from there. Trying to do something like that with something as large as the City of Bowling Green, I don't think so."*

Because the department was short-staffed, **slack resources** seemed almost non-existent. Even though the department had two test systems, one of which had installed Linux, an OSS operating system installed on it, there did not appear to be sufficient employee time to experiment with these technologies.

Meanwhile **wealth,** while a driver for the consolidation of IT within Bowling Green, did not appear to affect OSS adoption. As stated earlier,

> *"…the low hanging fruit is getting some efficiency in how we go through identifying (software) … (this allows us to) keep costs as low as I can. It is pretty easy for me to demonstrate (savings)…Hey we've got eight different departments*

in the city that need to cut work orders. I can buy eight different systems and try to support them all, and give everybody exactly what they want. Your costs are going to go way up. Or we can buy one system, everybody gets 80% of what they need, but I keep the cost down." - Administrator of IT

"We try to stay very consistent. We stay with, you know two operating systems, one being for risk based processors – HP UNIX and the other being Intel based processors – being Windows, and we stay with, on the server side one set of hardware."

These statements indicated that the IT department was able to cut IT costs within the city by focusing on using single applications. Perhaps OSS will become more attractive to the IT department once these operational efficiencies have been maximized. Wealth and the effects that other organizational factors have on OSS adoption are summarized in Table 31.

Table 31. Bowling Green's Organizational Model Factors

Factor	Theorized Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Internal Communication	Facilitate adoption by building consensus around potential new technologies	Hindered adoption as internal communication focused on completing work tasks, not discussing new technologies.	Moderate (rejection)	Awareness and Interest
Environmental Scanning	Facilitate adoption as scanning should increase awareness of OSS	Hindered adoption as environmental scanning focused on vendor technologies that met 'best of breed' standards.	High (rejection)	Awareness and Interest
Administrative Intensity	Hinder adoption as decision making is consolidated into a few individuals	Hindered OSS adoption, technology adoption decisions were extremely formal and limited to select individuals within the IT department. This increased the influence of the 'best of breed' philosophy when choosing information technologies.	High (rejection)	Awareness and Interest
Technical Knowledge	Facilitate adoption as increased knowledge is associated with understanding how to use and apply OSS	Hindered OSS adoption as technical knowledge focused on using vendor technologies as opposed to the underlying service or problem.	Moderate (rejection)	Awareness and Interest
Wealth	Facilitates adoption as organizations having higher levels of wealth are thought to have more resources to implement new technologies	Hindered adoption even though departmental budgets are limited and highly monitored	Moderate (rejection)	Awareness and Interest
Slack Resources	Positively facilitates adoption as employees with more slack time can search for and experiment with new technologies	Facilitated adoption as employees had begun experimenting with OSS	Low (adoption)	Awareness, Interest and Adoption

Innovation Factors

The **relative advantage**, **compatibility** and **complexity** of OSS appeared to play a secondary role to the department's 'best of breed' philosophy when adopting OSS. The Administrator of Security Operations, the only area at Bowling Green that had adopted OSS at a routinization level, stressed that he used OSS only when the tool was considered to be the best and aligned well with existing technologies.

"a lot of those tools (OSS) still exist and a lot of them still… maintained their status as being the best thing still to use…You run it (OSS) when it has a lot of tools already built on there, already so you don't have to do any configuring, you don't have to build your own Linux workstation and stuff, you pretty much boot up to it." – Administrator of Security Operations

The characteristics of the technologies appeared to play a secondary role in their adoption as the IT department focused on industry leading vendor products to implement Bowling Green IT. Where OSS mirrored industry perceptions, such as premier security applications, the IT department adopted the technology. However, where OSS applications did not fit with the 'best of breed' philosophy, the **complexity** of the innovation was quickly pointed out, that the technology would require new skills or new processes. The innovation factors are summarized in Table 32.

Table 32. Bowling Green Innovation Factors

Factor	Effect on OSS Adoption	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Relative Advantage	Facilitate adoption through superior performance	Bowling Green personnel perceived the relative advantage of OSS in the security area as being the 'best' tools to use in this area.	High (Adoption)	Awareness, Interest, adoption and routinization
Compatibility	Facilitate adoption by working with other technologies	OSS adopted by Bowling Green's security area seamlessly integrated with other technologies used by the area.	High (Adoption)	Awareness, Interest and Adoption
Complexity	Hinder adoption by erecting barriers to adoption	OSS applications that were not considered to be 'best' tools were thought to be complex and difficult to understand. Departmental members perceived OSS to alter work processes and cause disruptions to operations.	High (Rejection)	Awareness and Interest

Interpretation of Bowling Green's OSS Adoption

Bowling Green's IT department adopted OSS applications only where the technologies aligned with the 'best of breed' philosophy. However, the departmental staffing shortage appears to have interrupted IT departmental experimentation with OSS technologies. It is unclear as to what will happen if and when new personnel are hired. Additionally, the department appears to have little motivation to change what technologies it is adopting as operational efficiencies are still being found by consolidating different applications throughout the city. Perhaps once these operational efficiencies have been maximized the IT department will begin to look for new areas to find ways to cut costs within the municipality. But for now, OSS adoption is strictly limited to 'best of breed' applications within the IT department's security area.

Interpretation of OSS Disruption within Bowling Green's IT Department

OSS adopted by Bowling Green's IT department did not cause change work processes or require departmental members to learn new skills. Consequently there was no discernable disruption to IT operations by the adoption of OSS in the security area. Perhaps this is because the OSS adopted was very specific, being security applications, and was only accessed by personnel who understood why the application was needed and how to apply the technology within the workplace.

Summary of the Bowling Green Case

Bowling Green's adoption of OSS appeared to be driven by the 'best of breed' philosophy. This approach seems to be needed to gain organizational support to consolidate IT resources around the city. However it affects OSS adoption by focusing both environmental and organizational factors on vendors and their technologies as opposed to alternative software options like lesser known proprietary or OSS vendors.

Additionally because Bowling Green uses 'best of breed' technologies, this approach appears to create unintended organizational turnover. This reinforces the need for vendor technologies as employees appear to be caught in a cycle where experienced IT department members are training new hires and work accumulates. The urgency this creates to complete IT projects seems to reinforce the department's focus on vendor technologies, causing the department to overlook or reject technologies that do not fit with the 'best of breed' philosophy.

Chapter 5.

Discussion

This chapter discusses the results of the study. It is organized as follows; the first section discusses each of the guiding questions. Within this section the theoretical operation of the constructs or factors are discussed, including the effect of these constructs on adoption stages and adoption levels. The second section is a general discussion of the theories that the study is based upon. This discusses how the theories appeared to work in the case studies. It is followed by the third major section, a general discussion of municipal government IT departments and OSS adoption within the municipal government context. Fourth the study's limitations are covered while the last section projects potential future research.

Discussion of Guiding Questions

To generate the study model, this research synthesized eight existing organizational adoption theories. The relationships between the model constructs formed the basis for six guiding questions for this study which are summarized in Table 33.

Table 33. Study Guiding Questions

Study Guiding Questions		Finding
G1a	*Do environmental adoption constructs operate in accordance to organizational adoption theory during OSS adoption, facilitating adoption?*	Mixed support
G1b	*Do organizational constructs operate in accordance to organizational adoption theory during OSS adoption?*	Mixed support
G1c	*Do innovation constructs operate in accordance to organizational adoption theory?*	Accept
G1d	*Is the adoption of open source software is best explained by organizational characteristics as opposed to environmental factors or innovation characteristics?*	Mixed support
G2a	*Do OSS Adoption stages of adoption, routinization and infusion disrupt an organization's IT functions in terms of implementation, operation, and support?*	Reject
G2B	*Does open source adoption level moderate the disruptive impact of OSS on the organizational IT function, with lower levels of adoption having less disruptive effects?*	Mixed support

Like many other qualitative studies this one found that relationships between constructs are seldom simple and often appear to interact. Consequently many guiding questions, G1a, G1b, G1d and G2B, had mixed support. Answers to these questions had evidence that could either facilitate or hinder the fundamental question. Several accepted organizational constructs had instances that contradicted theory, but also had instances that supported existing theory.

For example answers to question G1a, which focused on environmental constructs of external communication, vendors, peer adoption and technical communities, had instances of some constructs that both fit with and contradicted existing theory. G1b, the guiding question that focused on organizational constructs had similar instances of some constructs that both fit and contradicted existing theory.

Additionally G1d had mixed support. While organizations were the focus of this study, it is difficult to definitively claim that organizational characteristics were of the most importance in determining the adoption of OSS. In many instances environmental factors and innovation attributes appeared to be as critical as, if not more important than, organizational factors for OSS adoption.

Guiding question G2B, open source adoption level moderates the disruptive impact of OSS on the organizational IT function also has mixed support. Because no disruptions were observed due to OSS and because only two adoption levels were observed in the case studies, the evidence provides mixed support for this guiding question. Nearly all OSS implementations were at an 'as-is' level. But OSS implementations may not cause any disruptions within IT departments as one of the case sites had adopted OSS at a design level, a level thought to facilitate OSS disruptions. Therefore this guiding question, like G1a, G1b, and G1d has mixed support.

Guiding question G1c was the only question that was fully supported. Innovation constructs were the only theoretical constructs to consistently operate in accordance with existing theory. Meanwhile, because disruptive effects were not observed at any of the participating sites, guiding question G2a appears to have sufficient evidence to be answered negatively, it appears that at the time of this study the different levels of adoption do not disrupt organizational processes.

Perhaps this highlights the temporal nature of organizational disruption as none of the organizations was in the process of adopting these technologies. Or perhaps the adoption of OSS by municipal IT departments simply does not cause disruptions. As IT departments they may be able to handle additional complexity or knowledge needed and the activities that might disrupt municipal end users do not disrupt IT department members. Regardless, evidence from the case studies appears sufficient to answer G2a in the negative, that an OSS adoption stage greater than implementation will not cause disruptions to an organization's IT function. The remaining sections more closely examine each guiding question, discussing the individual factors that comprise the constructs, teasing out the richness of the case study method.

Theoretical Operation of Environmental Factors

G1a – Do environmental adoption constructs operate in accordance to organizational adoption theory during OSS adoption, facilitating adoption?

Existing theory proposed that environmental factors of external communication, vendors, peer adoption and technical communities would facilitate the organizational adoption of OSS. While there were many instances of environmental factors conforming to theory, facilitating the adoption of OSS; environmental factors, primarily vendors and associated external communication and technical communities, were also observed hindering OSS adoption. This provides mixed evidence for G1a as many instances of environmental factors had positive influences on OSS adoption as well as negative effects on OSS adoption.

While the theories of network externalities and technical knowledge and know-how identify technology sponsors, like vendors, as active proponents for the adoption of their technologies, these theories do not predict that technology sponsors would actively hinder the adoption of rival innovations. Interviews from the case studies highlight how vendors and vendor related technical communities highlighted the short-comings and risks of OSS to promote their own technologies.

This is not surprising as marketing is a common business practice. But, what was surprising was the ability of vendors to alter organizational beliefs. For example one security administrator was led to believe that OSS technologies were not approved for use in GLBA (Gramm-Leach-Bliley Financial Services Modernization Act of 1999) environments. This is in stark contrast to the reality of OSS use in GLBA compliance as there are several OSS vendors who specialize in software and services to facilitate GLBA compliance.

Another factor, possibly more important than vendor activities, which appeared to interact with vendor activities and environmental factors, was an organization's philosophy or approach to IT. If a municipal IT department committed to a single vendor to provide an IT area function then environmental constructs, primarily external communication and technical communities, appeared to hinder OSS adoption as the IT areas focused on vendor technologies to accomplish their work tasks. This appeared to facilitate network effects, encouraging the use of proprietary software over the use of OSS.

Bowling Green's 'best of breed' philosophy most succinctly highlights this phenomenon. The external communication and interaction with technical communities of this department almost exclusively focused on proprietary vendor technologies. OSS adoption occurred only where OSS aligned with the 'best of breed' philosophy.

Municipal IT departments or IT areas that encouraged a broader approach to implementing IT area functions appeared to have external communication and technical communities that facilitated the adoption of OSS. For example Columbus's networking IT area did not commit to any single IT vendor. Rather they experimented with multiple networking technologies and adopted OSS technologies that aligned with their IT philosophy of 'IT Success'.

Roswell also exemplified how external communication and technical communities could be used to facilitate OSS adoption. IT department members at Roswell were encouraged to 'find…and play with…new technologies'. This philosophy facilitated Roswell's IT department to adopt several OSS applications where the technologies aligned with organizational needs.

Therefore this guiding question has mixed support. Some environmental factors facilitated organizational adoption of OSS while others either actively or passively hindered the adoption of this technology. Active hindrance by vendors seemed to occur through misinformation or highlighting the potentially negative aspects of OSS. However information supplied by vendors only seemed to be evidence for organizations to implement philosophies or beliefs about software. If organizations sought to integrate proprietary vendor technologies then they focused on proprietary vendors.

Adoption Stages Influenced by Environmental Factors

As a group of factors within the organizational adoption model, environmental factors appear to play a major role in one stage, awareness and influence another adoption stage, implementation. Environmental factors influence organizational awareness through communication and work tasks. As they do not exist in a vacuum, organizations contact and are contacted by others, such as peers, vendors, or technical communities. This communication, as theorized by several organizational adoption theories, appears to generate organizational awareness of new technologies. Without environmental factors it is doubtful that organizations would become aware of a new technology like OSS.

However vendors appear to influence the communication function of these environmental factors. By supplying communication channels vendors can market their technologies and create network effects to hinder the adoption of OSS. Additionally the implementation stage of adoption appears to be heavily reliant upon vendors because municipal IT departments rely upon vendors to supply and support most of their IT. Consequently the innovation characteristics of these supplied technologies, especially the compatibility, influence which vendor standards are adopted as information technologies interact and the integration of IT appear to be critical for IT departments. These factors are more fully discussed in the following sections that examine the individual environmental factors.

External communication

One of the more influential environmental factors in the organizational adoption of innovations appears to be external communication. This factor summarizes how often individuals within an organization contact and are contacted by people or other organizations outside of their own. The influence of external communication on innovation adoption seems to be dependent upon two different factors, what channels an organization decides to use to gather information and the perspective of that channel on the innovation in question.

If an organization chooses to interact with a communication channel that strongly endorses the adoption of an innovation, like OSS, then external communication appears to become a facilitating factor. However, the reverse is also true; if an organization chooses to use a channel that hinders OSS adoption, such as vendors promoting proprietary software, then external communication seems to hinder OSS adoption.

As a construct, external communication is generally accepted as being an overall positive influence on an innovation's adoption. This study confirms that external communication often operates in this manner. When a positive communication channel is contacted it typically facilitates the adoption of an innovation. But prior theory identifies network effects which appear to influence organizational communication channels, in turn effecting organizational perspective. For example if an organization chooses to contact a communication channel that has a negative perspective about an innovation, external communication seems to become a hindering factor, not a facilitating one.

Because this construct appears to operate in both a facilitating and hindering manner in the adoption of OSS, external communication seems to have a much more complex role in the adoption of organizational innovations than previously thought. Further investigation into this construct may be needed as the originating source of external communication, i.e. an organization initiates communication or an external organization starts communication, appears to affect the influence of information.

Additionally how organizations choose communication channels and the influence different channels have on organizational adoption appears to vary.

External communication also had an effect on the adoption stage of OSS. Because these constructs were used for information gathering purposes, it should come as no surprise that the awareness and interest adoption stages were influenced by environmental factors. What was surprising was that environmental factors appeared to influence latter stages of OSS adoption, primarily adoption and routinization, as technical communities surrounding OSS became a part of the IT support processes. These technical resources were used to train IT personnel and update or support OSS. The integration of technical communities into organizational activities appears to highlight organizational reliance or outsourcing of IT activities. The only stage that did not appear to be influenced by external communication was infusion as an organization needed to identify organizational specific activities for the technologies to achieve this stage of adoption.

Table 34. External Communication

Site	Finding	Influence on OSS Adoption	Adoption Stage Influenced
Roswell	Personnel contacted a variety of sources about technologies in general. This facilitated the adoption of both OSS and proprietary applications.	High (Adoption)	Awareness, interest, adoption, and routinization.
Columbus	Columbus focused on contacting existing vendors of proprietary technology, hindering the adoption of OSS	Moderate (Rejection)	Awareness, interest, adoption and routinization
Decatur	**Rejection:** more experienced IT personnel focused on established relationships with existing vendors, hindering OSS adoption **Adoption:** new hires contacted both traditional and OSS vendors about IT products, facilitating adoption	Moderate (Adoption and Rejection)	Awareness, interest, adoption and routinization
Jackson	Jackson focused on existing vendor offerings, hindering the adoption of OSS.	Moderate (Rejection)	Awareness, interest, adoption and routinization
Bowling Green	Bowling Green’s ‘Best of Breed’ IT philosophy appeared to limit IT adoption to industry ‘Best’ solutions. This facilitated OSS adoption in one area while encouraging rejection of OSS in the other four areas.	Moderate (Rejection)	Awareness, interest, adoption and routinization

Peer adoption

This study reveals that organizational peers can be a communication channel that organizations can use to gather information about an innovation like OSS. As a communication channel peers appear to provide information about how a technology operates within the municipal context, or within city operations. When used, peer adoption seems to be a valuable perspective as the context of a peer more closely aligns with a potentially adopting organization than an organization outside of the organization. However, like vendors, peer adoption seems capable of taking on a spectrum of roles, from facilitating to hindering organizational innovation adoption depending on the perspective or perception of OSS of an organizational peer.

Like other forms of external communication the perspective of the peer on the innovation appears to determine the facilitating or hindering effects of this communication channel. For example Columbus was aware of another municipality using OSS to lower costs. As Columbus's IT department was also interested in cutting costs, this information appeared to facilitate OSS adoption. Meanwhile Jackson did not communicate with their peers about OSS technologies. Rather the IT department in Jackson focused on discussing proprietary technologies with their peers, hindering OSS adoption.

Peer adoption in the municipal context appears to take on a third form of influence, that of non-influence. Many municipalities view themselves as being unique. These municipal IT departments seemed to ignoring the innovations adopted by their peers. The influence that peer adoption has on an organization's adoption of an innovation like OSS seems to increase when that information aligns with an organizational value or goal. Two of the municipalities in this study had implemented OSS applications based upon peer usage when their goals aligned with the characteristics of the technology.

The actions of these two departments seem to indicate that the influence of peer adoption, as a construct in the organizational adoption of innovations, may be dependent upon organizational goals, philosophy or values. This seems to be the source for the variation in influence that peer adoption had among the cases, ranging from a facilitating, to neutral, to hindering factor.

Table 35. Peer Adoption

Site	Finding	Influence on OSS Adoption	Adoption Stage Influenced
Roswell	Roswell personnel were largely unaware of other municipality’s use of OSS. This appeared to neither facilitate nor hinder the adoption of OSS.	Neutral	None
Columbus	Columbus appears to have adopted one OSS application parallel to existing proprietary software because of the cost savings another municipality has experienced.	Moderate (Adoption)	Awareness and Interest
Decatur	Decatur IT personnel appeared to be largely unaware of OSS implementations at other municipalities, neither facilitating nor hindering OSS adoption.	Neutral	None
Jackson	Jackson IT personnel appeared to consult with their peers about proprietary information systems as opposed to OSS. This seemed to hinder OSS adoption.	Moderate (Rejection)	Awareness and Interest
Bowling Green	Bowling Green’s awareness of another municipality’s use of OSS led to an experimental implementation of an OSS that was not recognized as being ‘Best of Breed’. This innovation was experimented with but not deployed for use.	Low (Adoption)	Awareness and Interest

Vendor Relations

Vendor relations appear to be a critical environmental factor in the organizational adoption of innovations. Like peer adoption, vendors provide an external communication channel for organizations to learn about innovations like OSS. However, unlike peer adoption, vendors do not appear to be an optional source of information. As IT departments rely on vendors to provide hardware and software to implement municipal information systems, vendors are a necessity. Consequently the information IT departments receive from vendors focuses on the capabilities of their technology, focusing communication on the benefits of organizational adoption of their technology. As with many marketing activities this often downplays competing innovations like OSS.

Like peers, vendors appear able to facilitate or hinder OSS adoption. Vendor facilitation of OSS seems to be predicted by network externality theory as OSS vendors supported their technologies. However vendors that offered proprietary technologies hindered OSS adoption in favor of their own products and services. This hindering effect was not predicted by network externality theory, but should come as no surprise as marketing activities that highlight the weaknesses of competitor products are common.

The strength of vendor relations as a communication channel on organizational adoption of innovations seemed to vary based upon organizational goals, philosophies or values. Communication strength appeared to be linked to the vendor's relationship with the municipality which seemed to fall into one of three categories, those vendors currently employed by the municipality, vendors offering technical standards similar to those currently employed by the municipality and vendors who offer technical standards radically different from those currently employed by the municipality.

Of these three different vendor groups the relationships between municipalities and the vendors whom they have existing relationships with, i.e. vendors who supply the current technologies used by the municipal IT department, seemed to be the strongest. The strength of these relationships is unclear as it was not the focus of this study. But several factors in the research model appear to be linked to the strength of existing vendors.

Perhaps existing vendors were more influential as their technologies were perceived to seamlessly integrate, or were more compatible, with the existing IT function of an organization. Or maybe existing vendors established stronger interpersonal relations with the management of a municipality. A third reason may stem from the technical knowledge and know-how of a municipal department that already knows how to use a vendor's products. Regardless of the underlying reason, the case studies highlight how important existing vendors are to municipal IT departments.

Meanwhile the influence of vendors who offer similar technical standards or vendors who offer radically different technologies was unclear. While it seems that these two groups of vendors appear to have different effects on organizational innovation adoption it is unclear as to how organizations perceive these communication channels to operate. The information gathered in this study does not appear sufficient to characterize these relationships.

Adoption stages influenced by vendors ranged from the awareness stage to the routinization stage. While most proprietary vendors provided negative information about OSS products, OSS vendors became instrumental in offering services for organizations. Roswell used vendor training and support to more effectively utilize their OSS adoption. Most IT departments focused on proprietary vendors who provided negative information about OSS technologies, hindering the adoption of OSS. Table 36 highlights the impact of IT vendor relations on adoption and adoption stage.

Table 36. Vendor Relations

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Roswell's vendors, both proprietary and open source, facilitated technology adoption when the functionality of the technologies aligned with organizational needs. Because Roswell's thin-client thick-server architecture facilitated the use of OSS, many OSS vendors appeared to offer 'best-fit' solutions, leading to OSS adoption.	Moderate (Adoption)	Awareness, interest, adoption and routinization.
Columbus	Columbus's use of vendor technologies focused departmental technology sourcing on vendors, creating switching costs in terms of licensing, processes and technical knowledge, hindering OSS adoption	High (Rejection)	Awareness and interest
Decatur	Decatur vendors focused on proprietary technology offerings, biasing Decatur IT solutions towards these vendor offerings. This seems to have limited many OSS implementations to new projects or technologies that seamlessly integrated with existing vendor standards.	High (Rejection)	Awareness and interest
Jackson	IT area use of vendor technologies appeared to focus on vendor offerings. This seems to have focused IT areas on the use of vendor technologies.	High (Rejection)	Awareness and interest
Bowling Green	Appeared to hinder adoption of OSS as strong vendor relations seemed to focus the department on vendor technologies and standards.	High (Rejection)	Awareness and interest

Technical Communities

This study identified technical communities as a third communication channel that organizations can contact for information about new innovations like OSS. Similar to peers and vendors, technical communities are an environmental factor that many theories recognize as positively impacting the organizational adoption of innovations. Technical communities are theorized to provide organizations with knowledge about the capabilities or characteristics of an innovation, increasing the awareness and interest in a new innovation. By influencing these adoption stages, communication with technical communication is thought to promote an innovation's adoption.

The case studies reveal that municipal IT departments used several different types of technical communities in the theoretically predicted manner. Most individuals at each case site said that they used a variety of websites and other technical groups, such as the

CACM, to ‘keep their fingers on the pulse of industry’. Individuals describing such relationships appeared to be keeping with theory, and these technical communities seem to have the positive impact predicted by theories (i.e. increasing technical knowledge and know-how as well as exposing municipal IT workers to new innovations) concerning organizational adoption of innovations.

However paramount to municipal IT departments are technical communities that are routinely accessed to complete work tasks. Websites linked to work tasks are commonly associated with a specific vendor or vendor technology. These websites appear to act as extensions of vendors, and act as network externalities for organizations and vendors. Because technical communities linked to work tasks are critical for completing the services IT departments provide, vendor driven technical communities are capable of hindering organizational adoption of innovations like OSS. This indicates that technical communities, like other communication channels, appear to have a range of effects on organizational adoption of innovations, from facilitation to a neutral effect to hindering the adoption of a specific innovation like OSS.

Therefore the orientation or origin or focus of technical communities appear to moderate how technical communities behave during the organizational adoption process. Technical community orientation or origin or focus seem to be grouped into two categories, vendor supported and non-vendor supported technical communities.

As stated above, vendor supported technical communities appear to act as extensions of a vendor. These technical communities act as an outlet for vendor goods and services as well as information about the use and support of vendor and competitor products. Because these sites supply many different types of information, from advertisements to technical support and training, they appear to influence several different adoption stages in the innovation adoption process. These stages include awareness, interest, adoption and routinization as information details not only innovation characteristics, but also innovation operations. Information provided by vendor sponsored websites can be generalized in favor of the vendor. So if the vendor sponsored website is an OSS provider it should facilitate the adoption of OSS, otherwise vendors tend to promote their proprietary technologies.

Non-vendor related technical communities appear to serve a similar function in the organizational adoption of innovations. These communities also provide information about potential new technologies and information about work task solutions and innovation maintenance. However these sites do not appear to have a motivation to 'lock-in' an organization to a particular product or technical standard. It is difficult to assess the influence theses communities have in the organizational adoption of innovations as they range in influence or prestige, some sites are sponsored by experts or provide technical code while others reflect opinions or simply serve as online advertisements. Regardless of whether tied to vendors or not, technical communities are an important communication channel that influences many adoption stages. Because these communities provide information about new products or services they have the potential to increase awareness and interest in new technologies. But these communities also provide information about the operation and support of new technologies, facilitating the adoption and routinization of a technology. Table 37 highlights the effect that technical communities had at the case sites, and how these communities could both facilitate and hinder OSS adoption.

Table 37. Technical Communities

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Facilitated adoption as technical communities not only increased awareness and interest of OSS, but also participated in software development	High (Adoption)	Awareness, interest, adoption and routinization
Columbus	Use of technical communities appeared to focus on work tasks associated with vendor technologies. This appeared to hinder awareness and interest in OSS.	Moderate (Rejection)	Awareness and interest
Decatur	**Adoption:** Like external communication, newer hires appeared to focus on technical communities that would accomplish a task or provide a service, regardless of its fundamental source. This had the effect of increasing OSS adoption by facilitating awareness and interest in the technology. **Rejection**: Older employees appeared to focus on vendor communities to solve established work routines. This served to limit their external communication to vendor related sites.	Moderate (Rejection and Adoption)	Awareness, interest, adoption and routinization
Jackson	Focus on vendor resources to support vendor technologies when completing work tasks.	Moderate (Rejection and Adoption)	Awareness, interest, adoption and routinization
Bowling Green	Seemed to hinder OSS adoption as the department interacted with technical communities that focused on proprietary technologies. This appeared to reinforce the use of vendor standards as opposed to creating awareness and interest in other technologies like OSS.	Moderate (Rejection)	Awareness and interest

Theoretical Operation of Organizational Factors

G1b – Do organizational constructs operate in accordance to organizational adoption theory during OSS adoption?

This question, like the other questions formed from the model relationships, seeks to examine if organizational factors perform consistently with theory in OSS adoption. Like G1a, G1b also has mixed support. Many of the organizational factors were observed to operate as theory predicts, for example higher levels of administrative intensity increased the formalization and centralization of technology adoption decisions, resulting in a decreased adoption of OSS. But there were also instances in the case studies when many of these constructs acted contrary to theory. Administrative intensity was also observed to increase environmental scanning activities in some IT department areas, an activity not accounted for by existing theory. Other organizational constructs also exhibited these mixed behaviors.

Adoption Stages Influenced by Organizational Factors

As a group, organizational constructs appear to influence every stage in the adoption process. However not every organizational factor seems to effect every adoption stage. The factors appear to be divided into three main groups, those constructs needed to become not only aware of an innovation, but interested in how the innovation could affect IT department operations. A second group of factors appears to be involved in implementing the innovation in the organization while a third group of factors seems to facilitate a transition from adoption to routinization or infusion. Interestingly several of the factors appear to overlap these three areas, primarily technical knowledge and administrative intensity. The effects individual organizational factors have on organizational adoption examined by this study are more fully discussed in the following sections.

Internal Communication

Although it is an organizational factor, the case studies indicate that internal communication appears to be a fourth communication channel available to organizations. Unlike peers, vendors or technical communities, internal communication is a communication channel that focuses on the organization’s specific context and needs.

Where organizations have high levels of internal communication, municipal IT department members discuss ideas like OSS adoption in the context of the existing IT infrastructure. This includes insight as to how changes could benefit or hinder departmental efforts by discussing costs in terms of learning and resource consumption.

Like other communication channels, internal communication appeared to have a range of adoption effects, from positive to neutral to negative, for organizations in the adoption process. Internal communication appeared capable of working as a facilitating factor in OSS adoption when more organizational members were involved in discussing OSS adoption. Larger discussion groups appeared to promote in-depth discussions of the technology that seemed to access more communication channels, i.e. peers, vendors and technical communities, and account for more organizational roles. Facilitation of OSS adoption appeared to occur when a critical mass of organizational members decided that adopting OSS would benefit the organization along some organizational axis, i.e. innovation cost, maintenance, functionality…

This factor also seemed capable of hindering OSS adoption when a group of individuals decided to reject the technology. Motivations for rejecting the technology appeared to vary. Some individuals, especially those at Bowling Green, cited strict enforcement of organizational technology standards. Other individuals seemed hesitant to learn new technologies or interfere with existing work processes. Still others appeared to have genuine concerns about the capabilities about OSS. Regardless of the motivation, internal communication appeared to work as a hindering factor when a critical mass of organizational members decided to reject the technology.

As a construct, internal communication seemed to follow theory. It appeared to facilitate consensus within the organization towards an innovation. However this consensus could be positive or negative based upon a variety of organizational and individual motivations.

Additionally internal communication appears to be one of a handful of adoption factors that seemed to influence multiple adoption levels. Internal communication appeared to be an essential activity in moving from one adoption stage, such as awareness, to the next, such as interest. And this factor did not seem to lessen in importance as organizational adoption levels increased as internal communication appeared critical for work processes needed to advance adoption stages beyond adoption. Table 38 highlights how internal communication operated at the case sites.

Table 38. Internal Communication

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Roswell had high levels of internal communication that appeared to build consensus around new technologies.	High (Adoption)	Awareness, interest, adoption, routinization and infusion
Columbus	When administrative intensity was low, internal communication appeared to operate as theorized, facilitate adoption by building consensus around OSS. High levels of administrative intensity appeared to reduce the influence of internal communication as decisions about technology adoption was limited to individuals with specific beliefs.	Low (Adoption)	Awareness, interest, adoption and routinization
Decatur	**Adoption:** New hires that formed project teams had moderately high levels of communication within their teams. This served to build consensus around OSS technologies, facilitating OSS adoption. **Rejection:** Traditional IT areas with more established personnel seemed to have internal communication that focused on work tasks, reinforcing existing technology standards, hindering OSS adoption.	Moderate (Adoption and rejection)	Awareness, interest and adoption
Jackson	Internal communication appeared to have three different levels that had little interaction with one another: operations personnel and managers within an IT area, IT department areas within the IT department and the IT department within the greater municipality. These levels of communication seemed to form barriers around technology adoption decisions, hindering consensus or awareness of new innovations.	Moderate (Rejection)	Awareness and interest
Bowling Green	Hindered adoption as internal communication focused on completing work tasks, not discussing new technologies.	Moderate (rejection)	Awareness and interest

Environmental Scanning

The construct of environmental scanning appears to summarize organizational activities surrounding the active pursuit of information gathering. This characterizes environmental scanning as an internal social process that interacts with external communication channels. Because environmental scanning, like external communication, bridges the gap between an organization and the environment, environmental scanning is linked to many other model factors, primarily communication channels like peers, vendors and technical communities, but also administrative intensity as this dictates who should be actively scanning for new technologies.

Communications channels heavily influence environmental scanning as they determine what information is passed on to organizational decision makers about a new innovation. This includes environmental factors, like vendors, peers and technical communities, as well as internal channels formed through internal communication.

Administrative intensity is another model factor that influences environmental scanning. This factor determines the centralization and formalization of information gathering activities. As centralization and formalization increase, or as administrative intensity increases, environmental scanning seems to center on meeting these processes as opposed to information gathering. This appears to change the focus of information gathering activities from a fluid process that can consider any communication channels, to a more mechanistic process, one that focuses on meeting specific goals or requirements. This appears to be a limiting factor on innovation as organizations that can quantify what they are looking for seem to pursue a routine or incremental innovation as opposed to a radical or disruptive one.

A third factor appears to affect organization's environmental scanning, but it is neither a model factor nor an organizational characteristic: individual differences. Because individuals perform environmental scanning their own motivations for scanning the environment from new technologies appears to influence what information they gather for their organization. Organizational role, the hierarchical level within the organization and departmental affiliation appeared to affect individual technology searches. Individual differences in environmental scanning appear to moderate the effects of administrative intensity. Even though several individuals interviewed in the case studies were not required to scan the environment for new technologies, their individual habits or curiosity drove them to have higher levels of environmental scanning than their peers.

As a construct, environmental scanning appears to follow existing theory as it seems to be positively linked to organizational adoption stages, especially awareness and interest. However, environmental scanning alone does not appear to guarantee that an organization will move through adoption stages when looking for new technologies. Additionally environmental scanning seems to be dependent on a number of organizational and individual factors that, in turn, may be affected by organizational goals or philosophies.

Table 39. Environmental Scanning

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Roswell had high levels of environmental scanning. These activities appeared to be part of routine work processes as opposed to slack activities.	High (Adoption)	Awareness, interest and implementation
Columbus	As theorized environmental scanning appeared to facilitate adoption by increasing the awareness of OSS. However environmental scanning differed by employee role and administrative intensity. Those employees with lower administrative intensity and a higher organizational role had higher levels of environmental scanning. Higher levels of administrative intensity and operations roles had lower levels of environmental scanning.	High (Adoption)	Awareness and interest
Decatur	Project teams had moderately high levels of environmental scanning as they looked for lower cost alternatives to city technologies. This appeared to increase awareness of OSS within these teams, increasing the likelihood of adoption. Meanwhile IT areas seemed to have limited environmental scanning as they focused on work tasks.	Moderate (Adoption)	Awareness and interest
Jackson	Environmental scanning appeared to heavily rely on individual initiative and work load. Within this context, two area managers, the security and networking leads, displayed high levels of environmental scanning that appeared to contribute to their adoption of OSS.	High (Adoption)	Awareness and interest
Bowling Green	Hindered adoption as environmental scanning focused on vendor technologies that met ‘best of breed’ standards.	High (rejection)	Awareness and interest

Administrative Intensity

Administrative intensity, or the degree to which innovation adoption decisions are consolidated and formalized, appears to be the key organizational construct as it influences several model factors. This factor appears to affect several model constructs, primarily environmental scanning, internal communication, external communication, peer adoption, vendor relations, and technical communities. Administrative intensity appears to affect so many model constructs because it is linked to assigning duties to IT departmental members. This can influence which organizational members search for information about new innovations as well as what tasks organizational members are held accountable for.

Higher levels of administrative intensity seem to reduce the number of individuals involved in information gathering activities. Centralization or the consolidation of information gathering activities to fewer individuals and formalization, or restricting information gathering activities to specific areas or features, limits organizational information gathering as it puts constraints on what information is thought to be pertinent in a technology search.

Higher levels of administrative intensity were also present in organizations that were more likely to dictate technology standards to their IT areas, often hindering OSS adoption. Perhaps high levels of administrative intensity hinder OSS adoption because consolidation of adoption decisions to area or department managers highlights organizational characteristics, such as technical support or the reputation of the developer, rather than innovation characteristics, like process operations or technical efficiency.

Lower levels of administrative intensity, or including more sources and having more discussion about technology adoption decisions, seemed to facilitate OSS adoption. Unlike higher levels of administrative intensity, more information channels and individuals discussing OSS appears to highlight the technical and operational aspects of OSS, and how they fit within the organization, often resulting in their adoption.

This difference in innovation focus, high levels of administrative intensity appear to focus on organizational characteristics of innovations while low levels of administrative intensity appear to focus on operational characteristics of innovations, appears to be affected by organizational values or organizational philosophy. These values can favor organizational characteristics, such as IT support or the developer of a particular piece of software, or they can favor operational characteristics, such as work processes or technical efficiencies.

As a construct administrative intensity appears to be critical in the early stages of technology adoption. It seems to influence which organizational members access communication channels to gather information about potential technologies. In turn, this limitation of information appears to influence the internal communication, or the internal discussion the organization has about the candidate technologies. Because it influences what information is discussed about potential innovations, administrative intensity seems to be a highly influential moderating factor in the early adoption stages. This influence appears to diminish in the later adoption stages as administrative intensity seems to focus on centralizing and formalizing awareness generating activities.

Finally, it is generally accepted by theory that the centralization and formalization activities will hinder the organizational adoption of technologies. This effect was observed at four of the five cases. However, of the four sites where administrative intensity was observed to decrease the adoption of OSS, two sites had observations where centralization and formalization increased the adoption of OSS. Columbus and Decatur both had high levels of administrative intensity surrounding innovation search activities but allowed for flexibility in accessing information sources. Additionally one of the five case studies, Roswell, highlighted how administrative intensity promoted OSS adoption.

These findings appear to indicate that administrative intensity was linked to an organizational characteristic, a goal or objective or philosophy that caused the individuals involved in the technology search to focus on specific types of technologies. This is contrary to theory which predicts that the simple activities of formalization and centralization will lead to reduced adoption of an innovation.

Table 40. Administrative Intensity

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Administrative intensity appeared to fluctuate based upon the stage in the adoption process. There were high levels of administrative intensity at the requirements gathering and testing phases, but low levels of administrative intensity in idea generation and physical design.	Moderate (Adoption)	Awareness, interest, adoption, and routinization
Columbus	**Adoption**: Low levels of administrative intensity allowed areas with successful track records to make technology decisions that drew from more information sources. **Rejection:** High levels of administrative intensity, present in areas with less successful track records, consolidated technology adoption decisions within the IT department. These areas had less input into the technologies that they used.	High (Adoption and rejection)	Awareness, interest, adoption, and routinization
Decatur	**Adoption:** Project teams appeared to have lower levels of administrative intensity as they discussed and experimented with a wide variety of technologies. This appeared to increase adoption. **Rejection:** Established IT areas appeared to have set IT standards to reinforce task completion. This seemed to hinder OSS adoption as these IT areas focused on existing standards and technologies.	Moderate (Adoption and Rejection)	Awareness, interest, adoption, and routinization
Jackson	Low levels of administrative intensity appeared to fragment technology adoption decision making within the city. This allowed municipal departments and IT areas to select technologies as they saw fit. Several of these technologies did not integrate or communicate with one another.	Moderate (Rejection)	Awareness and interest
Bowling Green	Hindered OSS adoption, technology adoption decisions were extremely formal and limited to select individuals within the IT department. This increased the influence of the 'best of breed' philosophy when choosing information technologies.	High (rejection)	Awareness and interest

Technical Knowledge

As a construct technical knowledge appears to be critical in nearly all organizational adoption stages. Technical knowledge helps organizational members understand how an innovation may fit with organizational processes, increasing the likelihood of interest, it helps organizational members understand how to use an innovation, facilitating adoption and routinization and technical knowledge appears critical for understanding how to apply an innovation in new and unusual ways, facilitating infusion. Because technical knowledge manifests in adoption stages in different ways it appears present to have many components, and not be a single factor. These components seem to include technical knowledge, or the operation of a technology, application knowledge, or understanding how a technology aligns with or can enhance existing organizational processes, and support knowledge, understanding how to maintain and extend technologies over time.

All three components of technical knowledge seem to be intimately related to technical standards, which can facilitate or hinder the adoption of OSS. Individuals who have technical knowledge of the standards used by OSS appear to be able to adopt OSS with relative ease, even if the technology is not a recognized organizational technology. Several individuals were observed who had adopted OSS applications to enhance proprietary software used by the organization, often without their peers or area manager's knowledge. Meanwhile technical knowledge of standards not used by OSS seems to be able to hinder OSS adoption. Organizations that focus on non-OSS standards appear to have related technical knowledge and the learning of OSS standards appears to be a cost as individuals need time and materials to learn these standards.

Organizational technical knowledge observed in this study appears to differ from existing theory in that technical knowledge seems to be comprised of multiple components and does not always act as a positive influence on technology adoption. Because technical knowledge seems to focus on specific technology standards there are opportunity costs associated with learning a new technical standard when another is already known. The willingness to absorb opportunity costs appears to vary among individuals and organizations, occasionally allowing existing technical knowledge to hinder the adoption of a new standard like OSS. Perhaps the different components of technical knowledge have differing effects on organizational adoption of innovations and explain the variations in how technical knowledge affected the adoption of OSS. Table 41 highlights how technical knowledge was observed in the case sites.

Table 41. Technical Knowledge

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Roswell's adoption of OSS appeared to rely heavily on technical knowledge. Their understanding of open source communities, open source standards and open source software seemed to form the basis of their open source adoption.	High (Adoption)	Awareness, interest, adoption, routinization and infusion
Columbus	As theorized, increased technical knowledge helps departmental members evaluate and implement OSS. The department appears to rely on new hires to acquire new sources of technical knowledge as opposed to developing existing employees.	High (Adoption)	Awareness, interest, adoption, and routinization
Decatur	**Adoption:** Project teams displayed a wide breadth of technical knowledge that appeared to facilitate the adoption of OSS. **Rejection:** IT areas appeared to focus on technical knowledge concerning vendor technologies and work routines within these technologies. This appeared to reinforce vendor standards, hindering the adoption of OSS.	High (Adoption) Moderate (Rejection)	Awareness, interest, adoption, and routinization
Jackson	Technical knowledge appeared to focus on the application of proprietary technologies to IT area tasks. This seemed to decrease the adoption of OSS as departmental members focused on technical knowledge that would allow them to complete their tasks. In the instances of OSS adoption the technical knowledge of the individuals adopting the technologies appeared to play a major role in their implementation. These individuals more readily recognized how OSS could be applied to benefit their IT areas.	High (Adoption) Moderate (Rejection)	Awareness, interest, implementation and routinization
Bowling Green	Hindered OSS adoption as technical knowledge focused on using vendor technologies as opposed to the underlying service or problem.	Moderate (rejection)	Awareness and interest

Wealth

While many of the model factors showed mixed effects, wealth is the only model factor to consistently operate contrary to theory. Organizations with less wealth or undergoing economic hardships appeared to be more interested in, and more likely to adopt OSS than those organizations with more wealth. Perhaps this is due to the lower end disruptive nature of OSS; the innovation itself appears likely to cut costs. Organizations consistently identified reduced cost as a relative advantage of OSS. However, this implies that organizations have a priority or goal when adopting innovations that can be affected by their organizational context, of which organizational wealth appears to play a major role.

Regardless of its cause, organizational wealth does not appear to operate as theoretically predicted in the adoption of OSS. Because organizations expressed interest in OSS primarily because it reduced organizational costs, it appears that the nature of an innovation, such as a lower-end disruptive innovation, may influence how it is perceived by an organization's current context. During this study the state of Florida was undergoing a period of economic hardship that increased the appeal of cost cutting innovations like OSS.

Table 42. Wealth

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Facilitated adoption as the department sought out technologies that reduced costs associated with IT.	High (Adoption)	Awareness, interest, adoption, routinization and infusion
Columbus	Low levels of departmental wealth increased interest in OSS, but lower funding restricted how the department experimented with OSS.	Low (Adoption)	Awareness, interest, adoption and routinization
Decatur	Decatur's wealth appeared instrumental in the adoption of OSS as the department looked for options to reduce costs. Although the departments' budget was held constant for two years the department was asked to take on more IT projects, essentially resulting in a net budget cut. In most instances where OSS was adopted it was selected to reduce IT costs.	High (Adoption)	Awareness, interest, adoption and routinization
Jackson	Organizational wealth appeared to be divided by the nature of the department, those that generated their own revenues and those that drew from the municipality's general fund. The IT department drew from the general fund and appeared to have limited resources. These limited resources seemed to focus the department on critical or immediate needs, not allowing the department to plan for longer periods of time. By focusing on solving immediate needs the department appeared to lower interest in new technologies like OSS.	Low (Rejection)	Awareness and interest
Bowling Green	Hindered adoption even though departmental budgets are limited and highly monitored	Moderate (rejection)	Awareness and interest

Slack Resources

Slack resources did not appear to play a major role in the adoption of OSS. Nearly every individual interviewed at all of the case sites did not report having slack time. Perhaps this was due to a participant belief that they would be reported as wasting time. But each case site had several positions within the IT departments that were unfilled at the time of the interviews. These responsibilities appeared to be passed out among the remaining IT department members. The municipal IT departments at Decatur and Bowling Green had IT project backlogs of over 18 months.

As most staffs were short-handed they did not have slack time to perform environmental scans or to examine non-routine communications channels to increase their awareness of innovations like OSS. Rather the lack of slack time appeared to have little positive effect on the adoption of OSS adoption. Rather organizational members appeared to dislike the idea of learning new technologies as they seemed to prefer to focus on existing work tasks.

Table 43. Slack Resources

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Roswell seemed to have low levels of slack resources. This did not appear to affect search and testing activities as they appeared to be part of routine work activities.	Low (Adoption)	Awareness and interest
Columbus	The IT department had few slack resources as it was currently understaffed by three positions. Searches for and experimentation with new technologies did not appear to be dependent upon slack resources. Rather these activities seemed to be tasks given to IT department members.	Neutral	None
Decatur	Slack resources appeared to have little impact on technology adoption. Most employees reported no slack time as the department had an 18 month backlog on projects. Rather environmental scanning appeared to be a part of new IT projects. Project teams appeared to actively search for technologies that could reduce organizational costs while maintaining appropriate levels of quality.	Neutral	None
Jackson	The department had few, if any, slack resources. Consequently there were not enough instances of slack resources at Jackson to determine how this characteristic influenced the adoption of OSS in the city.	Neutral	None
Bowling Green	Facilitated adoption as employees had begun experimenting with OSS	Low (adoption)	Awareness and interest

Theoretical Operation of Innovation Factors

G1c – Do innovation constructs operate in accordance to organizational adoption theory?

Innovation diffusion theory promotes the idea that organizations adopt innovations for their characteristics. Simply put, the communication of these characteristics, through different communication channels, results in the adoption of innovations. The three innovation characteristics examined by this study, relative advantage, compatibility and complexity, do indeed appear to be linked, as theory predicts, to organizational adoption of OSS. However simple awareness of an innovation characteristic does not appear to be sufficient to drive organizational adoption. Rather it seems to be the alignment between innovation characteristics and organizational goals that determine the adoption of an innovation like OSS.

Adoption Stages Influenced by Innovation Factors

The case studies provide strong evidence that innovation characteristics influence the interest and implementation stages of adoption. Organizations appear more interested in an innovation when one or more innovation characteristics align with an organizational goal. For example with OSS most municipal IT departments were interested in reducing departmental costs. Therefore the reduced cost of OSS highly appealed to municipal IT departments. However it appeared that the cost advantage of OSS was not sufficient for organizations to adopt the innovation. The ability of OSS to integrate with other technologies, or its compatibility, and the time it takes to learn how to use the innovation, or an innovation’s complexity, seemed to moderate how an innovation is perceived by an organization, which in this study, affected the adoption of OSS.

The case studies provide some evidence that OSS characteristics also influence later adoption stages of routinization and infusion. These stages of adoption seem to be more process oriented, routinization meaning that an organization has adopted an innovation to commonly handle or implement one or more processes, while infusion implies that an innovation’s use has been extended to handle one or more processes that it was not originally intended to perform. Both levels of adoption are dependent upon organizational processes, which in turn seem to be affected by innovation characteristics. Without appropriate characteristics an innovation could not handle the process or the new tasks that constitute the infusion level of adoption. However, routinization and infusion, like other organizational processes, also appear to be dependent upon organizational members. Organizational member buy-in or participation appears to be critical in these latter stages of adoption. The remaining parts of this section discusses each of the three innovation characteristics examined by this study, relative advantage, compatibility and complexity, and highlights their role in the organizational adoption of OSS.

Relative Advantage

The relative advantages of OSS applications, or the functions and characteristics that were perceived superior to peer technology appeared to be motivating factors for the adoption of OSS where the relative advantage aligned with organizational goals or philosophies. Organizations in the case studies sought OSS applications that did one or more of three things that aligned with organizational goals; performed existing tasks better, faster or cheaper than the technologies they currently used.

Being a better application appeared to mean one of two different things. First the innovation itself, or the innovation characteristics, could have functions or associated procedures superior to proprietary equivalents. These functions were either more easily understood or provided contextual functionality that could not be found elsewhere. Innovation characteristics seemed to include the functional nature of OSS including resource consumption, support and technical improvements. Many OSS applications consumed fewer technical resources, such as processing power or data storage, allowing the organization to more efficiently apply these resources.

The second form that relative advantage took related to the organizational characteristics of the innovation. This focused on the organizational costs associated with adopting and using an OSS. OSS price and related services, including customization, support and training, appeared to be the focus of organizational characteristics regarding OSS.

The OSS organizational characteristic that most IT departments were most concerned about was the cost of OSS. Lower IT costs appealed to local governments during the time of this study as all the participating local governments were undergoing budget reductions. The ability to substitute OSS, a lower cost technology, for a higher costing proprietary technology aligned with organizational needs. Substitution of OSS for proprietary technologies appeared to drive the adoption stages of awareness, interest and adoption.

However cost reduction did not appear to drive adoption stages of routinization and infusion. These stages appeared to rely upon the surrounding OSS communities as these organizations enabled customizations and new applications of OSS technologies. For example Roswell was able to get customizations implemented as standard functionality for an OSS through interaction with the community. Additionally Roswell was able to use bounties, or the practice of getting members of an OSS community to program specific functionality for an application, to extend or enhance existing programs. These organizational characteristics of OSS appeared to drive the adoption stage of the OSS, moving from adoption to routinization, as the technology became standard within the organization, to infusion, as new uses for the technology were discovered.

Table 44. Relative Advantage

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Perceived relative advantages in security, licensing, maintenance, and resource consumption facilitated adoption.	High (Adoption)	Interest, adoption, routinization and infusion
Columbus	Columbus personnel perceived one major relative advantage of OSS, the reduced cost of the innovation.	High (Adoption)	Interest and adoption
Decatur	Decatur personnel perceived one major relative advantage of OSS, the reduced cost of the innovation. However, other relative advantages, such as circumventing technology purchasing and high quality were perceived by some members.	High (Adoption)	Interest and adoption
Jackson	Relative advantage appeared to depend on IT context. Security and networking applications seemed to have a higher fit than other IT applications.	Moderate (Adoption)	Interest and adoption
Bowling Green	Bowling Green personnel perceived the relative advantage of OSS in the security area as being the 'best' tools to use in this area.	High (Adoption)	Interest and adoption

Compatibility

While the costs of OSS, or the relative advantage of purchasing OSS, appeared to drive interest in the technology, the ability of OSS to integrate with an organization's existing technologies, or the compatibility of OSS, appeared critical for adoption. Compatibility was a critical construct as it appeared to operationalize in two different forms: technical and procedural compatibility. Both types of compatibility appeared to influence adoption stages of interest and adoption.

The technical compatibility of OSS appears to describe how the innovation integrates or interfaces with other technologies. For example how two computer programs communicate or how software communicates with a piece of hardware. Meanwhile operational compatibility focuses on the operation and use of the technology. Does the technology seamlessly integrate with existing processes; utilize current technology standards and skills?

As a construct affecting organizational adoption stages, compatibility seemed to mainly affect interest and adoption. These two stages appeared tightly coupled in regards to compatibility as municipal IT departments did not adopt OSS that caused disruptions to their operations. Organizational interest was spiked when an OSS application could work with an organization's existing technologies and procedures.

Adoption was more likely where compatibility with existing technologies was high and a relative advantage of the technology aligned with an organizational goal. This circumstance, reliance upon a relative advantage of the technology, appeared to make compatibility less important than relative advantage. But because no organizational IT department had adopted an OSS solely on a relative advantage, the priority for organizations between the two constructs is difficult to understand and may be the focus for future research. Table 45 highlights how compatibility was observed to influence adoption at the case sites.

Table 45. Compatibility

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Integration with other OSS applications facilitated adoption. High level activities were similar with proprietary equivalents, but actual commands and execution were substantially different.	High (Adoption)	Interest and adoption
Columbus	OSS adopted at Columbus seamlessly integrated with other technologies.	High (Adoption)	Interest and adoption
Decatur	OSS adopted at Decatur seamlessly integrated with other technologies, no modifications or customizations were needed for the software.	Moderate (Adoption)	Interest and adoption
Jackson	Technical compatibility was essential for the OSS adopted by Jackson's Security and Networking areas. However compatibility appeared to extend to organizational functions such as support and training.	High (Adoption)	Interest and adoption
Bowling Green	OSS adopted by Bowling Green's security area seamlessly integrated with other technologies used by the area.	High (Adoption)	Interest and adoption

Complexity

OSS complexity also influenced the adoption of the innovation. The construct operated according to theory, hindering the adoption of OSS. Like relative advantage and compatibility, OSS complexity appeared to be multidimensional, having two levels or dimensions: one focusing on the innovation itself and another centering on organizational aspects of the innovation. These two dimensions of complexity appeared to primarily affect early adoption stages, interest and adoption.

The interviews revealed that complexity related to the innovation focused on how individuals used the technology. This involved understanding technical standards and functions needed to operate the innovation. Most IT department personnel did not believe that OSS was complex, it was just perceived to be a different technical standard. IT personnel did believe that OSS would be complex to those unfamiliar with similar technologies and disrupt business processes outside of the IT department.

Meanwhile the organizational aspects of OSS complexity appeared to be more daunting to municipal IT departments. This focus on training, support and third party assistance was of primary concern to municipal IT department members. A common belief was that OSS changed the operation or processes associated with routinely used IT. Because IT department personnel believed that OSS alters the supply and support of the technology, shifting from a business organization to a community of developers. Common among IT departments was concern that such a standard shift or change would cause a major backlash, disrupting IT operations. Not only did IT department personnel believe that support would be inconsistent, they were concerned that OSS adoption would strain interpersonal relationships, create extra or unwanted work, and increase overall ill-will towards the IT department.

However where OSS was used the organizational support of the technology did not appear complex to IT department personnel as most OSS applications were provided by IT vendors. Vendors appeared to shield municipal IT departments from any unnecessary complexity as they bridged the gap between the open source community and the municipal IT departments. This allowed the IT departments to use OSS like other vendor offerings.

As a construct in the organizational adoption of innovations, OSS complexity appeared to influence the interest and adoption stages. These adoption stages were negatively linked to complexity as theory predicts. Apparently organizations had less interest in a technologies perceived to be complex as organizations thought that the time invested in learning the technology would either cause major disruptions in operations or greatly decrease operational efficiencies. Table 46 highlights how complexity affected OSS adoption at the case sites.

Table 46. Complexity

Site	Finding	Influence on OSS Adoption	Adoption Stages Influenced
Roswell	Complexity appeared to facilitate adoption as it created a knowledge barrier or filter surrounding what technologies they would implement.	High (Rejection)	Interest, implementation, and routinization
Columbus	Many OSS applications were not considered technology options as the complexity associated with those technologies was perceived to alter work processes and cause disruptions to operations.	High (Rejection)	Interest, implementation, and routinization
Decatur	IT areas considered OSS applications as being complex, changing work processes and activities, hindering OSS adoption. IT project teams did not considered OSS to be complex as their perceptions of what IT department members varied from their IT area peers.	Moderate (Rejection)	Interest, implementation, and routinization
Jackson	Complexity of OSS appeared to be low to many Jackson IT personnel. What was complex were the organizational attributes of OSS such as support and training. Personnel questioned where these functions would come from.	Moderate (Rejection)	Interest, implementation, and routinization
Bowling Green	OSS applications were considered to be complex and difficult to understand. Departmental members perceived OSS to alter work processes and cause disruptions to operations.	High (Rejection)	Interest, implementation, and routinization

Theoretical Operation of Adoption Perspective

G1d – Is the adoption of open source software is best explained by organizational characteristics as opposed to environmental factors or innovation characteristics?

While the organizational adoption of innovations is clearly dependent upon an organization, the dominance of the organizational perspective of OSS adoption is difficult to state. The question itself questions what is organizational adoption? Does organizational adoption focus on the last two stages of organizational adoption, routinization and infusion? There is little question that organizational characteristics best explain the routinization and infusion of technologies. How else can an innovation become routine or infused within an organization if not through an organization’s processes i.e. an organization’s operational characteristics? However if organizational adoption includes the stages of awareness, interest and adoption then it is difficult to definitively state that organizational characteristics dominate this process as third parties play major roles in these first three stages.

All of the organizations examined in this study had shifted some organizational processes, which included environmental scanning, training, or support to external third parties. Shifting these activities outside of the organization changes how organizations view new technologies. Rather than focusing on an innovation's characteristics or an organization's own ability to utilize an innovation, organizations become reliant upon third parties. Third parties create network effects that influence how organizations behave.

Third parties were extremely influential to both the adoption and rejection of OSS. Roswell, the site with the most OSS adoption routinely employed vendors to support their OSS. OSS vendors supplied training and IT support, either new versions or patches of the programs. Without these vendors could the IT department continue to use their OSS? The answer is likely 'no', as vendors allow the department to operate with fewer personnel who can focus on different tasks. Without the OSS vendors it is highly likely that Roswell would not have had interest in the technology in the first place.

Indeed the availability of third party vendors is the reason why other municipal IT departments limited their OSS use; they needed their proprietary technology vendors to help operate their IT. Perhaps this highlights how vendors play an increasingly important role in organizational activities. One organization, Bowling Green, had even shifted environmental sensing, traditionally an organizational characteristic reliant upon organizational members, outside of the organization. Because they had adopted 'Best of

Breed' technologies Bowling Green's IT department relied upon industry experts to evaluate existing IT options, and then adopted technologies recommended by IT experts.

The integration of vendors into IT operations appears to reduce the importance of organizational characteristics; shifting responsibilities and expectations to vendors rather than internal personnel. Therefore this question has mixed support. While IT department characteristics clearly influenced OSS adoption and were the defining factors for routinization and infusion, it is not clear that organizational adoption could happen without third party assistance.

Theoretical Operation of Adoption Stage on Innovation Disruption

G2a - *Do OSS Adoption stages of adoption, routinization and infusion disrupt an organization's IT functions in terms of implementation, operation, and support?*

Because OSS is a disruptive technology, the development, distribution and support of this technology are radically different from proprietary software; this research proposed that the adoption of OSS at the adoption, routinization or infusion stages would disrupt the organizational IT function. Evidence from the case studies contradicts this perspective as OSS adoption stages of adoption, routinization, and infusion did not appear to disrupt an organization's IT functions.

The case studies provide three possible explanations for the observed non-disruptions. First the nature of the disruptions caused by OSS may be limited to segments of the value chain outside of the adopting firm. Second the compatibility of OSS adopted by IT departments may be such that it aligns or fits with existing technical and operational processes with adopting organizations. Finally, as the third guiding question states, the adoption level of OSS may influence the disruptive effects of OSS.

Because OSS disrupts fundamental software processes, such as development, distribution and support, these three software processes may be disrupted outside of the scope of adopting organizations. Consequently, by using OSS vendors or third parties, organizations appear to be shielded from the disruptive effects of OSS. Because organizations focus on use, a feature of OSS that does not appear to cause disruptions in IT operations, organizations are shielded from the disruptions associated with OSS.

Perhaps municipal IT department use of OSS has matured or had enough time to cause disruptions in the IT function. Maybe it is only a matter of time before the support of the technology; an activity that is disruptive to software in general, alters IT department functions. But, where critical, OSS was purchased from OSS vendors like Red Hat Inc. These vendors provide support like traditional software companies, and seem to provide an additional layer of insulation from the disruptive nature of OSS.

This implies that the disruptions caused by OSS technologies may be outside of an organization’s operations or scope of use of the technology. If thought of in terms of the value chain, the inbound logistics and after sale support activities are the only processes influenced by the technology’s open nature. The other stages in the value chain surround the internal application and use of the technology and do not appear to be affected.

Along this line of reasoning may also be the nature of disruptions caused by OSS technologies. Disruptions in operations do not appear to last forever, eventually these innovations become the new organizational norm. This may also account for the lack of disruptions observed. Each site had already overcome the disruptive effects of the technologies.

The compatibility of OSS may also influence the lack of disruptions observed in the case sites. While not used for every IT function, where it was used, OSS appeared to seamlessly integrate with other technologies. The standards and interfaces of OSS did not necessitate the purchase of new equipment or other technologies. And while some individuals needed to learn new processes or ways to execute tasks through the software, the concepts implemented by OSS were not new. This appeared to have high alignment with existing procedural knowledge, or what activities were being done, in the organization. This seamless integration into the existing architecture may be due to the technical knowledge of the adopting sites or due to a selection bias as every case site had adopted OSS in some form or fashion. Perhaps a site that did not adopt OSS in any IT function would have different results.

Finally disruptions caused by OSS may be linked to the adoption level of the technology. The third guiding question specifically addressed this possibility and is discussed in the next section.

Theoretical Operation of Adoption Level on Innovation Disruption

G 3 - *Does open source adoption level moderate the disruptive impact of OSS on the organizational IT function, with lower levels of adoption having less disruptive effects?*

Another explanation for the non-disruptive effects of OSS on IT operations at the participating IT departments is the third guiding question: that open source adoption levels moderate the disruptive impact of the technology. This question has mixed support as four of the five sites had only adopted OSS at an ‘as-is’ level; these ‘as-is’ adoptions were most often standard versions or vendor supplied versions of OSS. Because participating municipal IT departments did not exhibit disruptions to the IT function it is likely that an ‘as-is’ level of adoption allows IT departments to treat OSS like proprietary software; especially where OSS vendors exist to provide third party services.

Meanwhile the fifth case study, Roswell, had extensively adopted OSS, even having some instances of infusion adoption stages. While the majority of Roswell’s OSS adoption was at a design level, the IT department also participated in the development and extension of a select group of OSS applications. This qualifies as OSS adoption at the design level.

Design level adoption appeared to lead to activities, such as OSS development or testing and the use of code bounties with OSS groups, which may have been considered disruptive at the other case sites. However the IT department did not consider these activities to be disruptive as these activities were commonly used. Perhaps the use of bounties or OSS development may have once caused disruptions in Roswell’s IT department. There is some evidence of this as the CIO of Roswell, a recent hire by the city, implied that it took him a year to adjust to the OSS environment.

But once the adjustment was made to the OSS technologies and processes, these activities became commonplace. Maybe this is what happens with OSS technologies that are adopted at a design level or an infusion adoption stage; the disruptive procedures or activities normalize over time. Regardless of the explanation, no disruptions were observed at the participating IT departments, providing potential negative answers to the second and third guiding questions of this study.

Discussion of Adoption Theories

While no theory claimed to fully explain organizational adoption of innovations the theories seem to describe parts of an organizational process that has both social and technical elements. The theories used for this study seem to mirror a fable, the six blind men from Indostan. Like the six blind men who tried to describe an elephant by touching the animals different parts (see appendix item D), the theories touch on different parts of organizational adoption. However unlike the blind men, the organizational adoption theories make no final claims about the phenomenon and appear to integrate together to accurately highlight different parts of the adoption process.

The theories were difficult to fit into adoption stages and adoption levels as most organizational adoption theories focus on the entirety of organizational adoption, trying to explain various stages of adoption through specific constructs. Combinations of theories that included both social and technical and organizational processes appear to best predict the organizational adoption of OSS. The following sections highlight what parts each theory identified and their apparent predictive power on the organizational adoption of innovations.

Innovation diffusion theory

By describing both social and technical factors that influence the organizational adoption of innovations, innovation diffusion theory (IDT) appears to be the most complete organizational adoption theory. Key to IDT is the idea that an adopter needs information about an innovation's characteristics. This information is communicated through some kind of social channel. IDT also recognizes the importance of a new innovation's characteristics. How these characteristics compare to existing innovations is of central importance. This highlights a need to align or fit with the existing technologies used by the organization.

The case studies indicate that these factors, communication channels and innovation characteristics, play a major role in the organizational adoption of innovations. However IDT appears to be incomplete as it does not provide an explanation for variations in adoption stages, even though the theory itself recognizes different adoption stages. Finally IDT appears to limit adoption to the implementation stage, overlooking the routinization and infusion of innovations.

By itself, IDT predicts that organizations should adopt similar technologies at similar stages and levels as organizations became aware of new technologies. This does not appear to happen in the case studies as five similar organizations had adopted OSS in a variety of different departments and capacities at two different levels and a variety of stages.

Perhaps these differences in adoption stage and adoption level can be explained by organizational knowledge, which was found to differ among the case sites.

Alternatively an organizational philosophy or objective appears to provide the best explanation for these variations. Columbus's use of OSS was driven by the need to succeed; Bowling Green's use of OSS was driven by the 'best of breed' philosophy, and Roswell's use of OSS optimized the network of the city. The two organizational characteristics, knowledge and philosophy, varied among the participating IT departments and, when combined with IDT's other constructs, appear to provide more accurate insight as to why adoption stages and levels varied among the IT departments. Despite the difficulty in predicting adoption stages, IDT appears to be the most complete organizational adoption theory as it recognizes the importance of social as well as technical elements.

Technical knowledge and know-how

Attewell's theory of technical knowledge and know-how (TKKH) does not claim to fully explain the organizational adoption of innovations. Rather this theory focuses on explaining knowledge gaps associated with new technologies like OSS. By itself this theory does not appear capable of explaining organizational adoption of innovations as several key elements of adoption are overlooked; TKKH does not recognize the importance of an innovation's characteristics.

Rather Attewell focuses on third parties providing knowledge through a social channel to enable organizations to overcome knowledge barriers to use innovations. Attewell's theory that adoption is affected by an organization's knowledge and the organization's ability to learn and apply new innovations appears critical to explaining later adoption stages, especially routinization and infusion.

If combined with IDT, the theory of technical knowledge and know-how appears to explain different adoption stages among the case sites. Although not explicitly stated, if Attewell's stages of knowledge supply or use are substituted for adoption stages then this theory, when combined with IDT would seem to be a more complete theory for adoption. This perspective discounts the importance of an organizational goal or philosophy towards technology adoption; a critical factor present at nearly all of the case sites.

Organizational Resources

Like Attewell's theory, Damanpour's organizational resources theory did not try to explain the entirety of organizational adoption. Rather this meta-analysis accurately identified and refined many constructs that contribute to organizational adoption of innovations. The theory focuses on social factors inside and outside of the organization that influence the adoption of innovations.

Social factors, both internal and external to the organization, and organizational factors that influenced these social factors, such as administrative intensity and slack resources, were identified as being critical to Damanpour's theory. The case studies also acknowledge the importance of technical knowledge. All of these factors were found to be important in the OSS adoption observed in the case sites.

But most importantly this theory seems to hint at or suggest an organizational philosophy or object towards innovation adoption. Factors like managerial attitude towards change and managerial tenure appear to indicate that these beliefs and values influence innovation adoption. However a philosophy or mission characteristic was not formally identified in this theory. Additionally Damanpour's organizational resources theory never postulated relationships between the various factors he identified. Without these relationships it is difficult to identify which factors influence different adoption stages or adoption levels.

Managerial fashion

Managerial fashion, like most of the organizational adoption theories, did not seek to explain the entirety of organizational adoption of innovations. Rather it highlighted the importance of external communication channel by focusing on organizational peers and perceived experts, such as consultants or vendors. By examining managerial trends and the interactions between organizations, Abrahamson highlighted how these social channels were influential to organizational adoption of innovations.

Abrahamson stated that the social channels had varying affects based upon organizational knowledge and vision. His theory appears to be alone in that it seems capable of explaining some variations in adoption stage or adoption level. The knowledge and vision of an organization affects organizational adoption. In some situations organizations appear to have sufficient knowledge or vision to avoid influence by peer actions. In other circumstances Abrahamson notes that organizations are vulnerable to the actions of their peers or industry leaders. This theory highlights the importance of social and organizational processes but downplays the importance of the technology to be adopted and the adopting organization's technical infrastructure as Abrahamson appears to overlook these factors.

Network externalities

Network externalities theory is another organizational adoption theory that highlights the importance of social channels. This theory focuses on communication and service networks formed between vendors and their customers. The theory highlights how important vendor support in the organizational adoption process. Katz and Shapiro's theory appears to be the first theory to identify innovation characteristics beyond the functionality of an innovation or its ability to integrate with other technologies. Third party support appears to play a critical role in technology services and adds additional functionality that is valuable to an organization. Indeed many of the case sites only used vendor versions of OSS that were supported and maintained through service contracts.

This theory appears to refine social aspects of organizational innovation adoption which are critical in determining organizational adoption. By highlighting the importance of third party support, Katz and Shapiro identify innovation characteristics linked to the innovation's vendor rather than the technology itself.

Critical mass

Unlike other adoption theories, critical mass theory focuses on the usefulness of a given technology relative to the number of adopters. In the case studies critical mass effects were not observed. Peer adoption did not affect the usefulness of OSS within the different IT departments. As critical mass effects were not observed, this theory appears to lack explanatory power in the adoption of OSS.

IT Context

Like many of the other organizational adoption theories, Swanson's IT context theory did not try to explain the entirety of organizational adoption. Rather this theory proposed that there were different types of applications within an organization. This theory appears to have high explanatory power in examining the organizational adoption of OSS as nearly all OSS implementations were in the IT area. Very few OSS applications were adopted outside of the IT area. This indicates that these technologies are likely affected by organizational IT contexts including contextual knowledge or goals of different organizational functions.

Despite the accuracy of identifying adopting organizational areas, the IT context theory does not appear capable of predicting organizational adoption stage or adoption level of the participating sites. Because of these shortcomings it appears necessary to combine the IT context theory with other adoption theories to explain adoption. It appears that IT context may be a function of organizational knowledge, rather departmental knowledge. As such it is possible that Attewell's theory of technical knowledge and know-how may be a stronger explanation for contextual factors affecting adoption of OSS.

Routine versus Radical

Nord and Tuckers theory of routine and radical innovations appears to support several parts of the proposed organizational adoption process. Their study, which examined the adoption of a single innovation by multiple organizations, found that some organizations considered the innovation to be routine while others perceived an innovation as radical.

Several organizational variables, both internal and external to the organization, appeared to influence both the adoption of the innovation and explain the variation in the perceived nature of the innovation. Variables included domain area expertise, or knowledge, existing technologies similar to the innovation being adopted, and the use of outside consultants.

These factors appear to support an ongoing process that has both technical and social elements, including the presence of different network externalities, such as consultants, organizational knowledge, and an existing technical infrastructure. Additionally the research explains variations in the perceived nature of the innovation through different combinations and levels of organization variables.

This theory appears to integrate well with what was observed at the case sites. OSS was often adopted where it aligned with existing technical knowledge or standards, such as Linux adoption where Unix versions had been used.

Discussion of Research Questions

This study sought to answer two research questions about the organizational adoption of disruptive innovations. The first question, how does the adoption of a disruptive innovation result in disruptions to the adopting organization, appears to remain unanswered. Because OSS did not seem to cause disruptions in the organizations examined it is difficult to state that the technology did not cause disruptions to the adopting organizations. There are three possibilities as to why the investigation at the municipalities did not answer this question.

The first explanation appears to be overly simple: OSS is not disruptive to IT departments. Although OSS has been labeled a disruptive innovation, Christensen himself calls the technology disruptive; perhaps it is only disruptive to the software industry. Because IT departments routinely work with different technologies, supporting and enhancing organizational software, OSS may just be another technology. The nuances in support and development do not affect adopting organizations. Again this explanation appears to be overly simple, and there is some evidence in the case studies that this is not accurate. The CIO at Roswell, the heaviest adopter of OSS, stated that it took him a year to become accustomed to OSS technologies. This gives rise to the second possibility that disruptions caused by disruptive technologies are temporal and the changes they require eventually become routine to the adopting organization.

Because this study was not longitudinal it is quite possible that any disruptions or changes caused by OSS were integrated into processes before the interviews. It is likely that IT department members had grown accustomed to using OSS and at the time of the interviews the technologies had become routine. There is strong support for this possibility as absorptive capacity, or the ability for organizations to integrate new innovations into their processes is an accepted organizational characteristic.

The third possibility stems from OSS adoption level. Perhaps OSS adoption level, as the third guiding question proposes, does moderate disruptions to adopting organizations. Because four of the five adopting organizations had limited their OSS adoption to the ‘as-is’ level, maybe OSS operates like proprietary software. Indeed even the most radical adopter, Roswell, employed OSS vendors and appeared to limit their software development to mission critical applications, leaving their adoption of many OSS applications at the ‘as-is’ level.

These three possibilities indicate that the first research question, how does the adoption of a disruptive innovation result in disruptions to the adopting organization, while investigated, remains elusive. Evidence suggests that disruptions caused by OSS are not permanent. Organizations adapt to new technologies and processes. Perhaps a definitive answer could be achieved by a longitudinal case study. An organization or group of organizations, seeking to adopt a disruptive technology could be followed over time. By understanding how an organizations perceives the radicalness of OSS before, during and after a given period of time, could better answer this question.

The second research question, which adoption perspective, environmental factors, organizational characteristics or innovation characteristics, best explains the organizational adoption of disruptive innovations also remains partially unexplained. As G1d sought to answer, no single perspective appears to hold the key to organizational adoption of an innovation. Because organizations segment their processes and outsource IT services it is difficult to definitively state that organizational characteristics best explain the entire organizational adoption process.

The latter stages of organizational adoption, especially routinization and infusion, are heavily influenced and best explained by organizational characteristics. But because organizations rely upon vendors and third parties for information about new technologies and for services, like training and support, it is difficult to separate the importance of third parties in the early stages of adoption, from awareness and interest to adoption.

Rather evidence suggests that organizational adoption of innovations appears to be a combination of social processes and technical functions. Social processes include internal and external communication that the organization participates in. Meanwhile technical functions highlighted by the different theories include the characteristics of the innovation to be adopted and the organization's existing IT function. Table 47 highlights how these different factors appear to influence organizational adoption stages. Factors are rated either high or low based upon their perceived influence in organizational adoption but these factors do not appear to influence the different sites equally. If they did adoption stages predicted by IDT would be found in the case sites. A motivation for adoption appears to be missing.

Table 47. Factor Effects on Adoption Stage

	Awareness	Interest	Adoption	Routinization	Infusion
Innovation Characteristics	Low	High	High	Low	Low
External Social Processes	High	High	High	Low	Low
Internal Social Processes	High	High	High	High	High
Internal IT Function	Low	High	High	High	High

The organizations examined in this research appeared to be guided by an organizational goal or philosophy. The alignment between a new innovation, an organization's goal or philosophy and the existing IT function appear to best explain how organizations adopt new innovations. How organizations determine an innovation's fit or alignment with their goals is highly contextual as these factors appear to influence one another.

In conclusion the answer to the second research question, which perspective best predicts organizational adoption of innovations, appears to be yet more questions. Is adoption found in the latter stages? Or are the early stages of adoption of concern? There is no doubt that the organization plays an instrumental role in the adoption of innovations at all stages, but the most influential role in all stages is questioned. Because of the segmentation of IT department services, including environmental scanning, training and support, the influence of environmental factors appears to be growing. Perhaps this is indicative of the invasive and converging nature of IT on business practices. Regardless, this study highlights how rich the organizational adoption process is.

Chapter 6.

Findings and Contributions

This chapter discusses the findings and contributions of the study. It is organized around the two research questions. The first part discusses what was learned about the adoption of OSS, a disruptive innovation. This is followed by a section that examines what was found about organizational adoption perspectives. After these sections the study's limitations and future research conclude this study.

The first research question sought to understand when the adoption of a disruptive innovation causes disruptions in an adopting organization. Evidence from this study indicates that no organization was disrupted by simply adopting OSS. No disruptions were observed in the participating IT departments, especially organizations that used OSS as provided by the OSS developers.

This leads to one of two possibilities, first disruptions may be temporal, meaning that they last only for a limited amount of time. Perhaps the interviews were conducted after the IT departments had grown accustomed to the OSS technologies. And while there was some evidence that OSS changed organizational processes, the interviews failed to indicate any ongoing disruptions in IT operations. Any changes appeared to be absorbed into operations.

Alternatively OSS may not disrupt IT department operations at all. Because many of the adopting IT departments used OSS in the same manner as proprietary software, purchasing it from a vendor, it is possible that disruptive technologies may only affect their market of origin. In the case of OSS this would mean that only software providers, or organizations that create and sell software, would be the organizations feeling the disruptive effects of the technology and not the adopting organizations.

The second contribution of this study is a better understanding of the different perspectives of organizational adoption theories. By testing a model that synthesized eight different organizational adoption theories, organizational adoption is better understood. No single perspective or adoption theory appears to best explain this organizational process. Rather these theories all appear to touch on or identify different parts of the organizational adoption process.

Additionally the strengths of these different constructs appear to change during the adoption process. During the beginning of organization adoption, environmental constructs and innovation characteristics appear to influence organizational awareness and interest. However, once identified, organizational constructs, such as knowledge and administrative intensity, seem to become more important. The importance of organizational constructs gradually increases until they ultimately determine the routinization or infusion of an innovation.

Based upon the examination of the eight different organizational adoption theories, this study highlights how organizational adoption can be divided into social and technical processes. Socially, communication within and outside of the organization seems to impact an organization's awareness and interest in new technologies. Technical processes, such as support, and technical fit, appear to influence later stages of adoption. Table 48, Theoretical Fit with organizational adoption highlights how these different theories appeared to influence adoption stages during the organizational adoption of OSS.

Table 48. Theoretical Fit of Adoption Theories

Theory	Alignment with Adoption Stages	Explanation of Organizational Adoption	Level
Innovation Diffusion Theory	Had significant influence on organizational adoption as it identified social process and innovation characteristics that influenced adoption	Awareness Interest Adoption Routinization Infusion	High High Moderate Low Low
Technical Knowledge and Know-How	Had significant influence on organizational adoption as all adoption stages were affected by organizational knowledge	Awareness Interest Adoption Routinization Infusion	Moderate High High High High
Organizational Resources	Had substantial influence on organizational adoption as organizational characteristics were influential in all stages of adoption	Awareness Interest Adoption Routinization Infusion	Moderate Low Moderate Moderate Low
Managerial Fashion	Had little influence on organizational adoption as participating organizations did not appear to be concerned with their peers or industry trends	Awareness Interest Adoption Routinization Infusion	Moderate Moderate Low Low Low
Network Externalities	Had significant influence on organizational adoption as externalities, such as third party support, often determined the adoption of OSS by an organization	Awareness Interest Adoption Routinization Infusion	High High High Moderate Low
Critical Mass	Had little influence on organizational adoption as participating organizations were not subjected to critical mass effects	Awareness Interest Adoption Routinization Infusion	Low Low Low Low Low
IT Context	Had substantial influence on organizational adoption as the majority of organizations had adopted OSS only within the IT department	Awareness Interest Adoption Routinization Infusion	Moderate Moderate Moderate Low Low
Routine vs. Radical	Had moderate influence on organizational adoption as participating organizations were less likely to adopt OSS that was perceived to be radical	Awareness Interest Adoption Routinization Infusion	Moderate High Moderate Low Low

This research also contributes to organizational adoption of innovations by testing existing organizational adoption constructs. Many theories propose that constructs work in one way, either positive or negative, in organizational adoption. However this research confirms that network effects can alter how organizational adoption constructs operate.

Constructs like communication channels, such as peer adoption, vendor interaction and technical communities, often have both positive and negative effects on the adoption of innovations. This research highlights how these constructs often align with existing theory, acting as positive forces for adoption. But occasionally these constructs work to hinder the adoption of innovations like OSS. Apparently many of these constructs are influenced by different entities that have their own goals or objectives that can either align with or against the adoption of new innovations like OSS.

Organizational level constructs examined also exhibited varying effects on the adoption of OSS. Many of these constructs, such as technical knowledge or environmental scanning, were believed to facilitate the adoption of new innovations. However existing technical standards, or network externalities caused by the knowledge of existing standards, caused the need to learn new technologies to apparently increase the adoption cost of OSS.

This was interesting as the learning costs appeared to influence some personnel to say that these constructs had a negative influence on their adoption of OSS while other personnel examined reported that these constructs had a positive influence on their OSS adoption. Individual differences in attitudes towards learning apparently play major roles in the adoption of new technical standards. Organizational constructs, like social constructs, are often influenced by an object or driving motivation that may cause organizational constructs to facilitate or hinder the adoption of innovations.

This study also identified constructs that were not part of these eight different organizational adoption theories. The first is an organizational philosophy or objective. The participating IT departments were guided by philosophies or approaches to technologies as well as department goals and objectives that influenced their adoption of new technologies. While Damanpour's meta analysis of organizational adoption hints at this construct through administrative intensity and managerial tenure, an IT philosophy or goal is not identified. The identification of this construct, an organizational perspective on IT, extends theory and facilitates understanding variations in adoption stages. Previous organizational adoption theories focused on the fit between the communications of an innovation's characteristics with organizational leaders. But if adoption were merely determined by the communication of characteristics, why were there so many variations in OSS adoption? Organizational beliefs or objects appeared to influence which technologies were chosen.

A second construct identified is the existing IT infrastructure. While implied in innovation diffusion theory through a compatibility characteristic, this implication does not recognize the importance of an existing infrastructure on the adoption of an innovation. IT infrastructures have existing processes and associated knowledge that alters the compatibility characteristic of an innovation. Therefore innovations not only need to be compatible with existing technologies but also with existing processes and organizational knowledge.

This research also makes contributions beyond the original research questions. Because most OSS studies have examined the adoption of a specific OSS, like Linux, this study contributes as it examined how entire IT departments comprised of many IT areas adopted OSS. The interviews show that many areas within the IT department, primarily the security, networking and servers areas, adopt OSS. Perhaps this is because many of these technologies are perceived to be more mature than their OSS peers as their communities are well established. Or maybe the highly technical functions of these areas, hidden from most end users, allow these departments to adopt OSS more easily than other IT department areas. Regardless, this research highlights how the participating organizations adopted a diverse range of OSS across many IT department areas.

Additionally this research contributes to the understanding of OSS by confirming two of four OSS adoption levels proposed by Grand, Von Krogh, Leonard and Swap (2004). Grand et al proposed that organizations can adopt OSS at four different adoption levels. This research observed two of these levels, ‘as-is’ and design. It did not identify instances of hybrid or business model adoptions. The absence of these levels may be due to the non-profit nature of municipal governments. Because these organizations do not create or sell an information technology, combinations of proprietary and open source technologies to create a product for sale may not be found. Additionally adoption levels of open source business models may be absent because of the non-profit nature of municipal governments. They simply do not create a product.

Limitations

This study, like all research has several limitations that may influence the scope or the application of the research findings. These limitations stem from the source of the data and the research methods used to gather data for the study. The remainder of this section will address these two areas and highlight how they may influence the research findings.

Municipal government information technology departments supplied the context for data collection in this study. These IT departments may limit the findings of this study as they all belong to municipalities, non-profit organizations, which volunteered to participate in this study. Perhaps the non-profit nature of municipal IT departments, when combined with municipal unions creates a work environment that most businesses do not mimic. Because municipal IT department workers did not receive workplace incentives and were protected by union contracts they may have been less innovative than business IT departments. Additionally only IT department personnel were interviewed. Their perspective may not accurately represent what the city as a whole believes as the IT department and its activities are central to their concerns.

The participating municipal IT departments also volunteered to take part in this study. These five locations may be very different from the other six municipal IT departments that were invited to participate in the study. Perhaps this is a self-selecting group as each of the municipal departments believed that there were areas within their IT department that excelled or stood out among other municipal IT departments. This may indicate that these IT departments are leaders within the municipal government context, placing them at the cutting edge of technology. If this is the case, then it would be unlikely that other municipalities would follow the trends found in this research.

Finally the municipal context may have altered findings as the years 2007 and 2008 were economically tough for the state of Florida. Each of the municipalities that participated in this research had their budgets affected by lower tax collection and other revenues. This may have altered the research findings as all of the departments were looking to cut costs while maintaining current service levels.

The second area of limitations stems from the research method of using multiple case studies. These studies relied upon structured interviews as the principle means of collecting data. Interviews provided a snap shot of what these individuals thought of on a single day. Rare events or participant mood or relationship with the researcher may have influenced findings. Additionally the researcher’s own bias, a favorable opinion of OSS, could have influenced the interpretation and coding of transcript data.

Future Research

This dissertation investigated the organizational adoption of OSS, a disruptive innovation. While the research contributes to existing theory in three different areas, organizational adoption, disruptive innovations and open source adoption levels, it raises many questions about these three topics that could serve as future research projects.

One potential research project could more closely examine environmental or organizational adoption constructs. Prior to this study existing theory has had deterministic beliefs about the influences that these constructs have on the organizational adoption process. External communication sources were thought to be beneficial for innovation adoption as were technical knowledge and environmental scanning. This study identified situations in which these constructs appeared to hinder OSS adoption as well as circumstances where these constructs facilitated OSS adoption. Therefore these adoption constructs appear to operate with paradox, making them ripe targets for future research.

Additionally this study highlights how disruptive innovations are not inherently disruptive to adopting organizations. Perhaps a closer examination of the value chain of OSS, from creation to distribution to application, could reveal where this technology is disruptive and better understand how disruptive innovations affect business markets and organizations.

Finally this research investigated open source adoption levels, a unique adoption characteristic to OSS technologies. The study confirmed that two of the four different adoption levels, as-is and design, exist in municipal government environments. Further research could confirm or disprove the existence of the other two adoption levels, hybrid and business models. This research could add to the understanding of OSS technologies and the potential changes they can bring to software development and usage.

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Appendices

Appendix A. Coding Schema

Factor	Construct	Code	Description
Environment	External Communication	E-C	Communication with parties outside of the organization about OSS. Including, but not limited to, magazines, websites, other organizations.
	Peer Adoption – Effectiveness	E – PAE	Knowledge of a peer that has implemented an OSS to better solve a problem or solve a problem with better performance
	Peer Adoption – Managerial Fashion	E – PAM	Adoption of an OSS because a peer has adopted the same technology
	Vendor – Services	V-S	Use of vendors to provide knowledge, support, or other services to the IT department
	Vendor – Standards	V-VS	Use of vendor products to facilitate information system integration
	Technical Community	TC	Communication with OSS development/support community
Organization	Structure – Internal Communication	S-IC	How communication is structured within an organization – either formally or informally
	Structure – Administrative Intensity	S-AI	How the organization dictates aspects of the IT function, from standardization of software to training to hardware to how work is done. Characterized as either high or low
	Knowledge – Environmental Sensing	K-ES	If the employee engages in evaluations of technologies outside of the organizations to better perform organizational tasks – coded either as yes or no
	Knowledge – Absorptive Capacity	K-AC	An aggregated construct based off of the number of different technologies an IT department has adopted
	Knowledge – Technical Knowledge	K – TK	The number of technologies the individual develops, implements or supports as well as different standards that they are familiar with
	Size – Specialization	S-Sp	The number of different specialty areas within the department
	Size – Wealth	S-W	The budget of the department
	Size – Slack Resources	S-SL	The amount of time employees have to search for new solutions or experiment with new technologies
Innovation	Relative Advantage – context	RA	The characteristics of an OSS that are better than a proprietary OSS for the same context and application
	Compatibility – values	C-V	How congruent an OSS is with existing values
	Compatibility- technical standards	C-TS	How readily an OSS meets existing technical standards
	Compatibility – Radicalness	C-R	How similar an OSS is to existing departmental technologies
	Complexity	C	How difficult OSS is to understand
Adoption Stage	Awareness	AS-AW	If organizational members are aware of OSS technologies
	Interest	AS-I	If organizational members are interested in OSS technologies
	Adoption	AS-AD	If organizational members have adopted OSS technologies
	Routinization	AS-R	If organizational members consider the use of OSS technologies standard or routine
	Infusion	AS-I	If organizational members have applied OSS technologies to new uses
Adoption Level	'As is'	AL-A	If organizational members use an OSS distribution without modifying it
	Design	AL-D	If an organization has adopted an OSS design
Disruptive Effects	Disruptive	D-D	If an OSS technology has disrupted the IT function
	Routine	D-R	If an OSS technology has not disrupted the IT function

Appendix B. Understanding OSS as a Disruptive Technology

OSS as a Disruptive Technology

Experts agree that open source software (OSS) licensed under the GPL is a disruptive technology (Raymond 1999, Spinellis and Szyperski 2004, Hicks and Pachamanova 2007). Linux and other communally developed programs licensed under the GPL appear to radically shift how software is created, used and maintained. However, it is not enough for this study to simply label OSS as a disruptive technology to determine how OSS is being adopted by organizations. Therefore this section reviews existing definitions of disruptive technologies to understand how OSS is disruptive and can potential affect organizations.

Disruptive innovations have been defined at two different conceptual levels. They have been defined at the industry level and at the information technology (IT) innovation level. These disruptive definitions are then reconciled to identify open source software as a disruptive innovation.

Environmental-Level Definitions of Disruptive Technologies

Bower and Christenson, the originators of the term disruptive technology, originally distinguished disruptive innovations from other innovations by examining their characteristics which in turn affected their market positions (1995). Those innovations that change or alter the status quo of an industry are considered to be disruptive, while innovations that embrace traditional market strategies are routine as they sustain industry status quo.

These researchers further refined market entry strategies by characterizing them as either new-market or low-end disruptive technologies (Bower and Christenson 1995). New-Market innovations are aptly named as they create new markets. Rather than alter existing industries these innovations offer something new, solutions or services for problems or opportunities that were not being addressed before the innovation. Because they create new possibilities as well as new markets, it is easy to understand how new-market innovations can be seen as disruptive.

At first glance OSS does not appear to be a new-market disruptive technology. Although some OSS applications, like the Apache web-server, have created new markets, most OSS applications are different versions of existing proprietary computer programs.

Because most open source applications mirror existing computer programs they appear to be low-end innovations. Christenson distinguishes low-end innovations from new market innovations in their market entry strategy. As opposed to creating a new market, lower-end innovations enter existing markets by focusing on specific market segments (Bower and Christenson 1995). After establishing a presence in these segments, an organization follows a low-end strategy by moving into another, preferably more profitable segment. This is accomplished by innovating and improving their original product. This incremental improvement is repeated, creating an emerging product which eventually disrupts the status quo of an industry.

OSS appears to fit the mold of incremental lower-end disruptive technologies. These applications have typically begun as a hobby or an intellectual ‘itch’ of a computer programmer (Raymond 1999). Because the software is released under a GPL-like license, the application's source code and the rights to use it are freely available. As a free product, OSS enters a low-profit segment of the computer software market. Over time OSS have been shown to mature and attract a community of developers (Raymond 1999). These developers continue to incrementally improve the application until one day the application becomes a viable software alternative. This trend has resulted in several open source applications, like Linux, MySQL, or Firefox, that now directly compete with their proprietary equivalents. This competition appears to be disrupting the status quo of the software industry as new business models have emerged around OSS technologies.

Traditionally proprietary software organizations, like Microsoft, rely upon the licensing of their software to generate revenues. Microsoft's 10Q filed in 2008 reveals that 80% of the organization's revenues were generated through software licenses at original equipment manufacturers (OEM) like Dell computers and Hewlett Packard (10Q). These revenue streams are challenged as open source applications pursue alternative business models that do not rely upon the licensing or purchase of a software license.

Rather business models that use OSS focus on services or add-ons to generate revenue (Markus 2000). Services range from support to implementation to contextual applications to create alternative revenue streams (Markus 2000). Add-ons include hardware or software that extends the functionality of an OSS (Markus 2000). These business models disrupt the software industry as they eliminate the costs associated with licensing software (Benkler 2001, Cusumano 2004). Christenson's definition of disruptive technologies highlights the importance of an innovation disrupting industry-level factors, or environmental factors. OSS appears to meet the criteria for this definition as it alters the revenue structure of the software industry, transitioning from licensing to services and add-ons.

Innovation Level Definitions of Disruptive Technologies

Disruptive innovations have also been defined at the innovation level. Lyytinen and Rose (2003) specifically defined disruptive IT innovations as those technologies that are both pervasive and radically different from their predecessors (Lyytinen and Rose 2003). Pervasive is defined as an innovation simultaneously and necessarily spanning new services and new types of development processes. Radicalness is determined by whether or not an innovation's adopter needs to engage in behaviors that depart significantly from existing alternatives (Lyytinen and Rose 2003).

OSS meets both of these characteristics as the development, distribution, and support of OSS create new organizations that use new processes which depart from traditional proprietary software activities. Table 1a highlights how these activities differ between the two types of software.

Table 1a. Differences between GPL Based Open Source and Proprietary Software

Category	Reference	GPL Based Open Source	Proprietary Software
Development	Hars and Ou (2002), Koch and Schneider (2003), Kuk (2006), Shah (2006)	Paid and/or volunteer developers with differing motivations	Paid developers working within a single organization
Distribution	Raymond (1999)	Source code is available according to license - the most common being GPL v2 – which is free to download	Licensed distributions
Software Support	Raymond (1999), Lakhani and von Hippel (2003)	Traditional Reliance upon volunteers and support groups; new corporate participation with differing motivations	Paid developers and virtual communities working with a single organization

The first item in the table, software development is disrupted by GPL-like licenses in two major ways. The characteristic of OSS changes who is allowed to participate in development activities. Proprietary software traditionally restricts development to a select few individuals. While OSS development is not open to the public, there are project leaders who determine what is and what is not allowed in a project, the source code is freely available. Anyone, free-lance contractors, volunteers, or salaried programmers, are free to solicit ideas and source code to an OSS project. This can create a community of developers who may or may not have the same motivations for developing the software (Raymond 1999, Bergquist and Ljungberg 2001, Hars and Ou 2002, Franke and von Hippel 2003, and Roberts, Hann and Slaughter 2006).

These community members directly interact with the individuals responsible for modifying and supporting the application (Koch and Schneider 2003, Bagozzi and Dholakia 2006, Kuk 2006). Because OSS projects are closely linked to their communities there is no exclusive source of project expertise. Individuals with differing motivations across multiple organizations tend to be involved with an OSS project. If a project fails to answer to their user communities, forking can occur. Forking, though rare, occurs when a user community becomes disgruntled enough to separate. An independent group forms to support a separate version of an OSS (Dahlander and Magnusson 2005 and Koch 2002). The forking developers simply take the latest version of an OSS's source code and begin their own separate version of the program. Again, this is a rare event as the open source community sees this as a waste of time and effort. However it serves an important governing mechanism as OSS projects that ignore their communities may fork in a new direction.

GPL-like licenses can also disrupt the distribution and organizational acquisition of software. Organizations have traditionally acquired software through licenses from software vendors. While some vendors, like RedHat and MySQL, provide OSS services and distributions, GPL-based OSS provides organizations with a new alternative; organizational members can simply download an application. The freedoms granted by GPL licenses allow users to copy, modify, or redistribute versions of the application allowing organizations to take independent action to acquire an OSS. Not only does this potentially disrupt the software industry, but it also alters how organizations can acquire software.

OSS and their GPL licenses also pervasively change software support. While proprietary software relies upon the near-exclusive use of salaried developers within their organization to make changes to the application and help customers troubleshoot, GPL-based OSS uses a much more diverse group of stakeholders to support OSS. At one time OSS support consisted solely of volunteers and user groups (Lakhani and von Hippel 2003). Like its development, these volunteers had varying motivations for participating in OSS support. Differing motivations for software support remain a challenge as major players in the software and hardware industries have started supporting OSS. AMD, IBM, Intel, Cisco are but a handful of software vendors who are actively supporting open source applications (http://www.linuxsymposium.org/2007/sponsors.php). However vendor involvement in supporting OSS appears to be tightly coupled to their business models and corporate support for new open source applications is far from common. This fragmentation of support radically departs from traditional proprietary models.

Because OSS pervasively and radically changes the development, distribution, and support of software it meets the criteria that Lyytinen and Rose laid out for disruptive IT innovations. Meeting this definition appears to indicate that OSS is disruptive not only to the software industry, but is also in and of itself a disruptive IT innovation.

Open Source Software as a Disruptive Technology

OSS appears to fit both the industry-level and innovation-level definitions of a disruptive technology. As a lower-end disruptive innovation OSS appears to disrupt many industry level factors such as suppliers, vendors, partners or third parties. At the innovation-level the definition of a disruptive IT innovation highlights several IT processes associated with IT that are disrupted. The development, distribution and support of OSS are all significantly different from proprietary software.

Defining Open Source Software

The previous section has shown that OSS is a disruptive IT innovation. But what is it? What makes an application an opens source one versus a proprietary one? This section answers this question to identify OSS innovations for this study. OSS is not a new phenomenon as its origins date back more than forty years (Markus 2000, Lerner and Tirole 2002, Glass 2004). Despite this history many researchers have found this type of software difficult to define (Fitzgerald 2007). This is in part because of the many different parties, both academics and practitioners, who have defined this type of software. This section examines these definitions, taking elements from each to arrive at a working definition for this study.

The first section examines open source licenses. This is followed by definitions that advocacy groups use and historical perspectives that have been used by researchers to define OSS. These perspectives are combined to arrive at a definition of OSS for this study.

Open Source Software Licenses

Software licenses are critical in determining if an application is considered open source or proprietary. They do so by outlining what rights are granted to the user of a computer application and its source code. Almost any aspect of use, from who can use the software, to how it is developed, to how contributions are recognized, to a software's distribution can be legally outlined in a license.

The standard for open source licenses is GNU's GPL. This license is used as a benchmark by open source advocacy groups when considering if a license is an open source or not (St. Laurent 2004, Fitzgerald 2007). To date over 50 different licenses appear to be similar enough to the GPL to be considered open source (http://www.opensource.org/licenses). This indicates that the freedoms inherent in a license as identified by the Free Software Foundation, as outline in Table 4, are critical for an application to be considered open source. Therefore this study will incorporate rights and uses of applications in the definition of OSS.

Open Source Advocacy Definitions

Open source licenses are strongly tied to open source advocacy groups. There are two main open source groups, the Open Source Initiative (OSI) and Free Software Foundation (FSF). Each group defines OSS differently. The OSI definition of open source software is based on ten criteria which set guidelines for access, modification, recognition and distribution of OSS. Fundamentally this group approaches OSS as a new development method (http://www.gnu.org/philosophy/free-software-for-freedom.html).

Meanwhile, the Free Software Foundation (FSF) defines OSS through freedoms, or what actions users are allowed to take with the software (http://www.fsf.org/licensing/essays/free-sw.html). The FSF appears to believe that OSS is a social movement rather than a new form of software development. The two group's definitions are detailed in Table 2a.

Although the definitions differ, both seek to adhere to the main principles of the GPL. Both advocacy groups center on the ability to for anyone to access, modify and/or redistribute an application at the source code level. Therefore these definitions not only define OSS by whether or not it adheres to GPL-like licenses, but also highlight the importance of developer participation as both definitions center around including developers from all backgrounds. Anyone, regardless of race, creed, sex, or application intentions should be allowed to participate in the development of an OSS. The OSI accomplishes this by using ten specific rules to explicitly state who has access to the source code. Meanwhile the FSF accomplishes nearly the same goal by ascribing generic freedoms through the GPL.

Table 2a. OSI and FSF Definitions of Open Source

The Open Source Initiative's 10 Criteria of Open Source Software	
Criteria	Description
Free Redistribution	The license shall not restrict any party from selling or giving away the software as a component of an aggregate software distribution containing programs from several different sources. The license shall not require a royalty or other fee for such sale.
No Discrimination Against Fields of Endeavor	The license must not restrict anyone from making use of the program in a specific field of endeavor. For example, it may not restrict the program from being used in a business, or from being used for genetic research.
Source Code	The program must include source code, and must allow distribution in source code as well as compiled form. Where some form of a product is not distributed with source code, there must be a well-publicized means of obtaining the source code for no more than a reasonable reproduction cost preferably, downloading via the Internet without charge. The source code must be the preferred form in which a programmer would modify the program. Deliberately obfuscated source code is not allowed. Intermediate forms such as the output of a preprocessor or translator are not allowed.
License Must Not Be Specific to a Product	The rights attached to the program must not depend on the program's being part of a particular software distribution. If the program is extracted from that distribution and used or distributed within the terms of the program's license, all parties to whom the program is redistributed should have the same rights as those that are granted in conjunction with the original software distribution.
Derived Works	The license must allow modifications and derived works, and must allow them to be distributed under the same terms as the license of the original software.
Distribution of License	The rights attached to the program must apply to all to whom the program is redistributed without the need for execution of an additional license by those parties.
Integrity of The Author's Source Code	The license may restrict source-code from being distributed in modified form *only* if the license allows the distribution of "patch files" with the source code for the purpose of modifying the program at build time. The license must explicitly permit distribution of software built from modified source code. The license may require derived works to carry a different name or version number from the original software.
License Must Not Restrict Other Software	The license must not place restrictions on other software that is distributed along with the licensed software. For example, the license must not insist that all other programs distributed on the same medium must be open-source software
No Discrimination Against Persons or Groups	The license must not discriminate against any person or group of persons
License Must Be Technology-Neutral	No provision of the license may be predicated on any individual technology or style of interface
The Free Software Foundation's Necessary Freedoms of Open Source Software	
Criteria	Description
Freedom 0:	Users should be able to run the program, for any purpose
Freedom 1	Users should be able to study how the program works, and adapt it to your needs
Freedom 2	Users should be able to redistribute copies so you can help your neighbor
Freedom 3	Users should be able to improve the program, and release your improvements to the public, so that the whole community benefits

Historical Definitions of Open Source Software

Social scientists have used two different approaches to define open source software. The first method has focused on identifying and describing the different generations, or stages, of the software. This historical perspective examines the different legal and social events that have affected the open source phenomenon (Raymond 1999, Lerner and Tirole 2002, von Hippel and von Krogh 2003, Fitzgerald 2007). When these different historical perspectives are combined four different stages or generations of open source software can be identified. Table 3a highlights these different periods of time, highlighting different trends and events that occurred during these periods.

Table 3a. Identifying Open Source Software Generations

Time line	Characteristics of Generation	Specific Event	Year
1960's-1980's (Shareware)	• Aopyrighted software packages.	Unix development begins	1969
		Lawsuit forces IBM to separate its hardware and software	1969
		Arpanet developed	1969
1980's-1990's (Free Software)	• Commercialization of copyrighted software packages. • Beginnings of open source movement	Kermit development begins	1981
		Sendmail development begins	1981
		MIT Commercialization of some source code	1984
		Free Software Foundation founded	1985
		GPL created	1985
		Perl development begins	1986
		Cygnus Solutions founded	1989
1990's (Free and Open Source Software)	• Volume and diversity of OSS contributions increases exponentially with the Internet use. • Most open source projects limited to infrastructure and utilities.	Linux development begins	1991
		Apache development begins	1994
		RedHat founded	1995
		Open Source agreed upon term for the software movement	1998
1990's-2000's (Open Source Software 2.0)	• Open source business models gain greater traction in traditional organizations • More visible open source applications emerge.	Netscape adopts OSS	1998
		Opens Source Initiative founded	1998
		NASA experiments with open source solutions	2000
		Brazilian government adopts open source software solutions	2005

Examination of Table 3a reveals that the eras overlap. For example Cygnus Solutions, the first company created to support OSS, was created in 1989. But it would take almost ten years for other organizations to pursue open source business models. Generation overlap may be caused by the lack of a single governing body that has the power to label how specific events influence the community. Or perhaps generational overlap indicates that the open source community is similar to other groups in that it takes time for new ideas to diffuse through a population.

Regardless of why eras overlap, researchers agree that there are over-arching trends (Lerner and Tirole 2002, von Hippel and von Krogh 2003, Fitzgerald 2007). This is useful to define open source software, since it indicates that the open source community changes over time. It also highlights the importance of a community and communication within the community, as well as the absence of a single governing body. Therefore the generational approach extends the definition of OSS to include not only a license and a group of developers but also a changing community that has imperfect communication and a decentralized structure, as being essential to OSS.

Defining Open Source Software

The three different sources examined in this section have each highlighted important characteristics of what open source software is. Integrated, they create a working definition of OSS for this study.

The first part of the definition focuses on the license. To be considered OSS, an application must have a GPL-like license. This is in keeping with the OSI and FSF as these groups use the GPL as the benchmark to certify other licenses as being open source or not.

The second part of this study's definition incorporates aspects from open source activists. Both the OSI and FSF believe that it is essential to allow a group of individuals to be able to access, modify, and redistribute an OSS. This differs from the license itself by requiring a group of people to be associated with the technology.

Finally the generational or historical perspective that academics have used to define OSS emphasizes the need for change. OSS apparently changes over time, in development, application and in personnel. Therefore, this research defines open source software as an application licensed under the GPL which provides a developer community the opportunity to extend or modify the application. This definition ties together aspects from licensing, OSS Activists and academic perspectives. It also recognizes that open source software is an evolving IT artifact intrinsically linked to a community of developers.

Appendix C. John Godfrey Saxe's (1816-1887) version of the famous Indian legend

It was six men of Indostan
To learning much inclined,
Who went to see the Elephant
(Though all of them were blind),
That each by observation
Might satisfy his mind.

The *First* approach'd the Elephant,
And happening to fall
Against his broad and sturdy side,
At once began to bawl:
"God bless me! but the Elephant
Is very like a wall!"

The *Second*, feeling of the tusk,
Cried, -"Ho! what have we here
So very round and smooth and sharp?
To me 'tis mighty clear
This wonder of an Elephant
Is very like a spear!"

The *Third* approached the animal,
And happening to take
The squirming trunk within his hands,
Thus boldly up and spake:
"I see," quoth he, "the Elephant
Is very like a snake!"

The *Fourth* reached out his eager hand,
And felt about the knee.
"What most this wondrous beast is like
Is mighty plain," quoth he,
"'Tis clear enough the Elephant
Is very like a tree!"

The *Fifth*, who chanced to touch the ear,
Said: "E'en the blindest man
Can tell what this resembles most;
Deny the fact who can,
This marvel of an Elephant

Is very like a fan!"

The *Sixth* no sooner had begun
About the beast to grope,
Then, seizing on the swinging tail
That fell within his scope,
"I see," quoth he, "the Elephant
Is very like a rope!"

And so these men of Indostan
Disputed loud and long,
Each in his own opinion
Exceeding stiff and strong,
Though each was partly in the right,
And all were in the wrong!

MORAL.
So oft in theologic wars,
The disputants, I ween,
Rail on in utter ignorance
Of what each other mean,
And prate about an Elephant
Not one of them has seen!

Appendix D: Interview Questions for Semi-Structured Interview

Introduction:

To start us off I was curious if you understood what we are doing here? We are here on behalf of the city to look at knowledge management and innovation best practices here in the IT department.

We have an agreement with the city, not only to come and interview you, but to remain anonymous. In other words you will not be named directly nor will the city in any report or writing that we do. Additionally the city will remain anonymous when create any larger reports or articles.

With that being said, please tell us your name, job title and how you got here!

I. Knowledge Management

What is the city philosophy towards IT…

What is the philosophy of the IT department

What is the most effective way to increase effectiveness and efficiency here?

Are there any motivations for reducing budgets/spending here?

Are there any new strategic initiatives going on here?

Do you communicate the career opportunities here at the city?

How does the city of use vendors?

What are vendors used for?

How important are vendors to IT operations?

Does the department use Systems Development Lifecycle project methods?

a. Training/Skills development

Does the department subsidize or promote employees to get certifications or further education?

How does the department identify new skill sets or training for employees?

Does the department reward or recognize individuals who develop themselves?

Are employees rotated throughout the areas of the department?

b. Blogs or document repositories

Does the department keep existing records or documentation on existing systems?

Are these records updated to reflect changes to the systems?

Are these records used to determine future enhancements or directions for the system?

Does the department have blogs or message boards to help members accomplish tasks or report what happened on a project? If so, does anyone manage these boards?

Is it easy to find materials or lessons that others have learned in the departmental records?

Have you found anything in the records or blog that has actually been helpful?

Would you use a blog or web page that captured prior projects and technical help?

c. Mentoring

Does the department have a mentoring program?

Does the department participate in external mentoring programs?

Do you have any peers who help you with your work?

If so, how do they help you?

d. HR practices

How does the department identify employees to fire or hire?

How long does it take the average department member to get up to speed?

What is involved in finding an employee who is a good fit for the department?

Does the department have an internship program?

Has anyone retired or been let go who was a great loss because of their familiarity with the system?

II. Knowledge types

a. Technical

What computer languages are commonly used in the department?

How many different operating systems are used in the department?

How many different software packages are used in the department?

For the technology that you use/develop/support where do you get training/skills development and ongoing support?

b. Contextual

Do you know of any departments that have their own IT staff? If so, which ones.

Why do you think they have their own staff?

Are there departments that have complex operations that need consultants or specific feedback to work on their systems? If so, which ones? Who generally participates in these projects or tasks?

III. Innovation

a. Lead user

In your opinion, who is the most innovative or creative member of the IT department?

If you were in trouble with a technical problem who would you turn to?

If you needed some advice to come up with a new idea or solution to a problem who would you turn to?

b. Reengineering/Tasks

Are employees ever given time to examine what they do and to see if they could do it better?

Does the department give you enough time to plan or come up with new ideas to meet your responsibilities?

How does the department identify replacement technologies for existing hardware or software?

c. New Initiatives

When the department identifies a project or new need, who gets involved in the process of analyzing, designing and implementing the solution?

When given an assignment or project how much flexibility do you have? Are you given an objective to achieve or are you given a technology to implement?

How are new capabilities, such as GIS, approved by the city government?

How are new projects approved by the city government?

How are new projects or initiatives implemented? Are they phased in? Are they mandated? Are they locally deployed? Are they optional (by individual, by department)?

e. Idea generation

How does the department find out about new technologies and how they compare to old technologies?

How does the department come up with new ideas to meet its goals?

Who is involved in coming up with new ideas or projects to help the department?

Where do most new ideas come from? Upper management? End users? IT staff?

f. Purchasing

How does the department identify new technologies (hardware or software) for purchase?

How does the department purchase new hardware or software?

Are there any strategies in making these purchases?

How often does the department replace its hardware or upgrade its software?

Open Source

Does the department use open source software?

Has the use of open source software changed anything in the department?

Would the department have a local resource to draw on to start an open source initiative? (I.E. is there someone in the department that supports Open Source and promotes its use?)

Fads and Fashion

Would the city need to see an example to implement OSS in the city?

Does the city know of any OSS implementations in the area?

Technical knowledge

In your opinion how different a knowledge base, i.e. coding, implementation, training, support, and use, would open source software be for the city? To shift to OSS equivalents of the operating system and enterprise packages (office, email) would this be a radical or routine implementation?

Attitudes and culture

How open to new ideas and to change is the city IT department?

How much do the different city departments share with one another?

If OSS is used and they have worked in non-governmental setting could you comment on the fit between organizational values and the values of OSS.

Knowledge externalities

Who do you consider your professional network?

Do you read any technical or trade magazines? If so, which ones?

Do you attend any IT conferences for the city IT department? If so, which ones?

Do you interact with your organizational equivalent from other city IT departments? If so, who? How often? When? Formally or informally?

How would you feel about following advice or suggestions from members of other city IT departments?

How would you describe the department’s use of consultants and vendors?

Does the department utilize any free resources on the Internet? If so, which ones?

Does the department participate in any open source communities? If so, which ones?

Cost Management

In your opinion, how could the department cut costs? Are there any initiatives, such as energy management initiatives, that haven't been considered?

If your department cuts costs does the annual budget shrink?

Are there any incentives for a department to cut costs?

Are there any incentives for a department to minimize the number of vendors it has relations with?

Are there any incentives for a department to increase the number of vendors it has relations with?

Appendix E – Municipal and Municipal IT Department Sizes

Table 1. Participant Size Characteristics

City Name	2007 City Population	2007 City Budget*	City Employees	City Departments
Jackson	250,000+	725+	4,000+	30+
Columbus	250,000+	550+	3,000+	30+
Roswell	75,000+	125+	900+	15+
Bowling Green	90,000+	535+	2,000+	15+
Decatur	150,000+	725+	3,000+	25+

*Millions of dollars

Table 2. Case Site Budgets and Employees

City Surname	2007 IT Department Budget*	IT Department Employees	Tenure of Centralized IT Department
Jackson	13+	80+	10+ years**
Columbus	10+	60+	10+ years**
Roswell	2+	20+	20+ years
Bowling Green	12+	60+	2+ years
Decatur	15+	60+	10+ years**

*Millions of dollars
**Not sole IT department within the Municipality

About the Author

Del received a Bachelor's Degree in Management Information Systems from the University of Alabama and a Master of Science in Management Information Systems from Texas Tech University. Before his doctoral studies he was a competitive swimmer, racquetball player, martial artist and an avid gamer.