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DEDICATION

To My Family,

First, to my parents Ik-ja (Clara) Kim and Dr. Jong-il Kang,
who always encouraged and supported me wholeheartedly
ever since I was born.

Second, to my wife and best friend, Sun-jeong (Sunny) Kim,
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Finally, to my daughter, Hannah Kang,
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ABSTRACT

The current study of wireless local area networks (WLAN) adoption in educational institutions is motivated by three reasons. First, most students are exposed to information technology when they are at K-12 schools. Indeed, educational institutions represent the largest segment in the WLAN market in the United States in terms of the number of adopters. Second, WLAN requires a substantial financial investment before it can enable an "anytime, anywhere" learning environment, and may thereby aggravate the digital divide between rich and poor schools. Third, although WLAN is infrastructure technology, it has different characteristics compared to other infrastructure information technologies; traditional infrastructure information technologies are mostly located such that they are transparent to the users, whereas WLAN is close to end users, so that they directly experience benefits related to mobility and convenience, which eventually impacts organization boundary and business processes.

Recognizing the importance of WLAN and its difference from traditional infrastructure information technologies, this dissertation examines how WLAN adoption (i.e., whether or not to adopt WLAN) and deployment (i.e., the extent to which WLAN is used) are influenced by technological, environmental, organizational factors, socio-economic, and policy-related factors. It is based on an online survey of principals of 435 K-12 elementary, middle, and high schools in Missouri, including 190 adopters of WLAN and 245 schools that have not adopted WLAN. The results indicate that perceived benefit is not a significant predictor of WLAN adoption. Unlike previous research, satisfaction with current wired system positively affects WLAN adoption. Some of socio-economic variables also affect adoption of WLAN. Schools near urbanized areas are more likely to adopt WLAN than the schools near rural areas. Furthermore, the government and state subsidy E-rate positively affect WLAN adoption.

When examining the determinants of WLAN deployment, perceived benefits of using WLAN significantly affect WLAN usage. Moreover, perceived benefits and barriers strongly affect satisfaction with WLAN, which in turn affects WLAN usage. Satisfaction from using

WLAN significantly mediates the effect of various antecedent factors on WLAN usage. Implications of the results for IS researchers, practitioners, marketers, and policy makers are discussed and future avenues of the study are examined.

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1. INTRODUCTION

Wireless Local Area Network (WLAN) offers mobility, flexibility, and efficiency compared to wired networks. Based on these advantages, many organizations have exhibited strong interests in employing WLAN (Cisco, 2003). Some cities, like *Philadelphia* and *San Francisco*, consider using WLAN as a low-cost solution for providing broadband access to low-income families. For example, the *School District of Philadelphia* is planning to service over 210,000 students across 278 schools by WLAN. This will enable students to have Internet access, educational applications, and instructional management tools (Government Technology News Release, 2006). One of the interesting market trends in WLAN is the fast deployment of the educational organization segment. According to *Cisco* reports (2003), the educational organization segment has the highest WLAN penetration rate (29 percent), followed by manufacturing (23 percent), healthcare (13 percent) and government segment (12 percent).

The recent technology development of Web and Internet entails a fundamental rethinking of teaching practice. "Students no longer are required to be at a set time and a set place to learn. Teachers are no longer the gatekeepers of knowledge. At the same time, schools, colleges and universities play a much wider role than merely transmitting information from one generation to another" (Farrell, 2001, p. 42). WLAN is one of the current available information technologies that enables these wherever-whenever e-learning practices at schools. Students can download or refer to materials from a school web site or portal whenever they wish. Some schools offer Internet video lectures and students can see a lecture anytime, anyplace if WLAN connection is available. For example, some schools in St. Lucie, Florida are piloting the use of PDAs (Personal Digital Assistants) through WLAN in schools. In the schools, students receive homework assignments and browse the internet through PDAs. The school administrators say that the PDAs are proving beneficial in increasing student-teacher interaction as they offer a more direct method of providing specialized instruction. Furthermore, students can access the digital library at any time while on campus (Computer Business Online, 2006 March 23rd)[1].

WLAN has different characteristics compared to other information systems because WLAN is infrastructure technology (which is different from other technology adoption studies – e-commerce, web-based online banking, and recommendation agent, etc.). Although WLAN is an infrastructure technology (albeit not as transparent as using applications such as Internet Explorer), it is still close to end users (e.g., access network technology), and thus increases mobility and convenience of users. These similarities and differences of technology adoption issues are worth investigating in IS research domain.

Despite this WLAN penetration in educational institutions, there have been few WLAN studies for this segment (including high schools and/or middle schools). Furthermore, previous IS studies rarely consider the context of educational institutions. This may be partly because the educational institution market is traditionally smaller in terms of IT spending than the business and industry market. Therefore, a systematic investigation of WLAN in educational organizations is needed for both practitioners and IS researchers.

WLAN adoption in educational organizations can *also* be investigated in terms of 'the digital divide.'[2] Since WLAN is an infrastructure information technology, it can facilitate access to networks, overcome spatial restrictions, and increase ubiquitous computing environments in educational institutions (Stallings, 2005). However, there is no consensus on the definition, extent, or impact of the digital divide after a decade of debate in public policy, communications, philosophy, social sciences, and economics (Dewan and Riggins, 2005; DiMaggio et al., 2004; Dickard and Schneider, 2002; Hoffman and Novak, 1998; Pew report, 1995). Furthermore, the effect of the digital divide on management strategies has not received research attention (Dewan and Riggins, 2005). For this reason, this dissertation will focus on the investigation of socio-

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1 *The article can be viewed at the following URL: http://www.cbronline.com/article_news_print.asp?guid=85D54D9B-3629-43D3-A3D3-F4F8A11E53F0*

2 *The digital divide is the gap between those with regular, effective access to digital technologies and those without. For this reason, in the context of WLAN, the digital divide in WLAN adoption in this study means WLAN adoption divide with respect to diverse socio-economic gaps.*

economic determinants of WLAN adoption. More specifically, I propose to pursue the following research questions in my dissertation:

- What are the important organizational determinants of WLAN adoption in educational institutions?
- What are the important socio-economic determinants of WLAN adoption?
- What are the important factors for increasing the extent to which WLAN is used?
- Does federal and local government E-rate subsidies influence WLAN adoption in schools?

The current dissertation is expected to contribute to organizational technology adoption studies because the current research models in WLAN adoption context and their proposed determinants are employed and adapted from previous organizational technology and/or innovation studies. Furthermore, socio-economic and government policy issues are investigated and empirically tested for their influences on organizational level technology adoption. Important adoption determinants differences between schools with WLAN and those without WLAN are identified. Furthermore, important factors to increase WLAN usage in WLAN adopted schools are also investigated. For practitioners, marketing implications for non-profit organizations are discussed; while for policy makers, implications for decreasing the digital divide are suggested.

The current dissertation is organized as follows: First, WLAN technology and network configuration are introduced. There have been a number of WLAN standards in the market (e.g., 802.11b, 802.11g, and 802.11a, etc.). The current dissertation discusses why 802.11b and 802.11g have been *de facto* standards in the current market. Furthermore, how WLAN is connected through networks (i.e., network topology) and recent publications regarding WLAN are summarized. Second, after describing diverse developments of WLAN technology standards, the research framework is developed. Since WLAN adoption in K-12 schools is another example of technology adoption, the current dissertation summarizes prior studies regarding organizational level technology adoption and innovation for employing/accommodating important determinants for WLAN adoption. Moreover, socio-economic influences and a government policy will be investigated in order to find the impact for WLAN adoption.

Chapter 2 presents the literature review of wireless standards and empirical research on wireless adoption. Chapter 3 presents the empirical analysis that is employed for identifying important determinants between schools with WLAN and schools without WLAN. Furthermore, important factors for increasing WLAN usage are also investigated. Implications for practitioners, policy makers, and researchers are discussed in the discussion chapter and future avenues of technology adoption studies are suggested in the concluding remark section.

2. LITERATURE REVIEW

2.1. WLAN technologies

The concept of WLAN is rather simple: LAN (Local Area Network) using air as a transmission medium without wires. Whereas wired networks in which workstations (or clients) send and retrieve data across cables, a wireless network uses radio frequency waves. Furthermore, unlike WAN (Wide Area Network) devices, WLAN uses 2.4 GHz and 5 GHz frequency bands, which are free of charge. The 2.4 GHz frequency band is called the ISM (Industry, Scientific, and Medical) band and the 5 GHz frequency band is called the UNII (Unlicensed National Information Infrastructure) band. Cordless phones, microwave ovens, infant monitors, and other personal and household devices are operating in the frequency bands for free. If someone operates a device on other radio frequencies, they need to pay fees to FCC (Federal Communications Commission). In 1997, IEEE (the Institute of Electrical and Electronics Engineers) released the 802.11 specification for the manufacture of WLAN devices operating in the 2.4 GHz and this was the cornerstone of WLAN deployment [Table 1].

[Table 1] WLAN standard and features

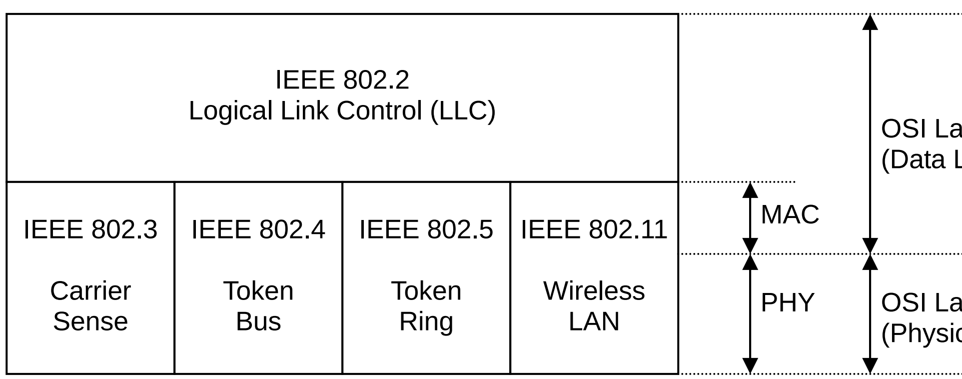
IEEE standard	Features	Year of Ratification by IEEE
IEEE 802.11	■ The original WLAN standard ■ 1-2 Mbps speed	■ 1997
IEEE 802.11b	■ Faster data transfer rates than IEEE 802.11 ■ Max speed 11 Mbps	■ 1999
IEEE 802.11a	■ No backwards interoperability with the 802.11 standard ■ Max speed 54Mbps ■ 5 GHz UNII frequency bands	■ 1999
IEEE 802.11g	■ Backwards interoperability with the old standard devices. ■ Max speed 54Mbps ■ 2.4 GHz ISM frequency bands ■ As of May 2007, this standard is the *de facto* standard in the market	■ 2003
IEEE 802.11i	■ Enhanced security - data integrity and encryption ■ No backward compatibility with old 802.11x standard	■ 2004
IEEE 802.16e	■ Mobile WiMax ■ Mobile based Wireless MAN (data+voice) ■ Quality of Service features (VoIP) ■ 2.5GHz (US, Sprint Nextel), 3.5GHz (other areas, Service providers are not decided yet) ■ Converged to 4G Telecom system	■ 2005

But why should 802.11x be the standard? Indeed, there are a couple of wireless technologies to compete with 802.11x WLAN. Bluetooth is one of the competitors for WLAN 802.11x standard. However, since Bluetooth was initially introduced in 1994 as a connection method between small devices on a desktop, the speed and coverage of Bluetooth devices were very limited (up to 2 Mbps and normally 1-2 meters coverage). Furthermore, WLAN has an organization named *WiFi alliances* that can effectively coordinate the technology standard and interoperability of multiple vendors. These factors have facilitated the 802.11x standard to deploy fast. Consequently, WLAN 802.11x has been the dominant *de facto* standard in the wireless device market.

2.2. WLAN 802.11x topology[3]

The IEEE 802.11x topology consists of components to enable station mobility transparent to higher protocol layers, such as the Logical Link Control (LLC). A station is any device that has the functionality of the 802.11 protocol. For instance, wireless access point is referred to as a base station whereby laptops and PDAs are referred to as mobile stations. LLC is especially important in WLAN protocol structure (Stallings, 2005). LLC provides end-to-end link control over an 802.11-based wireless LAN: exchanging data between end users across an 802-based MAC controlled link. Furthermore, LLC provides addressing and data link control and it is independent of the topology, transmission medium, and medium access control. The protocol layer of LLC and other topologies are depicted in Figure 1.

[Figure 1] LLC and 802 topologies*



LLC has similar protocol functions that would be done by higher protocols such as TCP (Transmission Control Protocol). By using appropriate LLC services (Unacknowledged

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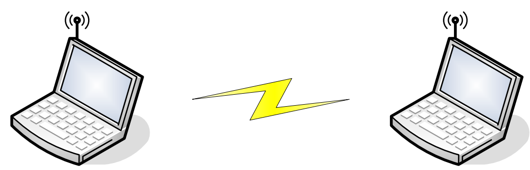
[3] *Network topology is the study of the arrangement or mapping of the elements (links, nodes, etc.) of a network.*

connectionless service, Connection-oriented service, and Acknowledged connectionless service), wireless LAN can achieve network efficiency.

In IEEE's standard for WLAN (IEEE 802.11x), there are two different modes to configure a network (topology): “ad-hoc mode” and “infrastructure mode”. Different names for these configurations are “Independent Basic Service Set (IBSS)” and “Extended Basic Service Set (EBSS),” respectively. An IBSS is a standalone BSS that has no backbone infrastructure and consists of at least two wireless mobile stations. This type of network is often referred to as an ad hoc network because it can be constructed quickly without much planning [Figure 2].

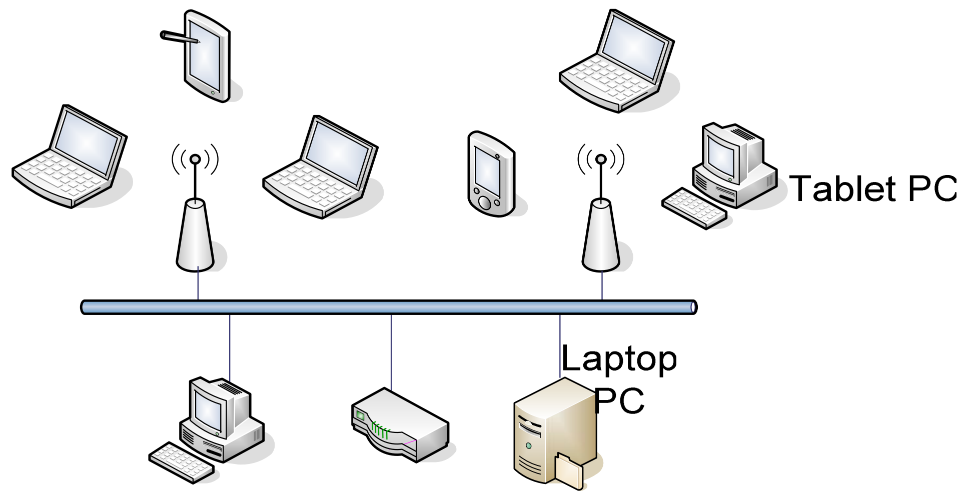


[Figure 2] WLAN structure – Ad-hoc mode

The second type of network structure used in WLANs is the infrastructure mode. This architecture uses fixed network access points with which mobile stations can communicate [Figure 3]. Unlike the ad-hoc mode, the infrastructure mode offers outside Internet access and can connect to other types of networks. The ad-hoc mode is easy to connect to and is good for file sharing among mobile stations. However, the ad-hoc mode is not appropriate for broadcasting of data packets, which in turn limits the expandability of networks (Stallings, 2005; CWNA, 2006).

802

Laptop



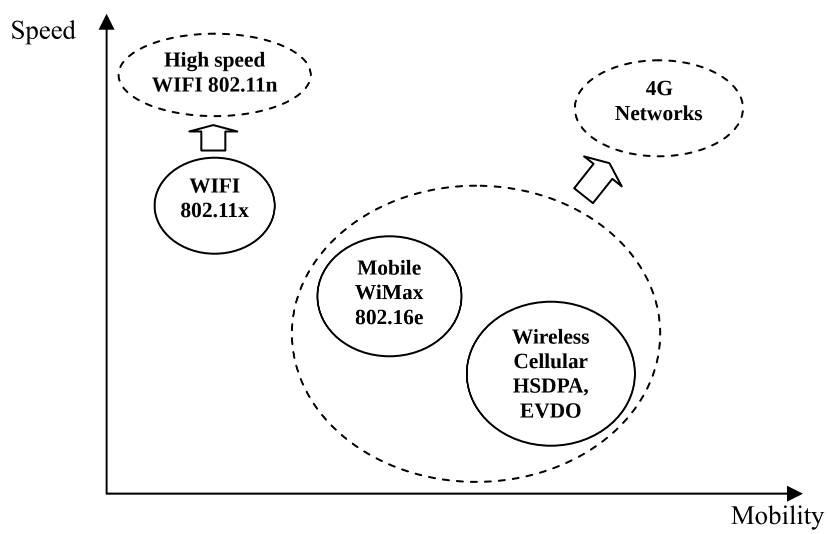
[Figure 3] WLAN structure – infrastructure mode

The 802.11x standard recognizes the following mobility types: (1) No-transition: This type of mobility refers to stations that do not move and those that are moving within a local IBSS. (2) BSS-transition: This type of mobility refers to stations that move from one BSS in one ESS to another BSS within the same ESS. (3) ESS-transition: This type of mobility refers to stations that move from a BSS in one ESS to a BSS in a different ESS. In simpler words, the current WiFi 802.11x standard doesn't offer seamless mobility of signals between independent service sets. For instance, if one uses WLAN 802.11x on a moving car across one service set to the other; he/she can not use the WLAN "no hands-off" function. This is because the IEEE 802.11x standard was originally designed for a fixed based internetworking.

The next generation of technology standards, such as IEEE 802.16e mobile WiMax, can overcome this limitation (Bremner and Moon, 2006). One can download data files up to 75Mbps in a car moving at a speed of up to 70mph. For this reason, future applications of wireless LAN will be more convenient in terms of mobility. However, for a usage within organizations, 802.11x is still competent because within a campus or buildings, users don't need seamless connections at a speed of up to 70mph. Furthermore, the new fixed based standard

802.11n offers 600 Mbps (max) for data transmission. For this reason, the 802.11x standard will remain competitive even though new mobile based wireless standard (802.16e) is prevalent. The network in K-12 schools can be upgraded to a high bandwidth wireless network such as 802.11n. As of May 2007, 802.11n standard is at the 2nd draft of RFC (Request For Comments) among stakeholders. Figure 4 depicts the comparison between standards in terms of mobility and speed. HSDPA stands for High Speed Downlink Packet Access and it is the *de facto* standard for 3G (third generation) telecommunication devices worldwide. EVDO stands for Evolution Data Only service and Qualcomm has developed the standard.

[Figure 4] Comparison of Wireless Standards



2.3. Wireless technology adoption

Recent studies on wireless technology adoption focused more on individual adoption of wireless application and/or devices. For instance, Turel et al. (2007) found the perceived value of wireless Short-Messaging-Service (SMS) to be important determinants of the intention to adopt SMS. Lee et al. (2007) argued that usage of wireless devices, such as PDA, at an insurance company is affected by a type of tasks, such as recruiting new contracts, post-contract customer services, and tax and legal information services. Major determinants of PDA adoption were position experience, cognitive style, and computer self-efficacy. Furthermore, they suggested that gender and age are not significant determinants for adopting SMS. The recent studies regarding wireless technology/adoption are summarized below [Table 2].

[Table 2] Recent studies regarding wireless technology adoption

Article	Context	Method	Unit of Analysis	Research model and Findings
Turel, et al. (2007)	Short-term messaging service (SMS) of wireless devices	Survey of 222 students	Individual	■ Perceived value of SMS was measured based on four factors – Performance/quality value, emotional value, value-for-money, and social value (2nd order factor analysis) ■ Social value was not influencing Perceived value of SMS ■ Perceived Value of SMS was a significant determinant of intention to adopt SMS ■ In turn, intention to adopt SMS strongly affects actual adoption of SMS
Lee, et al. (2007)	Usage of wireless device (Personal Digital Appliance) PDA at an insurance company	Survey of 238 managers at the insurance company	Individual	■ Task-technology fit model is used for research model ■ Position experience, cognitive style, and computer self-efficacy affect the cognitive fit of using PDA technology ■ PDA is appropriate for the tasks of the insurance company. ■ Gender and age are not significant determinants for adopting SMS
Fang, et al.(2006)	Mobile commerce context Using PDA (Palm Pilot)	Survey 101 adults	Individual	■ The hypothesized 12 tasks are grouped into three: (1) general tasks that do not involve transactions and gaming, (2) gaming tasks, and (3) transactional tasks. ■ Different tasks calls for different determinants. ■ Problems in measurement of some items
Chen and Nath (2006)	Tested the influence of WLAN on employees	Survey to 66 users in 14 organizations	Individual	■ Factor analysis of 23 items ■ WLAN improves quality of work life, enhanced work efficiency and effectiveness, and brought better

				collaboration among employers. ■ By employing correlation analysis, they also found that impact of WLAN is strongly associated with WLAN satisfaction.
Hsi, S. and Fait, H. (2005)	RFID (Radio Frequency Identification) deployment at a science museum in San Francisco	Case study	Individual	■ The *eXspot* solution uses RFID tag carried by visitors and reader package installed on museum exhibits. ■ Wireless RFID technologies are appropriate for museums in that it is cost effective and increase visitors' learning experience.
Lu et al. (2005)	Investigating a causal relationship between facilitating conditions and wireless technology adoption mediated by wireless trust	357 MBA student sample	Individual	■ TAM model is used for item development ■ The authors examined these causal relationships: Facilitating condition -> wireless trust -> Intent to adopt wireless device ■ Facilitating condition affects wireless trust and wireless trust affects intention to adopt wireless device ■ No direct effect examination between facilitating condition and Intention to adopt wireless device
Lehner et al. (2003)	WELCOME (Wireless E-Learning and Communication Environment) at Regensburg University, Germany	Action research	Organizational	■ Wireless information system should be complementary to the current wired system ■ Educational wireless applications are also important for deployment
Banitsas et al. (2002)	WLAN system at hospital (MedLAN), UK	Action research	Organizational	■ WLAN system named *MedLan* is very helpful to save human life in accident ■ A trolley equipped with WLAN device is the key to the project

Unlike studies with respect to individual level adoption of wireless technology, there are only few studies on organizational adoption of wireless technology. A study by Lehner et al. (2003) explains a wireless LAN system (WELCOME: Wireless E-Learning and Communication Environment) at *Regensburg University, Germany.* By doing action research, the authors argued that wireless information system should not replace current school/instruction services but rather, it should supplement the current education services. Banitsas et al. (2002) demonstrated the benefits of using medical WLAN at hospitals. The authors described technical aspects of

WLAN application (*MedLAN*) at *West London hospital, UK.* One of key features of the WLAN system is a mobile trolley which is equipped with an 802.11b standard WLAN PCMCIA card. By using this trolley, the staffs/doctors/nurses can have anytime, anywhere access to backbone systems. Furthermore, a high quality digital camcorder is installed and high resolution video and audio can be transmitted real-time by using IEEE1394 protocol. As a part of the action research, they did a simulation of an ongoing WLAN system project for measuring effectiveness of the system. They found that the WLAN system can increase the efficiency of rescue services, thus saving lives. They argued that transferring video and image with conversation from the accident scene to the hospital is available by *MedLAN* and this will increase the possibility of saving casualties. Although this study has provided a new application of WLAN in a medical organization, it is largely based on a technical aspect of WLAN: a posterior WLAN adoption process. In addition to these technical findings, it would be better if the study provided important determinants for adopting WLAN.

The current dissertation research examines the adoption of WLAN from the organizational perspective because IT adoption decisions are normally made at organizational level (Sabherwal and King, 1995). For this reason, prior theories and empirical studies on IS/IT innovation and technology adoption at organizational level are used as starting points of current research framework.

Wireless technologies have many unique properties that may be utilized to produce business value. As with any innovative technology, however, adoption of WLAN requires investment and may create new sources of risk in organizations; thus environmental elements and organizational contextual factors are both significant determinants of WLAN adoption. For this reason, the current dissertation research starts with 'technology-organization-environment' framework proposed by Tornatzky and Fleisher (1990); (see also, Grover and Goslar, 1993a, 1993b; Swanson, 1994; Chau and Tam, 1997; Grover, 1997).

To provide a coherent structure to study IS innovations in organizational contexts, Swanson (1994) expanded the traditional dual-core model in general innovation theory and proposed a tri-core model tailored to the unique nature of IS innovations. Daft (1978) suggested that innovations can be associated with the technical core and the administrative core. Innovations for technical core are related to technical system of organizations. Innovations for administrative core mean, as the words stand for, the innovations with respect to business process (social aspect) of organization.

Swanson (1994) argued that Daft (1978)'s model is inappropriate in that IS innovations affect the two cores at the same time; that is IS innovations change the business process and technical system interactively. For this reason, Swanson (1994) proposed the Tri-core model. The Tri-core model has three types of innovations: Type 1 innovation, type 2 innovation, and type 3 innovation. Type 1 innovation is associated with a functional core including IS service and products. Type 1 innovation breaks into two sub-innovations (type 1a and type 1b). Type 1a is IS administrative process innovation (e.g., IS department) and type 1b is IS technological process innovation (e.g., DBMS (Database Management System)). Type 2 innovation is administrative process innovation. Accounting information systems, e-mail systems can be examples of Type 2 innovation.

Type 3 innovation is combining the technological and business aspect and then is subdivided into three innovations: type 3a, type 3b, and type 3c. Type 3a innovation refers to IS product and business technological process innovation (e.g., Material Requirement Planning (MRP) system). Type 3b innovation is IS product and business product innovation (e.g., airline reservation system), and Type 3c innovation is IS product and Business Integration innovation (e.g., EDI or Electronic Data Interchange).

Grover (1997) proposed an extension of the tri-core model based on critical analysis of Swanson’s framework. According to Grover, the tri-core model was built on the notion of innovation dynamics, which implicitly assumed that “the innovation will stem from organizational contexts conducive to innovative behavior."

Chwelos et al. (2001) proposed an EDI adoption model integrating technological, organizational, and inter-organizational factors. Based on a questionnaire survey administered to 317 Canadian companies, they identified two formative constructs (external pressure and readiness) and one reflective construct (perceived benefits) that significantly affect the intention to adopt EDI. Competitive pressure, which was a sub-construct of external pressure in the model, was found to be the single most important factor involved in EDI adoption decisions. Based on codifying over previous IS study results, and weighting the relationship between determinants and a dependent variable by the number of examination, Jeyaraj et al. (2006) found that competitive pressure is one of the important explanatory variables for IS adoption.

Chau and Tam (1997) developed a model for the adoption of open systems based on the technology-organization-environment framework proposed by Tornatzky and Fleischer (1990). They found that one technology factor (perceived barriers) and one organizational context factor (satisfaction with existing systems) are significantly associated with the adoption of open systems. This article used bivariate dependent variable and employed logistic regression for the subsequent analysis. However, the environment factor (environmental uncertainty) was not found to have a significant effect on the adoption of open systems. Chau and Tam (1997) provided two possible explanations for this finding. One is that companies may choose to adopt a wait-and-see attitude (more conservative) due to the risk involved in making discontinuous changes to the IT infrastructure when they are confronted with severe competition and market uncertainty. Another explanation is based on the nature of open systems. An open system is relatively disconnected from the core business processes. Therefore, environmental factors are likely to be of less significance.

Chau and Tam (2000) examined open systems adoption decisions from another perspective using the same data source. This adoption model proposed the following set of variables: 'technology-push' (TP) factors, 'need-pull' (NP) factors, and two variables: availability of IT human resources and organization size. The TP and NP concepts are borrowed from engineering literature (e.g., Zmud, 1984) to reflect the underlying driving forces behind innovations. In terms of open systems adoption, two TP factors are identified: perceived benefits resulting from the adoption of open systems and perceived barriers associated with the adoption. One 'internal need' factor (satisfaction level with existing system) and one 'external need' (market uncertainty) factor are included in the model to represent the NP elements. The results of the empirical test indicated that organizations tend to emphasize internal need rather than external need in their decision to adopt open systems. As with the TP factors, companies seemed to devote greater attention to the potential problems, rather than the potential benefits associated with adoption of open systems. In general, the NP factor had more significant impacts on adoption decisions than the TP factors. However, availability of IT human resources was the most important factor related to adoption decisions. As discussed earlier, prior studies (Chau and Tam, 1997; Chau and Tam, 2000; Chwelos et al., 2001) on organizational adoption of IS innovations have used different frameworks to examine the factors influencing IS adoption decisions. From a theoretical perspective, these conceptual frameworks represent the various approaches in which researchers explicate the underlying forces behind IS innovation adoption.

2.4. The digital divide and socio-economic influences on WLAN adoption

In 1990s' the definition of the digital divide is the socio-economic gap between 'information haves' and 'information have-nots' (US Department of Commerce, 1995). Recently the definition has been expanded to mean "the gap between those who have access to and can effectively use information technologies and those who cannot." (Lynch, 2002) Different views of access (to information) can yield different conclusions: For instance, if the word "access" means an individual's ability to get online connection at some location, inequality seems much diminished. However, if 'access' means an individual's ability to use websites with large size graphical images, the differences among groups may be still prominent (DiMaggio et al., 2004).

The digital divide has also been examined from a global or perspective (Dewan et al., 2005). Dewan et al. (2005) found that ICT (Information Communication Technology) is productive/ efficient for development in developed countries but not in developing countries. Genus and Mohamad (2005) described the challenges of bridging the digital divide between developed and developing countries. Corrocher and Ordanini (2002) suggested cross-country measurements of the digital divide. They argued that the digital divide consists of six factors of digitalization: markets, diffusion, infrastructure, human resources, competitiveness, and competition. Mossberger et al. (2003) argued four different types of the digital divide: 'The access divide' – demographic influences to access ability, 'the skills divide' – computer and/or information devices usability, 'the economic opportunity divide' – a gap by unequal opportunity of training, and 'the democratic divide' – inability to participate in e-government.

Previous studies (e.g., Corrocher and Ordanini, 2002; Dewan et al., 2005) have measured the digital divide in terms of digitalization. Digitalization has been defined as the 'access' ability to the Internet. These studies suggested that the digital divide is the gap between levels of digitalization. For instance, Dewan et al. (2005) used *deviation from the mean of digitalization index* as the measurement of the digital divide.

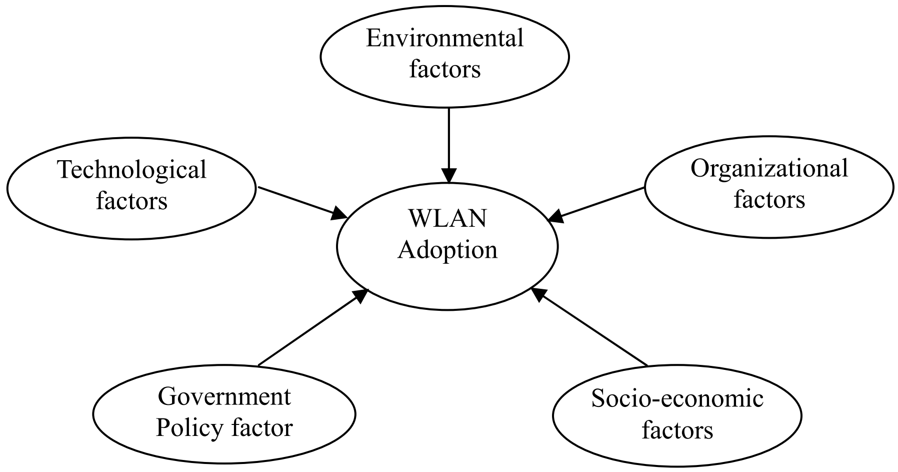
Some IS researchers extended these digital divide issues: Dewan and Riggins (2005) proposed that the digital divide consists of individual-level the digital divide, organizational-level the digital divide, and global the digital divide. This break-down of the digital divide makes some sense but these issues have been investigated a lot in IS research but with different names – *"Adoption of IT (Internet)"* and/or *"Diffusion of innovation"* because access to Internet is closely related to the individual adoption of access information technology and to the organizational level technology adoption (innovation). Dewan and Riggins (2005)'s conceptual framework may be problematic because their conceptual the digital divide is mixed with IT adoption differences regarding (1) Technology Acceptance Model (TAM) or Theory of Planned Behavior (TPB) at the individual level, (2) Organizational technology adoption at the organizational level, (3) Diffusion of innovation at the global level.

Based on a literature survey, the concept of the digital divide has originated from, and is widely accepted in sociology and economics because access to Internet may result in a stratification of society between "haves" and "have-nots." IS research focuses on individual/organizational level of adoption of a new technology (not limited to Internet access) but pays relatively less attention to socio-economic influences (region and place of residence, employment status, income, educational attainment, race-ethnicity, age and/or gender) regarding Internet access. Furthermore, IS research focuses on IT adoption itself but not on diffusion across organizations.

For this reason, and consistent with previous the digital divide studies (Dewan et al., 2005; Corrocher and Ordanini, 2002), I will follow this approach of measuring the digital divide in WLAN adoption context. The digital divide in WLAN adoption in this study means *WLAN adoption divide with respect to large socio-economic gaps.* For this, WLAN adoption is examined in relation to various socio-economic variables. For instance, socio-economic variables (household income level, student-teacher ratio, location of the school, and school type (public or private)) and state/government subsidy (E-rate) level will be entered into a regression model investigating whether these factors affect WLAN adoption.

Accommodating all the factors, five major categories of determinants are included in the current study: technological factors; organizational factors; environmental factors; socio-economic influences; and government subsidy. The conceptual diagram for the current dissertation research is as follows [figure 5].

[Figure 5] Conceptual Framework for WLAN adoption



In the next chapter, two proposed research models for WLAN adoption are presented. These models incorporate the above factors.

3. RESEARCH MODELS

Two research models guide this dissertation:

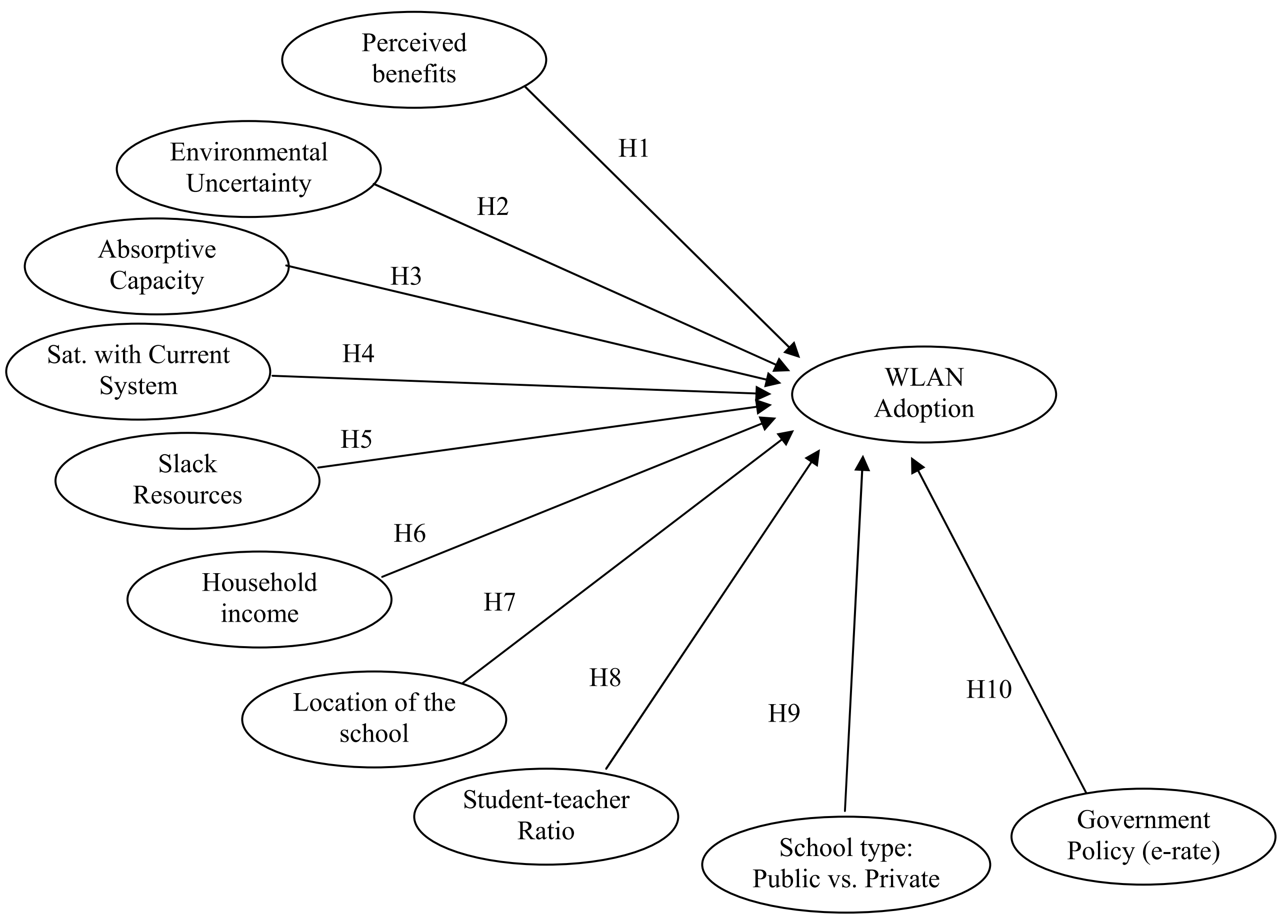
(1) A model analyzing WLAN adoption factors between schools with WLAN and those without (i.e., adoption vs. non-adoption). (See Figure 6)

(2) A model analyzing important factors for WLAN usage and WLAN satisfaction in WLAN equipped schools (i.e., level of adoption). (See Figure 7)

3.1. The Adoption vs. Non-adoption Model

The Adoption vs. Non-adoption Model is as follows [Figure 6]:

[Figure 6] Adoption vs. Non-adoption Model: Hypotheses



This model focuses on investigating important factors for WLAN adoption between schools adopting WLAN and those without WLAN. WLAN adoption (binary variable Yes=1, No=0) will be used as a dependent variable for the model. Furthermore, various socio-economic variables are also included in the model testing their significances for adopting WLAN and thus measuring the WLAN digital divide.

3.1.1. Dependent variable of Adoption vs. Non-adoption Model

The Adoption verses Non-adoption Model has one dependent variable called WLAN Adoption. WLAN Adoption is a binary variable indicating whether or not the school has adopted WLAN.

3.1.2. Determinants of Adoption vs. Non-adoption Model

3.1.2.1. Technology factors

3.1.2.1.1. Benefits and barriers

The technology factors describe the attribution of innovations as perceived by potential adopters: i.e., benefits and barriers of WLAN adoption (Chau and Tam, 1997; Chau and Tam, 2000; Chwelos et al., 2001). The benefits of WLAN have been widely cited in business journals and industry reports (e.g., Cisco, 2003). For example, in the Cisco report (2003), top 5 benefits of WLAN are identified: 1) Mobility within building or campus, 2) Convenience (no cable), 3) Flexibility (anytime, anywhere access), 4) Easier to set-up, and 5) Low cabling costs. Prior studies on organizational IS adoption have provided empirical supports for the role of perceived benefits in the adoption decision, (e.g., Chau and Tam, 1997; Chwelos et al., 2001; Zhang and Wolff, 2004).

Unlike perceived benefits, perceived barriers of WLAN can delay or block the adoption of WLAN. According to a Cisco report (2003), several challenges for WLAN were identified: 1) Speed, 2) Frequency range, 3) Security, 4) Interference, 5) Dead spots and 6) Reliability. Since the current WLAN study is exploratory in nature, diverse benefits are suggested. Based on these understanding, I posit that the benefits (barriers) positively (negatively) influence WLAN adoption [See Table 1 for Hypotheses][4].

H1: Perceived benefits of adopting a WLAN positively affect WLAN adoption.

3.1.2.2. Environmental factors

The environmental perspective encapsulates factors that provide opportunities or impose constraints of technology adoption. This includes government policies, industry standards, competitors, regulations, and relationships with a government (Chau and Tam, 1997). Researchers have long argued that the business environment factors affects the diffusion of innovations (e.g., ; Kwon and Zmud, 1987; Grover and Goslar, 1993a, 1993b; Sabherwal and Kirs, 1994). In this perspective, environmental uncertainty (Grover and Goslar, 1993a, 1993b; Sabherwal and Kirs, 1994; Newkirk and Lederer, 2006) and competitive pressure (Chwelos et al., 2001) are initially proposed as being associated with WLAN adoption.

However, after interviewing a number of principals, a vice principal, and a computer resource specialist, I found that competitive pressure was not an appropriate construct for technology adoption in a school context [see also pilot study in Chapter 4]. A number of previous studies (Chwelos et al., 2001; Jeyaraj et al., 2006;) found that competitive pressure was important for technology adoption. Nonetheless, since the current study investigates non-profit organizations, competitive pressure is not included in the subsequent analysis.

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[4] *'Perceived barriers' construct in the Adoption vs. Non-adoption Model shows low reliability and thus, dropped for the subsequent analysis. This might be come from the perception difference of barriers/costs between WLAN adopters and WLAN non-adopters.*

3.1.2.2.1. Environmental uncertainty

Organizations facing intense environmental uncertainty are more likely to be motivated to pursue technology adoption in an attempt to maintain or enhance core competencies. Previous studies have indicated that environmental uncertainty facilitates technology adoption in organizations (Grover and Goslar, 1993b). Sabherwal and Kirs (1994) investigated environmental uncertainty in academic institutions. They suggested measurement of environmental uncertainty by using six items: changing demand for various courses and programs, Innovations by similar institutions, availability of external funds (e.g., state, federal, donations, and gifts), government actions and interference, availability of faculty, and availability of staff/administrative personnel. Duncan (1972) argued that environmental uncertainty consists of two components: complexity and rate of change. Miller and Friesen (1982) argued that environmental uncertainty is defined by heterogeneity, dynamism, and hostility. Newkirk and Lederer (2006) also adopted these factors.

In my dissertation research, I will utilize the broader construct of *environmental uncertainty* suggested and tested by Grover and Goslar (1993b) and Sabherwal and Kirs (1994) in the context of educational institutions. I will adopt their measurements of environmental uncertainty: demand of information technology and rate of technology change in an educational institution context. Furthermore, I will include predictability of federal and local government policy regarding information technology adoption at educational institutions as one of the measurements of environmental uncertainty. For example, schools like *Fletcher Hills Elementary PTA, Unit #1378,* in California submitted *'California State PTA Resolution on Wireless Equipment/Cellular Phones and Antennas'* for investigating whether wireless technology (radio frequency or RF) could harm children. If there is any proven wireless danger for children's health, federal or local governments will enact policy which may not allow schools to install wireless devices at educational institutions.

Previous studies (e.g., Grover and Goslar, 1993b) argued that higher environmental uncertainty led to a higher level of technology adoption. However, I argue that as the environmental uncertainty level (e.g., RF harm) increases, the pressure of technology adoption at institutional institutions will be decreased – the focal educational institutions may follow a wait-and-see strategy (Chau and Tam, 2000). As such, I posit that educational institutions facing higher level of environmental uncertainty are less likely to adopt WLAN.

H2: Environmental uncertainty negatively affects WLAN adoption.

3.1.2.3. Organizational factors

Organizational characteristics may also facilitate or inhibit technology adoption. A number of organizational factors are identified from previous studies: *IS Maturit*y (Grover and Goslar, 1993b; Sabherwal and Vijayasarathy, 1994), *absorptive capacity (*Cohen and Levintal, 1990; Chau and Tam, 1997;), *organizational structure* (Grover and Goslar, 1993b), *satisfaction level with current system* (Chau and Tam, 1997) and *slack resources* (Swanson, 1994).

3.1.2.3.1. Absorptive capacity

Cohen and Levinthal (1990) proposed a concept of 'absorptive capacity.' Absorptive capacity refers to an organization's ability to recognize the value of new information, assimilate it, and exploit it (p.131). They argued that the level of skills and cumulative knowledge gained in the adopter's innovative activities are a critical factor of the organization's capacity of innovation. If a school has an organizational ability to assimilate and exploit a new information technology, it will find the potential easily and are thus likely to adopt it. For this reason, I propose that absorptive capacity will positively affect wireless LAN adoption.

H3: Absorptive capacity positively affects WLAN adoption.

3.1.2.3.2. Satisfaction level with the current system

Chau and Tam (1997) found the satisfaction with current system to be negatively associated with adoption of open systems. This may be due to open systems being viewed as a discontinuous innovation incompatible with the existing systems. In other words, the adoption of open system means the abandonment of current systems. This is not the case in WLAN adoption because WLAN usually serves as a complementary technology to current wired networks (Varshney and Vetter, 2000; Stallings, 2005). However, the two types of network may be competing in a sense that the basic function of both technologies is to provide a communication infrastructure. As a result, I posit that educational organizations satisfied with the performance of a wired communication platform (mostly Ethernet) may perceive a wireless network as unnecessary and thus are less likely to adopt the technology.

H4: The satisfaction level with wired communication network will negatively affect WLAN adoption.

3.1.2.3.3. Slack resources

Availability of slack resources is crucial to organizational adoption of innovations (Swanson, 1994). The rationale is that adoption of innovations is feasible only when the required investment capital is in place (Lai and Guynes, 1997). As an infrastructure technology, investments in WLAN come either from IS budgets or user departments. The measurements of slack resources will be measured based on IS budgets. I posit that the availability of slack resources is positively associated with adoption of a wireless network.

H5: The availability of slack resources positively affects WLAN adoption.

3.1.2.4. Socio-economic influences on WLAN adoption

61.8 percent of U.S. households had PCs in their homes as of 2003, 58.7 percent had Internet connection and 22.8 percent had broadband Internet (DSL or CATV-modem) (NTIA, 2004). Hoffman and Novak (1998) found that income, racial, and education levels significantly affect the digital divide. They recommended provision of information technology at schools especially aiming at providing more access opportunity for African-American/Hispanic students. Since the current study examines diverse socio-economic factors among educational organizations, the following variables are chosen: household income, race-ethnicity (percentage of Black/Hispanic students), fraction of lunch program, location, student-teacher ratio (Howard, et al., 2001; Hargittai, 2002; Mossberger et al., 2003; DiMaggio et al., 2004).

Student-teacher ratio has been an important selling point for inducing enrollment of potential students. De Cervantes (2000) found that mere exposure to information technology itself might not influence student performance; rather, hiring more qualified teachers for training students to find relevant information will help increasing student performance and technology usage. This logic may be applied to WLAN adoption. Low student-teacher ratio will have high likelihood of letting each student know the benefits of WLAN and thereby increasing the likelihood of adopting WLAN. For this reason, in the current study, student-teacher ratio is posited to have negative association with WLAN adoption.

According to *First Research* industry report regarding K-12 schools (2007)[5], technology usage in private schools is described as follows:

"To match or surpass public schools, many private schools spend heavily on computer and communication technology, mainly to allow students access to e-mail and the Internet. Some private schools use computers extensively for instruction and administration."

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5 http://www.hoovers.com/private-schools-k-12-/--ID__126--/free-ind-fr-profile-basic.xhtml

Despite the above industry report and common presumptions, a generalization is not possible because these days many public schools offer an excellent technology education and exposure, whereby some private schools are far less qualified in terms of digitalization than other private schools. About 9 years ago, National Center for Education Statistics (NCES) 1998-99 survey results reveal that public schools have slightly higher level access ability (i.e., low student numbers per computers: 6 vs. 8). There have been no direct comparisons between private and public schools with respect to technology after the survey.

For this reason, the effect of public/private nature of the school needs further investigation. For an exploratory investigation of difference between public vs. private schools toward WLAN adoption, the current study follows the recent notion of industry report with respect to technology usage in private schools: private schools are posited to adopt WLAN more than public schools.

If there is a WLAN adoption difference between adopter and non-adopters with respect to these socio-economic variables, it is suggested to say that there is WLAN digital divide between schools. Based on variables from previous studies and new socio-economic variables, the following hypotheses are posited[6]:

H6: Average household income of students in the school is positively associated with WLAN adoption.

H7: Rural areas are more likely to have lower WLAN adoption rate than urban areas.

H8: The school's student-teacher ratio is negatively associated with WLAN adoption.

H9: Private schools will have higher WLAN adoption than public schools.

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[6] *Some of the socio-economic variables identified from prior research are dropped from the subsequent analysis: Percentage of Lunch program and Percentage of Black/Hispanic students because the two variables are highly correlated ($|r|=0.7$, $p<0.001$) with household income and location of schools, respectively. This means that schools with high household income will have a low percentage of the federal lunch program. Furthermore, schools near city area will have higher Black/Hispanic student population than rural area. Adding perfectly correlated items into a regression model yields multicolinearity problem (Hair et al., 1998).*

3.1.2.5. Government policy influence on WLAN adoption

In order to diminish the growth of the digital divide among educational institutions, the US government (*Clinton and Gore* Administration in year 1997) enacted a ground-breaking subsidy program (named *E-rate*) for Internet and communications investment in educational institutions. Under this law, schools (and libraries)[7] can have discounts on telecommunications, Internet access and internal connections products/services. For a school to be eligible for this program/benefit, it 1) must be an elementary or secondary school as defined by the Elementary and Secondary Education Act of 1965, 2) must not operate on a for-profit basis and 3) must not have an endowment greater than $50 million. (AT&T report, 2006). E-rate is aimed at supporting for telecommunications and Internet access. The subsidy is based on need. Recently, entities can be funded only two out of every five years. The program subsidized spending by 20-90 percent, depending on school characteristics (mostly based on the percentage of students who receive the federal lunch program). Goolsbee and Guryan (2006) estimated the impact of internet subsidies in public schools. They found that the subsidy (*E-Rate*) did succeed in increasing Internet investment in public schools but it didn't provide a substantial increase in student performances (math, reading, and science scores). However, after 2001 (*Bush* Administration), the digital divide was not a major issue – FCC chairperson *Powell* has tried to eliminate the *E-rate* subsidy.

Qualified K-12 schools can have e-rate subsidy used for WLAN devices (e.g., wireless routers and/or network interface cards) only (AT&T report, 2006). For this reason, I posit that the government subsidy positively influences WLAN adoption in educational institutions.

H10: Federal and local government subsidy is positively associated with WLAN adoption.

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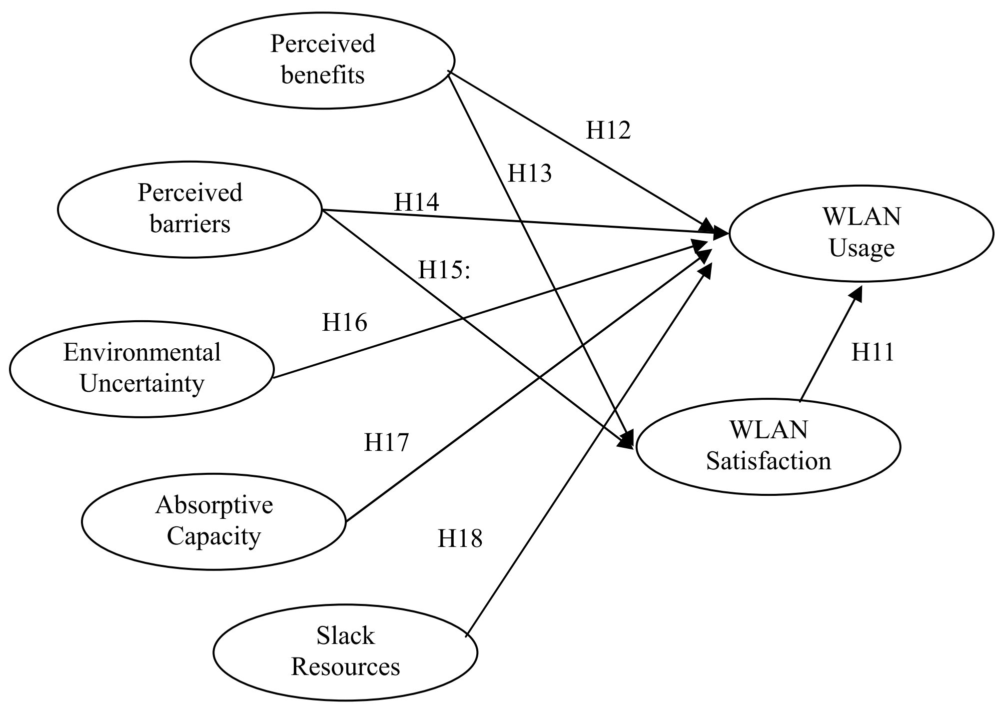
[7] *Not only schools but also libraries are eligible for e-rate subsidy. However, only libraries whose budgets are independent from K-16 school are eligible for the fund.*

3.2. Level of Adoption Model

In this model, K-12 schools equipped with WLAN are included in the analysis to identify important factors for their WLAN usage. The model is as follows [Figure 7]:

[Figure 7] Level of adoption model



3.2.1. Dependent variables in the Level of Adoption Model

The model includes only adopters; it has different dependent variables such as "WLAN satisfaction" and "Extent to which WLAN is used." The causal relationships among satisfaction, system use, and benefits are somewhat controversial. For instance, DeLone and McLean (1992)'s model argued that satisfaction and system use have a bidirectional relationship. Seddon (1997) argued that system use is an outcome measure derived from satisfaction. Seddon (1997) criticized DeLone and McLean model in that the authors confused of process and IS success measure. For this controversy, Rai et al. (2002) found some support and verification of both models. Rai et al. (2002) found that satisfaction affects system use and that there is a strong association between benefits and system use. Sabherwal et al. (2006) found that there are no significant relationships between satisfaction and system use, and between benefits and satisfaction.

In the current dissertation study, I follow the criteria suggested by Sabherwal et al. (2006) mentioned in the previous chapter: (1) theory based and (2) recent study results. Along with technology adoption theories such as TPB (Theory of Planned Behavior; Ajzen and Fishbein, 1973), TRA (Theory of Reasoned Action; Ajzen, 1985), TAM (Technology Acceptance Model; Davis, 1989) and UTAUT (Unified Theory of Acceptance and Use of Technology; Venkatesh et al., 2003) and other related extended models, I believe attitude (satisfaction) affects behavior (use). Furthermore, I agree with recent empirical findings and their perception by Wu and Wang (2006): user satisfaction influences system use rather than vice versa. The authors argued that DeLone and McLean's argument that the fact 'system use' affects 'satisfaction' can be just a temporal rather than causal relationship. Therefore, I hypothesize user satisfaction affects system use. The posited hypotheses are as follows:

H11: WLAN satisfaction positively affects the extent to which WLAN is used.

3.2.2. Determinants in the Level of Adoption Model

As with the Adoption vs. Non-adoption model, the Level of Adoption model also used similar determinants within technology – environmental - organizational framework (detailed description of each construct is in the previous chapter 3.2.1). The difference is to investigate the impact of each determinant to WLAN usage and WLAN satisfaction.

3.2.2.1. Technology factors

3.2.2.1.1. Benefits and Barriers

As discussed in the Adoption vs. Non-adoption Model, perceived benefits and barriers may influence the extent to which technology is used. For instance, if a user expects perceived benefits of using a new type of technology, he/she will increase the usage of the technology. Likewise, if a user identifies perceived barriers, he/she will decrease the usage of the technology (e.g., Chau and Tam, 1997; Chwelos et al., 2001; Zhang and Wolff, 2004). Based on these understanding, 'benefits' (barriers) is posited to influence the extent to which WLAN is used positively (negatively).

As in the formulation of hypothesis 11, the current study follows Rai et al.(2002) and Sabherwal et al.(2006)'s recommendation: benefits (barriers) are associated with satisfaction and the satisfaction influences system usage (Wu and Wang, 2006). Therefore, 'perceived benefits' (barriers) is posited to influence satisfaction and system use positively (negatively). The posited hypotheses are as follows:

H12: Perceived benefits of adopting a WLAN positively affect the extent to which WLAN is used.

H13: Perceived benefits of adopting a WLAN positively affect WLAN satisfaction.

H14: Perceived barriers of adopting a WLAN negatively affect the extent to which WLAN is used.

H15: Perceived barriers of adopting a WLAN negatively affect WLAN satisfaction.

3.2.2.2. Environmental factors

3.2.2.2.1. Environmental uncertainty

Previous studies found that environmental uncertainty increases technology adoption in organizations (Grover and Goslar, 1993b). However, as discussed in the previous chapter, environmental uncertainty in K-12 schools may negatively influence the extent to which WLAN is used because schools are more or less conservative organizations and may follow a wait-and-see strategy (Chau and Tam, 1997). For example, if wireless technology has a harmful effect on children's growth, schools will not use WLAN if adopted (c.f., will not adopt if not yet adopted – discussed in the Adoption vs. Non-adoption model) until a relevant policy is enacted. As such, I posit that educational institutions facing a higher level of environmental uncertainty are less likely to use WLAN.

H16: Environmental uncertainty negatively affects the extent to which WLAN is used.

3.2.2.3. Organizational factors

3.2.2.3.1. Absorptive capacity

If an organization has an ability to recognize the value of new information, to assimilate it, and to exploit it (Cohen and Levinthal, 1990; p.131), it means the organization has skills and cumulative knowledge to maximize the potential of WLAN. For this reason, I propose that absorptive capacity will positively influence the extent to which WLAN is used.

H17: Absorptive capacity positively affects the extent to which WLAN is used.

3.2.2.3.2. Slack resources

The rationale of slack resource to WLAN usage is that as an infrastructure technology, investments in WLAN come either from IS budgets or user departments. Well equipped/ user friendly devices will increase the usage of WLAN. As such, slack resources are hypothesized to influence WLAN usage.

H18: The availability of slack resources positively affects the extent to which WLAN is used.

[Table 3] Summary of hypotheses

Hypotheses	Proposed rationale
Adoption vs. Non-adoption Model	
H1: Perceived benefits of adopting a WLAN positively affect WLAN adoption.	Perceived benefits would be associated with the adoption of WLAN
H2: Environmental uncertainty negatively affects WLAN adoption.	Environmental uncertainty is negatively associated with WLAN adoption.
H3: Absorptive capacity positively affects WLAN adoption.	Absorptive capacity would influence WLAN adoption
H4: The satisfaction level with wired communication network will negatively affect WLAN adoption.	Satisfaction level with current system would decrease WLAN adoption
H5: The availability of slack resources positively affects WLAN adoption.	Monetary and personnel slack resources would increase WLAN adoption
H6: Household income of students is positively associated with WLAN adoption. **H7:** Rural area is likely to have lower WLAN adoption rate than urban area. **H8**: Student-teacher ratio is negatively associated with WLAN adoption. **H9:** Private schools will have higher WLAN adoption than public schools.	Socio-economic influences on WLAN adoption
H10: Federal and local government subsidy is positively associated with WLAN adoption.	E-rate will positively influence on WLAN adoption
Level of Adoption Model	
H11: WLAN satisfaction positively affects the extent to which WLAN is used.	Satisfaction (attitudes) affects adoption (behavior).
H12: Perceived benefits of adopting a WLAN positively affect the extent to which WLAN is used. **H13:** Perceived benefits of adopting a WLAN positively affect WLAN satisfaction	Perceived benefits and the adoption of WLAN
H14: Perceived barriers of adopting a WLAN negatively affect the extent to which WLAN is used. **H15**: Perceived barriers of adopting a WLAN negatively affect WLAN satisfaction.	Perceived barriers and the adoption of WLAN

H16: Environmental uncertainty negatively affects the extent to which WLAN is used.	Environmental uncertainty would not increase WLAN usage
H17: Absorptive capacity positively affects the extent to which WLAN is used.	Absorptive capacity would influence WLAN usage
H18: The availability of slack resources positively affects the extent to which WLAN is used.	Monetary and personnel slack resources would increase WLAN usage

In this chapter, two models (1) Adoption vs. Non-adoption Model and (2) Level of Adoption Model are proposed and their hypotheses are posited. In the Adoption vs. Non-adoption Model, a binary dependent variable is used and ten hypotheses are posited. Proposed determinants for the model are as follows; Perceived benefits, Environmental uncertainty, Absorptive capacity, Satisfaction with current system, Slack resources, Household income, Location of schools, Student-teacher ratio, School type, and Government subsidy.

In the Level of Adoption Model, WLAN usage and WLAN satisfaction are used as dependent variables. Eight hypotheses are posited based on the following independent variables: Perceived benefits, Perceived barriers, Environmental uncertainty, Absorptive capacity, and Slack resources. The next chapter will examine the posited hypotheses. For the Adoption vs. Non-adoption Model, logistic regression will be deployed, and for the Level of Adoption Model, Structural Equation Modeling (SEM) will be used. Furthermore, data collection process and demographic information of the sample data will be described and compared to the recent national survey results by *U.S. Education Department's National Center for Education Statistics.* Hypotheses testing results will be summarized at the end of the next chapter.

4. RESEARCH METHODS AND RESULTS

In the current dissertation research, an online questionnaire survey was executed for all K-12 schools in the state Missouri. The process of collecting data, a sample size, and a sample demographic information will be presented first. Next, each measurement model for the two proposed models will be examined. For the Adoption vs. Non-adoption Model, logistic regression is employed and for the Level of Adoption Model, SEM is used.

4.1. Pilot study

In order to increase the validity of items used in the questionnaire survey, a number of interviews were executed with a number of people who work for K-12 schools: two principals (one from a public elementary school, the other from a private elementary school), a vice principal from a public school, a computer-resource-specialist, and an IT director at a district level were the participants for the pilot study interview. The interviewees were reviewing the survey questionnaire and discussed whether the measurements are realistic and valid along with the interview guide [Appendix 2].

The interviewees mentioned that all the measurements were acceptable except for the construct ‘competitive pressure.’ According to the principals and interviewees, they strongly suggested that ‘competitive pressure’ is not relevant in a school context because schools are more or less conservative and that they are mostly not affected by other schools when they adopt new information technology. Although ‘competitive pressure’ was found as an important determinant for IT adoption in IS previous literature (Jeyaraj et al., 2006), ‘competitive pressure’ in a school context may not be appropriate. For this reason, ‘competitive pressure’ was not included in the subsequent analysis.

After the survey questionnaire was finalized by the interviews, it is also pilot tested online by a number of principals who are randomly chosen in the population but not included in the subsequent analysis. 16 responses are analyzed and there were no confounding results (e.g., outliers).

4.2. Sample

The Missouri Department of Education provides information of 2,275 schools in Missouri. The information also includes the e-mail addresses of principals and their names. However, the number 2,275 doesn't include private (independent) schools. For this reason, additional search was conducted for gathering information regarding private schools in Missouri. A number of websites provided information regarding U.S. K-12 schools. For instance, *Greatschools.net* provides information of U.S. K-12 schools (http://www.greatschools.net). *Allprivateschools.org* offers private K-12 school information (http://www.allprivateschools.org). *Independentschools.org* provides private school information in St.Louis area. (http://www.independentschools.org). The web addresses of private schools were available from these websites. After visiting these school websites one by one, 218 e-mail addresses of private school principals (directors) were collected. Overall, 2,493 schools were identified for the current research.

An online survey questionnaire [Appendix 3] was sent to the K-12 principals on 10th of March (1st round) and the same online questionnaire was sent to non-respondents at the 2nd round one week later. Furthermore, an additional 225 computer lab teachers or media resource specialists were identified from non-responded school websites and sent to each person instead of non-responded principals. After verifying the responses, 435 responses (190 WLAN adopters vs. 245 WLAN non-adopters) were finally identified as valid for subsequent analysis and the response rate is 16.1 percent.

[Table 4] Respondent characteristics

	Frequency
Grade levels	
Elementary school	203
Middle school	88
High school	144
School type	
Public school	389
Private school	46
Job title	
Principal	319
Vice principal	3
Teacher	20
Computer/media specialist	63
Staff	4
Other	25
Missing	1
Years in the position	
Less than 1 year	48
1 -2 years	73
3 - 5 years	116
6 - 10 years	107
More than 10 years	88
Missing	3
Age	
Under 30	10
30 - 40	113
40 - 50	156
50 - 60	140
Over 60	16
Gender	
Male	214
Female	220
Missing	1

Elementary school has the largest portions among the sample (47.3 percent) followed by high school (33.2 percent) and middle school (19.5 percent) [Table 4]. The number of responded public schools (405 or 89.6 percent) is larger than that of responded private schools

(47 or 10.4 percent). The ratio is similar to the number of identified public and private schools for the current research. The total number of public schools in Missouri is 2,275 (91.6 percent) and that of private schools is 218 (8.4 percent). According to *The Center for Education Reform*, national percentage of public school and private schools are 83% and 17% respectively (Base rate).

Principals are the largest responded group (73 percent) followed by computer/media specialists group (15 percent). Others group is 5.7% followed by Teachers group (4.6 percent). Ages of respondents are as follows; age 40 - 50 category consists of 36.5 percent followed by age 50 - 60 category (32.1 percent). Overall, 68.6 percent of respondents are between age 40 and 60. 71.4 percent of respondents have worked more than 3 years for the current job positions and 75.6 percent of respondents worked more than 3 years in the current schools. The respondents' gender ratio is close to the even number: female (49 percent) and male (51 percent). In terms of WLAN adoption, 190 (43.6 percent) schools adopted WLAN and 245 schools (56.3 percent) didn't adopt WLAN. *U.S. Education Department's National Center for Education Statistics* (2007) reported that 47.53 percent of U.S. K-12 public schools use WLAN and 52.27 percent schools don't use it, which is close to the current survey response ratio.

Most respondent schools in the current study have classrooms with Internet access. 91.2 percent of survey responded schools described that more than 60 percent of their classrooms are connected to Internet. The interesting thing is the number of high speed PCs at their schools: 31.6 percent of schools reported that 80 percent of school computers are not high speed ones. Network speed is also interesting in a sense that 98.9 percent of schools reported to have some kind of a broadband network (e.g., DSL, dedicated lines (T1, E1), etc.). However, 27.1 percent of the respondents felt that broadband network was lower than moderate speed. One of possible explanations to this issue is related to PC computing power - network speed is affected not only by network bandwidth per se but also by PC computing power. Still 31.6 percent schools use mostly old computers (80 percent) on their campuses and this may cause the slow network speed.

49.1 percent of schools reported that their household income of students is in the $20,000 – $49,999 range followed by the $50,000 – $99,999 group (19.0 percent). In 2005, according to *the US Census Bureau*, the median annual household income in Missouri is $41,974 which falls into the largest income group in the current survey. 13.5 percent of schools report that their student household income is less than $20,000 and this amount meets national poverty criteria - the average poverty threshold for a family of four in 2005 was an income of $19,874[8]. Furthermore, according to *the US department of agriculture (USDA)*, the Missouri poverty level (less than $20,000) is 13.0 percent, which is close to the current survey data; and this reveals that the current data reflects demographic sample characteristics well. For this reason, in terms of student household income distribution, the current survey data has no confounding sample bias toward population.

School locations found in the current survey are: City (16 percent), Suburbs (32 percent), Town (9 percent), and Rural (43 percent). The descriptions of the four categories are as follows [Table 5]:

[Table 5] Description of four locations

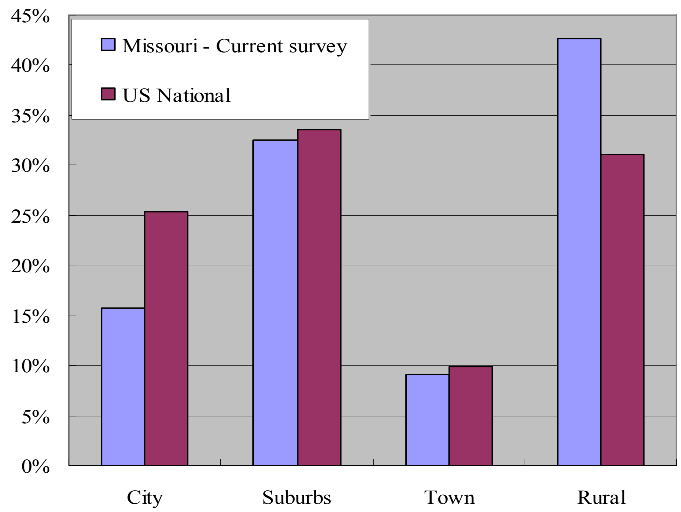
Category	Description
City	Territory inside an urbanized area and inside a principle city with population more than 100,000
Suburbs	Territory outside a principal city and inside an urbanized area with population more than 100,000
Town	Territory inside an urban cluster that is more than 10 miles from an urbanized area
Rural	Territory that is more than or equal to 5 miles from an urbanized area

This proportion is close to the national survey data by *the U.S. Education Department's National Center for Education Statistics* (2006). The comparison of the two statistics is described below [Figure 8]. In terms of school location, the current survey data is well

[8] *U.S. Census Bureau, Current Population Survey, 2006 Annual Social and Economic Supplement.*

distributed throughout these four categories. Thus, in terms of location of schools, the current survey data reflected population well.

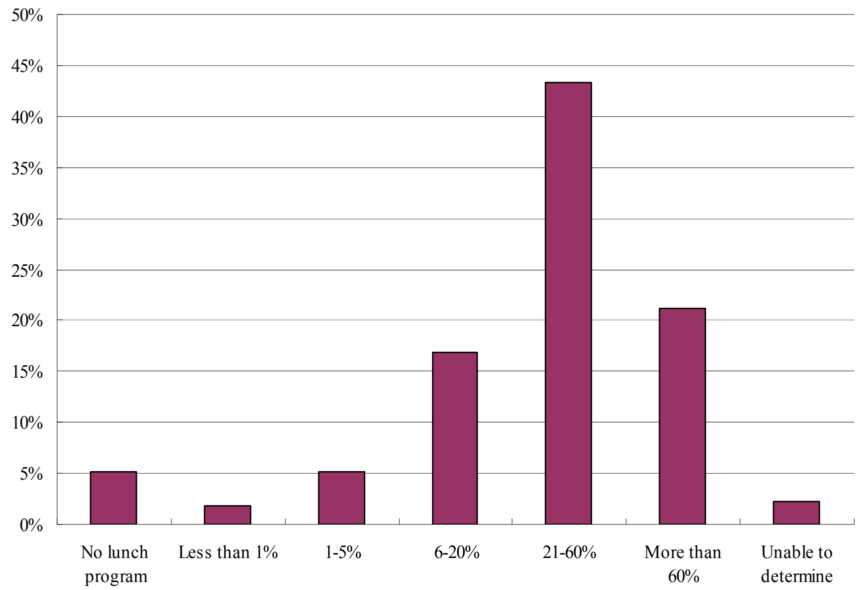
[Figure 8] Comparison of two survey data in terms of school location



The student percentage of federal government lunch program is an alternative measure for poverty. The National School Lunch Program is a federally assisted meal program with over 100,000 public and non-profit private schools and child care institutions. The program assists free/reduced lunches to more than 29 million children per school day (USDA, 2006). If students' family income is below 130 percent of the poverty level, they are eligible for free meals. If the income is between 130 and 185 percent of the poverty level, these students are eligible for reduced-price meals but they can be only charged no more than 40 cents. According to USDA report, as of July 2006, 130 percent of the poverty level is $26,000 for a family of four; 185 percent is $37,000.

5.1 percent of schools reported that they do not subscribe to the federal lunch program. 6.9 percent of schools subscribe to the lunch program with less than 5 percent of students. The largest group is 21-60 percent group (43.3 percent) [Figure 9].

[Figure 9] Federal lunch program subscription



53.7 percent of schools reported that they have less than 5 percent of African-American and Hispanic students. However, 10.8 percent of responded schools argued that they have more than 60 percent of African-American and Hispanic students. 60.3 percent of responded schools have 30:1 student-teacher ratio followed by 10:1 (31.3 percent). About 42 percent of responded schools do not subscribe to E-rate. 24.1 percent of schools reported that they subscribe to E-rate less than $30,000.

4.3. Non-response analysis

A number of empirical tests were employed to investigate whether the respondents systematically differ from the non-respondents (Armstrong and Overton, 1977; Sabherwal and King, 1992). In one of seminal papers of the non-response analysis, Armstrong and Overton (1977) described a number of methods to verify non-response bias. They recommended (1) comparison with known values for the population (2) subjective estimates, and/or (3) extrapolation method. Among these methods, (1) comparison with known values for the population and (3) extrapolation method are relevant to the current study because (2) subjective estimates are related to the situation when respondents' subjective interests are important (e.g., product design, brand names, etc.). To apply 'comparison with known values for the population,' (i) public and private schools (ii) number of students (iii) Frequency of ZIP codes between respondents and non-respondents are compared. Furthermore, since the above (i) (ii) and (iii) are comparing demographic variables, extrapolation method with variables used in the current analysis is also employed. Extrapolation method includes the comparison between early respondents and late respondents. The authors argued that in many cases late respondents are expected to be similar to non-respondents. For this reason, comparing early and late respondents will be important for identifying non-response bias.

The first quantitative test investigated whether the response rate was different among public and private schools. For this purpose, the entire sample of schools was divided into: (a) respondent and non-respondent schools; and (b) public and private schools. A chi-square test of the association between these two classifications found no significant difference (chi-square = 1.85, p=0.174), indicating that there is no systematic difference between public and private schools in the proportion of respondents.

The second empirical test of a potential non-response bias compared the number of students between responded schools and non-responded schools. For this, publicized information on Missouri K-12 schools from the *Missouri Department of Education* is used. The provided information only contains the information on public schools. Since most private schools do not provide detailed information such as number of students, etc., this analysis could only be conducted using public schools[9]. A T-test was conducted to investigate whether there is a

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[9] *91.6% of schools are public whereby 8.4% are private in Missouri. Furthermore, 89% of the current survey respondents are from public school and 11% from private schools.*

systematic difference between respondent public schools and non-respondent public schools in terms of the size of the school (evaluated using the number of students). No significant difference was found between respondent public schools and non-respondent public schools with respect to the size of the school (t=1.48, p=0.138).

The third empirical test of a potential non-response bias compared whether the response rate systematically differs across geographic areas. The zip codes of respondents and non-respondents were identified for this purpose. The first digit of ZIP codes represents a certain group of U.S. states, the second and third digits together represent a region in that group (or perhaps a large city) and the fourth and fifth digits representing more specific areas, such as small towns or regions of the city (see Wikipedia on ZIP code, http://en.wikipedia.org/wiki/ZIP_code). 631 five-digits ZIP codes were identified and these ZIP codes are reduced to three digits. For example, for 64122, 64132, and 64130, all these ZIP codes are grouped into 641. Twenty-five three-digits ZIP codes were present in the sample. A chi-square test was conducted to test whether the response rates differ across these three-digit ZIP codes. The Chi-square test shows that there is a difference between these ZIP codes (Chi-square = 58.06, p=0.01). This difference may be due to the fact that large city ZIP code has more respondents. Nevertheless, further analysis was done to examine whether the influence is critical for respondents included in the current analysis. The three-digit ZIP codes were classified into high response rate areas and low response rate areas (i.e., if a ZIP code had higher response rate than average response rate for the sample, it was coded as a high response rate area, and if a ZIP code had lower response rate than average response rate for the sample, it was coded as a low response rate area). Each of the research variables included in both models of the current study was compared across these two groups (i.e., a t-test was done comparing the mean of each variable between respondent schools from the high-response rate areas and respondent schools from the low-response rate areas). The results are as follows: [Table 6]

[Table 6] T-test results between high-response rate group and low response rate group

	t	df	Sig. (2-tailed)	Mean Difference
Expected Benefit1	.357	321	.722	.031
Expected Benefit2	-.013	320	.990	-.001
Expected Benefit3	1.739	318	.083	.166
Expected Benefit6	-.488	320	.626	-.044
Expected Benefit7	.134	318	.893	.013
Expected Benefit8	-1.147	319	.252	-.112
Actual Benefit5	-.640	136	.523	-.087
Actual Benefit6	-.327	136	.744	-.052
Actual Benefit7	.226	136	.821	.039
Expected Barrier1	.984	320	.326	.097
Expected Barrier2	-.742	320	.459	-.087
Expected Barrier3	-.658	320	.511	-.070
Actual Barrier2	-.367	135	.714	-.068
Uncertainty2	-1.578	320	.116	-.146
Uncertainty3	-2.025	320	.044*	-.194
Absorptive Capacity2	.728	320	.467	.074
Absorptive Capacity3	-.162	321	.872	-.016
Slack resources1	-1.009	320	.314	-.131
Slack resources2	-.437	320	.663	-.060
Usage2	.665	134	.507	.197
Usage3	.174	137	.862	.049
Satisfaction1	-1.241	138	.217	-.214
Satisfaction3	-.569	138	.571	-.092
Satisfaction4	-.081	138	.935	-.012

Thus, none of the t-tests are significant, except the one for 'Uncertainty 3' ($p \leq 0.05$). The number of statistically significant difference (one) is consistent with the number expected due to chance alone (0.05 * 24 = 1.20). Thus, the comparison of high response rate areas vs. low response areas does not indicate a significant non-response bias.

In addition to the above non-response analysis, I compared early and late respondents. Since the first two analyses only include demographic variables, testing variables included in the analysis is important for investigating non-response analysis. For this reason, in addition to the two tests, early-late respondents were compared with respect to 24 variables included in the current study. Responses were sorted by time, and then classified the first 40 percent as EARLY responses and the last 40 percent as LATER responses, while excluding the middle 20 percent from this analysis. I conducted t-tests to compare these two groups (EARLY vs. LATER) in terms of all 25 items used in the two measurement models. I found that only one variable (Expected_Barrier1, which was greater for LATER respondents) of the 24 t-tests was significant ($p \leq 0.05$) [Table 7]. The number of statistically significant difference (one) is consistent with the number expected due to chance alone (0.05 * 24 = 1.20). Thus, the comparison of early and late respondents provides no indication of non-response bias. Based on these multiple empirical tests, the non-response problem does not appear to be a major concern for the current study.

[Table 7] T-test results for non-response analysis

	t	df	Sig. (2-tailed)	Mean Difference
Expected Benefit1	-.025	354	.980	-.002
Expected Benefit2	.267	357	.790	.022
Expected Benefit3	.760	356	.448	.071
Expected Benefit6	-.024	358	.981	-.002
Expected Benefit7	-.063	356	.950	-.006
Expected Benefit8	.411	356	.681	.038
Actual Benefit5	.250	165	.803	.032
Actual Benefit6	-.287	165	.774	-.041
Actual Benefit7	-.354	165	.724	-.051
Expected Barrier1	-2.702	356	.007*	-.235
Expected Barrier2	-.762	357	.446	-.081
Expected Barrier3	-1.362	357	.174	-.133
Actual Barrier2	-.424	164	.672	-.070
Uncertainty2	1.636	350	.103	.142
Uncertainty3	-.442	350	.659	-.040
Absorptive Capacity2	1.957	348	.051	.188
Absorptive Capacity3	1.395	350	.164	.129
Slack resources1	.098	351	.922	.012
Slack resources2	.419	350	.676	.053
Usage2	-1.411	157	.160	-.374
Usage3	-.642	161	.522	-.160
Satisfaction1	-.263	163	.793	-.039
Satisfaction3	-.253	165	.800	-.035
Satisfaction4	-.906	165	.366	-.116

4.4. Measurement model

Items used in the current study are mostly adapted from prior IS studies and reports. For instance, the measurement items for perceived benefits of WLAN is based on Cisco reports (2003) and Chau and Tam (2000)'s study. Furthermore, the current WLAN study is exploratory in a sense, diverse items are measured: Mobility/portability, no cabling, Easy set-up, Cost savings, Administrative process flexibility, Competitive advantage, Easy collaboration, Time saving, and Improved organization image. One of future avenues of WLAN study is to validate WLAN benefits by employing confirmatory factor analysis. The selection of barriers item is adapted from Chau and Tam (2000) modified to WLAN context.

For 'Environmental uncertainty,' three items are adopted from Sabherwal and Kirs (1994) because the study was conducted and tested in the K-12 school context, which is parallel to the meaning of environmental uncertainty in the current study. Organizational factors initially designed for the current research includes (1) absorptive capacity, (2) IS maturity, (3) satisfaction with current system, (4) slack resources and (5) organizational structure.

Items of absorptive capacity are adapted from Chau and Tam (1997) and Grover (1997), and are modified to the WLAN context in K-12 schools. Items for 'satisfaction with current system' are adopted from Chau and Tam (1997)'s study (Open source technology adoption) and modified to the WLAN context. However, in the Level of Adoption Model, 'satisfaction with current system' is not included because for adopters, the current system can be of as a wireless system as well as of a wired system. Furthermore, 'satisfaction with the current system' has high cross loadings with 'WLAN satisfaction' and 'perceived benefits of using WLAN.' For these reasons, the hypothesis investigating 'satisfaction with current system' is dropped for the Level of Adoption Model. Slack resources are measured with respect to monetary slacks and personnel slacks (Lai and Guynes, 1997). The items of IS maturity were initially measured using the following items: (1) top management knowledge of information technology (2) top management's involvement in IS planning, (3) the extent of infusion and diffusion of IT and (4) IS performance criteria based on organizational goals rather than cost (Grover and Goslar, 1993b). However, it is dropped in the subsequent analysis because it has high cross loadings with absorptive capacity. Furthermore, the internal consistency of the construct is also not acceptable. Some researchers have pointed out that there exists an overlap between the concepts of 'absorptive capacity' and 'IS maturity' in IS research context (Grover and Goslar, 1993b). I think this is also applied in the current dissertation research.

'Organizational structure' is also measured in the current research. However, like IS maturity, it exhibited low reliability and was dropped for the subsequent analysis. In a study of the adoption of telecommunication technologies, Grover and Goslar (1993a) found that decentralizing decision-making authorities tend to adopt more telecommunication technologies. However, Jeyaraj et al. (2006) reported that 'organizational structure' has not been a good predictor for IS outcome variables; the small organization structure of K-12 schools in this research may not be appropriate for differentiating decentralized/centralized organizational structure.

Socio-economic variables and e-rate subsidy levels were measured in single items, which were frequently measured in the sociology and economic studies (e.g., Mossberger et al., 2003; DeMaggio et al., 2004). Furthermore, the bivariate variable indicating public and private school is also included in the subsequent analysis. Based on the selection criteria, [Table 8] summarized the scales and the corresponding items used in the analysis.

[Table 8] Summary of measurements [see also full questionnaire in Appendix 3]

Context	Construct	Measurement Items	References / Comments
Dependent variables and measurements			
WLAN adoption	Binary value	"1" = Yes, "0" = Not adopted	Used as a dependent variable for the adopter vs. non-adopter analysis
Extent to which WLAN is used	A summated variable of three	WLAN usage by top administrators	Used as one of dependent variables for the adopter analysis
		WLAN usage by students	

	measurements	WLAN usage by staffs	
Perceived WLAN satisfaction	3 items	Top administrator's satisfaction	Used as one of dependent variables for the adopter analysis
		Students' satisfaction	
		Teachers/staffs' satisfaction	
Independent variables and measurements			
Environmental	Environmental uncertainty	Predictability of government policy	Sabherwal and Kirs (1994), Sabherwal and Vijayasarathy (1994), Grover and Goslar (1993b), Tornatzky and Fleischer (1990)
		Predictability of demands/needs	
		Rate of technology change	
Technological	Perceived benefits	Mobility/portability	Zhang and Wolff (2004), Chau and Tam (2000), Chau and Tam (1997), Kwon and Zmud (1984), Cisco report (2003)
		no cabling	
		Easy set-up	
		Cost savings	
		Administrative process flexibility	
		Competitive advantage	
		Easy collaboration	
		Time saving	
		Improved organization image	
	Perceived Cost/Barriers	High cost of system change	Chau and Tam (2000), Chau and Tam (1997)
		Personnel is not familiar to WLAN	
		System compatibility	
Organizational	Absorptive capacity	Capability of recognizing technology value	Cohen and Levinthal (1990) Chau and Tam (1997), Swanson (1994), Grover (1997),
		Capability of assimilating technology	
		Capability of applying technology to the organization	
	Slack resources	Extent to which financial slack resources exist	Tornatzky and Fleischer (1990), Swanson (1994), Lai and Guynes, 1997
		Extent to which personnel slack resources exist	
	Satisfaction level with the current system	Satisfaction with the price/performance of the current system	Chau and Tam (2000)
		Serving the needs of organization by the current system	
Socio-economic influences	Household income	Household income of students	Dewan and Riggins (2005), DeMaggio et al. (2004), Mossberger et al., (2003), Hargittai, (2002), Howard, et
	Location	City, Suburbs, Town, Rural (from city to rural area)	

	Student-teacher ratio	Student-teacher ratio	al., (2001)
	School type: Public vs. private	Public school (1) vs. private school (0) - a binary variable	Included in the current research
Government policy influence	E-rate subsidy	E-rate amount	Goolsbee and Guryan (2006)

4.4.1. Measurement model for Adoption and Non-adoption Model

Structural equation modeling (SEM) – Confirmatory Factor Analysis (CFA) was used to run a measurement model. CFA provides estimates for convergent / discriminant validity, composite reliability, average variance extracted of the scales (Fornell and Larcker, 1981; Joreskog and Sorbom 1996). LISREL was used to run CFA. In LISREL, the output includes completely standardized Lamdas (loadings) and Theta-Deltas (error terms). With these standardized values, composite reliabilities and average variance extracted (AVE) was calculated for testing convergent validity, discriminant validity, and internal consistency (Fornell and Larcker, 1981; Sabherwal et al., 2006). Fornell and Larcker (1981) suggested that the square root of AVE be higher than any other correlations to provide discriminant validity and that AVE be greater than 0.5 to achieve convergent validity. [Table 7 and Table 8] reveal that the current constructs meet Fornell and Larcker (1981)'s recommendation for convergent and discriminant validity. Diagonal values of [Table 8] (0.81, 0.85, 0.90, 0.91, and 0.89) refer to the square root of AVE's which are all greater than the other construct correlations. Furthermore, all the AVEs (0.66, 0.73, 0.82, 0.84, and 0.80) are greater than the 0.50 level for achieving convergent validity.

Composite reliabilities of each construct show internal consistency of the scales/measurements: Perceived Benefits (BENEFIT, 5 items, Reliability = 0.91), Environmental Uncertainty (UNCERT, 2 items, Reliability = 0.84), Absorptive Capacity (ABS, 2 items, Reliability = 0.90), Satisfaction with current system (SATCUR, 2 items, Reliability = 0.91), and Slack Resources (SLACK, 2 items, Reliability = 0.89). All the composite reliabilities exceed recommended level of 0.70 (Hair et al., 1998). All the included items and descriptions[10] are summarized in [Table 9 and Table 10]

[Table 9] Measurement model results for Adoption vs. Non-adoption Model

			Lxs	TDs	Composite Reliability	AVE	SQRT (AVE)
BENEFIT	expben1	Expected benefits of mobility	0.91	0.17	0.91	0.66	0.81
	expben2	Expected benefits of no cables	0.62	0.62			
	expben6	Expected benefits of competitive advantage	0.71	0.5			
	expben7	Expected benefits of easy collaboration	0.83	0.32			
	expben8	Expected benefits of time saving	0.96	0.08			
UNCERT	uncert2	Predictability of demands	0.86	0.26	0.84	0.73	0.85
	uncert3	Rate of technology change	0.85	0.28			
ABS	abscap2	Assimilating technology	0.89	0.22	0.90	0.82	0.90
	abscap3	Applying technology	0.92	0.15			
SATCUR	satcur1	Satisfaction of price/performance of current system	0.93	0.14	0.91	0.84	0.91
	satcur2	Serving organizational needs by the current system	0.9	0.19			
SLACK	slack1	financial slack resources	0.85	0.28	0.90	0.80	0.89
	slack2	personnel slack resources	0.94	0.12			

[Table 10] Correlation matrix of constructs (Diagonal values are square root of AVE)

	BENEFIT	UNCERT	ABS	SATCUR	SLACK
BENEFIT	**0.81**				
UNCERT	0.25	**0.85**			
ABS	0.24	0.53	**0.90**		
SATCUR	-0.03	0.32	0.38	**0.91**	
SLACK	0.03	0.3	0.47	0.5	**0.89**

[10] *For the 'Adoption vs. Non-adoption model,' I included expected benefits/barriers; for the 'Level of adoption model,' I included expected benefits/barriers and actual benefits/barriers. Some items were dropped for meeting construct validity requirements (e.g., convergent validity, discriminant validity, composite reliability, and AVEs).*

The recommended fit statistics for SEM are as follows: goodness-of-fit index (GFI) greater than 0.9, adjusted goodness-of-fit index (GFI) greater than 0.9, normed fit index (NFI) greater than 0.9, non-normed fit index (NNFI) greater than 0.9, and Root Mean Square of Approximation (RMSEA) less than 0.08 (Hair et al, 1998; Sabherwal et al., 2006). In the current dissertation research, these criteria will be used for identifying SEM fits.

Fit statistics[11] for the Adoption vs. Non-adoption measurement model show appropriate values in terms of the following criteria: goodness of fit index (GFI) = 0.97, normed fit index (NFI) =0.98, and non-normed fit index (NNFI) =0.98 , Root Mean Square of Approximation (RMSEA) = 0.050. Based on these statistics, the measurement model for the Adoption vs. Non-adoption Model fits the data well.

Common method variance bias can be problematic for studies with multi-item constructs. Common method variance is a type of spurious internal consistency which results from the apparent correlation due to their common source (i.e., same respondent). For instance, if the data is responded to by single respondents, the correlation is due to the likelihood of the subjects to answer similarly to multiple items rather than due to true correlation among items (Garson, 2007).

For this, Harman's one factor test (Podsakoff and Organ 1986) is conducted. Harman's single-factor approach suggests that if common method bias is present among variables, an exploratory factor analysis will yield a single factor structure. I employed Harman's one-factor test in two different ways (Kearns and Sabherwal, 2006). First, factor analysis with all the independent and dependent variables with unrotated factor solution was executed. If the result does not have a single-factor solution, it is suggested that common method bias is not a problem (Podsakoff and Organ, 1986). The unrotated first factor explained 28.67 percent of the variance and there seems no general factor extracted (Scott and Bruce, 1994).

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[11] *All fit indexes and LISREL output are in [Appendix 5]*

Second, a confirmatory factor analysis using SEM approach was employed for identifying common method variance bias (Menon at al., 1996). A measurement model in which a single factor is located from 13 variables was conducted. The measurement model from the second approach does not fit the sample data well: GFI = 0.69, NFI = 0.64, NNFI = 0.52, and RMSEA = 0.224. Based on the results of two approaches, there seems no presence of common-method variance bias.

4.4.2. Measurement model for Level of Adoption Model

As done with the measurement model for the Adoption and Non-adoption Model, Confirmatory Factor Analysis using LISREL was executed to test the measurement model. [Table 9] and [Table 10] summarize that the constructs satisfy Fornell and Larcker (1981)'s recommendation for convergent and discriminant validity. Diagonal values at [Table 10] (0.75, 0.71, 0.87, 0.78, 0.83, 0.79, and 0.86) refer to the square root of AVE's and these values are all greater than the other construct correlations (discriminant validity). Furthermore, all the AVEs (0.56, 0.50, 0.76, 0.61, 0.68, 0.63, and 0.74) are greater than 0.50 level for achieving convergent validity.

Composite reliabilities of each construct are as follows: Perceived Benefits (BENEFIT, 4 items, Reliability = 0.84), Perceived Barriers (BARRIER, 3 items, Reliability = 0.75), WLAN Satisfaction (SATCUR, 3 items, Reliability = 0.90), Usage (USAGE, 2 items, Reliability = 0.76), Environmental Uncertainty (UNCERT, 2 items, Reliability = 0.81), Absorptive Capacity (ABS, 2 items, Reliability = 0.77), and Slack Resources (SLACK, 2 items, Reliability = 0.85). The composite reliability exceeds recommended level of 0.07 (Hair et al., 1998). Furthermore, included items and their descriptions are summarized in [Table 11 and Table 12]

[Table 11] Measurement model results for the Level of Adoption Model

			Lx's	**TD's**	**Composite Reliability**	**AVE**	**SQRT (AVE)**
BENEFIT	expben6	Expected benefits of competitive advantage	0.68	0.54	0.84	0.56	0.75
	aftben5	Actual benefits of flexibility	0.68	0.53			
	aftben6	Actual benefits of competitive advantage	0.93	0.13			
	aftben7	Actual benefits of Easy collaboration	0.68	0.54			
BARRIER	expbar2	Expected barriers of current system familiarity	0.79	0.37	0.75	0.50	0.71
	expbar3	Expected barriers of system compatibility	0.67	0.55			
	aftbar2	Actual barriers of current system familiarity	0.65	0.58			
SATIS	wsatis1	WLAN satisfaction by top administrator	0.89	0.20	0.90	0.76	0.87
	wsatis3	WLAN satisfaction by students	0.88	0.23			
	wsatis4	WLAN satisfaction by staffs	0.84	0.30			
USAGE	use2	WLAN usage by students	0.68	0.52	0.76	0.61	0.78
	use3	WLAN usage by staffs	0.87	0.25			
UNCERT	uncert2	Predictability of demands	0.73	0.46	0.81	0.68	0.83
	uncert3	Rate of technology change	0.91	0.17			
ABS_CAP	abscapa2	Assimilating technology	0.84	0.29	0.77	0.63	0.79
	abscapa3	Applying technology	0.74	0.45			
SLACK	slack1	financial slack resources	0.78	0.39	0.85	0.74	0.86
	slack2	personnel slack resources	0.93	0.14			

[Table 12] Correlation matrix of constructs (Diagonal values are square root of AVE)

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP	SLACK
BENEFIT	**0.75**						
BARRIER	-0.28	**0.71**					
SATIS	0.48	-0.24	**0.87**				
USAGE	0.47	-0.29	0.44	**0.78**			
UNCERT	0.23	-0.2	0.15	0.11	**0.83**		
ABS_CAP	0.48	-0.27	0.43	0.43	0.5	**0.79**	
SLACK	0.25	-0.17	0.37	0.16	0.22	0.44	**0.86**

As with the Adoption vs. Non-adoption measurement model, the fit statistics for the Level of Adoption measurement model show appropriate values: goodness of fit index (GFI) = 0.92, normed fit index (NFI) =0.94, and non-normed fit index (NNFI) =0.98, Root Mean Square of Approximation (RMSEA) = 0.034. Based on these statistics, the measurement model for the Level of Adoption Model fits the data well.

Common method variance bias was investigated using the same two approaches in the previous Adoption vs. Non-adoption Model (Kearns and Sabherwal, 2006). Harman's one factor test (Podsakoff and Organ 1986) reveals that the unrotated first factor explained 29.24 percent of the variance and there seems no general factor extracted (Scott and Bruce, 1994). Second, the measurement model from the second approach does not fit the sample data well: GFI = 0.63, NFI = 0.65, NNFI = 0.64 and RMSEA = 0.180. Based on the results of the two approaches, there seems no presence of common-method variance bias. The two measurement models (1) Adoption vs. Non-adoption Model and (2) Level of Adoption Model achieve required conditions for a measurement model. The descriptive statistics of variables included in the analysis are as follows [Table 13] :

[Table 13] Descriptive statistics of variables included in the current study

	N	Min	Max	Mean	Median	Std. Deviation
Wireless LAN adoption	435	0	1	0.44	0	.497
Expected Benefit1	435	1	5	4.23	4	.789
Expected Benefit2	434	1	5	4.32	4	.782
Expected Benefit3	432	1	5	3.78	4	.883
Expected Benefit6	434	1	5	3.81	4	.807
Expected Benefit7	432	1	5	3.84	4	.830
Expected Benefit8	433	1	5	3.91	4	.873
Actual Benefit5	187	1	5	3.50	3	.792
Actual Benefit6	187	1	5	3.71	4	.894
Actual Benefit7	187	1	5	3.70	4	.915
Expected Barrier1	433	1	5	3.44	3	.856
Expected Barrier2	434	1	5	3.52	4	1.008
Expected Barrier3	433	1	5	3.07	3	.935
Actual Barrier2	186	1	5	3.01	3	1.048
Uncertainty2	434	1	5	3.47	4	.821
Uncertainty3	434	1	5	3.60	4	.852
Absorptive Capacity2	432	1	5	3.52	4	.911
Absorptive Capacity3	434	1	5	3.63	4	.882
Slack resources1	434	1	5	2.27	2	1.177

Slack resources2	433	1	5	2.63	2	1.206
WLAN Usage2	183	1	5	3.17	3	1.664
WLAN Usage3	189	1	5	3.52	4	1.556
Satisfaction1	190	1	5	3.83	4	.939
Satisfaction3	190	1	5	3.77	4	.875
Satisfaction4	190	1	5	3.72	4	.823

4.5. Hypotheses testing

4.5.1. Adoption vs. Non-adoption Model

Logistic regression was employed for comparing WLAN adopters and nonadopters because the dependent variable is a binary variable. For a binary dependent variable - WLAN adoption (Yes “1” and No “0”), logistic regression is said to have better feature than ordinary least square regression (Chau and Tam, 1997).

For the logistic regression model fit, *Hosmer and Lemeshow* Goodness-of-fit Test was executed. The rationale of the test is; “the test is a goodness-of-fit test of the null hypothesis that the model adequately fits the data. If the null hypothesis is true, then the statistic should have an approximately chi-square distribution with the displayed degrees of freedom. If the significance of the test is small (i.e., less than 0.05) then the model does not adequately fit the data.” (SPSS V.14 embedded tutorial) In the current model, the test statistics is 8.155 (df=8, p=.418). For this reason, the model is not significantly different from the perfect fit model.

Multicollinearity in logistic regression models is the outcome from a strong correlation among independent variables. Multicollinearity is said to generate problems by inflating the variance parameters (Cooper and Chen, 2001). For this reason, identification of multicollinearity among independent variables is one of critical assumptions for the validity of logistic regression. For investigating multicollinearity in a logistic regression model, prior studies (see Cooper and Chen, 2001, p.823) suggest calculating Tolerance value and VIF (Variance Inflation Factor) for each variable. Tolerance = 1- R^2 where R^2 is the coefficient of determination of that variable on all remaining independent variables. The VIF is 1/Tolerance, it is always greater than 1 and it is the degree to which the coefficient is increased by multicollinearity. Values of VIF exceeding 10 are often regarded as the indication of strong multicollinearity. But in most cases of logistic regression, VIF values above 2.5 will be problematic (Cooper and Chen, 2001) and thus it is recommended excluding these independent variables from the logistic model. The VIF value for the current Adoption vs. Non-adoption model is described in [Table 14] and fit statistics are depicted in [Table 15].

[Table 14] Multicollinearity validation: VIF values of independent variables

	Tolerance	VIF
WLAN Benefits	.932	1.072
Environment uncertainty	.809	1.236
Absolute capacity	.620	1.612
IS maturity	.766	1.306
Satisfaction with current system	.737	1.357
Slack resources	.685	1.460
Household Income	.666	1.503
Student-Teacher ratio	.890	1.123
Location of schools	.767	1.303
School type	.673	1.487
E-rate amount	.903	1.108

As see from the above table, all VIF values are less than the 2.5 level, which presents multicollinearity of independent variables are no concerns in the current model.

[Table 15] Logistic regression results for Adoption vs. Non-adoption Model

	B	**S.E.**	**Wald**	**df**	**Sig.**	**Exp(B)**
Benefit	-.255	.204	1.560	1	.212	.775
Environmental uncertainty	.049	.173	.081	1	.776	1.050
Absorptive capacity**	**.390**	.171	5.216	1	**.022**	1.477
Satisfaction with current system**	**.368**	.142	6.668	1	**.010**	1.444
Slack resources	.184	.127	2.095	1	.148	1.202
Household income	-.022	.102	.048	1	.827	.978
Location of the school**	**-.333**	.113	8.707	1	**.003**	.717
Student-teacher ratio	-.267	.224	1.422	1	.233	.766
School type	.541	.418	1.675	1	.196	1.717
E-rate **	**.221**	.082	7.232	1	**.007**	1.247
Constant	-1.658	1.331	1.552	1	.213	.191

** $p<0.01$, * $p<0.05$

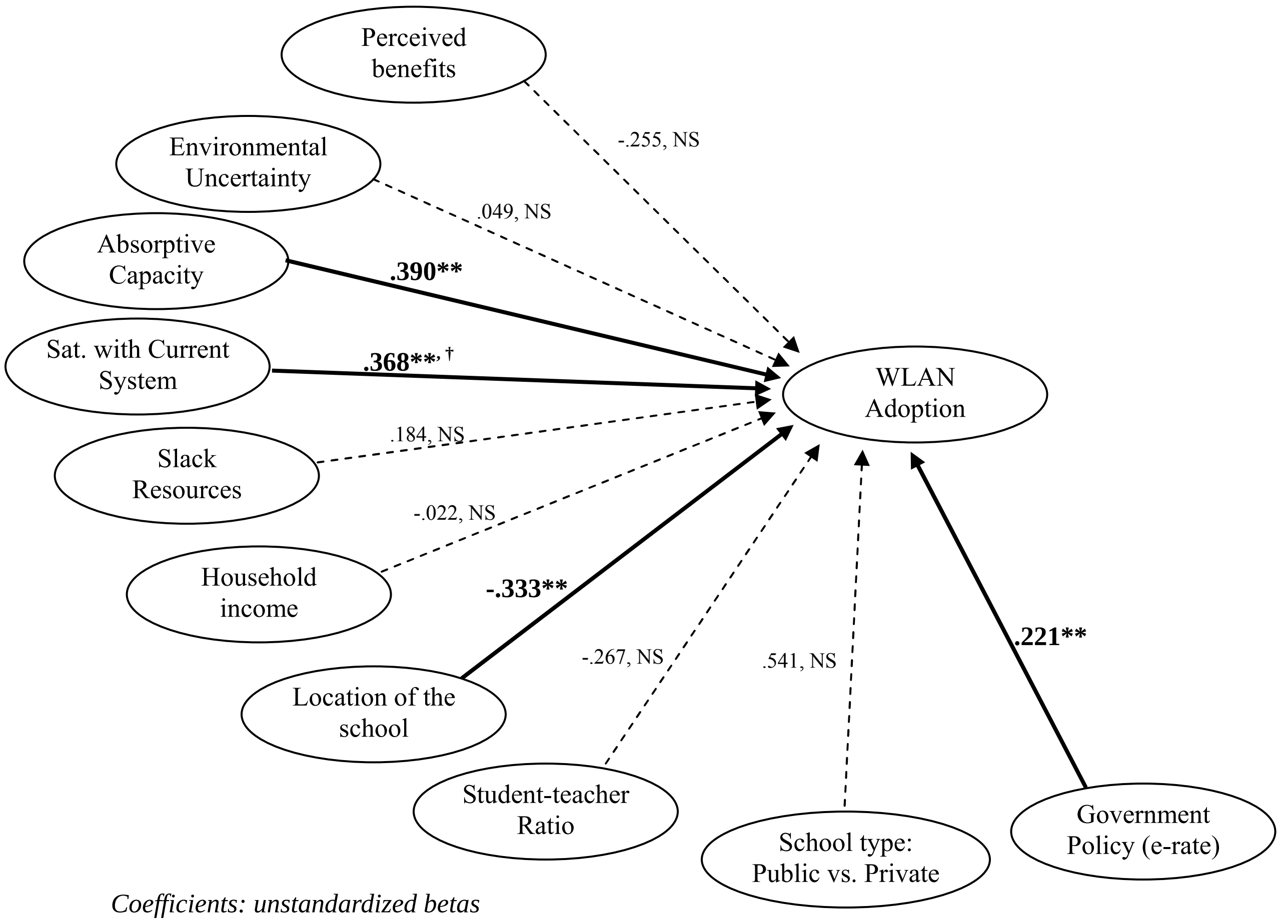
[Table 16] Correlation matrix of variables

	wlan	benefit	uncert	abscap	satcur	slack	income	location	s-t_ ratio	s_type	erate
wlan	1										
benefit	-.00	1									
uncert	.11(*)	.17(**)	1								
abscap	.24(**)	.20(**)	.40(**)	1							
satcur	.24(**)	-.00	.24(**)	.32(**)	1						
slack	.24(**)	.06	.22(**)	.37(**)	.40(**)	1					
income	.14(**)	.02	.07	.17(**)	.17(**)	.33(**)	1				
location	-.16(**)	-.12(*)	-.03	.04	.06	-.12(*)	-.19(**)	1			
s-t_ ratio	-.07	-.04	-.03	-.03	.15(**)	.04	.09	.09	1		
s_type	.13(**)	.00	.08	.11(*)	.15(**)	.12(*)	.48(**)	-.26(**)	.26(**)	1	
erate	.13(*)	-.04	.10	.02	.07	-.03	-.20(**)	.12(*)	-.08	-.19(**)	1

*** p<0.01, * p<0.05*

Variable names: **wlan:** Wireless LAN adoption, **benefit**: Perceived benefit, **uncert:** Environmental uncertainty, **abscap:** absolute capacity, **satcur:** satisfaction with current system, **slack:** slack resources, **income**: household income, **location:** location of the school, **s-t_ ratio:** Student-teacher ratio, **s_type**: School type (public or private), and **erate:** Erate amount.

[Figure 10] Adoption vs. Non-adoption Model: hypothesis test results



Coefficients: unstandardized betas

*** P<0.01, * P<0.05*

† Counter to hypothesized direction

There are a number of interesting findings. *Perceived benefit* is not a significant predictor for WLAN adoption. Thus, H1 is not supported (p=0.212). This result is not uncommon in the IS research domain (e.g., Chau and Tam, 1997). Perceived benefit and actual adoption may be different. *Environmental uncertainty* is not a significant predictor for WLAN adoption (H2 is not supported, p=0.776). Environmental uncertainty in organization is somewhat controversial. Detailed interpretation with respect to previous study findings are discussed in the discussion section. *Absorptive capacity* strongly influences WLAN adoption (H3 is supported, p=0.022). This confirms previous studies (e.g, Hovorka and Larsen, 2006).

Satisfaction with current system is a significant predictor for WLAN adoption. However, to my surprise, the sign of the coefficient is positive, which is contrary to the hypothesis (H4 is significant but with different sign (0.368, p=0.010). I think this is partly because WLAN is an infrastructure technology which can be implemented step by step in addition to the current hot-wired LAN system – not replacing one system; rather, WLAN is extending the current Ethernet system (Stallings, 2005). For this reason, if one is satisfied with the current system, they are likely to extend the system to get the maximum system capacity.

For hypotheses regarding socio-economic influences on WLAN adoption, household income is not significant (H6 is not supported, p=0.827). Thus, there is no WLAN digital divide with respect to schools in rich areas and those in poor areas. The location of the school is strongly supporting WLAN adoption difference (H7 is supported, p=0.003). As hypothesized, schools close to urbanized areas have higher likelihoods of WLAN adoption than schools in rural areas (WLAN digital divide between urbanized area and rural area). Student-teacher ratio is not a significant for WLAN adoption (H8 is not supported, p=0.233). School type (Public vs. private) is not supported (H9 is not supported, p=0.196). It is an interesting finding in that private schools are viewed as being rich whereas public schools are not; however, in terms of WLAN adoption, there is no such presumption.

For the hypothesis regarding government policy (E-rate), E-rate has a significant influence on WLAN adoption (H10 is supported, p=0.007). To increase WLAN adoption and thus digitalization among schools, government subsidy E-rate is found to be an important factor.

4.5.2. Level of Adoption Model

Level of Adoption Model is tested by SEM (LISREL). With the sample size, the supportive measurement results, and the number of total indicators, the variable values used in the structural model are computed from the measurement model. The variance-covariance matrix, generated from the PRELIS was used for the analysis.

To test the hypothesized model, structural equations modeling was used. One of advantages of using SEM is the model specifies causality rather than empirical association (Wayne and Liden, 1995; Jöreskog and Sörbom, 1996). Furthermore, structural equations modeling can correct measurement errors for structural estimates. Finally, structural equations modeling can report overall fit of a model and to suggest alternative (emergent) models (Jöreskog and Sörbom, 1996). To adjust measurement errors in scale values, the path from each latent variable to its measure equal to the square root of the scale reliability (Williams and Hazer 1986; Wayne and Liden 1995; Jöreskog and Sörbom 1996). The error variances for the variable were set to the variance of the variable multiplied by one minus composite reliability (Williams and Hazer 1986; Wayne and Liden 1995; Jöreskog and Sörbom 1996). The results of structural model[12] tested for the Level of Adoption Model is summarized in [Table 17]

[Table 17] Results for structural model for Level of Adoption model

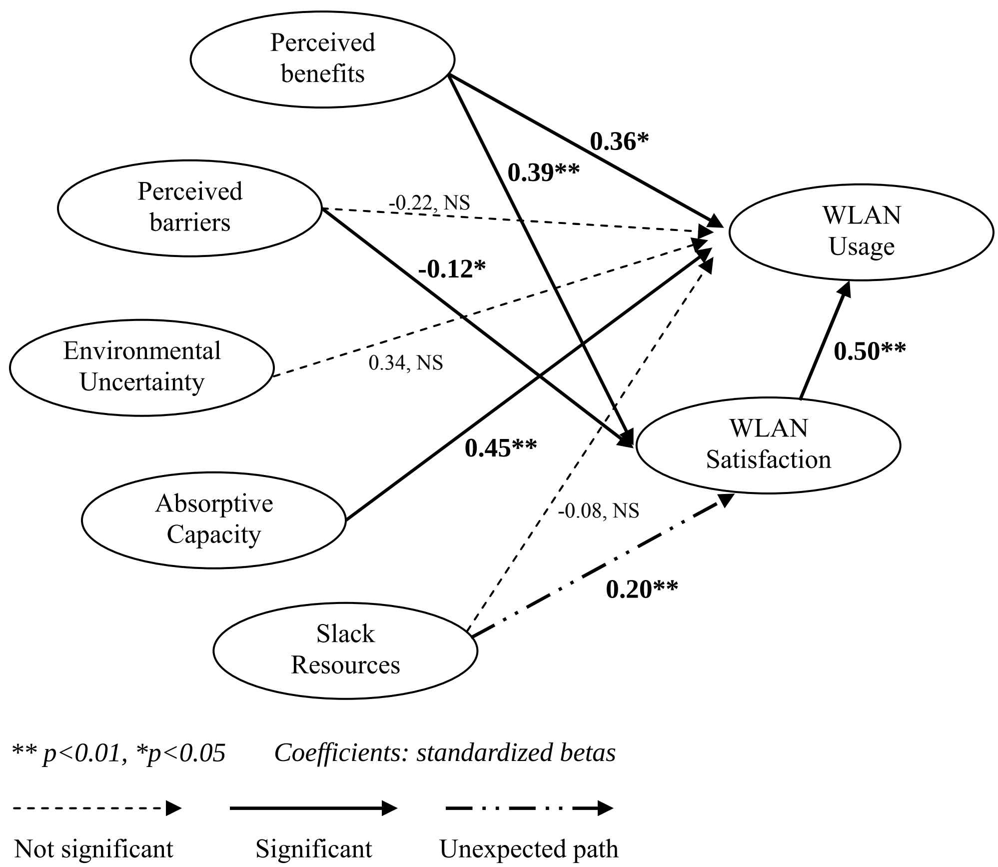
	Hypothesized model	1st	2nd	3rd	Final (emergent model)
Path	FR GA 1 1 FR GA 2 1 FR GA 2 2 FR GA 1 2 FR GA 1 3 FR GA 1 4 FR GA 1 5 FR BE 1 2	FR GA 1 1 FR GA 2 1 FR GA 2 2 FR GA 1 2 FR GA 1 3 FR GA 1 4 FR BE 1 2	FR GA 1 1 FR GA 2 1 FR GA 2 2 FR GA 1 3 FR GA 1 4 FR BE 1 2	FR GA 1 1 FR GA 2 1 FR GA 2 2 FR GA 1 4 FR BE 1 2	**FR GA 1 1 FR GA 2 1 FR GA 2 2 FR GA 1 4 FR BE 1 2 FR GA 2 5**
Added or excluded paths	All hypothesized paths	Drop GA 1 5 (Slack ->Usage) t = -0.67	Drop GA 1 2 (Barrier ->Usage) t = -1.47	Drop GA 1 3 (uncert -> usage) t=-1.57	**Add GA 2 5 (Slack -> Satisfaction) - Unexpected path**
Fits	RMSEA = 0.15 NFI = 0.95 NNFI = 0.70 GFI = 0.98 AGFI = 0.79	RMSEA = 0.12 NFI = 0.95 NNFI = 0.78 GFI = 0.98 AGFI = 0.84	RMSEA = 0.12 NFI = 0.94 NNFI = 0.81 GFI = 0.97 AGFI = 0.85	RMSEA = 0.11 NFI = 0.93 NNFI = 0.82 GFI = 0.97 AGFI = 0.86	**RMSEA = 0.068 NFI = 0.97 NNFI = 0.95 GFI = 0.99 AGFI = 0.93**
Remarks					**No confounding MI's**

Based on the above test of the structural model, I dropped insignificant path one by one

[12] *Full testing results including fit indexes and path coefficients from LISREL output are given in Appendix 5.*

and find every model fit indexes and t-values of path coefficients. Furthermore, after dropping all the insignificant paths, emergent paths are investigated. The emergent model includes one unexpected path that was included based on theoretical considerations and modification indices (MIs) of 10.0 or more (Sabherwal et al., 2006). The final structural model (emergent model) is as follows [Figure 11].

[Figure 11] Level of Adoption model: Hypotheses testing results



WLAN satisfaction strongly affects WLAN usage (H11 is supported, 0.50, t=4.00). This confirms the previous findings (e.g., Rai et al., 2002; Sabherwal et al., 2006). *Perceived benefits* is significant for *WLAN usage* (H12 is supported; 0.36, t=1.83). Furthermore, *Perceived benefits* also strongly affects *WLAN satisfaction* (H13 is supported; 0.33, t=4.72). This will be another empirical finding for the debate among IS success models of DeLone and McLean (1992), Seddon (1997), and Rai et al. (2002); the empirical result in this research found that benefit affects system usage and satisfaction, and satisfaction affects system usage.

Conceptually opposite construct to *Perceived benefits* is *Perceived barriers.* *Perceived barriers* is not a good predictor for *WLAN usage* (H14 is not supported; -0.22, t = -1.47). However, as with *Perceived benefits*, *Perceived barriers* negatively influences *WLAN satisfaction* (H15 is supported; -0.13, t=-1.66). This also confirms that benefit (barrier) – satisfaction – adoption framework. *Environmental uncertainty* is not a significant predictor for *WLAN usage* (H16 is not supported; 0.34, t=-1.57). *Absorptive capacity* strongly influences WLAN usage (H17 is supported; 0.61, t = 2.25). *Slack resources* is not significant for WLAN usage (H18 is not supported; -0.08, t=-0.67).

The results for the emergent model are given in [Table 13]. It has one unexpected path that was included based on theoretical considerations and LISREL modification indices of 10.0 or more (Sabherwal et al., 2006). The unexpected path is between slack resources and WLAN satisfaction. Modification index for this path is 11.90. The theoretical consideration between *slack resources* (financial and personnel) and organizational level *satisfaction* was not thoroughly investigated. However, as Thong (2001) argued, the presence of slack personnel (experts) will increase user satisfaction. Although Thong (2001)'s study was based on the outside slack personnel (experts), I believe this can be extended to an intra-organizational perspective.

5. DISCUSSION

Hypotheses testing results are summarized in [Table 18] and [Table 19].

[Table 18] Adoption vs. Non-adoption Model

Hyp. No.	Hypothesis	Result
H1	Perceived benefits of adopting a WLAN positively affect WLAN adoption.	Not supported
H2	Environmental uncertainty negatively affects WLAN adoption.	Not supported
H3	Absorptive capacity positively affects WLAN adoption.	**Supported (b=.390, t<0.01)**
H4	The satisfaction level with wired communication network will negatively affect WLAN adoption.	**Supported (Opposite sign) (b=.368, t<0.01)**
H5	The availability of slack resources positively affects WLAN adoption.	Not supported
H6	Average household income of students is positively associated with WLAN adoption.	Not supported
H7	Rural areas are likely to have lower WLAN adoption rate than urban areas.	**Supported (b=-.333, t<0.01)**
H8	Student-teacher ratio is negatively associated with WLAN adoption.	Not supported
H9	Private schools will have higher WLAN adoption than public schools.	Not supported
H10	Federal and local government subsidy is positively associated with WLAN adoption.	**Supported (b=.221, t<0.01)**

[Table 19] Level of Adoption Model

Hyp. No.	Hypothesis	Result
H11	WLAN satisfaction positively affects the extent to which WLAN is used.	**Supported (b=0.61, p<0.01)**
H12	Perceived benefits of adopting a WLAN positively affect the extent to which WLAN is used.	**Supported (b=0.36, p<0.05)**
H13	Perceived benefits of adopting a WLAN positively affect WLAN satisfaction	**Supported (b=0.39, p<0.01)**
H14	Perceived barriers of adopting a WLAN negatively affect the extent to which WLAN is used.	Not supported
H15	Perceived barriers of adopting a WLAN negatively affect WLAN satisfaction.	**Supported (b=-0.13, p<0.01)**
H16	Environmental uncertainty negatively affects the extent to which WLAN is used.	Not supported

H17	Absorptive capacity positively affects the extent to which WLAN is used.	**Supported (b=0.61, p<0.01)**
H18	The availability of slack resources positively affects the extent to which WLAN is used.	Not supported
Unexpected significant result		
The unexpected path: from slack resources to WLAN satisfaction. Modification index = 11.90. **Strongly supported (b=0.20, p<0.01)**		

5.1. General discussions with respect to analysis results

WLAN adopters and. non-adopters do not significantly differ in terms of *perceived benefits* of adopting WLAN. Since WLAN is appropriate to access network that is close to end-users, people who are already exposed to WLAN benefits may recognize the benefits of adopting WLAN despite not having adopted WLAN in the school environment.

The following WLAN benefits are identified in the current study: Mobility/portability, No cabling, Competitive advantage, Easy collaboration, Time saving. The identified benefits are related to efficiency and convenience of using WLAN. Future studies in this domain should focus more on these benefit aspects rather than cost initiative.

The correlation between WLAN adoption and perceived WLAN benefit is close to zero, and this means that perceived benefit is not a primary determinant for actual WLAN adoption. Unlike Adoption vs. Non-adoption model, in the Level of Adoption model 'Perceived benefits' strongly affects WLAN satisfaction and WLAN usage. From these results, mediating variables (or implicit hierarchy) between WLAN adoption and perceived benefits such as WLAN user satisfaction should be paid more attention.

This will be another empirical finding for the debate among IS success models. Recent publications (e.g., Rai et al., 2002; Sabherwal, et al., 2006) argued that there is an association between perceived benefits (e.g., usefulness) and system use. The current study confirms that perceived benefit influences both satisfaction and system usage. Furthermore, whereas previous studies limit the benefits construct as perceived usefulness (DeLone and McLean, 1992; Seddon, 1997; Rai et al., 2002), the current study includes diverse benefit measurements including: expected benefit of competitive advantage, actual benefit of flexibility, actual benefit of competitive advantage, and actual benefit of easy collaboration.

Another interesting finding with respect to 'perceived benefit' is the negative correlation $r=-0.12$ ($p<0.05$) between 'perceived benefit' and 'location of school,' which means that schools in urbanized areas perceived more WLAN benefits than those in rural areas. This makes perfect sense in that schools in urbanized areas have opportunities to recognize benefits of WLAN whereas schools in rural areas do not. This empirical evidence also calls for some policy implication for digital divide. If we flip the empirical evidence, it tells us that in order to increase WLAN adoption in a rural area, exposure to WLAN benefits is critical. Not only increasing e-rate for rural areas but also increasing the opportunity of recognizing WLAN benefits is also important for mitigating the digital divide.

'Perceived barriers' does not seem to influence *WLAN usage*. However, as with *Perceived benefits*, *Perceived barriers* negatively affect *WLAN satisfaction*. The identified barrier items are: expected barriers of familiarity to current IS, expected barriers of system compatibility and actual barriers of system compatibility. The measurement items are related to WLAN compatibility issues to the current system. In order to increase WLAN usage in the organization, service providers and policy makers both make effort to eliminate WLAN compatibility issues.

'Environmental uncertainty' is also not a significant predictor for WLAN adoption. Uncertainty in organization is somewhat controversial: For instance, Grover and Goslar (1993b) argued that environmental uncertainty is a strong predictor for telecommunication technology adoption. They explained that when environmental uncertainty is greater, organizations are willing to adopt relevant technology to obtain information processing power. By the same token, though dependent variable is a bit different, Sabherwal and Kirs (1994) found that environmental uncertainty is a significant predictor for IT success in educational institutions. Unlike Grover

and Goslar (1993b), Chau and Tam (1997) found that uncertainty does not affect open source adoption. The authors tried to explain this result by the risk of discontinuous use of technology and Swanson (1994)'s IS innovation. They suggested that many-non-adopting organizations will be taking a wait-and-see attitude to evade high risk of changing their technology infrastructure. Second, they argued that open source adoption is more or less not a business innovation but IS oriented adoption (Swanson's type Ib innovation). For this, environmental factors for affecting business values were not considered important for core technology innovation.

The current study result calls for a different explanation for insignificant influence of environmental uncertainty to WLAN adoption. First, from an interview with principals, K-12 schools are very conservative and they are not keen to outside trends as profit organizations do. Non-profit organization context may play an important role for insignificance of environmental uncertainty to WLAN adoption. Second, WLAN technology has not only the feature of Swanson (1994)'s Type 1b technology (IS technological process innovation) but also the feature of business administrative process because organizations can increase business process flexibility and fast responses by employing WLAN. In this respect, the innovation that has both IT technological process innovation and business administrative process innovation will be the characteristics of WLAN, which is not defined in Swanson (1994) model. For this reason, Chau and Tam (1997)'s explanation using Swanson (1994)'s theory, by which environmental uncertainty is not a significant predictor for technology adoption may not be applied to WLAN context.

'Absorptive capacity' strongly influences WLAN adoption. This confirms previous studies. For instance, Hovorka and Larsen (2006) found that absorptive capacity facilitates the adoption of large-scale IT system. If schools have a high level of absorptive capacity, they tend to adopt WLAN for adopting benefits. Cohen and Levinthal (1990) described the role of absorptive capacity as follows (p.148): "…Our perspective implies that the easy of learning,

and thus technology adoption, is affected by the degree to which an innovation is related to the pre-existing knowledge base of prospective users." If K-12 schools have pre-existing knowledge to find the value of WLAN and the ability to assimilate innovation, they tend to adopt WLAN for improving their school environments (e.g., innovation).

'Satisfaction with current system' is a very interesting finding. Previous studies found that if organizations are satisfied with their information systems, they tend not to change to a different system: for instance, changing operating system (OS) from *Windows NT* to *Open source Linux* (e.g., Chau and Tam, 1997). However, unlike previous findings, the current study found that organizations tend to adopt WLAN if they are satisfied with a current system. I think this is because WLAN IEEE 802.11x standard is a port based infrastructure technology which can be implemented as an extension of Ethernet (CSMA/CD[13]) structure. If schools are satisfied with a current wired Ethernet, they may deploy WLAN because extending network based on Ethernet (IEEE 802.3) is relatively easy for WLAN (IEEE 802.11x) (CWNA, 2006). If a new technology is replacing the old technology, satisfaction with current system will negatively work. However, as seen from the WLAN case, if technology is extending or upgrading the current system, satisfaction with current system will positively work for new technology adoption.

'Slack resources' is also an interesting finding. 'Slack resources' is not significant for both WLAN adoption and WLAN usage. However, the unexpected path between slack resources and WLAN satisfaction calls for a research attention. The theoretical consideration between *slack resources* (financial and personnel) and organizational level *satisfaction* was not thoroughly studied. Thong (2001) argued that outside slack personnel (experts) will increase user satisfaction. The rationale is as follows; if an organization has enough slack resources with respect to money and people, the organization is highly likely to adopt more solid and user friendly sophisticated technology. This in turn increases user satisfaction and increased satisfaction positively influences WLAN usage. The unexpected significant results from the

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[13] *Carrier Sense Multiple Access / Collision Detection – 802.3 Ethernet*

current study need to be further investigated in a different technology adoption context.

Socio-economic factors show some interesting digital divide insights among WLAN adopters and non-adopters. First, *household income* of student is not different with respect to WLAN adoption at K-12 schools. Hoffman and Novak (1998) found that household income explains Internet access from home (home computer ownership) but not Internet access from organizations (schools and libraries). This in turn, there seems no WLAN digital divide between schools in rich areas and those in poor areas.

Location of the school has a negative relationship to WLAN adoption, which means schools in urban areas have higher likelihood of adopting WLAN than schools in rural areas. This suggests that there is WLAN digital divide between urban schools and rural schools. This empirical result is supported by the negative correlation between household income level and school location; that is, schools in urban areas will have higher household income than those in rural areas. According to Reeves (2003), although government subsidy (E-rate) helps network connectivity of rural schools by having discounted price of telecommunication service and equipment, the discount does not impact the starting price: the starting price is as high as $3,000 per month in some schools. Furthermore, some rural area is too far to have network connectivity - if the service is not available, the subsidy is not helpful. Moreover, the low population rate at rural areas is not a good marketing driver for Internet Service Providers (ISPs). There is only low profit incentive for ISPs in these areas. Increasing network connectivity and WLAN in these areas will be important for policy makers.

'Student-teacher ratio' does not significantly differ between WLAN adopters and non-adopters. A high student-teacher ratio is viewed as a weakness of a school or school system and it implies students will have lower likelihood of utilizing benefits of WLAN and thereby low likelihood of adopting WLAN. This means in turn that there is no WLAN digital divide between low student-teacher ratio schools and high student-teacher ratio schools. However, this measure is a bit confusing because the student-teacher ratio is based upon 'full time teachers' per

number of students. According to The National Center for Education Statistics (NCES), student-teacher ratio can be high for schools that have a large number of part-time teachers. This would show the student-teacher ratio higher than the actual status. For this reason, the empirical findings in this research regarding student-teacher ratio would require more systematic investigation for future generalization:

Public and private schools do not show any significant difference in the likelihood of adopting WLAN. Previous NCES report (2003) found that private schools have lower ability of advanced telecommunication than public schools. However, it is an interesting finding in that in terms of WLAN adoption, private schools and public schools are indifferent. However, this should be further investigated for generalization because there are a number of studies reveal that even private schools have different levels of digitalization. This is further supported by the negative association ($r=-0.19$, $p<0.01$) with the e-rate amount and school type, which reveals that public schools will have larger amount of E-rate than private schools. E-rate is need-based subsidy and there are many public schools subscribing to E-rate so that amount of E-rate assigned to public schools are larger than private schools. However, not only public schools but also some private schools need E-rate.

'*State and government subsidy* (E-rate)' is significantly different between adopter sand non-adopters. As expected, schools with a larger amount of subsidy will have more chances of adopting WLAN. According to US Department of Education (2003), 90 percent of E-Rate funds are going to public schools and districts (about 10 percent to private and parochial schools). Furthermore, 97 percent of the largest public school districts (over 25,000 students) are said to apply for E-Rate discounts compared to 74 percent of the smallest public school districts (under 3,000 students).

The current study extends the research by Goolsbee and Guryan (2006). They found that E-rate helps increasing the Internet investment of schools. The current study found that E-rate helps WLAN adoption among schools (including both public and private schools). Goolsbee and Guryan (2006)'s study results are based on public K-12 schools only. However, since about 10 percent of E-rate is assigned to private and parochial schools, it would not be underestimated.

5.1. Implication for practitioners

Unlike other information technologies, WLAN has public and non-profit organization market demands. For instance, Chicago plans to create a big 228-square mile hotspot that would cover the entire city. Philadelphia is deploying citywide WiFi with Earthlink and San Francisco is considering an offer from Google to deploy public WLAN service. Furthermore, some schools are pilot testing the use of PDAs in their curriculum with the help of Cisco Systems. In each of these schools, Cisco has installed wired and wireless IP networks, allowing students and staffs access to educational information whenever-wherever they are in the school. "One of the schools, St. Lucie, is piloting the use of PDAs, which students use to receive homework assignments and browse the internet. The school says that the PDAs are proving beneficial in increasing student-teacher interaction as they offer a more direct method of providing specialized instruction. Teachers are also providing educational content and resources to the students' PDAs, enabling students to access the information for remedial or specialized instructional needs" (Computer Business Online, 2006 March 23rd). As seen from these cases, WLAN service solution providers and device manufacturers should pay more attention to the WLAN public and non-profit organization market.

One of empirical findings from the current analysis is that schools tend to adopt WLAN if they are satisfied with the current information system, which is contrary to the previous findings (Chau and Tam, 1997). WLAN service solution providers are recommended developing integrated solution for WLAN market. For instance, WLAN integration solution should not hamper current system performance and seamlessly extending the current network. Some WLAN solution provider such as *Cisco* is already driving similar marketing campaign. *Cisco* promotes *Unified Wireless Solution*™ which covers not only wireless but also wired networks and these two integrated networks are controlled and managed by a single solution (http://www.cisco.com/en/US/netsol/ns340/ns394/ns348/ns337/networking_solutions_package.html). Based on the current analysis results, I think this is a very appropriate marketing strategy for potential WLAN adopters. For WLAN adopters, satisfaction plays an important role for WLAN usage. Vendor WLAN strategy would focus on increasing customer satisfaction of using WLAN. Furthermore, 'perceived barriers' has a strong negative impact on user WLAN satisfaction. For this reason, compatibility issues and security concerns should be eliminated to increase WLAN usage.

5.2. Implication for policy makers

E-rate has been investigated for its effectiveness in sociology and public policy (e.g., Goolsbee and Guryan, 2006). They found that E-Rate allowed schools increase Internet investment but didn't influence student performances. The study result only pertains to public schools. Furthermore, their measures of dependent variables seem somewhat problematic. They used four items to measure the digital divide in public schools: (1) Classrooms with Internet Connections, (2) Classrooms with Internet Connections per Teacher, (3) Computers for Instructional Purposes and (4) Computers for Instructional Purposes per Teacher. These measurements were also investigated in the current dissertation research. The identified problem is that almost all of the instructional classrooms are connected to Internet. 95 percent of respondents reveal that more than 60 percent of class rooms are connected online. Furthermore, national survey (NCES, 2006) also reported that in 2005, 95 percent of public school classrooms are connected to online. For this reason, if the above items are used for measuring digitalization of schools, schools with large number of classrooms will be considered highly digitalized. For this reason, for effective policy making effort with respect to digitalization (i.e., Internet connection and/or WLAN adoption), more sophisticated digitalization measures should be developed.

As with previous E-rate studies, WLAN adoption is significantly influenced by E-rate. Furthermore, as seen from the St Lucie virtual classroom case, WLAN can help teachers and students easy access to specialized instruction material as well as seamless interaction. However, current E-rate only supports wireless access points and network interface card, not overall solution and consulting fees (AT&T report, 2006). If the government find further supports that WLAN improves school communication and student performance, state and local government are recommended to extend the coverage of E-rate items.

Finally, the current study found that there is WLAN digital divide between rural areas and urbanized areas. As Reeves (2003) argued, some rural area can't afford or attract the e-rate discount; in this case, the government should consider different policy for increasing Internet connectivity as well as WLAN adoption.

5.3. Limitations

As an exploratory study, the current WLAN research is not free from limitations. First, some of constructs which were initially designed in the current study dropped because of a low internal consistency of measurement. 'Organization structure,' 'IS maturity,' and 'Expected Barriers' are dropped. Although prior studies (Jeyaraj et al., 2006) reported that 'organization structure' is not a good predictor for IT adoption, it would be richer if the constructs were included.

Second, due to the exploratory nature in terms of WLAN benefits (barriers), a number of measurements are excluded because of construct validity requirements (convergent validity, discriminant validity, composite reliability and AVEs). Future study in this domain would perform an extensive confirmatory factor analysis for finding WLAN benefits (barriers).

Third, the current study accommodates/differentiates expected benefit (barrier) and actual benefit (barrier) of WLAN so that it provides richer set of measurement of WLAN benefits (barriers). However, the measurements in this study, albeit providing richer measurements by segmenting expected and actual benefits (barriers), were measuring the two sets of variables retrospectively. Asking respondents retrospectively is not uncommon in IS research domain, but it may not clearly differentiate expected benefits and actual benefits, it is rather mixed perceived benefits (barriers). One extension of the current study with respect to WLAN benefits (barriers) is employing longitudinal study measuring benefits after actual implementation: e.g., comparing benefits at day 1 and day 100. This will help to identifying exact benefits and barriers of WLAN adoption.

5.4. Direction for future research

An unexpected significant path is the relationship between slack resources and WLAN satisfaction. To increase WLAN satisfaction, which will eventually increase WLAN usage, provision of additional financial and personnel resources is strongly recommended. Increasing customer care by adding more experts for WLAN installed school would increase satisfaction level and consequently increase WLAN usage. It would be a good topic for a future confirmatory study that identifies the relationship between slack resources and satisfaction in a different technology adoption context.

Second, unlike previous findings, satisfaction with current system is found to affect WLAN adoption positively. However, for further generalization, this result should be tested in a different technology adoption context. For instance, the future studies would seek the answer for the following question: unlike WLAN - infrastructure information technology, if new information technology is more or less at an application level (e.g., replacing Microsoft Internet Explorer by Mozilla FilreFox), would this relationship still exist?

Third, school type (either public or private) does not differ in terms of WLAN adoption. Future studies may investigate whether different school type affects technology adoption.

Finally, future studies with respect to WLAN adoption in schools may include the application of WLAN and investigate its impact on student performance. A number of previous studies such as Goolsbee and Guryan (2006) used SAT math scores as a proxy of student performance. They found that E-rate increased the digital investment of schools but the digital investment supported by E-rate does not affect students' math scores. I believe this is a bit narrow aspect of technology adoption and limited measurement of its influence. Future studies in this domain will be sought to develop WLAN success and student performance measurements.

6. CONCLUDING REMARKS

The study has provided some insights for academic researchers, business practitioners and policy makers, alike. The integrated WLAN technology adoption framework in the current study will be a good starting point for future WLAN adoption research because the current adoption framework has integrated innovation studies and tested various organizational determinants of technology adoptions. Furthermore, the study included diverse socio-economic factors. Secondly, business practitioners may have a number of implications: the current study offers an in-depth analysis for facilitating factors (absorptive capacity, satisfaction with current system) and barriers of WLAN with various organizational / demographic statistics. The educational institutions market is ever increasing with the help of government subsidy and other government funds. The explanation of real marketing strategy examples (e.g., Cisco's Unified Wireless Solution) can be a guideline for this big emerging market.

For policy makers, the present results will provide strong empirical evidence of the E-rate program and its relationship to WLAN adoption. WLAN adoption is strongly influenced by E-rate. The E-rate subsidy has revealed a number of fraud and misuse cases by a federal investigation. However, the real impacts of E-rate on organizational the digital divide should not be discounted. Furthermore, the E-rate subsidy didn't allow schools to spend money to deployment of WLAN. I think this is very restrictive statutory clause in the E-rate program. The current study provides a counter evidence for this limited policy and provides a recommended revision for the next policy making with respect to WLAN deployment. Finally, I hope this research triggers future studies of wireless technology in other organizational contexts.

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[Appendix 1] Confidentiality Policy

Project: *Wireless LAN 802.11x in U.S. Educational Institutions: Technology Adoption and Digital Divide Perspective*
Investigator: Mr. Sang-Baek (Chris) Kang

The goal of the current research is to explore important wireless LAN adoption factors with respect to digital divide among educational institutions by conducting 3-5 in-depth case studies (high schools and/or middle schools) in Missouri.

As a participant in this research, you are being interviewed about your perceptions of wireless LAN adoption with respect to digital divide (and E-rate subsidy) issues. Interviews are tape recorded to ensure accuracy of data collection. The audio-tapes are accessible only to the investigator and an individual who will be hired to transcribe the tapes. The transcripts will be available only to the investigator and his dissertation committee members. Tapes are destroyed after the project is complete, or alternatively, you may have the tapes after the project is complete.

To preserve confidentiality, identity of individual and schools will remain anonymous. In all publications based on this study, no specific schools or individuals will be identified.

You may ask questions you have now. If you have questions later, you may contact the investigator at 314.516.6291 (S. Chris Kang) or the investigator's advisor at 314.516.6490 (Dr. Rajiv Sabherwal). If you have any questions about your rights as a research subject, you may call the Chairperson of the Institutional Review Board at 314.516.5897.

____
Sang-Baek (Chris) Kang
Principal Investigator
Doctoral Candidate
College of Business Administration

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

I have read the statement above and have had the opportunity to express my concerns, to which the investigator has responded satisfactorily. I believe I understand the purpose of the study, the benefits and risks involved, and I agree to be a participant in this study.

____
Signature of Participant

____
Date

[**Appendix 2] Interview guide**

1. Handing out a questionnaire draft and ask the interviewee whether words and questions are appropriate.
2. Can you tell us something about your professional career as a principal? Where did you work? And how long and when did you join your educational organization? And can you tell us something about the following items?
   - The number of students at your organization
   - The number of IT employees (staffs) at your organization
   - IT budget of your organization
3. Approximately, how many WLAN users (laptops) are at your organization?
4. How severe is the competition among peer schools? (Peer factors, i.e. Other schools' WLAN use)
5. How predictable are students' demands for WLAN?
6. At what rate does information technology change in schools? For example, what technological changes have been seen since you worked at your school? (dial-up -> dedicated lines (and/or DSL) -> WLAN)
7. Do you think using WLAN makes educational institution competitive (attractiveness to students, e.g. private schools)?
8. What are the benefits from WLAN adoption in your school?
9. What are some of the barriers to WLAN migrations within on organization?
10. Do you think your school has the capability to assimilate WLAN deployment? In other words, how do you view your school's capability for embrace and assimilate WLAN technology?
11. What are the evaluation criteria of information systems performance at your organization?
12. To what extent is your organization's top administrators (i.e. Principal of your school)

informed about information technology?

13. How is IS/IT planning formalized at your organization? Is IT planning done by a steering committee? How about Top administrators' support? How about organization structure - centralized / decentralized?
14. To what extent is your organization's IT infrastructure geographically distributed?
15. Can you comment on the price/performance of your organization IT system?
16. What do you think of your organization's existing network system? Do you think they serve the needs of the organization?
17. To what extent financial and personnel slack resources of your organization for WLAN adoption?
18. What are the students' overall levels of computer usability in your organization?
19. Do you think your organization has more/less computing resources, IT personnel, computing literacy of students, and/or network connections than other peer schools?
20. Do you think *E-rate* subsidy can facilitate overall investment regarding IT?
21. How is E-rate subsidy assigned?
22. What are major drawbacks of E-rate?
23. What are the most important IT issues in your school?

[Appendix 3] Survey Questionnaire

Survey Questionnaire: Wireless LAN 802.11x in U.S. Educational Institutions

The current survey explores important factors affecting adoption of wireless LAN (Local Area Network) in educational organizations. The study results will examine the current status of wireless LAN deployment of schools in Missouri (High schools, Middle schools, and Elementary schools). The results could be a helpful guide for future wireless LAN investment and deployment.

It will take about 10 minutes to complete this survey. All survey data will be confidential. Furthermore, the survey results and implications for future WLAN deployment will be summarized and given to you in a research report.

For any further information or queries please contact:

Mr. Sang-Baek (Chris) Kang (sbkang@umsl.edu) (Principal investigator)
Doctoral Candidate of IS
College of Business Administration
University of Missouri-St. Louis
(314) 516-6291

Dr. Rajiv Sabherwal (Sabherwal@umsl.edu) (Principal investigator's Dissertation Advisor)
University of Missouri Curators Professor
College of Business Administration
University of Missouri-St. Louis
(314) 516-6490

Thank you very much for your valuable participation

THIS SECTION IS ALL ABOUT YOUR SCHOOL:

1. Please indicate which grade levels your school has (click all that apply):
- High school
- Middle school
- Elementary school

2. What is your current job title?

Principal | Vice principal | Teacher | Staff | Other

3. How long have you been in this position?

4. How long have you worked at this school?

5. Please indicate your age group:
- Under 30
- 30 - 40
- 40 - 50
- 50 - 60
- Over 60

6. Please indicate your gender:

Male | Female

*** 7. Approximately, how many students are enrolled in your school?**

*** 8. Approximately, how many teachers are employed in your school?**

9. Approximately, what is the dollar amount of your school's annual operating budget?

10. Approximately, what percentage of your school's annual operating budget is allocated for IT (information technology)?

11. Approximately, what is the dollar amount of your capital improvement budget?

12. Approximately, what percentage of your capital improvement budget is allocated for IT (information technology)?

* 13. Has your school implemented wireless LAN?

YES NO

PRIOR TO WIRELESS LAN ADOPTION

*** 14. Prior to wireless LAN, my school anticipated the following benefits/difficulties of adopting wireless LAN:**

	Strongly disagree	Disagree	Neither agree nor disagree	Agree	Strongly agree
Mobility / Portability / Accessibility (any time, any where)					
Convenience (No cabling required)					
Ease of set-up					
Cost savings					
Business process flexibility					
Competitive advantage					
Easy collaboration					
Time saving					
Improved efficiency					
Improved school image					
High cost for changing information system					
Existing staffs are not familiar with wireless LAN					
Very difficult to dispose of existing system					

<< Prev Next >>

AFTER THE ACTUAL IMPLEMENTATION OF WIRELESS LAN

*** 15. After implementing wireless LAN, my school actually experienced the following benefits/barriers:**

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Mobility / Portability / Accessibility (any time, any where)	○	○	○	○	○
Convenience (No cabling required)	○	○	○	○	○
Ease of set-up	○	○	○	○	○
Cost savings	○	○	○	○	○
Business process flexibility	○	○	○	○	○
Competitive advantage	○	○	○	○	○
Easy collaboration	○	○	○	○	○
Time saving	○	○	○	○	○
Improved efficiency	○	○	○	○	○
Improved school image	○	○	○	○	○
High cost for changing information system	○	○	○	○	○
Existing staff is not familiar with wireless LAN	○	○	○	○	○
Infeasible to dispose of existing system	○	○	○	○	○

<< Prev   Next >>

*** 16. Number of wireless LAN users (teachers/staff/students) in your school. (approximately) (Check one)**

- 1-4
- 5-49
- 50-249
- 250-999
- 1,000 or more
- Unable to determine

*** 17. What is your main source of information about wireless LAN? (Mark all that apply):**

- Hardware/software vendors
- Teachers and/or staff at my school
- Peer educational organizations
- Industry (Vendors or Service Providers)
- News articles
- Academic journals
- Unable to determine

*** 18. In which locations can users (teachers/staff/students) access the wireless LAN server? (Mark all that apply):**

- In specific workgroups / departments
- Building wide
- School wide
- In the testing lab
- Unable to determine

*** 19. Which devices are used to access the wireless LAN? (Mark all that apply):**

- Notebook PCs (Laptops)
- Desktop PCs
- PDA or hand-held computers
- Unable to determine

*** 20. In which areas of your school building is wireless LAN accessible? (Mark all that apply)**

- Individual offices/ cubicles
- Conference / Meeting rooms
- Classrooms
- Inventory area/Warehouses
- Libraries
- Unable to determine

*** 21. Which applications are accessed through wireless LAN at your school? (Mark all that apply)**

- [ ] E-mail
- [ ] Internet surfing
- [ ] Office Suite (Word Processing, Spreadsheets, Presentation Tools)
- [ ] Data management
- [ ] File Transfer
- [ ] Other programs
- [ ] Unable to determine

*** 22. How satisfied are you with your school's wireless LAN?**

Very dissatisfied	Dissatisfied	Neither dissatisfied nor satisfied	Satisfied	Very Satisfied
○	○	○	○	○

*** 23. How satisfied are your students with your school's wireless LAN?**

Very dissatisfied	Dissatisfied	Neither dissatisfied nor satisfied	Satisfied	Very Satisfied
○	○	○	○	○

*** 24. How satisfied are your teachers with your school's wireless LAN?**

Very dissatisfied	Dissatisfied	Neither dissatisfied nor satisfied	Satisfied	Very Satisfied
○	○	○	○	○

*** 25. How satisfied are your staff with your school's wireless LAN?**

Very dissatisfied	Dissatisfied	Neither dissatisfied nor satisfied	Satisfied	Very Satisfied
○	○	○	○	○

*** 26. How strongly would you recommend the adoption of wireless LAN to peer schools?**

Strongly not recommend	Not recommend	Neutral	Recommend	Strongly recommend
○	○	○	○	○

*** 27. How frequently do you use wireless LAN at your school?**

A few times a month or less	About once a week	Several times a week	About Once a Day	Multiple Times Daily
○	○	○	○	○

*** 28. How frequently do your students use wireless LAN at your school?**

A few times a month or less	About once a week	Several times a week	About Once a Day	Multiple Times Daily
○	○	○	○	○

29. How frequently do staff use wireless LAN at your school?

A few times a month or less	About once a week	Several times a week	About Once a Day	Multiple Times Daily
○	○	○	○	○

*** 30. How large is the size of wireless LAN coverage (accessibility) at your school?**

Less than 20%	20% to 40%	40% to 60%	60% to 80%	80% to 100%
○	○	○	○	○

*** 31. How stable is the wireless LAN connection in your school?**

Very unstable	Unstable	Neither unstable nor stable	Stable	Very Stable
○	○	○	○	○

*Q32 is for non-adopter questions only (Web questionnaire logic: at Question 14, IF "No" is chosen, THEN GOTO Q32 AND PROCEED TO Q33, ELSE GOTO Q15 UPTO Q31 AND SKIP Q32 AND PROCEED TO Q33)

THIS SECTION IS ONLY FOR THE SCHOOLS WHERE WIRELESS LAN IS NOT AVAILABLE.

*** 32. My school would likely achieve the following benefits/difficulties if we adopted wireless LANs**

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
Mobility / Portability / Accessibility (any time, any where)	○	○	○	○	○
Convenience (No cabling required)	○	○	○	○	○
Ease of set-up	○	○	○	○	○
Cost savings	○	○	○	○	○
Business process flexibility	○	○	○	○	○
Competitive advantage	○	○	○	○	○
Easy collaboration	○	○	○	○	○
Time saving	○	○	○	○	○
Improved efficiency	○	○	○	○	○
Improved school image	○	○	○	○	○
High cost for changing information system	○	○	○	○	○
Existing staff is not familiar with wireless LAN	○	○	○	○	○
Infeasible to dispose of existing system	○	○	○	○	○

*** 33. For the following questions, please describe the extent to which you agree or disagree with each of the following statements:**

	Strongly disagree	Disagree	Neither disagree nor agree	Agree	Strongly agree
My school can predict how government policy will affect our school					
My school can predict how IT innovations in the market could benefit our school					
My school can predict what IT technologies are needed to prepare our students for the next level in their education					
My school's quality of education is frequently compared to that of other peer schools or measured by 3rd party ranking institutions					
The adoption of wireless LAN allows my school to remain competitive					
Peer schools influence my school's adoption of new technology					
My school has the ability to figure out the expected value of wireless LAN adoption					
My school has the ability to assimilate wireless LAN to school administration /curriculum					
My school has the ability to apply wireless LAN to school environments					
In my school, a number of administrative processes are supported by information technology					
Information systems performance evaluation in my organization is based on minimizing costs					
Information system planning is prevalent in my organization					
Top administrator support is important to my school's successful adoption of information technology					
My school's decision process for adopting wireless LAN is more or less centralized					
My school has a clear hierarchy for deciding to adopt wireless LAN. For example, teacher / staff -> senior staff -> vice principal -> principal					
Compared to other schools in Missouri, my school covers a geographically wide area					
I am satisfied with the performance of the current information systems at my school					
The existing computer network serves the needs of my school well					
My school has slack financial resources for adopting new technology					
My school has slack organizational/personnel resources for adopting new technology					

*** 34. Percentage of classrooms with Internet access (approximately): (check one)**

- Less than 1%
- 1-5%
- 6-20%
- 21-60%
- More than 60%
- Unable to determine

*** 35. Percentage of high speed computers (approximately): (check one)**

- Less than 1%
- 1-5%
- 6-20%
- 21-60%
- More than 60%
- Unable to determine

36. Number of computers in your school: (approximately): (check one)

- Less than 10
- 10-30
- 31-100
- 101-200
- More than 200
- Unable to determine

37. What is the network speed of your school per individual users? e.g., uploading, downloading, navigating websites, etc.(approximately):

- Less than 56K bps (Dial-up modem speed)
- 56K bps - 100 Kbps
- 100Kbps - 300Kbps (DSL Lite speed)
- 300Kbps - 1Mbps
- Faster than 1 Mbps (DSL pro speed)
- Unable to determine

*** 38. What is average household income of students in your school? (check one)**

- Less than $20,000
- $20,000-$49,999
- $50,000-$99,999
- $100,000-$199,999
- $200,000 or more
- Unable to determine

*** 39. Percentage of students enrolled in the federal lunch program (approximately): (check one)**

- Less than 1%
- 1-5%
- 6-20%
- 21-60%
- More than 60%
- Unable to determine

*** 40. Percentage of African-American and Hispanic students (approximately): (check one)**

- Less than 1%
- 1-5%
- 6-20%
- 21-60%
- More than 60%
- Unable to determine

*** 41. School Location: (check one)**

- City (Territory inside an urbanized area and inside a principal city with population more than 100,000)
- Suburbs (Territory outside a principal city and inside an urbanized area with population more than 100,000)
- Town (Territory inside an urban cluster that is more than 10 miles from an urbanized area)
- Rural (territory that is more than or equal to 5 miles from an urbanized area)

*** 42. What is student-teacher ratio of your school? (approximately) (check one)**

- 100:1
- 50:1
- 30:1
- 10:1
- 5:1
- Unable to determine

*** 43. Do your school subscribe to E-rate?**

YES	NO
○	○

*** 44. What is your school's E-rate amount (approximately)? (check one)**

- ○ Less than $50,000
- ○ $50,000-$199,999
- ○ $200,000-$499,999
- ○ $500,000-$1,999,999
- ○ $2,000,000 or more

[Appendix 4] LISREL Output for measurement models

(1) Measurement model fit indexes of Adoption vs. Non-adoption Model

```
                    DATE:  5/17/2007
                      TIME: 16:55


                    L I S R E L  8.72

                          BY

                Karl G. Joreskog & Dag Sorbom



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 The following lines were read from file
C:\Dissertation\data\Overall_final\overall_final13.LS8:

 Measurement model for logistic model
 DA NI=13 NO=435 MA=CM
 CM FI='c:\dissertation\data\Overall_final\overall_final.cov'

 LA
 expben1 expben2 expben6 expben7 expben8
 uncert2 uncert3
 abscapa2 abscapa3
 satcur1 satcur2
 slack1 slack2

 MO NX=13 NK=5 PH=SY TD=SY

 FR Lx 1 1 Lx 2 1 Lx 3 1 Lx 4 1 LX 5 1
 FR Lx 6 2 LX 7 2
 FR Lx 8 3 Lx 9 3
 FR Lx 10 4 Lx 11 4
 FR Lx 12 5 Lx 13 5

 FR TD 1 2 TD 2 3 TD 3 4 TD 4 5 TD 1 3 TD 2 3 TD 2 4 TD 1 4 TD 1 5

 LK
 Benefits UNCERT ABS SATCUR SLACK


 PD
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OU AD=OFF SC TV MI

Measurement model for logistic model

```
Number of Input Variables 13
Number of Y - Variables    0
Number of X - Variables   13
Number of ETA - Variables  0
Number of KSI - Variables  5
Number of Observations   435
```

Measurement model for logistic model

Covariance Matrix

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	6.44					
expben2	4.43	4.37				
expben6	1.33	0.95	1.06			
expben7	1.67	1.39	1.02	1.74		
expben8	1.92	1.76	0.99	1.44	2.02	
uncert2	0.39	0.19	0.10	0.16	0.26	0.69
uncert3	0.49	0.30	0.14	0.20	0.23	0.55
abscapa2	0.68	0.38	0.17	0.22	0.27	0.35
abscapa3	0.79	0.55	0.16	0.27	0.30	0.40
satcur1	0.17	0.14	-0.04	-0.07	-0.10	0.23
satcur2	0.21	0.17	-0.10	-0.13	-0.12	0.20
slack1	0.14	0.02	0.05	0.01	0.01	0.16
slack2	0.17	0.12	0.13	0.08	0.05	0.23

Covariance Matrix

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	0.83					
abscapa2	0.41	1.17				
abscapa3	0.41	0.98	1.24			
satcur1	0.28	0.37	0.39	1.27		
satcur2	0.27	0.38	0.41	1.05	1.25	
slack1	0.25	0.46	0.47	0.54	0.53	1.42
slack2	0.31	0.51	0.58	0.61	0.57	1.18

Covariance Matrix

	slack2
slack2	1.54

Measurement model for logistic model

Parameter Specifications

LAMBDA-X

Benefits	UNCERT	ABS	SATCUR	SLACK

expben1	1	0	0	0	0
expben2	2	0	0	0	0
expben6	3	0	0	0	0
expben7	4	0	0	0	0
expben8	5	0	0	0	0
uncert2	0	6	0	0	0
uncert3	0	7	0	0	0
abscapa2	0	0	8	0	0
abscapa3	0	0	9	0	0
satcur1	0	0	0	10	0
satcur2	0	0	0	11	0
slack1	0	0	0	0	12
slack2	0	0	0	0	13

PHI

	Benefits	UNCERT	ABS	SATCUR	SLACK
Benefits	0				
UNCERT	14	0			
ABS	15	16	0		
SATCUR	17	18	19	0	
SLACK	20	21	22	23	0

THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	24					
expben2	25	26				
expben6	27	28	29			
expben7	30	31	32	33		
expben8	34	0	0	35	36	
uncert2	0	0	0	0	0	37
uncert3	0	0	0	0	0	0
abscapa2	0	0	0	0	0	0
abscapa3	0	0	0	0	0	0
satcur1	0	0	0	0	0	0
satcur2	0	0	0	0	0	0
slack1	0	0	0	0	0	0
slack2	0	0	0	0	0	0

THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	38					
abscapa2	0	39				
abscapa3	0	0	40			
satcur1	0	0	0	41		
satcur2	0	0	0	0	42	
slack1	0	0	0	0	0	43
slack2	0	0	0	0	0	0

THETA-DELTA

	slack2
slack2	44

Measurement model for logistic model

Number of Iterations = 28

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	2.31 (0.28) 8.41	- -	- -	- -	- -
expben2	1.29 (0.12) 10.41	- -	- -	- -	- -
expben6	0.73 (0.06) 11.40	- -	- -	- -	- -
expben7	1.09 (0.12) 8.73	- -	- -	- -	- -
expben8	1.36 (0.10) 13.45	- -	- -	- -	- -
uncert2	- -	0.71 (0.04) 18.40	- -	- -	- -
uncert3	- -	0.78 (0.04) 18.13	- -	- -	- -
abscapa2	- -	- -	0.96 (0.04) 21.27	- -	- -
abscapa3	- -	- -	1.03 (0.05) 22.47	- -	- -
satcur1	- -	- -	- -	1.04 (0.05) 21.73	- -
satcur2	- -	- -	- -	1.00	- -

				(0.05)	
				20.88	
slack1	- -	- -	- -	- -	1.01
					(0.05)
					19.29
slack2	- -	- -	- -	- -	1.16
					(0.05)
					21.74

PHI

	Benefits	UNCERT	ABS	SATCUR	SLACK
Benefits	1.00				
UNCERT	0.25	1.00			
	(0.05)				
	5.13				
ABS	0.24	0.53	1.00		
	(0.05)	(0.04)			
	5.01	12.85			
SATCUR	-0.03	0.32	0.38	1.00	
	(0.04)	(0.05)	(0.05)		
	-0.67	6.39	8.26		
SLACK	0.03	0.30	0.47	0.50	1.00
	(0.04)	(0.05)	(0.04)	(0.04)	
	0.63	5.92	10.95	12.20	

THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	1.07					
	(1.22)					
	0.88					
expben2	1.42	2.69				
	(0.48)	(0.29)				
	2.94	9.38				
expben6	-0.35	0.01	0.53			
	(0.25)	(0.13)	(0.08)			
	-1.39	0.05	6.78			
expben7	-0.85	-0.02	0.23	0.55		
	(0.40)	(0.18)	(0.10)	(0.25)		
	-2.14	-0.10	2.32	2.22		
expben8	-1.23	- -	- -	-0.04	0.17	
	(0.36)			(0.19)	(0.24)	

	-3.43			-0.21	0.71	
uncert2	- -	- -	- -	- -	- -	0.18 (0.03) 5.14
uncert3	- -	- -	- -	- -	- -	- -
abscapa2	- -	- -	- -	- -	- -	- -
abscapa3	- -	- -	- -	- -	- -	- -
satcur1	- -	- -	- -	- -	- -	- -
satcur2	- -	- -	- -	- -	- -	- -
slack1	- -	- -	- -	- -	- -	- -
slack2	- -	- -	- -	- -	- -	- -

THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	0.23 (0.04) 5.63					
abscapa2	- -	0.25 (0.04) 6.06				
abscapa3	- -	- -	0.18 (0.05) 4.06			
satcur1	- -	- -	- -	0.18 (0.05) 3.25		
satcur2	- -	- -	- -	- -	0.24 (0.05) 4.65	
slack1	- -	- -	- -	- -	- -	0.39 (0.06) 6.68
slack2	- -	- -	- -	- -	- -	- -

THETA-DELTA

	slack2
slack2	0.18

(0.07)
2.59

Squared Multiple Correlations for X - Variables

expben1	expben2	expben6	expben7	expben8	uncert2
0.83	0.38	0.50	0.68	0.92	0.74

Squared Multiple Correlations for X - Variables

uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
0.72	0.78	0.85	0.86	0.81	0.72

Squared Multiple Correlations for X - Variables

slack2
0.88

Goodness of Fit Statistics

Degrees of Freedom = 47
Minimum Fit Function Chi-Square = 102.10 (P = 0.00)
Normal Theory Weighted Least Squares Chi-Square = 97.84 (P = 0.00)
Estimated Non-centrality Parameter (NCP) = 50.84
90 Percent Confidence Interval for NCP = (26.28 ; 83.16)

Minimum Fit Function Value = 0.24
Population Discrepancy Function Value (F0) = 0.12
90 Percent Confidence Interval for F0 = (0.061 ; 0.19)
Root Mean Square Error of Approximation (RMSEA) = 0.050
90 Percent Confidence Interval for RMSEA = (0.036 ; 0.064)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.48

Expected Cross-Validation Index (ECVI) = 0.43
90 Percent Confidence Interval for ECVI = (0.37 ; 0.50)
ECVI for Saturated Model = 0.42
ECVI for Independence Model = 10.04

Chi-Square for Independence Model with 78 Degrees of Freedom = 4331.40
Independence AIC = 4357.40
Model AIC = 185.84
Saturated AIC = 182.00
Independence CAIC = 4423.38
Model CAIC = 409.15
Saturated CAIC = 643.86

Normed Fit Index (NFI) = 0.98
Non-Normed Fit Index (NNFI) = 0.98
Parsimony Normed Fit Index (PNFI) = 0.59
Comparative Fit Index (CFI) = 0.99

Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.96

Critical N (CN) = 308.95

Root Mean Square Residual (RMR) = 0.070
Standardized RMR = 0.032
Goodness of Fit Index (GFI) = 0.97
Adjusted Goodness of Fit Index (AGFI) = 0.94
Parsimony Goodness of Fit Index (PGFI) = 0.50

Measurement model for logistic model

Modification Indices and Expected Change

Modification Indices for LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	- -	0.52	0.75	2.09	0.00
expben2	- -	0.00	2.74	1.11	0.30
expben6	- -	0.04	0.00	0.15	3.38
expben7	- -	0.66	0.01	0.16	0.22
expben8	- -	0.08	5.40	2.12	1.77
uncert2	1.39	- -	0.01	2.25	3.99
uncert3	1.39	- -	0.01	2.25	3.99
abscapa2	0.38	0.01	- -	0.01	0.40
abscapa3	0.38	0.01	- -	0.01	0.40
satcur1	0.08	0.07	1.31	- -	0.54
satcur2	0.08	0.07	1.31	- -	0.54
slack1	0.40	2.22	0.41	0.90	- -
slack2	0.40	2.22	0.41	0.90	- -

Expected Change for LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	- -	0.10	0.11	0.12	0.00
expben2	- -	0.00	0.13	0.06	0.03
expben6	- -	-0.01	0.00	-0.01	0.06
expben7	- -	-0.05	0.00	-0.01	-0.02
expben8	- -	0.02	-0.16	-0.07	-0.06
uncert2	0.03	- -	0.01	-0.06	-0.07
uncert3	-0.04	- -	-0.01	0.06	0.08
abscapa2	0.02	0.01	- -	0.00	-0.03
abscapa3	-0.02	-0.01	- -	0.00	0.03
satcur1	0.01	0.01	-0.05	- -	0.06
satcur2	-0.01	-0.01	0.05	- -	-0.06
slack1	0.02	-0.07	-0.04	0.07	- -
slack2	-0.02	0.08	0.05	-0.08	- -

Standardized Expected Change for LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	- -	0.10	0.11	0.12	0.00

expben2	- -	0.00	0.13	0.06	0.03
expben6	- -	-0.01	0.00	-0.01	0.06
expben7	- -	-0.05	0.00	-0.01	-0.02
expben8	- -	0.02	-0.16	-0.07	-0.06
uncert2	0.03	- -	0.01	-0.06	-0.07
uncert3	-0.04	- -	-0.01	0.06	0.08
abscapa2	0.02	0.01	- -	0.00	-0.03
abscapa3	-0.02	-0.01	- -	0.00	0.03
satcur1	0.01	0.01	-0.05	- -	0.06
satcur2	-0.01	-0.01	0.05	- -	-0.06
slack1	0.02	-0.07	-0.04	0.07	- -
slack2	-0.02	0.08	0.05	-0.08	- -

Completely Standardized Expected Change for LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	- -	0.04	0.04	0.05	0.00
expben2	- -	0.00	0.06	0.03	0.02
expben6	- -	-0.01	0.00	-0.01	0.06
expben7	- -	-0.04	0.00	-0.01	-0.01
expben8	- -	0.02	-0.11	-0.05	-0.04
uncert2	0.04	- -	0.01	-0.07	-0.09
uncert3	-0.04	- -	-0.01	0.07	0.09
abscapa2	0.02	0.01	- -	0.00	-0.03
abscapa3	-0.02	-0.01	- -	0.00	0.03
satcur1	0.01	0.01	-0.05	- -	0.05
satcur2	-0.01	-0.01	0.05	- -	-0.05
slack1	0.02	-0.06	-0.03	0.06	- -
slack2	-0.02	0.06	0.04	-0.06	- -

No Non-Zero Modification Indices for PHI

Modification Indices for THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	- -					
expben2	- -	- -				
expben6	- -	- -	- -			
expben7	- -	- -	- -	- -		
expben8	- -	0.28	0.28	- -	- -	
uncert2	0.81	6.25	1.91	2.53	15.37	- -
uncert3	0.90	3.22	1.62	1.25	8.09	- -
abscapa2	2.80	5.79	1.81	2.20	0.69	4.98
abscapa3	2.00	10.45	2.98	3.41	3.12	6.98
satcur1	0.04	0.00	0.45	1.43	1.10	0.27
satcur2	1.20	0.28	2.57	1.87	0.26	0.76
slack1	4.89	5.89	2.12	0.03	1.73	3.67
slack2	6.66	3.79	9.30	0.02	1.99	0.56

Modification Indices for THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	- -					
abscapa2	4.86	- -				

abscapa3	6.87	- -	- -			
satcur1	0.00	0.02	1.19	- -		
satcur2	0.13	0.01	0.80	- -	- -	
slack1	0.38	3.34	3.38	0.53	2.01	- -
slack2	0.18	4.15	4.18	1.46	3.45	- -

Modification Indices for THETA-DELTA

	slack2
slack2	- -

Expected Change for THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	- -					
expben2	- -	- -				
expben6	- -	- -	- -			
expben7	- -	- -	- -	- -		
expben8	- -	-0.23	0.13	- -	- -	
uncert2	0.03	-0.07	-0.02	-0.03	0.09	- -
uncert3	-0.04	0.06	0.02	0.02	-0.07	- -
abscapa2	0.07	-0.08	0.03	-0.03	0.02	-0.04
abscapa3	-0.06	0.11	-0.03	0.04	-0.05	0.05
satcur1	-0.01	0.00	0.01	0.03	-0.03	0.01
satcur2	0.04	0.02	-0.03	-0.03	0.01	-0.01
slack1	0.10	-0.09	-0.03	0.00	0.04	-0.04
slack2	-0.12	0.07	0.07	0.00	-0.04	0.01

Expected Change for THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	- -					
abscapa2	0.04	- -				
abscapa3	-0.05	- -	- -			
satcur1	0.00	0.00	-0.02	- -		
satcur2	0.01	0.00	0.02	- -	- -	
slack1	0.01	0.04	-0.04	-0.02	0.03	- -
slack2	0.01	-0.05	0.05	0.03	-0.04	- -

Expected Change for THETA-DELTA

	slack2
slack2	- -

Completely Standardized Expected Change for THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	- -					
expben2	- -	- -				
expben6	- -	- -	- -			
expben7	- -	- -	- -	- -		
expben8	- -	-0.08	0.09	- -	- -	

uncert2	0.02	-0.04	-0.03	-0.03	0.08	- -
uncert3	-0.02	0.03	0.03	0.02	-0.05	- -
abscapa2	0.02	-0.03	0.02	-0.02	0.01	-0.04
abscapa3	-0.02	0.05	-0.03	0.03	-0.03	0.05
satcur1	0.00	0.00	0.01	0.02	-0.02	0.01
satcur2	0.02	0.01	-0.03	-0.02	0.01	-0.02
slack1	0.03	-0.04	-0.03	0.00	0.02	-0.04
slack2	-0.04	0.03	0.05	0.00	-0.02	0.01

Completely Standardized Expected Change for THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	- -					
abscapa2	0.04	- -				
abscapa3	-0.05	- -	- -			
satcur1	0.00	0.00	-0.02	- -		
satcur2	0.01	0.00	0.01	- -	- -	
slack1	0.01	0.03	-0.03	-0.01	0.02	- -
slack2	0.01	-0.03	0.03	0.02	-0.03	- -

Completely Standardized Expected Change for THETA-DELTA

	slack2
slack2	- -

Maximum Modification Index is 15.37 for Element (6, 5) of THETA-DELTA

Measurement model for logistic model

Standardized Solution

LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	2.31	- -	- -	- -	- -
expben2	1.29	- -	- -	- -	- -
expben6	0.73	- -	- -	- -	- -
expben7	1.09	- -	- -	- -	- -
expben8	1.36	- -	- -	- -	- -
uncert2	- -	0.71	- -	- -	- -
uncert3	- -	0.78	- -	- -	- -
abscapa2	- -	- -	0.96	- -	- -
abscapa3	- -	- -	1.03	- -	- -
satcur1	- -	- -	- -	1.04	- -
satcur2	- -	- -	- -	1.00	- -
slack1	- -	- -	- -	- -	1.01
slack2	- -	- -	- -	- -	1.16

PHI

	Benefits	UNCERT	ABS	SATCUR	SLACK
Benefits	1.00				

UNCERT	0.25	1.00			
ABS	0.24	0.53	1.00		
SATCUR	-0.03	0.32	0.38	1.00	
SLACK	0.03	0.30	0.47	0.50	1.00

Measurement model for logistic model

Completely Standardized Solution

LAMBDA-X

	Benefits	UNCERT	ABS	SATCUR	SLACK
expben1	0.91	- -	- -	- -	- -
expben2	0.62	- -	- -	- -	- -
expben6	0.71	- -	- -	- -	- -
expben7	0.83	- -	- -	- -	- -
expben8	0.96	- -	- -	- -	- -
uncert2	- -	0.86	- -	- -	- -
uncert3	- -	0.85	- -	- -	- -
abscapa2	- -	- -	0.89	- -	- -
abscapa3	- -	- -	0.92	- -	- -
satcur1	- -	- -	- -	0.93	- -
satcur2	- -	- -	- -	0.90	- -
slack1	- -	- -	- -	- -	0.85
slack2	- -	- -	- -	- -	0.94

PHI

	Benefits	UNCERT	ABS	SATCUR	SLACK
Benefits	1.00				
UNCERT	0.25	1.00			
ABS	0.24	0.53	1.00		
SATCUR	-0.03	0.32	0.38	1.00	
SLACK	0.03	0.30	0.47	0.50	1.00

THETA-DELTA

	expben1	expben2	expben6	expben7	expben8	uncert2
expben1	0.17					
expben2	0.27	0.62				
expben6	-0.14	0.00	0.50			
expben7	-0.25	-0.01	0.17	0.32		
expben8	-0.34	- -	- -	-0.02	0.08	
uncert2	- -	- -	- -	- -	- -	0.26
uncert3	- -	- -	- -	- -	- -	- -
abscapa2	- -	- -	- -	- -	- -	- -
abscapa3	- -	- -	- -	- -	- -	- -
satcur1	- -	- -	- -	- -	- -	- -
satcur2	- -	- -	- -	- -	- -	- -
slack1	- -	- -	- -	- -	- -	- -
slack2	- -	- -	- -	- -	- -	- -

THETA-DELTA

	uncert3	abscapa2	abscapa3	satcur1	satcur2	slack1
uncert3	0.28					
abscapa2	- -	0.22				
abscapa3	- -	- -	0.15			
satcur1	- -	- -	- -	0.14		
satcur2	- -	- -	- -	- -	0.19	
slack1	- -	- -	- -	- -	- -	0.28
slack2	- -	- -	- -	- -	- -	- -

THETA-DELTA

	slack2
slack2	0.12

Time used: 0.047 Seconds

(2) Measurement model fit indexes of the Level of Adoption Model

```
                                DATE:  5/17/2007
                                  TIME: 18:20


                                L I S R E L  8.72

                                       BY

                          Karl G. Joreskog & Dag Sorbom
```


The following lines were read from file C:\Dissertation\data\adopter_final\final_measurement.LS8:

```
 Measurement model
 DA NI=18 NO=190 MA=CM
 ra FI='c:\dissertation\data\adopter_final\use18only.psf'

 LA
 expben6 aftben5 aftben6 aftben7
 expbar2 expbar3 aftbar2
 wsatis1 wsatis3 wsatis4
 use2 use3
 uncert2 uncert3
 abscapa2 abscapa3
 slack1 slack2

 MO NX=18 NK=7 PH=SY TD=SY

 FR Lx 1 1 Lx 2 1 Lx 3 1 Lx 4 1
 FR Lx 5 2 Lx 6 2 Lx 7 2
 FR Lx 8 3 Lx 9 3 Lx 10 3
 FR Lx 11 4 Lx 12 4
 FR Lx 13 5 Lx 14 5
 FR Lx 15 6 Lx 16 6
 FR Lx 17 7 Lx 18 7

 LK
 BENEFIT BARRIER SATIS USAGE UNCERT ABS_CAP SLACK

 PD
 OU AD=OFF SC TV MI
```

Measurement model

Number of Input Variables 18
Number of Y - Variables 0
Number of X - Variables 18
Number of ETA - Variables 0
Number of KSI - Variables 7
Number of Observations 190

Measurement model

Covariance Matrix

	expben6	aftben5	aftben6	aftben7	expbar2	expbar3
expben6	0.69					
aftben5	0.33	0.63				
aftben6	0.48	0.44	0.80			
aftben7	0.30	0.37	0.51	0.83		
expbar2	-0.04	-0.09	-0.16	-0.11	1.05	
expbar3	-0.10	-0.13	-0.15	-0.09	0.48	0.75
aftbar2	-0.11	-0.12	-0.24	-0.13	0.55	0.37
wsatis1	0.16	0.18	0.33	0.30	-0.08	-0.11
wsatis3	0.11	0.17	0.29	0.27	-0.15	-0.09
wsatis4	0.15	0.18	0.31	0.31	-0.04	-0.10
use2	0.17	0.15	0.39	0.36	-0.34	-0.18
use3	0.29	0.35	0.55	0.47	-0.27	-0.17
uncert2	0.06	0.15	0.09	0.11	0.00	-0.05
uncert3	0.07	0.16	0.13	0.13	-0.13	-0.10
abscapa2	0.18	0.21	0.28	0.24	-0.14	-0.14
abscapa3	0.08	0.16	0.22	0.20	-0.13	-0.14
slack1	0.07	0.11	0.17	0.21	-0.10	-0.12
slack2	0.14	0.16	0.23	0.22	-0.16	-0.14

Covariance Matrix

	aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
aftbar2	1.08					
wsatis1	-0.24	0.87				
wsatis3	-0.27	0.65	0.76			
wsatis4	-0.23	0.56	0.52	0.67		
use2	-0.33	0.39	0.44	0.41	2.60	
use3	-0.29	0.43	0.42	0.49	1.48	2.34
uncert2	-0.06	0.05	0.08	0.04	0.05	0.06
uncert3	-0.09	0.09	0.10	0.05	0.09	0.12
abscapa2	-0.08	0.28	0.21	0.18	0.35	0.34
abscapa3	-0.09	0.21	0.20	0.17	0.38	0.36
slack1	-0.09	0.33	0.21	0.30	0.38	0.11
slack2	-0.08	0.36	0.25	0.31	0.44	0.16

Covariance Matrix

	uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
uncert2	0.60					

uncert3	0.40	0.60				
abscapa2	0.20	0.26	0.70			
abscapa3	0.18	0.19	0.40	0.58		
slack1	0.02	0.12	0.29	0.21	1.42	
slack2	0.14	0.19	0.35	0.27	1.04	1.44

Measurement model

Parameter Specifications

LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	1	0	0	0	0	0
aftben5	2	0	0	0	0	0
aftben6	3	0	0	0	0	0
aftben7	4	0	0	0	0	0
expbar2	0	5	0	0	0	0
expbar3	0	6	0	0	0	0
aftbar2	0	7	0	0	0	0
wsatis1	0	0	8	0	0	0
wsatis3	0	0	9	0	0	0
wsatis4	0	0	10	0	0	0
use2	0	0	0	11	0	0
use3	0	0	0	12	0	0
uncert2	0	0	0	0	13	0
uncert3	0	0	0	0	14	0
abscapa2	0	0	0	0	0	15
abscapa3	0	0	0	0	0	16
slack1	0	0	0	0	0	0
slack2	0	0	0	0	0	0

LAMBDA-X

	SLACK
expben6	0
aftben5	0
aftben6	0
aftben7	0
expbar2	0
expbar3	0
aftbar2	0
wsatis1	0
wsatis3	0
wsatis4	0
use2	0
use3	0
uncert2	0
uncert3	0
abscapa2	0
abscapa3	0
slack1	17
slack2	18

PHI

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
BENEFIT	0					
BARRIER	19	0				
SATIS	20	21	0			
USAGE	22	23	24	0		
UNCERT	25	26	27	28	0	
ABS_CAP	29	30	31	32	33	0
SLACK	34	35	36	37	38	39

PHI

	SLACK
SLACK	0

THETA-DELTA

expben6	aftben5	aftben6	aftben7	expbar2	expbar3
40	41	42	43	44	45

THETA-DELTA

aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
46	47	48	49	50	51

THETA-DELTA

uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
52	53	54	55	56	57

Measurement model

Number of Iterations = 11

LISREL Estimates (Maximum Likelihood)

LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	0.56 (0.06) 10.16	- -	- -	- -	- -	- -
aftben5	0.54 (0.05) 10.22	- -	- -	- -	- -	- -
aftben6	0.83	- -	- -	- -	- -	- -

	(0.05) 15.74					
aftben7	0.62 (0.06) 10.07	- -	- -	- -	- -	- -
expbar2	- -	0.81 (0.08) 10.41	- -	- -	- -	- -
expbar3	- -	0.58 (0.07) 8.84	- -	- -	- -	- -
aftbar2	- -	0.68 (0.08) 8.55	- -	- -	- -	- -
wsatis1	- -	- -	0.83 (0.05) 15.18	- -	- -	- -
wsatis3	- -	- -	0.77 (0.05) 14.83	- -	- -	- -
wsatis4	- -	- -	0.68 (0.05) 13.72	- -	- -	- -
use2	- -	- -	- -	1.12 (0.13) 8.76	- -	- -
use3	- -	- -	- -	1.33 (0.13) 10.55	- -	- -
uncert2	- -	- -	- -	- -	0.57 (0.06) 8.88	- -
uncert3	- -	- -	- -	- -	0.71 (0.07) 10.45	- -
abscapa2	- -	- -	- -	- -	- -	0.70 (0.06) 11.87
abscapa3	- -	- -	- -	- -	- -	0.57 (0.05) 10.45
slack1	- -	- -	- -	- -	- -	- -

slack2	- -	- -	- -	- -	- -	- -

LAMBDA-X

	SLACK
expben6	- -
aftben5	- -
aftben6	- -
aftben7	- -
expbar2	- -
expbar3	- -
aftbar2	- -
wsatis1	- -
wsatis3	- -
wsatis4	- -
use2	- -
use3	- -
uncert2	- -
uncert3	- -
abscapa2	- -
abscapa3	- -
slack1	0.93 (0.09) 9.98
slack2	1.12 (0.10) 11.49

PHI

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
BENEFIT	1.00					
BARRIER	-0.28 (0.08) -3.45	1.00				

SATIS	0.48	-0.24	1.00			
	(0.06)	(0.08)				
	7.39	-2.91				
USAGE	0.47	-0.29	0.44	1.00		
	(0.07)	(0.09)	(0.07)			
	6.54	-3.24	6.05			
UNCERT	0.23	-0.20	0.15	0.11	1.00	
	(0.08)	(0.09)	(0.08)	(0.09)		
	2.96	-2.23	1.85	1.30		
ABS_CAP	0.48	-0.27	0.43	0.43	0.50	1.00
	(0.07)	(0.09)	(0.07)	(0.08)	(0.08)	
	6.73	-3.06	5.88	5.24	6.64	
SLACK	0.25	-0.17	0.37	0.16	0.22	0.44
	(0.08)	(0.09)	(0.07)	(0.08)	(0.08)	(0.08)
	3.23	-1.96	5.05	1.90	2.70	5.77

PHI

	SLACK
SLACK	1.00

THETA-DELTA

expben6	aftben5	aftben6	aftben7	expbar2	expbar3
0.37	0.34	0.10	0.45	0.39	0.41
(0.04)	(0.04)	(0.04)	(0.05)	(0.09)	(0.06)
8.67	8.64	2.80	8.70	4.41	7.00

THETA-DELTA

aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
0.63	0.18	0.17	0.20	1.36	0.58
(0.09)	(0.03)	(0.03)	(0.03)	(0.22)	(0.25)
7.34	5.58	6.08	7.34	6.19	2.33

THETA-DELTA

uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
0.28	0.10	0.21	0.26	0.55	0.20
(0.06)	(0.07)	(0.05)	(0.04)	(0.13)	(0.16)
5.03	1.33	4.01	6.41	4.38	1.24

Squared Multiple Correlations for X - Variables

expben6	aftben5	aftben6	aftben7	expbar2	expbar3
0.46	0.47	0.87	0.46	0.63	0.45

Squared Multiple Correlations for X - Variables

aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
0.42	0.80	0.77	0.70	0.48	0.75

Squared Multiple Correlations for X - Variables

uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
0.54	0.83	0.71	0.55	0.61	0.86

Goodness of Fit Statistics

Degrees of Freedom = 114
Minimum Fit Function Chi-Square = 143.55 (P = 0.032)
Normal Theory Weighted Least Squares Chi-Square = 138.49 (P = 0.059)
Estimated Non-centrality Parameter (NCP) = 24.49
90 Percent Confidence Interval for NCP = (0.0 ; 58.34)

Minimum Fit Function Value = 0.76
Population Discrepancy Function Value (F0) = 0.13
90 Percent Confidence Interval for F0 = (0.0 ; 0.31)
Root Mean Square Error of Approximation (RMSEA) = 0.034
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.052)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.93

Expected Cross-Validation Index (ECVI) = 1.34
90 Percent Confidence Interval for ECVI = (1.21 ; 1.52)
ECVI for Saturated Model = 1.81
ECVI for Independence Model = 13.26

Chi-Square for Independence Model with 153 Degrees of Freedom = 2469.75
Independence AIC = 2505.75
Model AIC = 252.49
Saturated AIC = 342.00
Independence CAIC = 2582.20
Model CAIC = 494.57
Saturated CAIC = 1068.24

Normed Fit Index (NFI) = 0.94
Non-Normed Fit Index (NNFI) = 0.98
Parsimony Normed Fit Index (PNFI) = 0.70
Comparative Fit Index (CFI) = 0.99
Incremental Fit Index (IFI) = 0.99
Relative Fit Index (RFI) = 0.92

Critical N (CN) = 201.17

Root Mean Square Residual (RMR) = 0.051
Standardized RMR = 0.049
Goodness of Fit Index (GFI) = 0.92
Adjusted Goodness of Fit Index (AGFI) = 0.89
Parsimony Goodness of Fit Index (PGFI) = 0.62

Measurement model

Modification Indices and Expected Change

Modification Indices for LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	- -	1.67	5.48	2.90	0.68	2.55
aftben5	- -	0.00	0.67	0.36	6.72	1.10
aftben6	- -	1.15	0.56	0.46	2.93	0.28
aftben7	- -	0.13	4.41	1.77	0.70	1.75
expbar2	3.13	- -	5.67	0.18	0.11	0.23
expbar3	0.23	- -	0.07	0.32	0.39	1.24
aftbar2	2.46	- -	9.38	1.16	0.06	0.36
wsatis1	0.21	0.82	- -	2.96	0.00	0.92
wsatis3	1.30	1.95	- -	0.12	0.80	0.35
wsatis4	3.12	0.27	- -	5.47	1.16	0.19
use2	2.89	1.40	0.98	- -	0.00	1.93
use3	2.89	1.40	0.98	- -	0.00	1.93
uncert2	0.04	3.69	0.04	0.23	- -	0.32
uncert3	0.04	3.69	0.04	0.23	- -	0.32
abscapa2	0.21	0.42	0.20	2.42	0.34	- -
abscapa3	0.21	0.42	0.20	2.42	0.34	- -
slack1	0.23	0.08	0.44	0.02	1.79	0.48
slack2	0.23	0.08	0.44	0.02	1.79	0.48

Modification Indices for LAMBDA-X

	SLACK
expben6	0.41
aftben5	0.00
aftben6	0.12
aftben7	1.26
expbar2	0.01
expbar3	0.54
aftbar2	0.42
wsatis1	1.20
wsatis3	5.12
wsatis4	1.60
use2	8.39
use3	8.39
uncert2	0.41
uncert3	0.41
abscapa2	0.23
abscapa3	0.23
slack1	- -
slack2	- -

Expected Change for LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	- -	0.07	-0.14	-0.11	-0.04	-0.10
aftben5	- -	0.00	-0.05	-0.04	0.13	0.06
aftben6	- -	-0.06	0.04	0.04	-0.09	-0.03
aftben7	- -	0.02	0.14	0.09	0.05	0.09
expbar2	0.14	- -	0.18	0.03	0.02	0.04
expbar3	-0.03	- -	0.02	0.04	-0.04	-0.07
aftbar2	-0.12	- -	-0.22	-0.08	0.02	0.05
wsatis1	-0.02	0.04	- -	-0.09	0.00	0.05
wsatis3	-0.05	-0.06	- -	-0.02	0.04	-0.03
wsatis4	0.08	0.02	- -	0.11	-0.04	-0.02
use2	-0.32	-0.15	0.16	- -	0.00	0.22
use3	0.38	0.18	-0.20	- -	0.01	-0.26
uncert2	-0.01	0.10	-0.01	-0.02	- -	0.09
uncert3	0.01	-0.13	0.01	0.03	- -	-0.12
abscapa2	0.04	0.05	-0.03	-0.12	0.05	- -
abscapa3	-0.03	-0.04	0.03	0.10	-0.04	- -
slack1	-0.04	0.02	0.07	-0.01	-0.10	-0.11
slack2	0.04	-0.03	-0.08	0.01	0.12	0.13

Expected Change for LAMBDA-X

	SLACK
expben6	-0.03
aftben5	0.00
aftben6	-0.02
aftben7	0.06
expbar2	0.01
expbar3	-0.04
aftbar2	0.05
wsatis1	0.05
wsatis3	-0.10
wsatis4	0.06
use2	0.31
use3	-0.37
uncert2	-0.03
uncert3	0.04
abscapa2	0.04
abscapa3	-0.03
slack1	- -
slack2	- -

Standardized Expected Change for LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	- -	0.07	-0.14	-0.11	-0.04	-0.10
aftben5	- -	0.00	-0.05	-0.04	0.13	0.06
aftben6	- -	-0.06	0.04	0.04	-0.09	-0.03
aftben7	- -	0.02	0.14	0.09	0.05	0.09
expbar2	0.14	- -	0.18	0.03	0.02	0.04
expbar3	-0.03	- -	0.02	0.04	-0.04	-0.07
aftbar2	-0.12	- -	-0.22	-0.08	0.02	0.05

wsatis1	-0.02	0.04	- -	-0.09	0.00	0.05
wsatis3	-0.05	-0.06	- -	-0.02	0.04	-0.03
wsatis4	0.08	0.02	- -	0.11	-0.04	-0.02
use2	-0.32	-0.15	0.16	- -	0.00	0.22
use3	0.38	0.18	-0.20	- -	0.01	-0.26
uncert2	-0.01	0.10	-0.01	-0.02	- -	0.09
uncert3	0.01	-0.13	0.01	0.03	- -	-0.12
abscapa2	0.04	0.05	-0.03	-0.12	0.05	- -
abscapa3	-0.03	-0.04	0.03	0.10	-0.04	- -
slack1	-0.04	0.02	0.07	-0.01	-0.10	-0.11
slack2	0.04	-0.03	-0.08	0.01	0.12	0.13

Standardized Expected Change for LAMBDA-X

	SLACK
expben6	-0.03
aftben5	0.00
aftben6	-0.02
aftben7	0.06
expbar2	0.01
expbar3	-0.04
aftbar2	0.05
wsatis1	0.05
wsatis3	-0.10
wsatis4	0.06
use2	0.31
use3	-0.37
uncert2	-0.03
uncert3	0.04
abscapa2	0.04
abscapa3	-0.03
slack1	- -
slack2	- -

Completely Standardized Expected Change for LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	- -	0.09	-0.16	-0.13	-0.05	-0.12
aftben5	- -	0.00	-0.06	-0.05	0.16	0.08
aftben6	- -	-0.07	0.05	0.05	-0.10	-0.04
aftben7	- -	0.02	0.15	0.10	0.05	0.10
expbar2	0.13	- -	0.17	0.03	0.02	0.04
expbar3	-0.03	- -	0.02	0.04	-0.04	-0.08
aftbar2	-0.11	- -	-0.21	-0.08	0.02	0.05
wsatis1	-0.02	0.05	- -	-0.10	0.00	0.05
wsatis3	-0.06	-0.07	- -	-0.02	0.04	-0.03
wsatis4	0.10	0.03	- -	0.14	-0.05	-0.03
use2	-0.20	-0.09	0.10	- -	0.00	0.14
use3	0.25	0.12	-0.13	- -	0.00	-0.17
uncert2	-0.01	0.13	-0.01	-0.03	- -	0.12
uncert3	0.02	-0.17	0.02	0.04	- -	-0.15
abscapa2	0.05	0.06	-0.04	-0.15	0.06	- -
abscapa3	-0.04	-0.05	0.04	0.13	-0.05	- -
slack1	-0.03	0.02	0.06	-0.01	-0.08	-0.09
slack2	0.04	-0.02	-0.07	0.01	0.10	0.10

Completely Standardized Expected Change for LAMBDA-X

	SLACK
expben6	-0.04
aftben5	0.00
aftben6	-0.02
aftben7	0.07
expbar2	0.01
expbar3	-0.05
aftbar2	0.04
wsatis1	0.06
wsatis3	-0.11
wsatis4	0.07
use2	0.19
use3	-0.24
uncert2	-0.04
uncert3	0.05
abscapa2	0.04
abscapa3	-0.04
slack1	- -
slack2	- -

No Non-Zero Modification Indices for PHI

Modification Indices for THETA-DELTA

	expben6	aftben5	aftben6	aftben7	expbar2	expbar3
expben6	- -					
aftben5	0.78	- -				
aftben6	7.10	3.96	- -			
aftben7	3.32	2.15	1.29	- -		
expbar2	1.38	0.38	0.04	0.03	- -	
expbar3	0.84	1.75	0.42	0.26	1.66	- -
aftbar2	0.08	0.65	2.70	0.61	0.09	1.98
wsatis1	0.31	0.15	0.02	0.04	1.86	0.80
wsatis3	3.38	0.03	0.06	0.06	6.00	4.70
wsatis4	0.00	0.12	0.10	3.39	7.85	0.80
use2	0.50	3.19	0.02	0.29	0.86	0.18
use3	0.02	1.11	0.07	0.11	0.00	0.24
uncert2	0.04	2.08	1.55	0.50	6.70	0.14
uncert3	0.23	0.65	0.06	0.00	3.55	0.11
abscapa2	1.61	0.00	0.02	0.26	0.14	0.12
abscapa3	4.42	0.05	0.00	0.63	0.02	0.68
slack1	0.87	0.15	0.03	1.24	0.43	0.09
slack2	0.95	0.04	0.01	0.34	1.06	0.00

Modification Indices for THETA-DELTA

	aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
aftbar2	- -					
wsatis1	0.00	- -				
wsatis3	1.00	5.30	- -			
wsatis4	2.32	3.31	0.08	- -		

use2	0.15	0.79	1.77	0.13	- -	
use3	0.12	0.81	1.50	5.52	- -	- -
uncert2	0.84	1.06	1.18	0.01	0.03	0.04
uncert3	0.17	0.13	0.03	0.51	0.16	0.36
abscapa2	1.73	5.00	1.16	2.43	0.09	0.75
abscapa3	0.23	0.86	1.10	0.01	0.98	0.21
slack1	0.22	0.33	1.90	2.11	0.42	0.47
slack2	1.69	0.00	0.32	0.02	1.92	0.93

Modification Indices for THETA-DELTA

	uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
uncert2	- -					
uncert3	- -	- -				
abscapa2	0.11	0.30	- -			
abscapa3	1.74	1.89	- -	- -		
slack1	4.72	0.56	0.38	0.11	- -	
slack2	1.71	0.07	0.07	0.00	- -	- -

Expected Change for THETA-DELTA

	expben6	aftben5	aftben6	aftben7	expbar2	expbar3
expben6	- -					
aftben5	0.03	- -				
aftben6	0.11	-0.08	- -			
aftben7	-0.06	0.05	-0.05	- -		
expbar2	0.04	0.02	-0.01	-0.01	- -	
expbar3	-0.03	-0.04	0.02	0.02	0.16	- -
aftbar2	0.01	0.03	-0.05	0.03	0.04	-0.13
wsatis1	0.01	-0.01	0.00	-0.01	0.04	-0.02
wsatis3	-0.04	0.00	0.00	-0.01	-0.07	0.06
wsatis4	0.00	-0.01	0.01	0.05	0.08	-0.02
use2	-0.04	-0.10	-0.01	0.04	-0.07	0.03
use3	-0.01	0.05	0.01	0.02	0.00	0.03
uncert2	0.01	0.04	-0.03	0.02	0.09	-0.01
uncert3	-0.01	0.02	-0.01	0.00	-0.06	0.01
abscapa2	0.04	0.00	0.00	-0.02	-0.01	-0.01
abscapa3	-0.06	0.01	0.00	0.02	0.00	-0.02
slack1	-0.04	-0.01	-0.01	0.05	0.03	-0.01
slack2	0.04	0.01	0.00	-0.02	-0.05	0.00

Expected Change for THETA-DELTA

	aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
aftbar2	- -					
wsatis1	0.00	- -				
wsatis3	-0.03	0.12	- -			
wsatis4	-0.05	-0.08	-0.01	- -		
use2	-0.03	-0.04	0.06	-0.02	- -	
use3	0.03	-0.04	-0.05	0.10	- -	- -
uncert2	-0.03	-0.02	0.02	0.00	-0.01	-0.01
uncert3	0.01	0.01	0.00	-0.01	-0.02	0.03
abscapa2	0.05	0.05	-0.02	-0.03	-0.02	-0.05
abscapa3	0.02	-0.02	0.02	0.00	0.05	0.02

slack1	-0.02	0.02	-0.04	0.04	0.05	-0.05
slack2	0.07	0.00	-0.02	0.00	0.10	-0.07

Expected Change for THETA-DELTA

	uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
uncert2	- -					
uncert3	- -	- -				
abscapa2	-0.01	0.02	- -			
abscapa3	0.03	-0.04	- -	- -		
slack1	-0.07	0.02	0.02	-0.01	- -	
slack2	0.04	-0.01	-0.01	0.00	- -	- -

Completely Standardized Expected Change for THETA-DELTA

	expben6	aftben5	aftben6	aftben7	expbar2	expbar3
expben6	- -					
aftben5	0.04	- -				
aftben6	0.14	-0.11	- -			
aftben7	-0.09	0.07	-0.06	- -		
expbar2	0.05	0.03	-0.01	-0.01	- -	
expbar3	-0.04	-0.06	0.02	0.02	0.19	- -
aftbar2	0.01	0.04	-0.06	0.04	0.04	-0.14
wsatis1	0.02	-0.01	0.00	-0.01	0.04	-0.03
wsatis3	-0.06	0.01	0.01	-0.01	-0.08	0.07
wsatis4	0.00	-0.01	0.01	0.06	0.10	-0.03
use2	-0.03	-0.08	0.00	0.02	-0.04	0.02
use3	-0.01	0.04	0.01	0.01	0.00	0.02
uncert2	0.01	0.06	-0.04	0.03	0.11	-0.02
uncert3	-0.02	0.03	-0.01	0.00	-0.08	0.01
abscapa2	0.05	0.00	0.00	-0.02	-0.02	-0.01
abscapa3	-0.09	0.01	0.00	0.03	-0.01	-0.04
slack1	-0.04	-0.01	-0.01	0.04	0.03	-0.01
slack2	0.04	0.01	0.00	-0.02	-0.04	0.00

Completely Standardized Expected Change for THETA-DELTA

	aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
aftbar2	- -					
wsatis1	0.00	- -				
wsatis3	-0.03	0.15	- -			
wsatis4	-0.06	-0.10	-0.02	- -		
use2	-0.02	-0.03	0.04	-0.01	- -	
use3	0.02	-0.03	-0.04	0.08	- -	- -
uncert2	-0.04	-0.03	0.03	0.00	-0.01	-0.01
uncert3	0.02	0.01	0.01	-0.02	-0.02	0.03
abscapa2	0.06	0.07	-0.03	-0.05	-0.01	-0.04
abscapa3	0.02	-0.03	0.03	0.00	0.04	0.02
slack1	-0.02	0.02	-0.04	0.04	0.03	-0.03
slack2	0.05	0.00	-0.02	0.00	0.05	-0.04

Completely Standardized Expected Change for THETA-DELTA

	uncert2	uncert3	abscapa2	abscapa3	slack1	slack2

uncert2	- -					
uncert3	- -	- -				
abscapa2	-0.02	0.03	- -			
abscapa3	0.06	-0.06	- -	- -		
slack1	-0.08	0.03	0.02	-0.01	- -	
slack2	0.05	-0.01	-0.01	0.00	- -	- -

Maximum Modification Index is 9.38 for Element (7, 3) of LAMBDA-X

Measurement model

Standardized Solution

LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	0.56	- -	- -	- -	- -	- -
aftben5	0.54	- -	- -	- -	- -	- -
aftben6	0.83	- -	- -	- -	- -	- -
aftben7	0.62	- -	- -	- -	- -	- -
expbar2	- -	0.81	- -	- -	- -	- -
expbar3	- -	0.58	- -	- -	- -	- -
aftbar2	- -	0.68	- -	- -	- -	- -
wsatis1	- -	- -	0.83	- -	- -	- -
wsatis3	- -	- -	0.77	- -	- -	- -
wsatis4	- -	- -	0.68	- -	- -	- -
use2	- -	- -	- -	1.12	- -	- -
use3	- -	- -	- -	1.33	- -	- -
uncert2	- -	- -	- -	- -	0.57	- -
uncert3	- -	- -	- -	- -	0.71	- -
abscapa2	- -	- -	- -	- -	- -	0.70
abscapa3	- -	- -	- -	- -	- -	0.57
slack1	- -	- -	- -	- -	- -	- -
slack2	- -	- -	- -	- -	- -	- -

LAMBDA-X

	SLACK
expben6	- -
aftben5	- -
aftben6	- -
aftben7	- -
expbar2	- -
expbar3	- -
aftbar2	- -
wsatis1	- -
wsatis3	- -
wsatis4	- -
use2	- -
use3	- -
uncert2	- -
uncert3	- -
abscapa2	- -
abscapa3	- -

slack1	0.93
slack2	1.12

PHI

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
BENEFIT	1.00					
BARRIER	-0.28	1.00				
SATIS	0.48	-0.24	1.00			
USAGE	0.47	-0.29	0.44	1.00		
UNCERT	0.23	-0.20	0.15	0.11	1.00	
ABS_CAP	0.48	-0.27	0.43	0.43	0.50	1.00
SLACK	0.25	-0.17	0.37	0.16	0.22	0.44

PHI

	SLACK
SLACK	1.00

Measurement model

Completely Standardized Solution

LAMBDA-X

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
expben6	0.68	- -	- -	- -	- -	- -
aftben5	0.68	- -	- -	- -	- -	- -
aftben6	0.93	- -	- -	- -	- -	- -
aftben7	0.68	- -	- -	- -	- -	- -
expbar2	- -	0.79	- -	- -	- -	- -
expbar3	- -	0.67	- -	- -	- -	- -
aftbar2	- -	0.65	- -	- -	- -	- -
wsatis1	- -	- -	0.89	- -	- -	- -
wsatis3	- -	- -	0.88	- -	- -	- -
wsatis4	- -	- -	0.84	- -	- -	- -
use2	- -	- -	- -	0.69	- -	- -
use3	- -	- -	- -	0.87	- -	- -
uncert2	- -	- -	- -	- -	0.73	- -
uncert3	- -	- -	- -	- -	0.91	- -
abscapa2	- -	- -	- -	- -	- -	0.84
abscapa3	- -	- -	- -	- -	- -	0.74
slack1	- -	- -	- -	- -	- -	- -
slack2	- -	- -	- -	- -	- -	- -

LAMBDA-X

	SLACK
expben6	- -
aftben5	- -
aftben6	- -
aftben7	- -
expbar2	- -

expbar3	- -
aftbar2	- -
wsatis1	- -
wsatis3	- -
wsatis4	- -
use2	- -
use3	- -
uncert2	- -
uncert3	- -
abscapa2	- -
abscapa3	- -
slack1	0.78
slack2	0.93

PHI

	BENEFIT	BARRIER	SATIS	USAGE	UNCERT	ABS_CAP
BENEFIT	1.00					
BARRIER	-0.28	1.00				
SATIS	0.48	-0.24	1.00			
USAGE	0.47	-0.29	0.44	1.00		
UNCERT	0.23	-0.20	0.15	0.11	1.00	
ABS_CAP	0.48	-0.27	0.43	0.43	0.50	1.00
SLACK	0.25	-0.17	0.37	0.16	0.22	0.44

PHI

	SLACK
SLACK	1.00

THETA-DELTA

expben6	aftben5	aftben6	aftben7	expbar2	expbar3
0.54	0.53	0.13	0.54	0.37	0.55

THETA-DELTA

aftbar2	wsatis1	wsatis3	wsatis4	use2	use3
0.58	0.20	0.23	0.30	0.52	0.25

THETA-DELTA

uncert2	uncert3	abscapa2	abscapa3	slack1	slack2
0.46	0.17	0.29	0.45	0.39	0.14

Time used: 0.125 Seconds

[Appendix 5] Model fits for developing a structural model

(1) Hypothesized model fits

```
                        Goodness of Fit Statistics

                          Degrees of Freedom = 3
             Minimum Fit Function Chi-Square = 15.60 (P = 0.0014)
      Normal Theory Weighted Least Squares Chi-Square = 15.32 (P =
0.0016)
               Estimated Non-centrality Parameter (NCP) = 12.32
           90 Percent Confidence Interval for NCP = (3.63 ; 28.51)

                   Minimum Fit Function Value = 0.083
             Population Discrepancy Function Value (F0) = 0.065
            90 Percent Confidence Interval for F0 = (0.019 ; 0.15)
            Root Mean Square Error of Approximation (RMSEA) = 0.15
          90 Percent Confidence Interval for RMSEA = (0.080 ; 0.22)
             P-Value for Test of Close Fit (RMSEA < 0.05) = 0.011

                Expected Cross-Validation Index (ECVI) = 0.35
           90 Percent Confidence Interval for ECVI = (0.30 ; 0.43)
                      ECVI for Saturated Model = 0.30
                     ECVI for Independence Model = 1.72

     Chi-Square for Independence Model with 21 Degrees of Freedom =
310.29
                         Independence AIC = 324.29
                            Model AIC = 65.32
                          Saturated AIC = 56.00
                         Independence CAIC = 354.02
                           Model CAIC = 171.50
                          Saturated CAIC = 174.92

                       Normed Fit Index (NFI) = 0.95
                     Non-Normed Fit Index (NNFI) = 0.70
                  Parsimony Normed Fit Index (PNFI) = 0.14
                     Comparative Fit Index (CFI) = 0.96
                     Incremental Fit Index (IFI) = 0.96
                      Relative Fit Index (RFI) = 0.65

                          Critical N (CN) = 138.51


                  Root Mean Square Residual (RMR) = 0.039
                          Standardized RMR = 0.047
                     Goodness of Fit Index (GFI) = 0.98
                Adjusted Goodness of Fit Index (AGFI) = 0.79
               Parsimony Goodness of Fit Index (PGFI) = 0.10
```

(2) 1st revised model (drop GA15)

```
                        Goodness of Fit Statistics

                          Degrees of Freedom = 4
```

```
          Minimum Fit Function Chi-Square = 16.03 (P = 0.0030)
  Normal Theory Weighted Least Squares Chi-Square = 15.78 (P = 
0.0033)
           Estimated Non-centrality Parameter (NCP) = 11.78
        90 Percent Confidence Interval for NCP = (3.12 ; 27.96)

                 Minimum Fit Function Value = 0.085
          Population Discrepancy Function Value (F0) = 0.062
        90 Percent Confidence Interval for F0 = (0.017 ; 0.15)
        Root Mean Square Error of Approximation (RMSEA) = 0.12
       90 Percent Confidence Interval for RMSEA = (0.064 ; 0.19)
         P-Value for Test of Close Fit (RMSEA < 0.05) = 0.024

            Expected Cross-Validation Index (ECVI) = 0.34
        90 Percent Confidence Interval for ECVI = (0.29 ; 0.42)
                  ECVI for Saturated Model = 0.30
                 ECVI for Independence Model = 1.72

  Chi-Square for Independence Model with 21 Degrees of Freedom = 
310.29
                     Independence AIC = 324.29
                         Model AIC = 63.78
                       Saturated AIC = 56.00
                    Independence CAIC = 354.02
                        Model CAIC = 165.70
                      Saturated CAIC = 174.92

                     Normed Fit Index (NFI) = 0.95
                 Non-Normed Fit Index (NNFI) = 0.78
              Parsimony Normed Fit Index (PNFI) = 0.18
                 Comparative Fit Index (CFI) = 0.96
                 Incremental Fit Index (IFI) = 0.96
                  Relative Fit Index (RFI) = 0.73

                      Critical N (CN) = 157.56


              Root Mean Square Residual (RMR) = 0.038
                      Standardized RMR = 0.047
                 Goodness of Fit Index (GFI) = 0.98
            Adjusted Goodness of Fit Index (AGFI) = 0.84
           Parsimony Goodness of Fit Index (PGFI) = 0.14
```

(3) 2nd revised model (drop GA15 GA12)

```
                    Goodness of Fit Statistics

                       Degrees of Freedom = 5
          Minimum Fit Function Chi-Square = 18.20 (P = 0.0027)
  Normal Theory Weighted Least Squares Chi-Square = 18.07 (P = 
0.0029)
           Estimated Non-centrality Parameter (NCP) = 13.07
        90 Percent Confidence Interval for NCP = (3.67 ; 30.02)
```

```
Minimum Fit Function Value = 0.096
Population Discrepancy Function Value (F0) = 0.069
90 Percent Confidence Interval for F0 = (0.019 ; 0.16)
Root Mean Square Error of Approximation (RMSEA) = 0.12
90 Percent Confidence Interval for RMSEA = (0.062 ; 0.18)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.025

Expected Cross-Validation Index (ECVI) = 0.34
90 Percent Confidence Interval for ECVI = (0.29 ; 0.43)
ECVI for Saturated Model = 0.30
ECVI for Independence Model = 1.72

Chi-Square for Independence Model with 21 Degrees of Freedom =
310.29
Independence AIC = 324.29
Model AIC = 64.07
Saturated AIC = 56.00
Independence CAIC = 354.02
Model CAIC = 161.75
Saturated CAIC = 174.92

Normed Fit Index (NFI) = 0.94
Non-Normed Fit Index (NNFI) = 0.81
Parsimony Normed Fit Index (PNFI) = 0.22
Comparative Fit Index (CFI) = 0.95
Incremental Fit Index (IFI) = 0.96
Relative Fit Index (RFI) = 0.75

Critical N (CN) = 157.67


Root Mean Square Residual (RMR) = 0.042
Standardized RMR = 0.049
Goodness of Fit Index (GFI) = 0.97
Adjusted Goodness of Fit Index (AGFI) = 0.85
Parsimony Goodness of Fit Index (PGFI) = 0.17
```

(4) 3rd revised model (drop GA15 GA12 GA13)

```
Goodness of Fit Statistics

Degrees of Freedom = 6
Minimum Fit Function Chi-Square = 20.66 (P = 0.0021)
Normal Theory Weighted Least Squares Chi-Square = 20.31 (P =
0.0024)
Estimated Non-centrality Parameter (NCP) = 14.31
90 Percent Confidence Interval for NCP = (4.23 ; 31.96)

Minimum Fit Function Value = 0.11
Population Discrepancy Function Value (F0) = 0.076
90 Percent Confidence Interval for F0 = (0.022 ; 0.17)
Root Mean Square Error of Approximation (RMSEA) = 0.11
90 Percent Confidence Interval for RMSEA = (0.061 ; 0.17)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.026
```

```
Expected Cross-Validation Index (ECVI) = 0.34
90 Percent Confidence Interval for ECVI = (0.29 ; 0.43)
ECVI for Saturated Model = 0.30
ECVI for Independence Model = 1.72

Chi-Square for Independence Model with 21 Degrees of Freedom =
310.29
Independence AIC = 324.29
Model AIC = 64.31
Saturated AIC = 56.00
Independence CAIC = 354.02
Model CAIC = 157.74
Saturated CAIC = 174.92

Normed Fit Index (NFI) = 0.93
Non-Normed Fit Index (NNFI) = 0.82
Parsimony Normed Fit Index (PNFI) = 0.27
Comparative Fit Index (CFI) = 0.95
Incremental Fit Index (IFI) = 0.95
Relative Fit Index (RFI) = 0.77

Critical N (CN) = 154.82


Root Mean Square Residual (RMR) = 0.045
Standardized RMR = 0.052
Goodness of Fit Index (GFI) = 0.97
Adjusted Goodness of Fit Index (AGFI) = 0.86
Parsimony Goodness of Fit Index (PGFI) = 0.21
```

(5) Final (Emergent model)

```
Goodness of Fit Statistics

Degrees of Freedom = 7
Minimum Fit Function Chi-Square = 14.01 (P = 0.051)
Normal Theory Weighted Least Squares Chi-Square = 13.12 (P =
0.069)
Estimated Non-centrality Parameter (NCP) = 6.12
90 Percent Confidence Interval for NCP = (0.0 ; 20.42)

Minimum Fit Function Value = 0.074
Population Discrepancy Function Value (F0) = 0.032
90 Percent Confidence Interval for F0 = (0.0 ; 0.11)
Root Mean Square Error of Approximation (RMSEA) = 0.068
90 Percent Confidence Interval for RMSEA = (0.0 ; 0.12)
P-Value for Test of Close Fit (RMSEA < 0.05) = 0.26

Expected Cross-Validation Index (ECVI) = 0.29
90 Percent Confidence Interval for ECVI = (0.26 ; 0.37)
ECVI for Saturated Model = 0.30
ECVI for Independence Model = 1.72

Chi-Square for Independence Model with 21 Degrees of Freedom =
310.29
```

```
Independence AIC = 324.29
Model AIC = 55.12
Saturated AIC = 56.00
Independence CAIC = 354.02
Model CAIC = 144.31
Saturated CAIC = 174.92

Normed Fit Index (NFI) = 0.95
Non-Normed Fit Index (NNFI) = 0.93
Parsimony Normed Fit Index (PNFI) = 0.32
Comparative Fit Index (CFI) = 0.98
Incremental Fit Index (IFI) = 0.98
Relative Fit Index (RFI) = 0.86

Critical N (CN) = 250.23


Root Mean Square Residual (RMR) = 0.044
Standardized RMR = 0.054
Goodness of Fit Index (GFI) = 0.98
Adjusted Goodness of Fit Index (AGFI) = 0.92
Parsimony Goodness of Fit Index (PGFI) = 0.25
```