

The Study of Students Perceptions of On-campus Wireless Local Area Networks (WLANs) usage

A research study by

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Abstract

Wireless Local Area Networks (WLANs) have become increasingly popular, particularly in education sectors. Understanding of the demand from students is critical for the people who want to deploy, manage and improve their WLANs at educational institutes.

The aim of this research was to identify the issues arising from the use of WLANs from the perspective of students. This study presents the results of the research on the use of on-campus WLANs from two campuses of UNITEC New Zealand. The data gathered through literature review, observations surveys and interviews with students who were currently using the WLANs at either campus, were identified and analysed. The opportunities for education sectors to improve their current wireless networks are outlined. Recommendations are given for deploying, managing and improving the wireless services in educational settings.

Key words: Wireless Local Area Networks (WLANs), campus wireless networks, IEEE 802.11 series, wireless services, wireless networking.

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Table of Contents

Abstract.....	ii
Acknowledgement.....	iii
Table of Contents.....	iv
List of Figures.....	vi
List of Tables	vii
1. Introduction.....	1
2. Literature Review	3
2.1 Literature	3
2.2 Literature Map.....	23
2.3 Summary	26
3. Methodology	28
3.1 Purpose of the Research.....	28
3.2 Research Method.....	29
3.3 Data Collection.....	33
3.3.1 Data collection strategies:.....	33
3.3.2 Data collection procedures:.....	33
3.4 Data Analysis	37
3.4.1 Literature review	37
3.4.2 Observation data	38
3.4.3 Survey responses	39
3.4.4 Interview answers	40
3.4.5 Journal notes	41
3.5 Summary	43
4. Data	45
4.1 Quantitative data findings	46
4.1.1. Surveys	46
4.2 Qualitative data findings.....	56

4.2.1.	Observations.....	56
4.2.2.	Interviews.....	57
4.2.3.	Wireless Information from Unitec website	88
4.3	Summary	89
5.	Data Analysis	91
5.1	The group of the users of on-campus WLANs.....	92
5.2	The reasons why students use on-campus WLANs.....	94
5.3	The behaviours of students who use on-campus WLANs	95
5.4	Current WLANs challenges that students perceive	96
5.4.1.	How could students get on the WLANs?.....	96
5.4.2.	What restrictions are there on the use of the WLANs?....	98
5.4.3.	What are the students' satisfactions with the WLANs?...99	
5.5	Impacts on students from using on-campus WLANs	100
5.6	The opportunities for educational institutions to provide convenience of WLANs for students.....	101
5.6.1.	Current advantage of the convenience of the WLANs....	101
5.6.2.	Opinions from participants.....	102
5.7	Technical issues concerning the WLANs	104
5.7.1.	The concerns about speed and signal of the WLANs.....	104
5.7.2.	The concern for security.....	105
5.8	Summary	107
6.	Conclusions and Recommendations	109
7.	Appendix.....	113
	Appendix A: Survey Questions	113
	Appendix B: Interview Questions.....	115
	Appendix C: Information Sheet.....	116
	Appendix D: Consent Form.....	117
8.	References:.....	119

List of Figures

Figure 2- 1: Literature Map	25
Figure 4- 1: Year of Courses	46
Figure 4- 2: Frequency of WLANs use	47
Figure 4- 3: Duration of WLANs use.....	48
Figure 4- 4: Wireless Zone Awareness	49
Figure 4- 5: Places of WLANs use.....	50
Figure 4- 6: Purpose of using WLANs on campus.....	51
Figure 4- 7: Places of Internet connection before WLANs were provided on campus.....	52
Figure 4- 8: Terms and conditions Awareness	53
Figure 4- 9: Restriction of WLANs Connection.....	54
Figure 4- 10: Connection speed of WLANs on campus	55
Figure 4- 11: Satisfaction with WLANs services on campus	55

List of Tables

Table 3- 1: Summary of qualitative research techniques.....	32
Table 3- 2: Progress of the research	44
Table 4- 1: General information given by participants.....	59
Table 4- 2: Behaviours of using WLANs.....	60
Table 4- 3: Experiences of the use of Wireless Local Area Networks (WLANs) by participants	65
Table 4- 4: The status of completion of the interviews	67
Table 5-1: Relationship between research questions and survey/interview questions.....	92

1. Introduction

Wireless Local Area Networks (WLANs) have rapidly become popular, particularly in educational institutions. There are many wireless technologies on the market today such as IEEE 802.11 series. Many laptops are wireless capable either in IEEE 802.11a, b or g standard. Moreover, the new standard of 802.11n has many drafts on the market recently. Wireless technology has been replacing the wired networks and gradually taking over the network market.

With Wireless networking, the cables are eliminated, the networks are more compatible, and the connections become easier. With so many benefits of the wireless network, many tertiary institutes have provided WLANs at campuses for students and faculties. The advantages of wireless networking are more obvious in tertiary institutes because of the dynamic environment. Rudsar, Joyce & Kolahi (2006) believe that the flexibility of wireless networking allows students greater access without the expense of cabling new buildings or areas like computer laboratories.

The researcher of this study is a student and also a user of WLANs at UNITEC New Zealand. This research is based on the understanding of academic literatures related to the status of the adoption of WLANs in the education sector and developed to identify the issues arising from the use of WLANs from the perspective of users, and particularly from the perspective of students. The result would be used for developing, managing and improving the wireless services in educational settings.

This research focuses on the main research question of “How has the availability of Wireless Local Area Networks (WLANs) on campus affected

students?” The following are seven sub-research questions developed to help understanding of the main research question.

- What kind of students are the users of on-campus WLANs?
- What do students use on-campus WLANs for?
- What are the behaviours of students who use on-campus WLANs?
- What are the current challenges that students perceive with WLANs?
- Are there any impacts on students from the use of on-campus WLANs?
- What opportunities are available for educational institutions to provide the convenience of WLANs for students?
- Are there any technical issues concerning WLANs relevant to educational institutions that arise from user requirements?

The research questions above are aimed to obtain answers from students from their own point of view. There is no standard answer for any of the above questions. The questions mostly require qualitative answers, for example the impacts on students from the use of on-campus WLANs. This question is also an interview question in this research. The interviewees were free to respond with their personal experience. Therefore the methodology of this research is qualitative methodology. The data were gathered for this research through literature review, observations, surveys and interviews.

The review of academic literature is presented in Chapter 2. Chapter 3 presents and discusses the details of the research methodology. In Chapter 4 and 5, the gathered data is coded and analysed. Finally, Chapter 6 sets out the conclusions.

2. Literature Review

Wireless Local Area Networks (WLANs) are being adopted in larger number by campuses. Users could benefit from easier access and information technology (IT) departments could benefit from the reduction of physical cabling requirements. The WLANs make today's campuses more flexible by providing new features of mobility and expanding areas of support. WLANs have been reported and/or discussed in the information technology industry in journals, books, reports and news. This chapter reviews the literature on the provision of WLANs in the education sector.

2.1 Literature

In 1995, "UC Santa Cruz first to pilot wide-area wireless" (1995) reported that the University of California in Santa Cruz California had become the first university to provide a wireless network to students and faculty. The coverage of the wireless network was campus-wide and included cafeteria and parking lot, etc. Even today, many universities are not able to provide a wireless network on campus or to provide it with such wide coverage. Many universities just provide wireless networks in buildings, such as at UNITEC New Zealand.

The AirBears Project is an example of a project that defined the proliferation of WLANs in the education industry. AirBears: the WLAN Project, which was begun in the autumn of 2001, "*enables one to connect to the campus network using a laptop equipped with a wireless Ethernet card. The service is based on the IEEE standard 802.11b wireless LAN technology, which supports speeds of up to 11 Mbps*" (AirBears, 2006). The AirBears project mainly aimed to accomplish more technical goals such as "*identify*

ways to minimize maintenance and installation problems and maintain reasonable security for the campus and privacy for the users” (AirBears, 2006). The WLAN service provided by AirBears is free of charge but users may have needed to purchase a wireless network card. The AirBears project’s website listed technical issues such as authentication, encryption and roaming; policy issues such as interference with other wireless equipment and user privacy and also have mentioned health and safety issues (AirBears, 2006).

There have been many projects similar to the AirBears in recent years. Many mobile network equipment vendors such as Cisco and HP are providing on-campus wireless technology to educational institutes. *“Norway’s largest telecommunications provider is to deploy Europe’s largest wireless local area network (LAN) campus, using Cisco’s Architecture for Voice, Video and Integrated Data (AVVID) technology platform”* (Cisco News, 2002). This project is aimed to serve over 7,700 employees from 40 offices in the WLAN campus and to reduce operational expenses for the company.

Sharp (2001) reported that Minnesota State University (MSU) provides wireless services on MSU campuses. It was initiated by the Student Technology Committee of MSU in the spring of 1999. Information Technology Services (ITS) staff advised and encouraged the student technology committee to establish a process model. This process model was intended it *“would lead into the wireless technology age”* (Sharp, 2001). They planned to cover the core campus in three years. There were seven steps in the process model and the project would be developed by both the networking staff and the student technology committee (Sharp, 2001). According to Sharp (2001), Lucent WaveLan access points were selected but in order to save costs Apple AirPorts were also installed. By testing,

they found Apple products were even better than Lucent WaveLan products. Students could get help for loading the wireless drivers, obtain users instruction and register their PC card MAC address from the Laptop Help Centre (Sharp, 2001). The funding from students was used for purchasing access points, and laptops included three IBM ThinkPads and three Apple iBooks for the Library Laptop Research Tool prototype project. The funding from the student senate association was used for the purchases of 20 laptops, 15 Dell Inspirons and five Apple iBooks for the Campus Computer Store Laptop Loaner project (Sharp, 2001). There were some donations from Midwest Wireless and Nokia which were “*used to train students on programming for cell phones and to develop creative uses of cell phones for educational purposes*” (Sharp, 2001). MSU became a wireless campus in January 2001. With the benefits from the wireless technology of cost savings and convenience, “*the U.S. Congress awarded a financial grant to further the wireless technology efforts*” (Sharp, 2001).

Sharp (2001) reported the details of how MSU joined the wireless revolution. This project was not only accomplished by MSU but also included much interest and assistance from many groups and computing industry, for example the practical help and funding from different groups and donations from Midwest Wireless and Nokia. The comparison of access points from Apple and Lucent WaveLan would help other organisations in their selection of products. The wireless campus project has been very successful and introduced people a new technology age in education industry.

Schwartz (2002) stated that “*concerns such as roaming, interoperability, and security must be addressed with management tools, not just the technology alone, and the management capabilities of WLANs, while not as robust as the wired network, are evolving rapidly.*” The article of “WLAN on

campus” discussed the adoption of a WLAN in an organisation from five aspects: *“vexed by interoperability, central control questions, the speed factor, reasons for WLAN installation and WLANs getting the green light”* (Schwartz, 2002). Schwartz (2002) considered that the lack of interoperability among vendors’ products was the biggest problem for populating wireless local area networks. Schwartz (2002) gave an example in the article to define central control of WLANs by managers *“in an academic organization a manager might want to be able to create a policy that said during exam week, during specific hours, and in certain locations, the class of users designated as ‘students’ will not have access to instant messaging.”* Schwartz (2002) believed that *“with the help of the wireless network, Bernai was able to coordinate all its efforts, add more nodes to the network more quickly, and have everyone up and running – and back to doing business – more quickly.”* The author also gave two figures that well defined the reasons for installing WLANs and giving WLANs the green light. Schwartz (2002) stated the reasons for installing WLANs were horizontal applications with the highest score of 83%, conference room connectivity with 57%, specific vertical applications with 53%, and telephony with 32%. The number of WLANs getting the green light showed the popularisation of WLANs was increasing and *“no need for WLAN”* was decreasing from 2001 to 2002 (Schwartz, 2002).

The article discussed the populating of WLANs in organisations from both management and business aspects. The author compared the adoption of WLANs in 2001 and 2002. The researcher thinks it is good that one example of new policy was to stop instant messages during exams in an academic organisation.

Campbell & Pargas (2003) showed how teachers take advantage of the availability of laptops in the classroom. The authors first stated the

background to a variety of experiences of taking wireless services into classrooms. They gave many examples of how each college or university implemented this. For example *“the University of Arizona, Tucson, is developing learning centres.... Clemson University began a pilot laptop program for 100 freshmen in the fall 1998 semester.... Carnegie Mellon is working on ‘invisible halos’ of computing surrounding participating student and faculty”* (Campbell & Pargas, 2003). All of these universities were trying to enhance the classroom experience by providing wireless services. Then the authors had a question and asked themselves: *“How can the instructor do a better job of teaching given that a laptop computer with a wireless connection to the Internet is available to each student?”* (Campbell & Pargas, 2003). This was also the purpose of their article. With the question they asked themselves, Campbell & Pargas (2003) discussed eight categories of how to integrate laptops into the lesson plan. The eight categories were *“Posting Instructional Material Online”, “Animating and Demonstrating Concepts”, “Collaborative Learning Exercises”, “Instant Feedback”, “Automatic Program Execution and Visualization”, “Evaluation and Testing”, “Communication”, “Laptop Etiquette and Discipline”* (Campbell & Pargas, 2003). Under each category, there was detailed information from interviews with professors who were teaching courses that required laptops in classrooms. For example, under instant feedback, one professor said that from a short online survey, the professor could know instantly whether *“a certain topic should be revisited in today’s lecture”* (Campbell & Pargas, 2003). Campbell & Pargas (2003) concluded that the use of laptops with wireless connections in classrooms needed to be enhanced and most professors did not know how to integrate the laptops into their daily lectures.

Campbell & Pargas (2003) clearly stated eight categories of how a professor could integrate laptops into lectures. From the education sectors’ point of

view, professors could use these features to help improve their teaching. From the students' point of view, they could benefit from instant feedback and communicate during the class. With the eight features, the classrooms would become more flexible and functional. The rules for exams may need to be changed in that they are not only "open book" but also "open web".

Roshan & Leary (2003) mentioned several considerations for design of wireless LAN in an educational environment. The first consideration was the convenience: "*WLANs give them the opportunity to provide ubiquitous coverage so that they can bring networks to the students instead of bringing the student to the network*" (Roshan & Leary, 2003, pp. 246-247). The second consideration was the cost savings: "*As computers have become a larger part of the learning process, the time and resource savings that wireless brings has proven to be rewarding*" (Roshan & Leary, 2003, pp. 246-247). The third consideration was no physical boundaries: "*many school buildings were designed before the computer revolution. It just might not be feasible to run wires to the students*" (Roshan & Leary, 2003, pp. 246-247). The fourth consideration was the challenges, in deploying wireless in an educational environment, of "*ensuring that the infrastructure can support a multivendor client environment*" (Roshan & Leary, 2003, pp. 246-247). This means "*these scenarios create a situation that can include client devices with many different operating systems and with wireless NIC devices that need to communicate with a common infrastructure*" (Roshan & Leary, 2003, pp. 246-247). The fifth consideration was security. The wireless LAN provider might want to restrict the access level for different user groups. Roshan & Leary (2003) believed that "*the easiest and most rapidly deployable solution might be to employ wireless bridges to connect the remote network with the school network.*"

First of all, this article talked from the educator's point of view about why to use wireless LAN for education. The writer mentioned the advantages of deploying wireless LAN at campus and also explained the security level for WLANs. Certainly, there were two benefits of adopting wireless LAN on campus. One was the educator could save time and resource costs. The other was that students could connect to the Internet and Intranet in open spaces such as cafeterias. This article also mentioned that from students' perspective the use of WLAN was more convenient than the use of wired network. As regards the security aspect of using WLAN, there was barely any difference for students, because when logging on students would be restricted by either WLANs or the wired network.

According to "Government Solution Blueprint" (2003), more and more universities were adopting WLAN technology in order to enhance their value to attract and retain more students. Students and staff would benefit from easier access and IT departments would benefit from the reduced requirements for physical cabling. Based on those benefits and demands, *"the Portuguese Government is a leading example of this as they have created an initiative called the e-U project to drive the use of technology in education"* ("Government Solution Blueprint", 2003). E-U stands for Electronic University. The e-U project allowed students to *"have access to classes, R&D articles, students' papers, grades, bookshops and academic administrative services online, as well as access to the internet through a broadband wireless LAN"* ("Government Solution Blueprint", 2003). By this token, students would be benefit on a large scale and most students would be satisfied. According to "Government Solution Blueprint" (2003), the e-U project involved three main areas of the university campus: students, teachers and university services. The demands for adoption of WLANs on campuses were mainly from students. From a business perspective adopting wireless network solutions was cost effective if the

institute owns multi buildings. For different types of organisation, the benefits to people are different. In education, students and teachers are benefit from easier access to information. This can be compared with the people in IT departments who are benefit from *“easier infrastructure implementation in the reduction of physical cabling required”* (“Government Solution Blueprint”, 2003).

“Laptop has become must-have for today’s college students” by Brass (2004) stated that the demand for laptops by college students was rising to a top position on the supply lists for schools. The report mentioned that *“in the past couple of years almost 100 percent of dorm students have activated their network connections and increasing numbers are lugging laptops to class”* (Brass, 2004). As soon as wireless happened laptop sales increased. Students not only took laptops but also took personal digital assistants or PDAs to school. According to Brass (2004), students took laptops to school for academic uses and other capabilities of the wireless network, such as keeping in touch with friends and family through instant messaging services. The report stated that a first year student would spend \$759.97 on electronics out of \$1,200 on school gear. According to Brass (2004), *“the organization estimated that, in all, parents and students would spend \$7.5 billion on electronics compared to \$3.2 billion on clothing and accessories, \$2.6 billion on dorm or apartment furnishings, \$2.1 billion on school supplies and \$1.5 billion on shoes.”* The author considered that computers were expensive and computer purchases increased the students’ budget. If schools required students have to have a computer, they could pay for it by using federal loans. The school might require students to have computers because of the needs of some courses, such as architecture and design, engineering and business. For example, *“business students have used the computers to set up simulated business”* (Brass, 2004).

From this report, it appears that the demand for wireless network and laptops had greatly increased. Over the previous couple of years, the demand had changed from optional for some students, to required by all students. The student budget for school had increased dramatically as computers are expensive, even though students could pay through federal loans. But the effect of using laptops was clear.

“Wireless Networks in Education – A New Zealand Perspective” by Nisbet (2004) is an article that from a New Zealand perspective talked about wireless networks in education. The writer mentioned *“four key questions that must be answered when planning a wireless network for a campus”* (Nisbet, 2004). The four questions were *“Who will use it? Where will they use it? What services to deliver? How will they use it?”* (Nisbet, 2004). The article discussed WLANs using these four questions as the framework. Nisbet (2004) believed that *“the choice of wireless technology available means that organisations need to decide on the standards that best suit their needs.”* Nisbet described two cases of providing wireless network in private schools. The first one required all form 7 students to carry a laptop with them. The school required the students to purchase Toshiba laptops and in a deal with Toshiba changed the 802.11b to 802.11a wireless access. This was because the school only provided 802.11a. For security reasons, the wireless network required encryption key, username and logon password for user login. The second school required all students to carry a laptop to school. The official choice of this school was Toshiba. Students could choose another brand but the school would not provide hardware and software support. This school chose the most common standard – 802.11b because of the excellent range and ability to upgrade to “g”. All students had laptops in classrooms and were connected to Internet and Intranet as education tools. For the security aspect, a specialist company in network security solutions was employed. The writer believed this school had “a

truly mobile computing solution” (Nisbet, 2004). By studying those two cases, Nisbet concluded *“the decision to install a wireless network in a campus environment is a major strategic initiative for an organisation”* (Nisbet, 2004).

Nisbet (2004) had mainly studied two cases. The two cases were both in private schools and the students were teenagers. All form 7 students from the first school and all students from the second school were required to purchase Toshiba laptops and carry them to school. From the educators’ perspective, the same brand of laptops was easier to support and manage, but from the students’ perspective, they were restricted and lost their choice. Although the second school allows students to chose another brand, the students will lose the hardware and software support from the school.

Brawn, Koan & Caye (2004) outlined the authentication process of wireless network services on campus at Arizona State University West (ASU West). The authentication process incorporated security for both wired and wireless networks. The 802.1x security protocol was used for this authentication process. Compared to the Microsoft PPTP VPN, which was the previous encryption protocol, the 802.1x was faster and scalable. There were more advantages in using the 802.1x to replace the Microsoft PPTP VPN. For example, the 802.1x required at least a minimum encryption which made the traffic in the wireless network safer. The authors defined the IEEE 802.1x authentication as a standard Extensible Authentication Protocol (EAP) for 802.11 wireless local area networks. The article stated that the client, access point and the authentication server were the main components of the 802.1x authentication. Then each of the main components were explained and presented in the article. The 802.1x authentication consisted of five steps and it started from sending packets from the client side to an access point, then passed on to the authentication

server (Brawn et al., 2004). The authors described the procedures for configuring the 802.1x authentication protocol on Windows XP, Windows 2000 and Windows ME Workstation separately. The article concluded that it is necessary to ensure that users are authenticated and encrypted while entering and transmitting in a network (Brawn et al., 2004).

Brawn et al. (2004) believed the 802.1x authentication protocol could be more secure for students and faculties while they were in the campus network. No matter whether they were in a wired network or wireless network, the 802.1x was the best security solution for campus networks. With more campuses providing wireless networks to students and faculties, the security should be the concern of the information technology (IT) department of those campuses. Students and faculties desired to connect to secured campus wireless networks even with their own laptops or portable devices.

Communications News (2004) talked about the adoption of WLANs by McGill University. According to *Communications News* (2004), the university's plan to install network connectivity jacks in the wall was changed to a WLAN solution, because "*students did not want to wait in line for computer jacks, and they were not wild about always being tied to a wall*" (*Communications News*, 2004). The whole article talked about how the university adopted and managed the WLANs, and also stated the challenge of installing WLANs in classrooms: "*It's tough when you have a lecture room filled with a hundred students and they're all logging on to the campus' wireless network*" (*Communications News*, 2004). At the end of article, the writer gave an ideal solution for this problem: "*giving only professors access to the wireless network while in class*" (*Communications News*, 2004).

This article had an excellent point of view on why the university changed the network plan to adopt the WLAN solution. They thought students would like to have unlimited access to network when they were anywhere on campus. This is the first article the researcher found that considered it from the students' perspective and not from easy management or maintenance by the IT department.

Benson (2004) believed the education sector was not alone in the wireless revolution while the number adopting wireless technology on the campus was increasing. Students' desire for wireless was supported by many reasons, for example "*unwired connectivity in high-traffic areas such as the student centre and college quad,*" and "*the ability to easily and wirelessly access the university library, register for classes, as well as have a more interactive relationship with their professors and fellow students*" (Benson, 2004). According to Benson (2004), in order to provide an integrated wireless solution to students, St. John's University partnered with IBM, Intel and Cisco. The IBM ThinkPad R40 was selected because of "*ease of use and enhanced security capabilities*" (Benson, 2004). That the ThinkPad could switch between wired and wireless LAN connections based on the speed and without rebooting, this was another reason for adopting the IBM ThinkPad. Benson (2004) believed having the encryption engine equipped in both hardware and software on the ThinkPad R40 was very important. The flexibility and freedom made students happy with the school's wireless laptop distribution program (Benson, 2004). Benson (2004) emphasised that St. John's University saved at least \$20 million potential cost by using wireless local area networks. And most important was students were taking advantage of using wireless tools.

Benson (2004) clearly stated the reasons, benefits and demands from students for adopting wireless on the university campus. The effects of

using wireless network on campus were obvious. This was a good example of providing wireless services to faculty and students on campus.

Roach (2004) stated several survey result and listed some statistic reports, such as *“the 2003 survey data reports that 77 percent of the participating campuses have wireless LANs on campus, up from 68 percent in 2002 and 29 percent in 2000.”* The adoption of wireless LAN on campus from 2000 to 2003 increased dramatically from 29 percent to 77 percent. Roach (2004) believed *“the increase in wireless networks was reported among all levels of academe from large public and private universities to community colleges.”* Roach (2004) reported *“in another trend in higher education IT, colleges and universities are taking dramatic steps to stem the unauthorized distribution of digital content on campus networks”* because the data confirmed that there was a lot unauthorised downloading of digital content on campus networks.

By reviewing the statistical reports and results of those surveys, even in 2004 we could see the trend to adopting of WLANs on campus was increasing steadily.

Henderson, Kotz & Abyzov (2004) studied, over seventeen weeks, a trace from a mature wireless LAN which supported 7000 users connected over 550 access points. The article also compared the results to another trace of initial wireless network deployment two years previously. The authors described the test environment and listed the devices used by the client. According to Henderson et al. (2004), the client devices varied from Windows, MacOS, Linux, PocketPC and Unidentified. There were 7134 devices in total seen on the wireless network and Windows was the most common among ten categories. Several measurement techniques were employed for tracing collection such as sys-logs and telephone records

(Henderson et al. 2004). By comparing the results of the trace to the other one two years earlier, the article conclude as follows: “*the user population*”, “*roaming*”, “*AP utilization*” and “*overall traffic*” increased; “*the proportion of heavy users*” and “*the busiest types of building*” remained the same; “*the applications used on the network*” and “*traffic destinations*” changed; “*Usage remained diurnal*”, and “*Residences continued to generate the most traffic*” (Henderson et al. 2004). The article analysed specific applications such as VoIP, peer to peer applications and streaming media. The article also analysed the mobility of the users and obtained the results of “*Users spent almost all their time in their home location*”, “*Users persisted at a single location for longer*”, “*Different devices travelled more widely*”, and “*Different applications had different mobility characteristics*” (Henderson et al. 2004).

The authors believed their study was the largest and most comprehensive characterization of WLAN users at the time the article was written. But a year later, Kotz & Essien (2005) made similar claims to Henderson et al. (2004). Regardless, both of these studies are comprehensive on data gathering and analysis. The results are useful for people who are developing, implementing and managing campus-wide wireless networks.

“*Analysis of a Campus-Wide Wireless Network*” by Kotz & Essien (2005) reported an experiment that traced wireless network activities among nearly two thousand users for eleven weeks. This trace aimed to analyse the wireless local area networks (WLANs) patterns for developing and managing WLAN technology at campuses. The authors reported that the location for the test was the Dartmouth College campus with 476 access points installed in 161 buildings; the trace collection focused on the data gathered during eleven weeks in 2001 (Kotz & Essien, 2005). The authors gathered a large amount of data which they analysed in the categories of

traffic, users and user mobility, card activity, access point activity, building activity, and protocols (Kotz & Essien, 2005). Kotz & Essien (2005) concluded that the patterns of activity and traffic varied across hours, days and weeks; wireless cards competed with each other while accessing access points which resulted in different roaming performances between different access points. That meant the wireless network activities varied between buildings, access points and network cards. The authors suggested developing a new solution to stop network card roaming. The article also described related work on the characterised wireless network usage by Tang and Baker (Kotz & Essien, 2005). Future research on the behaviour of different users from groups such as students, faculties and staffs was recommended.

Kotz & Essien (2005) did excellent work on a large experiment on wireless network activities. The users were traced, and the geographical area, and the data gathered were large and comprehensive. There are not many similar experiments on usage patterns in WLANs. The results of this experimental are significant for developing, implementing, and managing WLAN on campuses.

Bruns (2005) reported that Charleston Southern University (CSU) partnered with CDW Government In. to upgrade its dial-up network to campus-wide wireless networks. It was important to spend less money and to provide a more productive learning environment for students and faculty. By comparing the budget for expanding the dial-up system and building a wired network with Category 5 cable (over \$500,000), CSU calculated it would save at least \$250,000 if wireless technology was selected. CSU decided to adopt a wireless network and provide it to students and faculty (Bruns, 2005). According to Bruns (2005), a test wireless network was initiated in 2001 and supported up to 500 students. But of those 500

students, only 40 used all the bandwidth. A Cisco PIX 515 firewall and a bandwidth packet shaper were selected to control bandwidth usage. Finally, CSU controlled the bandwidth and blocked excessive downloads so that all students could enjoy a faster network system (Bruns, 2005). "*With a more sophisticated networking system, students have the freedom to access educational resources....with uninterrupted, fast, convenient connectivity, students experience a more positive learning environment*" (Bruns, 2005). After successfully testing the system, CSU expanded the network to cover at the whole campus.

CSU changed from dial-up network to wireless network successfully. The article believed the success at CSU was because good people planned well and used good technology. It was crucial that education sectors should be sensitive with cutting edge technologies and use them properly.

Rudsar, Joyce & Kolahi (2006) gathered and compared data from 19 institutes mainly in Auckland but also in other cities. The paper discussed the status of wireless networks in seven educational institutes in Auckland. The writers interviewed the head of the IT services department from 19 institutes and conducted the results of research into some aspects: stage of the wireless implementation, who maintains the wireless networks, and devices used on the wireless networks, etc. Compared to the institutes in other countries, Rudsar et al. (2006) found that "*the Auckland institutes were a little ahead with their pilot projects and planning of their wireless networks.*" A table in the article stated the purpose of providing wireless. The purposes included: "*Student access, Staff access, Increased access, Flexible access / mobility, Outside access, Areas without feasibility for wires, Give students and staff 24/7 access, Testing, Demand, Promote use of laptops, More seats*" (Rudsar et al. 2006). The purpose of providing student access to wireless stands the highest with a score of 11 out of 19 and areas

without feasibility for wires stands in the middle with a score of 3. The area without feasibility for wires is the most common reason to use WLAN on campus.

The article stated why colleges provide wireless network services to faculties and students. Rudsar et al. (2006) emphasised twelve reasons for providing wireless on campus, and many colleges in New Zealand were providing wireless right then. The impact or effect on students of providing wireless should be also studied. Studying the impact on students of using wireless networks on campus may help the education sector improve their wireless network services on campuses.

Kelly & Johnson (2006) analysed statistical data on the growth of wireless services in Arizona and Arizona State University (ASU). The demand for wireless services was growing with the growth of population in order to meet demand from greater numbers of students and faculty at the campus of ASU. Kelly & Johnson (2006) believed many students owned portable electronic devices such as PDA and cell phones. They were already using wireless connection to the Internet. Universities just needed to provide wireless access for students. Kelly & Johnson (2006) highlighted that “Student needing technology...Faculty embracing technology”. With the responses of 237 faculties who use media for the lecture, over half the responses were “always” and “almost always” use technology in the classroom. As the demand for wireless technology at the campus grew, the ASU decided to explore wireless technology to support the campus growth. The University Technology Office (UTO) staff were assigned to separate teams such as “*Computing Sites Team, Classroom Team, Faculty Training and Technology Integration and Information Dissemination*” (Kelly & Johnson, 2006) to support students and faculties. ASU developed 1:1 computer program to solve the digital divide; it provided training to solve

the faculty technology; it created a standard model and changed all classroom technologies into one standard for the entire campus (Kelly & Johnson, 2006). The authors defined the support that today's campuses need to evolve over the next few years and recommended that Universities should stretch the resources to react new challenge in the future, for example "*more new technologies appearing, IT budgets shrinking, and the need for support to faculty and students growing*" (Kelly & Johnson, 2006).

The article stated that universities had to provide technologies to faculties and students because of the demand. With the population increasing, the demand was increasing. The campuses were expanding their use of wireless solutions. But using wireless solutions meant not only providing but also supporting them. How to support the expanding campuses become new class for university information technology departments compared with what the campuses used to be.

Communications News (2006) reported that universities across the United States, including the Universities of Texas and Dallas, were providing wireless networks for staff and students. A project of "*deploying a campus-wide converge wireless LAN system to bring business-critical voice and data applications to the school's 14,000 students and 2,500 employees*" was initiated for three years and it would pay for itself in three years. "*After assessing the costs of re-cabling older buildings with CAT 5, staff decided that a wireless LAN would better satisfy UTD's needs for anytime anywhere access and, simultaneously, would be less expensive to deploy and maintain*" (*Communications News*, 2006). The wireless LAN project would "*provide the coverage necessary to give our students and employees ubiquitous access to the applications they need*" (*Communications News*, 2006).

The report stated the cost saving of cabling the buildings was another reason for deploying wireless LAN for staff and students. The education sector considered the wireless LAN project mainly from the cost aspect, said in this report. The project manager also mentioned that they would be better to satisfy the needs for anytime/anywhere access to the networks. Without question, the wireless LAN project would give staff and students more convenience and benefits.

“Tech Check” (2007) discussed some statistics of some popular electronic devices being used by students. According to “Tech Check” (2007):

- *93% of college students own a Cell phone (up 15% since 2003)*
- *64% own a digital camera and 16% plan to purchase one this year (up 100%)*
- *58% own an MP3 player vs. 17% in the pre-iPod days of 2003*
- *A little under one in three (28.9%) of college campuses offer wireless coverage, while four years ago, only 14% of campuses had this capacity. Additionally, today, two-thirds are planning a wireless strategy*
- *63% of college students own laptops today compared with less than half only two years ago (2005: 42%)*

This means the trend of owning and using mobile electronic devices among college students was increasing and seemed unlikely to stop in the next few years. The college campuses that provided wireless connection for students doubled in four years, and more campuses were planning on wireless solutions. It seemed the ever-increasing demand by students forced colleges to provide more flexible campuses with more features. The campus wide wireless network was one of those features to meet the needs of students.

McLaughlin (2008) reported that one university – Carnegie Mellon

University – adopted 802.11n devices on campus late last year and one other – Duke University – planned to adopt the campus-wide 802.11n wireless network. Duke University’s chief information officer believed “*the value of a technology like 802.11n is about enabling new kinds of uses on our campus, giving our students new opportunities, and enabling faculty to push the limits and try things that were not possible before on previous wireless technologies*” (McLaughlin, 2008). Meanwhile, he also believed “*Universities are an ideal testing ground for new technologies, especially wireless uses and devices, because students are spending their entire day on campus in a mobile manner. They live, learn, work, and play on campus*” (McLaughlin, 2008). According to McLaughlin (2008), the speed would be doubled if clients used 802.11g connect on to the 802.11n-based access points and the Duke University planned to deploy the new Cisco 802.11n access points to serve approximately 45,000 students, faculty, and staff.

Certainly those two universities were doing their best to provide new technology and meet the demands of students and faculty, but the article did not state what the demands of students and faculty were. Did they want what the university gave them? Maybe those universities’ IT departments could ask this question before they adopted new technologies.

Cox (2008) reported that Duke University planned to install the largest wireless network 802.11n standard on the campus. According to Cox (2008), Duke University planned to cover 6 million square feet of campus by installing at least 2,500 Cisco Aironet 1250 access points in the following six to nine months. The 802.11n network would serve about 45,000 students and faculty with a range of 2Mbps to 25Mbps. The speed would depend on the numbers of users. It could be 25Mbps if there were about five or six users and 2Mbps for up to 30 users. Duke University believed the wireless technology has become the primary connectivity mode for

large population at campus (Cox, 2008). The article stated the reasons for providing 802.11n wireless network in Duke University were because of positive features such as higher throughput for end users, higher aggregate network capacity and more reliable signal than the existing Wi-Fi network. But there were some technical issues to be addressed, such as 802.11n was not a formally ratified standard by the IEEE (Cox, 2008). Duke University was not the only one deploying 802.11n in campus. Morrisville State College and Carnegie Mellon University had already installed hundreds of 802.11n access points on their campuses; and Concordia University was planning to replace existing access points by 802.11n access points (Cox, 2008).

In these universities which have 802.11n installed already or plan to upgrade their wireless networks to 802.11n technology, there is no doubt that wireless technology has become the most important mode of communication. Each of them was seeking a better way to upgrade their wireless networks and provide the best service to their students, faculty and staff. Obviously, 802.11n is the way that they have fund so far.

2.2 Literature Map

A literature map is a useful tool to organise the topics of the literature the researcher has gathered for this study. It enables the researcher to understand the link between academic literature and research questions. A literature map can be organised into various types, such as by research methods and content of articles. In this study, the literature map is organised by content of articles. The adoption and population of the use of WLANs at campuses are divided into four main areas as shown in Figure 2-1: Literature Map. As the following literature map shows, there are few

academic that consider it from the student perspective. Among the 22 publications found by the researcher, the Sharp (2001) and Campbell & Pargas (2003) reports are the only two articles that involved students in their discussion of the use of campus WLANs.

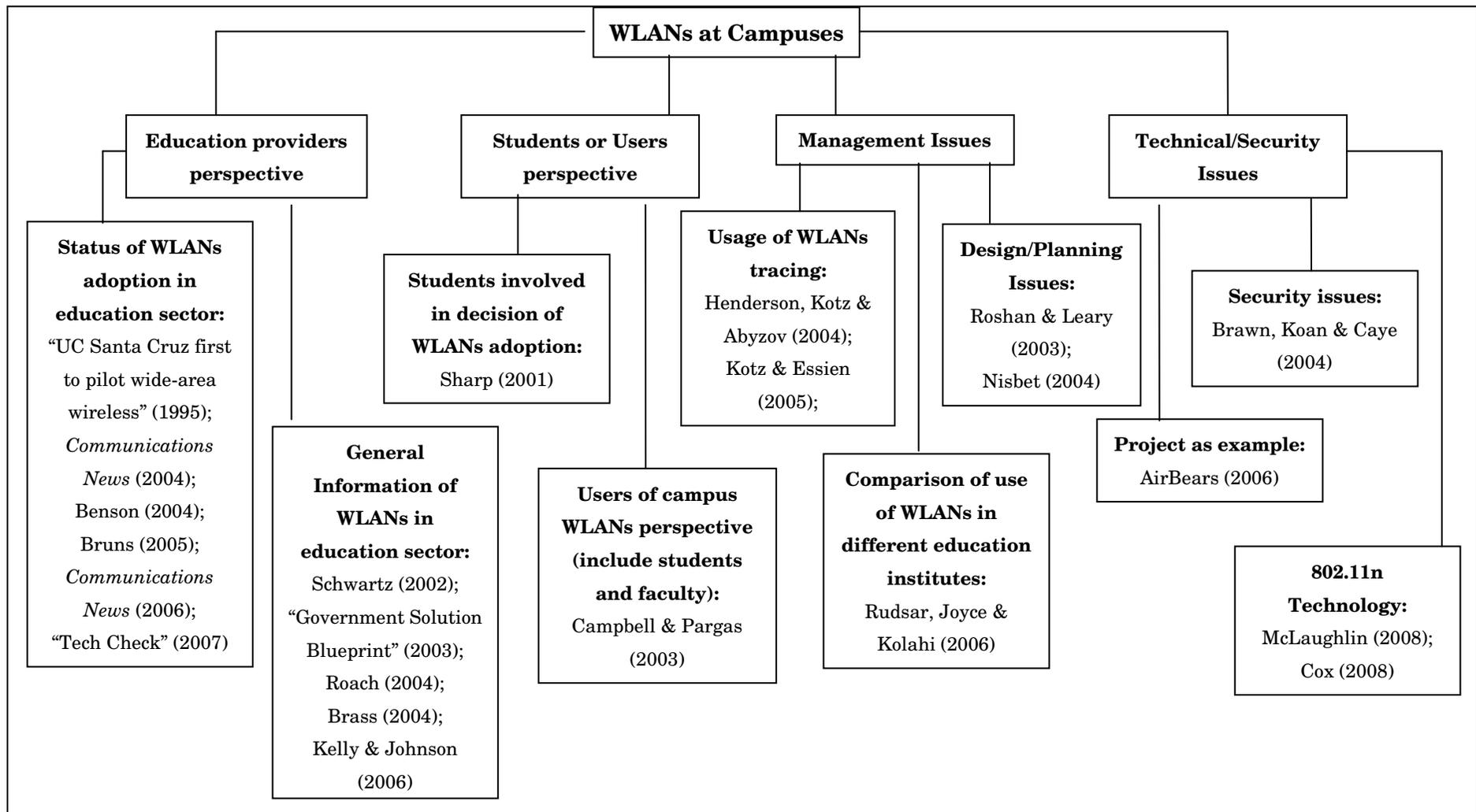


Figure 2- 1: Literature Map

2.3 Summary

This literature review is the basis of the research. Before searching the literature, the key words of wireless local area networks were identified. The scope of the search area was within the education sector.

This chapter reviewed 22 articles from the first university – University of California in Santa Cruz California which adopted WLANs at campus on 1995 – to the McLaughlin (2008) and Cox (2008) reports of two universities currently upgrading their on-campus WLANs to 802.11n technology. These articles showed the processes of development of WLANs in the education sector.

Preview of these articles showed that one of the reasons for providing WLANs on campus was the demand from students and faculty. Most of the articles report the decisions made and the processes of adopting WLANs at campus.

Brawn, Koan & Caye (2004) was the only report on security issues in this literature review. Sharp (2001) reported a different pattern, where students of Minnesota State University proposed to use WLANs and were involved in the process of the project. Campbell & Pargas (2003) reported the use of WLANs in lectures in a different point of view from users' perspective.

With the knowledge from the literature review, the researcher designed this research and aimed to determine the issues arising from the use of on-campus WLANs from the perspective of students. The research questions were generated and developed by reviewing academic literature

on the topic of WLANs adoption in the education setting, especially at Tertiary level. The main research question and sub-questions will be discussed in the next chapter. The strategy and literature review procedures are also stated in the next chapter on methodology.

3. Methodology

3.1 Purpose of the Research

The purpose of this research is to identify the issues arising from the use of wireless local area networks (WLANs) on campus, and to analyse opportunities for education sectors to advance the current wireless networks they have. The analysis results and recommendation also could be used by those educational institutions which are planning on adopting WLANs. All the participants of this research were students who use the WLANs at either Mt. Albert Campus or Waitakere Campus of UNITEC New Zealand. The participants were selected randomly in order to avoid bias from groups of users.

This research was focused on the following main research question: **“How has the availability of Wireless Local Area Networks (WLANs) on campus affected students?”** Based on the purpose of the research, there are many questions related to this research topic, such as:

- What kind of students are the users of on-campus WLANs?
- What do students use on-campus WLANs for?
- What are the behaviours of students who use on-campus WLANs?
- What are the current challenges that students perceive with WLANs?
- Are there any impacts on students from the use of on-campus WLANs?
- What opportunities are available for educational institutions to provide the convenience of WLANs for students?
- Are there any technical issues concerning WLANs relevant to educational institutions that arise from user requirements?

3.2 Research Method

The primary research methodology chosen for this research was qualitative who's design was informed by an initial survey. According to Bouma (1996, p.169), "*Qualitative research is designed to provide an impression; to tell what kinds or types of something there are; to tell what it is like to be, do or think something.*" The reason for using a qualitative research approach is "*if a concept or phenomenon needs to be understood because little research has been done on it, then it merits a qualitative approach*" (Creswell, 2003, p. 22). As this is a qualitative research study, qualitative research techniques and qualitative data were required. According to Myers (1997), "*Qualitative research methods were developed in the social sciences to enable researchers to study social and cultural phenomena. Examples of qualitative methods are action research, case study research and ethnography.*" After considering all qualitative research approaches, case study research, which is the most common qualitative approach used in information systems research, was chosen for this study. This will be discussed later in this chapter.

Myers (1997) states "*Qualitative data sources include observation and participant observation (fieldwork), interviews and questionnaires, documents and texts, and the researcher's impressions and reactions.*" In order to gather data for these research questions, observation, surveys and interviews were used for data gathering. The researcher has developed two lists of questions for survey and interview (see Appendix A and B).

The survey was use to gather initial data, such as the general information about the use of on-campus WLANs from each participant. Based on the answers to the survey, the interview questions could be modified or changed. In order to gain a good understanding of the impacts of the use of

WLANs on students, the interview was needed. As the interview questions were open-ended questions, qualitative data was expected. The participants were free to talk. The primary data of this research was the data gathered from interviews.

The strategies and procedures for data gathering from observation, survey, interview, and the data analysis will be presented individually in this chapter.

Case study

Yin (1994) believed *“In general, case studies are the preferred strategy when “how” or “why” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context.”* This research is based on the uses of WLANs by students and the research has generated some questions such as “How has the availability of Wireless Local Area Networks (WLANs) on campus affected students?”

In case study research *“the researcher explores in depth a program, an event, an activity, a process, or one or more individuals. The case(s) are bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time”* (Stake, 1995). In this study, each individual student (participant) using WLAN (activity) on campus (place) was considered as a particular case. Surveys, interviews and observation were the approaches to be used for initial data gathering.

Observation will let the researcher get primary data such as when and where the most students were using WLAN. By observing the students on the campus, the researcher could clearly see whether they were alone or in

groups, male or female. The researcher also knew which campus had more students using WLANs and then the researcher would expect more results on that campus when doing the surveys. Surveys were used to collect initial data from simple questions. These results were used as a basis for in-depth interview questions, such as what WLANs services do students expect to gain from the provider. Because this study was trying to determine how students thought management strategy could be improved, the interview questions were open questions in order to gather different opinions from students.

A thematic analysis of this survey data was conducted as outlined in the following chapter. After that, eight to ten students were to be interviewed in depth for their perceptions and comments regarding the impact and requirements of wireless LANs on campus and what emerged from the thematic analysis above. (During the survey, students were asked to identify if they were prepared to be involved in an in-depth interview). The fieldwork of the research was conducted from October 2007 to July 2008.

Summary of qualitative research techniques:

Methods	Purpose	Number of participants
Literature Review	The basis of the research; used to provide understanding of related studies that had been reported.	N/A
Participant Observation	The observation notes would help to increase understanding of students' behaviour. According to Creswell (2003, p.186), <i>“Researchers has a firsthand experience with participants; research can record information as it is revealed; useful in exploring topics that may be uncomfortable for participants to discuss”</i>	As many as the researcher saw for in the duration of one hour each day. There may be further observation at the time of doing the surveys.
Surveys	Use to gather initial data. Based on the answers to the survey, the interview questions would be modified or changed. (Appendix A).	Approximately 60-80 students
In-depth Interviews	Use to gather qualitative data. Based on questions outlined in interview questions (Appendix B).	Selection of 8 to 10 students from survey participants

Table 3- 1: Summary of qualitative research techniques

3.3 Data Collection

Data collection methods of this research were by survey, interview and observation. Data were gathered by the researcher. Data will be collected from December 2007 through June of 2008 from Mt. Albert campus and Waitakere campus of UNITEC New Zealand. Approximately 60 to 80 students were involved in this study. This included a survey (see survey questions in Appendix A) and one hour of daily observation at different locations in two campuses. Following this a selection of ten students was interviewed in depth (See interview sheet in Appendix B).

3.3.1 Data collection strategies:

The primary data collection strategies were surveys and interviews. Observation, fieldnotes and reflective journal were also be used. The researcher record details related to the observations in a notebook as the research journal notes. These journal notes also record the researcher's thoughts, feelings and experiences during the research. Writing research journal notes helped the researcher keep the research on track and it also reminded the researcher what had been done and what was next.

3.3.2 Data collection procedures:

Step 1: Bounding the study. Miles and Huberman (1994) identified four aspects of research involving human participants: *“the setting (where the research will take place), the actors (who will be observed or interviewed), and the events (what the actors will be observed or interviewed doing), and the processes (the evolving nature of events undertaken by the actors within the setting).”*

Setting

This study was conducted on both Mt. Albert Campus and Waitakere Campus of UNITEC New Zealand. More than 65,000 students study on these two campuses.

Actors

The participants in this study were students who used campus WLANs from these two campuses. The primary participants were the surveyed and interviewed students. The secondary participants were the students who used the campus WLANs but were not surveyed.

Events

Using case study research methodology, the focus of this study will be the everyday activities undertaken by students using WLANs on campus. This includes the data gathered by surveys and interviews.

Process

The processes were the impacts or influences of the uses of WLAN on students. Particular attention was paid to the decision making of why students used WLANs instead of desktop computers in the library or computer labs.

Step 2: After the target participants had been identified, the next step was to indicate the types of data that needed to be collected for this study. According to Creswell (2003), there are four main types of qualitative data collection. They are observations, interviews, documents and audiovisual materials. Observations mean *“researchers has a firsthand experience with participants; researcher can record information as it is revealed; useful in exploring topics that may be uncomfortable for participants to discuss”*

(Creswell, 2003, p.186). In this study, literature review, observations, surveys and interviews were decided on. The data gathered for this study is qualitative data.

Step 3: The researcher kept a journal notes during the research study, and established a schedule for recording reflections in the research journal to help ensure that quality, quantity and data types were consistent.

Step 4: Literature review. Wireless, campus, students were the main keywords used for searching literature related to this study. Each publication has been reviewed by the researcher and presented separately in the Literature Review chapter. All literature was sorted by year of publication from 1995 to the present. The literature used in this study was from many different sources, including books, journals, conferences and websites.

Step 5: The observational notes were made, recording the locations and durations of students using on-campus WLANs. The observations were conducted for one hour each day for four weeks. The first observation began at 8:00am, the next were one hour later and so on. The observations of the first and second weeks were at Mt. Albert Campus and the third and fourth weeks at Waikatore Campus. The observation at Waikatore Campus began from 8:00 am in the third week. This is in order to collect data at different times and in different places.

While the researcher was doing the surveys, a secondary observation took place as well. The secondary observation was used to confirm the analysis result from the first observation.

Step 6: The results of observation were used to inform the survey questions. Students were surveyed until at least 60 responses collected. All the participants of this study are selected randomly. Students were asked in the last question of the survey to identify if they are prepared to be involved in an in-depth interview. Following this a selection of ten students was interviewed in depth.

Step 7: Interview. The information sheet (see Information Sheet in Appendix C) and the interview questions were shown to the participants before the interviews. All the interviewees had sufficient time to consider whether they would like to be interviewed or involved in this research. The interviewees signed the consent form and received a copy of it (see Consent Form in Appendix D). It contains information about both this research and contact details of the researcher. They could withdraw from the research at any time if they intend.

The details of any participants in this research are confidential. The participants are anonymous in this research. There are no materials that could identify any particular participant. The interviews were all face-to-face and were recorded by the researcher. Further information and/or conversations during the interviews (such as the behaviour of the interviewee) could be gathered and used in this research. The interview lasted about 20-30 minutes.

If there were fewer than eight interview respondents, more surveys and interview requests would be carried out.

The researcher surveyed students who have used on-campus WLANs in UNITEC New Zealand. If the responses did not reach expected, the research would continue the survey stage in order to have enough

responses. The researcher started the data analysis once the surveys were completed. The results were analysed in accordance with the steps and approaches introduced later in this chapter. The categories of the results helped to inform the interview questions. For example, is it permissible to use laptops connected to the WLANs in lectures?

3.4 Data Analysis

According to Merriam (1998) and Marshall and Rossman (1999), as quoted in Creswell (2003, p. 203), *“data collection and data analysis must be a simultaneous process in qualitative research.”* During the data collection and data analysis stages, the data were organised into categories and reviewed repeatedly. These categories evolved as the surveys were analysed as is typical in qualitative approaches. As a start however the following procedure was followed as per Creswell (2003).

Data analysis was separated into four stages. Stage one was the review of literatures related to this study. Stage two was the analysis of observation data. Stage three was the analysis of survey answers. Stage four was the analysis of interview answers.

3.4.1 Literature review

Stage one was the review of literature related to this study. Each publication was reviewed and commented on. The literature is presented above in Chapter 2, Literature Review. A literature map was used as a tool to organise categorised information, such as dividing the literature into education provider’s perspective and students’ perspective.

Step 1: Identifying key words. The researcher identified some key words such as campus wireless, wireless network and wireless local area network. These key words were used to locate materials in the library. With these key words in mind, the researcher started to search the library catalogue for journals and books. At the beginning, the researcher searched in computerised databases in the library in order to save time. It was easy to locate articles related to the topic with the help of computers.

Step 2: Identifying useful literature. The researcher located about 40 articles. Using this initial group of articles, the researcher started to look at the abstract and skim the articles. By overview of the articles, about 30 articles were selected for the study.

Step 3: Organising literature map. After the useful literature had been identified, the researcher began designing the literature map. At the same time, the researcher also began to summarise each publication.

Step 4: Assembling literature review. After summarising the literature, the researcher combined them into the final literature review. The literature was arranged by year of publication.

3.4.2 Observation data

Stage two was to analyse the observation data gathered during the research. Since the observations took place during two separate periods, the analysis of observation data was divided into two parts. The following steps applied to both observations. The first observation result was used to decide places and time for gathering surveys.

Step 1: Using journal notes to record observation notes on each day.

Step 2: Using spreadsheet to re-record observation data. This was in order to record data consistently and to organise data in standard categories such as the places, time and duration of observation on each day.

Step 3: To categorise and present data in chapter 4, Data.

Step 4: To compare result of observation with survey and interview data in chapter 4, Data, and to present the analysis in chapter5, Data analysis.

3.4.3 Survey responses

Stage three was to analyse the survey answers according to the following procedure:

Step 1: Use a table in the journal notes to record information about the numbers of respondents and non-respondents. The numbers of same answers to each question were also recorded.

Step 2: Use spreadsheet to record the survey answers. Student surveys could be categorised by different reason for using on-campus WLAN or duration of using WLAN. The initial categories for this study were the reason for students using the WLAN on campus, such as research purpose, e-learning, discussion and other purposes, and also how long students use WLAN, such as long term and short term.

Step 3: Divide the answers into different groups. For example, one group contained the answers of those satisfied with the on-campus WLANs and another group contained the answers of those not satisfied with the WLANs.

3.4.4 Interview answers

The categorised answers could be used to modify interview questions. Stage four was mainly based on the interview answers and was following:

Step 1: Prepare for data analysis

Separate gathered data into units. Set up case for every interview result from participants. Arrange and organise together the set of answers from the same questions. Microsoft Excel was used to store and generate statistical figures for survey answers.

Step 2: Coding process

According to Rossman & Rallis (1998), as quoted in Creswell (2003, p.192), "*Coding is the process of organising the material into 'chunks' before bringing meaning to those 'chunks'*". Creswell (2003, p.192) also explained that "*it involves taking text data or pictures, segmenting sentences (or paragraphs) or images into categories, and labeling those categories with a term, often a term based in the actual language of the participant.*" Preparation for the coding process included reading all gathered information carefully to get a sense of the whole. After reading the document, the researcher recorded her thoughts and wrote notes about each document. The researcher then made a list of all topics, found the most descriptive words and turned them into

categories.

Step 3: Generate data description by using coding process

Creswell (2003, p.193) advised researchers to “*Use the coding process to generate a description of the setting or people as well as categories or themes for analysis.*” The researcher will describe all settings, people, categories and themes by using a coding process so that the information could be described separately in detail in the Data chapter, for example the result of statistics generated from survey answers.

Step 4: Convey descriptive information about each participant in a table

The gathered information was quite large and in confusion. The researcher conveyed the findings of the analysis by using figures and tables. The advantage of using figures and tables is that it is easy to focus on information and easy to categorise information as well. As this is case study research, Creswell (2003, p.194) recommends conveying descriptive information about each participant in a table.

Step 5: Make an interpretation or meaning of the data

This was the final step of data analysis. The researcher wrote the personal interpretation and comparison of the findings with the literature.

3.4.5 Journal notes

The researcher’s journal notes for this study contain fieldnotes and reflective journal. Fieldnotes were defined in Sanjek, (1990) as “*they are first, certainly, texts; they are documents with the security and concreteness*

that writing lends to observation...immutable records of some past occurrence.” Usually, fieldnotes would be difficult for anyone except the researcher to read. The reflective notes were the thoughts of the researcher when reviewing the fieldnotes and/or the progress of research.

The journal notes started when the researcher was planning this study. From the research question to the survey and interview question design, all the thoughts of the researcher have been written down. The survey and interview questions were not developed once; they were built up as the research progressed.

The observation notes were written as fieldnotes along with the researcher’s assumptions during the observation. The assumptions relied on the observation result. One assumption was based on the small number of campus WLANs users during the observation at the beginning of the semester. It was that fewer students had classes and assignments at the beginning of that semester so the numbers of campus WLANs users would increase as long as classes and assignment increased. This assumption was verified across the whole semester. As the semester went to its end, more users were using the campus WLANs, especially during the exam weeks.

The thoughts of the researcher in the journal notes were used to analyse data. The observation notes, answers to survey and interview along with categories were all recorded in the journal notes. The categories were used in the coding process.

3.5 Summary

The research method for this research study is case study. Literature review, observation, survey and interview are four qualitative research techniques used in this research study. As planned in data collection, ten interviews were conducted as primary data for the study. Each interview was treated as a case. The analysis was not only within each case but also across cases. Data collection and analysis procedures for this research were planned ahead. The data collection and analysis are summarised and related to each other as below:

Data collection procedures:	Data analysis procedures:
Step 1: Bounding the study	Stage 1: based on literature review, use literature map to organise and analyse
Step 2: Indicate the types of data	
Step 4: Literature review.	
Step 5: Observation	Stage 2: based on the observation data Step 1: Record observation notes Step 2: Use spreadsheet to re-record observation data. Step 3: Categorise and present data Step 4: Compare result of observation with survey and interview data
Step 6: Surveys	Stage 3: based on surveys Step 1: Record numbers of respondents and non-respondents Step 2: Use spreadsheet to record the survey

	<p>answers.</p> <p>Step 3: Divide the answers into different group</p>
Step 7: Interview	<p>Stage 4: based on the interview</p> <p>Step 1: Prepare for data analysis</p> <p>Step 2: Coding process</p> <p>Step 3: Generate data description by using coding process</p> <p>Step 4: Convey descriptive information about each participant in a table</p> <p>Step 5: Make an interpretation or meaning of the data</p>
Step 3: Keep journal notes during the research study	

Table 3- 2: Progress of the research

4. Data

This chapter presents both quantitative data results and qualitative data results. The data were gained followed the procedures mentioned in chapter 4, Methodology. The quantitative data were gathered from sixty-four surveys and the qualitative data were gathered from observation and ten interviews. Each interview was carried out face-to-face. Every interview was prepared and organised individually in association with the survey completed by them before they were interviewed.

As described in the previous chapter, all the participants were selected randomly from either Mt. Albert Campus or Waitakere Campus.

The quantitative data and qualitative data were coded separately for appropriate comparisons and/or classifications in data analysis chapter.

4.1 Quantitative data findings

4.1.1. Surveys

- **Participants' courses and year of the course:**

The participants of the survey are required to be students and to have used wireless local area network services on either Mt. Albert Campus or Waitakere Campus. The surveys were completed by 43 students from Mt. Albert Campus and 21 students from Waitakere Campus.

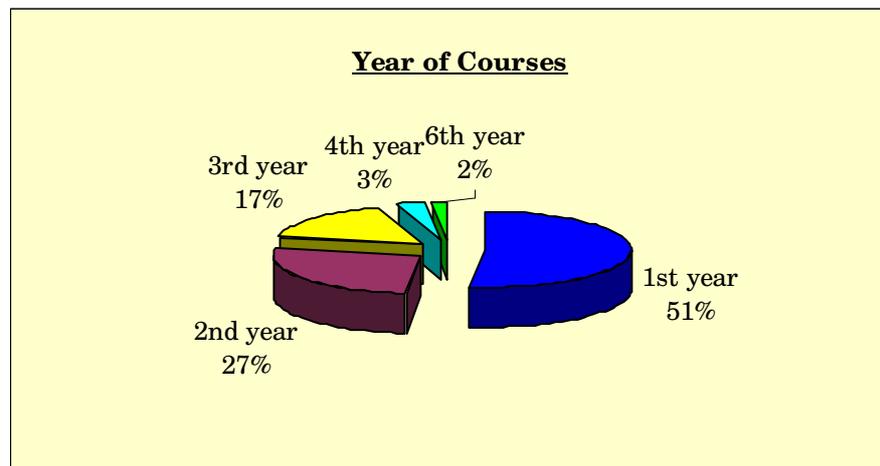


Figure 4- 1: Year of Courses

Based on the 64 surveys, there are over 30 different courses. Among those courses, 16 courses had only one survey participant; seven courses had two survey participants; four courses had three survey participants and four courses had four survey participants. Six participants were doing a Bachelor of Civil Engineering and this was the greatest number of participants taking the same course in this research. As can be seen in Figure 4-1, over half of the participants were in the first year of their courses. There were just three participants are in their 4th to 6th years.

- **Frequency of the use of on-campus WLANs:**

One third of participants used the on-campus wireless local area networks (WLANs) every day. Most of the participants use the WLANs to a plan or schedule, such as every second day, once/twice per week, twice per month and weekdays. There were also some students who connected to the WLANs at unspecified times. Twelve participants said they did not often use the wireless services. Only one student stated he used the wireless services at any time after class. Another student used it twice a day. Quite a few students said they used WLANs less than once a week, and only two students used it twice a month.

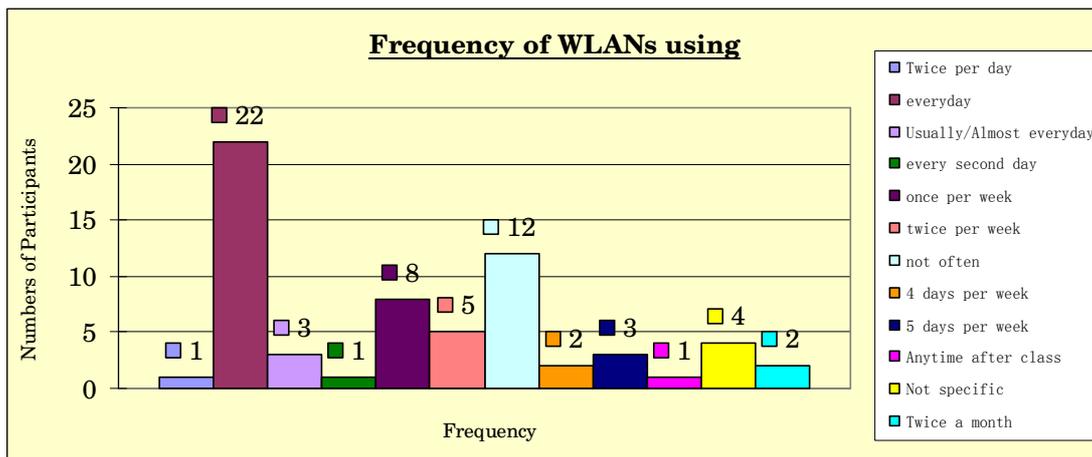


Figure 4- 2: Frequency of WLANs use

- **The time when participants usually start to use:**

Most students have a specific time when they start using the wireless services. Only four participants connected to WLANs before 9:00 in the morning, and 9:00-10:00am became the first peak time of the day. Up to 22 participants usually started their wireless services connection between 9:00-10:00am and 36 participants usually used the wireless services in the morning. That meant 61% of the morning users and 34.4% of all participants use the wireless services in the first peak time. The second

peak time was at noon, this may be caused by the lunch break. Eight participants stated that they usually use the WLANs at lunch time. Users of wireless services decreased dramatically in the afternoon: only twelve participants. Only one participant usually used wireless services in class and three participants after class. Three participants usually started to use the WLANs to no specific schedule.

- **The duration of the use of on-campus WLANs:**

Ten participants usually used WLANs for less than one hour and another ten participants usually used WLANs for 1-2 hours. The users decrease as the duration increased. Seven participants used WLANs for 2-3 hours, six between 3-4 hours and four for 5-6 hours. The participants who used WLANs for half a day (4-5 hours) and all day were the most, with nine and eleven responses. Seven participants did not specify the duration of their wireless services use.

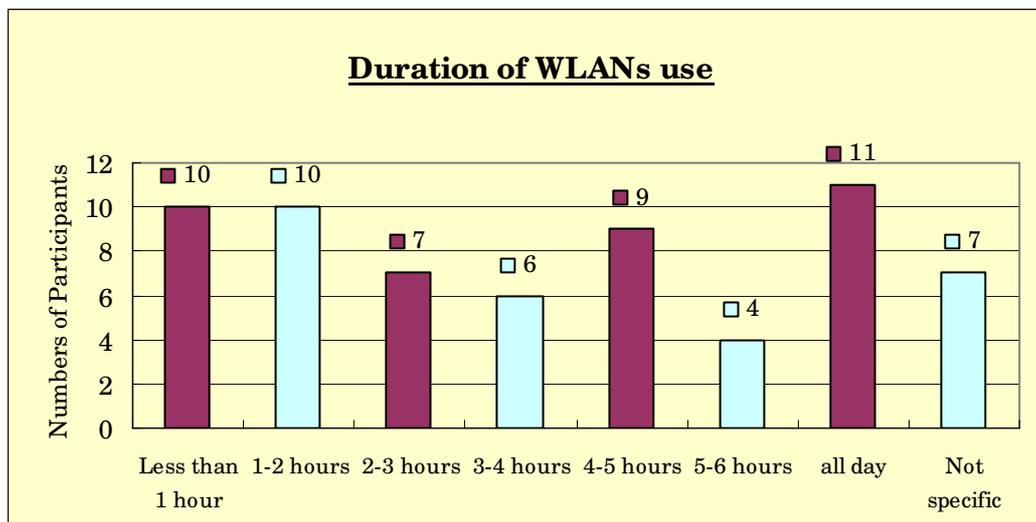


Figure 4- 3: Duration of WLANs use

- **The wireless zone positions:**

To the question “where are the wireless zones” most responses (29 participants) said by the “wireless Zone” sign. Next highest were 15 participants who found out from Unitec’s website. Eleven participants were aware of ask I.T., which is the IT department of UNITEC New Zealand. Three participants thought the wireless services were provided everywhere on the campus, four participants found out from friends or classmates and only one participant found out from school map. Two participants had no idea about the areas of wireless services; they just let their laptop search for it.

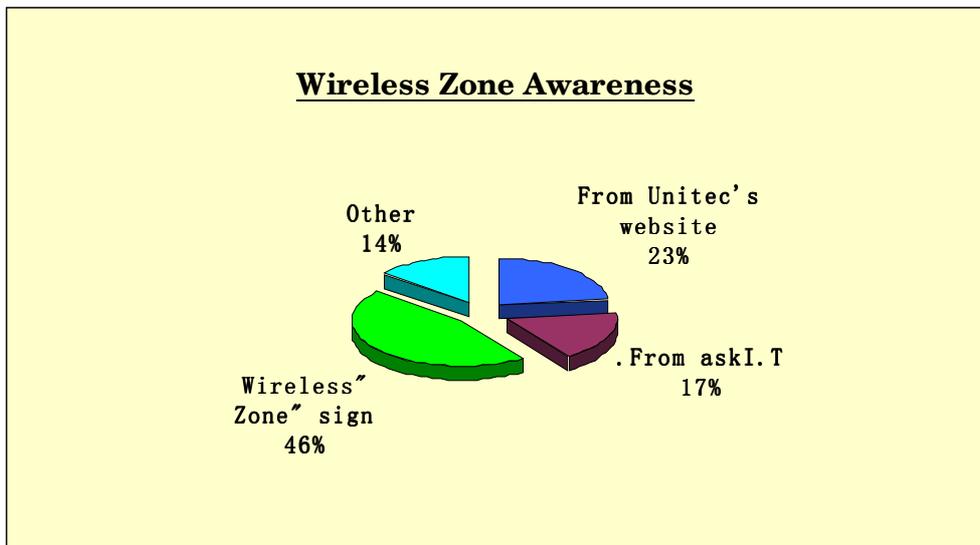


Figure 4- 4: Wireless Zone Awareness

45% of all surveyed participants knew of the wireless zone by the “Wireless Zone” sign. This result showed that most students were aware by visual clues around them instead of finding out from school announcement or asking the IT department. This finding showed that the “Wireless Zone” signs are helpful and most of time they are well-marked. But there are still some locations where a few students could not find those signs.

- **Places where participants usually use the on-campus WLANs:**

Seven participants said they usually used WLANs in the campus Hub, three said they usually go to the café, six said they usually use them in the graduate centre and nine said they also use WLANs in the resident village and lecture rooms. There were 53 participants, which was almost all of them who usually connected to the wireless services in the library.

Of the 64 surveys, nearly 82% of participants used WLANs at the same place and 18% of participants used WLANs in different areas. 51 participants (64% of all participants) selected the library as the only place where they usually connect to WLANs. Two participants selected Hub only, one selected Café only, five selected graduate centre only and three selected lecture room only. For the 18% of participants who used WLANs more than one area, they all used WLANs in the library and one or two other places. The combination of library with Hub and library with lecture room or resident village had the most responses: three and five.

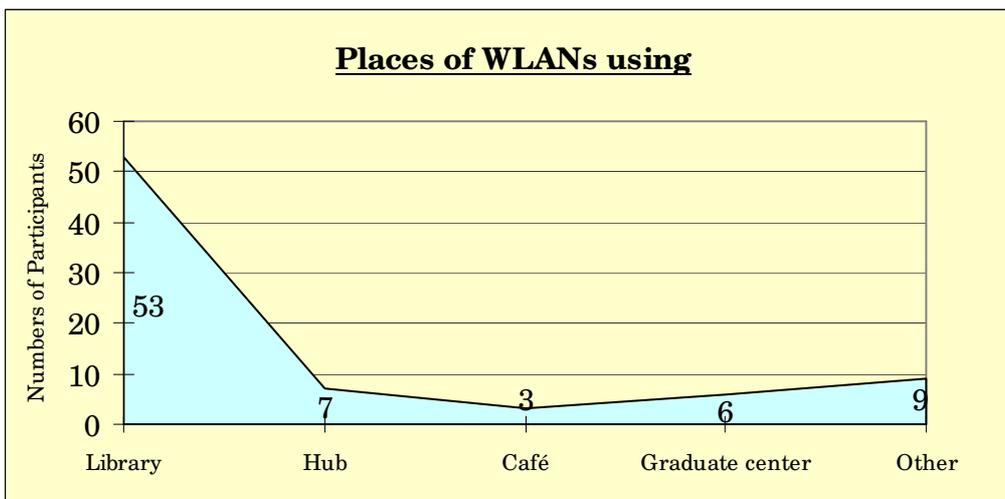


Figure 4- 5: Places of WLANs use

- **What did participants use WLANs for?**

Almost all the participants had multiple reasons for using WLANs on campus. Two participants used the WLANs just for surfing the Internet and 13 participants used them for research only. All the rest (49 participants) had multiple reasons. Research was definitely the most important reason for using WLANs on campus, with 53 responses. Surfing the Internet was second, with 38 responses. Shopping on the Internet had the least, with two responses and playing Internet games was just one more than shopping on the Internet. Chatting on the Internet and E-learning had exactly the same number, with 18 each. Getting entertainment and downloading from the Internet had close results with 14 and 15. Having discussion over the Internet had nine responses. Only one participant was doing all those activities via WLANs on campus. Other activities included checking emails with three responses, and doing assignments and studying with one response each.

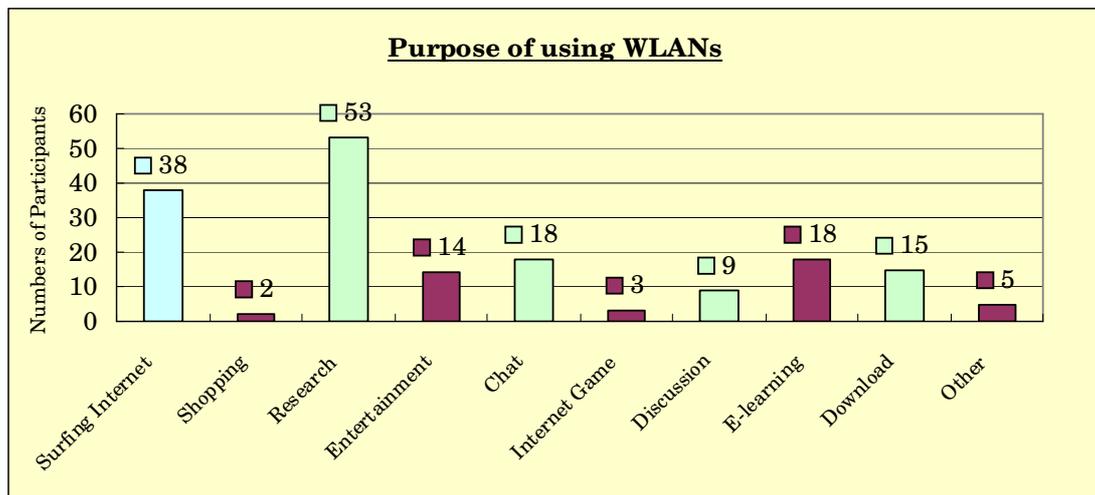


Figure 4- 6: Purpose of using WLANs on campus

- **Places where participants got Internet before WLANs were provided on campus:**

Surfing the Internet, shopping on Internet, research, entertainment, chatting, Internet games, discussion, E-learning, downloading, checking emails and doing assignments were 11 activities that participants usually did via WLANs. Almost 60% of participants liked to get on the Internet at one specific place and did not like to change. On the other hand, 40% of participants had two places as a minimum and four places as a maximum. Based on the survey results and as can be seen in the figure below, home (78% of responses) was the first place that students went to for those activities, before the campus provided WLANs. It was followed by computer lab, library and Internet Café. Only one participant mentioned place of work place and another one mentioned in class.

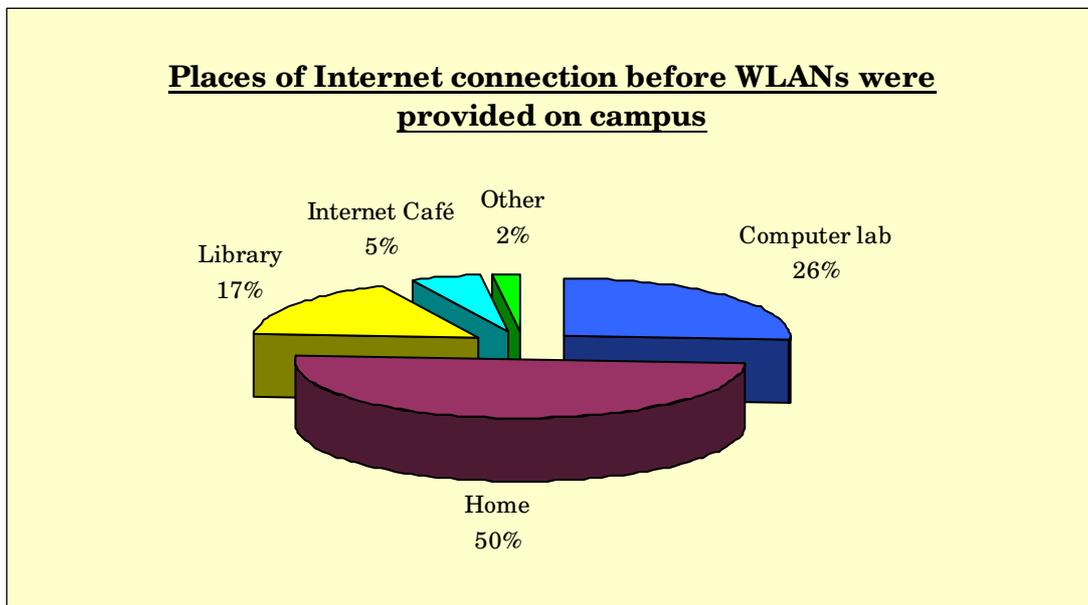


Figure 4- 7: Places of Internet connection before WLANs were provided on campus

- **Types of Internet connection currently used:**

All the participants were students and WLAN users on campus, thus have wireless connection. 25 participants used broadband and four participants used dial-up. Six participants clearly stated that they had no idea of what types of connection they were currently using and ten participants responded with their ISP details, stating the website they were browsing or application they were using.

- **Terms and conditions for connecting to WLANs:**

As can be seen in Figure 4-8, 26 participants had no idea about the terms and conditions for connecting to campus WLANs. 24 participants said there were some terms and conditions and some of them also wrote down some conditions they knew about. But fourteen participants said there were not any terms and conditions at all.

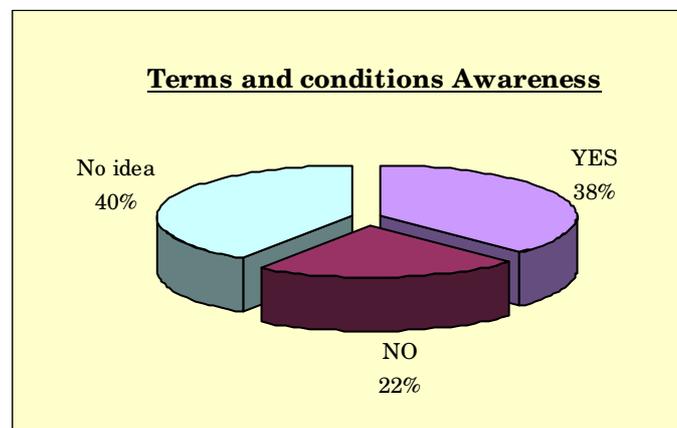


Figure 4- 8: Terms and conditions Awareness

- **Restrictions on connecting to the on-campus WLANs:**

Fourteen participants thought that there were no restrictions on connecting to campus WLANs and 50 participants thought that there were some restrictions. Fourteen out of 50 participants considered there were several restrictions, such as time, place, undertaking a course and having a

student account. The other 36 participants considered there was only one restriction. Over 83% of those 36 participants agreed that whether the user had a student account was the only restriction for connecting to campus WLANs. Of the total 64 surveys, 30 participants agreed on having a student account. Only four participants considered undertaking a course was the restriction. Time and place had close responses with 13 and 19.

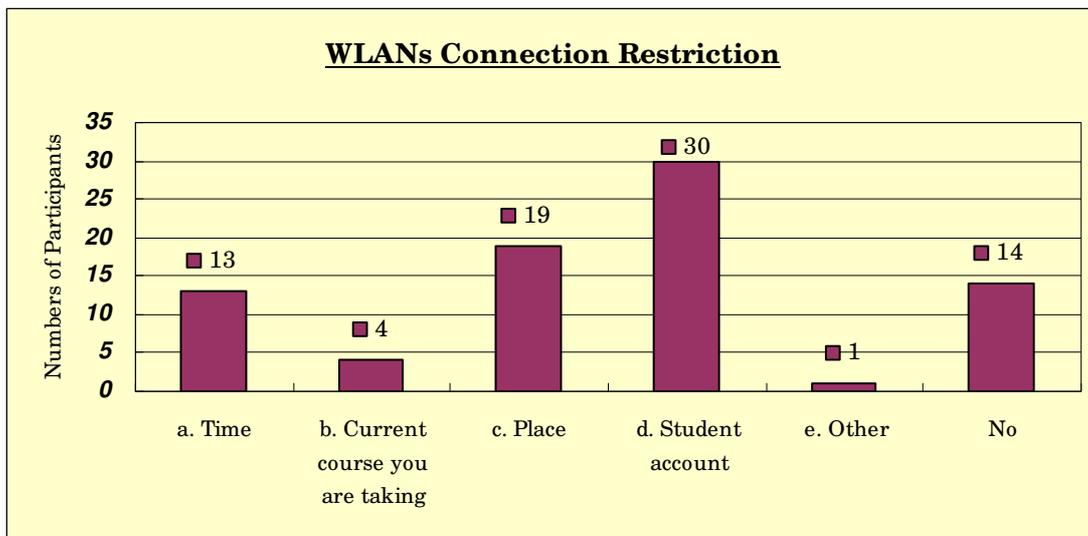


Figure 4- 9: Restriction of WLANs Connection

- **Connection speed of WLANs on campus:**

There were 22 participants who had no idea about the connection speed of WLANs. Twelve participants wrote down a specific speed, such as 56Kbps (slow), 500Kbps, 48Mbps and 54Mbps (fast). The remaining 29 participants just wrote their feelings about using WLANs on campus, such as very slow, OK and/or fast. One participant, who wrote the lowest speed of 6.5Kbps, thought the connection speed of WLANs was very slow. Fifteen participants felt the connection speed was very slow or just slow. Eight participants were satisfied with the connection speed and seven participants thought it was fast.

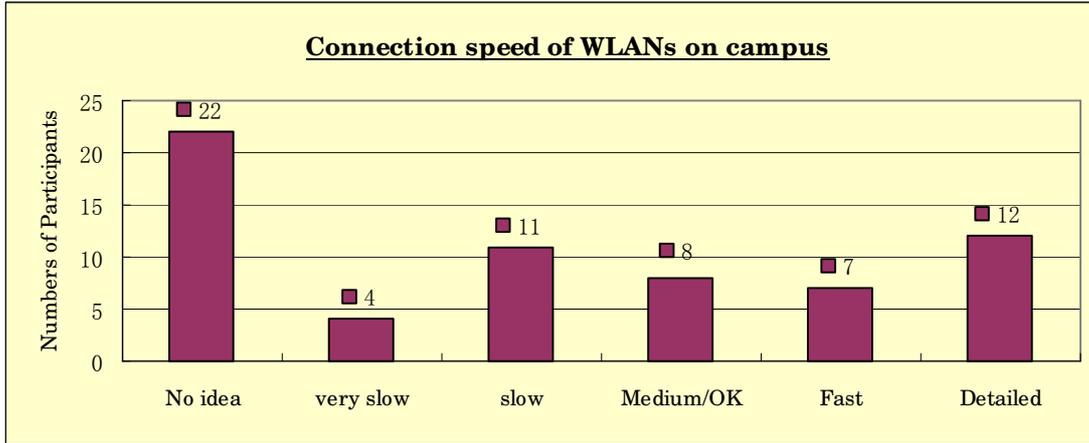


Figure 4- 10: Connection speed of WLANs on campus

In fact, it is recommended that “for an 11Mbps 802.11b network, the best possible throughput is 6Mbps” (Wireless, 2007).

- **Satisfaction with on-campus WLANs:**

Four participants felt the campus WLANs were very poor and seven felt they were poor; 29 participants were satisfied, 18 said it was good and six felt it was very good.

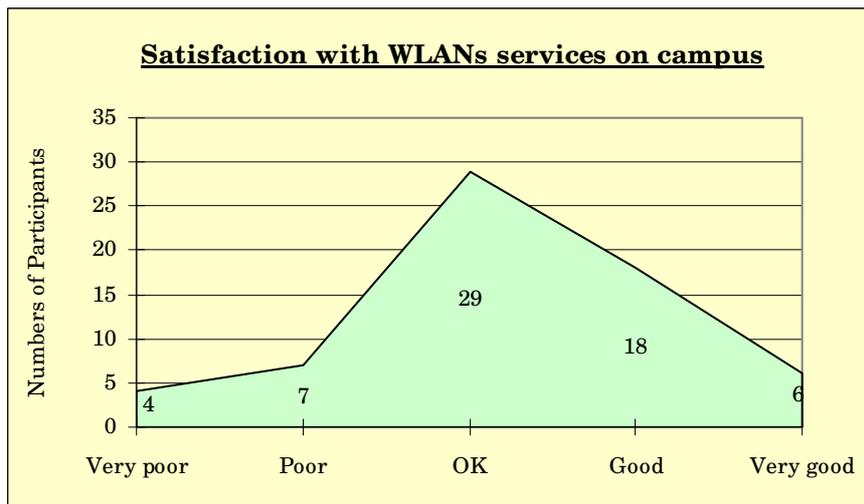


Figure 4- 11: Satisfaction with WLANs services on campus

4.2 Qualitative data findings

4.2.1. Observations

- **Beginning of the semester**

The first observation for this research was carried out for a period of four weeks at the beginning of one semester. The researcher spent two weeks on each campus. The first two weeks (from 25 Feb 2008 to 09 Mar 2008) were on Mt. Albert Campus and then the following two weeks were on Waitakere Campus. During the four weeks of observation, there was one public holiday from 21st to 24th of March. There were almost no wireless users on this public holiday.

According to the observation, there were more people using WLANs on campus at noon than at any other time of the day. There were hardly any users on both campuses on Sundays and Mondays. There were more users on Mt. Albert Campus than on Waitakere Campus.

- **Mid term to the end of semester – observed students when taking surveys and interviews**

The second observation was completed during the semester when the researcher was doing surveys and interviews for this research.

There were obviously more users of WLANs at the end of semester than at the beginning of the semester. The users of WLANs increased during the semester. The number of users was highest towards the end of the semester. There were more than twenty users of WLANs at the same time when the semester ended.

Based on the results of observation, the users of WLANs on both campuses

were mainly in the library or cafeteria.

4.2.2. Interviews

Each of the interviewees completed a survey before doing an interview. Instead of writing the real name of participants, each participant was given a code, such as participant S, E and L. These letters are the first letters of their courses. These codes are used in the tables and the following chapters as well.

For the entire data collection, there were sixty-four students in over thirty different courses, such as in Language school, short course, undergraduate study and postgraduate study. No participants for this research were undertaking a doctoral degree.

In order to view the findings from interviewees clearly, the information gathered from both survey and interview is present in tables and the open questions are reported individually.

Sub-headings are given for information obtained from participants for each question or a group of questions. For example the sub-heading “General information on participants” contains a batch of information obtained from the survey, such as the frequency and duration of the use of on-campus WLANs; and the sub-heading “The convenience and inconvenience of use of Wireless Local Area Networks (WLANs) on campus” contains information from the interview questions “What is the convenience of using WLANs on campus?” and “What is the inconvenience of using WLANs on campus?” The reason for grouping answers from questions is to make it easy for the researcher to make sense of related information.

The situation or answers from all participants are presented separately under each sub-heading in order to compare the answers to each question from different participants.

The information gathered from the surveys is divided into general information, behaviours and experiences of using wireless networks on campus. These three sections are presented in three different tables in this chapter. The table on the following page (Table 4-1) contains the general information given by the participants, and then Table 4-2 contains the behaviours of each interviewee. Finally, the Table 4-3 contains the general experiences of use of Wireless Local Area Networks (WLANs). A further Table 4-4 contains the status of completion of the interviews.

- **General information on participants**

The following section aims to take a general look at each of the interviewees for this research. In addition, the simple background of each of them had been recorded. The general information on participants was mainly obtained from the survey completed by each participant. None of the information here can be used to link directly to any particular person.

	S	E	L	A	MC	M	N	BC	B	P
Course currently taking	BSM	PD in Education	Language	BA	MCom	BAT-AE	CoN	Bcom	Mbus	CoP
Year of Course	6 th	1 st	1 st	3 rd	2 nd	2 nd	1 st	2 nd	2 nd	4 th
Places for Internet connection (before WLANs provided by campus)	Computer lab and Home	Computer lab	Home	Home	Home and place of work	Home	Home	Computer lab	Home	Computer lab and Library
Campus of use of WLANs	Mt.Albert Campus	Mt.Albert Campus	Mt.Albert Campus	Mt.Albert Campus	Mt.Albert Campus	Mt.Albert Campus	Waitakere Campus	Waitakere Campus	Mt.Albert Campus	Mt.Albert Campus

Table 4- 1: General information given by participants

	S	E	L	A	MC	M	N	BC	B	P
Frequency of use of WLANs	Daily	Daily	Once per week (week day)	Usually	Once per week	Once per week	Daily	Daily	Daily	Daily
Time of use of WLANs	9:30am	10:00am	3:00pm	Afternoon	1:00pm	Not specific	1:00pm	9:00am	2:00pm	9:00am
Duration of use of WLANs	1-2 hours	6 hours	Less than 1 hour	3-4 hours	4+ hours	3-4 hours	1 hour	7+ hours	6+ hours	Not specific
Places of use of WLANs	Library	Graduate Centre	Library	Library	Library, Graduate Centre	Library	Library	Library, Café	Graduate Centre	Library, Building 76
Activities when using WLANs	Internet Surfing, Research, Entertainment, Chat, Discussion, Download, Assignments	Discussion, E-learning, Download, All study purposes	Internet Surfing, Entertainment	Internet Surfing, Research, Download	Internet Surfing, Research, Chat	Research	Internet Surfing, E-learning	Internet Surfing, Research	Internet Surfing, Research, Chat	Internet Surfing, Research, Chat, Discussion, Download

Table 4- 2: Behaviours of using WLANs

As can be seen above, two participants used WLANs at Waitakere Campus and the other eight participants were from Mt. Albert Campus.

Participant S

Participant S was a Bachelor of Sport Management student and was doing his 6th year of the course (also the last year). S planned his schedule regularly. He came to campus daily and usually started at 9:30 in the morning. S did not spend much time before getting on the Internet via the wireless local area networks (WLANs) in the library. Normally, he just spent about 1-2 hours doing some research and discussion for his assignments. S also surfed the Internet, got some entertainment and downloaded from the Internet. As most people do, S chatted with friends over the Internet.

Participant E

Participant E was a Postgraduate Diploma in Education student and was doing her 1st year of the course. In fact, E was just in her 1st semester at UNITEC New Zealand. She had been doing well in her course and was enjoying her student life in the school. Like participant S, E had a regular schedule of coming to school and getting on WLANs by using her own laptop. E normally started at 10 o'clock in the morning. But she would come to school at night on some days if she had to go to her part time job. No matter whether her start time was early or not, she usually had approximately 6 hours on the WLANs to do her studies. As E was a Postgraduate Diploma student, she could and did hire a swipe card which could help her get into the graduate centre at any time.

Participant L

Participant L was a Language school student; he was doing his intensive course. L only used the WLANs on campus once a week and he always came after 3 o'clock. He said he only came on week days which meant after his class for the whole day. L usually came with his classmate and took his own laptop to the library. They surfed the Internet and had fun, for example

getting entertainment from his home country.

Participant A

Participant A was a Bachelor of Architecture student. A is a foreigner and she came to New Zealand with her best friend who was also her class mate three months earlier. A and her friend were in the 3rd year of their course. They usually spent most of their time on campus. If they did not have many classes, they would take their own laptops to the library and connect to the WLANs to surf the Internet, do some research for their course and download some stuff.

Participant MC

Participant MC was a Master of Computing student. MC was doing her 2nd year at UNITEC New Zealand. She said she was a Postgraduate Diploma in Computing student last year, and she did not plan to continue to the Master course when she first came to Unitec. She did quite well the previous year and enjoyed studying here. MC was quite busy; she had two part time jobs so that she could only come to school once a week on Wednesday or Thursday afternoons. Normally, MC spent at least four hours at school and certainly she needed the WLANs to get on the Internet to do her research and assignments. Like participant E, MC also had a swipe card to get into the graduate centre. If necessary, she used that to get into the graduate centre when the library was closed.

Participant M

Participant M was a Bachelor of Applied Technology student, specialising in Automotive Engineering. Usually M had more practical classes than lectures. He came to the library once a week. His main reason for using WLANs was purely for research. "I always write my assignments in the library" he said.

Participant N

Participant N was a Certificate in Nursing student. She was new at Unitec, doing her 1st year. She came to the library every day in the afternoon and got on WLANs for at least one hour. E-learning was quite important for her, she said. If she had spare time, she also surfed the Internet for a while.

Participant BC

Participant BC was a Bachelor of Computing student. He was doing his 2nd year of the course. BC studied very hard. He spent all his time in school and used WLANs for over 7 hours a day. Although his classes were all in Mt. Albert Campus, Waitakere Campus was much closer to his home. So if he wanted to study at school, he would come to Waitakere Campus on the day he did not have any classes. Usually, BC studied in the library. But he also studied in the cafeteria area. He said he liked to sit in different environments.

Participant B

Participant B was a Master of Business student. He had been off school for one semester but he always came to school and spent more than six hours on campus. He said he was trying to find a full time job and that was why he did not take any class for this semester but he would go back to class next semester. He really enjoyed staying at school with friends so he came to school every day. B was only comfortable in the graduate centre so the interview took place in the graduate centre. B was easygoing, and some students came to say hello to him during the interview. He said he made a lot of friends there. He did research, surfed Internet and chatted with friends over the Internet when he was in the graduate centre.

Participant P

Participant P was a Certificate of Proficiency student and he was in his 4th year of the course. P came to campus every day at 9 o'clock in the morning either to the library or building 76. P usually did some research, discussions

and downloads related to his assignments. He said he liked to use his own laptop so he needed WLANs to help him. As he spent a long time at school, he also liked to surf news and chat with friends while he was on the Internet via WLANs.

- **The general experiences of the use of Wireless Local Area Networks (WLANs) on campus**

This section aims to examine the interviewees' experiences of the use of WLANs. Table 4-3 shows the prime experiences and Table 4-4 shows whether participants gave more detailed information. N/A means that participant did not give an answer.

The table below (Table 4-3) shows how these participants knew that there were WLANs provided on the campus, what types of Internet connection they were currently using, were there any terms and conditions on WLANs that they knew about, did they know whether there were any restrictions on using WLANs on campus, did they know the speed of WLANs and finally their satisfaction with the WLANs.

	S	E	L	A	MC	M	N	BC	B	P
How they knew of WLANs	School map	Unitec's website	"Wireless Zone" sign	Unitec's website	"Wireless Zone" sign	"Wireless Zone" sign	"Wireless Zone" sign	"Wireless Zone" sign	"Wireless Zone" sign	IT department
Internet Connection types	Wireless, Broadband	Wireless only	Wireless only	Wireless, Broadband	Wireless, Broadband	Wireless Only	Wireless only	Wireless, Dial-up	Wireless only	Wireless only
Terms and conditions	No idea	Enrol as student and get username and password	No idea	No idea	No terms and conditions at all.	No idea	No terms and conditions at all.	No idea	Login with student ID and password	Probably there are some, but I don't know them.
Restrictions	Student account	Current course undertaken and Student account	Places	Time and places	Places and Student account	Student account	Student account	Student account	Student account	Time and Numbers of people on makes connection slow
Speed	No idea	Fast	Very slow (6.5Kbps)	Very slow	Normal	No idea	No idea	Fast	56Kbps	1-54Mbps
Satisfaction with WLANs	Good	Very Good	Poor	OK	OK	Good	OK	OK	OK	Very Good (Residential village very poor)

Table 4- 3: Experiences of the use of Wireless Local Area Networks (WLANs) by participants

As can be seen from Table 4-3, only participant P had actually found help from the IT department to find out where were the WLANs provided. Participant E and A worked it out by browsing the official website of UNITEC New Zealand. Participant S liked to carry a school map on him and check out where he wanted to connect to the WLANs.

The types of Internet connection showed that participant B was the only one with dial-up connection. Participants S, A and MC stated that they had broadband connection at home. The remaining participants had only one type of Internet connection, which was wireless. All of those participants certainly use wireless connection on campus. But they did not state whether they used wireless at home.

Most participants did not know whether there were terms and conditions or not. Some of them stated some conditions might be:

- Enrol as Unitec student
- Username and password.

Most of the interviewees thought the WLANs were restricted to people with a student account. Participants E, L, A and P had some different opinions on places, time and courses currently being taken.

All students use the same on-campus WLANs, but the interview participants had different experiences with speed. The answers varied from very slow to fast. The speed of WLANs may influence the satisfaction of the WLANs. Participant L thought the WLANs were poor because the speed was very slow.

The following sections present responses from each interview participant. The table on the next page (Table 4-4) shows the completion status of the interview questions by interviewees.

	S	E	L	A	MC	M	N	BC	B	P
Convenience	Very	Very	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Inconvenience	Some	Occasionally	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Use WLANs in class?	Not for all classes	Yes	No	Yes	Yes	No	No	Yes	Yes	Yes
WLANs help in study?	Can be	Definitely	N/A	Definitely	Yes	Not necessarily	Don't need	Yes	Yes	Of course
Difficulties in connecting to WLANs	Not at all	Occasionally	Sometimes	Not at all	No	No	No	No	Sometimes	Depends
Influence	Sometimes	Don't think so	Yes	No	Yes	Not really	No	No	No	Not really
Aspect(s) should be enhanced	Yes	Yes	Yes	Yes	Yes	No	Yes	Good enough	Yes	Yes
Suggestions	Yes	Yes	Yes	No	Yes	No	Yes	No	Yes	Yes

Table 4- 4: The status of completion of the interviews

- **The convenience and inconvenience of use of Wireless Local Area Networks (WLANs) on campus**

As shown in Table 4-4, all the interviewees felt there was convenience in using WLANs on campus. But at the same time, most of them also felt some inconvenience. Participant MC was the only interviewee who did not feel there was any inconvenience at all.

Participant S

“I feel it is very convenient” said participant S. He meant that he could read news or surf the Internet while he had a laptop turned on and the WLANs made it easier to do research. He felt it was convenient also because that he could use his own laptop.

Participant S felt some inconvenience when the speed of WLANs in library was quite slow and when he could not find an electrical outlet for his laptop. The slow speed meant he had to be patient because it took more time to open a web page. He said that when looking for a power supply for his laptop, he always had to look around to see whether someone was leaving.

Participant E

Participant E said the WLANs on campus were high speed at most of the time even sometimes it was slow. Generally it was convenient to use WLANs. “I can use my own laptop and I can choose the place I like. It is easy to connect. And the most important thing is it is free!” E felt it was very convenient to use WLANs on campus.

When E talked about the inconvenience, she thought a little bit and said there was some inconvenience at the weekends and noon. She was not happy that the speed was quite slow then. She thought that there were more people getting on the WLANs at that time and the heavy network traffic caused the speed to drop. She said it was still acceptable for her even though the speed was slow, because it just happened occasionally.

Participant L

Participant L comes from Korea and he brought his laptop from Korea. L felt that to use his own laptop was important because he could type Korean on his laptop which was not possible in the computer lab. The WLANs provided allowed him to use his own language to contact his family and friends in Korea. He said he liked to sit in different places for different reasons. He liked to sit in library when he wants to online research; he liked to sit in the Café and chat with friends via Internet and get some food and drink. These different places let him feel comfortable.

Since the WLANs are a kind of local area networks, he sometimes received messages like someone sharing files with people. He felt that was annoying. He was worried about his laptop would affect virus or his privacy was violated. He also felt some inconvenience with the signal weakness and the restriction on places.

Participant A

Participant A had a similar situation to Participant L. A is from China and came to New Zealand a few months earlier. She was not accustomed to living in this new country on her own. She said she was lucky because her best friend came to New Zealand and studied in same school as her. They met every day and studied and spent their spare time together. They brought their laptops and chose places where they could connect to WLANs and also talk to each other.

Finding a suitable place for both A and her friend was difficult. She felt that was the only inconvenience. She said she thought the WLANs were provided everywhere but soon she found that was not so. Some places did not have WLANs services at all. Some places had a weak signal which made the WLANs connections unstable.

Participant MC

Participant MC thought the major convenience was she could use her own laptop. She did not like using computers in the computer lab. That forced her to save a lot of copies of her work and she would get confused about which one was the latest version. "I can start my laptop at a comfortable place and then at the same time I can get connected to the Internet. That is amazing!" MC said.

When participant MC was asked about any inconvenience with the use of WLANs, she said "all I can see is convenience, such as using my own laptop, no fees and movable. I do not feel any inconvenience about WLANs."

Participant M

Participant M was same as other interviewees. M felt that being able to use his own laptop was great, because he had some special applications installed on his laptop and some applications were in his first language, which is not English. Those applications were not available on computers in the library or computer lab. M said he needed those applications when he was on the Internet.

The inconvenience for M was the places where WLANs were provided were restricted. WLANs services were not provided everywhere on campus. The places he could go to were only in the library for now.

Participant N

Participant N thought that the WLANs could support more people to get Internet at the same time and without adding more computers in the library. Participant N liked to borrow a laptop and connect to the WLANs. N said that made her mobile and made it easy to do research.

Instead of waiting in a queue for computers, she had only 30 minutes to use the laptop she borrowed. She was annoyed that she did not own a laptop. The

borrowed laptop was mobile, which was good for her. But most of the laptops were old and not good enough. So the inconvenience for her was the time restriction and old laptops.

Participant BC

“Finding a comfortable place is the most important because I spend a lot time sitting in front of my laptop” participant BC said. He stated that he did not like to sit in one place all the time. He liked to walk around and look for some friends. Sometimes he liked to share with friends the entertainment he found from the Internet.

When the researcher asked him about the inconvenience, BC said it was good to stay on campus. It made him stay on campus a long time and did not like to go home. He always spent his whole day on campus. There were some inconveniences though, such as slow speed and unstable signal.

Participant B

The mobility and no cables attracted participant B to use his laptop to connect to the WLANs for long periods of time. Since B had permission to access the graduate centre 24 hours 7 days, there were no restrictions for him at all. B spent most of his time in the graduate centre and he made friends who always liked stay there too.

Because he used WLANs for long periods on campus, B found that the Internet connection speed was slow and the signal for connecting to the local area network server was weak. Sometimes B just could not login to the WLANs.

Participant P

Participant P was a quiet person. He did not like to sit with friends and share stuff with others. P liked to bring his own laptop and sit in a corner quietly. P had a lot of work to download and upload. P explained that he could do

assignments and research in the library and upload them to online storage when the work was finished. It made him feel safe to save files at a second place. He had been through the experience of losing everything because the operating system crashed. These days with the provision of WLANs on campus, he could sit at a quiet place and enjoy the experience of free Internet connection.

There were many great reasons for him to talk about the convenience. But for the inconvenience, he just mentioned the speed was not that fast occasionally.

- **The use of Wireless Local Area Networks (WLANs) in class**

This section shows whether the participants could use the WLANs in their class and for what purposes they used the WLANs. As shown in Table 4-4, participants L, M and N did not use WLANs in their class at all. Participant M thought it was allowed to use WLANs in class because no one said it was not allowed. But M would not use it since his classes are mainly practical. Participants L and N said the WLANs could not be used in class. Participant S said not all classes allowed the use of WLANs.

Participant S

Not all classes that participant S was taking required the use of the WLANs in class. The major reason for using the WLANs in class for participant S was to get lecture notes from the Internet. Participant S liked to use his laptop in class and make class notes. The WLANs provided him the opportunity to get on the Internet and retrieve some information or other material. He said it allowed him to handle and/or control the processes of his study. It made him more efficient than most of his other classmates who were not users of on-campus WLANs.

Participant E

Participant E was allowed to use the WLANs in class. But normally, E would not use it. It depended on the content of each lecture. The reasons for using the WLANs in class for E would be for study from the Internet, like go through the e-library, get examples from search engine, discuss online, submit assignments or class work, and get on Blackboard. Blackboard (Bb for short) was Unitec's eLearning Gateway. Students could login with their own username and password. They could find course announcements on it and they could communicate with professors or classmates. Bb provided all the information that a student needed. Usually, those tasks could be done if class was held in a computer lab. Most times those classes were not held in a computer lab, so the WLANs would be helpful.

Participant A

Participant A usually liked to bring her laptop to class and the laptop connected to the WLANs automatically. A said she was new in this English speaking country and she always needed an English dictionary at hand. She had an English dictionary program installed on her laptop, which was the major reason she brought in the laptop. As regards use of the WLANs, she said that at first she thought it was not necessary. But with her laptop already connected on the WLANs, she did research related to the content in class as well. She had been studying this way for the last three months and she felt that she could not be separated from the use of WLANs.

Participant MC

Participant MC had a similar situation to participants E and A. MC liked to download the lecture notes and search for information from the Internet in class.

There were also some different circumstances for her. MC had some classes held in the computer lab, because sometimes her class needed to get on the Internet. For example the subject of website management needed students to

compare websites or do some tests for a particular website. MC had another subject that required Internet connection as well, and students in this subject always had to do some class tasks and then email the professor immediately. When MC was doing that, she was happy that she could use her own computer and use the WLANs to do all those tasks in class straightaway.

Participant BC

For participant BC, the reasons for using the WLANs in class were to save time and paper. BC said most of his classmates always spent a long time in the computer lab or library. They usually printed a lot and brought all the paper and many books from the library to the classroom. All he did was to bring his laptop and connect to the WLANs. Just like participant E, BC had everything he needed by having that Internet at hand.

Participant B

Participant B was special among the ten interviewees. One of his reasons for using the WLANs in his classroom was to do research, and the other one was to send and receive instant messages. B had some research goals as other interviewees did. Normally, instant messages should not appear during a class. But B had his reason. B was an enthusiastic person and he liked to communicate with people at any time. He said he could use the instant messages to talk with other students in the same class. Sometimes, B just used it to discuss or ask opinions about class content in silence. He was proud of discussing things in this way.

Participant P

Participant P was very happy to use WLANs in classroom. P could do research and get results immediately. This appeared to be similar to participant BC. But in addition, P could download and upload files, either research results or tasks that had been done.

- **Use Wireless Local Area Networks (WLANs) in class helps study**

This section aims to understand how the participants use WLANs in class to help them study. As the last section showed that the participants L, M and N had never used WLANs in their class, the researcher asked them to assume they could use the WLANs in class and re-think how it might help. Participants M and N considered it was not necessary or there was no need to use WLANs in class.

Participant S

As not all of classes that the participant S took allowed him to use the WLANs, the researcher asked him to assume those classes all allowed it. Then the researcher asked whether in that case the use of the WLANs would help in all his classes and how would it help. S started with “it can be”. S thought that using the WLANs would only help make his studying more efficient. By using the WLANs in lectures, he could look up information straightaway and could do research when issues across. He could do all the work related to the Internet or Intranet straightaway in class instead of finding a computer in the computer lab or library after class. He would solve questions immediately during class instead of holding the question till the next class.

Participant E

Participant E said her laptop with the WLANs was her friend, because she felt safe by using her own laptop. Once she got her laptop connected to the on-campus WLANs, she had already got everything. E said her reasons for using the WLANs in class were that there were many tasks that could be completed only by using an Internet capable computer. A laptop with WLANs connection was ideal for participant E. Any information, examples, discussions, and even the library were all at her hand.

Participant A

Participant A considered she now definitely had help with her studies. She was involved in her new life and new style of lectures at UNITEC New Zealand. She could not use WLANs or even just the laptop in class in her home country, because the professor thought that students would pay more attention to the laptops than to the lectures. A consider the information on the Internet is comprehensive. She could get any idea from the Internet and she said “I feel I am prepared enough if I have the Internet at hand. I will not be confused again when my professor or classmates mention some subject that I have no idea about.”

Participant MC

Participant MC considered the help she got from using WLANs in class was significant. Getting on the Internet via WLANs and searching for information instantly in class made the process of learning different from what it used to be. Students use to study and research in library or computer lab after class. Nowadays, students could choose any way of learning they liked and felt comfortable. MC chose to use a laptop with WLANs connection in class. She felt it was the best way for her because of efficiency. She told me that she could finish her study tasks faster than some other classmates who had never used on-campus WLANs before.

Participant BC

Participant BC was very dependent on his laptop. BC had a private library on his laptop of lots of materials that he used for writing web pages. There were some classes where BC had to write web pages during class. The private library was very important for him when he wrote web pages. At the same time, he also needed the Internet because he usually needed to search coding scripts for his programming or discuss things with other programmers. The on-campus WLANs gave him the ability to do these activities by using his own laptop in class.

Participant B

Participant B had some classes that require Internet research during the lectures. B thought it was great to look up topics or content in class when the professor asked them to. Just like other interviewees, B liked to use his own laptop too. B said there were a lot of things he could do on his own laptop with the WLANs. One of his professors always gave out a lot of class notes to students when the lecture started. B could always ask and download them from the professor's online drive because B preferred to read from his laptop instead of paper. The advantages were ease of filing and finding things when needed.

Participant P

The help that participant P got from using the WLANs in class was quite similar to other interviewees, such as research instantly, download and upload files, save time and paper.. This was common with most interviewees, who thought they had everything if they had their laptop at hand.

• Difficulties with Wireless Local Area Networks (WLANs) connection

This section aims to understand the difficulties participants have had in connecting to the WLANs since they started to use it. Of the ten interviewees, four participants had difficulties sometimes when they tried to login into the WLANs.

Participant S

Participant S did not have any difficulty in connecting to the WLANs on campus. S said "It is good. They build it good enough and make it very simple to connect. There should not be any trouble at all. The steps are very easy."

Participant E

On weekdays, participant E usually spent approximately six hours at the graduate centre on her laptop with the WLANs connection. Most weekends,

she had her classes. E said she had trouble logging in to the WLANs on weekends and weekends only. E mentioned the traffic problem over the networks again as she said it was an inconvenience. The login would take a long time and/or fail when there were a lot of students using the WLANs at the same time. At that time too, she could not get help from the IT department (which is called “askI.T.” at UNITEC New Zealand) because the IT department is only available from Monday to Friday 8:00 am to 5:00 pm. The issue was that there was no such login problem when they were available.

Participant L

Normally, there was no problem in connecting to on-campus WLANs for participant L. Signal or speed was not stable sometimes and it could cause login failure or take a longer time. L felt that might be a difficulty for him.

Participant A

Participant A was one of those who had no problem connecting to the WLANs by themselves. The reason A gave was: “There is an orientation when the semester begins. Some people from the IT department came and taught us how to login to the computers in the computer lab and we know can get help from them if we have any technical problem. Then later, I took my laptop to the IT department, and they taught me how to connect to the WLANs as well. It is easy and similar with login to the system in the computer lab.”

Participant MC

Participant MC thought the steps for connecting on-campus WLANs were quite simple and easy, she just followed the instructions. The instructions could be obtained from the IT department.

Participant M

Participant M also said it was quite easy. Users first needed to make sure their laptops could find the wireless networks around, by opening the

“Wireless” switch on their laptops. Next open a web browser and type in a username and password. Then it was all done.

Participant P

Participant P thought it was easier nowadays than it used to be. P said two years earlier students had to bring their laptops to the IT department for the WLANs authorisation settings. If those students re-installed their laptops, they also had to reset the authorisation settings at the IT department. That was very inconvenient and sometimes it would slow some students down. P had a story about it. Two years ago, his laptop crashed and he re-installed the operating system on Friday night. That meant the laptop could not be able to connect to the on-campus WLANs during the whole weekend because the IT department was closed. Fortunately, students had alternative way of connection, which was to login with their unique username and password.

- **Influence and impact of the use of on-campus Wireless Local Area Networks (WLANs)**

This sections aims to find out if there was any influence or impact from the use of on-campus WLANs and how the WLANs affected students. For example, whether how long students spent on the use of on-campus WLANs showed as a part of scheduled part of students’ lives. Each of the interviewees had their own opinions and definitions about whether they had been affected or not. Participants A, N, BC and B thought there was no influence or impact at all.

Participant S

Participant S could not use the WLANs in his class, so he usually connected to the WLANs between two classes or at lunch time. That was why he spent just 1-2 hours on the WLANs connections a day. S also said he would sometimes change his schedule to create a gap in order to get on the WLANs.

Participant E

The availability of the on-campus WLANs did not influence participant E. E came to school almost every day. Sometimes she came after work and sometimes she came at any time she felt like. Since E had permission to access the graduate centre, she did not feel there were any restrictions or influence on her. E had a swipe card so that she could get into the graduate centre at any time. The graduate centre was available 24 hours 7 days for swipe card holders. E could continue using the WLANs at the graduate centre even when classrooms were locked and the library was closed. E said “I know there are some students who could not use the WLANs when it is too late. But for me, there is no problem. It is OK for me even if it is midnight.” The swipe card required a charge, but E did not care about it much. She felt safe inside the graduate centre because the doors were locked. She mentioned safety was very important when students study till very late.

Participant L

Participant L was an international student living in a home-stay. L had a roommate and both of them shared one broadband wire for getting on the Internet at night. Their home-stay mother was afraid spending too much time on the Internet would affect their learning but L disagreed. L decided to spend up to one hour at the library and use his laptop to get on the Internet by connecting with on-campus WLANs. Although it would make him an hour late home, he thought it was necessary.

Participant A

As another international student, participant A was a little bit different. A had a friend who came to New Zealand with her. They spent most of the time together both in class and after class. A said she did not think they had any interests in sports or other social activities. All they did was spend hours in the library.

Because they had come to New Zealand not long before, they tried to enter into their new life. At the same time, they liked their family and friends know

they had not disappeared. So they spent a lot of time contacting family and friends in their home country, such as by email and online chatting.

Participant MC

Participant MC considered there were some influences. MC said sometimes the speed of on-campus WLANs was faster than her home broadband. MC felt the environment on campus made her more likely to study harder. These were the reasons why MC spent a lot of time on campus. MC would not study on campus without the on-campus WLANs provided to students.

Participant M

Participant M thought there were not really any influences or impacts on him of using on-campus WLANs. M usually used on-campus WLANs in the library for his assignments. M said he could do assignments at home too, but it was easier to find books and journals inside the library. Besides, the WLANs were provided in library. The library became an ideal place for doing assignments. M said that “I just spend more time at the library and get home a little bit later.” Although M spent 3-4 hours in the library, he still thought that is “not a big deal.”

Participant P

Participant P considered providing the WLANs on campus was an extra study service for students. By providing the WLANs on campus, it put less pressure on the short supply of desktop computers. In past years, the desktop computers were always in short supply for serving masses of students. Many students had to wait in a queue in order to get a computer. Participant P was one of those students. Since the WLANs were provided on campus, P no longer waited for desktop computers. As P said, he liked to get on the Internet at any time and anywhere he wanted. P used the on-campus WLANs, saving time and finding comfortable places.

- **Aspect(s) of Wireless Local Area Networks (WLANs) that needs to be enhanced, and suggestions**

From their experience of using the WLANs on campus, each interviewee pointed to aspect(s) where of the WLANs should be enhanced and also made the suggestions about each aspect. The following goes through the interviewees one by one. Although some of them had the same complaints on specific aspects, they had different opinions about the causes of problems. They made suggestions from their own knowledge of wireless local area network technology.

Participant S

Participant S pointed to three aspects of on-campus WLANs that should be enhanced. Firstly, the speed of on-campus WLANs should be faster. S had experienced long time for downloading. S suggested that maybe the IT department could upgrade the speed.

Secondly, S felt the places where the on-campus WLANs were provided were very limited. Students could not use on-campus WLANs in many areas. S suggested providing on-campus WLANs at more areas or even unlimited so that students could use it more easily. S mentioned that the Gymnasium building and ground should be provided at least.

Thirdly, S pointed out that knowledge of on-campus WLANs was not enough for students. The IT department should provide more information, such as what kind of applications could not be used when students' laptops were connected to on-campus WLANs. Some friends of S had some problems with that. They said they had some applications that could not get on the Internet when they were using on-campus WLANs. The point was they had used those applications before and they did not know why they could not use those applications any more. S said if the IT department let students know what

they could do and/or could not do that would be better. For example they could list some applications that would not work and give an acceptable reason.

Participant E

Participant E had just used the WLANs for less than one semester, but she still had enough experience to give advice on it. E pointed out the problem of the speed of on-campus WLANs many times during the interview. E also thought that the restriction on access time and shortage of voltage should be enhanced as well. E considered the speed was slow because of a lot of students using the on-campus WLANs at the same time. This caused a traffic jam on networks. So E suggested adding more wireless access points to reduce the pressure of high traffic. At the same time, she said the low speed also caused login problems and those always happened on weekends. E suggested extending the open hours of the IT department, because the open hours of Monday to Friday 8:00 am to 5:00 pm was not enough to provide sufficient help to those students who really needed help at weekends and nights.

The restriction of access time would not influence E because she could access the graduate centre at any time. E still suggested they should solve this problem for most students, who could not enter classrooms and the library at night. E considered the time problem was caused by the restriction on places, because the on-campus WLANs are provided 24 hours 7 days.

At the end of the interview, E suddenly remembered another problem, about the shortage of power points. E said there were not enough power points for large groups of students. Some students had to wait for a power point in order to stay and use on-campus WLANs longer.

Participant L

Participant L had many opinions about the signal, speed, areas of provision

and security issues of the on-campus WLANs. First of all, L considered the weak signal made the connections between laptops and on-campus WLANs unstable. L suggested adding access points to help increase the WLANs signal so that users could have a stronger signal to get stable connections.

Secondly, L mentioned the speed of on-campus WLANs was quite slow sometimes. It took too long to login or open comprehensive web pages. L suggested increasing bandwidth or adding a backup server to solve the low speed and login problem.

Finally, L suggested expanding the areas where on-campus WLANs were provided. This could help to spread students to different places. They may feel it was convenient and comfortable if the place was not so crowded.

Participant A

Compared to participant L, another international student participant A did not have so many suggestions. A just thought the low speed of on-campus WLANs was a problem. She said she could not open some overseas websites or they took a long time to open. Most of those websites were from her home country. Even though this was not for study purposes she still suggested enhancing the speed of the WLANs. A did not make any particular suggestions about how to enhance this feature. She said she was not good at the technologies and had no idea of it.

Participant MC

Participant MC stated that sometimes the speed of the WLANs was quite slow and the signal was weak. Participant MC gave her advice in solving these two problems as follows: increase the bandwidth and add more access points.

MC believed the speed problem was caused by too many people using the networks at the same time and the IT department had restricted the

bandwidth of the WLANs. The distance between laptops and access points may influence the speed and signal performance of the WLANs. Greater distance between the laptops and the access points would result in weaker signal and slower speed.

On the other hand, MC also believed the wireless network card could be another possible reason for people to feel the WLANs were “very slow” or “always slow”. Different network cards use different wireless standards such as 802.11a and 802.11b.

At the end of the interview, MC suggested expanding the wireless coverage, for example car parks. Nowadays, most students have more powerful electronic devices. Not only laptops, but also PDAs and mobile phones could connect to the WLANs too. MC liked to get on the Internet by using her mobile phone. If her mobile phone could connect to the WLANs anywhere on campus, she would save money on her mobile fees.

Participant M

Participant M did not have any opinions on enhancing the WLANs. M said he felt the WLANs were good enough. Some friends of M told him the speed of the WLANs was quite slow, but M did not agree with them. M believed the reason he did not have any speed problem was he did not use the WLANs as much as his friends. M was only doing his research for his assignments when he connected to the on-campus WLANs in the library. M’s requirement was lower than for other people. Because his friends always complained of the speed problem, M suggested maybe the IT department should upgrade the speed of the WLANs to meet students’ needs.

Participant N

Participant N did not own a laptop to get on the WLANs. N liked to borrow one from the library. The borrowed laptop could be used for a duration of 30 minutes. N felt 30 minutes was quite short for study purposes. So she

suggested the library should extend the duration, for example to an hour.

N believed those laptops which could be borrowed were old models and they were quite thick and heavy. N suggested the laptops should be replaced with new models. N knew that would cost a lot, but the computers in the computer labs were updated. There were not as many laptops as those computers in the computer labs, so N believed this was acceptable advice.

There was sometimes a shortage of laptops for students. N considered the number of laptops should be recalculated to meet the needed of students.

Participant BC

Participant BC mentioned the slow speed and unstable signal when talking about inconvenience. He recommended that the IT department could upgrade their hardware to solve those problems. For example, they could upgrade to IEEE 802.11n standard. It was faster compared with IEEE 802.11a, b and g. BC believed the signal was weak because the access point was too far away. If there were more access points, it might be better.

Security problems were the major concern for BC. There were two types of wireless networks provided by UNITEC New Zealand. One was the UNITEC-HOTSPOT wireless network and the other was the semi-trusted wireless network. In previous years, the semi-trusted wireless network was the only one provided. It required students' laptops to have up-to-date anti-virus software and the connection had to be set by staff from the IT department. Before they set up the connection, they needed to make sure the laptop was up-to-date with virus protection. But now, with the emergence of the UNTEC-HOTSPOT wireless network, the anti-virus software check was not that necessary. Although the IT department still require laptops to have anti-virus software, students could login into the UNTEC-HOTSPOT wireless network with their username and password by themselves. Some of those laptops did not have anti-virus software. BC believed the anti-virus

software was necessary for protecting laptops in the same network when users surfed the Internet.

During the interview, we talked about login problems which mentioned by other interviewees. BC believed it might be caused by the login server being too busy, so he suggested adding a backup login server.

Participant B

Participant B recommended strongly that the IT department should upgrade the speed of the WLANs. B said the speed problem not only bothered himself but also all his friends. Most of his friends complained all the time about the slow speed of the WLANs.

B had another login problem. B thought the slow speed and weak signal could both cause login problems. B believed the speed was too slow so it took longer to get authorisation. Login failure could be caused by time out, for example the web page could not open if it took too long to connect to the web server.

B could not see where the access points were, but he felt some areas did not have enough access points. B and his friends worked this out by finding out which room had strong signals and which had weak signals. B also found that the signals varied at different places in one room. B recommended the IT department should maintain a stable signal everywhere in the areas of the WLANs.

Participant P

Participant P believed he could study more efficiently at school if the speed of the WLANs got faster. P said he always had to wait when opening Adobe files or web pages with pictures. Sometimes the pictures could not be opened because of the slow speed. P would be very happy to see the IT department upgrade the speed of the WLANs. It would save time for him.

P said sometimes he could get a stable signal. Lost signals made his laptop lose the connection to the WLANs. He was really concerned to find places with a strong signal. P wondered whether there was a solution to fix this problem. P wondered if there were more access points or fewer users connecting to one access point that might help.

4.2.3. Wireless Information from Unitec website

According to “Wireless” (2007), wireless information for users is as follows: There are two Unitec wireless networks, the UNITEC-HOTSPOT wireless network and the semi-trusted wireless network. These two wireless networks provide different levels of security and access to users. Both of them support the IEEE 802.11a, b or g standard; both require laptops of users have up to date anti-virus software installed.

Users of the UNITEC-HOTSPOT wireless network could login by themselves each time they start their laptops. There are two separate documents which show the instructions on how to connect to the UNITEC-HOTSPOT wireless network for Windows XP and Vista users. The instruction for Windows XP could be found from http://askit.unitec.ac.nz/shadomx/apps/fms/fmsdownload.cfm?file_uuid=C17824C0-C09F-E035-20BF-16D99A5A1548&siteName=unitec_askit and for Vista could be found from http://askit.unitec.ac.nz/shadomx/apps/fms/fmsdownload.cfm?file_uuid=C17823E5-C09F-E035-2031-97C0B0130286&siteName=unitec_askit.

Users of the semi-trusted wireless network have to bring their laptops and visit the help desk of IT department during open hours. The staff working at the IT department could configure the wireless connection for users.

There is a list of coverage locations of wireless for both Mt. Albert Campus and Waitakere Campus on the Unitec website. They could be seen from <http://askit.unitec.ac.nz/?D3C5CF53-B116-415D-AECC-8DE12F23D884#3>. A map on the

same webpage shows not only the wireless coverage areas, but also locations of wireless access points.

4.3 Summary

This chapter presents the information gathered from survey, observation and interview. The information from the survey is classed as quantitative data because of the statistical results from the responses to sixty-four surveys. The information from observation and interviews is classed as qualitative data. The survey responses from the participants, who also did the interview, are classed as qualitative data as well and are presented in detail for each participant. The survey responses are combined with the interview responses from the same participant as cases in this study.

Although the information gathered from each participant is classed as one case, the responses from different participants for the same question or a group of questions are divided into one group. The responses of each group correspond with the research questions. The relationship between the survey and interview with the research questions is presented in the next chapter: Data Analysis. The data analysis is based on the findings presented in this chapter. The data analysis leads the researcher to address the outcome for this research, i.e. the answers to the research main question: “How had the availability of Wireless Local Area Networks (WLANs) on campus affected students?”

The observation data is not presented in the same way as the researcher recorded in the journal notes. It is a summary of the two observations by the researcher.

Some participants mentioned some wireless information in their responses, and the information from the participants is different from each other. The reader of this study may want to compare this with the formal information. The research presents the wireless information from the provider as the last

section of this chapter. This is in order to let the reader read the information from participants without prejudice.

5. Data Analysis

This chapter analyses the data presented in the last chapter. The survey and interview questions were generated based on the research questions. To understand the connection between the research questions and the survey or interview questions was important. This helped the researcher narrow down the scope of the answers from each survey or interview question for a specific research question. The relationship between the sub-research questions and the survey and interview questions is shown as below:

Research questions	Survey/Interview Questions
What kind of students are the users of on-campus WLANs?	<ul style="list-style-type: none"> • What course(s) are you taking? • What year are you in?
What do students use on-campus WLANs for?	<ul style="list-style-type: none"> • What do you use on-campus WLAN for?
What are the behaviours of students who use on-campus WLANs?	<ul style="list-style-type: none"> • How often do you usually use the WLAN on campus? • What time do you usually start to use the WLAN? • How long do you usually use the WLAN on campus? • Do you know where the wireless zones are? How do you know? • Which place do you usually use the WLANs? • Where did you do these activities before using on-campus WLAN? • What types of Internet connection are you currently using?
What are the current challenges that students perceive with WLANs?	<ul style="list-style-type: none"> • Are there any term and conditions on connecting to campus WLAN? • Are there any restrictions on connecting to campus WLAN? If yes, what are they? • How would you rate the on-campus WLAN?
Are there any impacts on students from the use of on-campus WLANs?	<ul style="list-style-type: none"> • On which campus do you usually use the on-campus WLAN? • Where did you do these activities before using the

	<p>on-campus WLAN?</p> <ul style="list-style-type: none"> • Are there any activities affected by using on-campus WLAN?
<p>What opportunities are available for educational institutions to provide the convenience of WLANs for students?</p>	<ul style="list-style-type: none"> • What is the convenience of using WLANs on campus? • What is the inconvenience of using WLANs on campus? • Can WLAN be used in classrooms? If so, for what purpose? • Do you think that using WLAN in classrooms is helpful for your study? If so, how did using WLAN help you?
<p>Are there any technical issues concerning WLANs relevant to educational institutions that arise from user requirements?</p>	<ul style="list-style-type: none"> • What is the connection speed to the Internet? • Are there any difficulties for you in connecting to on-campus WLAN? • Do you think the on-campus WLAN services should be enhanced so that it would help you more in your study? Why? • Do you have any suggestions on how to make the WLAN service better?

Table 5-1: Relationship between research questions and survey/interview questions

As can be seen in the table above, the answers from surveys and interviews presented in last chapter can be grouped according the link with each sub-research question. This chapter is divided into seven sections by seven sub-research questions.

5.1 The group of the users of on-campus WLANs

According to the responses to survey questions 1 and 2, which were about the participants' courses and year of course, over 30 courses were being undertaken by 64 participants. In most the cases there was only one participant in any particular course. This included Diploma in English, Bachelor of Arts, and Bachelor of Interior Décor, etc. There were on average two to four students in each course, and the greatest number of participants

in same course was six. Based on the result shown in Figure 4-1, the users of on-campus WLANs were mostly in the first or second year of their courses: 51% of the participants in their first year and 27% in their second year. The numbers dropped so that only 3% of the participants were fourth year and 2% sixth year. The interviewees covered students from 1st year up to 6th year of their courses.

This finding showed that as the year of course increased the users of on-campus WLANs decreased. This may be a result of students liking to stay and study at school in order to adapt their learning in a new study environment, for instance in their new school. Another possible reason could be that students in the third or fourth year of their course, which would be their last year of school, were busy on other activities such as working and did not have as much time spend on campus. But, no matter which year they were in, they could gather together at one corner of the school for their group assignments, and could use WLANs on campus while they were in group meetings. This was demonstrated by some participants being in group meetings when they were surveyed.

Although some participants were in group meetings for their assignments while doing the survey for this research, most of the participants were alone when doing the survey. This explains why there were 16 participants in different courses and several participants taking exactly the same course, e.g. Bachelor of Civil Engineering with six participants and Bachelor of Construction with three participants.

A group of users of the on-campus WLANs were international students. Of the ten interviews, two were with international students. They used the on-campus WLANs instead of the computers in the computer lab because they could use their own laptops with operating system and applications in their first languages.

However, no matter whether the users were in groups or alone and no matter which year they were in, they were not from any particular grade or subject. The users of on-campus WLANs could be a student learning Applied Technology in his first year or a student learning Sport Management in his sixth year. They could be anyone in any school of UNITEC New Zealand.

5.2 The reasons why students use on-campus WLANs

The finding from the surveys showed that the reasons for students used WLAN were very broad. Many students used on-campus WLANs for research, doing assignments, E-learning and on-line discussion. It was as one participant concluded “all the study purposes”. In addition to study purposes, there were also many other reasons, such as for fun and relaxing. These could include downloading on-line entertainment, chatting, surfing the Internet, shopping on-line and checking email.

All of the activities listed on the survey as an operational question were the ones that the researcher knew, but there could have been more. There is one special activity: Internet gaming. Although only one participant was doing this, such an occurrence does happen. The researcher accepts that playing Internet games has become a common occurrence among students today. But the researcher does not accept the campus is the right place for playing Internet games. The campus had always been the place for accessing education and study. Students used the WLANs on campus like broadband at home. They used the WLANs to do anything they could do on the Internet, no matter where they were (even on campus) and no matter whether the place was suitable for those activities.

It could be concluded that students are using the internet on campus for all types of activities, not only study related.

5.3 The behaviours of students who use on-campus WLANs

The research shows that one third of participants used the on-campus WLANs every day; 9:00am to 10:00am was the busiest time for the wireless networks; and the duration of the use of the WLANs varied from less than 1 hour to all day. Many participants consider that the network traffic was slowed down by many students using the WLANs at the peak time. A significant proportion of students (45% of all participants and 6 out of 10 interviewees) were aware of the coverage of the WLANs from the “Wireless Zone” sign. The number of WLANs users, who had usually used the Internet at home before the WLANs were provided on campus, was the total of users who had accessed the Internet in the library, computer lab or Internet cafés. The on-campus WLANs mean a lot students have changed from staying at home to staying on campus, although almost half of the participants had at least one alternative Internet connection such as broadband or dialup at home. In addition, there were many computers available in the library, computer lab and Internet café. Lots of students switched their Internet connections from home, library, computer lab and Internet café to on-campus WLANs with their own laptops.

As discussed in the previous section, many participants were in group meetings while they were surveyed. Of course, not all of the participants taking the same course were in groups. For example, among the six participants who were doing the Bachelor of Civil Engineering course, four were in two different groups when they were surveyed, and the other two were using the on-campus WLANs alone. In addition, most of the participants were surveyed in the library; this allowed the researcher find out that first of all, some students were forced to use the on-campus WLANs because of group assignments. Secondly, since the library was the most common place for research and doing assignments there were more users of on-campus WLANs there than in other places on campus. The second finding

explains why most of participants were surveyed in the library.

Certainly, the findings above also applied to the interviewees. The researcher selected ten participants from different user groups of on-campus WLANs. Each of the ten interviewees was taking a unique course, though Participants MC and BC were both in the school of computing. As the study environments of Participants MC and BC were however quite different, the researcher believed they could represent different group of users. However although the study environment and conditions varied among the interviewees, the interview results still showed that the library was the most common place for study.

We could conclude then that having wireless provision did not exclude the need to provide physical space or locations for students to work. The provision of a common work area is still needed with on campus wireless service.

5.4 Current WLANs challenges that students perceive

5.4.1. How could students get on the WLANs?

The research showed that most of the participants did not know whether there were any terms and conditions for the use of on-campus WLANs. Of the ten interviewees, six knew nothing about it. Of the remaining four interviewees, two clearly stated that there were no terms and conditions at all and the other two stated that users must be students at Unitec and have their username and password generated by the IT department. There may be two reasons for this result. One is that some users were using the semi-trusted wireless network, and the other is that some users chose the easier way of getting connected to the UNITEC-HOTSPOT wireless network

and ignored all requirements for getting connected to the wireless networks.

As mentioned earlier, there are two wireless networks provided to users at both campuses. The requirements for getting connected to both wireless networks are outlined on the Unitec website. “Wireless” (2007) clearly stated that

1. *Ensure your laptop or wireless device supports the 802.11a, b or g standard.*
2. *Ensure your laptop or wireless device is suitable.*
3. *Ensure that your laptop is up to date with Virus Protection and Security Updates. We recommend that a personal firewall is enabled.*

These requirements are suitable for getting connected to both wireless networks. The difference is that the UNITEC-HOTSPOT wireless network allows users to make their own connection and the semi-trusted wireless network requires students to bring their laptops and “*Visit the ask I.T. Help Desk at any time during our hours of support and we will configure wireless for you on the spot*” (“Wireless”, 2007). This means the authentication process for getting onto the semi-trusted wireless network is stricter than for getting onto the UNITEC-HOTSPOT wireless network. Users of the semi-trusted wireless network can take advantage of the more secure and internal network services (“Wireless”, 2007). Most users did not even know what made the two wireless networks different. They preferred to connect to the UNITEC-HOTSPOT wireless network by typing in a username and password rather than to take their laptops to the I.T. Help Desk.

The IT department should find some ways to let all WLANs users well known what the differences between two wireless networks are. By doing this, the students could distinguish the security and access levels of the two wireless networks and choose the wireless network according the individual needs.

5.4.2. What restrictions are there on the use of the WLANs?

Among the 64 participants in this research, all the interviewees considered there must be at least one restriction on the use of the WLANs. Student account, a undertaking course, time and places were the four higher factors that students considered as restrictions.

As shown in Figure 4-9, almost half of the participants agree that the users of on-campus WLANs must be students and have valid student accounts. This may be a result of all students being told by IT department staffs that they could only login to the network on any computer within campus by typing in their student account username and password. Taking course did not restrict the use of the WLANs directly. The participants considered users must be taking any course so that they could get valid student accounts. Based on the finding, seven out of ten interviewees agreed that having a student account was a major factor of restriction on the use of the on-campus WLANs. Although this was identified in the surveys as a restriction, the interviews revealed that this was not a negative restriction and students were happy about their access on campus via their user accounts.

There was always a connection between time and place. Users may be restricted to the use of on-campus WLANs at a given time because the place e.g. library is not available out side the given time. It is the same in another way: the use of on-campus WLANs is allowed in the library only during opening hours. For the group of users who had access to the graduate centre, time was not considered to be a restriction. Participants E, MC and B were ones who could enter the graduate centre at any time. This group of users could use their laptops to get on the WLANs at any time. But place could still be considered as a restriction for participant MC. She thought that she could use the WLANs 24 hours 7 days but not in every place, for example she could not enter the library after hours.

As well as the time restriction, Participant P pointed out that the speed of the WLANs may be slow when many users get on the WLANs at the same time. Participant P thought the effect of multiple users on speed was a restriction on the use of on-campus WLANs.

Physical provision of areas to use internet is still a restriction in the use of WLANs in the opinions of the students surveyed.

5.4.3. What are the students' satisfactions with the WLANs?

Basically, most of the participants of this research were satisfied with the on-campus WLANs. The result from the interviews was consistent with that. In the ten interviews, only one interviewee considered the on-campus WLANs is poor because the connection speed was only 6.5Kbps. Another interviewee (participant P) put two conditions on the satisfactions.. Participant P was very satisfied with the wireless networks in library, but he also emphasised that the WLANs in the residential village were very poor.

Even if there was only a small group of users who were not satisfied with the on-campus WLANs, the provider still should consider why this was so. Especially as one participant made it clear that he was not satisfied with the speed of only 6.5Kbps. For users who had the same experience as participant P of using on-campus WLANs both in the library and the residential village, it was unreasonable that the on-campus WLANs were quite different in different buildings.

5.5 Impacts on students from using on-campus WLANs

The on-campus WLANs are provided and cover most buildings and areas in both campuses of the UNITEC New Zealand. This coverage of the WLANs allows students to choose the right place for each of them. For example, participant BC stated that he liked to enjoy the wireless networks at the campus near his home even though his classes were all held on the other campus.

As mentioned previously, almost half of the participants had at least one alternative Internet connection at home, library, computer lab or Internet café. Those participants had clear reasons for using the on-campus WLANs, for example learning with friends. However, the provision of WLANs on campus means that students could attend to all their internet requirements, both study and personal on campus. As a result students are spending more time on campus.

Using on-campus WLANs definitely has an impact on students. The research showed that the users of on-campus WLANs usually included the wireless connection on campus as one activity in their lives. They liked to spend hours on campus after class, squeeze in time between classes, use their lunch time, change their schedules and spend money on hiring a swipe card in order to get into the graduate centre. All these decisions to create space in their normal lives were in order to get onto the on-campus WLANs. Before the on-campus WLANs were provided, students would never surf the Internet during lunch or download lecture notes during class by using their own laptops. The convenience of using on-campus WLANs made many students consider the on-campus WLANs as essential for their learning.

According to the statistical data in “Tech Check” (2007), 63% of college students owned laptops and 93% owned a cell phone. Portable electronic

devices had increased dramatically over the last few years. With the popularity of the on-campus WLANs, more and more students bring their own wireless-capable electronic devices on campus and use these electronic devices to get on the Internet any time any where. The desire to use the on-campus WLANs has meant that portable electronic devices with wireless capability have become common equipment for learning. As Brass (2004) agreed, the *“laptop had become must-have for today’s college students”* and the purchase of portable electronic devices increases their budget for school. Similarly Nisbet (2004) stated that students in some private schools were required to carry laptops to school. The potential risks to security and safety for those students carrying portable electronic devices were not only virus infection and privacy violation, but also damage to or loss of those expensive electronic devices.

The researcher believes the impact of the use of on-campus WLANs is two-way. The on-campus WLANs provide students with an extra learning mode. Also, the use of on-campus WLANs makes education institutes provide better facilities and learning environments to students. As Internet usage becomes more common everyday requirement for students, got on campus WLANs provision means they don’t have to separate their personal, work and study requirements for Internet access.

5.6 The opportunities for educational institutions to provide convenience of WLANs for students

5.6.1. Current advantage of the convenience of the WLANs

According to the data gathered from interviews, there were many benefits. Mobility and free Internet access were the most attractive benefits for the users of on-campus WLANs. Mobility was also the reason why most students chose to use on-campus WLANs. It showed that the convenience of the

on-campus WLANs affected student decisions on whether or not to use it. Sometimes, the students' decisions were very simple. They used on-campus WLANs simply because they could use their own laptops. Mobility was one advantage for the campus to provide WLANs to students that facilitates learning and study. Whilst this had been shown to be the case it did not preclude the need of the institution to provide physical work areas.

5.6.2. Opinions from participants

In considering the findings of the inconveniences reported by interviewees, there are many opportunities for the provider to improve the on-campus WLANs. The slow speed and unstable signal were the two major concerns of the users. Most of the users were not satisfied with the quality of the on-campus WLANs when they participated in this research. They expected the speed of the WLANs to be faster and the signal to be more stable and strong. The slow speed and weak signal made a lot of problems for surfing on the Internet and even made it difficult to login to the wireless networks. Based on the findings, the users are also expected more power outlets and more physical places to sit or meet for a longer opening times.

Some participants of this research were using laptops borrowed from the library. Since they were only allowed to use them for thirty minutes, they wondered if they could use them for longer, such as an hour. As the on-campus WLANs were available for all students at UNITEC New Zealand and Unitec's international students were some of the users of the on-campus WLANs, cultural differences influenced the expectations of some students. As the researcher knows, there is one dictionary application in Chinese that can be used on computers at Unitec's computer labs although those computers can not type in Chinese. So if the laptops which could be borrowed in the library had multiple language input method or some applications in other than English installed, many international students could benefit from them. They would not need to bring their heavy laptops to campus and they could

use the borrowed laptops to chat or email in their first language.

The use of on-campus WLANs in the library or the cafeteria was not the only way to offer a convenience to students. The use of WLANs in classrooms especially during lectures was also welcomed by students. The information about the use of WLANs in class gathered from the interviews was consistent with the views of Campbell & Pargas (2003). Because the WLANs were provided in classrooms, the interviewees experienced the advantages of using WLANs in class. The reasons and advantages made their decision on whether to use Wireless Local Area Networks (WLANs) in class. The students believed that the ability to download lecture notes, do instant research relevant to class content, submit class tasks, browse e-library and on-line discussion helped them learn more effectively and efficiently. As discovered in the literature review, Campbell & Pargas (2003) included all these abilities in their eight categories of providing wireless connections in classrooms. These abilities were also the reasons why many universities integrated laptops with wireless connection into lectures. Those universities believed that to provide and integrate wireless connections into lectures would enhance classroom experiences of students. Despite all those advantages, laptops with wireless connection were not used in all classes at UNITEC New Zealand according to participants L, M and N. They said they did not need or were not allowed to use the WLANs in their lectures. Participants L and N did not give any answers on the use of WLANs in class. The participants L and N were the only two participants who never considered using the WLANs in their class.

To conclude, it is very important that the providers provide convenience of on-campus WLANs for students. On the one hand, it will encourage more students to use the on-campus WLANs; on the other hand, it will let existing users be more satisfied with the wireless services.

5.7 Technical issues concerning the WLANs

5.7.1. The concerns about speed and signal of the WLANs

This research shows that a significant proportion of the users were not satisfied with the speed of the on-campus WLANs. Almost all the interviewees suggested upgrading the speed of the WLANs. The worst rating of the connection speed by the user was only 6.5Kbps. In theory, it was probably at least 6Mbps throughput in both the UNITEC-HOTSPOT wireless network and the semi-trusted wireless network at Unitec. The information from “Wireless” (2007) stated that the WLANs provided at Unitec campuses were in 54Mbps IEEE 802.11a and g and 11Mbps 802.11b standard. The data throughput was in the range between 5 to 20Mbps and the average of 6Mbps at 20 metres.

The weakness of the signal of the on-campus WLANs was another issue raised by the users. Many participants pointed out that the signal of the WLANs was sometimes weak and unstable. As can be seen in Figure 4-4, four participants had experienced difficulties with the wireless connections. They said those difficulties were from time to time and depended on different situations. The connection speed being too slow and the signals being too weak were the main problems causing connection difficulties. Certainly, the users strongly supported upgrading the performance of on-campus WLANs, especially to enhance the speed and signal.

As discussed by McLaughlin (2008) and Cox (2008), the 802.11n technology could be one option to solve both speed and signal issues. It was stated in Cox (2008) that the 802.11n network would serve users at a speed of 2Mbps to 25Mbps, depending on the number of the users. The speed of 802.11n standard was not only 25Mbps anyway. Xiao (2005) believed that the 802.11n standard would bring enhancements for higher throughput in wireless LANs because the 802.11n standard was “*capable of much higher throughputs, with*

a maximum throughput of at least 100 Mb/s, as measured at the medium access control data services access point.” This was agreed by Thryft (2007) that depending on the design, an 802.11n network could reach a typical throughput of 144Mbps and a maximum throughput of 600Mbps. Of course, the 802.11n standard was not simply faster than any other 802.11 standards; the MIMO (multiple-input/multiple-output) technology and 40MHz channels made it more competitive. On the one hand, Abramowitz (2006) believed that the MIMO technology would improve wireless network performance by taking advantage of the multipath. The MIMO technology allowed multiple transmissions received by multiple receivers at almost the same time which construct the multipath, and this multipath was the reason why 802.11n could provide higher throughput and better reconstruct weak signals (Abramowitz, 2006). On the other hand, Garcia (2007) pointed out that the 802.11n technology could operate in two frequencies of 2.4GHz and 5GHz. The 802.11n technology could also operate wide 40MHz channels, which provided higher throughput, in either frequency.

5.7.2. The concern for security

Security seemed a minor issue as only one participant mentioned that he had noticed file-sharing requests from other laptops and he felt annoyed by it. He thought sharing files in a public network may be not that secure and he was afraid his privacy could be violated.

The users of on-campus WLANs were certainly many, but why was only one participant worried about his privacy? The researcher thought most of the users chose to trust the IT department to take care of them. Indeed, the IT department had very strict criteria for using the semi-trusted wireless network. They require the semi-trusted wireless network users to have up-to-date anti-virus software installed on their laptops and this is double checked by the staff working in the IT department. The requirements are the same for the UNITEC-HOTSPOT wireless network users, but there is no one

to check whether the laptops used to login are protected by up-to-date anti-virus software. Because users can login to the UNITEC-HOTSPOT wireless network by typing in their unique username and password this means they can login by themselves without any check by IT department staff. It is great that students could login by themselves but some students do not follow the requirement to “*ensure your laptop is up to date with Virus Protection and Security Updates*” (“Wireless”, 2007). If the IT department could check all user laptops or check randomly, the researcher believes that would help to remind users to update their anti-virus software. If the IT department could provide courses to teach users how to use WLANs in a secure way, maybe it could help to prevent virus infection of their laptops and violation of privacy.

Because users of the UNITEC-HOTSPOT wireless network could login onto the network with their username and password without any security check from the IT department, this makes the UNITEC-HOTSPOT wireless network a sort of open wireless network. The SSL (secure sockets layer) encryption and VPN (Virtual Private Network) technology were both suggested by Breeding (2005) for employment on open wireless networks. Breeding (2005) believed that with the SSL encryption and VPN technology, users in open wireless network could protect their sensitive information. Of course, SSL encryption and VPN technology are not the only way to protect students’ laptops. For example, Brawn et al. (2004) stated that the Arizona State University West used the 802.1x security protocol for both their wired and wireless networks.

5.8 Summary

This chapter showed the relationship between the sub-research questions and the survey and interview questions. The link between each question and the coding of data in each question helped the researcher to analyse the data gathered. It was easy for the researcher to look at a particular research question, and compare opinions from different participants on particular survey or interview questions. Based on the answers from the survey, there was no particular group of users of the on-campus WLANs. The users could be any students in any school and in any year of their course. The users could be any students who owned portable electronic devices with wireless capability.

During the data analysis, the researcher identified a phenomenon that exists not only among the participants of this research but also in the academic literature. Based on the data gathered from 64 participants, users of the on-campus WLANs were varied, from different schools and different year of course; students had different reasons besides study, and students used laptops in classrooms, the library, the cafeteria and the residential village. Students who used on-campus WLANs had integrated the WLANs into their lives. In the academic literature, “Tech Check” (2007) reported that more students owned portable electronic devices; Brass (2004) stated that laptops had become must-have devices for students and Nisbet (2004) emphasised that students had to take laptops to class in two private schools. There are also many articles reported that many universities used and provided wireless networks for students and faculties.

Not all the participants knew the exact restrictions or requirements for getting connected to the on-campus WLANs. Satisfactions with the on-campus WLANs varied from very poor to very good. This shows that student perception were quite different as the quality of the wireless networks was not stable when more users were connected.

This chapter integrates the concerns and opinions from participants with the technologies reported from academic literature to help educational institutions to improve their wireless networks and solve existing problems. Some of the participants considered that the current speed of on-campus WLANs was slow, the signal was weak, the coverage was limited and some classes prohibited student use of WLANs. The researcher found that similar problems had happened at other educational institutions and they had been solved. McLaughlin (2008) and Cox (2008) discussed adoption of the 802.11n technology for campus wireless networks; Campbell & Pargas (2003) mentioned that integrating laptops into lecture plans would help improve lecture experience; and Brawn et al. (2004) described a university using the 802.1x protocol for security protection.

6. Conclusions and Recommendations

This research determined issues arising when students use the on-campus WLANs at either campus of UNITEC New Zealand. This research further analysed the opportunities for an education setting to provide or improve on-campus wireless networks to students.

A predominantly qualitative research approach was taken to answer the research questions. An in-depth literature review was conducted in order to determine the importance and benefits of providing the WLANs on campuses. Some academic literature quoted in this thesis pointed out that laptops had become necessary in class and students had to take laptops to school. In addition, the status of adopting WLANs at educational institutes was identified and technologies and security issues were discussed. The literature review showed few opinions from users but a huge amount of information about the popularity of WLANs in higher education sectors. Most of the academic literature discussed the WLANs from the provider's point of view.

The literature review created the basis of this research. The survey and interview questions were based on the findings of the literature review. Sixty-four users of the on-campus WLANs at UNITEC New Zealand were surveyed randomly and ten students from the survey were selected and interviewed face-to-face. The surveys and interviews focused on the student's perceptions of using WLANs on campus. The data gathered for this research, including literature review, observation, surveys and interviews, were divided into seven parts according to how the content related to particular research sub-questions.

The first three sub research questions "What kind of students are the users of on-campus WLANs? What do students use on-campus WLANs for? What are the behaviours of students use on-campus WLANs?" have been answered as

follows: The users of on-campus WLANs were potentially all the students studying at UNITEC New Zealand and their reasons for using the WLANs were not only for study, although most participants did. Students were using the Internet on campus for all types of activities. The provision of a common work area is still needed with on campus wireless service.

The fourth sub research question “What are the current challenges that students perceive with WLANs?” had been answered by three aspects by which students are accessing the WLANs, the restrictions on the use of on campus WLANs and students’ satisfaction. Students could connect to the WLANs in two ways which meant configuring the connection by themselves or IT staff. But the research results showed that students did not quite understand the difference between the two wireless networks. When comparing the two wireless networks, the security and access levels are different. The UNITEC-HOTSPOT wireless network is easier and more flexible to configure, and the semi-trusted wireless network is more secure. The participants preferred to use the easier configuration to connect to the UNITEC-HOTSPOT wireless network. This led to security concerns from students about information and privacy protection in open wireless networks. The finding showed that there were some restrictions on the use of WLANs. The student account was considered as a restriction from the survey results but it was considered as a positive restriction by the interviewees. The participants were satisfied with the easy configuration by using their student accounts. The finding also showed that physical provision of areas to use WLANs was still a restriction in the use of WLANs in the opinions of the students surveyed. Most of the participants were satisfied with the on campus WLANs, although there was a small group of users who were not satisfied with the slow speed and poor signal. Maybe the IT department ought to consider some solution for the speed and signal problems.

The fifth sub research question “Are there any impacts on students from the use of on-campus WLANs?” had been answered by the fact that students

were spending more time on campus. With the provision of the WLANs on campus, students brought their own portable electronic devices with wireless capabilities to school. Students spent more time on campus after class since the WLANs had been provided. Students used the on-campus WLANs during and after lectures. Students thought the provision of WLANs was essential for their learning because of the advantages and convenience of the use of on-campus WLANs.

The sixth and seventh sub research questions “What opportunities are available for educational institutions to provide the convenience of WLANs for students?” and “Are there any technical issues concerning WLANs relevant to educational institutions that arise from user requirements?” have been answered as recommendations. To provide convenient WLANs is important because most participants spent a lot of time on campus because of the convenience of having WLAN access. In this research, the opportunities for providing convenience of WLANs were determined from the aspects of student dissatisfaction. The participants were obviously dissatisfied with the slow speed and poor signal of the on-campus WLANs. Some of the participants recommended upgrading the bandwidth of the networks and adding more access points within the areas where WLANs were provided. The researcher recommended some examples of technical solutions for improving speed and signal problems which were found from the literature review, such as the 802.11n technology, SSL encryption and the 802.11x protocol.

The over arching response was that WLAN provision had enabled students to continue with their personal and business Internet requirements on campus without being restricted by the use of hard wired equipment supplied by the institute or having to move off site. The advantages of the mobility and free Internet access were attracting students to spend more time on campus. The compatibility of the networks enabled students to connect to the Internet anywhere any time. As Internet usage becomes increasing common and an

everyday requirement for students, on campus WLAN provision means they do not have to separate their personal, work and study requirements for Internet access.

Further research

This study started from a current user of the on-campus WLANs and used participants from two campuses. The culture of the use of on-campus WLANs in different campuses or different institutes would be varied. This research could not avoid bias in that the data gathered from two campuses is not diversified because the two campuses belong to the same educational institute. Further research could be done on more campuses and in different countries.

WLANs have become more and more popular in higher education institutes, and there is no doubt that users are expecting more convenient wireless networks and the providers are improving their wireless networks to meet user demands. Further research could be done on both users and providers.

7. Appendix

Appendix A: Survey Questions

1. What course(s) are you taking?

2. What year are you in?

3. How often do you usually use the WLAN on campus?

4. What time do you usually start to use the WLAN?

5. How long do you usually use the WLAN on campus?

6. Which campus do you usually use the on-campus WLAN?

- a) Mt. Albert Campus b) Waitakere Campus

7. Do you know where wireless zone are? How do you know?

- a) From Unitec's website b) From ask I.T.
c) "Wireless Zone" sign d) Other: _____

8. Which place do you usually use the WLANs?

- a) Library b) Hub
c) Café d) Graduate Centre
e) Other: _____

9. What do you use on-campus WLAN for?

- a) Surfing internet b) Shopping c) Research
d) Entertainment e) Chat f) Internet Game

g) Discussion h) E-learning i) Download

j) Other: _____

10. Where did you do these activities before using on-campus WLAN?

a) Computer lab b) Home c) Library

d) Internet Café e) Other: _____

11. What types of Internet connection are you currently using?

12. Are there any terms and conditions to connect to campus WLAN? If yes, what are they?

13. Are there any restrictions to connect to campus WLAN? If yes, what are they:

a) Time b) Current course you are taking

c) Place d) Student account

e) Other: _____

14. What is the connection speed of the WLANs?

15. How would you rate the on-campus WLANs:

Very poor Poor OK Good Very good

16. Would you like to be involved in an in-depth interview?

a) Yes b) No

Appendix B: Interview Questions

1. What is the convenience of using WLANs on campus?

2. What is the inconvenience of using WLANs on campus?

3. Can WLANs be used in classrooms? If so, for what purpose?

4. Do you think that using WLAN in classrooms is helpful for your study? If so, how did using WLAN help you?

5. Are there any difficulties for you to connect to on-campus WLAN? If yes, please explain.

6. Are there any activities affected by using on-campus WLAN? If yes, please explain.

7. Do you think the on-campus WLAN services should be enhanced so that it would help you more on your study? Why?

8. Do you have any suggestions on how to enhance the WLAN service be better?

Appendix C: Information Sheet

Hello!

I am a Master of Computing student at Unitec. My last course is a research paper. I am doing the research to identify the impacts of campus Wireless Local Area Networks (WLANs) on students.

The research will be conducted by Yue Han, and will be under supervision from Logan Muller, UNITEC New Zealand (principal supervisor) and Sam Kolahi (associate supervisor). The research proposal had been approved by the Unitec Research Ethics Committee. The research will take place over an 11 months period from September 2007 to August 2008.

Data collection will be through questionnaire and observation of students who are using campus WLAN, and the analysis of documentation, articles, reports, journals, books, and other related information.

Submission of a completed questionnaire will be taken as demonstration of consent.

Your name will not be recorded and any other information that may identify you will be kept completely confidential. All information collected from you will be stored on a password protected file and the only access to your information is by the researcher and my supervisors.

Thank you!

Appendix D: Consent Form

Consent Form

The purpose of this research is to identify the impacts of campus Wireless Local Area Networks (WLANs) on students. The subjects of the research are students who are using wireless network at both Mt. Albert campus and Waitakere campus of UNITEC New Zealand. The purpose of the research is to identify how the availability of Wireless Local Area Networks (WLANs) on campus had affected students. The technical issues around wireless network may be involved.

The research is being done by Yue Han and will be supervised by Logan Muller (principal supervisor) and Sam Kolahi (associate supervisor) from UNITEC New Zealand.

Name of Participant:

I have seen the Information Sheet dated () for students taking part in the wireless network on campus research project. I have had the opportunity to read the contents of the Information Sheet and to discuss the project with Yue Han. I am satisfied with the explanations I have been given. I understand that taking part in this project is voluntary (my choice) and that I may withdraw from the project at any time up to final draft stage. I understand that my participation in this project is confidential and that no material that could identify me will be used in any reports on this project.

I have had enough time to consider whether I want to take part.

I know whom to contact if I have any questions or concerns about the project.

The principal researcher for this research project is Yue Han – email: tianmibaobei@hotmail.com, phone 09-8261336 (home), 021-1795764 (cell).

Signature:(participant)

Date:

The participant should retain a copy of this consent form.

UREC REGISTRATION NUMBER: (2007.xxx)

This study had been approved by the UNITEC Research Ethics Committee from (4 October 2007) to (3 October 2008). If you have any complaints or reservations about the ethical conduct of this research, you may contact the Committee through the UREC Secretary (ph: 09 815-4321 ext 7248). Any issues you raise will be treated in confidence and investigated fully, and you will be informed of the outcome.

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