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WIRELESS TECHNOLOGY DIFFUSION WITHIN HIGHER EDUCATION INSTITUTIONS: DETERMINING THE LEVELS OF STUDENT SATISFACTION

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ABSTRACT
As wireless technology advances and learner behaviors evolve, internet access has become easy, convenient and quite popular for students at the University of Botswana (UB) campus. The use of portable and light laptops and notebooks, connected onto one large wireless local area network (WLAN), has mushroomed in, among other places, lecture rooms, corridors, tree shades, car parks and students' hostels. The connection to the internet in a wireless technology environment does not require Ethernet connection and almost everywhere within the campus, there is a strong enough signal which is publicly accessible. This article analyses the levels of students' satisfaction in a computing environment in which access to the Internet does not require computers with Ethernet connection; an environment that is almost unrestricted, unlike the computer laboratories that need to be opened every morning for connectivity to commence. 40 constructs based on wireless advantages and disadvantages have been built from literature to become the basis of the research instrument. A total of 109 questionnaires were administered randomly to students working on their laptops in the university environment. The results of the study show that: (1) Students are largely satisfied with the wireless network technology because of the convenience it provides regarding, among others, the speed of accessibility it provides and the quality of the signal/service; (2) Although students still regard the traditional computer laboratories dotted around the campus as still essential, they feel that the same laboratories have become inconvenient working places as they are always fully booked and sometimes monopolized by a few; (3) Students expressed a desire to see the wireless technology scaled up so as to provide, among others, more power, more security, more bandwidth and more speed.

KEYWORDS – University of Botswana, Wireless Technology, Laptops, Ethernet Connection, WLAN

1   INTRODUCTION

Wireless technology (WT) continues to rapidly change and is also playing an increasingly significant role in the lives of millions, if not billions, of people throughout the world in terms of connectivity which in turn results in effective and efficient information sharing. It continues to extend the boundaries of higher education into an *"anytime/anywhere"* experience (Wentzel at al., 2005)

The University of Botswana (UB) has recently introduced wireless technology at its main campuses resulting in the provision of convenient computing to the student population. For many years, connectivity has only been possible in the traditional computer laboratories with computers connected using Ethernet cables and firmly fixed using chains and other security gadgets. With emerging technologies changing the whole computing arena worldwide, the UB has also joined the race for WT. With this rapid development and diffusion of technology, organizations are bracing themselves for the change and digital future, ensuring that they keep abreast with rapid developments in information technology that can go a long way to separate the followers from the leaders. Therefore, this study investigates whether the students of the UB are satisfied or not with the new technology being introduced.

1.1 Objectives

The main aim of this study is to investigate the levels of student satisfaction in computing experiences, in light of the introduction of wireless technology connectivity that has been introduced in the University of Botswana (UB) campuses. Specifically, the study will solicit the opinions and feelings of students regarding quality of service provided by the wireless connectivity; flexibility of options at hand; acquisition, speed and retention of connectivity, as well as convenience provided by this new development. Further, the study aims to gauge the feelings of students with regard to the wireless technology platform in comparison with the traditional computer laboratory set up. Lastly, the article also targets to advise the UB management on scaling up the current wireless technology setup because of the convenience that it provides.

It is hoped that the launching of this technology would herald the beginning of a new era in which serious research is not only confined to lecturers but to the entire university population as well.

1.2 Limitations

A study of this nature requires the participation of as many subjects as possible so as to obtain a true and representative

result. In this vein, the University of Botswana top management, who are both the creators and funders of such a huge project, must take the initiative to gauge the students' feeling through a web-based survey. Web-based surveys have the ability to reach a wider population. The result thereof would be more accurate enough to inform policy on further development towards a better wireless technology platform. Regarding this study, a sample of 109 students would certainly not truly reflect the exact feelings of the whole students' population. However, we take solace from Jankowicz (1991) who suggests that even if a proportion of the respondents reply in a particular way, there is an assumption that the others would have replied identically. Therefore, the results drawn from the analysis of part of the respondents can be generalized for the wider university students' population. Again, this kind of study would rather be carried out as a longitudinal study as compared to a cross-sectional study. Longitudinal studies have been found to be more effective as they can be used to test the validity of a result on at least two occasions considering the before and after treatment stages, Sekaran and Bougie (2010).

1.3 Hypotheses

H_1: Students are largely satisfied with the wireless technology at the University campus than the traditional computer laboratories.

2. LITERATURE REVIEW

Discussions concerning emerging technologies continue to dominate the world. One of these technologies, although it has matured, is wireless technology which continues to grow phenomenally in, among others, commercial parks, shopping centers, colleges, universities, schools and homes. Millions of people around the universe use the internet for various reasons that include communication through email, news sharing online, shopping online, research, games and even learning. Although Ethernet connection can serve the purpose, it may not prove to be as versatile and convenient in many instances if the transactions to be carried out are crucial on the fly and time is of the essence. To always keep connected, wireless technology has become very useful in many people's lives as there is no need for cable connections and even electricity as many laptops are now equipped with long-life batteries. To set this study into proper perspective, a discussion of literature on the subject of wireless technology follows.

2.1 Definition of Wireless Technology

Wireless Technology (WT) is a network that uses radio waves instead of Ethernet cables for transmission of data packets to and from the computer. There is no "plugging" of a cable to the computer and the "wall". Likening networks growth to weed, Bansal et al (2010: 67) have coined a definition as follows: "*A wireless communication is a flexible data communication system implemented as an extension to or as an alternative for wired communication*".

They also elaborate on the fact that wireless technology uses some standards (for local area networks) and one such standard which is predominantly used for local-area networks has also been defined by Greenwood (2003) as the IEEE 802.11. IEEE is an abbreviation for *I*NSTITUTE OF *E*LECTRICAL AND *E*LECTRONICS *E*NGINEERS. These standards are used to "transmit and receive radio waves through the air medium" (Bansal et al, 2010:67).

The design of such a network, as noted by various authors, has been found to be simple. Thomas (2005), referencing Gast (2002), discusses a typical wireless LAN technology describing its components in a complete suite as shown in Fig 1 that include one or more wireless devices that are connected to each other in a "peer-to-peer manner or through access points, which in turn are connected to the backbone network providing wireless connectivity to the covered area" (Bansal, Gupta and Malhotra, 2010). These devices include, among others, a radio bridge device installed in convenient locations of buildings, connecting the bridges to the LAN using the standard Ethernet cabling, LANs linked in different buildings, roof-top mounted antenna in each building and deployment of wireless link in a few hours.

The architecture of this technology has also been extensively discussed by Papageorgiou (2003) who dealt much on wireless sensor networks. Other authors include Tilak et al (2002) (taxonomy of wireless micro-server network models), Estrin et al (1999) (next century challenges), Intanagonwiwat et al (2000) (robustness and scalability of sensor networks), Braginsky et al (2002) (rumor routing), Heinzelman et al (2000) and Ephremides (2002) (energy concerns in wireless networks) and Stajano et al (2001) (sensory issues). Early definitions by Leahy (2003) unravel the background of telecoms infrastructure; it is embedded within other structures and technologies, it is transparent in use and there is no reinvention, among others.
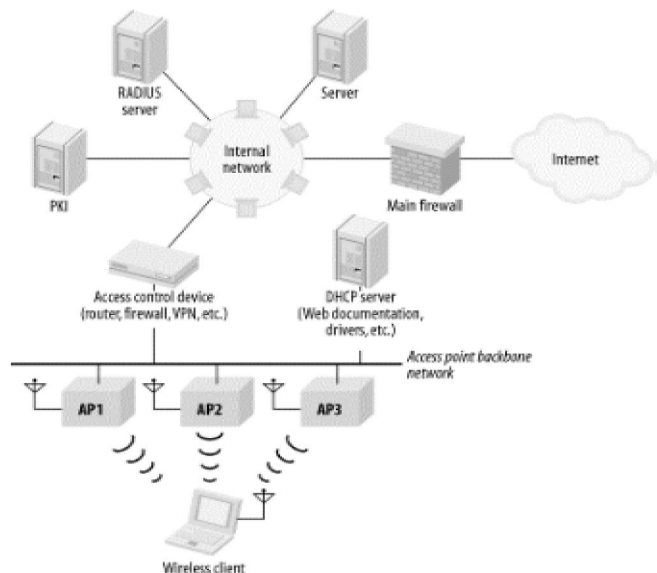
Fig 1: Standard Wireless LAN (Thomas, 2005)

2.2 Advantages of Wireless Technology

Students in any college setup are enterprising, both young and old. By their nature, they need challenges and one of the greatest challenges people can crave for is technology, more precisely wireless technology. Thomas (2005) suggests that universities are an attractive market for wireless LAN deployment because of the many advantages associated with it. The following few sections are dedicated to highlight some advantages.

2.2.1 Convenient Connection

One obvious advantage of WT is that connectivity is available from virtually any place within the boundaries of a corporate organization that owns the technology. The UB carries this advantage. Again Internet connection is free, reliable, convenient and continuous. There is no need for an Ethernet cable to connect computers to each other (cords no more). In his article entitled "No strings attached", Thomas (2005) suggests that "universities need to understand the many benefits as well as the lower costs for deployment that wireless LANs provide as compared to the conventional wired LAN" praising the 'cords no more' concept. The convenience is brought about by the fact that no cables are involved, at least on the part of the students.

2.2.2 Rapid Deployment

Rapid deployment is of prime importance in an environment (like a university campus) where work or assignment turn-around time is of the essence. In this regard, Thomas (2005) enumerates some advantages of this technology over fixed wired systems. The most notable ones are: rapid deployment is possible, connectivity on the fly, use of temporary or industrial locations and cost. The deployment of wireless technology hubs and switches is also easier than in wired solutions.Extending cables to new buildings with an establishment like a university is often a common problem. This is the case with the University of Botswana which is currently experiencing a phenomenal growth in terms of buildings on the main campus. This calls for deployment of Ethernet cabling which is sometimes difficult and may even result in the defacing of the new structures. It is in this light that deployment, as discussed by Thomas (2005), becomes better/faster in wireless technology than in an Ethernet cable environment.

2.2.3 Devices

Many more different devices, apart from laptops, can be connected onto the wireless network. Among others, cellular phones and handheld computers are examples in case.

2.2.4 Other benefits

Greenwood (2003) benchmarks a wireless network based on, among others priorities, low cost, greater decision making tool for management, speed, high performance, convenience, throughput and response time while Thomas (2005)

summarizes the benefits of wireless technology as mobility, improved productivity, flexibility, portability, ease of installation and cost/time savings. Bansal et al (2010) praise wireless technology regarding "*high-speed and high quality information exchange*" between devices. Other reported cases in which wireless technology has been observed to have generated benefits were reported in Cambodia where communities changed from an agricultural-based to an information economy (Fong, 2000). McKenzie (2001) identifies more benefits: ease of use, relaxed fit, strategic deployment, low profile, flexibility, cleanliness, convenience, simplicity and speed. Some successes have also been recorded in universities such as University of Dakota, Virginia Commonwealth University and Kansas State University (Kim et al., 2006). Liu (2007) has observed that wireless technology environments offer many educational possibilities that are not easily achieved in other learning environments.

2.3 Disadvantages of Wireless Technology

2.3.1 Class Disruption

Despite the upside, wireless technology also has some disadvantages associated with it. The most prevalent, from the experience of the researcher, is class disruption. Although Internet connectivity has helped students realize their learning and research potential, wireless technology has tended to disrupt class activities. Frequently, some students with laptops spend whole lecture periods surfing through, among other social web pages, facebook, twitter, youtube and Google.

2.3.2 Bandwidth

Basal et al (2010) notes that bandwidth in wireless LANs is limited as compared to that of 'wired LANs' due to air.

2.3.3 Security

Security is an issue in dealing with wireless technology. If the password that protects the network is known, hackers can temper with personal information.

2.3.4 Other Problems

Although wireless networks can be largely reliable, Thomas (2005) notes some problems that are associated with the technology. The most common one is the problem of blocked signals because of buildings and interference with radio frequencies since wireless LANs require what is referred to as a 'line-of-sight' which may be difficult to get in a congested area. Further, unlike Ethernet cables, wireless networks can have dead spots that can impact much on connection speeds. It is also argued that the weather can also play a major role in weakening the connection. Overall, although the difference in Internet connectivity speed is negligible, it is argued that wireless networks are usually slower than networks directly connected with an Ethernet cable.

2.4 Growth in Wireless Communication

The rapid and continued growth of wireless technology (WT) has made information accessible anywhere and this has been extensively discussed by, among others, Abdollahian (2010), Riha (2006), Thomas (2005), Rogers et al (2003) and Koprowski (2006).

This technology is a revelation to the world population as it continues to traverse through an unprecedented growth stage with no decline in sight, thereby aiding in effective and efficient information sharing. Thomas (2005) and Rogers et al (2003) note that wireless LANs have been in existence for a long time with the latter concluding that this technology is "*certainly the fastest growing segment of the communications industry*". In the same vein, Thomas (2005) has forecast a great leap in wireless technology across the Asia-Pacific and other regions and comments about a recent survey which showed that in the USA, "*seventy-seven percent of universities have a WLAN up and running*". Schornack et al (2000) have noted that the use of wireless technology has greatly expanded markets in business as well as the fact that the use of wireless technology (wireless mouse, LAN, keyboards, PDA) is gradually expanding. In a similar line of argument, Koprowski (2006) reports that "WT grew fastest amongst 25- to 39-year-old men, an encouraging development that adds to evidence elsewhere in the latest survey that 3G is now being considered by a much wider target group than teenagers who download music".

Further, Schornack et al (2000) quoting Menezes (2000), provide some statistics on market projections regarding wireless technology as he discusses, among others, wireless penetration levels in excess of 40%, growth rate in Internet connections of 80% and wireless lines globally exceeding wire lines. By 2005, it was expected that most Internet access would be via wireless technology rather than through the physical wire lines and personal computers (PC).

Countries have gained their competitive edge over others by engaging more in wireless technology systems. For instance, Leahy (2003) has lamented Estonia's WT rapid growth as having had a huge and positive impact on the country's economy resulting in it being able to compete effectively in the Euro zone as well as on the global market. Abdollahian (2010) stresses much on economic indicators that predict positive growth for this steadily-growing field of wireless technology. The indicators noted are the exponential growth in the numbers of, among others, careers as network security specialists, network administrators, network installers, network engineers, and network technicians. Further, Riha (2006) predicts that as "*wireless technologies evolve and interoperate, the practical application for healthcare providers and organizations grow exponentially*". This would provide, among others, increased access to patient data, decision-making tools, and error reduction systems.

A key finding from two research reports in 2004 "Cellular M2M: Generating Profit from the Business Opportunities" and "Wireless M2M and Telematics: Gaining Value in Vertical Markets", has indicated that "the use of new wireless technologies for machine to machine (M2M) communications will greatly improve and expand M2M business applications and create significant new revenue opportunities for cellular, WLAN, service providers and application developers".

The ARC Advisory Group Inc (2008) has also argued that "the market for wireless devices and equipment in process manufacturing is projected to grow at 32 percent per year, to more than $1.1 billion in 2012". These and other arguments have proved that wireless technology is poised to undergo a rapid growth that will improve the global economy.

Wentzel et al (2005) compare the two cases of Netherlands and the United States concluding that both countries are enhancing their technical infrastructures by adding greater bandwidth and service capabilities. For their part, Kim et al (2006) describe how an increasing number of colleges and universities are adopting mobile wireless technologies to aid them in teaching and learning. Citing many private universities in the United States, they note that "many major buildings and places such as libraries, lecture halls, cafeterias and research centers on college and university campuses are already equipped to provide wireless access".

2.5 The UB wireless technology structure

The wireless technology structure of the University of Botswana can be described briefly under the headings: hardware setup, security, bandwidth and cost.

2.5.1 Hardware set up, software updates and radius

The wireless access points are centrally managed by a controller. Software for the access points is stored on the controller and pushed to the access points. An update performed on the controller is enough to effect changes on the entire network.

2.5.2 Security

The University is using CISCO network admission techniques to control access to the network. Currently, this has only been implemented on the students' service set identifier (SSID) and will be implemented on the other SSIDs in the near future. The SSID (a 32-character unique identifier attached to the header of packets sent over a wireless LAN (WLAN)), also referred to as a network name, differentiates one WLAN from another, so all access points and all devices attempting to connect to a specific WLAN must employ the same SSID, otherwise access will be denied. For a student to gain access to the wireless network, they should have a valid login account on the student domain. The idea is to admit only client personal computers

(PCs) that are certified to have, among others, antivirus software and updates.

2.5.3 Bandwidth

An important feature that makes a wireless network the best choice for students is bandwidth which, in computer networks, is often used as a synonym for data transfer rate - the amount of data that can be carried from one point to another in a given time period (usually a second). The data transfer rate or bandwidth for the UB system from the access point to the network is 1000 megabits per second (MBPS) and a client can connect to the wireless network at a maximum transfer rate of 300 MBPS.

2.5.4 Cost

For all University of Botswana users of the internet, wireless access is free.

3. METHODOLOGY

This study is largely quantitative and partly qualitative. It uses a questionnaire (Appendix A) to investigate the levels of satisfaction in students regarding several constructs about wireless technology in the University of Botswana campus. Questionnaires were administered to students who were working on their laptops in a wireless environment throughout the university. The selection of the sample is purely random as any student surfing on his/her laptop has an equal chance of being selected as a subject. To make the sample a bit more representative, questionnaires were administered in almost all the major assembly points of the university where the students meet regularly. The areas include the Faculty of Business (Block 245), the new students centre (Block 159), the area around the library and in various cafeteria around the campus. Convenience sampling, however, was also applied where most subjects targeted were from the Faculty of Business block where the research is being conducted from.

The questionnaire has two sections A and B.

Section A: This section contained demographics (gender, age group, programme of study and academic year).

Section B: This section contained 40 constructs in which respondents are expected to state their level of satisfaction regarding each construct. The level of satisfaction is weighted on a four-point Likert scale (1=not at all satisfied, 2=somewhat satisfied, 3=moderately satisfied and 4=very satisfied). The measurement for satisfaction was carried out in areas such as, among others, speed and friendliness of access, convenience of wireless technology as compared to Ethernet wired PCs, flexibility and connectivity. An example of a statement testing the level of satisfaction is, "How satisfied are you about speed of access?". Still in this section, three extra qualitative questions try to probe the overall feeling of the respondent towards wireless technology, computer laboratory systems and the way forward. The respondents have a chance to explain why they would go for one and not for the other and what the university should do to improve wireless technology accessibility.

Also, the data (40 constructs) was subjected to Principal Components Analysis (PCA) extraction method. The rotation method used was Varimax with Kaizer Normalization, the results of which would be dealt with later in this article.

The total sample representation of the students who responded to the questionnaire is depicted in Table I in which the grouping is according to gender and within academic year.

Table I Demographics: Male/Female by Academic year

		Gender		Total
		Male	**Female**	
first year	Count	12	27	39
	% within academic year	30.8%	69.2%	100.0%
second year	Count	5	12	17
	% within academic year	29.4%	70.6%	100.0%
third year	Count	8	16	24
	% within academic year	33.3%	66.7%	100.0%
fourth year	Count	8	21	29
	% within academic year	27.6%	72.4%	100.0%
Total	**Count**	**33**	**76**	**109**
	% within academic year	**30.3%**	**69.7%**	**100.0%**

Another representation of the sample was done according to gender, within programme of study as depicted in Table II.

A total of 14 programmes are represented in the sample targeted.

Table II- Demographics: Male/Female by Academic year

			Gender		Total
			Male	**Female**	
programme of study	**BAC280**	Count	8	18	26
		% within programme of study	30.8%	69.2%	100.0%
	BAC290	Count	0	1	1
		% within programme of study	.0%	100.0%	100.0%
	BAF200	Count	0	4	4
		% within programme of study	.0%	100.0%	100.0%
	BAH220	Count	0	1	1
		% within programme of study	.0%	100.0%	100.0%
	BAS240	Count	1	2	3
		% within programme of study	33.3%	66.7%	100.0%
	BBA285	Count	1	7	8
		% within programme of study	12.5%	87.5%	100.0%
	BBA290	Count	7	32	39
		% within programme of study	17.9%	82.1%	100.0%
	BBA295	Count	4	6	10
		% within programme of study	40.0%	60.0%	100.0%
	BED270	Count	2	0	2
		% within programme of study	100.0%	.0%	100.0%
	BIS200	Count	3	2	5
		% within programme of study	60.0%	40.0%	100.0%
	BIS2OO	Count	1	0	1
		% within programme of study	100.0%	.0%	100.0%
	BSC230	Count	3	0	3
		% within programme of study	100.0%	.0%	100.0%
	LLB260	Count	1	0	1
		% within programme of study	100.0%	.0%	100.0%
	PSY240	Count	2	3	5
		% within programme of study	40.0%	60.0%	100.0%
Total		**Count**	**33**	**76**	**109**
		% within programme of study	**30.3%**	**69.7%**	**100.0%**

4. FINDINGS

This study aims to investigate the levels of satisfaction among students using wireless technology at the University of Botswana. Specific constructs addressed issues of accessibility, connectivity, cost, quality of service in terms of bandwidth, just to name a few. Preliminary findings on the fly show a totally satisfied student population. The results show that BBA290 had the highest number of respondents (39 or 35.8%) followed by BAC280 with 26 (23.9%). The lowest count of 1 respondent only per programme was recorded by BAC290, BAH220, BIS200 and PSY240. This is so as most of the questionnaires were

administered in the Faculty of Business Block where BAC280 and BBA290 students have the majority of their lessons conducted.

4.1 The Mean and Standard Deviation Measures analyses

Another finding, as depicted in Table I, is that females constitute a larger number (76, 69.7%) than their male counterparts (33, 30.3%).

Table III- Descriptive Statistics: Mean and Standard Deviation

Construct	Mean	SD	Construct	Mean	SD
speed of access	2.81	.844	setup of laboratory	2.44	.855
friendliness of access	2.76	.961	support of the laboratory	2.28	.829
continuity of connectivity	2.60	.992	booking in the laboratory	1.96	.892
time to complete assignments	2.85	.891	laptop convenience	3.23	.889
use of laptop as opposed to lab	3.30	.701	internet connectivity in lab	2.92	.904
use of laboratory PC	2.06	.951	internet connection on wireless	2.94	.895
IT support on connecting and passwords	2.61	1.139	password change on wireless	2.91	1.032
it staff friendliness	2.45	.976	your laptop security	2.45	1.014
it support available	2.46	.977	quality of wireless signal	2.50	.939
laptop security	2.47	1.050	quality of connection in wireless	2.57	.956
download speeds	2.45	.986	wireless flexibility	2.69	.900
Google search speeds	3.31	.729	convenience of wireless technology	2.59	.983
your it skills improvement	3.05	.886	no Ethernet cable	2.82	1.029
knowledge of anti-virus software	2.58	.965	access to entertainment	2.50	1.102
wireless technology knowledge	2.76	.902	access to internet shopping	2.32	1.088
access from anywhere in campus	1.98	1.054	access to quick email checks	3.28	.826
your privacy on wireless	2.69	.952	access to news update	3.12	.889
laptop portability	2.79	1.046	access to UB news	2.91	.948
increase in productivity	3.11	.750	wireless continuous connectivity	2.66	.915
quick response time on wireless	2.43	1.022	broader bandwidth	2.36	.800

**SD=Standard Deviation

Table III shows a descriptive summary (using mean and standard deviation) of the level of students' satisfaction regarding some aspects of wireless technology. From the depiction, it is clear that '*Google search speeds*' (Mean=3.31, SD=0.729), '*use of laptop as opposed to lab*' (Mean=3.30, SD=0.701), '*access to quick email checks*' (Mean=3.28, SD=0.826), '*laptop convenience*' (Mean=3.23, SD=0.889), '*increase in productivity*' (Mean=3.11,

SD=0.750) and '*skills improvement*' (Mean=3.05, SD=0.886) have been rated the highest in terms of satisfaction. A mean between 3 and 4 would indicate that respondents are 'moderately' to 'very satisfied' with the wireless technology.

The level of satisfaction was low in the following constructs: '*access from anywhere in campus*' (Mean=1.98, SD=1.054), '*booking in the laboratory*' (Mean=1.96, SD=0.892), '*use of*

laboratory PC' (Mean=2.06, SD=0.951), 'ITstaff friendliness' (Mean=2.45, SD=0.976), 'broader bandwidth' (Mean=2.36, SD=0.800), 'setup of computer laboratory' (Mean=2.44, SD=0.855) and 'support of the computer laboratory' (Mean=2.28, SD=0.829). Of interest in this finding is the issue of the computer laboratories in the university faculties. This may be explained as an indication that students are not satisfied with the current laboratory set up which is characterized by, among others, fixed 'wired' personal computers (PCs), IT staff who may not be that helpful and booking for laboratory use which is largely inconvenient as it delays their work. Still on the issue of booking, students have indicated that the process is not friendly citing reasons such as (a) some students monopolize workstations, (b) the support given to these laboratories is not adequate, (c) laboratories are locked most of the time especially during vacations and (d) also that the bandwidth is

not broad enough. The broadband issue is however a contentious issue as most respondents in this study may not fully understand the meaning of bandwidth. Most of the respondents may have simply argued about this phenomenon because many a time they are engaged in downloading huge amounts of data in the form of streaming videos, a process that takes so much time and hence the issue of bandwidth arises.

Using the PCA, two main components were distinctly identified as everything to do with the convenience provided by the 'new' technology versus the inconvenient traditional computer laboratory setups. The two were conveniently named as follows:

(1) Wireless Connectivity
(2) Laboratory Connectivity

Using the rotated component matrix and a cut-off of 0.4, 13 constructs were picked that contributed to the 'Wireless Convenience' principal component as shown in Table IV.

Table IV-Principal Component 1: Wireless Connectivity Constructs

Construct	Construct	Construct
Speed of access	Friendliness of access	Continuity of connectivity
Laptop use versus laboratory	Laptop convenience	Internet connection on the laptop
Quality of signal	Wireless flexibility	Wireless convenience
No Ethernet cables	More access anytime from anywhere	Laptop portability
Increase in productivity		

The other principal component (laboratory connectivity) was yielded as a result of 8 constructs indicated in Table V.

Table V- Principal Component 2: Laboratory Connectivity Constructs

Construct	Construct	Construct
IT support on connecting and passwords	IT support available	Use of laboratory PC
IT staff friendliness	setup of laboratory	support of the laboratory
booking in the laboratory	Internet connectivity in lab	

The two identified components (wireless technology and computer laboratory) had been subjected to a couple of questions (one close- and another open-ended one) at the end of the questionnaire. The first question read: "Which technology setup would you recommend for the UB?" Out of the 109 respondents, 87 (80%) chose the wireless route while only 22 (20%) preferred the traditional laboratory Ethernet wired personal computers. The second question probed why they had made their choice to which (22 or

20%) mainly stated that, although they would have preferred wireless technology because of the convenience that it provides, they could not afford to own a laptop which is a major requirement for wireless technology. The 87 who preferred wireless technology argued on the following general points:

1. Wireless technology is convenient because there are no cables involved, a result consistent with the findings of Thomas (2005);

2. Wireless technology is fast and friendly and that there is no need for 'waiting' for connectivity because the laboratory is still locked; and
3. Support of the computer laboratories is largely poor to non-existent.

Based on the above points, it is evident that students prefer wireless technology to 'wired' PCs.

5. DISCUSSION

The main aim of this study was to investigate the levels of satisfaction in students' computing experiences in light of the introduction of wireless technology connectivity at the University of Botswana. According to the results of this study, there is a general preference for wireless technology to the computer laboratory. The study has also shown that students are largely satisfied with the technology, arguing on the issues of flexibility of options at hand; acquisition, speed and retention of connectivity as well as convenience provided by this new development. The claim that students are largely satisfied with wireless technology in the campus cannot be overemphasized. Most students generally suggested that the University of Botswana should scale up the wireless technology infrastructure. Again, impromptu interviews with respondents and the general public have also shown that wireless technology, rather than the computer laboratories, is needed on a much wider scale with more bandwidth.

6. CONCLUSION

Wireless technology defines the state of an organization's currency in terms of current and future development. The University has finally come of age by introducing this novel technology. This has certainly opened avenues for more research to be carried out by all in the university. Students will slowly gain confidence as they have more capacity and time to look for literature that is relevant to their areas of research. Some of the suggestions that can be tried by the University of Botswana are:

1. The wireless access project should be speeded up to have more power and more capacity to handle the massive data downloads required for intensive research.
2. A 'rent-a-laptop' can be introduced as a project in itself to ensure that the technology reaches the wider population of the university.

There is so much research going on concerning wireless technology. Future research should be carried out in conjunction with the highest office in the university to make the sure that the results are used to feed the policy regarding the scaling up of the wireless technology.

REFERENCES

1. Abdollahian, H. (2010) Wireless technology growth creates demand for skilled workers. Retrieved from http://www.cleveland.com/employment/plaindealer/index.ssf/2010/09/wireless_technology_growth_creates_demand_for_skilled_workers.html

2. ARC Advisory Group Inc. Dedham, Mass. (2008).

3. Bansal, R. K., Gupta, V. and Malhotra, R. (2010) Performance Analysis of Wired and Wireless LAN Using Soft Computing Techniques- A Review. Vol. 10, No. 8, pp. 67-71.

4. Braginsky, D., and Estrin, D. (2002) Rumor routing algorithm for sensor networks. In *ACM International Workshop on Wireless Sensor Networks and Applications*, 2002.

5. Cellular M2M: Generating Profit from the Business Opportunities and Wireless M2M and Telematics: Gaining Value in Vertical Markets (2004).

6. Ephremides, A. (2002) Energy concerns in wireless networks. *IEEE Wireless Communications, Aug 2002.* Wireless Communications, IEEE. Vol. 9, No. 4, pp. 48 – 59.

7. Estrin, D., Govindan, R., Heidemann, J. and Kumar, S. (1999) Next century challenges: Scalable Coordination in Sensor Networks. Retrieved from http://citeseer.ist.psu.edu/viewdoc/summary?doi=10.1.1.110.6935

8. Fong, M. W. L. (2009) Digital Divide: The case of developing countries. *Issues in informing science and Information Technology.* Vol. 6, 2009.

9. Gast, M. S. (2002) 802.11 Wireless networks: the definitive guide. Sebastopol, CA: O'Reilly.

10. Greenwood, G. (2003) Benchmarking a Wireless Network. Masters Thesis, Jacksonville State University. Retrieved on 10 Mar. 2011 from http://mcis.jsu.edu/studio/LiteratureReview.doc

11. Heinzelman, W. R., Chandrakasan, A. and Balakrishnan, H. (2000). Energy-efficient communication protocol for wireless microsensor networks. Retrieved on 10 Mar. 2011 from http://citeseer.ist.psu.edu/viewdoc/summary?doi=10.1.1.112.3914

12. Hu, R. Q., Qian, Y., Chen, H. and Jamalipour, A. (2011) Recent progress in machine-to-machine communications. IEEE Communications Magazine, April 2011, pp. 24-26. Retrieved on 10 Sep. 2011 from http://dl.comsoc.org/livepubs//ci1/public/2011/apr/pdf/ciguest_qian.pdf

12. Intanagonwiwat, C., Govindan, R., Estrin, D., Heidemann, J., Silva, F. (2000) Directed Diffusion for Wireless Sensor Networking. IEEE/ACM Transactions on Networking, Volume 11, Number 1, pp. 2-16.

13. Jankowicz, A.D. (1991) Business research projects for students (1st edition). London & New York: Chapman & Hall.

14. Kim, S. H., Mims, C., & Holmes, K. P. (2006) An introduction to current trends and benefits of mobile wireless technology use in higher education. *AACE Journal, 14(1), 77-100.*

15. Koprowski G. J. (2006) Third-Generation Wireless Technology Generates Massive Global Growth. TechNewsWorld. Retrieved on 10 Mar. 2011 from http://www.technewsworld.com/story/51493.html

16. Leahy, K. (2003) Literature Review. Communication Infrastructure and Wireless Communication in Estonia. *Journal of Informing Science*, pp. 1275-1283.

17. Liu, T. C. (2007) Teaching in a wireless learning environment: A case study. *Educational Technology & Society, 10(1), 107-123.*

18. McKenzie, J. (2001) The unwired classroom: Wireless Computers come of age. *Educational Technology 10(4).*

19. Menezes, J. (2000), "Web brings 'immense power' to wireless world", Enterprise Computing, (April 28). Computing Canada Institute for Econometric Research

20. Papageorgiou, P. (2003) Literature Survey on Wireless Sensor Networks. *IEEE Communications*, pp.1-15

21. Riha C. (2006) Growth of wireless technology in healthcare institutions. Biomedical Instrument Technology. 2006; Supplement: 43-5.

22. Rogers, G. and Edwards, J (2003) Introduction to wireless technology. Upper Saddle River, NJ: Prentice Hall.

23. Schornack, G. R., and Beck, C. E. (2000) Wireless Technologies for Marketing And Management Professionals. *Journal of Applied Business Research* Vol. 20, No. 4, pp. 1-10.

24. Sekaran, U., and Bougie, R. (2010) Research Methods for Business: A skill Building Approach. 5th Edition.

25. Stajano, F. (2001) The Resurrecting Duckling. What Next? *Lecture Notes in Computer Science*, 2133:204.

26. Tilak, S., N.B., Ghazaleh, A. and Heinzelman, W. (2002) A Taxonomy of Wireless Micro-Sensor Network Models. *ACM SIGMOBILE Mobile Computing and Communications Review*, Volume 6, Number2, April 2002.

27. Thomas, E. C. (2005) No strings attached: The Benefits of Choosing a Wireless LAN for Today's for Today's University. *Journal of Applied Business Research (JABR)*, Vol. 20, No 4.

28. Wentzel, P., van Lammeren, R., Molendijk, M., de Bruin, S, & Wagtendonk, A. (2005) Using Mobile Technology to Enhance Students' Educational Experiences. *Case Study from the EDUCAUSE Center for Applied Research.*

Appendix A: QUESTIONNAIRE

<u>WIRELESS TECHNOLOGY DIFFUSION –A WELCOME DEVELOPMENT</u>

Please complete this easy questionnaire in five minutes. The questionnaire is about your experiences with the wireless technologies in the campus.

** The answers that you give will be used for this study only and would be treated with the utmost confidentiality and anonymity.

<u>SECTION A:</u> DEMOGRAPHICS

Please tick (**X**) appropriate box.

State your gender:

Female		Male	

Which Age group do you belong to?

16 to 20 years		21 to 25 years		over 25 years	

Programme of Study:

BBA295, BBA290, BAC280, BIS200, etc

Academic Year:	

e.g**. 1, 2, 3…**

SECTION B: Wireless Connectivity Project
 (**1**=NOT AT ALL SATISFIED; **2**= SOMEWHAT SATISFIED; **3** =MODERATELY SATISFIED; **4**= VERY SATISFIED)
Using (**X**), Indicate your level of **SATISFACTION** on each of the following:

HOW SATIFIED ARE YOU ABOUT…

#		1	2	3	4
1	Speed of access	1	2	3	4
2	Friendliness of access	1	2	3	4
3	Continuity of connectivity (no cut off)	1	2	3	4
4	Turnaround time on assignments and school work	1	2	3	4
5	Use of laptop	1	2	3	4
6	Use computer laboratory	1	2	3	4
7	Passwords to connect	1	2	3	4
8	IT staff friendliness	1	2	3	4
9	IT staff support	1	2	3	4
10	Security on your laptop	1	2	3	4
11	Wireless Technology download speeds	1	2	3	4
12	Google search from laptop	1	2	3	4
13	Improvement of IT skills in you	1	2	3	4
14	Knowledge about Anti-virus software	1	2	3	4
15	Knowledge of wireless technology	1	2	3	4
16	Internet access from anywhere	1	2	3	4
17	Privacy	1	2	3	4
18	Setup of computer laboratory	1	2	3	4
19	Support of the computer laboratory	1	2	3	4
20	Booking in the computer laboratory	1	2	3	4
21	Laptop convenience	1	2	3	4
22	Internet connectivity in computer laboratory	1	2	3	4
23	Internet connectivity on wireless	1	2	3	4
24	Changing passwords	1	2	3	4
25	Your laptop security	1	2	3	4
26	Quality of wireless signal	1	2	3	4
27	Quality of connectivity	1	2	3	4
28	Flexibility of wireless technology	1	2	3	4
29	Convenience of access, no hassles	1	2	3	4
30	No use of Ethernet cable	1	2	3	4
31	Entertainment online	1	2	3	4
32	Shopping online	1	2	3	4
33	Email checking	1	2	3	4
34	Regular news update	1	2	3	4
35	UB announcements	1	2	3	4
36	Continuous connectivity	1	2	3	4
37	Broader bandwidth	1	2	3	4
38	Response time: skype, teleconferencing, emails…	1	2	3	4
39	Laptop portability (light weight)	1	2	3	4
40	Productivity	1	2	3	4

Finally: Using (X),

	Wireless	Laboratory
Which technology setup would you recommend for the UB?		

Explain briefly why you made the above choice:
What would you suggest the University must do to improve its wireless technology infrastructure?