VITA

Hari N. Kuchibhotla

EDUCATION

2012	Indiana State University, Terre Haute, Indiana Ph. D. in Technology Management, Digital Communication Systems Specialization
2005	Campbell University, Buies Creek, North Carolina Master of Business Administration
1996	Birla Institute of Technology, Mesra, Ranchi, India M.S. in Electronics and Communication Engineering
1992	Nagarjuna University, Andhra Pradesh, India B.S. in Electronics and Communication Engineering

PROFESSIONAL EXPERIENCE

2010-Present	EarthLink Inc., Raleigh, North Carolina Senior Datawarehouse Architect
2005-2010	Credit Suisse, Research Triangle Park, North Carolina Assistant Vice President – Information Technology
2000-2005	Analysts International Inc., Morrisville, North Carolina Senior Database Engineer
1998-2000	Mastech Systems Inc., Pittsburgh, Pennsylvania, Sr. Software Engineer
1996-1998	Nucleus Software Ltd., Mumbai, India, Software Consultant
1992-1994	Kakatiya Engineering college, Andhra Pradesh, India, Lecturer in Electronics and Communication Engineering Department

PUBLICATIONS

Kuchibhotla, H. N., Dunn, D., & Brown, D. (2009, March 15-17). *Data integration issues in IT organizations and a need to map different data formats to store them in relational databases.* 41st Southeastern Symposium on Systems Theory, Tullahoma, TN.

THE STUDY OF COLLECTIVE ACTIONS IN A UNIVERSITY ANCHORED COMMUNITY WIRELESS NETWORK

A Dissertation

Presented to

The College of Graduate and Professional Studies

College of Technology

Indiana State University

Terre Haute, Indiana

In Partial Fulfillment

of the Requirements for the Degree

Doctor of Philosophy in Technology Management

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by

Hari N. Kuchibhotla

December 2012

Keywords: Technology, Management, Technology Management, Wireless, Communications

COMMITTEE MEMBERS

Committee Chair: Dewayne Brown, Ph.D.

Professor of Computer Systems Technology

North Carolina A&T State University

Committee Member: Robert English, Ed.D.

Associate Dean and Professor of Electronics and Computer Technology

Indiana State University

Committee Member: Qing-An Zeng, Ph.D.

Assistant Professor of Computer Systems Technology

North Carolina A&T State University

Committee Member: Cynthia Thompson, Ph.D.

Professor of Graphics Communication Systems

North Carolina A&T State University

ABSTRACT

The emergence of wireless devices and the ease in setting up wireless devices has created opportunities for various entities, and in particular to universities, by partnering with their local communities in the form of a university anchored community wireless network. This provides opportunities for students to be part of the community-based initiatives, and universities can use the network as a source to fund some of its research. The main issue with university anchored community wireless is not technical but social in that student involvement is crucial and their contributions are necessary. This study employed empirical research methods on participants to understand the factors that influence the student participation and its significance on the collective actions. This involved analyzing five distinctive elements that were essential in understanding the collective actions, namely behavioral intention, attitude towards technology, facilitating conditions, impediments, and student participation. The research results revealed that the students expressed interest in participation, facilitating conditions, followed by attitude towards technology, then behavioral intention as the most important factors, whereas impediments was statistically insignificant for them. The research results also revealed that the majority of the participants were interested in being part of the community wireless networks and almost all the participants expressed their intention to contribute to the success of this initiative.

ACKNOWLEDGMENTS

Despite the fact that only my name is on the front page, there were several individuals who provided valuable assistance and support to me on this dissertation.

I would like to thank each of the members of my committee, Dr. Robert English, Dr. Qing-An Zeng, and Dr. Cynthia Thompson, for their time and energy in providing input and challenging me to think beyond my comfort zone. I also want to thank and acknowledge Dr. George Maughan for his valuable assistance.

Special recognition and thanks goes to my committee chairperson, Dr. Dewayne Brown, who was always there to provide guidance, direction, and support. It was truly a pleasure to learn from him.

Most importantly, I would like to thank my parents, my wife Jyosthna, my daughter Sravya, my sons Bhargav and Pranav, my brother, and my sisters. My happiness, success, intelligence, and all my knowledge are the products of their love, understanding, and support.

A prayer of thanks goes to my creator and Lord, who gave me the strength to complete this esteemed goal in my life.

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CHAPTER 1

INTRODUCTION

Community Wireless Network (CWN) is a socio-technical network funded, designed, developed, implemented, and maintained by the community members in which available resources are utilized to the maximum extent in building a common wireless communication infrastructure. The primary concern with CWN is not related to technical but is social because communities need the participation of individual contributors and other CWN members who are ready to share their available resources.

Abdelaal and Ali (2007) proposed CWN business models in which social settings and the associated issues were considered. CWNs were classified as ad-supported, community, education centric, location hosting, public-utility, and private-public partnership. Various components of these models are grouped as, value-based offerings, targeted customers, business partnerships, infrastructure management, and other financial aspects. This classification was analyzed to link business models to its impact on society.

Bina and Giaglis (2006) proposed a motivation effort model for understanding the collective actions in the case of pure communities. According to this motivation effort model, participation in a CWN is influenced by extrinsic, intrinsic, and obligation motivations and is negated by the costs.

Abdelaal and Ali (2008) proposed a two-graph model to describe and analyze CWN, in which CWN was treated as two graphs—a social graph and a wireless graph. The in degree and out degree elements were then used to measure economic and social impacts of CWNs. The attributes and the interactions between the components of these two graphs indicated the various aspects of any network. The in degree was proposed to outline the benefits each CWN stakeholder could receive, and the out degree measure was used to identify the contributions of each stakeholder. On the other hand, the socio metric status was used for determining which business model would fit for a specific community. The deficiency facing this model was how to aggregate various tangible and intangible benefits and the contributions of different CWN contributors.

Giovanni and Anna (2010) proposed a qualitative approach for hybrid communities. According to this model, participation took place in hybrid communities by a combination of intrinsic motivation, social, psychological, and tangible benefits. Participation was hindered by member involvement, costs, and various other concerns. In hybrid communities, extrinsic motivations—social, tangible, and psychological rewards—were more important, then tangible rewards, followed by psychological rewards, and then social rewards were mostly important factors. In hybrid communities, effort and intrinsic motivation seemed unimportant.

The contents of this chapter state the problem, hypotheses, purpose of the study, and describe why the study was needed. This chapter also illustrates the methodology used.

Statement of the Problem

The objective of this research was to discover the ability and willingness of student participation in a university anchored CWN and to investigate the relationship between various motivating factors and different collective actions. This research focused on determining the

most important factors that influenced the prospective student participation as an indication of CWN longevity. The problem of this study was to understand the factors affecting the involvement of students and its impact on collective actions in a university anchored community wireless network.

Hypotheses

This study sought to understand the various factors that influence student participation in an education centric CWN and its significance on the collective actions. This involved analyzing five distinctive elements as essential in understanding the collective actions— behavioral intention, attitude towards technology, facilitating conditions, impediments, and student participation.

It is necessary to predict the effect of influencing factors on student participation, predicting the most influencing factor and least influencing factor, profiling the CWN participants, and a need to analyze various factors on the collective actions. All of these will be investigated using the following hypotheses as part of this research study:

Behavioral intention, which includes expected outcome, effort, and social influencing, has a positive influence on the stakeholder participation. Expected outcome is considered to be the combination of extrinsic motivation, and long-term consequences, complexity is associated with the effort, whereas social influence is considered to be a combination of subjective norm, various social factors associated with them, and the image associated with the student participation. This was investigated using the following hypothesis:

$H_0$1

Behavioral intention has a positive impact on prospective stakeholder participation in the university anchored CWN collective action sustainability.

An individual's attitude towards technology, which includes attitude towards behavior, intrinsic motivation factors, and affect being part of the CWN, has a positive influence on the stakeholder participation. This was tested using the following hypothesis:

$H_0$2

Attitude towards technology has a positive impact on prospective stakeholder participation in the university anchored CWN collective action sustainability.

The degree to which a person believes he or she will receive technical and organizational infrastructural support would have a positive influence on the student participation. Facilitating conditions include the support one expects from their university, and the training they anticipate before they start working on this initiative. The following hypothesis was researched in association with this assertion:

$H_0$3

Facilitating conditions is assumed to have a positive impact on the prospective student participation in the university anchored CWN collective action sustainability.

Student participation involvement required analyzing the factors that obstruct them. According to basic economics, any activity is completed only if the benefit is more than its costs. Impediments, which consist of tangible and intangible costs, onetime set-up costs, and personal constraints, will be investigated with a hypothesis that impediments have a negative impact on the student participation. Intangible costs include time and labor associated with the participation.

$H_0$4

Impediments have a negative impact on prospective stakeholder participation in the university anchored CWN collective action sustainability.

It was necessary to investigate which contributing factor had the most significant influence on the prospective participation. This is needed to understand the factors that are more influential for the student involvement versus the factors that are not important for students. The following hypothesis was tested in relation to this:

$H_0$5

Behavioral intention is the most influential factor out of the four on prospective stakeholder participation in the university anchored CWN collective action sustainability.

Facilitating conditions (university support, training) and attitude towards technology (which includes intrinsic motivation, attitude towards behavior, and the affect towards use) were compared to understand the influential factor of the three. This was investigated using the following hypothesis:

$H_0$6

Attitude towards technology is more influential than facilitating conditions in the university anchored CWN collective action sustainability.

It was proposed that three factors play a crucial role as direct determinants of student participant's behavioral intention. They were expected outcome, efforts, and social influence, which could vary among participants based on the nature of dependency between them. The following hypothesis was used to investigate this assertion:

$H_0$7

Is there a possibility of grouping various participants based on similarities in their behavioral intention profile?

It was difficult to measure participant involvement in a straightforward way because each person's contribution of attitudes versus consumption needs differ, and hence, there was a need to understand the possibility of these groupings based on the following hypothesis:

$H_0$8

Is there a possibility of grouping various participants based on their involvement with in university anchored CWN activities?

The success of a university anchored CWN depends on the involvement of various stakeholders and their contributions. It was needed to understand the impact of student participation on various collective actions. This was tested using the following hypothesis:

$H_0$9

Is there an impact of student participation on collective actions in the university anchored CWN?

Purpose of the Study

The purpose of this study was to answer research questions concerning various factors affecting student involvement in a university anchored CWN which could serve to provide policy makers, administrators, and management with strategies and decisions. Basically, it is used to analyze the following research questions:

1. What motivates students in the university environment to voluntarily participate in a CWN?, which involves,
    - Analyzing various motivational factors and sub-factors to understand the positive and negative effects on the student participation.
    - Understanding the factors that are more influential on the student participation and also less influential on the participation.

- Understanding the behavioral intention and CWN tasks profiles of student participants.
- The participatory preferences as exhibited by student participants with regard to the processes supporting the operation of a university anchored CWN.

2. What impact participation has on various collective actions in a university anchored CWN? This involved analyzing:
   - The effect of participation on collective actions, which included money, hardware, labor, open source software development, network administration, system administration, techinical suppport, and campaigning about the CWN.

Statement of the Need

CWNs will mainly serve the needs of a niche of group of individuals who are constrained by their house hold income, education levels, internet affordability, and are not subject to a technological imperative, and work to adapt a technology to their own needs. Universities are positioned to serve as the leaders in the growing community wireless initiative in which students are the main stake holders who can involve and contribute to the success of a university anchored CWN.

The need for this study was to assess the impact of student involvement on collective actions in a university anchored community wireless networks. By analyzing the factors affecting student participation, universities can predict the long-term benefits of participating in the community wireless.

This study will offer two insights that are of value to the research community. First, it tries to explore an under explored phenomenon, wireless communities anchored by a university,

where there is a lack of empirical evidence about the student involvement. Second, it advances the applicability of student involvement on the collective actions.

Statement of Assumptions

The following research assumptions were made in this study:

- Students are the main stakeholders in a university anchored CWN and participants were chosen not based on any of their previous computer and/or wireless exposure.
- Universities protect their security concerns by shielding their primary campus network with a firewall and also were assumed to protect their campuses against any liability issues.
- The sample frame consisted of 110 students from North Carolina A&T State University, Greensboro, North Carolina.
- Because participants were randomly picked, any potential bias was minimized.
- All participant interaction with individuals was similar for each participant.

Limitations of the Study

The following limitations were made on this study:

1. The number of respondents and their geographic locations in which the survey was implemented limited the results of this research study.
2. Researchers in other locations may well obtain different results due to the economic, technological, or geographic variations of their respondents.

Statement of Methodology

It was necessary to use a methodology that enables the researcher to test the effect of specific factors that influence student participation. The following research design was used to investigate this problem as shown in Figure 1.

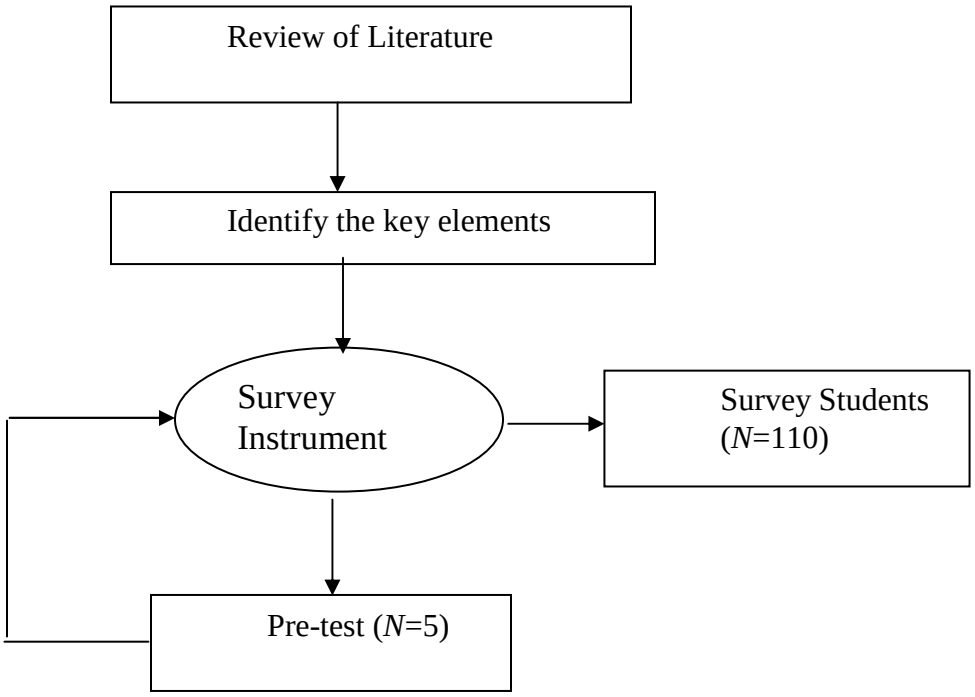

Figure 1. Schematic Representation of the Methodology Used in this Study

1. Analyzed and identified the relevant concepts and inter-dependability between the key elements involving student participation.
2. Transformed the elements into measurable indicators.
3. Developed a survey instrument covering the key elements involving students which was pre-tested with five participants and further revised based on the outcome.
4. Distributed survey to 110 students for investigation.
5. Collected the data from survey
6. Validated the research survey after received from the students.
7. Applied Logistic regression, Kruskal-Wallis, Mann-Whitney, Cluster analysis, and Analysis of Variance (ANOVA) tests on the data collected to address the hypotheses.

Definition of Terms

Hybrid communities refers to an organization that supports individual members who share their access points with other members in a CWN by offering them incentives and technical support.

Collective action refers to the pursuit of a goal or set of goals by more than one person.

Community wireless network refers to a wireless infrastructure built by the members of the community to provide free or affordable internet for improving the well-being of the community.

Pure communities refer to a network that is exclusively built by its members and operates it in a self-organized way.

Wireless network refers to any type of computer network that is wireless.

CHAPTER 2

REVIEW OF LITERATURE

Internet availability and its accessibility for various services have changed the world in different ways and made a significant impact on much of the world population, but its growth has not been uniform and is hindered by various techno-social factors. Affordable Internet access has been the important factor of improving people's livelihoods in the modern world. Also, 80% of the world population has limited access to the Internet, in particular those who live in the rural communities. Those rural communities cannot take advantage of the economic and social opportunities that were created by the Internet (Abdelaal, Ali, & Khazanchi, 2009).

In the United States of America, approximately 79% of the adult population uses the Internet (Pew, 2010) which leaves 21% of remaining adults without having Internet access or not accessing Internet. There is proposed to be a dependency among race, age, household income, community type (rural versus urban), and level of educational demographics related to the Internet usage in the United States. For age, race, household income, level of education, and community type, there exists a 14 to 53 percentage variance in the Internet usage among various demographics.

As an example, 96% of Americans who finished their college degree use the Internet as compared to 52% of the people who did not finish their high school education. This indicates that those people with higher college degree has more exposure to the internet and can benefit

from this, whereas those people without a college degree has less exposure to the internet. Also, 81% of Americans living in urban areas use the Internet compared to 67% in rural areas. In the age group category, 95% of people in the age group of 18-29 years use the Internet compared to 42% of people in the 65 years or above. On the household income front, 95% of Americans in the household income of $75,000/year or higher use the Internet as compared to 63% Internet usage in the lower income category which is less than $30,000/year (Pew, 2010).

Broadband connection is an important way of increasing the Internet speed in which wireless subgroup is considered to be creating more opportunities because of the infrastructure associated them. Wireless is a cheaper method of providing broadband Internet service to reach out to the underserved communities, particularly in the rural areas. This is because of the lower costs associated with the wireless infrastructure because no cable installations are necessary for wireless (U.S. Government Accountability Office [USGAO], 2006).

According to Abdelaal and Ali (2007), community wireless, a wireless network with a focus on providing universal Internet access within an area, has emerged as the connectivity solution to expand broadband services to under provisioned, under privileged, and remote areas as broadband wireless setup does not need a costly setup, instead needs reasonable router equipment.

Community Wireless Networks (CWNs)

CWNs are socio technical networks created with a primary objective of providing free or affordable Internet access to various community members. This requires a group of motivated and committed people and sometimes organizations, with a shared objective of contributing to the wireless for the development of the community (Abdelaal & Ali, 2009; Bina, 2007; Quinn, 2006). As the volunteers who are committed to design, develop, donate, and support the CWN is

the critical part of this CWN implementation and its success. Various activities associated with the CWN volunteerism includes, design of the CWN, donations for hardware, open source software development, money donations, installations of the CWN equipment in various locations, system administration, network administration, time, and labor associated with the CWN involvement.

Agents are those who are involved in the development of these CWNs with an objective of converting intangible and tangible available resources into proper offerings (Allee, 2008). These agents include universities, local municipalities, civil rights activists, community residents, local students, different technology vendors, developing agencies, software developers, and different researchers.

According to Abdelaal and Ali (2008), agents are classified as the beneficiaries who gain from the collective actions that include getting affordable or free internet, who can contribute to the hardware donations, provide technical advice, and other CWN gains. These are the people who could have free or affordable internet on the community wireless network.

The contributors are those individuals who donate to the CWN development who can provide technical skills and manpower, donate money or hardware, share nodes with others, and market the CWN to attract more and more volunteers to be part of this work. These contributors includes private, public, private-public, university supported, individual volunteers. Another group of people who are referred to as the isolated actors are those people who neither benefit from nor contribute to this project other than living in the proximity of the CWN (Drunen, Koolhaas, Schuurmans, & Vijn, 2003; Quinn, 2006). These isolated actors are those individuals who do not contribute to the CWN, but would use this because they live in the vicinity of the CWN establishment.

CWNs, Community wireless networks, are those where in members of the community provide the wireless infrastructure, is an example of the wireless mesh architecture. A mesh network is made up of various nodes placed together in a mesh topological manner to provide more bandwidth coverage over certain areas (Aseeja & Zheng, 2009; Avallone, Akyildiz, & Ventre, 2009; Das, Papagiannaki, Banerjee, & Tay, 2007).

Wireless mesh infrastructure is composed of a router network without the cabling between the nodes. Wireless mesh network uses wireless connections in connecting those computers to Internet. Most of the wireless mesh networks use an unlicensed spectrum which is considered to be a smaller slice of airwaves that are open for anyone to use (Middleton, 2007; (Siddiqui & Hong, 2007).

Creating a wireless mesh network using an unlicensed spectrum requires a onetime purchase of the equipment needed and one time administrative cost instead of monthly recurring fees that are set by a third party vendor (Middleton, 2007).

Classification of CWNs

Mandviwalla, Jain, Fesenmaier, Smith, Weinberg, and Meyers (2006) has classified CWNs based on the managing complexity and based on the funding into the following categories: government-owned and operated, government-owned and privately operated, public utility, cooperative wholesale, and private consortium-owned and operated. In the government-owned and operated, both the funding and management of those CWNs will be done by the governments. In the case of government-owned and privately operated, government funds the CWN project and will be managed by a private entity. Public utility is funded and managed by the contracting company with public funds and operate them. Private consortium owned and operated is funded and managed by a private consortium entity.

The authors highlighted the main differences between these different models in terms of ownership, policies, and finances. In addition, they addressed the interests of different stockholders and the main applications of CWNs.

Abdelaal & Ali (2007) has classified CWNs by considering the social settings and the issues associated with them as: public utility, community, public-private partnership, advertisement supported, education centric, and location hosting. In a public utility model, a municipality or a contracted company manages the infrastructure management with financing from the public funds and has a business partnership with the municipalities it serves. The value offerings provided by the public utility includes public services, bridges the digital divide, employs public resources to cater to the target customers in various communities residing in the area where these public utilities are setup.

In a community model, a nonprofit entity manages the infrastructure with the donations and volunteerism from the community members and has a business partnership with the municipalities, local businesses, and volunteers. Value offerings include, social capital, achieves civic engagement to serve to the target customers in various communities residing in the area of its operation. These municipal CWNs will use public properties to install the required hardware and associated system facilities. These wireless networks will be used by various users and transport a broad spectrum of data, voice, and video applications. These CWNs should consider the diversity of customer base and their needs in terms of providing larger bandwidth, the quality of service, and security associated with the usage.

In a public-private, a private company manages the infrastructure with the financing from private funds and has a business partnership with the service providers who use different public places to facilitate the required equipment to increase the managerial efficiency of the CWN

(Abdelaal & Ali, 2007). Value offerings include public venues to host the facilities, improve management efficiencies to cater to the big communities as its target customers. In an ad-supported model, content operators or Internet service providers (ISP) manage the infrastructure with the financing from advertising revenue and has a business partnership with content providers and technology vendors with a value offering of bridging the digital divide by content providers in which target customers are the business districts and large cities.

In an education centric business model, students of the academic institutions manage the infrastructure with the financing from the public fund, donations, student expertise and have a business partnership with academic institutions, local businesses, governments, and nonprofit organizations. In this model, students get an opportunity to work in the community activities and can become good citizens, whereas universities can partner with the local community to increase the reputation among locals. Universities could benefit from the revenue stream from this CWN maintenance from local business partners for their further research in other areas.

In a location hosting model, an ISP, or a nonprofit organization manages the infrastructure with financing from an ISP, sponsorship, or donations, and has a business partnership with various entities including members of the communities, local business entities, various public entities, and some nonprofit organizations to have value offerings. Target customers include rural and underserved communities in various business districts (Abdelaal & Ali, 2007).

Collective Actions and Social Capital

Collective action is considered in the pursuit of a set of different goals by more than one person. CWN is viewed as a combined effort of a group of people who cooperate and coordinate

with each other to achieve the common goal of deploying a wireless infrastructure to fulfill a common cause.

Collective actions in CWNs are viewed as the actions performed by various groups of individuals with a specific interest to satisfy their self needs (Olson, 1965). In the CWN context, the community wireless transforms its member and volunteers' contributions into collective actions which are critical for the success of the CWNs (Rogers, 1995).

According to Coleman (1988), social capital is identified as context specific, intangible, and fungible. Social capital exists among groups instead at an individual level. Nahapiet and Ghoshal (1998) described three facets of social capital: as relational, in which the social relationships exist between different individuals; structural, in which patterns of relationship links between various individuals; cognitive, which is to share meanings and understandings between individuals.

Collective Actions and Social Capital in Community Wireless

According to Simpson (2005), the longevity of community projects are developed because of the social capital involved in developing those projects. They are necessary to understand the capabilities of the community they serve. To understand the benefits from any of these projects, constructing a shared work is important in understanding the capabilities of any social structures. Engaging various volunteers in the community is achieved by various means including campaigning, word of mouth, organizing special events, community meetings, community newsletters, and using mailing lists (Quinn, 2006).

Bina and Giaglis (2006) explored the motivations of CWN participants in pure communities using constructs of collective action theory and social dilemmas theory in proposing taxonomy for participants and explained how people solve social dilemmas regarding

the involvement. They have focused on pure communities, where volunteers will design, develop, and maintain the development.

According to Abdelaal and Ali (2008), a CWN is viewed as a combination of two networks, one a social network and another one wireless network, wherein a wireless network will serve a social network.

Analyzing Collective Actions in Community Wireless

According to Best and Maclay (2002), various factors influencing the CWN design are, revenue, costs, policy, revenue, capacity, and business models. Rural communities are looking at an alternative in the new markets where the Internet is not available since half the global population lives in rural areas.

Best & Kahn (1998) indicate that support to build these rural communities could offer security for those in urban areas by contributing to the ultimate goal of economic and social benefits by providing economic opportunities, various new ways of learning, better dialogue with government, and by providing the information needed for better healthy living.

Drunen et al. (2003) analyzed and identified the role of community-based contributions for building a CWN in Netherlands and in maintaining that network. Drunen et al. (2003) also analyzed collective actions as open system software, low cost home built antennas, low cost network interfaces, skills needed for technical support, and member and voluntary manpower.

Ferreira, De Oliveira, Carrijo, and Bhargava (2009) and Spulber and Yoo (2005) used simulation methods in understanding the relation among the number of users and the network capacity of the CWN for understanding the wireless commons with respect to overuse or misuse. When doing this analysis, they used usage pattern, density, the environmental conditions, and the demand as the independent variables.

According to Damsgaard, Parikh, and Rao (2006), CWNs are identified as wireless networks where individuals on the wireless broadband network share with others their private WLANs to develop a common resource. Various members of this group might over utilize this infrastructure. Overusing or misusing this common infrastructure are problematic in social sciences and are known as the tragedy of commons.

Camponovo and Cerutti (2005) grouped various CWN entities into different categories—the beneficiaries of CWN who obtain Internet access free of charge, people who share their nodes with others, and Internet service providers.

Bina (2007) explored extrinsic and intrinsic motivations against collective actions in pure communities. Mandviwalla, Jain, Fesenmaier, Smith, Weinberg, and Meyers (2006) identified different stakeholders of CWN as universities, volunteers, underserved people, various municipalities and small businesses, different nonprofit groups, community organizations, utility providers, government agencies.

Mandviwalla, Jain, Fesenmaier, Smith, Weinberg, and Meyers (2006) has analyzed broadband networks as a public utility networks on the lines of water and power services. Muncipla governments will play a regulatory role and also will fund those networks. Public utility networks most likely depends on the tax dollars for its reliance. But, if a muncipal government is involved as the regulatory authority, that will ensure control over the coverage of the CWN to make a successful broadband network.

Abdelaal and Ali (2008) A graph concept is used to frame work contributions from the community in the design and development of CWNs in which a model is proposed that is used to classify, design, and compared with various CWNs. In this a two-graph model is used to describe and analyze CWN, in which CWN was treated as two graphs, a social graph and a wireless

graph. The in degree and out degree elements were then used to measure economic and social impacts of CWNs. The attributes and the interactions between the components of these two graphs indicated the various aspects of any network. The in degree was proposed to outline the benefits each CWN stakeholder could receive, and the out degree measure was used to identify the contributions of each stakeholder. On the other hand, the socio metric status was used for determining which business model would fit for a specific community. If the graphs are symmetric, that indicates the benefits and the contributions of the actors in a CWN are equal. The in-degree is used measure the social impacts and out-degree is used to measure the economic impacts of CWNs. The deficiency facing this model was how to aggregate various tangible and intangible benefits and the contributions of different CWN contributors.

Wellman, Haase, Witte, and Hampton (2001) and Quinn (2006) has discussed the roles of various collective actions as software development, computer hardware donation, and community activities engagement while developing three CWNs in the Chicago and surroundings. The term social capital is used interchangeably with social contact or civic engagement. Civic engagement is referred to the degree to which people involves in their community activities.

Quinn (2006) has provided a guide to understand and build CWNs based on different s case studies to support various roles in community engagement. This will help understanding the role of community involvement, collection actions through volunteerism, open source software development, and other collective actions like unused hardware donations, and about the broadband wireless technology in creating the CWNs.

Peter, Scott, and Wasserman (2004) discussed and analyzed the contributions of various volunteers in developing British Columbia wireless network. Contribution includes software

development, hardware development and hacking, surveys, content development, technical analysis, and legal support.

Shin and Venkatesh (2008) Community involvement should be continued throughout all the development stages since these are needed for the longevity of the CWNs. Different groups of stakeholders involved around the CWNs are municipal authorities, technological third party vendors, the CWN project development and maintenance team, and the community members.

University Anchored CWNs

The emergence of wireless technology and the subsequent growth of the Internet has played crucial role in the economy development of communities, and cities. However, wireless is not utilized to the maximum extent yet. There are a number of ways to optimize this technology utilization such as maximizing the use of the existing wireless infrastructure which is geographically distributed in relation to the wireless equipment and lower in cost of service to utilize (Bar, 2004; Souma, Fujiwara, & Aoyama, 2005).

Improving Internet usage and increasing the speed of the Internet connectivity could have positive impact and would provide more opportunities to the members of the community wireless networks (Avallone et al., 2009).

The emergence of community wireless and the ease in setting up wireless devices have created opportunities for various entities and in particular universities by partnering with their local communities in providing opportunities for students to become part of the community-based initiatives. Institutes of higher education benefit by being involved in the wireless community network partnership. Initially, CWN involvement increases the reputation of the university or college with the local people and potentially provides better publicity among the local people. Second, the institution benefits by using the network as the revenue stream for

gathering funds for the CWN or also by using this as revenue to generate funds for some part of the university-based research activity (Feld, 2005).

A majority of the university campuses already have wireless networks in the form of hotspots which allows faculty and students to connect to the campus network at any point in time. This allows universities to place themselves as CWN leaders by easily enhancing the university wireless networks by adding more nodal points. If a university chose to separate their main network for security reasons with CWN, they can so by providing additional fiber bandwidth to transport data from the main campus wireless network to the broader Internet cloud. By doing this universities play a vital role in the CWN initiative. Student volunteers in turn train community members beginning with the CWN setup, and then train them to maintain the CWN and provide technical support to these CWNs. Students get an opportunity to participate in the community activities and have an opportunity to learn important lessons about civic responsibility by participating in the CWN volunteerism (Feld, 2005).

Universities could eliminate the digital separation between full-time students staying on campus and the students staying off campus by enhancing the campus wireless network for outside campus by participating in the community wireless initiative. Another advantage would be using the voice over IP and streaming technologies. Universities could open more distance education programs that offers interactive programs to more and more students and instructors in various other locations. Universities, by partnering with the CWNs, could promote growth in the local economy by enhancing the university wireless cloud; the additional distance could serve the students as well as the local businesses. By installing proper firewalls on the campus network, universities could protect their main campus from the CWNs (Feld, 2005).

University centric CWNs depend on the student participation in each and every stage of its operation including design, development, and maintenance (Abdelaal & Ali, 2008). For example, students at the University of Nebraska built the Omaha wireless network and maintained it. Students designed, developed, and maintained the following CWNs: the SparkNet at University of Turku, Finland, and the Smart School project at Malaysia.

The SparkNet project provides incentives to various community members and local community in order to host the equipment or share their wireless access points as part of the CWN. This project used an open source software code and affordable hardware to lower the installation costs associated with the implementation. On the same lines of Sparknet, Smart School CWN provided wireless access to the rural community of Bario in Malaysia by utilizing a satellite system. Massechusetts Institute of Technology (MIT) students built a free CWN in Cambridge, Massachusetts. Key factors of various community wireless networks are outlined as below in Table.1 (Abdelaal & Ali, 2009). Academic institutions rely on funds from various grants or donations from the benefactors so usually the service is free.

Table 1. Key Factors of Various Community Wireless Networks

CWN Name	# users	AP	Volunteers	Free	Duration	Funding method
Funkfeuer	NA	400	30	Yes	5	NA
Retiem	600	200	NA	No	NA	NA
Court Housing	12	3	12	No	3	Participants buy equipment
SeattleWireless	20	10	20	Yes	9	Participants buy equipment
Champain-Urbana	100	45	5	Yes	8	Donations from participants
OmahaWireless	300	20	7	Yes	3	Donations

AirStream	100	40	150	Yes	7	Cost sharing
OpenGermania	50	3	2	Yes	NA	NA
PTAWUG	40	6	12	Yes	1	Cost sharing
WirelessGhana	50	20	10	No	4	Monthly fee
Bristol Wireless	500	NA	20	Yes	6	NA
Wireless Leiden	400	100	50	Yes	6	NA
Keur Sedaro	72	6	4	Yes	0	NA
Castle Square	200	80	3	Yes	3	Grants and revenue
Nepal Wireless	5,000	25	40	No	6	Flat rate ($15)
Batam Wireless	20	4	10	No	4	Flat rate ($10)
Red Libre de Ometepe	100	15	20	No	14	Businesses pay, students do not
Jawug	150	100	10	Yes	5	Sharing
NYC Wireless	3,000	15	8	Yes		Partnership with local businesses
Personal Telco	625	100	10	Yes	8	Grants
Inveneo	40	5	3	Yes	8	NA
Zgwireless	200	100	10		6	Donations
Digital el paso	NA	200	NA		1	Fund from the city
Jhai Networks	3,600	12	NA		9	NA

AP = Access Points

Factors Affecting Stakeholder Participation and Acceptance

The innovations needed to implement the work process in an organization are of little or no value if they are not used or complied with. Its target user group must realize the intended benefits and accept the new idea.

This is important to examine the acceptance of innovation within an organization. If there is not going to be acceptance among target groups, then the desired consequences are going to be unimaginable and ultimately the organizations discontinue any intended adoption of this innovation.

Bina and Giaglis (2006) has proposed a theoretical motivation model for understanding participation in a pure wireless communities by conducting interviews with different members of the Athens Wireless. This model suggests that, members participate due to a mix of intrinsic motivations (is it enjoyable or satisfying the needs of competence, and relatedness), motivations caused by the obligation based, and by extrinsic motivations which is to get explicit rewards, pressure from external sources, ego involvement, self- esteem, human capital, personal contacts, career prospects, aspirations.

On the other end, pure wireless CWN members may be dissuaded from the perceived effort that includes monetary and opportunity costs associated with the participation to join in the community based initiatives.

Following theories were reviewed and adopted (Venkatesh, Morris, Davis, & Davis, 2003) as part of this study to determine the sub-factors to be used in researching the 'University anchored Community Wireless Networks'.

Table 2. Theories and Sub-factors Reviewed for University Anchored CWN

Model	Sub-Factor
User Acceptance of Information Technology Model: Venkatesh, Morris, Davis, & Davis (2003) proposed a unified model for information technology acceptance in which performance expectancy, effort expectancy, social influence, and facilitating conditions play significant roles as direct determinants of user acceptance and usage behavior.	Performance Expectancy: "The degree to which an individual believes that using the system will help him or her to attain gains in job performance" (Venkatesh, Morris, Davis, & Davis, 2003, p. 447). Effort Expectancy: "The degree of ease associated with the use of the system" (Venkatesh, Morris, Davis, Davis, 2003, p. 450). Social Influence: "The degree to which an individual perceives that important others believe he or she should use the new system" (Venkatesh, Morris, Davis, & Davis, 2003, p. 451). Facilitating conditions: "The degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system (Venkatesh, Morris, Davis, & Davis, 2003, p. 453).

Motivational Model: A significant body of research in psychology has supported motivation theory as an explanation for behavior. Davis (1992) applied motivational theory to understand new technology adoption and its use.	Extrinsic Motivation: The perception that users will want to perform an activity "because it is perceived to be instrumental in achieving valued outcomes that are distinct from the activity itself, such as improved job performance, pay, or promotions" (Davis, Bagozzi, & Warshaw, Extrinsic and Intrinsic Motivation to Use Computers in the Workplace, 1992, p. 1112). Intrinsic Motivation: The perception that users will want to perform an activity "for no apparent reinforcement other than the process of performing the activity per se" (Davis, Bagozzi, & Warshaw, Extrinsic and Intrinsic Motivation to Use Computers in the Workplace, 1992, p. 1113).
Theory of Reasoned Action: Drawn from social psychology, TRA is one of the most fundamental and influential theories of human behavior. It has been used to predict a wide range of behaviors. Davis (1989)	Attitude toward behavior: "An individual's positive or negative feelings (evaluative affect) about performing the target behavior" (Fishbein & Ajzen, 1975, p. 216).

applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviors. Model of PC Utilization: Derived largely from Triandis' theory of human behavior, this model presents a competing perspective to that proposed by TRA and TPB. Thompson et al. (1991) adapted and refined Triandis' model for IS contexts and used the model to predict PC utilization. However, the nature of the model makes it particularly suited to predict individual acceptance and use of a range of information technologies. Thompson et al. (1991) sought to predict usage behavior rather than intention; however, in keeping with the theory's roots, the current research will examine the effect of these determinants on intention. Also, such an examination is important to ensure a fair comparison of the different models.	Subjective norm: "The person's perception that most people who are important to him think he should or should not perform the behavior in question" (Fishbein & Ajzen, 1975, p. 302). Complexity: "The degree to which an innovation is perceived is relatively difficult to understand and use" (Rogers & Shoemaker as cited in Thompson, Higgins, & Howell, 1991, p. 128). Long-term consequences: "Outcomes that have a pay-off in the future" (Thompson, Higgins, & Howell, 1991, p. 128). Affect towards use: Based on Triandis, affect toward use is "feelings of joy, elation, or pleasure, or depression, disgust, displeasure, or hate associated by an individual with a particular act" (Thompson, Higgins, & Howell, 1991, p. 127). Social factors: Derived from Triandis, social factors are "the individual's internalization of the reference group's

	subjective culture, and specific interpersonal agreements that the individual has made with others, in specific social situations" (Thompson, Higgins, & Howell, 1991, p. 126). Facilitating conditions: Objective factors in the environment that observers agree make an act easy to accomplish. For example, returning items purchased online is facilitated when no fee is charged to return the item. In an IS context, "provision of support for users of PCs may be one type of facilitating condition that can influence system utilization" (Thompson, Higgins, & Howell, Personal Computing: Toward a Conceptual Model of Utilization, 1991, p. 129).
Innovation Diffusion Theory: Grounded in sociology (IDT), IDT has been used since the 1960s to study a variety of innovations (Rogers, 1995). Within information systems, Moore and Benbasat (1991) adapted the	Relative advantage: "The degree to which an innovation is perceived as being better than its precursor" (Moore & Benbasat, 1991, p. 195). Ease of use: "The degree to which an

characteristics of innovations presented in Rogers study and refined a set of constructs that could be used to study individual technology acceptance. Moore and Benbasat (1996) found support for the predictive validity of these innovation characteristics.	innovation is perceived as being difficult to use" (Moore & Benbasat, 1991, p. 195). Image: "The degree to which use of an innovation is perceived to enhance one's image or status in one's social system" (Moore & Benbasat, 1991, p. 195). Visibility: The degree to which one can see others using the system in the organization adapted (Moore & Benbasat, 1991). Compatibility: "The degree to which an innovation is perceived as being consistent with the existing values, needs, and past experiences of potential adopters" (Moore & Benbasat, 1991, p. 195). Results demonstrability: "The tangibility of the results of using the innovation, including their observability and communicability" (Moore & Benbasat, 1991, p. 203). Voluntariness of use: "The degree to which use of the innovation is perceived as being voluntary or of free will" (Moore & Benbasat, 1991, p. 195).

People are intrinsically motivated to gain satisfaction due to the fun and challenges they encounter because of their involvement (Deci & Ryan, 2000).

According to (Deci & Ryan, 2000), Intrinsic motivation is the important factor when compared with extrinsic motivation which reflects the natural human propensity to learn and assimilate. Extrinsic motivation is found to be relative autonomy and thus can either reflect external control or true self-regulation. (Deci & Ryan, 2000) have used self-determination theory to come up with the distinction between behaviors that are volitional and accompanied by the experience of freedom and autonomy. Intrinsically motivated behaviors are performed out of interest and be used for satisfying the psychological needs, whereas extrinsically motivated behaviors which are executed because they are instrumental can vary in the extent to which it represent self-determination.

In the case of CWNs, involving in the CWN tasks, which includes, wireless internet usage, communication services, file sharing services, multimedia and/or other web services, network management services, creating content for the network, uploading content onto the network, reading comments that others have posted on the forums, posting comments on the forums, any forum moderation, participating in physical meetings with other members, offering technical assistance to other members, and website maintenance could be the factors for intrinsic satisfaction and the technical dimension of involvement could be the main factor for intrinsic motivation (Agarwal & Karahanna, 2000; Venkatesh, 2000).

Communication services includes Voice over IP (VoIP), chat, email services; File sharing services include File Transfer Protocol (FTP), Telnet, Remote file sharing; content management includes share point.

Different scholars have researched to discover the motivation behind each individual perspective about the new information technologies adoption. Different people have different views, and depending on which way the investigation evolves, could focus on people's acceptance of new technologies by employing intention variable (Davis, 1989).

Another method of investigation is focusing at the corporate level (Deci & Ryan, 2000; Lesser, Fontaine, & Slusher, 2000) or at the technology task level (Gale & Kariv, 2007; Hamid & Khan, 2006) and all these ways of interpretation have significant and unique contribution to the review of literature on user acceptance of new technology.

According to the Unified Theory of Acceptance and Use of Technology (UTAUT) model, four important determinants of intention and up to four moderators of key relationships are considered (Venkatesh, Morris, Davis, & Davis, 2003). Performance expectancy, effort expectancy, social influence, and facilitating conditions play a significant role as direct determinants of user acceptance and usage behavior. UTAUT provides a toolset for managers to understand the factors that are needed. This methodology was used to target population that might be less inclined to adopt and use new systems.

(Venkatesh, Morris, Davis, & Davis, 2003) detailed about the expected outcome, which is the degree to which an individual believes participating in a CWN will help him or her to gain benefits, effort, viewed as the degree of ease associated with the use of the system, social influence, as the degree to which an individual perceives that important others believe he or she should use the new system. Attitude towards technology is viewed as an individual's overall affective reaction to using a system; facilitating conditions is considered as the degree to which an individual believes that an organizational and technical infrastructure exists to support use of the system. Impediments are viewed as an individual's hindrance to be part of CWN. These are

the critical factors for CWN that are to be considered while analyzing the behavioral intention profiles, attitude towards technology, facilitating conditions, and costs associated with CWN participation.

The Theory of Reasoned Action (TRA) was formulated by (Fishbein & Ajzen, 1975) is one of the most fundamental and influential theories of human behavior. It has been used to predict a wide range of behaviors and also to estimate the discrepancy between behavior and attitude. Davis (1989) has applied TRA to individual acceptance of technology and found that the variance explained was largely consistent with studies that had employed TRA in the context of other behaviors.

Innovation Diffusion Theory (IDT) has been used since the 1960s to study a variety of innovations (Rogers, 1995). Rogers researched the organizational factors that influence adoption. He called this as 'diffusion' and defined this as the process by which an innovation is communicated through certain channels over time among the members of a social system. Rogers has proposed four distinct elements in the innovation diffusion process, they are innovation, objects that are perceived as new by an individual or a al or other unit of adoption; social system, which is a set of interrelated units that are engaged to accomplish a common goal; communication channels, which are the way of sending messages and receiving from one individual to another; time, which is defined as the relative time with which an innovation is adopted by an individual or group of individuals. Rogers differentiated the adoption process from the diffusion process. Adoption process pertains to an individual, whereas diffusion process occurs within the group society. The adoption process is a psychological process through which an individual passes what hear about an innovation to final adoption in five stages: awareness, when an individual is exposed to the innovation but lacks complete information regarding this

new innovation; stage 2 is associated with the interest, when an individual becomes interest about the new idea, seeks additional information about this new innovation; evaluation, this is when an individual applies the new innovation to his or her present and anticipated future situation, and then decides if it is feasible to implement this new idea.

Within information systems, (Moore and Benbasat 1991) has adapted the characteristics of innovations presented in Rogers study and refined a set of constructs that could be used to study individual technology acceptance.

It appears from the literature review that community wireless is a novel technology initiative with in which pure wireless communities, in which members of the CWN have designed, developed, and maintain their own CWNs, were investigated by different researchers, for example by (Bina and Giaglis 2006) by using a motivation model for understanding participation by conducting interviews with different members of the Athens Wireless community wireless.

Giovanni and Anna (2010) have proposed a qualitative approach for hybrid communities. According to this model, participation took place in hybrid communities by a combination of intrinsic motivation, social, psychological, and tangible benefits. Participation was hindered by member involvement, costs, and various other concerns. In hybrid communities, extrinsic motivations, social, tangible, and psychological rewards were more important, then tangible rewards, then psychological rewards, and finally social rewards were mostly important factors. In hybrid communities, effort and intrinsic motivation seemed unimportant.

It appear that literature is lacking in the area of collective actions in a university anchored community wireless networks. This study examines and analyzes the factors and sub-factors that influence student participation and by considering a framework that is built with the four factors

and thirteen sub-factors. Nine hypotheses were considered to understand the participation preferences, influencing factors, and segmentation which are central to this study.

CHAPTER 3

METHODOLOGY

Chapter 3 presents the research methodology of the experiment. In addition, Chapter 3 discusses (a) the framework of university anchored CWN research, (b) the experimental design of the study, (c) ethical considerations, (d) instruments and measures, and (e) the data collection and data analysis techniques.

The Framework of University Anchored CWN Research

In a university anchored CWN, academic institutions of higher learning plays a vital role in which it owns, designs, builds, and operates a CWN for the purpose of augmenting the educational mission, obtaining expertise for students, and improving the well-being of local communities (Akyildiz, Wang, & Wang, 2005; Lesser et al., 2000; Meinrath, 2007).

Universities usually depend on students for manpower and expertise for involvement in projects like community wireless and Habitat for Humanity, and other servant leadership projects. Such projects are funded by grants or donations from sponsors and the service is usually free since it involves student participation (Abdelaal & Ali, 2007). These projects provide incentives to the community members for hosting the facilities and/or sharing access points to be part of the network. Community wireless network projects uses open-source software and affordable hardware tools in order to minimize implementation costs. The process flow depicted in Figure 2 reflects the various components in a university anchored CWN.

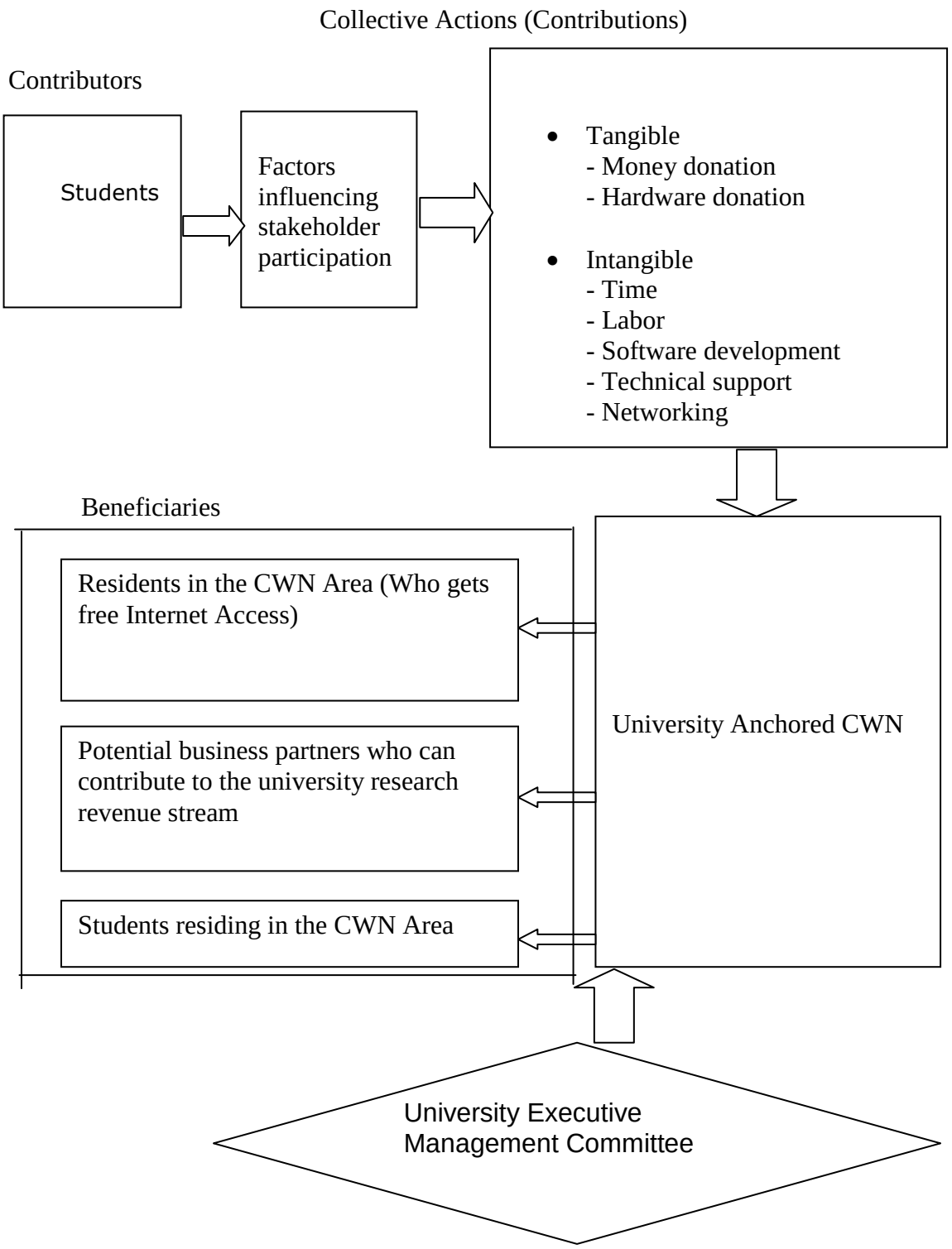

Figure 2. Process Flow for a University Anchored CWN

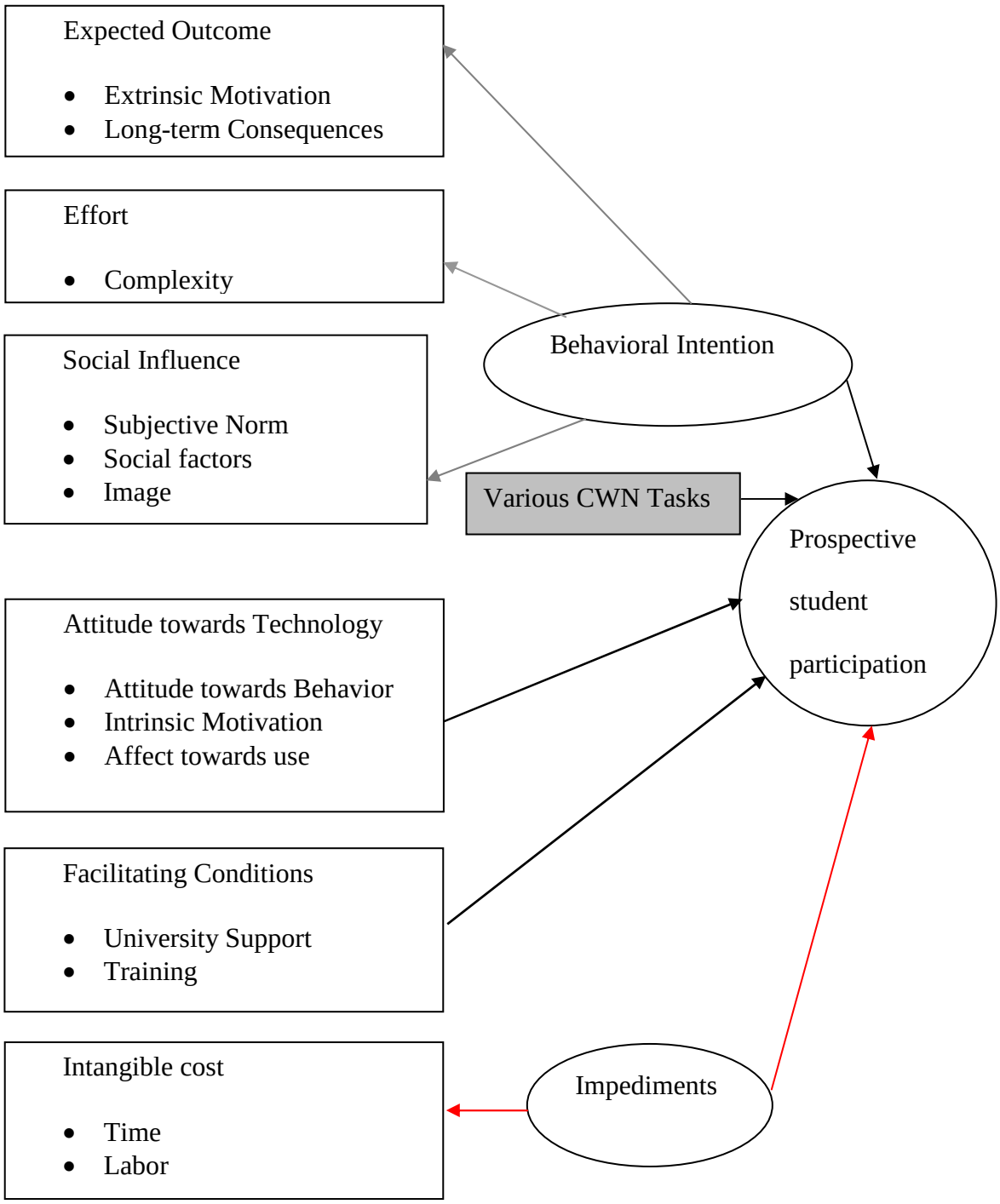

Figure 3. Framework for the University Anchored CWN

Students are the main contributors in an university anchored community wireless networks and their contributions which includes tangible, that includes money, and hardware, and also intangible, which are time, labor, software development, technical support, and networking about the community wireless with other members or future participants.

Beneficiaries associated with this CWN are the Residents in the CWN Area who gets free internet access, Potential business partners who can contribute to the university research revenue stream, and the Students residing in the CWN Area.

Another important actor in the university anchored CWN is the university executive management committee who can make decisions based on the empirical results to see whether participating in CWN initiative will help university in the long run. As seen from Figure 2 above, it is necessary to understand the factors and sub-factors that could influence student involvement.

This study involved developing a framework showcasing the relevant concepts and inter-dependability between key elements involving stakeholder participation. Development of this was considered important for understanding various aspects of participation and its relation to collective actions and other factors. These concepts to the CWN relied on the review of literature and the associated exploratory investigation.

A framework for the university anchored CWN was developed as part of this research and is shown in Figure 3. The factors that are proposed as part of this research are behavioral intention, which includes expected outcome that in turn considered to include extrinsic motivation, and long-term consequences, effort, that includes complexity, and social influence, that includes subjective norm, social factors, and mage; attitude towards technology, that includes attitude towards behavior, intrinsic motivation, and affect towards use; facilitating conditions, that includes the university support, training; and impediments which includes

intangible costs, that are time, and labor. CWN tasks are included as another factor which could influence student participation and is includes in Figure 3 above.

Collective action is a result of the student participation in a university anchored CWN and is depicted in Figure 4. These collective actions include, contribute money, donate unused hardware, working for the installation of the hardware, labor associated with the installation, open source software development, network administration associated with the network, system administration tasks, technical support associated with the CWN maintainability, and also the campaigning about the CWN anchored by the university and explain the ease associated with the participation.

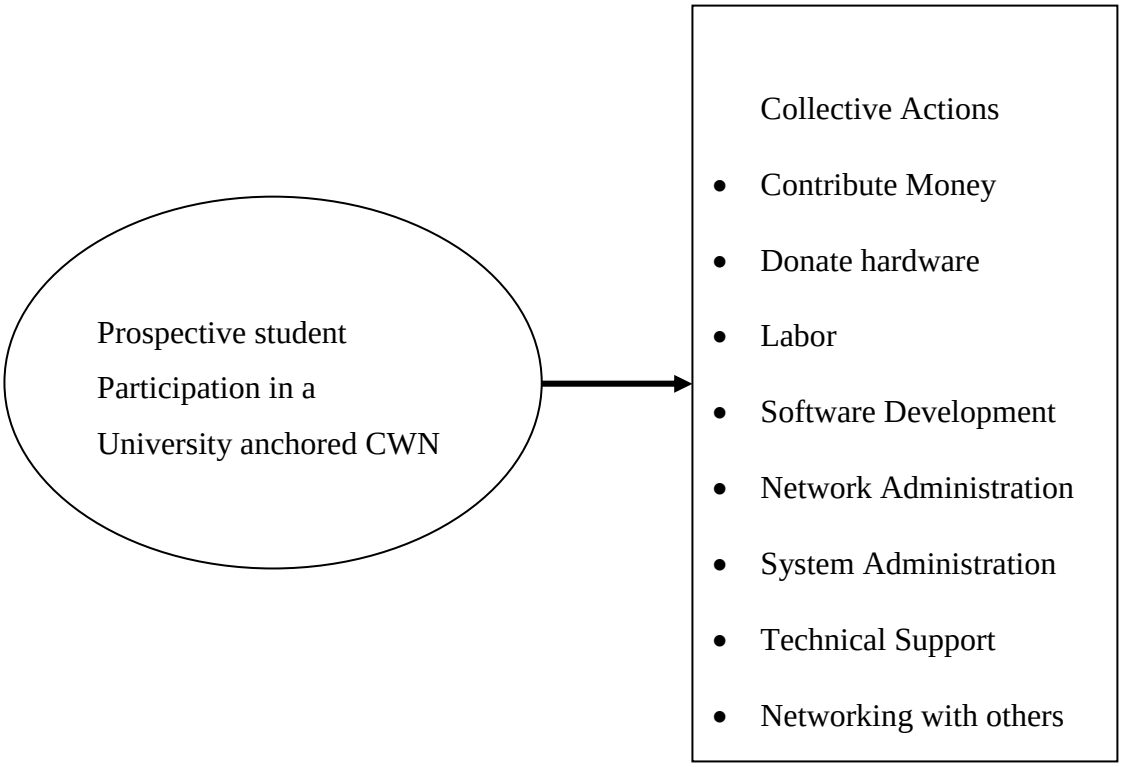

Figure 4. Collective Actions in a University Anchored CWN

Experimental Design of the Study

This study was intended to answer research questions concerning the willingness of stakeholder participation in a university anchored CWN. Specifically, the research questions posed were to investigate the relationship between the motivating factors and collective actions. This study served to provide policy makers, administrators, and management with strategies and decisions to become part of a university anchored CWN.

The analysis presented thus far outlines various distinctive elements as essential in understanding the university anchored CWN collective action, namely attitudes, motivations, facilitating conditions, impediments, with prospective student involvement as an indication of sustainability. Further investigation of these research questions implied that these various elements corresponded to the measurable indicators that pinpoint the various factors and relationship between them. It was proposed that behavioral intention, which included expected outcome, effort, and social influence, varies among participants based on the dependency between them which was assumed to have a positive influence on the stakeholder participation. This was investigated using $H_0$1 which stated, "Behavioral intention has a positive impact on prospective stakeholder participation in the university anchored CWN collective action sustainability."

Student involvement is hard to analyze in a direct way, because people vary their attitudes related to technological behavior, and the intensity in which they are involved in various activities associated with the CWN differ. An individual's attitude toward technology, which includes attitude towards behavior, intrinsic motivation factors, and how one is affected while being part of the CWN, was proposed to have a positive influence on the stakeholder participation. This was tested using the $H_0$2, "Attitude towards technology has a positive impact

on prospective stakeholder participation in the university anchored CWN collective action sustainability."

Individuals' involvement in university anchored CWN depends on the amount of training and support people receive from their university for their participation. It was proposed to identify to what degree a person believes that support received from an organization has a positive influence on the student participation. In association with this assertion, $H_0$3, "Facilitating conditions is assumed to have a positive impact on the prospective student participation in the university anchored CWN collective action sustainability," was researched.

Assessing student involvement also required analyzing the factors that obstruct them. According to economic basic theory, a task is done if the benefit is more than its associated costs. Impediments, which consist of tangible and intangible costs, onetime set-up costs, and personal constraints, were investigated with a hypothesis that impediments had a negative impact on the student involvement. This was tested using $H_0$4, "Impediments has a negative impact on prospective stakeholder participation in the university anchored CWN collective action sustainability."

It was necessary to investigate which contributing factor had the most significant influence on the prospective student participation. The purpose of this investigation was to analyze the different situations that favored CWN growth. $H_0$5, "Behavioral intention is the most influential factor of the four on prospective stakeholder participation in the university anchored CWN collective action sustainability," was investigated in relation to this. For this hypothesis, facilitating conditions (university support, training) and attitude towards technology was compared to understand the influential factor for these areas. This was necessary as it

involved university resources for training and support purposed and also to get an idea of individual's attitude towards technology. This was investigated using $H_0$6, "Attitude towards technology is more influential than facilitating conditions in the university anchored CWN collective action sustainability."

Individuals differ in their orientation (beneficiaries, contributors, and isolated actors) and the level of their involvement in various CWN activities. It is difficult to assess participation directly, and hence, $H_0$7, "Possibility of grouping various participants based on similarities in their behavioral intention profiles," was tested in relation to the nature of student involvement in a university anchored community wireless:

It is difficult to measure participant involvement without understanding each person's contribution, attitudes, and consumption needs and the interplay between them. This was tested using $H_0$8, "Possibility of grouping various participants based on their involvement with in university anchored CWN activities."

Finally, the success of a university anchored CWN depends on the involvement of various stakeholders and their contributions. It is necessary to understand the impact of student involvement on various collective actions and to seek out the conditions that favor the student involvement for the success of this university anchored community wireless. It was essential to discover the influencing collective actions viz; money, donations, time, and labor for the interested participants in the university anchored CWNs, which was researched using $H_0$9, "The impact of student participation on collective actions in the university anchored CWN."

It was necessary to use a methodology that enabled the effectiveness influencing factors for the stakeholder participation in an education centric CWN and its significance on the collective actions to be tested. Participants in this study received a questionnaire based on the

transformation of the elements from the framework developed. A schematic diagram testing various hypotheses is indicated in the Figure 5 below:

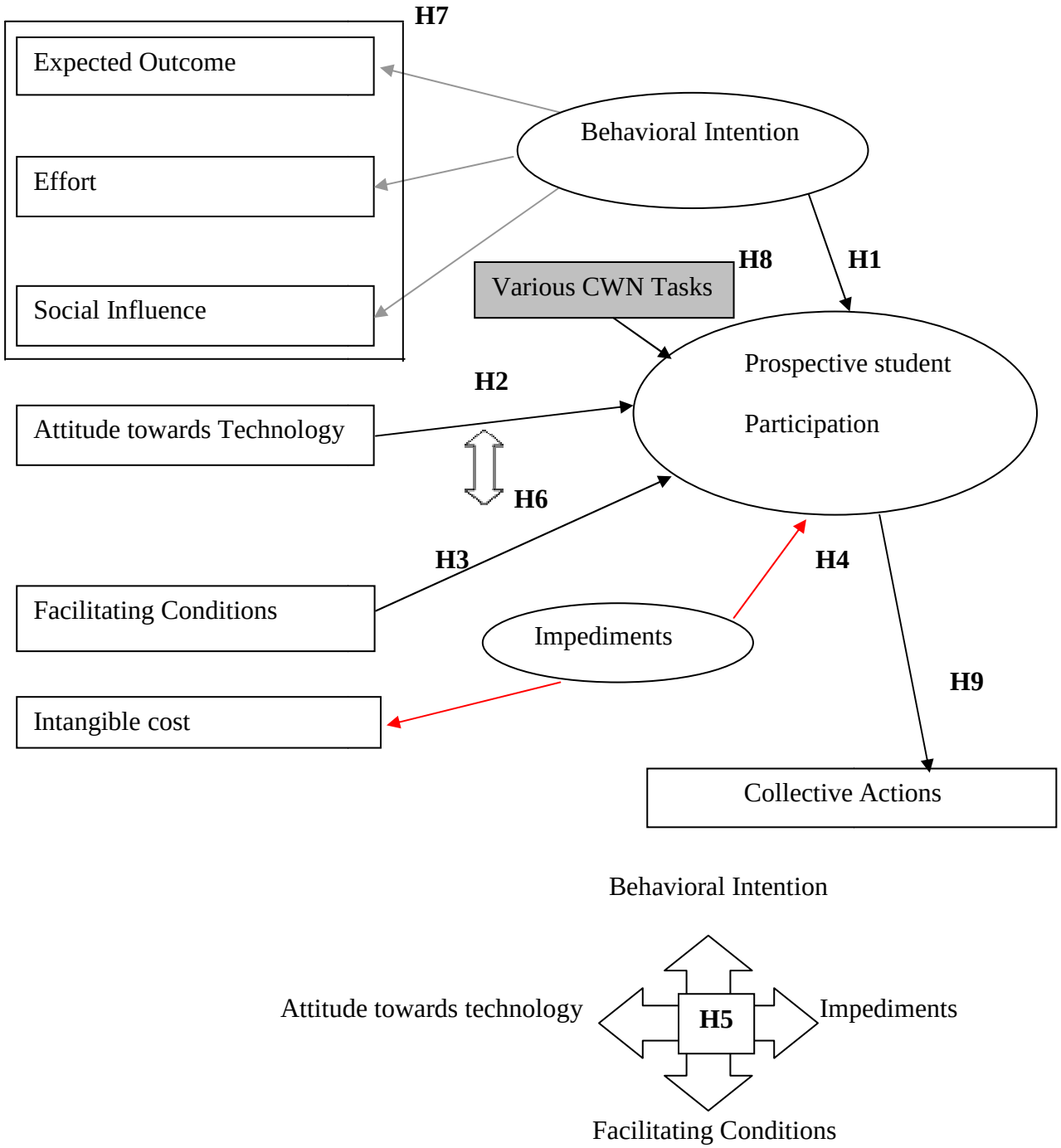

Figure 5. Schematic Representation of Hypotheses Used in this Research

Ethical Considerations

Participants were informed that they could voluntarily participate in this research study. If they elected to participate, the participants were instructed to sign an authorization form. This form was reviewed and approved as part of the overall approval of the research program by the Human Subjects Review Board (HSRB) of North Carolina A&T State University and the Institutional Review Board (IRB) of Indiana State University.

Participants

The ideal population for this investigation was students from different departments of all the universities. Because that was not possible, a sample was selected that did not cause any serious threat to the external validity. A relatively large sample of undergraduate students from Electronics, Computer, and Information Technology (ECIT), Graphics Communications Systems, and Fashion Merchandising and Design departments were selected to participate in this study.

The participants in this study were undergraduate student volunteers. Using these participants as subjects was important to this investigation because these were the people responsible for the design, development, and maintenance of a university anchored CWN.

Instruments and Measures

This research consisted of the following steps: (a) transformation of the elements from the framework into measurable indicators, (b) development of a survey instrument covering the key elements involving students which was pre-tested with five participants, and further revised based on the outcome, and (c) administer survey with 110 students volunteers for investigation.

Transformation of Factors into Measurable Indicators

The process of transforming various elements into measurable indicators is vital and is the first step in the investigation, where in elements are mapped with a set of items suitable for measurement. Table 3 depicts the mappings between various elements (factors) and the corresponding items for testing in the research process.

Table 3. Factors and Test Items

Factor	Item	Source
Extrinsic Motivation	• It would make me to finish my tasks quickly (EM1) • It would increase my performance (EM2) • It would improve my productivity (EM3) • It would enlarge my effectiveness on tasks (EM4) • It would make easier to do all my other tasks (EM5) • It would find involving in CWN is useful in my day-to-day activities (EM6)	Adapted from Davis, Bagozzi, & Warshaw, (1992); Venkatesh, Morris, Davis, & Davis (2003)
Long-term Consequences	Being part of this CWN; • I will increase my effectiveness in my work (LC1) • I will spend less time on my routine tasks (LC2) • I will increase my work quality (LC3) • I will enhance the quantity of output for the same amount of effort (LC4) • My coworkers will perceive me as competent (LC5) • I will enhance chances of getting a good job (LC6)	Adapted from Thompson, Higgins, & Howell (1991); Venkatesh, Morris, Davis, & Davis (2003)
Complexity	• Working on CWN is much complicated and hence	Adapted from

	difficult for me to see what is happening (CX1) • Working on the CWN involves too much time doing mechanical routine work (CX2) • It takes longer time to learn how to work on the CWN, but I feel is a worth an effort (CX3)	Thompson, Higgins, & Howell (1991; Venkatesh, Morris, Davis, & Davis (2003)
Subjective Norm	• People who influence my general behavior think I should be part of my university anchored CWN to be good citizen (SN1) • People who are more important to me think that I should be part of my university anchored CWN to full fill my responsibilities (SN2)	Adapted from Davis, 1989; Thompson, Higgins, & Howell (1994); Venkatesh, Morris, Davis, & Davis (2003)
Social Factors	• I want to be part of this CWN because of the proportion of my university co-stakeholders involved in this CWN (SF1) • My department is very supportive of individuals working on this CWN (SF2) • In general, my university has supported being part of this CWN (SF3)	Adapted from Thompson, Higgins, & Howell (1991; Venkatesh, Morris, Davis, & Davis (2003)
Image	• People in my university who are part of CWN have more prestige than who do not participate (IG1) • People in my university who are part of this CWN have a high profile (IG2)	Adapted from Moore & Benbasat, 1991; Venkatesh,

	• Being part of CWN is status symbol in my university (IG3)	Morris, Davis, & Davis (2003)
Attitude towards Behavior	• Being part of the CWN is a good idea (AB1) • I like the idea of university anchored CWN (AB2) • Being part of the CWN is pleasant (AB3)	Adapted from Venkatesh, Morris, Davis, & Davis (2003)
Intrinsic Motivation	• I find to be part of a CWN is enjoyable (IM1) • The process of CWN involvement is pleasant (IM2) • I have fun being part of CWN (IM3)	Adapted from Davis, Bagozzi, & Warshaw, (1992)
Affect towards use	• CWN makes my work interesting (AU1) • Working on the CWN is a fun activity (AU2) • Working on the CWN is okay for some people, but not for a person like me (AU3) • Working on the CWN frustrates me (AU4) • Once I start working, it is hard to stop (AU5) • I get bored quickly when working on CWN activities (AU6)	Adapted from Thompson, Higgins, & Howell, Personal Computing: Toward a Conceptual Model of Utilization (1991)
University support	• Guidance was available to me to work on the CWN from my university at any time (US1) • Specialized instruction concerning working on CWN will be available to me (US2) • A specific person (or group) is available for	*Tested as part of this research*

	assistance with any CWN difficulties (US3)	
Training	• I will get proper training to be part of CWN (TG1) • I have the knowledge necessary to use system (TG2)	*Tested as part of this research*
Time	• Being part of CWN would decrease the time needed for my important other responsibilities (TM1) • I could do better things than participating (TM2)	*Tested as part of this research*
Labor	• I would like to be part of a team performing labor associated with CWN project (Physical installation of antennas, installing wireless devices etc.) (LB1)	*Tested as part of this research*

Development of a Survey Instrument

In line with the research design, a survey instrument was designed to obtain answers for the various hypotheses formulated. Specifically, student participants were asked to respond about their involvement in the activities in the university centric community wireless networks. Participants were asked to answer various questions associated with the collective actions, and in particular, the main questionnaire consisted of the items that measure the expected outcome, effort, social influence, attitude towards technology, facilitating conditions, and impediments where participants were asked to answer how true the questions were on a 5-Likert scale. Items from the questionnaire were organized in a random pattern to reduce any common bias that came out of the research (Cook & Campbell, 1979; Straub, Boudreau, & Gefen, 2004).

Administering the Survey Instrument

The survey instrument was addressed to participants after their classes at North Carolina A&T State University in Spring-2012. Responses were collected anonymously using collection boxes (Appendix A contains the final survey instrument).

Data Collection and Data Analysis Techniques

The goal of this investigation was to answer research questions concerning the ability and willingness of stakeholder participation in a university anchored CWN and to investigate the relationship between the motivating factors and collective actions. Specifically this research focused on four key properties: Behavior Intention (B), Attitude towards technology (A), Facilitating conditions (F), and Impediments (I) and their relationship to participation. Participation (P) in a university centric CWN depends on the above key properties.

Prospective Participation = Function (B, A, F, I)

The independent variables were Behavior Intention, Attitude towards technology, Facilitating conditions, and Impediments. The dependent variable was "Prospective Participation." The number of participants who agreed to participate in the research study were tallied against the participants who submitted their responses back.

Two error estimates were made in this research. The first one was a margin of error. The margin of error is a risk assumed when performing the experiment sample that does not represent the population as a whole. Margin of error rates are normally set at 5% whereas continuous data is set at 3%. This investigation used the margin error as 5%.

The alpha level is the risk one is taking that the difference between the sample and the population does not exist, also known as the Type I error. For educational research, alpha is normally set at .10 for pilot studies, .01 for research in which errors may cause human injury or

significant financial exposure, and .05 for general research (Maxwell & Dlany, 1990). For this research alpha was set at .05.

From the collected data, the following nonparametric statistical tests were used in the analysis of this investigation as no assumptions were made on the population distribution used in this research. Best and Kahn (1998) noted that statisticians argue that the validity of nonparametric tests is not based on assumptions about the nature of the population distribution. These assumptions are frequently ignored or violated by researchers employing parametric tests (Best & Kahn, 1998).

Predicting the Effect of Influencing Factors on Student Participation

As postulated in Hypotheses 1, 2, 3, and 4, behavioral intention, attitude towards technology, facilitating conditions, and impediments are the influencing factors on the CWN sustainability. It was assumed that all of these factors had different influential effects on the prospective student participation. A logistic regression statistical technique was considered to analyze these hypotheses. Logistic regression statistical technique is a multivariable technique that was used to assess the predictive analysis of a set of independent variables on one dependent variable (Hosmer & Lemeshow, 1989).

In this research, the dependent ordinal variable was the *prospective student participation*, which was converted into a binary number (1 – for more or to the same extent, 0 – for less) in the distribution of the responses from the survey. As part of this analysis for Hypotheses 1 - 4, five models associated with logistic regression were developed and tested. These logistic models were developed various sets of factors and each of these models were used in analyzing the Hypotheses 1 - 4. An overall model resulted from the four models as shown in Figure 6.

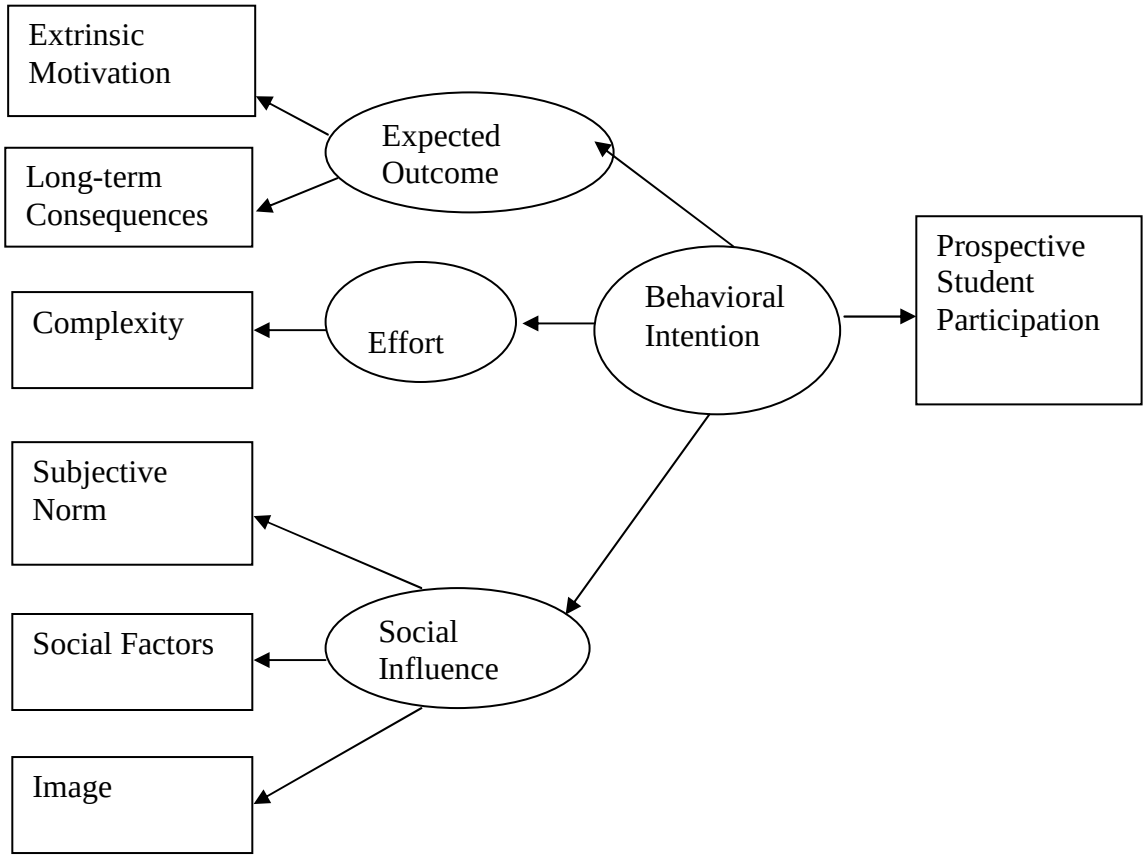

Figure 6. Logistic Regression Model 1

Logistic regression model 1 is designed to test the validity of hypothesis 1, in which behavioral intention which consists of expected outcome, effort, and social influence as the factors, and extrinsic motivation, long-term consequences, complexity, subjective norm, social factors, and image are tested to have positive influence on the prospective student participation as in Figure 6 above.

Logistic regression model 2 is designed to test the validity of hypothesis 2, in which attitude towards technology which consists of attitude towards behavior, intrinsic motivation, and affect towards use is tested to have positive influence on the prospective student participation as shown in Figure 7 below.

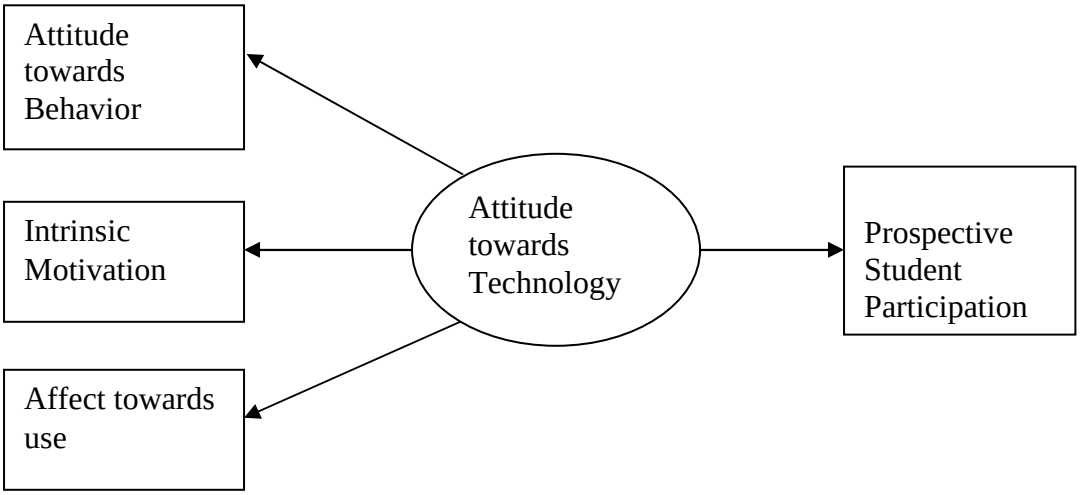

Figure 7. Logistic Regression Model 2

Logistic regression model 3 is designed to test the validity of hypothesis 3, in which facilitating conditions which consists of university support and training is tested to have positive influence on the prospective student participation as shown in Figure 8 below.

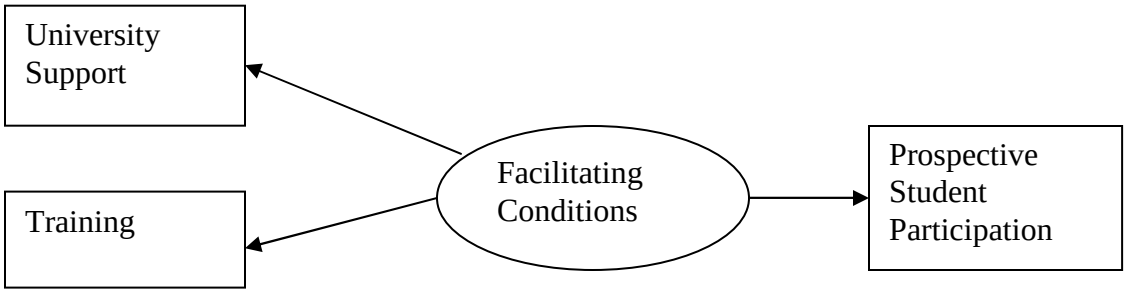

Figure 8. Logistic Regression Model 3

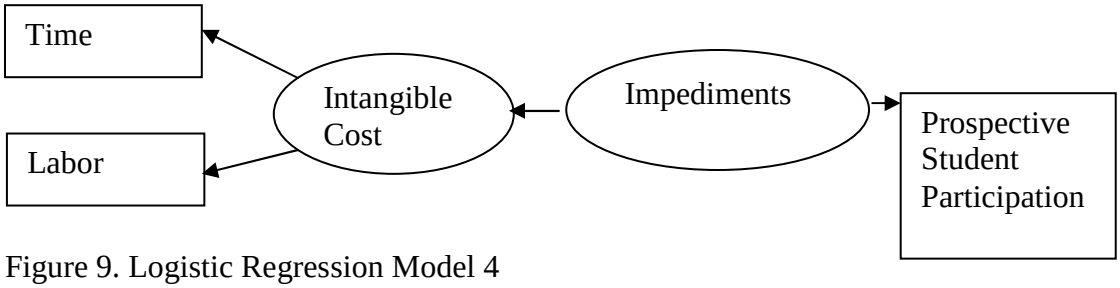

Figure 9. Logistic Regression Model 4

Logistic regression model 4 is used to test the validity of hypothesis 4, in which impediments which consists of time and labor are tested to have a negative influence on the prospective student participation as shown in Figure 9 above.

Logistic regression overall model is designed to test the validity of hypothesis 1 to 4, in which behavioral intention, attitude towards technology, facilitating conditions, impediments, and participation are analyzed to understand the impact of these factors on the student participation as shown in Figure 10 below.

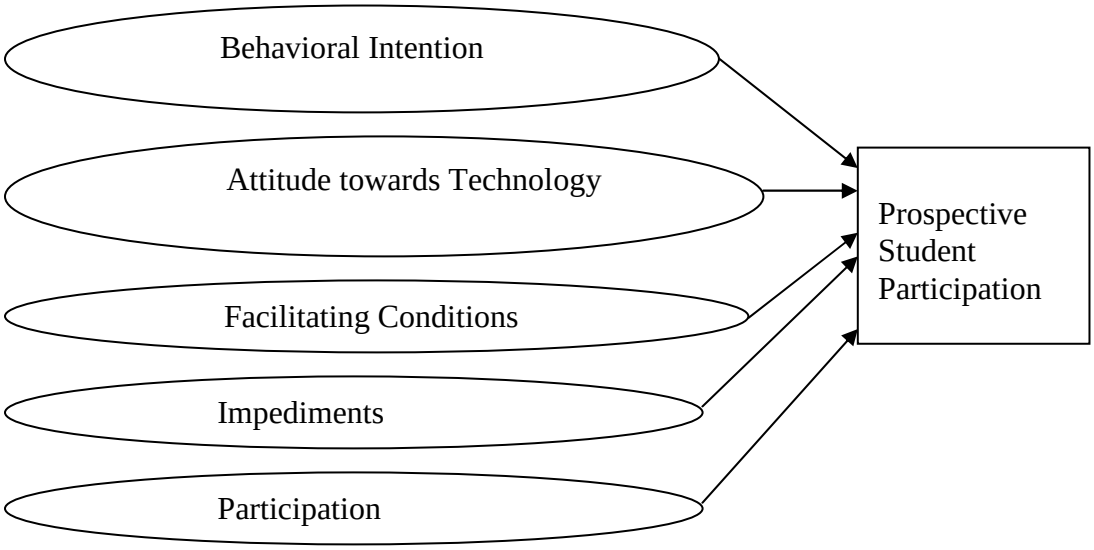

Figure 10. Logistic Regression Overall Model Used for Testing Hypothesis 1 – 4

Hypothesis 5 involved comparing four unmatched groups (Behavioral Intention, Attitude towards technology, Facilitating conditions, and Impediments) to discover the most significant of them. The Kruskal-Wallis test looked appropriate for this analysis.

When the means of *k* populations were compared, and it was known that the populations did not have equal variances or that the populations were not normal, the Kruskal-Wallis

nonparametric test was used. The data in the *k* samples are replaced by their ranks and the rank sums are analyzed (Stephen, 2004).

Hypothesis 6 involved comparing two unmatched groups (Attitude towards technology, and Facilitating conditions) and to identify which one was significant of the two. The Mann-Whitney test looked appropriate for this type of analysis.

The Mann-Whitney is used as a nonparametric to analyze data from two independent groups when the measurement is going to be ordinal value. This test analyzed the degree of separation between those two groups.

The null hypothesis assumed the two sets of scores were samples from the same population. Because sampling is assumed to be random, these two sets of scores do not differ systematically any from each other (Stephen, 2004).

CWN Participant Segmentation

CWN tasks were grouped into three factors—services, technical support, and meetings and forums as shown in Table 4 below.

Table 4. Grouping of Various CWN Tasks

Factor	CWN Task
Services	• Wireless internet usage. • Communication services (Email, Chat, and VoIP). • File sharing services (FTP, Telnet). • Communication services (Email, Chat, and VoIP). • Multimedia and/or other web services. • Network management services.

Technical support/maintenance	• Creating content for the network. • Uploading content onto the network. • Offer technical assistance to members. • Website maintenance.
Meetings and forums	• Involving in CWN meetings with other members. • CWN forum moderation. • Read comments posted on CWN forums. • Post comments on CWN forums.

To investigate Hypothesis 7 and 8, a cluster analysis technique was chosen as the suitable statistical technique. This is a statistical technique to be used for classifying various cases in such a manner as to reduce the variance among cases within the same group while maximizing the variance among different groups (Hair, Anderson, Tatham, & Black, 1998).

To research Hypothesis 9 and understand the motives behind stakeholder participation in a university anchored CWN, analysis of variance (ANOVA) was used as the statistical test between participation and collective actions (money, time, donations, and labor).

Table 5. Outline of the Statistical Methods Used

Hypothesis	Statistical Test Used	Information
Hypothesis 1	Logistic regression	Dependent variable is “Prospective Participation”
Hypothesis 2	Logistic regression	Independent variables are Behavioral Intention,
Hypothesis 3	Logistic regression	Attitude towards technology, Facilitating conditions,

Hypothesis 4	Logistic regression	and Impediments
Hypothesis 5	Kruskal-Wallis test	This involved comparing four unmatched groups: Group-1: Behavioral Intention Group-2: Attitude towards technology Group-3: Facilitating conditions, Group-4: Impediments
Hypothesis 6	Mann-Whitney test	This involved comparing two unmatched groups Group-2: Attitude towards technology Group-3: Facilitating conditions
Hypothesis 7	Cluster Analysis	Cluster analysis was a statistical method used for the classification of cases in a manner that the variance among various cases within a same group is reduced while the variance among different groups is maximized
Hypothesis 8	Cluster Analysis	
Hypothesis 9	ANOVA	To understand the discriminatory power of time, labor, donations, and money across the participation profiles

Table 5 outlines the statistical tests performed to investigate various hypotheses proposed in this research. More details about these statistical tools are outlined in Appendix B.

CHAPTER 4

FINDINGS AND ANALYSIS OF DATA

The purpose of this study was to answer research questions concerning various factors affecting student involvement and to test the impact of stakeholder participation on collective actions in a university anchored community wireless network. A total of 110 students participated in this study.

Descriptive Statistics

Table 6 displays the sample statistics, in which approximately equal mix of gender participation occurred (49.09% women versus 50.92% men). Descriptive statistics indicated that the majority (78.18%) of the participants were not involved in any of the CWN activities previously. Other respondents (21.82%) mentioned their familiarity about CWN for some length of time. It was interesting to note that 11.82% of the participants (13 out of 110 participants) noted that they were involved in CWN movement for more than two years. Furthermore, 2.73% of the respondents had been exposed to a CWN movement in the less than six months and between 12 and 24 month categories, whereas 4.55% participants mentioned their CWN involvement was between 12 and 24 months. Sample distribution among participants with and without prior CWN involvement followed a 1 to 4 ratio.

Table 6. Descriptive Statistics

Category	Demographic	Percent
Gender	Men	50.91%
	Women	49.09%
Student	Undergraduate	98.18%
	Graduate	1.82%
Time Spent with a CWN	0 months	78.18%
	<6 months	2.73%
	Between 6 and 12 months	4.55%
	Between 12 and 24 months	2.73%
	>24 months	11.82%

Note. $N = 110$

Table 7 contains mean, standard deviation, and correlation values between various factors in the prospective stakeholder participation. By observing the mean values, one could say CWN participants were more extrinsic motivated, with attitude towards behavior, long term consequences, intrinsic motivation, and training achieving the highest scores, followed by university support, social factors, image, affect towards use, subjective norms, and complexity. Among behavioral intention factors, extrinsic motivation had higher score, with complexity valued the least. Attitude towards behavior scored higher, and affect towards use scored least among the attitude towards technology factors. Training scores were higher followed by university support among facilitating conditions. Labor scores were higher when compared to time in the impediments.

These scores and rankings were on the expected lines based on the survey findings as generally human concerns had higher values than the ego anticipations. The smaller score for complexity confirmed less importance for student involvement in the complex applications.

For analysis, it is assumed that a strong relationship exists between variables for the Pearson coefficient between .75 and 1.0, good relationship exists between the variables for the Pearson coefficient between .50 and .75, somewhat less than average relationship for Pearson coefficient values between .25 and .50, and weak relationship between variables for the Pearson coefficient between .00 and .25.

Extrinsic motivation had a good relationship with long-term consequences, social factors, attitude towards behavior, training, and image factors, whereas complexity had a weak relationship with extrinsic motivation. In other words, participants were extrinsically motivated when they saw the benefits of long-term consequences, the status they held, social weightage, the training university provided, and the image they projected because of their participation in a university anchored CWN.

It was interesting to observe that participants prefer training to achieve their outcome that should reflect a pay-off in the long run from the relationship between long-term consequences and training. Social factors, attitude towards behavior, image, and also intrinsic motivation are the other important factors for someone to consider in the long-term consequences of the participation. Complexity has a weak relationship with all other factors of stakeholder participation.

It was noticeable that social factors, image, attitude towards behavior, intrinsic motivation, and training were the critical factors for the participants to consider during their involvement in the university anchored CWN. Another point to be noted from the observations

was that the amount of labor they needed to be involved was one of the important factors concerning their decision to participate in the CWN activity.

As observed in Table 8, a person's negative or positive feelings about the intended target behavior along with the training had a significant effect on intrinsic motivation. Participant's individual affect toward usage and Image played other key influencing roles about individual's intrinsic motivation.

In summary, observing motivation values and correlation indicated that participants exhibit strong extrinsic motivation behavior, followed by attitude towards behavior, long-term consequences, intrinsic motivation, and training factors have both positive and negative influences on the CWN collective actions. For the impediments in Table 8, labor had a relationship with intrinsic motivation, attitude towards behavior, image, training, subjective norms, social factors, affect towards use, university support, mainly, and has a weak relationship with complexity, time, long-term consequences, and extrinsic motivation. On the other hand, time had a weak relationship with majority of the factors, other than affect towards use, and training. Majority of the factors had a direct relationship with labor, and only few factors had a dependency with time as reflected in Table 8.

Table 7. Mean and Standard Deviation for Prospective Student Participation

Factor	Mean	*SD*
Extrinsic motivation	3.75	1.42
Long term consequences	3.35	1.00
Complexity	2.39	1.00
Subjective	2.47	1.27
Social factors	2.97	1.21
Image	2.71	1.28
Attitude towards behavior	3.46	1.16
Intrinsic motivation	3.18	1.22
Affect towards use	2.63	.99
University support	2.97	1.63
Training	3.15	1.27
Time	3.00	1.12
Labor	3.15	1.48

Table 8. Correlation between Factors in the Prospective Student Participation

Factor	1	2	3	4	5	6	7	8	9	10	11	12	13
Extrinsic motivation	1.000	.742**	.075	.417**	.591**	.530**	.574**	.437**	.445**	.345**	.567**	.353**	.420**
Long term consequences	.742**	1.000	.128	.537**	.657**	.638**	.656**	.603**	.593**	.503**	.679**	.488**	.495**
Complexity	.075	.128	1.000	.336**	.216*	.183	.029	.038	.285**	.061	.100	.290**	.081
Subjective	.417**	.537**	.336**	1.000	.748**	.682**	.616**	.644**	.582**	.515**	.636**	.358**	.539**
Social factors	.591**	.657**	.216*	.748**	1.000	.769**	.741**	.686**	.610**	.531**	.673**	.437**	.530**
Image	.530**	.638**	.183	.682**	.769**	1.000	.689**	.702**	.646**	.516**	.706**	.477**	.592**
Attitude towards behavior	.574**	.656**	.029	.616**	.741**	.689**	1.000	.833**	.563**	.547**	.713**	.401**	.660**
Intrinsic motivation	.437**	.603**	.038	.644**	.686**	.702**	.833**	1.000	.704**	.624**	.780**	.452**	.669**
Affect towards use	.445**	.593**	.285**	.582**	.610**	.646**	.563**	.704**	1.000	.554**	.615**	.629**	.514**
University support	.345**	.503**	.061	.515**	.531**	.516**	.547**	.624**	.554**	1.000	.660**	.445**	.512**
Training	.567**	.679**	.100	.636**	.673**	.706**	.713**	.780**	.615**	.660**	1.000	.543**	.585**
Time	.353**	.488**	.290**	.358**	.437**	.477**	.401**	.452**	.629**	.445**	.543**	1.000	.373**
Labor	.420**	.495**	.081	.539**	.530**	.592**	.660**	.669**	.514**	.512**	.585**	.373**	1.000

Note. **Pearson correlation significant at .01 level; *Pearson correlation significant at .05 level

Table 9. Mean, Standard Deviation, and Correlation for CWN Tasks

Task		Mean	*SD*	Services	Technical Support	Meeting forums
Services	Pearson correlation	3.81	.67	1.000	.607**	.565**
	Sig. (2-tailed				.000	.000
Technical support	Pearson correlation	2.54	1.03	.607**	1.000	.739**
	Sig. (2-tailed)			.000		.000
Meeting forums	Pearson correlation	2.98	1.03	.565**	.739**	1.000
	Sig. (2-tailed)			.000	.000	

Note. **Pearson correlation significant at .01 (2-tailed)

Mean Values and Correlations on CWN Tasks

Table 9 shows the means, standard deviations, and correlation values for different CWN tasks in the prospective stakeholder participation. Mean values for CWN tasks indicate that CWN participants strongly prefer to be part of services, followed by moderating meeting forums, and technical services. This was an interesting point, as participants expressed their desire to work more on the services, which included communication (VoIP, Chat, Email), File sharing (FTP, Telnet), Network, and Web services, but were less inclined towards providing technical services which included offering technical assistance to other members, website maintenance, and creating content.

As seen in Table 9, Technical support had a strong relationship with moderating the meetings, followed by the relationship between technical support and services, and then between meeting forums and services. One interesting point to observe was that all these CWN tasks were correlated at the .01 level. Overall, participation in a university anchored CWN had

significant interest and among various CWN tasks also had good relationship within all the factors.

Predicting the Effect of Influencing Factors on Student Participation

This involved investigation of Hypotheses 1 to 4 by analyzing the effect of behavioral intention, attitude towards technology, facilitating conditions, and impediments on stakeholder participation in order to understand the CWN sustainability. It was assumed that these four factors and their associated subfactors had an influencial effect on the participant involvement. In performing this analysis, a logistic regression statistical technique was chosen to be the best fit. Logistic regression statistical method is a multivariable technique that is used to assess the predictive analysis of a set of independent variables on one dependent variable (Hosmer & Lemeshow, 1989).

In this analysis, the dependent variable student participation, that was measured by three values in the survey (more, less, and same extenet) was transformed into a binary value (0: less vs. 1: more or same extent) for further analysis.

Hypothesis 1

Hypothesis 1 was tested based on logistic regression model 1 in which the independent variable used was behavioral intention, which consisted of extrinsic motivation, long-term consequences, complexity, subjective norm, social factors, image, and an ordinal dependent variable prospective participation. Within the behavior intention sub-factors, complexity (*p*-value = .007) and social factors (*p*-value = .015) were statistically significant with a *p*-value < .05 (alpha). All other sub-factors in the behavioral intention spectrum had *p*-values > .05 and, hence, were statistically insignificant (extrinsic motivation (*p*-value: .248, long term consequences (*p*-value: .465), subjective norms (*p*-value: .609), image (*p*-value: .676)). Based

on the odds ratio—which is an exponentiation of the *B* coefficient among the behavior intention sub-factors—social factor was observed to be a positive predictor of increased student participation. On the other hand, complexity was observed to be a negative predictor. Hence, Hypothesis 1 was accepted for some behavioral intention profiles and rejected for certain others.

Hypothesis 2

Hypothesis 2 was tested based on logistic regression Model 2 in which the independent variable used was attitude towards technology, which included attitude towards behavior, intrinsic motivation, affect towards use, and an ordinal dependent variable prospective participation.

Among the attitude towards technology sub-factors, attitude towards behavior (*p*-value = .009) was the only sub-factor which was statistically significant with a *p*-value < .05 (alpha). Other sub-factors had *p*-values > .05 and were statistically insignificant: intrinsic motivation, *p*-value: .286), affect towards use (*p*-value: .669). Based on the odds ratio, among the attitude towards technology sub-factors, attitude towards behavior was the only significant variable partly confirming Hypothesis 2.

Hypothesis 3

Hypothesis 3 was analyzed based on logistic regression Model 3 in which the independent variable involved was facilating conditions, whcih included university support, training, and an ordinal dependent variable prospective participation. Among the facilitating conditions sub-factors, training with a *p*-value = .042 was statistically significant and university support was statistically insignificant with a *p*-value =.729. Based on the odds ratio, training was found to be a positive predictor; thus, training was the only significant sub-factor among facilitating conditions partly confirming Hypothesis 3.

Hypothesis 4

Hypothesis 4 was analyzed based on logistic regression Model 4 in which the independent variable was impediments, which consisted of time, labor, and an ordinal dependent variable prospective participation. Among the impediments sub-factors, labor (*p*-value = .009) was statistically significant and time was statistically insignificant with a *p*-value =.964. Based on the odds ratio, labor was found to be a positive predictor; thus, impediment did not have a negative impact on the prospective student participation, hence rejecting Hypothesis 4.

A stepwise logistic regression was used and the output confirmed that facilitating conditions was the most significant factor out of all the other factors for prospective student participation in a university anchored community wireless networks. Overall, the statistical analysis conducted as part of testing Hypothesis 1 to 4 offered a comprehensive outlook on prospective participation. At the sub-factor level, social factors, in which an individual's specific interpersonal agreements made with other individuals in specific social situations, was the most influencing factor, followed by attitude towards behavior, which was related to the positive or negative feelings expressed by different students about their participation.

Table 10. Logistic Regression Results for Various University Anchored CWN Sub-factors

Model	Variable	Wald	Odds ratio	2 Log Likelihood	Cox & Snell R^2	Nagelkerke R^2	Chi-square (p-value)
1	Extrinsic motivation	1.335	1.776				
	Long term Conse-quence	.535	.669				
	Complexity	7.249 (*)	.323	83.906[a]	.230	.357	28.427 (.000)
	Subjective norms	.261	1.246				
	Social factors	5.892 (*)	3.519				
	Image	.174	.828				
2	Attitude towards behavior	6.806 (*)	3.309	96.187[a]	.138	.214	16.147 (.001)
	Intrinsic motivation	1.140	.606				
	Affect towards use	.183	1.183				
3	University Support	.120	1.101	101.525[a]	.097	.152	11.280 (.004)
4	Time	.022	.964	101.004[a]	.076	.120	8.636 (.013)
	Labor	6.875 (*)	1.665				

Over-all	CWN Tasks	3.829 (*)[1,2]	2.123[1,2]				
	Behavioral intention	.049	.891				
	Attitude toward technology	.062	1.118	94.080[a]	.131	.205	15.107 (.010)
	Facilitating conditions	7.114 (*)[1,2]					

Note. *.Significance at .05 level; [a] Estimation terminated at iteration number 5 because parameter estimates changed by less than .001; [1] Forward stepwise: terminated in two steps, variables entered on step-1: Facilitating conditions, step 2: CWN tasks; [2] Backward stepwise conditional elimination method: terminated in 4 steps, 2 variables retained

Predicting the Influencing Factors in a University Anchored CWN

The content of this section investigated Hypothesis 5 and 6 to better understand the influencing factors that favor the longivity of university anchored CWN.

Hypothesis 5

Hypothesis 5 involved comparing four unmatched groups, namely behavioral intention, attitude towards technology, facilitating conditions, and impediments to discover the most significant of the four. The Kruskal-Wallis test was used to analyze this hypothesis.

As presented in Table.11, among the students who expressed their interest in participation, facilitating conditions (*p*-value=.001), followed by attitude towards technology (*p*-value: .002), then behavioral intention (*p*-value: .026), whereas impediments was statistically insignificant (*p*-value: .068). From the average ranks for all four groups, facilitating conditions had the largest average rank (with the best score of 60.14) followed by attitude towards technology then behavioral intention. It appeared that behavioral intention was not the most

influential factor of the four for prospective stakeholder participation, and hence, Hypothesis 5 was rejected.

Table 11. Kruskal-Wallis Test Results for Various University Anchored CWN Sub-factors

Variable	Kruskal-Wallis Mean Rank	Chi-square (Sig.)	One ANOVA *F* (Sig.)
Behavioral intention	58.98[a] (*)	4.945[b] (.026)	4.411 (.038) (*)
Attitude towards technology	59.55[a] (*)	9.242[b] (.002)	9.214 (.003) (*)
Facilitating conditions	60.14[a] (**)	10.770[b] (.001)	9.766 (.002) (*)
Impediments	57.64[a]	3.340[b] (.068)	3.766 (.055)

Note. **Significant at .001 level; *Significant at .05 level; [a] Kruskal-Wallis test; [b]Grouping Variable: Participation

Hypothesis 6

Hypothesis 6 involved comparing two unmatched groups, namely attitude towards technology and facilitating conditions to find out the more significant of the two. The Mann-Whitney test was used to analyze this hypothesis.

As seen in Table 12, among the students who expressed an interest in participation, facilitating conditions was significant at *p*-value=.001, whereas attitude towards technology was significant at .002. From the mean ranks for these two groups, facilitating conditions had the best score when compared with attitude towards technology. Thus, attitude towards technology was not a higher influence than facilitating conditions on the prospective stakeholder participation factors, and hence Hypothesis 6 was rejected.

Table 12. Mann-Whitney Test Results

Variable	Mean Rank	Sum of Ranks	Mann-Whitney *U*	Wilcoxon *W*	*Z*
Attitude toward technology	59.55[a]	5121.50	597.500 (*) [a]	873.500	-3.040
Facilitating conditions	60.14[a]	5232.00	597.000 (**) [a]	873.000	-3.282

Note. **Significant at .001 level; *Significant at .002 level; [a]Grouping Variable: Participation

Profiling CWN Participants

The scope of profiling CWN participants was to reserach Hypothesis 7 and 8 by grouping survey answers using similar responses in behavioral intention profiles and CWN task profiles. Cluster analysis was chosen as the appropriate statistical technique to perform this analysis. Meaningful profiles that segment responses from the survey were constructed using cluster analyisis method based on the similarities in behavioral intention and CWN tasks.

Identifying the number of clusters used in Hypothesis 7 and Hypothesis 8 were based on analyzing various factors, in particular based on the elbow method. Elbow method looks at the percentage of variance as a function of the number of clusters. In doing so, one should choose a number of clusters so that adding another cluster does not give much better modeling of the data. More precisely, if the percentage of variance by the clusters was graphed against the number of clusters, the first clusters will add much information, but at some point the marginal gain will drop, giving an angle in the graph. The number of clusters will be chosen at this point, hence the "elbow criterion." Percentage of variance is the ratio of the between-group variance to the total variance, which is the *F*-value.

Hypothesis 7

The five cluster solution was applied to analyze the grouping of behavioral intention profiles to support Hypothesis 7 in that university anchored CWN participants could be grouped into five distinctive behavioral profiles. ANOVA results are analyzed and elbow method is employed as shown below in deciding about the number of clusters used in this hypothesis. Table 13 shows the F values that are associated with factors from behavioral intention profiles.

Table 13. Hypothesis 7 ANOVA Results

ANOVA

		Sum of Squares	*df*	Mean Square	*F*	Sig.
Extrinsic motivation	Between Groups	14.330	1	14.330	7.493	.007
	Within Groups	206.543	108	1.912		
	Total	220.873	109			
Long-term consequences	Between Groups	5.511	1	5.511	5.701	.019
	Within Groups	104.406	108	.967		
	Total	109.917	109			
Complexity	Between Groups	2.435	1	2.435	2.483	.118
	Within Groups	105.911	108	.981		
	Total	108.346	109			
Subjective norms	Between Groups	9.831	1	9.831	6.393	.013
	Within Groups	166.087	108	1.538		
	Total	175.918	109			
Social factors	Between Groups	21.177	1	21.177	16.492	.000
	Within Groups	138.681	108	1.284		
	Total	159.858	109			
Image	Between Groups	13.067	1	13.067	8.481	.004
	Within Groups	164.859	107	1.541		
	Total	177.926	108			

F-values from Table 13 above, a graph were plotted against the number of clusters to come up with the appropriate cluster number. At some point the marginal gain drops, giving an angle in the graph which was the pattern sought.

The start of the "elbow" is indicated by the arrow in the Figure 11. The number of clusters chosen should, therefore, be "5" for behavior intention profiles.

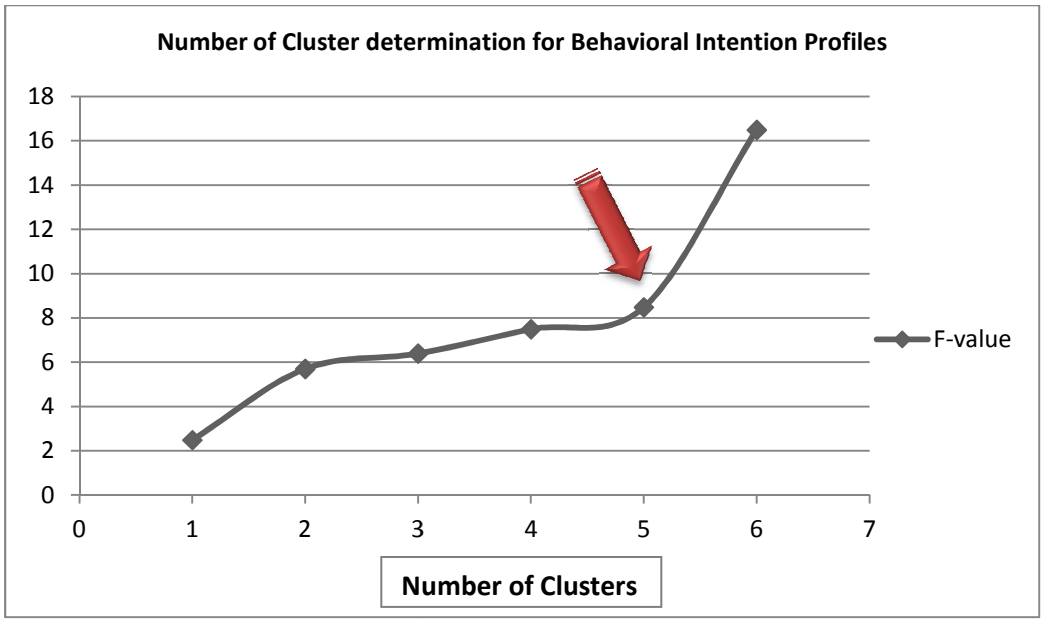

Figure 11. Number of Clusters - H7

To analyze these findings mean values (cluster centers) were analyzed and then compared to those values of the overall means. At the conclusion of the analysis, a label was assigned to each of the groupings. Table 14 summarizes the cluster centers and labels for each of the behavioral intention clusters based on each of cluster's performance against the overall means.

Table 14. Analysis of Behavioral Intention Cluster Results

	Cluster Centers					
Variable (Overall Mean/ Standard Dev.)	Cluster 1 (*n* = 26)	Cluster 2 (*n* = 27)	Cluster 3 (*n* = 12)	Cluster 4 (*n* = 1)	Cluster 5 (*n* = 43)	*F*=value
Extrinsic Motivation (3.75/1.42)	5.00	4.00	2.00	13.00	4.00	117.891 (**)[1]
Long term consequences (3.35/1.00)	4.31	3.27	1.49	4.83	3.36	48.453 (**)[1]
Complexity (2.391/1.00)	3.00	2.00	2.00	2.00	3.00	1.725[1]
Subjective norms (2.47/1.27)	4.00	1.00	1.00	3.00	3.00	66.752 (**)[1]
Social factors (2.97/1.21)	5.00	2.00	1.00	4.00	3.00	85.165 (**)[1]
Image (2.71/1.28)	4.27	1.52	1.28	4.00	2.89	69.087 (**)[1]
Cluster label	Very likely Motiva-tors	Moderate Motiva-tors	Less likely Motiva-tors	Extremely Motivators	Notice-able Motiva-tors	

Note. ** Significance at .000 level; [1] ANOVA

Among the five cluster groups, there existed a consistent motivated cluster group named "Very Likely Motivators." Participants with noticeable factors were grouped as "Noticeable Motivators." A moderately motivation group labeled was "Moderate Motivators." A group of participants with below average motivation and other factors were grouped as "Less Likely Motivators." A small extremely motivation group was named "Extremely Motivators."

The “Very Likely Motivators” group exhibited preferences wherein preferences gradually increased from complexity to subjective norms to image to long term consequences to extrinsic motivation and social factors. The “Noticeable Motivators” exhibited preferences that increased from image to complexity, subjective norms, and social factors to long term consequences to extrinsic motivation. The “Very Likely Motivators” and “Noticeable Motivators” groups exhibited more stable mean values (cluster centers) across the behavioral intention spectrum with values above the overall mean values.

Extrinsic motivation was the only factor above the overall mean for “Moderate Motivators” group and exhibited preferences below overall mean for the remaining. The “Extremely Motivators” group exhibited fluctuations in the cluster centers with extrinsic motivation at 13 and complexity at a cluster center of 2. The “Less Likely Motivators” group exhibited preferences below the overall mean for all the factors. It was interesting to note that all the cluster participants from various groups other than from the “Less Likely Motivator” were extrinsic motivated with group mean value above the overall mean value.

Hypothesis 8

The cluster technique was used on CWN tasks to corroborate Hypothesis 8 in which university anchored CWN students can be grouped into two different student profiles based on the CWN tasks. To analyze this hypothesis, mean values (cluster centers) were examined and compared those values with the overall means. As a final step, a label was assigned to each group of clusters with the CWN tasks.

ANOVA results are analyzed and elbow method is employed as shown below in table 15 in deciding about the number of clusters used in this hypothesis.

Table 15 shows the F values that are associated with different factors from behavioral CWN tasks profiles.

Table 15. ANOVA Results - H8

ANOVA

		Sum of Squares	*df*	Mean Square	*F*	Sig.
Services	Between Groups	1.735	1	1.735	4.012	.048
	Within Groups	46.708	108	.432		
	Total	48.444	109			
Technical support	Between Groups	2.500	1	2.500	2.363	.127
	Within Groups	114.233	108	1.058		
	Total	116.732				
Meeting forums	Between Groups	2.839	1	2.839	2.734	.101
	Within Groups	112.141	108	1.038		
	Total	114.980	109			

Using the *F*-values from table 15 above, a graph was plotted against the number of clusters to find the appropriate cluster number. At some point the marginal gain drops, giving an angle in the graph which is what is sought.

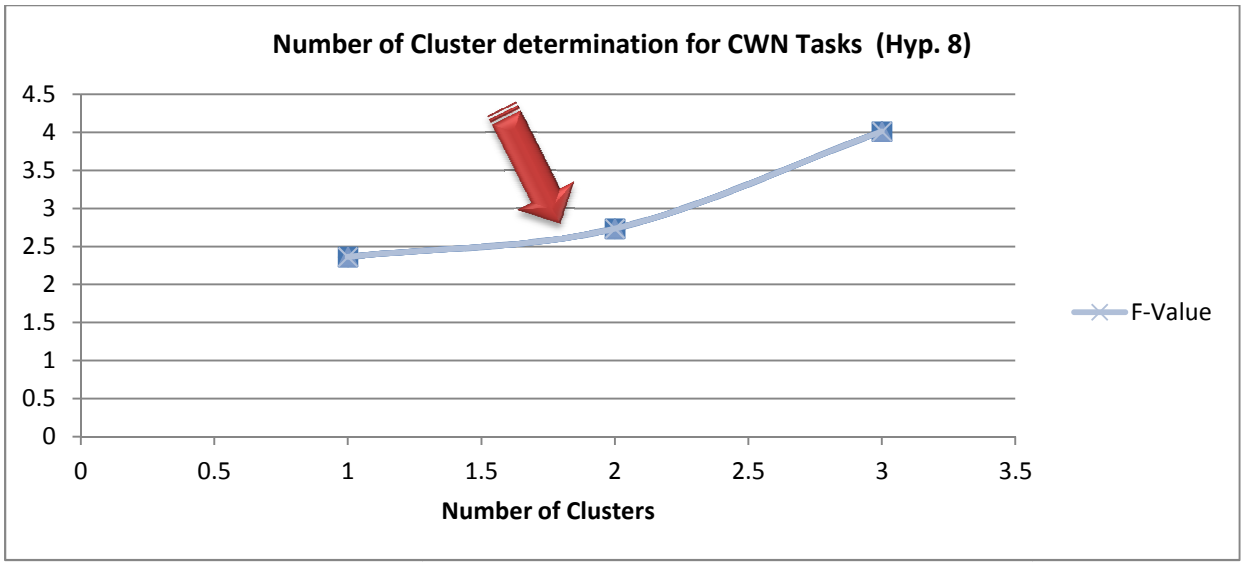

Figure 12. Number of Clusters - H8

The "elbow" start is indicated by the arrow in the above Figure 12. The number of clusters chosen, therefore, was "2" CWN Tasks profiles.

Table 16 summarizes the mean values and assigned labels for each of these clusters based on their values against the overall mean values. Table 16 defines two student member groupings: a cluster of more active participants who were more eager contributors and were labeled "Very Likely Involvers," a cluster of lesser enthusiastic student participants who exhibited below average preferences in the variables were labeled as "Less Likely Involvers."

As indicated in Table 16, 61 % of the participants fell within the Very Likely category which suggested considerable involvement in the university anchored CWN. The "Very Likely Involvers" group had preferences that gradually increased from technical support to meeting forums to services, interestingly "Less Likely Involvers" also exhibited similar preferences which increased from technical support to meeting forums to services with values less than the overall means. Based on this analysis, CWN tasks classification followed a 3:2 with and without involvement in the CWN tasks grouping.

Table 16. Analysis of CWN Tasks Cluster Results

Variable (Overall Mean/ Standard Dev.)	Cluster Centers		
	Cluster 1 (n = 43)	Cluster 2 (n = 67)	F-value
Services (3.81/.67)	3.3	4.1	52.574 (**)
Technical support (2.54/1.03)	1.6	3.2	129.882 (**)
Meeting forums (2.98/1.03)	2.1	3.6	101.159 (**)
Cluster Label	Less Likely Involvers	Very Likely Involvers	

Note. ** Significance at .000 level

Analysis of Various Factors on Collective Actions

This section investigated Hypothesis 9 by segmenting survey responses based on the collective actions.

Hypothesis 9

It was necessary to understand the motives behind student participation in a university anchored CWN on various collective actions. These collective actions included “Contribute money“, “Donate unused hardware, “Labor, “Software development, “Network administration, “System administration, “Technical support, and “Campaign. Hypothesis 9 was tested by considering a null hypothesis that all the collective actions had equal means. One-way analysis of variance was used to test this null hypothesis as this involved examining the variability of the means in order to draw conclusions about the population means.

Of the 110 participants in this survey, 79.09% expressed their desire to be part of the CWN anchored by their home university, whereas the remaining 20.91% students did not wish to be a part of this CWN movement.

On the collective actions, 5.45% of the respondants expressed their desire to contribute to all the eight contributing factors, 8.18% expressed a desire to contribue to any seven factors, 8.18% for any six factors, 3.64% for any five factors, 10% for any four factors, 10% for any three factors, 12.73 % for any two factors. The majority (40.91%, 45 respondents) expressed their interest to participate in any one of the contributing factors, and only .91% expressed that they did not wish to contribute anything. This showed that 99.09% participants showed an interest in contributing to the university anchored CWN and were ready to contribute to the success of this CWN.

Of the respondents, 13.64% expressed an interest in contributing money, 38.18% for contributing unused hardware, 44.55% for contributing to the labor, 37.27% for contributing to the open source software development, 45.45% for contributing to network administration, 37.27% for contributing to system administration, 47.27% for contributing to technical support, and 40.91% for campaigning about the CWN with others. This indicated that the majority of the student participants wanted to be involved in the technical support, network administration, labor associated with the university anchored CWN setup, and campaigning. A lesser number of students expressed their desire to contribute money. This was somewhat expected as students have other important financial commitments in an education centric environment.

Table 17. Analysis of Participation on Various Collective Actions Using ANOVA

Contributing Variables		Sum of Squares	Mean Square	*SD*	*F*	Sig.
Money	Between Groups	.071	.071	.345	.595	.442
	Within Groups	12.884	.119			
Hardware	Between Groups	.003	.003	.488	.011	.917
	Within Groups	25.961	.240			
Labor	Between Groups	.277	.277	.499	1.113	.294
	Within Groups	26.896	.249			
Software Dev.	Between Groups	1.707	1.707	.486	7.679 (*)	.007
	Within Groups	24.011	.222			
Network Admin.	Between Groups	.656	.656	.500	2.662	.106
	Within Groups	26.617	.246			
System Admin.	Between Groups	1.707	1.707	.486	7.679 (*)	.007
	Within Groups	24.011	.222			
Technical Support	Between Groups	2.597	2.597	.502	11.298 (**)	.001
	Within Groups	24.822	.230			
Campaigning	Between Groups	1.069	1.069	.494	4.522 (*)	.036
	Within Groups	25.522	.236			

Note. **Significant at .001 level; *Significant at .05 level

The larger value of *F* provided evidence against the null hypothesis. As seen in Table 17, technical support (*F*-value: 11.298 with a *p*-value of .001) was statistically significant for other collective actions followed by system administration and software development (*F*-value: 7.679 with a *p*-value of .007), then campaigning (*F*-value: 4.522, *p*-value: .036). All other collective actions were statistically insignificant (money, hardware, labor, network administration). Thus, not confirming null hypothesis that all the collective actions had equal means, and hence Hypothesis 9 was rejected.

CHAPTER 5

DISCUSSION, RECOMMENDATIONS, AND SUMMARY

The objective of this research sought to discover the ability and willingness of student participation in a university anchored CWN and to investigate the relationship between the motivating factors and collective actions. This research focused on finding the important factors for increased student participation as a measure of sustainability in a universoty anchored CWN. The focus of this study was to understand the factors affecting the involvement of students and the impact on collective actions in a university anchored community wireless network'.

The purpose of this study was intended to answer research questions concerning various factors affecting student participation in a university anchored CWN and could serve to provide policy makers, administrators, and management with strategies and decisions. This involved investigating the following research questions:

1. What motivates students in the university environment to voluntarily participate in a CWN? This involved analyzing:
    - The factors and sub-factors for positive and negative effects on the student participation.
    - The factors which are influential on the student participation.
    - The motivation profiles of student participants in a CWN.

- The participatory preferences as exhibited by student participants with regard to the processes supporting the operation of a university anchored CWN?

2. What impact participation has on various collective actions in a university anchored CWN? This involved analyzing:
    - The effect of participation on collective actions, which included money, hardware, labor, open source software development, network administration, system administration, techinical suppport, and campaigning about the CWN.

Discussion of Research Findings

The paragraphs below outline the contributions made by the student participants of this investigation.

Contribution 1

A Detailed Empirical Analysis on Student Participation in a CWN. The first objective of this research was to understand the features of university anchored CWNs and get an idea of the method used in mobilizing the student participants. To achieve this objective, this research differentiates itself from prior investigations by developing a framework showcasing the relevant concepts and inter-dependability between the key elements involving student participation. This investigation is mainly constrained within the walls of the student participation and university as an organization anchoring this CWN phenomenon.

This research was developed based on the sub-factors and factors from the framework designed and translated those elements into measurable indicators—designed, developed, and finally exploited the outcome of the survey on 110 student participants—which separates this from other scholarly work. Hence, this study contributes to the emerging university anchored CWN investigation by exploring the factors and sub-factors that impact student participation by

employing a quantitative approach offering a significant insight into the students that volunteer to be part of the community projects in a university anchored CWN.

Contribution 2

Impact analysis of participation on collective actions in a CWN. Collective action is viewed as the pursuit of a set of goals by more than one person. CWN is the result of efforts by various individuals who cooperate with each other to achieve a common goal in the deployment of wireless infrastructure for a good cause. In the CWN context, the wireless community transforms its volunteers and members' contributions to a collectively owned outcome, the wireless communications infrastructure.

It was necessary to understand the motives behind student participation in a university anchored CWN on various collective actions. These collective actions included "contribute money, "donate unused hardware, "labor, "software development, "network administration, "system administration", "technical support", "campaign.

Findings from this research showed that 79.09% of the participants expressed their desire to be part of the CWN anchored by their university, whereas the remaining 20.91% students did not wish to be part of this CWN movement. On the collective actions, 5.45% of the respondents expressed their desire to contribute to all the eight contributing factors, 8.18% expressed their desire to contribue to any seven factors, 8.18% expressed their desire to contribute to any six factors, 3.64% expressed their desire to contribute to any five factors, 10% expressed their desire to contribute to any four factors, 10% expressed their desire to contribute to any three factors, 12.73% expressed their desire to contribute to any two factors. The majority (40.91%, 45 respondents) expressed their interest to participate in any one of the contributing factors, and only .91% expressed that they did not wish to contribute anything. This showed that 99.09%

participants showed their interest in contributing to the university anchored CWN and were ready to contribute to the success of this CWN.

Of the participants, 13.64% expressed their interest to contribute money, 38.18% expressed their interest in contributing unused hardware, 44.55% expressed their interest in contributing to the labor, 37.27% expressed their interest in contributing to the open source software development, 45.45% expressed their interest in contributing to network administration, 37.27% expressed their interest in contributing to system administration, 47.27% expressed their interest in contributing to technical support, and 40.91% expressed their interest in campaigning for the CWN with others. This indicated that majority of the student participants wanted to be involved in the technical support, network administration, and labor associated with the university anchored CWN setup, and campaign with others students about their participation.

One interesting point to note is their willingness to donate their unused hardware, which is a little bit above their expressed intention to participate in the system administration and open source software development. A lesser number of participants expressed their desire to contribute money, this was somewhat expected as students have other important financial commitments in an education centric environment.

In summary, the majority of the participants expressed their intention to be part of their university anchored CWN with a 4:1 acceptance ratio, and interestingly nearly all of the participants in this survey expressed their intention to contribute to the collective actions, which would serve to provide policy makers, administrators, and management with strategies and decisions about the next step in the implementation process.

Recommendations

There are several recommendations that can be made from the results of this study. In terms of recommendations for future reserach, this study can be replicated in other universities to explore the trends and outcomes in other environmental conditions on the characteristics of student participation and collective actions. Consolidating and comparing these results from various universities would give an overall view on the university anchored CWN and would be helpful in undetstanding the relationship between student diversity and local factors that would influence student participation. For example, it would be intersting to reserach future university anchored CWNs with the important aspects shaping the local contexts such as students interest, student motivating factor variations among different student groups, legal and regulatory policies, impact on collective actions among various student groups, and any other factors that impact the implimentation of CWNs in the academic environment.

Next, it would be intersting to seek an alternate research technique to the one used in this study to investigate similar reserach objectives related to CWN collective actions in a university anchored setup. In particular, investigate the perceptions, attitudes, behaviors, and influencing factors of stakeholders, and its sustainability and longivity in a university anchored environment. There are two ways of making this focus shift; one way is to employ a qualitative method based on the case studies, student observations, then investigate the research objectives with any additional factor-sub factor sets. Another one involves exploring the same through different quantitative sets simulation and mathematical modelings to pinpoint the interests of CWN stakeholders.

It would be intersting to add aditional reserach questions that test additional elements/factors that could influence student participation in a university anchored CWN. These

may include an element that explicitly defines the cost that a participant could face for his or her participation in the CWN activity or may include a range of various cost elements for exploration. This could also be explored outside the six elements, namely behavioral intention, attitude towards technology, facilitating conditions, impediments, participation, and prospective stakeholder participation for additional measures of sustainability and any essential factors in understanding the collective actions.

Future studies could focus on identifying additional CWN characteristics by exploring other concepts that could influence collective actions to be useful for this study. Game theoretic tools could be used in exploring the addiitonal collective actions along with other collective actions theories in framing these additional collective actions. Game theory could be used to explore dilemmas associated with stakeholder behaviors and strategic implications for their involvement in a university anchored CWN.

Summary

Community Wireless Networks are a wireless technology-based community project in which individuals get together to build a wireless infrastructure. The emergence of community wireless has created opportunities for various entities and in particular to universities by partnering with their local communities in providing opportunities for students to be part of the community-based initiatives. Universities could benefit from participating in community wireless partnerships by improving the value of the university among the locals and also can use CWN for generating revenue that could be used to fund some of the university-based research.

Student involvement is the main influencing factor for any university participation in anchoring a CWN. This study was employed to seek out the ability and willingness of student

participation in a university anchored CWN and to investigate the relationship between the motivating factors and collective actions.

This study employed empirical research methods on participants to understand the factors influencing the student participation in an education centric CWN and its significance on the collective actions. This involved analyzing five distinctive elements as essential in understanding the collective actions: behavioral intention, attitude towards technology, facilitating conditions, impediments, and prospective student participation.

This study results revealed that the students expressed their interest in participation, followed by facilitating conditions, attitude towards technology, and behavioral intention as the most important factors, whereas impediments was statistically insignificant for them. The research results also revealed that majority of the participants were interested to be part of their university anchored CWN and almost all the participants expressed their intention to contribute to the success of the CWN.

REFERENCES

Abdelaal, A. M., & Ali, H. (2007, August 9-12). *A typology for community wireless network business models.* Proceedings of the 12th Americas Conference on Information Systems, Keystone, CO.

Abdelaal, A. M., & Ali, H. (2008, August 14-17). *A graph theoretic approach for analysis and design of community wireless networks.* Proceedings of the 13th Americas Conference on Information Systems, Toronto, Canada.

Abdelaal, A., & Ali, H. (2009, May 18-20). *Community wireless networks: emerging wireless commons for digital inclusion.* The International Symposium on Technology and Society, Tempe, AZ.

Abdelaal, A., Ali, H., & Khazanchi, D. (2009, January 5-8). *The role of social capital in the creation of community wireless networks.* Presentation for the 42nd Hawaii International Conference on Systems Sciences. Waikoloa, HI.

Agarwal, R., Karahanna, E. (2000). Time flies when you're having fun: Cognitive absorption and beliefs about information technology usage. *MIS Quarterly, 24,* 665-695.

Akyildiz, I. F., Wang, X., & Wang, W. (2005). Wireless mesh networks: a survey. *Computer Networks, 47,* 445-487.

Allee, V. (2008). Value network analysis and value conversion of tangible and intangible assets. *Journal of Intellectual Capital, 9*(1), 5-24.

Aseeja, V., & Zheng, R. (2009, June 1-5). MeshMan: A management framework for wireless mesh networks. *IFIP/IEEE International Symposium on Integrated Network Management* (pp. 226-233). Retrieved from http://www.inf.ufpr.br/aldri/disc/artigos/2010/rodrigom_txt_apr-pdf

Avallone, S., Akyildiz, I. F., & Ventre, G. (2009). A channel and rate assignment algorithm and a layer-2.5 forwarding paradigm for multi-radio wireless mesh networks. *IEEE Networking, 17,* 267-280. doi:10.1109/TNET.2008.918091

Bar, F., & Galperin, H. (2004). Building the wireless Internet infrastructure: from cordless ethernet archipelagos to wireless grids. *Communication & Strategies, 54*(2), 45-54.

Best, J. W., & Kahn, J. V. (1998). *Research in education.* Boston, MA: Allyn & Bacon.

Best, M. L., & Maclay, C. M. (2002). Community Internet access in rural areas: Solving the economic sustainability puzzle. In G. Kirkman, J. Sachs, K. Schwab, & P. Corneilus (Eds.), *The global information technology report 2001-2002: Readiness for the networked world.* Oxford, England: Oxford University Press.

Bina, M. (2007). *Wireless community networks: A case of modern collective action.* (Doctoral dissertation, Athens University of Economics and Business). Retrieved from http://www.wirelessresearch.eu/docs/thesis_bina.pdf

Bina, M., & Giaglis, G. M. (2006, June 12-14). *A motivation and effort model for members of wireless communities.* Proceedings of the European Conference on Information Systems, Göthenburg, Sweden.

Camponovo, G., & Cerutti, D. (2005, July 11-13). WLAN communities and Internet access sharing: A regulatory overview. *International Conference on Mobile Business,* 281-287.

Coleman, J. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94,* 95-120.

Cook, T. D., & Campbell, D. T. (1979). *Quasi experimentation: Design and analytical issues for field settings.* Chicago, IL: Rand McNally.

Damsgaard, J., Parikh, M. A., & Rao, B. (2006). Wireless commons: Perils in the common good. *Communications of the ACM, 49*(2), 104-109.

Das, S., Papagiannaki, K., Banerjee, S., & Tay, Y. C. (2007). *SWARM: Self-organization of community wireless mesh networks.* Retrieved from ProQuest Educatio Journals. doi:10.1145/1364654.1364716

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13,* 319-339.

Davis, F. D., Bagozzi, R. P., & Warshaw, P. R. (1992). Extrinsic and intrinsic motivation to use computers in the workplace. *Journal of Applied Social Psychology, 22,* 1,111-1,132.

Deci, E. L., & Ryan, R. M. (2000). The what and why of goal pursuits: Human needs and the self-determination of behavior. *Psychological Inquiry, 114,* 227-268.

Drunen, R., Koolhaas, J. V., Schuurmans, H., & Vijn, M. (2003, June 9-14). *Building a wireless community network in the Netherlands.* Presented to the USENIX/Freenix Conference, San Antonio, TX.

Feld, H. (2005). Community wireless networks. *EDUCAUSE Review, 40*(1), 62-63.

Ferreira, E. W., De Oliveira, R., Carrijo, G. A., & Bhargava, B. (2009, June 22-26). *Intrusion detection in wireless mesh networks using a hybrid approach.* 29th IEEE International Conference on Distributed Computing Systems Workshops, Montreal, Quebec.

Fishbein, M., & Ajzen, I. (1975). *Belief, attitude, intention and behavior: An introduction to theory and research.* Reading, MA: Addison-Wesley.

Gale, D., & Kariv, S. (2007). Financial networks, American economic review. *American Economic Association, 97*(2), 99-103:

Giovanni, C., & Anna, P. (2010). A model for investigating motivations of hybrid wireless community participants. 9th International Conference on Mobile Business, Athens, Greece.

Hair, J. F., Anderson, R. E., Tatham, R. L., & Black, W. C. (1998). *Multivariate data analysis* (5th ed.). Englewood Cliffs, NJ: Prentice Hall.

Hamid, Z., & Khan, S. A. (2006, October 18-20). *An augmented security protocol for wirelessman mesh networks.* International Symposium on Communications and Information Technologies, Bangkok, Thailand.

Hosmer, D. W., & Lemeshow, S. (1989). *Applied logistic regression.* New York, NY: Wiley Interscience.

Lesser, E., Fontaine, M., & Slusher, J. (2000). *Knowledge and communities: Resources for the knowledge-based economy.* Oxford, England: Butterworth-Heinemann.

Mandviwalla, M., Jain, A., Fesenmaier, J., Smith, J., Weinberg, P., & Meyers, G. (2008). Municipal broadband wireless networks: Realizing the vision of anytime, anywhere connectivity. *Communications of the ACM,51*(2), 72-80.

Maxwell, S., & Delany, H. (1990). *Designing experiments and analyzing data: A model comparision perspective.* Pacific Grove, CA: Brooks/Cole.

Meinrath, S. (2007). *Business models for community wireless networks.* Retrieved from http://www.saschameinrath.com/2005_02_19_17_02__update_2_business_models_for_community_wireless_networks

Middleton, C. (2007, August 15). *A framework for investigating the value of public wireless networks.* Telecommunication Policy Research Conference, Arlington, VA.

Moore, G. C., & Benbasat, I. (1991). Development of an instrument to measure the perceptions of adopting an information technology innovation. *Information Systems Research, 2,* 192-222.

Nahapiet, J., & Ghoshal, S. (1998). Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review, 23,* 242-266.

Olson, M. (1965). *The logic of collective action.* Cambridge, MA: Harvard University Press.

Peter, C., Scott, J., & Wasserman, S. (2004). *Models and methods in social network analysis.* New York, NY: Cambridge University Press.

Pew. (2010). *Demographics of Internet users.* Retrieved from http://www.pewinternet.org/Trend-Data/Whos-Online.aspx

Quinn, P. (2006). *Community wireless and the digital divide.* Chicago, IL: Center for Neighborhood Technology.

Rogers, E. (1995). *Diffusion of innovations.* New York, NY: Free Press.

Rogers, E. M., & Shoemaker, F. F. (1971). *Communication of innovations: A cross-cultural approach.* New York, NY: Free Press.

Shin, D. H., & Venkatesh, M. (2008, January 7-10). *Analysis of the development of Kutztown community network.* Proceedings of the 41st Annual Hawaii International Conference on System Sciences,Waikoloa, Big Island, HI.

Siddiqui, M. S., & Hong, C. S. (2007, April 26-28). *Security issues in wireless mesh networks.* Presented to the International Conference on Multimedia and Ubiquitous Engineering, Seoul, Korea.

Simpson, L. (2005). Community informatics and sustainability: Why social capital matters. *Journal of Community Informatics, 1*(2), 102-119.

Souma, W., Fujiwara, Y., & Aoyama, H. (2005). Heterogeneous economic networks, games and economic behavior. *Elsevier, 54,* 353-372.

Spulber, D. F., & Yoo, C. S. (2005). On the regulation of networks as complex systems: A graph theory approach. *Northwestern University Law Review, 99,* 1687-1722

Stephen, L. J. (2004). *Advanced statistics demystified.* New York, NY: McGraw-Hill.

Straub, D., Boudreau, M. C., & Gefen, D. (2004). Validation guidelines for IS positivist research. *Communications of the AIS, 13,* 380-427.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1991). Personal computing: Toward a conceptual model of utilization. *MIS Quarterly, 15*(1), 124-143.

Thompson, R. L., Higgins, C. A., & Howell, J. M. (1994). Influence of experience on personal computer utilization: Testing a conceptual model. *Journal of Management Information Systems, 11*(1), 167-187.

U.S. Government Accountability Office. (2006). *Telecommunications: Broadband deployment is extensive throughout the United States, but it is difficult to assess the extent of deployment gaps in rural areas.* Washington, DC: Author.

Venkatesh, V. (2000). Determinants of perceived ease of use: Integrating control, intrinsic motivation, and emotion into the technology acceptance model. *Information Systems Research, 114,* 342-365.

Venkatesh, V., Morris, M., Davis, G., & Davis, F. (2003). User acceptance of information technology: Toward a unified view. *MIS Quarterly, 27,* 425-478.

Wellman, B., Haase, A. Q., Witte, J., & Hampton, K. (2001). Does the internet increase, decrease, or supplement social capital? Social networks, participation, and community commitment. *American Behavioral Scientist, 45,* 435-455.

APPENDIX A: SURVEY

This survey was developed specifically for this study.

Information:

1. You are a:

	Undergraduate	Graduate
Student		

2. Gender:

	Male	Female
Gender		

Wireless and Internet Activities:

3. Please indicate how often you perform the following activities on a 1 – 5 scale

   1–Never 2-Seldom 3-Sometimes 4-Often 5-Very often

Activity	**1**	**2**	**3**	**4**	**5**
Wireless Internet usage					
Communication services (example: VoIP, Chat, Email)					
File sharing services (example: FTP, Telnet)					
Multimedia and/or other web services					
Network Management services					
Creating content for the network					

Uploading content onto the network					
Reading comments that others have posted on the forums					
Posting comments on the forums					
Any forum moderation					
Participating in physical meetings with other members					
Offering technical assistance to other members					
Website maintenance					

Community Wireless Networks:

Community Wireless Networks (CWN) creates an opportunity for colleges and universities to form partnerships with local communities and businesses to enhance their educational mission by creating an opportunity for university stakeholders (students, etc.) to anchor the local economic growth. Universities can anchor the creation of CWN by extending the campus wireless cloud and, thereby, engage with the local community and potentially use this as a revenue stream to fund some of the research projects. University anchored CWNs have a dual purpose of supporting the mission of the institution as well as providing digital connectivity to the community it serves.

4. Are you part of any CWN:

    - Yes
    - No
    - I do not know

5. If you have answered yes to Q-4 above, how long you have been involved with CWN?

    - < 6 months
    - 6 - 12 months
    - > 1 year
    - > 2 years

The creation of university anchored CWN depends on the contributions from stakeholders. Being a participant in the CWN will give an opportunity for the stakeholders to be engaged with the local community and also to be part of potential revenue stream creation for the university research projects.

6. Please indicate how true each of the following statements are for your involvement in the future university anchored CWN (as a University stakeholder).

   1–Not True 2-Somewhat True 3-Half True 4-Mostly True 5-Very True

Fact	**1**	**2**	**3**	**4**	**5**
It would enable me to accomplish my tasks more quickly.					
It would improve my performance.					
It would increase my productivity.					
It would enhance my effectiveness on the tasks.					
It would make it easier to do all my tasks.					
I would find CWN useful in my day-to-day activities.					
I will increase my effectiveness on the work.					
I will spend less time on the routine work tasks.					
I will increase the quality of output of my work.					
I will increase the quantity of output for the same amount of effort.					
My coworkers will perceive me as competent					
I will increase my chances of getting a good job.					
Working on CWN is so complicated and hence it is difficult to understand what is going on.					
Working on CWN involves too much time of mechanical operations					

It takes too long to learn how to work on CWN, but is worth effort.					
People who influence my behavior think that I should be part of my university anchored CWN.					
People who are important to me think that I should be part of my university anchored CWN.					
I want to be part of this CWN because of the proportion of my university co-stakeholders involved in this CWN.					
My department is very supportive of individuals working on CWN.					
In general, my university has supported being part of this CWN.					
People in my university who are part of this CWN have more prestige than those who do not.					
People in my university who are part of this CWN have a high profile.					
Being part of CWN is a status symbol in my university.					
Being part of the CWN is a good idea.					
I like the idea of university anchored CWN.					
Being part of the CWN is pleasant.					
I find to be part of a CWN is enjoyable.					
The actual process of CWN involvement is pleasant.					
I have fun being part of CWN.					
Working on CWN makes my work more interesting.					
Working on the CWN is fun.					
Working on CWN is okay for some people, but not to me.					
Working on the CWN frustrates me.					

Once I start working on CWN, I find it hard to stop.					
I get bored quickly when working on the CWN.					
Guidance was available to me to work on the CWN from my university at any time.					
Specialized instruction concerning working on CWN will be available					
A specific person (or group) is available for assistance with any CWN difficulties.					
I will get proper training to be part of this CWN.					
I have the knowledge necessary to use the system.					
Being part of CWN would decrease the time needed for my important other responsibilities.					
I think I could do more important things with my time than participating in the wireless community.					
I would like be part of a team performing labor associated with CWN (Physical installation of antennas, installing wireless devices etc)					

7. Please click on the following that you would like to be involved in the CWN:

Activity	**To be Involved**
Contribute Money for this project.	
Donate unused hardware for this project (Computers).	
Part of a team performing labor associated with CWN project (Physical installation of antennas, installing wireless devices etc)	
Part of a team responsible for the open source software	

development for this project.	
Part of a team responsible for the Network Administration.	
Part of a team responsible for the System Administration.	
Part of a team responsible for the Technical Support for this project	
Part of a team responsible for networking with other new stakeholders to become part of this CWN in the University.	

8. Please click on one of the following that is more appropriate to you:

Activity	**To be Involved**
More involved in the CWN.	
Less involved in the CWN.	
More or less involved to the same extent in the CWN.	

APPENDIX B: STATISTICAL TOOLS

Logistic Regression

In this university anchored CWN investigation, the final output "Prospective student participation" has an outcome that is dichotomy (1=More/Same extent to participate; 0=Not participating), hence, a multiple linear regression to study the relationship between the outcome (Prospective student participation) and the independent variables (behavioral intention, attitude towards technology, facilitating conditions, and impediments) cannot be used.

The logistic regression model is a flexible tool for studying the relationship between a set of variables that can be continuous or categorical and a categorical outcome. In logistic regression, one can directly estimate the probability of an event occurring is computed by using the following equation (Stephen, 2004):

$$\pi(x) = \frac{e^{(\beta_0+\beta_1 x)}}{e^{(\beta_0+\beta_1 x)}+1} = \frac{1}{e^{-(\beta_0+\beta_1 x)}+1},$$

β_0 is the intercept from the linear regression equation, and $\beta_1 x$ is the regression coefficient multiplied by some value of the predictor, base '***e***' denotes the exponentiation function.

Input was $\beta_0 + \beta_1 x$, and the output was $\pi(x)$. The logistic function is useful because it can take as an input any value from negative infinity to positive infinity, whereas the output is confined to values between 0 and 1.

Odds ratio is an important factor when analyzing the logistic regression output, which is defined as the ratio of probability that an event occurs to the probability that it does not. That is, odds ratio = Probability (positive nodes) / Probability (negative nodes).

In this research for analyzing the effect of influencing factors on student participation, logistic regression seemed to be the appropriate choice, which involved investigating ***Hypotheses 1, 2, 3, and 4***, in which behavioral intention, attitude towards technology, facilitating conditions, and impediments are studied for the influencing factors on the CWN sustainability.

Kruskal-Wallis Test

When the population means of *k* populations are compared and it is known that the populations do not have equal variances or that the populations are not normal, the Kruskal-Wallis nonparametric test is used. The data in the *k* samples are replaced by their ranks and the rank sums are analyzed (Stephen, 2004). The following steps were used in the Kruskal-Wallis analysis:

1. Rank the data from all groups combined together; that is by ranking the data from 1 to *N*.
2. Kruskal-Wallis Mean rank is computed by using the following formula:

$$K = (N-1)\frac{\sum_{i=1}^{g} n_i(\bar{r}_{i\cdot} - \bar{r})^2}{\sum_{i=1}^{g}\sum_{j=1}^{n_i}(r_{ij} - \bar{r})^2},$$

Where, n_i - The number of observations in group i

$\bar{r}_{i\cdot} = \frac{\sum_{j=1}^{n_i} r_{ij}}{n_i}$, $\bar{r} = \frac{1}{2}(N+1)$ - Average of all the r_{ij}

r_{ij} - Rank of observation j from group i

N - Total number of observations in all the groups together

In the case of university anchored CWN, Hypothesis 5 involved comparing four unmatched groups: behavioral intention, attitude towards technology, facilitating conditions, and impediments. As the data supports non-parametric, Kruskal-Wallis test was chosen as the appropriate analytical tool.

Mann-Whitney Test

The Mann-Whitney test is a non-parametric statistical method used to assess whether one of two independent observations tend to have larger values than the other. The following steps were used in the Mann-Whitney test:

1. Rank the data from all groups combined together; that is by ranking the data from 1 to *N*.
2. Add up the ranks for observations which came from group1 (say R1); and group2 (say R2)
3. Mann-Whitney U is computed by the following formulas:

   U1 = R1 – [n1 (n1+1)/2]; U2 = R2 –[n2 (n2+1)/2]

Where, n_1 is the sample size for group-1; R_1 is the sum of the ranks in group-1; *n2* is the sample size for group-2; *R2* is the sum of the ranks in group-2. The smaller value of U_1 and U_2 is the one used when consulting significance tables. In the case of university anchored CWN, Hypothesis 6 involved comparing two unmatched groups: attitude towards technology, and facilitating conditions, and to find out the significant out of those two. As the data supports non-parametric, Mann-Whitney test was chosen as the appropriate statistical test for this analysis.

Cluster Analysis

Identifying groups of individuals or objects that are similar to each other but different from individuals in other groups can be useful for analysis. Cluster analysis does not identify a particular statistical method or model.

In analyzing the university anchored CWNs, there was a need to see whether one can classify prospective participants based on the behavioral intention profiles and CWN tasks profiles and cluster was a good fit for this requirement.

(Norusis, 2006) K-means clustering was used to classify these datasets for university anchored CWN using SPSS. The algorithm used for this is called *k*-means where *k* is the number of clusters used; a case is assigned to the cluster for which its distance to the cluster mean is the smallest. Following are the steps in the algorithm used in this method:

- Identify the number clusters being used in this investigation
- Start out with an initial set of means and classify based on their distances to the centers.
- Next, compute the cluster means again, using the cases that are assigned to the cluster.
- Then, compute the cluster means again, using the cases that are assigned to the cluster.
- The, reclassify all cases based on the new set of means.
- Repeat this step until cluster means do not change much between successive steps.
- Finally, calculate the means of the clusters once again and assign the cases to their permanent clusters.