A STUDY OF THE NON-TECHNICAL ASPECTS OF FIBRE OPTIC TECHNOLOGY APPLICATION TO INTERNET SERVICE DELIVERY BY VODAFONE GHANA

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DECLARATION

I hereby declare that this dissertation is the result of my own research work carried out at the School of Communication Studies, University of Ghana Legon, under the Supervision of Professor Kwasi Ansu-Kyeremeh. I declare also that no part of this study has been published or copyrighted in Ghana or elsewhere. All references cited in this work are fully acknowledged. I fully accept all shortfalls in the work as my own.

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DEDICATION

I dedicate this study to my Lord and Saviour Jesus Christ who personally suggested this topic to me when I prayed for one. I love you Lord. Thank you.

ABSTRACT

This study was designed to investigate the phenomenon of Technological Change in the Ghanaian telecommunication sector and the Non-Technical aspects of the application of fibre optic to internet delivery. The implications of the new technology on social, cultural and educational facets of the people as deployed by Vodafone Ghana were the crust of this study. The objectives of the study were to explore through a case study approach the extent of adoption of fibre optics to internet delivery in Ghana and whether Vodafone Ghana, the company under study was meeting all the benefits the technology brings to the clients. A non-probability sampling method was employed to interview six experts in the field. Data collected was recorded, transcribed and analyzed along themes. The major findings were that Fiber Optic Technology has immense advantages over other media and has been diffused into Ghana with an 80% backbone from Accra to Bolgatanga touching all the regional capitals. The adoption of the technology had some benefits in terms of educational, that is providing excellent resources for quality studies, social, that is helping to bridge the rural urban gap and cultural, that is giving the people a sense of a common identity.

ACRONYMS

ISP: Internet Service Providers

IPTV: Internet Protocol Television

VOD: Video on Demand

VOIP: Voice over Internet Protocol, example Skype

ADSL: Asymmetric Digital Subscriber Line

ICAN: International Communication and Navigation Limited

ICT: Information, Communication Technology

GHC: Ghana Cedis

3G: 3rd Generation

Wi-Fi: Wi-Fi Alliance

ITEC: Indian Technical and Economic Cooperation Programme

DSLAMS: Digital Subscriber Line Access Multiplexers

ICT: Information Communication and Technology

R&D: Research and Development

ADSL: Asymmetric Digital Subscriber Lines

Contents

LIST OF TABLES

CHAPTER ONE

INTRODUCTION

When a technology is introduced into a society or an organisation, it usually has some consequences and benefits for the organisation and the particular society and culture in which it is introduced. There are the technical implications of the technology such as its ability to allow more work to be done faster and the non-technical implications such as the cultural or change in lifestyles it pioneers because of its adoption. Applied to communication, technology becomes a tool that brings societal change in the economic, social, cultural and educational living standards. Fibre optics is a technology that was developed and introduced into communication and can be defined simply as the use of light to transmit data. This research laid much emphasis on the application of Fibre Optic Technology to internet or the electronic network for communication and sharing of information around the world.

This chapter outlines the study by providing background information stating the problem and objectives. The Vodafone Group Plc which also provides total communications in terms of mobile and fixed line telephony is described. The choice of Vodafone Ghana was as a result of the company having an eighty percent fibre optic backbone across the nation with the potential of providing internet service to its clients. Vodafone Group Plc is also the world's leading telecom company and the biggest telecommunications organization in Ghana offering a wide range of telecommunication services. Furthermore, it has established presence in all the regions of Ghana riding on the back of Ghana Telecom (GT), a previously state owned organization.

Also stated in this chapter are the objectives of the study. Research questions relating to the extent of application and the social, cultural, educational and economic benefits of fibre

optics to internet delivery by Vodafone are posed. The significance of study is also outlined and operational definitions of some of the terms being provided.

1.2 BACKGROUND

The technology of fibre optics in communication evolved from the developed countries. These countries with a higher technological development appropriated the technology to drive their own economic growth. But most countries and Information Communication and Technology (ICT) companies took on the technology through transfer of ideas because of various reasons such as improving communication and economic yields. Olsson (2005) explained that productivity is achieved by Research and Development (R&D) companies (such as Vodafone) when profits are maximized dependant on new technological knowledge acting as both technological opportunity and a necessity.

At a trade caravan organized by the Ministry of Trade and Industry of Ghana and the Ministry of foreign trade of Morocco with La-Palm hotel on 20th June 2011, Dr. Nii Quaynor, founder of Network Computer Systems (NCS), the premier internet provider in Ghana, commented that internet penetration has gone up in Ghana with multiple cable providers. He said that a national monopoly or domination by these internet providers has now transformed into corporate monopoly with six multinational companies in a heavy competition. Dr. Nii Quaynor explaining these monopolies said that the multiple cable providers initially sought a country wide internet communication development (national monopoly) but now has an agenda to seek commercial or business control (corporate monopoly). The result of these corporate monopolies he explained is that, profoundly in developing countries, the biggest challenge to the use of a new technology is rather the creation of fragmentation by

telecommunications companies and businesses instead of a total technological development to benefit everybody in the nation.

1.3 Communication Tradition to the New Media

A look at communication history has proved an enormous leap from what may be termed as traditional modes of communication to a more vibrant new media. Dennis McQuail in his book Mass Communication Theory (2000) touches on the history of modern media beginning with books and describes how today the same media is being reproduced through technical devices and called electronic books. He also mentions the newspaper and the press and calls them traditional because they have been part of the beliefs, customs and way of life of people without change over a long period of time.

He then adds that the expression new media has been only used since the 1960s when there was the need for "digitalization", a term he explained as putting objects like sound, vision, image, and documents in one format. Channels of communication have advanced from face to face, to postal services and billboards, to telegraphs and telephones, to publications in newspapers, magazines and journals, to radio and television, and to a whole new media such as emails and the social media comprising of Facebook, Twitter, WhatsApp, YouTube, Nimbuzz, Gtalk, MySpace, and Viber, to websites and blogs, mobile equipments, search engines and Videoconferencing.

1.4 Rise of Internet Infrastructure in Ghana

According to the website of the Ghana Investment Promotion Council (GIPC), it has been part of Ghana government's Poverty Reduction Strategy I (GPRS I) to reduce poverty from 39% to 28.5% since 2005 with investment, policies and programmes in the ICT

infrastructural sector. ICT is top on the agenda of the government as explained on the government's website that:

> it has been argued that the development of ICT provides leapfrogging opportunities for developing countries. Ghana has not been left out in this revolution. According to the Data Development Group of the World Bank, ICT infrastructure in Ghana is progressing better than other low-income countries and above the 1.1% average for Sub-Saharan Africa.

According to a usage and population statistics from Internet World Stats 2011, there is a general growth in Africa's internet sector in recent years owing to improvements in infrastructure and the influx of the wireless access technologies resulting in lesser tariffs. The table below shows the growth pattern of the sector between the year 2000 of only thirty thousand internet users to that of three and half million users as of September 2012.

Table 1.1

INTERNET USERS, POPULATION AND FACEBOOK STATISTICS FOR AFRICA 2012 Q2						
AFRICA	**Population**	**Internet Users/Dec 2000**	**Internet Users 30-June-2012**	**Penetration (% Population)**	**Internet % Africa**	**Facebook 30-Sept-2012**
Ghana	**25.292,392**	**30,000**	**3,568,757**	**14.1 %**	**2.1 %**	**1,537,040**

Source: Internet World Stats

1.5 Ghana's ICT4AD Action Plan

The government of Ghana came out with a policy framework in 2003 called The Integrated ICT-Led Socio-Economic Development Policy and Plan Development Framework for Ghana. It was developed by the Economic Commission for Africa under the auspices of the United Nations to develop an ICT driven socio economic development policy and plan that will aid Ghana's development endeavor and move the country's economy and people towards an

information and knowledge based information society and economy in the shortest period of time.

As a priority, the policy document focused on the development and implementation of a four year continuous plan for an accelerated development in six areas including a rapid ICT and its enabling physical infrastructure and ICTs promotion in education. Chapter 5 of the policy framework touched on Ghana's ICT for Accelerated Development (ICT4AD) process that is "Moving Ghana to the Other-Side". It noted that

> there is no doubt that: information, knowledge and technology are increasingly becoming the key drivers for socio-economic development worldwide…it is clear that a nation's capability to accelerate its socio economic development process… improve the well-being of its people depends very much on the extent to which it can develop, use and sell, ---- information, knowledge and technology. Evidence shows that: although the mere use of information, knowledge and technology to improve on services products and processes can transform the socio-economic development fortunes of a given nation, those nations who in addition are involved in the development as well as the sale of information (and information products), knowledge (and knowledge products) and technology (and its products), are compared to others moving faster on the socio-economic development scale.

The substance of the policy is that governments around the world do recognize the important roles ICTs play in socio economic development process of a nation but those in Africa including Ghana have not taken a full advantage of them. It was as a result that the framework looked on the example of Nigeria to execute definite plans for both national and local information infrastructure backbone by making use of up and coming technologies such as Fibre Optic Technology Networks to provide high speed internet access and broadband services. The study found out that this framework resulted in the development of the National Fibre Optic Backbone and the Metropolitan Fibre connections which are discussed later in this study.

1.6 Modern Transmission of Communication

According to McQuail (2000), there is a communications revolution resting upon innovations and "computer-based" technologies. He meant that modern transmission of communication is

efficiently done through the development of computerized systems. The following reasons are outlined by McQuail for the modern transmission of communication dependent much on "computer-based" technologies. One is convergence where he gave a typical example of newspapers currently being placed as text on the internet. The Free Online Dictionary defines convergence in Electronics & Computer Science as combining different forms of electronic technology, such as data processing and word together to process information.

A typical example of convergence for a modern transmission of communication is the cell or mobile phone. They were in the beginning fashioned to receive and make calls. After convergence, mobile phones can now be used for multiple purposes with many formats such as playing music files, for radio, for browsing the internet and for video and audio conferencing. The second is digitalization and this McQuail said has allowed sound, text, voice and objects to be placed in one format. For instance, digitalization allows one compact disc to be used as part of computer based communication to both store and receive information.

The last reason McQuail gave as part of the reasons for modern transmission of communication is globalization. It is a term defined by globalization101.org as a process of interaction and integration among people, companies, and governments of different nations driven by international trade and investment and aided by information technology with effects on the environment, on culture, on political systems, on economic development and prosperity, and on human physical well-being in societies around the world. One cannot mention globalization without mentioning the Internet and the World Wide Web. It may be considered as one of the most influential modern means of transmission of communication.

1.7 Fibre Optic Technology

When a new technology is introduced into a company or a society, it is theoretically presumed to bring a difference in terms of performance. Fibre Optic Technology was introduced into communication because of the immense advantages over the other technologies of copper wire cables and microwave. The predominant medium for the internet communication has been copper wire cables with all the challenges such as the loss of data, interference in communication and theft of the cables.

Fibre Optic Technology is defined by the Transition Networks Group (2011) as the use of light to transmit data from one point to the other. They also add that the heaviest users of fibre optics are the telecommunications industry because fibre optics are theoretically unlimited in bandwidth. Bandwidth is defined as the measurement of the data carrying capacity of a medium. The greater the bandwidth, the more data or information that can be transmitted and copper has a bandwidth and a distance limitation, making it less desirable. (Transition.com 2011:3)

Fibre Optic Technology as a new product has gone through years of development. The uses of light to communicate have gone through years of rigorous experiments. Crisp (2001) noted that for thousands of years, humans have been communicating with light from smoke signals and mirrors to strong beam lights on ships today. According to Crisp (2001) light has always been accepted to travel in straight lines and therefore impossible to curve and go through corners. But John Tyndall in 1854 disproved the belief through an experiment and also brought a revolution in communications technology.

Through pivotal developments till today, a very good light source with a conduit such as plastic or glass can guide light around many intricate paths, and guiding light down a length

of fibre optic has resulted in distinct communications (Crisp 2001). Telephone companies in the 1970s and 1980s used fibre expansively in restructuring their communications infrastructure. In 1991, optical amplifiers used to carry 100 times as more information were invented through scientific innovations. In 1996, the first all fibre optic cable was laid across the Pacific Ocean with the longest fibre optic cable network following in 1997 providing infrastructure for the next generation of internet applications (Crisp 2001).

According to Crisp (2001), today's industries involved in telecommunication, data storage, medicine, military, manufacturing, networking and broadcasting apply and utilize Fibre Optic Technology in a multiplicity of function. Modern societies have virtually been condensed into what is called a "global village", and exchange of information has also encountered a very big explosion because of that technological change (Bashar 2002).

1.8 Description of Fibre Optic Communication

Even though this study sought purely to look at the non-technical characteristics of the application fibre optics to communicate internet data, a description of the process of sending information from a core point at Vodafone major station sites to receiving devices is necessary. Fibre Optic Technology has become the major medium that carries data from these core sites to devices such as computers and mobile phones. There is a Multi-Protocol Label Switching (MPLS) cloud which has routers[1] for internet and routers for voice switch.

Information from the routers is sent to an Optical Line Termination unit (OLT) which also forwards the information to a splitter. It is the splitter that sends the feed to a mobile device, a Multi-Service Access Node (MSAN), also known as a connection point or a computer. It is

[1] A device which sends data to the appropriate parts of a computer network

however important to note that at this stage, transmission depends on the receiving device and its capacity. If the receiving device is designed to receive all three services of voice, video and data, that is what is displayed and accessed.

Most of today's gadgets such as laptops, mobile phones, personal computers and digital television sets have inbuilt capacities designed to receive services in all three forms giving a complete communication solution. The concern here is the application of Fibre Optic Technology to internet hence a need to describe the internet.

1.9 The Internet

The internet can be defined as an electronic network for communication and information sharing that connects computer networks and organizational computer services around the world. An internet service, therefore, means the function providing information for communication, mainly electronically through the assistance of computer networks. This function is mostly through Internet Service Providers (ISPs) and Vodafone Ghana provides internet service to Ghanaians.

According to Foster, Goodman, Osiakwan and Bernstein (2004), the inception of internet service delivery in Ghana saw service providers using a number of transmission media to broadcast data to their customers. Notable of the data transmission media are copper wire cables, microwave also known as radio wave, satellite and fibre optics. Fibre optic cable technology is the use of strands of flexible glass as thin as human hair for transmitting information. Pulses of light are sent through the thin strands of flexible glass which are organized into cables. The technology has gained an advantage over the use of other media since it was introduced into internet delivery. Uses of fibre optics provide the best internet

experience for services such as browsing, electronic mailing, social networking, and internet protocol television, video on demand, voice over internet protocol, online gaming and internet shopping.

The challenge that is facing Ghana's telecommunications companies currently is how to migrate to an all fibre optic cabling. Most developed countries have already migrated from copper wire and radio wave technology to fibre optics because of the immense benefits offered by the cables. Internet has grown to be part of people's everyday life and most users want better access. Most homes in the developed countries have internet access speed of hundred megabytes per second. Up to ten megabytes per second speed can be accepted. Internet services provided with fibre optic cables have become a benchmark with more bandwidth necessity for today's communication. Fibre Optic Technology has become the best medium to connect to the internet since speed is important. Currently in Ghana, what the telecommunications companies are boasting of are wireless internet and wireless devices sold and used on portable devices. But the research found that even for wireless internet, there should be investment in cables to access points from which the wireless technology would be appropriated to transmit the feed to receiving devices.

There are thirty thousand residential and commercial customers currently on the fibre optics as informed by Vodafone Ghana and this proves that the technology has not been adequately appropriated in Ghana. For instance, according to Transition Networks (2011), a single optical fibre can carry about three trillion bits per second (bps) depending on the receiving device. The fastest wireless service (fixed wireless access) approaches two million bps. So, fibre optics can be more than a million times faster as explained by the telecom experts Transition Networks (2011).

Hays (2006), observes that fibre optics is all about economics. The advantages associated with the medium include higher bandwidth capacity, that is the amount of data transmitted on fibre is high than that of copper, resistance to outside interference, that is the forces of nature such as rain and lightning, longer reach, that is its ability to be laid over longer distances, lower maintenance costs, that is less amount of money spent on its preservation or safeguarding, longer life and better reliability, meaning the cables are durable.

The internet is a worldwide system of interconnected networks and computers for communication purposes such as browsing, research, studying, hobbies, emails, news, electronic marketing and job search. These communication functions can be performed effectively on connections done through fibre optics. The fibre optic enabling consequences of these and others such as voice over internet protocol were the subject of this research.

1.10 Vodafone Ghana

Vodafone Ghana is an operating corporation of Vodafone Group Plc. According to the technology giants, it is the leading mobile telecommunications company in Africa, Europe, the Middle East, United States and Asia Pacific. The company provides total communications in terms of mobile, fixed lines, internet, voice and data and says that it is currently unmatched in providing fixed line and internet services. According to the rankings of the National Communications Authority (NCA) (September 2012), Vodafone is second in providing mobile telephony in Ghana.

So the choice for study on fibre optics from Vodafone was based on the company having an 80% fibre presence covering the country involving districts and regional capitals. Also that Vodafone rides on the back of Ghana Telecom a previously state owned institution with a

previous national monopoly as explained by Dr. Quainoo. Vodafone Group Plc acquired 70% shares in Ghana Telecom (GT) amounting to US$900 million on July 23, 2008.

Vodafone Ghana says that it applies the latest industry technology to provide internet access to Ghanaians. The company as an Internet Service Provider (ISP) is going through a transition from a totally copper-based network to a hybrid network such as copper wire over fibre optic but is more geared towards the use of fibre optic cables. According to Vodafone, the organization is transmitting most of their internet clients from other technologies such as copper wires to the all-new fibre optics.

1.11 Problem Statement

Fibre Optic Technology seems to be the best medium for internet service delivery in the 21st century with most telecommunication companies migrating from the copper cables to fibre optics. The extent of deployment and capacity of the cables are being used even as catch phrases to lure more customers onto telecommunication networks.

Among the over six Telco's in the country, Vodafone Ghana has an eighty percent national fibre optic backbone across the nation with the potential of providing internet access to its clients. However, internet service in Ghana is still expensive and access is also very poor in most places.

This study sought to find out the extent to which the technology has not been adequately adopted to make internet delivery and services in Ghana better. The premise that access to quality information through effective communication should enhance empowerment in every society as it gives the people an advantage in acquiring knowledge that can help in individual and societal development.

1.12 Objectives

The objectives of the study were therefore to explore the extent of adoption of fibre optics to internet delivery in Ghana and whether Vodafone Ghana is meeting all the benefits the technology brings to the clients. Vodafone Ghana had applied Fibre Optic Technology to leverage the internet service it provides to its clients and the extent of application was to find how wide the technology has been used by the company and what really were the benefits associated with the application that does not exist primarily with the other media.

1.13 Research Questions:

Specifically, the study sought to answer the following research questions:

- What is the extent of adoption of Fibre Optic Technology to internet delivery by Vodafone Ghana?
- What are the benefits derived from Fibre Optic Technology as applied to internet delivery by Vodafone Ghana?

1.14 Significance of Study

There is an implied assumption of a massive difference between Fibre Optic Technology and other technologies that are being used to provide internet communication. This study is intended to clarify the assumption and also ascertain the extent of adoption of the technology and the potential benefits associated with its application. Also, just like many other technologies, the cables are presumed to be cheap and to have made the access of internet easier. The study is also to discover how much customers are spending on the service, comparatively, those on fibre and those on the other media.

1.15 Operational Definition

Non-technical: Aspects other than the mechanical and technical consequences. In this study, the non-technical aspects of the application of Fibre Optic Technology to internet use include social, cultural, educational and economic impact or implications.

Application to Internet Service: The function of Fibre Optic Technology serving as a carrier and a medium of information in the provision of internet service.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The review of literature puts this study into the context of examining the theoretical underpinnings of change in communication technology. The chapter therefore touches less on studies in the field of fibre optics as a technology but more on its adoption through the eyes of the theories of technological change. The chapter as a result touches on technological change, the society and the benefits of technological change and the tenets of technological change. A theoretical framework is developed with structures and then applied to Fibre Optic Technology.

2.2 The Theory of Technological Change

The theoretical framework for the study was derived from the perspective of studying communication in a changing environment. The theory of Technological Change discussed in this section by Schumpeter (1939) touches on invention, innovation and diffusion. Joseph Alois Schumpeter is the proponent of the Theory of Technological Change. He was an Austrian finance minister in 1919 and was one of the most influential economists of the 20th century. It is from this background that he described technological change as the overall process of Invention or creation of a technology, Innovation or its improvement and Diffusion or spread of the technology. He believed that change, improvement and development resulted from economic cycles in a capitalistic market and the introduction of new revolutionary skills, services and products by successful and innovative entrepreneurs is very crucial to sustain a lasting economic growth, (Spencer and Kirchhoff 2006). The study adopted this theory and will therefore elucidate it in subsequent topics.

2.3 Tenets of Technological Change Theory

Schumpeter (1942) gave three distinct tenets of his theory of Technological Change describing also that every change goes through these three distinct phases. First is Invention which he defined as part of the technological change process that involved the birth of a new idea. He mentioned that the emergence of these new ideas required an act of insight even beyond the normal professional or technical skills. He mentioned that occasionally, there arise problems or wants and various methods are designed to satisfy these wants. Through critical revision of these methods, those that bring solutions to the issues are adopted as inventions. For Vodafone Ghana to have access to the new Fibre Optic Technology there must have been an invention of the technology already. The need for a much more reliable communication service was the reason for this invention.

The second tenet or phase is Innovation and that all innovation is dependent on invention. Here, Schumpeter explained that the new idea that is invented is developed into a product worthy to market and bring growth. This phase, he explained, as when a firm takes to doing a new thing or doing the things that already exist in a new way (Spencer and Kirchhoff 2006). Typically speaking, Vodafone Ghana though was offering internet services to its clients using copper lines, it was expected that the adoption of the Fibre Optic Technology was to facilitate a more effective and reliable internet service. So though it is the same internet they are providing, it was now done in a new way. Schumpeter said that innovation is the essential function of every entrepreneur who has the mentality of profit maximizing. But he explained that the social process that warrants innovations might be different from that which warrants invention. This point is well explained subsequently to mean that it is not every society that can initiate a change or an invention, but most can simply adopt or adapt to the new. He also defined innovation as a change in the form of a production function. Simply, technological

leaders and entrepreneurs with the desire to grow economically adopt new methods of production and all economic change revolves heavily around innovation.

The third tenet or phase Schumpeter calls the Diffusion stage and here the new product is spread crossways to the prospective markets. In a review of their book The Theory of Economic Development, Antonelli, Gilberto and Nicola De Liso (1997) argued for Schumpeter in saying that development must be the outcome of the innovative capability of every entrepreneur in his or her introduction of new methods of production. All smart entrepreneurs must bring on board new ideas.

The spread of these new ideas to other markets and the adoption by other entrepreneurs is the point where the technology is diffused. If or when Vodafone Ghana comes to terms with the benefits of this new technology through usage, it is likely that they would plan their internet delivery around the Fibre Optic Technology. This is not simply because it is a new invention but because it works for the company and probably has a bearing on company returns. Ghana's continuous participation in the world summits of information society resulted in the ICT4AD Policy which also strongly supports the diffusion of ICTs and its technologies in the country of which Fibre Optic Technology, a better means to communications is part.

2.4 Society and Technological Change

Schumpeter (1939) supported the view that technological change brought about development and therefore these developments affected the society and the livelihood of a people. Papacharissi and Zaks (2006) supported this view to a point to say that the deployment of internet to both rural and urban societies contribute opportunities for more revenue to aid development. However, Papacharissi and Zaks (2006) noted that the speed at which

technological landscapes do change is too fast hence making it difficult for rural dwellers to catch up to enhance their own technological development before new ones emerge.

This has deepened the phenomenon of "digital divide" which is the form of inequity between a collection of people mostly defined in terms of contact or access to the use and knowledge of ICTs. The divide can occur within countries of which Papacharissi and Zaks (2006) coined the term digital culture and non-digital cultures. In his book Society and Technological Change, Volti (2010) wrote that there are different effects of technological change in a society when a new technology is diffused into it. There are always winners and losers resulting in both negative and positive sides of technology.

Bernard and Pelto (1987) noted that the introduction of a new technology to a society brings along changes in "cognitive definitions" about the older technology, even in the midst of persons who might have little or less contact with that new technology. Cognitive definitions means that decisions are related to a mental process of reasoning that will lead people to account for simple means by which cultural systems such as communication and transportation are being carried about in a society. According to Bernard and Pelto (1987), new technologies are regularly perceived by the individuals in the society as "labour-saving devices" and these are adopted mainly for that reason.

Pascal Zachary (2004) gave an extensive overview of the introduction of the new technology of fibre optics and the role of information technology in the economic and social development of Africa. He also supported the view that technological systems must promote productivity growth, prosperity and human joy. But he added that without the presence of strong political, social and economic systems, innovations cannot be introduced. Also, a

society without strong systems of education and health and safety measures cannot develop with the new technology.

Educated and talented people necessary for the application and progress of existing technical knowledge and the growth of new expertise are needed in a society (Zachary 2004). These experts with the existing technical knowledge will create a difference in the society. Zachary also went further to predict that the growing information technologies sectors will deepen Ghana's rural-urban gap and will generate social tensions and inequalities in wealth. Despite the above contributions, Bashar (2002) sums up the roles ICTs play in the economic and social development of a country that it can improve instant communication between people in distant places around the globe contributing to globalization.

2.5 THE BENEFITS OF TECHNOLOGICAL CHANGE

2.5.1 Social Benefits

Extensive studies such as that of Hays (2006) and Hecht (2004) sees most of the benefits of the fibre optic innovation on its economic profits and the fact of the cable's ability to carry the guarantee of universal access to internet services. The economic benefits mostly results in the improvement in social infrastructures and living conditions of a people. Papacharissi and Zaks (2006:9) noted that,

> the principle of relative constancy, articulated by McCombs (1972), establishes that over time, the percent of household income spent on mass media consumption remains constant. Therefore, the only way to get consumers to adopt a newer medium is to give them reason to abandon an older one, since they are not likely to spend over a certain fraction of their income on mass media expenditures.

However, Papacharissi and Zaks (2006) adds that telecommunication services like that of the internet should not be treated as a traditional commodity but rather be used to provide universal services. Oyelaran-Oyeyinka and Lal (2003:34) also noted that

> economic wealth is particularly relevant in the case of ICTs because governments need significant investment capital to develop a reliable and efficient national and global telecommunication network.

It is important to recognize that Fibre Optic Technology being adopted to spread the internet to the countryside creates what Malecki (2002) calls an economic space allowing small markets to identify similar niches around the world through these communication technologies. Technological change is the idea that modern knowledge hubs in a global market allows technology and capital to become mobile. The quality of a country's fibre optic infrastructure and access to the global information base will therefore contribute to more investment and that is why ICT infrastructural development is top on the Ghana government agenda of poverty reduction.

2.5.2 Educational Benefits

The diffusion of the technology through the nationwide fibre optic backbone contributes to the universal access to education where students all over the country will have good and quality access to ready information through the internet. Zachary (2004:24) notes that:

> all levels of education must improve in Ghana, but the greatest need is for improvement in science and engineering training. University graduates today are poorly prepared to either participate in the creation of new information technologies or to assist in the application of information technology to social and business problems.

However, Oyelaran-Oyeyinka & Lal (2003) found that just as with many innovations, ICT's adoption leads to inequality among social classes, races and educational divides and only individuals with higher education benefit from ICT related opportunities and command

higher wages and further deepen the social divide. The internet itself has been a product of governments and education related efforts, Papacharissi and Zaks (2006).

2.5.3 Culture Benefits

Pascal Zachary (2004) touched on the cultural and intellectual benefits of technology. He noted that people with a particular culture, history and in a geographic position creates conditions that reflect their experiences and aspirations through the devices and technologies they use**.** Bashar (2002) adds that the culture of instant communication between people in distant places around the globe contributes to a culture of globalization where people of different geographical areas can find a common sense of identity.

2.5.4 Communication Benefits

As discussed earlier, the benefits of fibre optics as a technology to communication include high bandwidth capacity, the ease of installation over long distances, security and general durability of the cables resulting in effective communication. Communication today is also based on the ability to reach certain number of people over long distances without interference and within a time frame. An effective communication infrastructure is an enabler of such in a modern communication era and fibre optics proves to be the right medium.

2.5.5 Other Benefits

Zachary (2004) writes about other benefits of Fibre Optic Technology such as the development of agriculture in terms of water delivery. The extension of the cables to provide internet technology helps to reduce the shortage of water in rural parts of Ghana. He explained that through the national backbone of fibre optic cables, very remote farmers have access to rainfall patterns from the internet and are able to preserve water during the rainy

seasons through conservation. Also, the internet contributes to the nation's health care issues where information such as that on malaria and HIV/AIDS education are brought to the rural folks. Basher (2002) mentions other ramifications of Fibre Optic Technology such as electronic government services. This allows government to deliver services such as retirement and pension funds electronically. Basher (2002) also mentions "telecommuting", which is the capability to accomplish office work from home. All these benefits are what this research sought to find as one of its objectives. If Fibre Optic Technology is an improvement in internet delivery, then one would have thought that its benefits outweighed earlier benefits of the copper wire technology and other media.

2.6 Development of a Theoretical Structure

The theory of Technological Change was deemed appropriate for this study for the reason that it focuses on the emergence, evolution and spread or diffusion of a new idea. The aspect of the extent of application of fibre optics, a new dominant design in communication and the implications the new design brings to stakeholders such as the ISPs and its customers was the focus of this study. The notion of the extent can be simply explained as how the technology has been diffused and where diffusion of the technology has reached. As earlier discussed, the theory of Technological Change simply touches on invention of a technology, its innovation or advancement and the diffusion or spread. Innovations introduce technological efficiencies that translate into improvement in the society or the workplace. This study chose Technological Change to explain that every change in communication infrastructure through diffusion is a means of development, achievement and progress that has repercussions for both an organisation and the society. Gino Cattani (2005) made assertions that each invention, innovation and diffusion offers a spectrum of opportunities for organisations that adopt it and according to Spencer and Kirchhoff (2006), Schumpeter's theory explored the

role of the new technology based firm in causing economic growth and development. Vodafone Ghana did not need to re-invent the wheel; it only had to adopt the technology as it was diffused across the world.

2.7 Relation of the Model to the Study

The model of Technological Change by Schumpeter was from Invention, to Innovation and to Diffusion. Firstly, it is obvious that the technology of fibre optics was not invented in the African setting but was diffused into it. Vodafone is a multinational company as such other Vodafone offices around the world discovered the usefulness of the Fibre Optic Technology. Since Vodafone Ghana is a branch of Vodafone worldwide, the technology had to be diffused into Ghana through Vodafone Ghana to improve the company's internet delivery. To adopt a new idea requires insight even beyond the normal professional or technical skills. The problems that existed with the other media and to curb them warranted the technology to be adopted by Africa. The social course that permits innovation in the African setting in the development or improvement of the Fibre Optic Technology might also be non-existent in the African setting. But as the technology was being diffused around the world and governments and companies were adopting it, it was beneficial to be introduced in Ghana. So as earlier discussed, it is not every society that can initiate a change or an invention and innovation, but most can simply adopt or adapt to a new idea for various reasons such as profit maximizing and Ghana did so. Sood and Tellis (2005) argued that the performance of a given technology such as the copper wire cables declines because of limits of scale (that is, things become either impossibly large or small) or system complexity (that is, things become too complex to work flawlessly).

When these limits are reached, the only possible way to maintain the pace of progress is through radical system redefinition that is, a move to a new technological platform. Moving to a new technological platform would mean technological change and for Vodafone Ghana, a move from the use of copper wire cables to the Fibre Optic Technology is a form of Technological Change. The adoption of the technology went through Schumpeter's three stages of technological change as earlier stated. Thus the idea was diffused to mother Vodafone Group PLC and later spread to Vodafone Ghana.

Fibre Optic Technology seems to contribute to human communication with capacities that overrides those of the other media. Zachary (2004) supported the view that technological change and development in Africa has received scholarly attention including that of the Human Development Report 2001 by the United Nations Development Program which offers many valuable insights into the role of technology and development. Vodafone Ghana prepared to adopt fibre optics and to transfer reserves from the copper wire cables, radio waves and satellite technologies to fibre to give customers the best service. Technological change followers and economic historians are more serious about how much a technological change contributes to improving the living standards of customers.

> They would like to have available welfare as well as a production interpretation of productivity growth… a cost of living index … measures the change in expenditures that a person would have to make in order to maintain a given standard of living…it should be noted that this type of growth accounting addresses the question how much did the new technology contribute (Crafts 2003: 17).

Most countries quickly adopted the Fibre Optic Technology and Vodafone Ghana, has also adopted it very swiftly to drive economic growth. According to Olsson (2005) the amount of productivity by research and development organizations (like Vodafone Ghana) to maximize

profit depends on new technological knowledge, which is also a technological opportunity and necessary.

The relationship of the new technology of fibre optics to communication in terms of its invention, innovation and diffusion, was to make communication affordable to all. This study also sought out to ascertain if really fibre optics has made internet communication affordable after its diffusion into the Ghanaian society. The application of the technology has contributed to changes in the society where access to information is easy and becoming less expensive thereby contributing to a way of life of a people.

Today, innovation has contributed to a culture of sending and receiving information through emails and social media such as Twitter, Skype and WhatsApp services allowing communication between many people with the phenomenon growing because of advancement in internet services offered through the Fibre Optic Technology. People can even access information through mobile phones which according to a report on TV3[2], a local television network in Ghana, has an 80% patronage by the population.

2.8 Critique of the Technological Change Theory

Despite the adoption of the Theory of Technological Change for this work, a few flaws are outlined to help for further studies. First of all, all theories must accept the principle of falsifiability to encourage more studies and Technological Change is no exception. Also, Malecki (2002) found that Technological Change brings niches thereby creating fragmentation in development. The diffusion of fibre optic cables for internet delivery may allow for easy communication between entities and data can be transferred from point to

[2] 7 pm News item on 23rd October 2011

point with the speed of light. Also, thanks to the internet, people now spend time working from home and outside offices.

It has allowed teleconferencing; is reducing the rate of travels; all these supporting development in the eyes of Schumpeter (1939). For instance, a story in the Ghana Business and Finance Magazine (August 2011:35) reads:

> Mr. Kyle Whitehill, CEO, Vodafone Ghana said that Vodafone is a green brand…have reduced global travels by 50% and now involved in webcasting and voice and audio conferencing through ICTs.

However, more studies could be conducted to establish the view technological change as a means of improvement may also reduce the quality of life with people unable to escape work.

2.9 Related Works

A study by Sood and Tellis (2005) give three basic stages that a new technology goes through after its invention. The first they call the introduction stage and at this stage the new technology in a slow progress is introduced. They say that the process is sluggish because the technology is not very familiar and may not attract the attention of researchers. Also, certain basic but important bottlenecks must be overcome before any new technology's sturdy growth. Sood and Tellis (2005) say that there is a second stage which they call growth stage. At this stage, (Sood and Tellis: 4)

> the technology after continued research, crosses a threshold after which it makes rapid progress and this rapid progress leads to increases in sales of products based on the new technology, which increases revenue and profits and offers further support for research…fuel further improvement in performance

Then the third stage they called the maturity stage and here they say that progress occurs slowly because of reasons such as a market aging that results in the focus of innovation

shifting from product to process (Sood and Tellis 2005). They cite the best explanation that the rate of improvement in performance of a given technology declines because of limits of scale (i.e., things become either impossibly large or small) or system complexity (i.e., things become too complex to work flawlessly). When these limits are reached, the only possible way to maintain the pace of progress is through radical system redefinition that is, a move to a new technological platform (Sood and Tellis 2005).

Zachary (2004), Foster *et al* (2004) and Oyaleran-Oyeyinka & Lal (2003) whose studies were basically done in Africa, touched circumspectly on the technology and its diffusion in Africa. The economic indicators for this technology were however given much treatment by the authors from the western countries. Cattani (2005) for instance, found that sustaining a competitive advantage in the face of technological change is especially critical in technology intensive industries where superior performance depends on consistent innovation or advancement, improvement or modernization. This study also sees Vodafone Ghana's effort to migrate customers unto the fibre optic cable as an innovation to sustain competitive advantage in the face of technological change and therefore discusses the benefits in much detail. Fibre Optic Technology is an innovation that has brought about great changes in the field of communication.

Jabulani Dhliwayo a senior research scientist at Corning Incorporated researched into the development of a fibre optic backbone for Africa. In his view, the high cost of telecommunication as a result of poor infrastructure in Africa and as such for an African backbone network to be successful, it has to be initiated and planned by Africans on the basis of potential long-term ability to help build wealth not on the basis of short-term return on

investment. Dhliwayo's work summed up the reason why despite the development of the Fibre Optic Technology in Ghana, internet service still suffers.

He looked at the current telecommunications infrastructure in Africa made up of radio relay links, open wire lines, radio telephone stations, fixed installations and substantial mobile cellular networks and zeroed in on the Fibre Optic Technology. According to Dhliwayo (2002), internet usage had only just begun in most of Africa and was currently concentrated in large cities because of the large number of shared accounts and the high usage of public services such as Internet cafés. Dhliwayo therefore concluded that it was difficult to accurately determine the number of people with Internet access.

To him, the poor African telecommunication status and low internet usage can only change if a major effort is undertaken to develop a Continental Fibre-Optic Backbone that interconnects Africa and the rest of the world via current and planned undersea fibre-optic cables. To him the network must be planned, owned and operated by Africans. Dhliwayo (2002) compared the Fibre Optic Technology to satellite technology and choose the former for the following reasons. With the rise of the Internet, education has been completely transformed. Distance learning, for example, used to be largely a lonely experience. In today's information age, students did not only overcome difficulties interacting with the tutor, but can now easily overcome the nightmare of waiting for tutorials in the mail for long periods of time. In addition, the Internet constitutes a virtual classroom in which interaction can take place between students anywhere in the world. The information age has seen the acceleration of research at educational and other institutions because of the abundance of scientific data on the Internet and the advent of electronic journals.

The cost of electronic technical information is negligible compared to traditional research journals. Yet in most of Africa education has not taken advantage of the information explosion; distance education is mostly what it was several decades ago, most libraries at universities and research institutions still rely on hard copy journals which are way too costly. In most cases by the time the journals get to Africa, the information is obsolete and makes it impossible for the quality of research in Africa to be comparable to that in developed countries.

Similarly this research sort to find out from Vodafone Ghana what the introduction of the Fibre Optic Technology meant for internet delivery in the education sector. This research wanted to ascertain what Vodafone Ghana had planned for in terms of education by moving away from the copper line technology to Fibre Optic Technology. These included benefits accruing to all facets of education including schools, universities, libraries and the students as the main users to aid in their education.

Bjorn Pehrson and Margaret Ngwira from the University of Malawi also conducted a study on the benefits of fibre optics titled optical fibre for education and research networks in eastern and southern Africa. For this research they interviewed heads in telecommunication companies responsible for policy frameworks. They conducted the study in South Africa, Malawi and Tanzania. Pehrson and Ngwira (2006) among the advantages of internet access via Fibre Optic Technology were benefits for academic institutions. These included faster internet connections and connections between all universities at lower cost enabling the universities in the different countries to have a connection to other academic and research networks in the region and outside of the region. Another benefit was sharing of human,

financial and technical resources, such as caching servers, supercomputers, a national grid, and virtual libraries.

Another benefit was to strengthen the position of academic networking in relation to authorities, industry and other parts of society. Pehrson and Ngwira (2006) from their study concluded that, the fibre was not everywhere and/or not always possible to use due to restrictions in telecom policy and regulations, such as in South Africa. Also they found that there was fibre available in Africa, and more fibre was being rolled out, in power grid extension programmes, along pipelines and in other infrastructure projects. This study is related to the current one in the sense that, the current study also sought to determine the social benefits of the fibre Optic Technology in terms of internet use. Again in terms of education, the current study sought to find out what Vodafone Ghana perceived educational institutions were using internet via the fibre Optic Technology.

Kawai and Horita (2006) looked at how the fibre optic communities in the United States of America were taking advantage of the technology for the betterment of their communities. This research started by identifying the relationship between organisations which run fibre optic communities and the geographical distribution of those communities. This study had two objectives. The first was to explicitly depict the overall picture of expanding fibre optic communities in the U.S. including their geographical distribution, their running organizations, and backgrounds of their expansion. Second, through case studies of chosen examples, current strategies in deploying fibre, in applying this communication tools, and in planning physical space of the communities are to be found.

For the study's methodology, series of interviews and site visits were carried out and

referential materials from governments were studied. The study contributed to the understanding of current issues and future plans of suburban and rural America in three different ways. That is the majority of fibre deployments in the U.S. were in metropolitan areas leaving smaller cities, outer suburbs, and rural areas behind, because their markets are too small to cover the construction cost with the expected revenue.

This research showed, in detail, how the recent fibre optic communities were brought into the world. Through this, it suggested important hints in exploring alternatives in ICT deployments in non-metro areas in the United States. The research also showed emerging efforts in suburban and rural America to use fibre strategically for the community could help solving their recent problems, such as economic down turn and dependency to the metropolitan areas, and the decreasing sense of communities. In general, the research discovered that ICT through fibre optics had effects of isolating individuals from the society, or sometimes, rural areas and suburbs from the metro areas. However, at the same time, ICT brought various social activities back to residential communities (from metro areas) in the forms of, for example, telework, remote education, and tele-medicine.

This research, through uncovering the strategic uses of fibre, showed models for rural and suburban communities to conquer common problems among them. In suburban and rural America, as a result of long-term economic dependency on metropolitan areas, less and less land use for building programs other than residential for last decades was noticed. Even if these areas were to be armed with new ICT infrastructure and to use it for economic and social activities, the spatial conditions of these communities were not ready to house them.

In essence this study sought to find out the extent of fibre optic usage in Ghana with regard

to the rural - urban gap. Thus with Vodafone Ghana's introduction of the Fibre Optic Technology which regions and towns has it reached and who are benefitting from the technology and for communities that were not on the fibre optic technology reasons why they were not.

2.11 Benefits of Fibre Optic Technology

The benefits of Fibre Optic Technology include high bandwidth capacity for storing data, voice and video formats. The cable can carry more information than what is very popular in Ghana, the copper wires. For example, the technology experts, Transition Networks (2011) postulate that one strand of fibre optic cable could carry all the telephone conversations in the United States at peak hour. Fibre optic cables are also lightweight compared to copper.

Also, there is a low loss of signal and frequency with fibre compared to copper. This means that data sent on fibre cables are more secure than that of copper. The higher the frequency, the greater chance the signal can be lost in terms of using copper cables. With fibre optic cables, the technology experts identify that the signal is the same across all frequencies. Fibre optic cables are also more reliable than copper wire cables having a longer life span whether placed in the ground or on poles. With the issue of security, fibre cables do not discharge electromagnetic emissions and with interference it is arduous to tap into. The study found out that thieves cut the copper wire cables and sell them to artisans who make copper wire bangles or bracelets out of them. In another TV3 news article on 26th November 2012, Mr. Kyle Whitehill said 20 to 30 volts of their copper wire cables are stolen every month costing the company between 2 and 3 hundred thousand Ghana Cedis per month.

2.12 Benefits of Fibre Optic Application to Internet Delivery

Bashar (2002) identifies similar characteristics and benefits of using the technology as their enormous potential bandwidth capacity and small size and weight like human hair. He added that the cables are immune to interference or cross talk; they are free from electromagnetic interference and have a good signal security. The cables have low transmission loss capacity and reduction in system cost and complexity. There is system reliability coupled with the ease of maintenance and lifetimes of 20 to 30 years.

2.13 Summary

The theoretical framework that served as a background for this study is Technological Change theory as it relates to the non-technical aspects of fibre optic cables. The key tenets of the theory are invention, innovation and diffusion. The main relevance here is using these as a guide to establish how Fibre Optic Technology has been diffused in the Ghanaian communication sector. The extent to which the cables are diffused is also determined by the level of investments made in terms of its application and other aspects of the technological change. The nature of telecommunications infrastructure in Ghana is soaring and internet delivery by Vodafone Ghana has a policy of universal internet access. There is always an effect on the society when a new technology is introduced. The benefits of technological change include social, educational, cultural and a general improvement in communication. The theoretical structure was developed from the point of the emergence, evolution and spread or diffusion of a new idea. Fibre Optic Technology has been diffused into the Ghanaian context to help in the development of communications in Ghana. The model as presented by Schumpeter relates to the study because it also sought to see how the technology has been diffused in Ghana. The literature review saw similarities in the related works of Jabulani Dhliwayo who researched into the development of a fibre optic backbone for Africa

and found that the high cost of telecommunication was as a result of poor infrastructure in Africa, Bjorn Pehrson and Margaret Ngwira from the University of Malawi also saw among the advantages of internet access via Fibre Optic Technology for academic institutions and concluded that the fibre was not everywhere and not always possible to use due to restrictions in telecom policy and regulation, but there were social benefits of the fibre Optic Technology in terms of internet use and finally, Kawai and Horita through case studies also looked at how the fibre optic communities in the United States of America used current strategies in deploying fibre as communication tools. Today, internet has become an everyday life activity and people do access information on mobile phones, personal computers and laptops. Almost all studies must have references from the internet. It is affecting the society, the culture and the education of today. A good internet access is therefore enhanced by the use of Fibre Optic Technology.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes and explains the techniques that were applied in collecting and analyzing the data for the research. It discusses the research design and with a case study approach looked qualitatively into the extent of application of fibre optics by Vodafone Ghana and where the technology had reached, who is benefiting and the benefits associated with the application that does not exist primarily with the other media. A non-probability sampling method was employed to interview six experts in the field. Data collected was recorded, transcribed and analyzed along themes.

3.2 Research Design

Qualitative research involves various methods of data collection such as in-depth interviews, focus group discussion, field observation and case studies. Since it was corporate Vodafone Ghana that was studied, some individuals as employees of Vodafone Ghana located in certain departments were interviewed. A more qualitative approach was adopted because the researcher was interested in the depth of the phenomenon. The research also used a case study approach because it is only Vodafone Ghana that was studied.

3.3 Sampling

Wimmer and Dominick (2003) note that mass media researchers predominantly employ a non-probability sample method as in the form of available samples, volunteer subjects and purposive samples for qualitative work. Purposive sampling was used to choose those to interview. The purposive method is a non-representative subset of the larger population and serves a specific need or purpose such as enabling the researcher to decide specifically which

people were germane for the interview as far as the research objectives and problem was concerned. The researcher therefore had an unambiguous group in mind from which to get the germane information.

This procedure was to select subjects with specific qualities and characteristics in the understanding of the field and one customer who had been migrated from copper wire to the Fibre Optic Technology. In all, six people, including three officials of Vodafone Ghana were interviewed. For instance, the Project Manager in charge of mounting fibre optic multi access nodes which serves as connection points all over the country was interviewed to ascertain the concentration of the technology and its extent of application.

Individuals with in-depth knowledge of the contribution of Fibre Optic Technology across the departments of Technology, Human Resources and Corporate Communications were therefore sampled and interviewed. They were Mr. Akombia S. Koomson, Fixed Data Manager, Mr. Daniel Adjepong, Project Manager, Mr. Sylvester Dikoh, Senior Engineer and a front desk person. Documents from the Vodafone Ghana were also analyzed. They included a folder called Transmission Media; Copper Wire, Glass Fibre, Microwave and Infrared Laser. Another folder from which the current extent of reach was derived in the form of a map is called the Transmission Route Plan. Others included the Transport Network Architecture showing the map of Ghana and the Fibre Optic backbone, documents of the Sub-Saharan and the Mediterranean Undersea Cables and how Ghana is cabled through three submarine cables currently terminated in Ghana called SAT-3, Main One and Glo -1 were also consulted.

Then, one expert and pioneer in the introduction of internet in Ghana Dr. Nii Quaynor, was also interviewed as part of the research. He is well versed in the internet phenomenon and credited with bringing internet to Ghana. He started Network Computer Systems (NCS) and now owns Ghana.com as a succeeding company of NCS. He is a registrar and provider of hosting services such as electronic cash and also has recognition from International Communication and Navigation (ICAN) society.

To make the work more interesting, a Local Area Network Administrator form the Australian High Commission was also interviewed. The High Commission is one of the customers of Vodafone Ghana who was migrated from copper wire cables to the all-new Fibre Optic Technology.

3.4 Data Collection

The method used to gather information was through in-depth interviews with officials of Vodafone. Then a trip was made to one site at Teshie a suburb of Accra where Vodafone officials were mounting a connection point for observation purposes. The flexibility of the qualitative approach allowed the researcher to explore all the aspects of the research objectives and also delve into new areas to enrich knowledge. All the questions were open ended questions allowing respondents to have a free flow in their response so as to allow the researcher to get quality response to write the report.

3.5 Data Collection Instruments

An interview guide as seen at the appendix was developed into four broad sections with each section having sub questions that focused on the extent to which Vodafone Ghana was applying fibre optic cable to deliver internet service and the advantages of using fibre optic

cable by Vodafone for its clients. The other sections focused on how Vodafone was applying the technology to meet consumer needs in Ghana and what exactly they were offering. Another section was later developed to ascertain the benefits that a client was enjoying as being migrated onto the Fibre Optic Network by Vodafone Ghana. The questions also focused on new things that the consumers could get from getting on the medium that the other cables do not provide.

3.6 Documentary Analysis

Documents from Vodafone Ghana included the Transport Network Architecture showing the map of Ghana and the Fibre Optic backbone, the Sub-Saharan and Mediterranean Undersea Cables and the current termination of Fibre Optic Technology in Ghana called SAT-3, Main One and Glo -1 were analyzed. The main documents that were analyzed from Vodafone therefore contained evidence of the performance of the technology of fibre optics and the diagrams of how the system works. Sources such as books and article journals on the subject of fibre optics were consulted to enrich the study. Data from authority websites like the World Bank's (2009) statistics on internet usage and data from National Communications Authority (NCA) (September, 2012), the regulatory body in charge of the telecommunications in Ghana were consulted. The researcher also gathered information through observation where visits were made to sites where fibre optic access nodes were being mounted. The researcher also gathered other secondary data from the website of Vodafone Ghana.

3.7 Data Analysis

The data was analyzed and presented in a narrative order. Responses from open ended questions were organized under a number of themes in conjunction with the objectives of the

study which were collated into subheadings to write the next chapter of this research. Also, documentary analysis was done from diagrams and charts received from the officials and also websites of Vodafone, the NCA and the World Bank.

CHAPTER 4

FINDINGS

4.1 Introduction

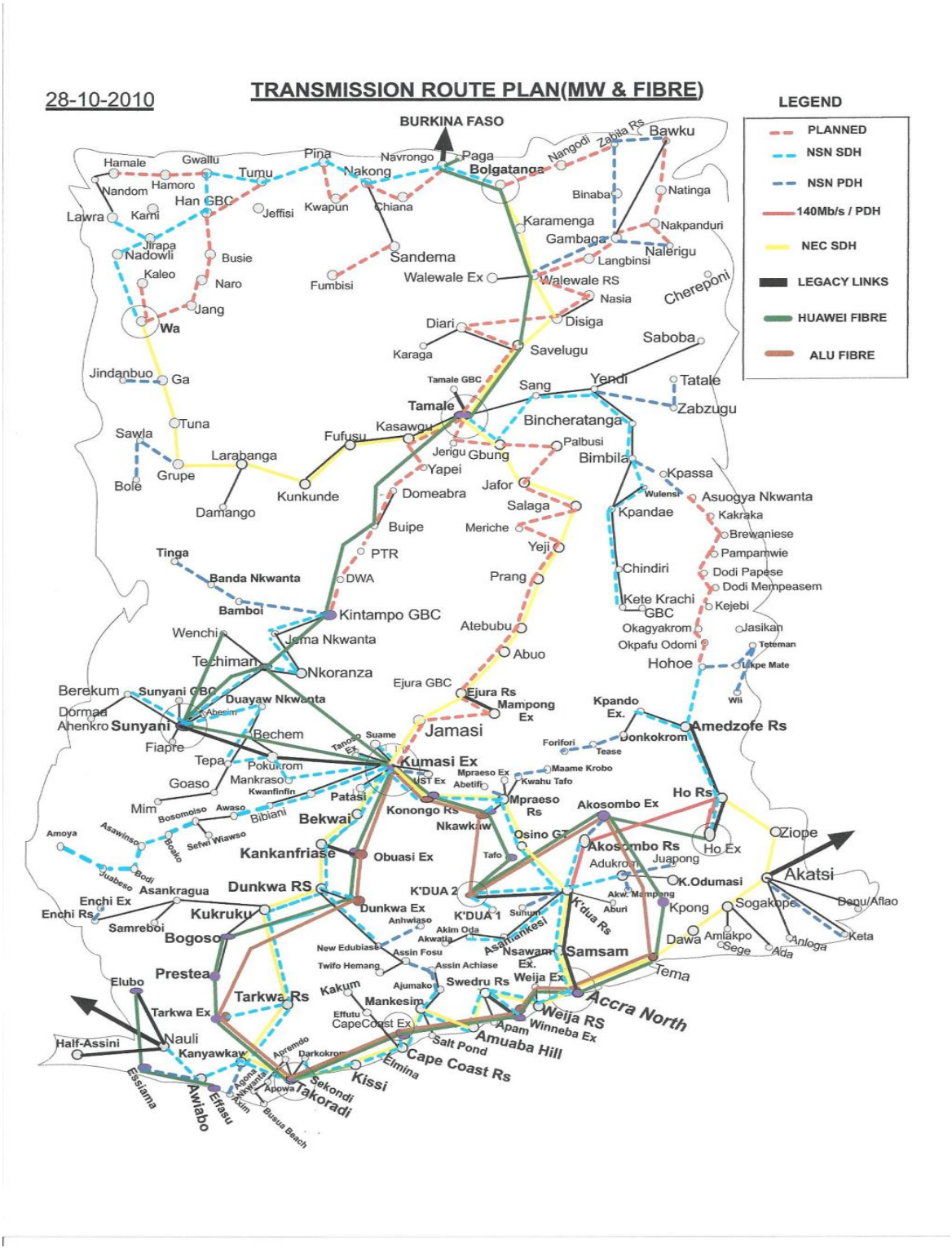
This chapter presents the non-technical findings of Fibre Optic Technology used by Vodafone Ghana in its internet delivery operations as reported through the in-depth interviews. It includes the reason for the technology in Ghana, the extent of reach in the country and general answers received from respondents. Themes were developed along the objectives of the study and the answers to the questions posed along these lines. Themes included educational benefits, social benefits, cultural benefits, application of Fibre Optic Technology by Vodafone Ghana and the future of communication.

4.2 Why Vodafone Adopted Fibre Optics

Copper wire cables have very high attenuation rate, that is, the signals they carry can reduce in strength and makes it impossible for the provision of similar amount of data or bandwidth across the country. The copper wires do not reach very far distances as the fibre cables from research do. There is also value for the copper cables, cable thieves cut them as earlier stated, melt them and sell them. Microwaves network is a wireless network that transmits data by radio signals. Frequencies are needed to transmit the signals and hence during changes in weather conditions reception is obscured. All these were reiterated by Vodafone as reasons for the transition to Fibre Optic Technology.

4.3 Extent of Application of Fibre Optic Technology

Fig 4.3.1



Mr. Daniel Adjepong said that the National Fibre Optic Backbone links all the regional capitals right from Accra to Bolgatanga. As per figure 4.3.1 above, the green line named

Huawei Fibre, links the major capitals of Accra, Cape Coast, Takoradi, Ho, Koforidua, Kumasi, Sunyani, Tamale and Bolgatanga and hence the name National Fibre Optic Backbone. He said that Vodafone has built metropolitan links called Metro Fibre linking most major business towns to the National Fibre Optic Backbone. Mr. Daniel Adjepong added that the Legacy Links as demarcated black on the map above are copper lines and Vodafone Ghana has a programme to replace them. They are replaced by what they call Multi Service Access Nodes (MSANs) which are devices mostly installed at the roadside in the form of a cabinet with a network exchange connecting customers' telephone lines to the core network and providing broadband and telephone or voice, video and data services.

Vodafone Ghana has so far mounted 300 (MSANs) with the capacity to deliver broadband speed up to 20 mps. However the research found that 90% of these MSANs are only deployed in Accra with the rest in Kumasi and Takoradi. The study concluded that these were some of the challenges hampering the development of ICT infrastructure in the country. Figure 4.3.1 shows a high concentration of cabling activity in the southern part of the country and according to Vodafone, only 40% of their clients in Accra have been migrated unto the fibre MSANs. The study found that there was a fibre presence covering only 80% of the country involving district and regional capitals. According to Vodafone Ghana, fibre presence was not yet to every corner of the country. There was the presence from Accra to Tema and to Ho, but not to the border town of Aflao. It continues from Ho to Tamale then crosses to Bolgatanga, even to Paga, the famous game reserve town. It continues to Sunyani but not Berekum and Sampa, then to Kumasi and down to Takoradi. Takoradi is linked through Cape Coast to Accra.

4.4 Benefits

The study sought to understand the benefits of the cables to the clients of Vodafone Ghana which included internet business owners, government, NGOs, banks, diplomatic missions, corporations and schools. Vodafone Ghana says it has migrated thirty thousand residential and what they call Small Office Home Office (SOHO) customers unto the Fibre Optic Technology. The Australian High Commission in Accra is one of such customers. According to Farida Karim Ahmadou, the Local Area Network Administrator (LANA) of the high commission, they accepted to be migrated from the copper wire cables to the all-new Fibre Optic Technology because during the rainy seasons, their link frequently goes down since the cables got contact with rain. She said their cables also suffered loss from thieves whom she suspects use the cables to make copper bracelets. Thirdly, she said the copper cables were costing the high commission much money because of the frequent issues and replacements.

She said there is a big change now in the service after they were migrated unto the Fibre Optic Technology. First of all, the link has never gone down since it was installed. Secondly, the technology provides excellent high speed internet and that according to the LANA, they are almost everlasting. However, she noted that despite all the benefits, the cost of installation of the Fibre Optic Technology was very expensive, three times more than that of the copper cables. The question to Vodafone was therefore that the new technology was supposed to cut down cost and so why the exorbitant nature of the installation. Mr. Sylvester Dikoh, Senior Engineer at Vodafone Ghana only said that most of the equipments such as the MSANs were not manufactured locally and hence their costs being factored in.

There was an assumed notion of reducing cost of internet delivery in Ghana coupled with reducing the stress with internet delivery. Mr. Kyle Whitehill, CEO of Vodafone Ghana said

that through the national fibre optic backbone, information was now disseminated to the farmers for them to be aware of weather patterns thereby improving crop yield and increasing food production in the country. This agricultural benefit will definitely improve the socio-economic livelihood of farmers. However, the research found that not even 10% of farming communities have access to this development. This agricultural aspect of the technology only seems to be hype by the company.

4.5 Educational Aspect of Fibre Optic Application

According to Foster *et al*. (2004) twelve percent of respondents to a survey at BusyInternet, (2002) preferred using the internet for educational purposes. Currently, according to Vodafone Ghana, teleservices, teleconferences and electronic distant learning are some of the benefits of using fibre optic internet technology in Ghana. Because there is low interference, low attenuation and high bandwidth capacity of the cables, a virtual classroom seems very real with the cables. Vodafone said it was part of the Ghana government agenda of bringing internet access to schools including the Senior High Schools and the universities. There is a One Laptop per Child Project (OLCP) initiated by the New Patriotic Party government in 2008. Such a project cannot be effective without internet connection for these children to broaden their knowledge. Fibre optic cables serving as the national backbone will help this agenda materialize. However, the research found out that, most of the rural areas were not connected to the national backbone neither the old copper wires.

Another benefit of Fibre Optic Technology to education that the study found was in the field of a paperless society and this was only a view point raised by Vodafone Ghana. Vodafone said students were now able to do assignments online and submit online. For instance, a supervisor of one of the students of the School of Communication Studies was in the United

States of America and all corrections were done through this means. There is also access to good renowned research databases everywhere such as Elsevier, Jstor and Cambridge libraries. Furthermore, the company said interactive learning has been enhanced by the fibre optics since it could have a high bandwidth base allowing for the download and upload of quality educational contents. According to Vodafone Ghana, because of the extent of application of the cables, students in Kumasi can now sit in a class or lecture going on in Accra without travelling to Accra.

There were electronic laboratories that Vodafone Ghana said enhance cross training and proactive tutorials between students of separate institutions. The experts said schools were taking advantage of the technological development where, for instance, medical students at University of Development Studies and that of the University of Ghana could have a virtual laboratory session. Such a reliable, constant streaming and constant access was made possible by the fibre cables because the bandwidth drove the services.

4.6 Social Aspects of Fibre Optic Application

Fibre Optic Technology reiterated by Vodafone was changing the society has the ability to bridge the gap between the rural folk dwellers and the urban city dwellers as cleared by the Project Manager. He noted that to ensure that there was a fair playing field for candidates of first cycle institutions in both urban and rural areas, ICT courses through provision of internet in the rural areas were made accessible. Though the process was gradual, the company believed that in a few years' time, most schools and homes in the rural areas would have access to internet. Also, cocoa farmers in the evenings after work on their farms, had access to internet tutorials provided on the national fibre optic backbone to give knowledge on how to improve crop yield. All these contribute to self-development and prevent rural urban

migration. He added that this gave the rural folks a sense of contentment through seeing and experiencing what is happening around the world and in the country.

The internet has contributed for the past 20 years to the knowledge development of the people and the society has gotten to a place where people must be able to sit in their rooms and get access to information. Mr. Adjepong observed that the market woman can now go online and compare prices; the teacher could go online and do research and refresh and upgrade their knowledge and pastors now go online and prepare. The deployment of fibre optic cables enhanced social networking and continuous communication and contact with friends and family. There was Skype made possible with Voice over Internet Protocol (VOIP), Facebook, emails and Twitter. The days of writing letters and waiting for two weeks for them to arrive had become a thing of the past as explained by the project manager. In an article entitled 'India plans rural development through fibre optic network', the author Liau Yun Qing (2011) writes that

The Indian government has announced nationwide plans to extend the existing fibre optical network to rural areas. The move will boost the village economy by creating additional jobs and curbing migration to urban centers…to cost 200 billion Indian rupee (US$4.5 billion) boost economic benefits such as provide additional employment, e-education, e-health, e-agriculture and other e-services…e-banking Source : ZDNet Asia

4.7 Cultural Aspect of Fibre Optic Application

The main advantage raised concerning the introduction of the fibre optic national backbone was the bridging of the rural urban gap and thereby giving the people a sense of a shared common identity. The study found that through the introduction of ICTs across the nation and

to the corners of the country, knowledge was being shared through information about issues going on in both the rural and urban centers and even foreign countries. Food, dressing, education and new trends were also shared across board through a better communication technology. According to Vodafone Ghana, the Fibre Optic Technology was aiding the state of culture as dynamic because, people in Accra could learn about people in Akwamu and vice versa. Each other's ways of life was valued and the constructive lifestyles were imbibed.

However, sociologists may argue that the more time people spend using the internet, the less they communicate with others in person or through other means of communication. The study found that because of the increase in accessibility of information, there are individuals, who can spend above six hours with online friends and games ignoring real life situations and friends. People become addicted to the internet resulting in individualism and secluded lifestyles.

4.8 Investments in Fibre Optic Communication

The study found that Fibre Optic Technology had an edge over the rest of the media. It is limitless in terms of the amount of traffic the cable can carry. How much a client could do on fibre depends on the end device. If the end device could do 10 terabytes, the fibre is ready to supply that. To break this down in terms of understanding how Fibre Optic Technology application results in direct economic advantage, for instance, if a company's document is hundred megabytes of data and can be retrieved on the internet. Averagely, a song will take up space of about four megabytes. It ends up that the average data of that company is about the size of twenty five songs. Downloading this as the project manager said, would be smoother on the fibre cables than any other media. One would pay less to stay online; the feed is fast and without interruption.

It was an investment that after putting in the ground, all that the organization worked on was the end device. Also, the cables could travel very far distances. According to Vodafone Ghana, the cable can be laid over a 100 kilometers distance without the need of an electronic device called a Repeater that receives signals and retransmits the signal by accelerating its level to enable it cover up lengthy distances. A Repeater aids in communication by receiving signals from an end point and relaying it to other areas. So for instance, a radio transmission to northern part of Ghana will be enhanced by mounting a receiver in Kumasi which would receive the signals and beam it to the north.

Also, according to Mr. Sylvester Dikoh, the cables do not suffer issues from change in weather conditions that is characterized with microwave. The current phenomenon with the mobile operators was digging. The digging is done to lay fibre optic cables to their mobile sites. The cables can carry a lot of traffic with low data loss ratio compared to microwave and copper. Also, with microwave, licensing is paid and kept for the frequencies to the issuing authority which is a drain on resources. But with the fibre, all they do is lay the cables and save in terms of dropping operational costs. All the networks in Ghana are striving to do fibre because customers are hungry for bandwidth. Other economic benefits of the media is that fibre can be used as a support with other media making it possible for fibre to be beamed to a point then radio or microwave or copper is used to broadcast the internet.

Most Vodafone clients totaling 70% of internet clients were still on the old copper cables as shown in Figure 4.3.1. The study found that it took a while and a lot of investment to transmit clients. However 20% were on fibre optics whiles 10% are on microwave. The research also found from Mr. Dikoh that Vodafone Ghana did not have clients on satellite technology because the technology is very slow. The research found that clients were still on copper

because it cannot just be eliminated. It was a process and copper still played a role, but looking into the future, Vodafone Ghana said that the company plans to migrate between 50% and 60% of their clients on the Fibre Optic Technology.

An article in Ghana Business and Finance magazine, issue one page 39, says

> many national fibre backbone projects in Commonwealth emerging markets similarly range between US$50 million and US$300 million or more…Ghana's national fibre optic backbone project has been valued variously between US$90 million and about $250 million depending on the length and distance to be covered.

The same magazine indicated that investment in ICT results in a country's growth and prosperity. There is, therefore, a global interest for investments by governments and ICT organizations. Because of the cost involved as noted above, development partners such as the United Nations do advise funding collaboration targeted towards infrastructural development in Africa.

However, the study found that some individual moguls such as Dr. Mike Adenuga, the Nigerian owner of Glo, landed his undersea fibre optic cable of 9,800 kilometers called Glo1 on the shores of Ghana in 2009. This was launched in April, 2011 leading to the beginning of a modern state of the art telephony business in Ghana[3]. His investment has a bandwidth speed of 2.5 terabytes per second though the technology seems to need more investment in terms of money.

4:9 Summary

This section dealt mainly with the objectives of the study touching on the extent and benefits of application of Fibre Optic Technology. There is a National Fibre Optic Backbone linking

[3] Daily Guide article on April 11, 2011

all the regional capitals right from Accra to Bolgatanga depicting the extent of application of Fibre Optic Technology. However, the study found that most remote or rural areas were not linked to the backbone. Clients on copper are 70%, clients on fibre are 20% and clients on microwave are 10%. The study found that there was a fibre presence covering 80% of the country involving district and regional capitals. Customers currently migrated unto the fibre cables included the Australian High Commission who said that the copper cables were costing the high commission much money because of the frequent issues and replacements but the fibre seems almost everlasting. The study found that there is a benefit of the technology to agriculture which is improving the socio-economic livelihood of farmers, educational through internet access to schools including the Senior High Schools and the universities and development in virtual classrooms. There have been increases in the mounting of access nodes around the country. The other benefits include social, cultural and economic. This section dealt with the reason why Vodafone Adopted Fibre Optics. Copper wire cables have very high signal loss and could not reach very far distances, microwave network also needed frequencies to transmit data and during changes in weather conditions reception is obscured.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

5.1 Introduction

The study set out to establish the non-technical aspects of fibre optic application, as a communication enabling facility to internet service delivery by Vodafone Ghana with particular reference to cultural, social and educational benefits. The study, therefore, did not seek to look at the rigorous scientific determinants of the technology, but sought how the technology contributes to effective communication and its benefits to the provider and those to whom the service was provided.

The study was guided by research questions which also sought to establish the extent to which the technology exists and had been applied by Vodafone Ghana to deliver internet service, how Fibre Optic Technology cut down loss of time and enhanced economic growth and the other benefits that could be derived from Fibre Optic Technology as applied to internet delivery.

5.2 Summary of Findings

Vodafone Ghana has so far mounted 300 (MSANs) with the capacity to deliver broadband speed up to 20 mps. However the research found that 90% of these MSANs are only deployed in Accra with the rest in Kumasi and Takoradi. The study therefore can draw a conclusion that the idea of technological change by Schumpeter and the tenet of the diffusion of innovations have not been properly utilized in the Ghanaian context. There is a concentration of these infrastructures only in the urban centers of the country and the majority of the people do not really benefit. This also degrades the national government agenda of ICT4AD policy. This high concentration of cabling activity in the southern part of

the country and only 40% of the clients of Vodafone, with a national fibre optic backbone of 80% shows poor abilities to take full advantage of the technology. The copper cables were costing clients much money because of the frequent issues of theft and replacements. But the installation of the fibre optic cables in general was very expensive because the equipments such as the MSANs and even common plugs and sockets were not manufactured in Ghana. This is the main reason why most companies have not migrated fully onto fibre networks. Comparatively, most of the studies done in the developed countries concluded that the technology was cheaper because most of the equipments for the deployment of the cables were ready on their markets where as massive importation was necessary in the Ghanaian context. All these had to be imported creating an irony that something that was supposed to be cheaper rather ends up being expensive. The Ghana government agenda of bringing internet access to schools and supplying free laptops to students and people also becomes an irony. The infrastructure has definitely not reached the corners of the country where people need more experience with development. The One Laptop per Child Project (OLCP) initiated by the New Patriotic Party government in 2008 cannot be effective since there is lack of better infrastructural networks to connect to the internet.

Fibre Optic Technology is also meant to bring changes in the society with the ability to bridge the gap between the rural folk dwellers and the urban city dwellers. Looking at the extent of application, this study concludes that there is little done in this regard. Many young rural dwellers are still migrating to the cities. With statistics, Vodafone clients totaling only 70% of internet users were still on the old copper cables and only 20% were on fibre optics. Jabulani Dhliwayo put it right that there is a high cost of telecommunication as a result of poor infrastructure in Africa and internet usage had only just begun in most of Africa and was currently concentrated in large cities. A decade of the introduction of a good communication facilitator should have seen a rigorous stride in a better usage.

Other benefits of Fibre Optic Technology include government institutions and civil services having access to internet services and improved communication between government and non-governmental institutions. Government institutions for instance are looking into the future of officials having to teleconference instead of travelling to the seat of government to deliberate on issues. The study sees this idea as not fundamentally right because these officials are to represent the local people and bring their grievances to government and present the right sentiments before the discussion assemblies. The social benefits of the technology include rural urban gap bridging by introducing rural folks, students and farmers to internet data as a contribution to self-development to prevent rural urban migration. However, there is no clear outcome of these ideas. Many young rural dwellers of school going age are still pouring into the urban centers. Social networking and continuous communication and contact with friends and family on social media such as Facebook, Twitter, WhatsApp, YouTube, Nimbuzz, Gtalk, MySpace, and Viber has rather giving the youth a different identity all together. The original sense of communalism in the African is now given way to adopted western lifestyles of seclusion.

The extent of application of Fibre Optic Technology to internet delivery is still very low. As at 2009, only 1.3 million Ghanaians had access to internet. With a rough projection due to development in technology and access to internet even on mobile phones, the World Bank indicators for 2010 and 2011 may go up to only 5 million Ghanaians having access to internet. Despite the problems with the other media like very high attenuation rate, stealing, frequency disruptions due to changes in weather conditions, copper wire and microwave are still the predominant media in the country having about 80% of internet being delivered on them. This also shows the patchy growth rate with Ghana's economy. The percentage distribution rate raises a lot of questions. For instance, if the fibre is cheap, why has the

telecom companies not taken full advantage of it? Even, the promise of migrating between 50% and 60% of clients unto fibre optic cables before the end of Vodafone's financial year is a public relations gimmick. The internet everywhere proposition is a brilliant idea to make internet accessible everywhere in the country. Whether in the house, office, transit, playground, there is access through the deployment of fibre. But it is only a few people who can enjoy these services. It is still expensive to access the internet. Around the Teshie area in Accra, it costs 1 (one) Ghana Cedi an hour at the internet cafe compared to claims that internet is as cheap as GHC6 a whole month in other countries because of better infrastructural development and investment. Most of these cafes have Vodafone Ghana supplying their internet.

This study recommends therefore that Vodafone Ghana must also drive down the price which means producing at a lower cost. The quality of service must improve through low production cost, incessant delivery and highest quality through massive investments in the infrastructure. The global company Vodafone has a road map and it is a policy to follow their global design based on their global growth path. Vodafone Technology Group's path was followed to prevent central problems that managers faced during technological change. So, what is being enjoyed in these developed countries must also be enjoyed locally.

5.3 Limitations of the Study

There were a number of limitations associated with this study. Vodafone Ghana was not ready to provide data on the economics of the technology. Just as with many organizations, the company was reluctant to share vital information on the differences in revenue prior to the adoption of the technology and after. Hence, an interview was not granted to the researcher from the finance department even though a request was made. Some of the reasons

giving included the fear of sharing such information with competitors. It would have been very interesting to know how much the company was making during these two eras. The question/interview guide was designed solely by the author with reference to the objectives of the study. The result was that some interviewees' objected to answering some questions while some did not even grant the interview. A few of the questions were therefore not adequately answered. Thirdly, because of the short time frame of this study, it was difficult to find and interview clients who were still on copper and radio. However one client on fibre optics was interviewed.

5.4 Recommendations for Future Studies

As it is with exploratory studies, this study sought to answer questions about the phenomenon of fibre optics. However, there are still many areas that could be further studied through adequate in-depth studies. One area is the cost of the cables. Adequate studies must be done to ascertain the fact that though the Fibre Optic Technology is cheap, there might be a reason why the telecom companies have not taken full advantage apart from the expensive nature of the equipments. Market prices around the world could also be studied to see if consumers are paying too much even though they are the cheapest.

Secondly, another area that could be studied qualitatively and quantitatively is the number of clients of any of the telecommunication companies and which particular medium they are on and the reason why. Thirdly, another interesting area that can be studied is the affordability of receiving devices and services. The top five telecom organizations and the costs of their receiving devices such as mobile phones and costs of services can be studied. There is fibre presence covering 80% of the country involving district and regional capitals. But translating this into better service delivery to every doorstep in the country is still vague.

5.5 The Future

The study found that there were other new services enjoyed in the Western countries that consumers in Ghana are yet to get from being migrated unto the cables. It seemed as if the optimum use of the cable as at the time of the study was not realized. Services yet to be delivered from Fibre Optic Technology included IPTV and VOD. MPedigree also allows customers to check authenticity of drugs online before they purchase them. Aside the major advantage of bringing internet to doorsteps, the cable can be used for what Vodafone calls quadruple play. This is offering the triple play, voice, data and video with mobility. With education, the idea of the universities having a common library was credible. With a system such as eBooks could be created for all universities in Ghana. Also, socially, very soon, because of the introduction of the cables, good internet connection would allow people to work from home or telecommute.

5.5 Conclusion

The study set out to research the non-technical aspects of fibre optic application to internet service delivery by Vodafone Ghana and the benefits that were being derived from using the technology to deliver internet service. This study contributes to theory and literature because it ascertains the level of diffusion of the technology of fibre optics in the Ghanaian society by a leading communications giant. The study outlines similar works both done in Africa and the western world which are obviously good grounds of consultation for future studies. The study is significant because by setting out to investigate the implied assumption that there is a difference in output between Fibre Optic Technology and other technologies, there is a case made for the importance of technological change. This is because as per the thematic sharing of the findings of this study, Fibre Optic Technology seamed cheap and the major medium of leveraging internet communication but the reason for the inaccessibility and continuous

expensive nature of the technology is also found to originate from lack of the manufacturing culture in the African society.

APPENDIX

1. **To explore the extent to which Vodafone Ghana is applying fibre optic cables to deliver internet service and how the technology is leveraging internet delivery provided by the same organization.**

    - When did Vodafone as an organization decide to provide internet access to clients and why?
    - When did Vodafone as a universal organization opt for the Fibre Optic Technology and why?
    - When did Vodafone decide to use fibre optic cables to provide internet service to Ghanaians and why?
    - How did you come about the fibre optic usage?
    - What triggered the change to fibre optic usage?
    - What were some of the initial setbacks and problems encountered?
    - How were these problems solved?
    - What is the percentage distribution of Vodafone clients on the 3 kinds of cables for internet delivery?
    - What are some of the services being delivered to clients on all the 3 kinds of media that is copper, radio wave and fibre optics and what are they demanding that you have plans to offer in the future?
    - In a step by step (in lay man's terms), explain how internet access from the fibre optic gets to a consumer's mobile phone and through the usage of the modem?
    - What is the Internet Everywhere Package by Vodafone and what role do fibre optic cables play in it?
    - Is every corner of the country linked to a fibre optic cable?

2. **To find out the advantages of using fibre optic cable by Vodafone for its clients.**
    - What has the economic turnaround been so far like?
    - What are the economic implications of these cables, does fibre optic cables have an edge over the rest and how?
    - In terms of pricing what are the ranges for those on all the three media?
    - The introduction of a new technology fuels the growth of new brands and creates new growth markets. Have you had any experiences in this wise?
    - Did the introduction of the cable have any diverse implications such as the downsizing of employees?

3. **To examine how Vodafone is applying the technology to meet consumers need in Ghana and what exactly they are offering.**
    - What are some of the services made possible by the introduction of fibre optics?
    - Is there a central, practical problem that managers face deciding when to shift investments from a current to a new technology?
    - Do you conduct client-satisfaction surveys to ascertain customer satisfaction?
    - How often do you conduct these surveys?
    - Did some of the findings spell out customer needs and
    - What were some of these needs?
    - What other findings were discovered from the client-satisfaction surveys?

4. **To find out if there is something new that the consumers could get from getting on the medium that the other cables do not provide**
    - Are there any other innovations that are yet to be derived from using the cables?

- Aside internet provision, what other service can the fibre optic cable be used for in the telecommunication industry?
- Are there any new non-technical aspects of the technology yet to be opened to clients?

5. **Specific questionnaire to a customer who have been migrated from copper wire to fibre optics.**
    - When and why did you decide to migrate from copper wire cables to Fibre Optic Technology
    - Specific challenges that were faced whiles you were on copper wires
    - What are some of the advantages you are enjoying on the new media

Documents Analyzed from Vodafone Ghana

- The Transport Network Architecture (showing the map of Ghana and the Fibre Optic backbone)
- Transmission Media (a folder describing Copper Wire, Glass Fibre, Microwave and Infrared Laser)
- The Transmission Route Plan, MW & Fibre (also showing the map of Ghana and the Fibre Optic backbone from Accra to Bolgatanga)
- The Sub-Saharan and Mediterranean Undersea Cables (Showing the current termination of Fibre Optic Technology in Ghana called SAT-3, Main One and Glo1.

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Sylvester Dikoh, Senior Engineer, Vodafone Ghana was interviewed on the 14th of September 2011

Mr. Akombia S. Koomson, Fixed Data Manager Vodafone Ghana was interviewed on the 14th of September 2011

Front Desk Person (name withheld), Vodafone Ghana was interviewed on the 14th of September 2011

Dr. Nii Quaynor, founder of Network Computer Systems (NCS), the premier internet provider in Ghana was interviewed on 20th June 2011.

Farida Karim Ahmadou, Local Area Network Administrator at the Australian High Commission, Accra was interviewed as clients of Vodafone Ghana on 20th November 2012.