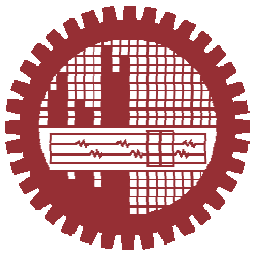
FEASIBILITY STUDY OF FOURTH GENERATION (4G/LTE) MOBILE NETWORK IN BANGLADESH

ZISHAN AHMED SIDDIQUEE



DEPARTMENT OF INDUSTRIAL & PRODUCTION ENGINEERING

BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

MASTER OF ENGINEERING IN ADVANCED ENGINEERING MANAGEMENT

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ZISHAN AHMED SIDDIQUEE

A thesis submitted in partial fulfillment of the requirement for the degree of

MASTER OF ENGINEERING IN ADVANCED ENGINEERING MANAGEMENT

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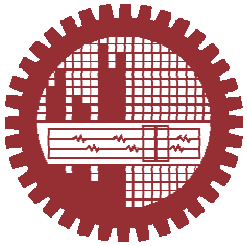

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The thesis titled **"FEASIBILITY STUDY OF FOURTH GENERATION (4G/LTE) MOBILE NETWORK IN BANGLADESH"**, submitted by Zishan Ahmed Siddiquee, Roll No. 1009082101 [F], Session October 2009, has been accepted as satisfactory in partial fulfillment of the requirement for the degree of MASTER **OF ADVANCED ENGINEERING MANAGEMENT** on this day 13th JUNE, 2016.

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III

CANDIDATE'S DECLARATION

It is hereby declared that this thesis or any part of it has not been submitted elsewhere for the award of any degree or diploma.

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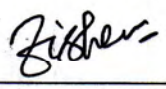

ZISHAN AHMED SIDDIQUEE

DEDICATED TO MY PARENTS

ANWARA SULTANA, M.A.SALAM

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ABSTRACT

The purpose of this study is to analyze market feasibility of 4G/LTE and evaluating financial viability of the investment using financial analysis. The possible outcome of the proposed project is the feasibility report to introduce 4G/LTE in Bangladesh.

LTE is aim to provide mobile voice, video and data services by promoting low cost deployment and service models through Internet friendly architectures and protocols. By Seeing the benefits and added value of LTE technology and return on investments, it's been observed that there is a growing interest of network operators across the world to migrate their existing 2G/3G networks to 4G technologies to enhance the user experience and service. However, although 4G technology will give a new dimension to the Mobile and Internet industry in Bangladesh, but it's worthwhile to understand whether deploying 4G/LTE Technologies in Bangladesh is financially viable or not for Mobile Operators. Keeping that in mind, In this report the focus is given on the cost and Revenue analysis, capital and operational expenditure of LTE roll out, return of investment, Average Revenue per User, LTE adoption trends worldwide, 4G network deployment considerations, Survey for Market Demands, Conjoint Analysis to understand peoples valuation on different attributes of 4G technologies and overall the feasibility for implementation.

Technological and economical balance is an important topic here to address. This report focuses on return of investment as it will be a key driver for Mobile operators to invest on 4G/LTE technologies. In addition to the Network implementation and maintenance cost, Mobile operators also have to consider the cost imposed by BTRC for License fee and Revenue sharing. In these situations, financial viability of the investment using financial analysis is very crucial for Mobile operators to ensure that the investment and the profitability are secured.

I have considered data from GrameenPhone in my study in order to evaluate financial viability of the investment for GrammenPhone using financial analysis. From my study it has been found that 4G/LTE implementation for GrameenPhone is feasible as the IRR is 33%, NPV is positive and the discounted payback period is 3.24 years considering the discounting factor is 13%. Moreover, it's been observed that in most of the countries 2G/3G technology is in its declining phase and its going to be taken over 4G/LTE. Although the 2G/3G technology will remain in the market with the 4G/LTE technology but moving forward the market for 4G will grow whereas the market for 2G/3G will decline.

CHAPETER 01

INTRODUCTION

1.1 Background

LTE technology represents an important evolutionary step in the development of mobile technology, with improved spectral efficiency, enormous scope for increased speed and the capability to address capacity issues through the dynamic addition of new spectrum bands. It promises attractive long-term financial benefits to service providers: LTE-based networks fundamentally change operator business models, making them more data-centric and enabling operators to create new revenue streams and reposition voice and text services, which are being undermined by OTT providers.

4G technologies enable network operators to offer users a wider range of advanced services while achieving greater network capacity through improved spectral efficiency.

a) High Speed Internet
b) Video on Demand
c) High Quality HD Video Streaming
d) Multi Channel hi-fi TV Broadcast
e) High Quality Gaming
f) Video Conference

Long-Term Evolution (LTE) is a standard developed by 3GPP and finalized at the end of 2008. It was designed to address a number of important requirements, most notably the exponential growth of data traffic, which puts significant strain on operator networks and in turn on their financial outlay. LTE addresses this fundamental issue through the use of Orthogonal Frequency Division Multiplexing (OFDM), the next technological step beyond CDMA, offering significant increases in spectral efficiency and speed. LTE also incorporates Multiple-Input Multiple-Output (MIMO) technology, which allows base stations to simultaneously transmit several data streams over the same carrier, thus increasing throughput.

LTE was created as an upgrade to the 3G standards. The cellular industry recognized its major benefits, and virtually every mobile carrier has embraced it as the next generation. All cellular operators are now on the path to implementing LTE. While 3GPP still defines LTE as a 3.9G technology, all of the current LTE networks are marketed at 4G. The real 4G as designated by 3GPP is LTE-A.
LTE brings amazing new capabilities to the cellular business. First, it expands carrier capacity, meaning more subscribers can be added for a given spectrum assignment. Second, it provides the high data rates needed by growing new applications, mainly video downloads to smart phones and other Internet access. Third, it makes cellular connectivity more reliable. All of these needs are important to maintaining growth and profitability in the wireless business.

LTE systems are commercially launched by 451 operators in 151 countries as of the end of December 2015 & it's expected that the number of 4G operators will increase by almost 50% by 2020 [1]. At the end of 2015, global LTE connections reached the 1 billion milestones. At the global level, 16% of all mobile connections are now on 4G networks and by 2020 over a third of mobile connections will be LTE. Despite this, many markets still lag behind, with strong potential for growth remaining in Africa and the Middle East [2]. In this report I have concentrated on the new features of 4G/LTE technologies, Survey for market demand, Capital cost and operational cost, customer segment and demand analysis [3,4], LTE trend adoptions [2], Pros and Cons of Current technology in mobile operator, cost effectiveness and overall feasibility for implementations.

The mobile phone industry in Bangladesh is growing rapidly, and is making a significant contribution to economic development and employment generation. Bangladesh is, in many ways, a country ahead of its time in terms of mobile access. Despite being ranked as a low income country, over 75% of the population subscribes to mobile services and it has outpaced all its peers in terms of network coverage [5]. Mobile network operators have to look into innovative value added services (VAS) to remain competitive and respond to the slowing growth in core mobile services. Services that add value to and improve on the livelihoods of the consumer are more likely to support these goals.
Bangladesh is one of the most populous and most densely populated countries in the world. Mobile penetration levels are relatively high, even in rural areas (something not seen in most other emerging markets). Although the average revenue per user is very low in Bangladesh but people are willing to spend for communications and internets due to the availability of 3G/4G compatible smart phones. Given the reality that there will be less reliance on growth from new subscribers over the next 4–5 years, mobile operators will need to develop new revenue streams beyond core mobile connectivity – services that support basic human needs around agriculture, education and employment provide a key opportunity. In

order to generate new revenue streams mobile operators has to invest on capacity expansion and new technologies that will drive their network revenue as well as providing great user experience.

In order to create a competitive market and taking the Mobile user and its affordability as the first priority, BTRC has pushed all the mobile operators to reduce their call rate drastically in last couple of years. In order to increase the average revenue per users, mobile operators has to provide innovative services to users which can be possible by implementing a next generation 4G/LTE network as it can offer high speed data services along with other Value added services.

Mobile operators all over the world is migrating their 2G/3G networks to 4G/LTE network in order to generate new revenue streams [6].

The development of telecommunications system in Bangladesh is encouraging. This sector has a substantial positive impact on the GDP. Now telecom sector has changed from 2G to 3G although other developing countries are using modern and new technology with 4G. BTRC has launched 3G services through the mobile operators in 2013 and it has been observed that 3G subscriber has been increased drastically whereas the 2G Subscriber has been dropped as expected due to value added services 3G can offer [7,8,9]. By seeing the value added services and benefits 4G and LTE Frequency Allocation is also part of BTRC's future planning list [7]. Mobile operators in Bangladesh are also deploying 3G network equipments which have got the capability to support 4G networks by software upgrades or less effort on the migration.

1.2 LTE Adoptions Status worldwide

TeliaSonera was the first operator in the world to commercially launch 4G in late 2009, in the city centers of Stockholm and Oslo [10]. LTE systems are commercially launched by 451 operators in 151 countries as of the end of December 2015 & it's expected that the number of 4G operators will increase by almost 50% by 2020 [1]. While LTE supports a number of different frequencies and is flexible in also supporting different carrier widths, the reframed 2G/3G spectrum i.e. 1800MHz band is the most popular one [11] and used in most of the commercial LTE networks. This is because the 1800MHz band provides better coverage than 2.6GHz and many operators can reuse the GSM 1800 spectrum they already own. This, in turn, has resulted in the widest range of devices being available in this frequency.

There are regional differences when looking at the share of LTE adoptions. 3G will have a greater share than 2G in all regions by 2020 and 4G will be the dominant technology in Europe and Northern America, accounting for 84% and 58% respectively. 4G will also account for around a third of connections in Asia Pacific, CIS and Latin America, but will lag behind in MENA and Sub-Saharan Africa (with only 13% and 7% of connections by 2020 respectively).The acceleration of 4G has been a particular highlight over the last year. 4G connections doubled in 2015, surpassing 1 billion. Most of this growth came from developing markets, where 4G connections more than tripled, and the developing world will overtake the developed world in terms of 4G connections by the end of 2016 [12].

In recent years, the majority of 4G network launches were in developed markets, such as the US and Europe. However, the developing world is now seeing an acceleration of network rollouts: just under half of total live networks are now in developing markets, up from a third in 2013. In addition, more than half of the countries with a live 4G network are in the developing world. The growing number of LTE rollouts in these markets is driving rapid migration to mobile broadband in the developing world [12].

1.3 Purpose

The purpose of this thesis is to analyze the 4G Mobile market and finding out the cost benefit analysis of deploying 4G network in Bangladesh. The additional revenue expected from the 4G implementation will be also taken into account for the financial analysis of return of investment. Competitive advantage and distinctive capabilities can be gained by the technology replacement with effective manner [13]. However, we have to bear in mind that in telecommunication industries, older-generation technologies often coexist in the market with latest generation technologies and more than one new product may enter the market at or around the same time. 4G/LTE driver, market opportunity, threat, strength and weakness will also be analyzed in order to get a complete picture on the feasibility of 4G/LTE Network implementation.

Market Survey will be done in order to get consumers preference in different scenarios and circumstances. Conjoint analysis will be done in order to understand how consumer value different attributes (Price, Technology, Value Added Services, Transmission Speed) that make up an individual product or service in case of 2G, 3G and 4G Network [14].

1.4 Methodology

1.4.1 Methods for approaching a problem

There are two different methodologies for approaching a problem.

a) Qualitative Methods
b) Quantitative methods

The most important difference between them is how we use numbers and statistics. Often, one can combine quantitative and qualitative methods in the same research [15]. The methods are described below

1.4.2 Quantitative and Qualitative research methods

Qualitative research is more focused on how people feel, what they think and why they make certain choices. The purpose of the Qualitative research method is

a) To gain an understanding of underlying reasons and motivations
b) To provide insights into the setting of a problem, generating ideas and/or hypotheses for later quantitative research
c) To uncover prevalent trends in thought and opinion

Quantitative research is a more logical and data-led approach which provides a measure of what people think from a statistical and numerical point of view. The purpose of the Quantitative research method is

a) To quantify data and generalize results from a sample to the population of interest
b) To measure the incidence of various views and opinions in a chosen sample
c) Sometimes followed by qualitative research which is used to explore some findings further

I have considered both quantitative and qualitative research methods for my study. I have prepared a questionnaire for market survey for market demand of 4G/LTE which will help on both the qualitative and quantitative judgment. Conjoint analysis will also help on the quantitative judgment of consumer's preference on different attributes.

1.4.3 Data collection and sources

There are two types of sources for data collection. These are Primary and secondary sources. Primary sources are interviews and phenomena experienced by the researcher and secondary sources include reports, articles, internets, Journals, Books and other types of written documents.

I have worked on the secondary data from my workplace, research articles, journals, internets, websites of companies related to Mobile communication industry, BTRC. In addition to that I have also gone through a market survey to gather the information on market demands on 4G/LTE and in order to do the conjoint analysis.

1.4.4 Source Inspection and Source evaluation

Source inspection consists of four phases: observation, determination of origin, interpretation and determination of usability. During the observation phase, the researcher searches for the information on the indentified problem. As soon as the data is collected, the origin of each source must be determined. The vital part of this stage is to find out who the author is and whether the source is correct or incorrect. In the interpretation phase the researcher analyses the content. The last phase is to determine the credibility of the source. Source inspection also deals with criticism of the sources. The purpose of criticizing the sources is to determine whether the collection information is valid, relevant and reliable [15].

I have tried to gather as valid information as possible. I have used multiple sources to collect the information and cross check them. I have also carefully studied the origin of each source and determine whether the source is correct or not. In cases where I have used information from websites, I have analyzed the information and crosschecked it with other sources as well.

1.5 Product Life cycle theory

The product life cycle, which was developed by the economist Raymond Vernon in 1966, is still a widely used model in economics and marketing. Products enter the market and gradually disappear again. According to Raymond Vernon, each product has a certain life cycle that begins with its development and ends with its decline. According to Raymond Vernon there are four stages in a product's life cycle: "introduction", "growth", "maturity" and "decline". The length of a stage varies for different products,

one stage of the product life cycle may last some weeks while others even last decades. The life span of a product and how fast it goes through the entire cycle depends on for instance market demand and how marketing instruments are used.

1.5.1 Stage 1: Introduction

When an organization has developed a product successfully, it will be introduced into the national (and international) outlet. In order to create demand, investments are made with respect to consumer awareness and promotion of the new product in order to get sales going. At this stage, profits are low and there are only few competitors. When more items of the product are sold, it will enter the next stage automatically.

1.5.2 Stage 2: Growth

In this stage the demand for the product increases sales. As a result, the production costs decrease and high profits are generated. The product becomes widely known, and competitors will enter the market with their own version of the product. Usually, they offer the product at a much lower sales price. To attract as many consumers as possible, the company that developed the original product will still increase its promotional spending. When many potential new customers have bought the product, it will enter the next stage.

1.5.3 Stage 3: Maturity

In the maturity stage of the Product life cycle, the product is widely known and is bought by many consumers. Competition is intense and a company will do anything to remain a stable market leader. This is why the product is sold at record low prices. Also, the company will start looking for other commercial opportunities such as adaptations or innovations to the product and the production of by-products. Furthermore, consumers will also be encouraged to replace their current product with a new one. There is fear of decline of the product and therefore all the stops will be pulled out in order to boost sales. The marketing and promotion costs are therefore very high in this stage

1.5.4 Stage 4: decline

At some point, however, the market becomes saturated and the product is no longer sold and becomes unpopular. This stage of the Product life cycle can occur as a natural result but can also be stimulated by the introduction of new and innovative products. Despite its decline in sales, companies continue to offer the product as a service to their loyal customers so that they will not be offended.

It is a myth that every product has to go through each of the stages of the product life cycle. There are products that never get beyond the introduction stage, whereas other products remain in the maturity stage for a considerable length of time. The duration of each stage depends on demand, production costs and revenues. Low production costs and a high demand will ensure a longer product life. When production costs are high and there is a low demand for the product, it will not be offered on the market for a long time and, eventually, it will be withdrawn from the market via the 'decline' stage.

Product life cycle can be applied to the mobile telecommunication technologies as well in order to describe the evolution of 1G, 2G, 3G, 4G/LTE and to determine what phase it has reached.

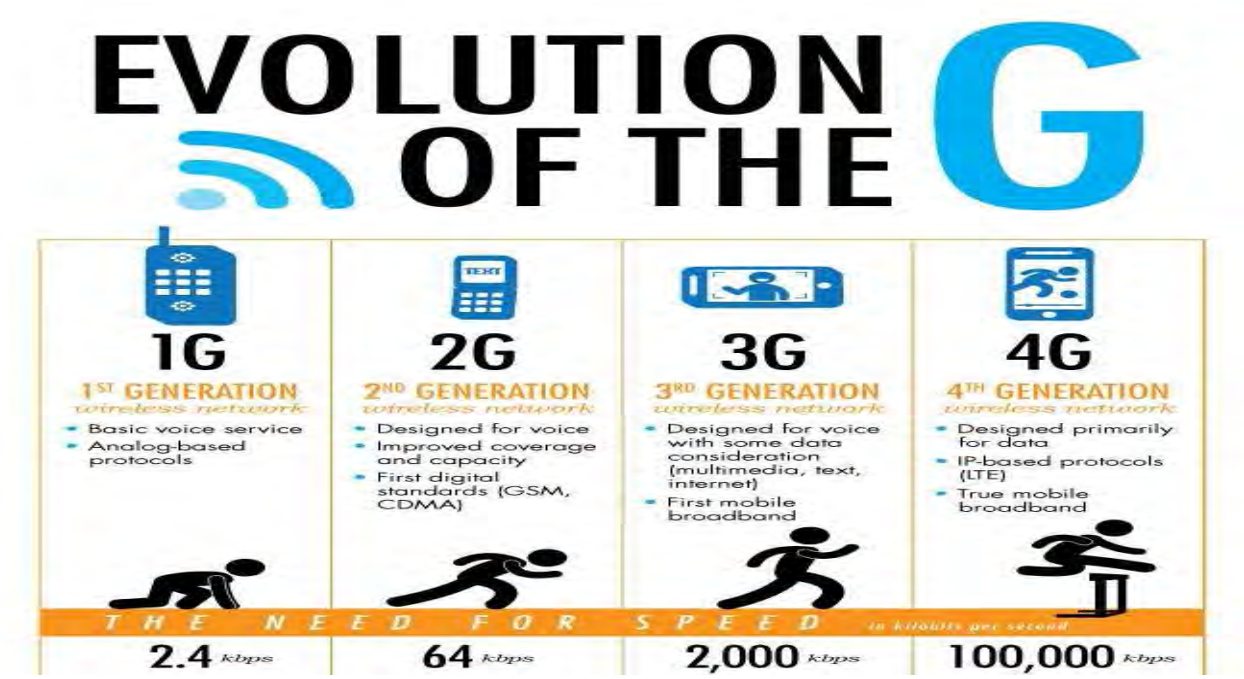

Figure 1.1 Evolutions of Mobile Technologies

The main technological development that distinguished the First Generation mobile phones from the earlier telecommunication technologies was the use of multiple cell sites, and the ability to transfer calls from one site to the next as the user travelled between cells during a conversation. The first commercially automated cellular network (the 1G generations) was launched in Japan by NTT in 1979. In the 1990s, the 'second generation' (2G) mobile phone systems emerged, primarily using the GSM standard. These 2G phone systems differed from the previous generation in their use of digital transmission instead of analog transmission, and also by the introduction of advanced and fast phone-to-network signaling. The second generation introduced a new variant to communication, as SMS text messaging became possible, initially on GSM networks and eventually on all digital networks. Later “2.5G” i.e. GPRS (General Packet Radio Service) with a data rate of 56 kbit/s to 115 kbit/s was introduced in the year of 2000 and 2.75G i.e. EDGE (Enhanced Data rates for GSM Evolution) with a data rate of 384kbit/s speed was introduced in the year of 2003 in order to enable services such as Wireless Application Protocol (WAP) access, Multimedia Messaging Service (MMS), and for Internet communication services i.e. email and World Wide Web access.

As the use of 2G phones became more widespread and people began to use mobile phones in their daily lives, it became clear that demand for data services (such as access to the internet) was growing. The 2G technology was nowhere near up to the job, so the industry began to work on the next generation of technology known as 3G. The main technological difference that distinguishes 3G technology from 2G technology is the use of packet switching rather than circuit switching for data transmission. The high connection speeds of 3G technology enabled a transformation in the industry: for the first time, media streaming of radio and even television content to 3G handsets became possible. NTT DoCoMo launched the world's first commercial 3G network in Japan on 1 October 2001. In the mid 2000s an evolution of 3G technology begun to be implemented namely High-Speed Downlink Packet Access (HSDPA). It is an enhanced 3Gmobile telephony communications protocol in the High-Speed Packet Access (HSPA) family to have higher data transfer speeds and capacity.

Consequently, the industry began looking to data-optimized 4th-generation technologies, with the promise of speed improvements up to 10-fold over existing 3G technologies. It is basically the extension in the 3G technology with more bandwidth and services offers in the 3G. The expectation for the 4G technology is basically the high quality audio/video streaming over end to end Internet Protocol. 4G Technologies was first offered in Scandinavia by TeliaSonera. One of the main ways in which 4G differed technologically from 3G was in its elimination of circuit switching, instead employing an all-IP network. Thus, 4G ushered in a treatment of voice calls just like any other type of streaming audio media, utilizing packet switching over internet, LAN or WAN networks via VoIP. 4G LTE data transfer speed can reach peak download 100 Mbit/s, peak upload 50 Mbit/s [16].

As the technology evolves, new generation technologies are replacing the old generation technologies & market share of old generation technologies are declining which is in line with product life cycle theory. There is an accelerating technology shift to mobile broadband networks across the world. According to GSMA intelligence, Mobile broadband connections (3G and 4G technologies) accounted for almost 50% of total connections at the end of 2015, and are set to increase to more than 70% by 2020 [12] . The factors driving this migration are greater availability and affordability of smart phones, more extensive and deeper network coverage, and in some cases operator handset subsidies.

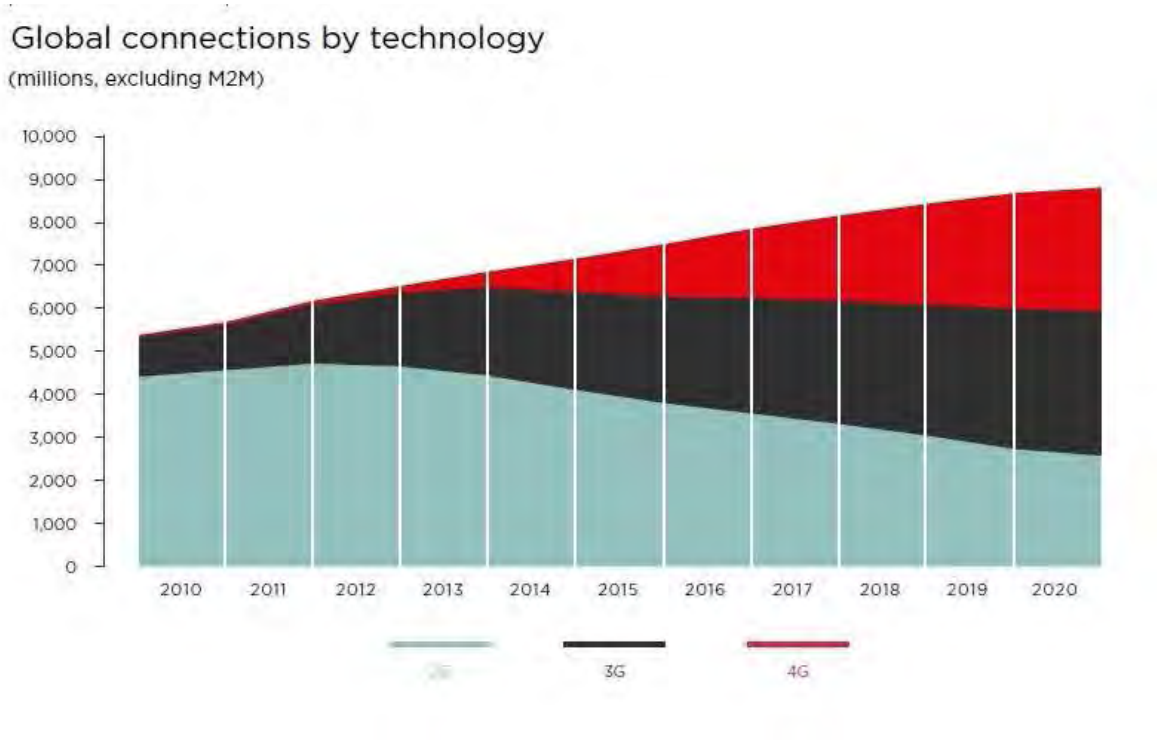

Figure 1.2 Global Connections by technology

In my study product life cycle theories have not been used as means of making forecasts of the future demand. It has merely facilitated the description of the market, analysis of market conditions and the evolution of different technologies. It will also give an overview of the dynamic market structure of the mobile telecommunication industry.

1.6 Market Demand Feasibility

Market demand feasibility may be defined as “The performance of all business activities involved in the flow of goods and services from the producer to the consumer”. It is one of the most critical segments of project feasibility analysis. With the outputs of market feasibility analysis the company assesses the opportunities and threats involved in the market and develops the strategic response that ultimately leads

it to its objective. The objective of market analysis is to see how much of the goods and/or services the consumer is disposed to acquire and at what price. Market analysis covers the following aspect.

a) Definite the target market structure
b) Find out the end user and customers benefit
c) Estimate market size
d) Does the demand of product or services of the project duly assessed considering all factors?

Living standards and economic growth in developing countries are invariably linked to the availability and use of telecom services. Effective policy decisions require the best estimates of the driver of these services. In recent decades we have seen dramatic changes in mobile communication technologies and services. This phenomenon raises wide research interests as the general availability and widespread adoption of advanced telecommunication technologies are linked to the economic potential of nations.

1.7 Feasibility Study

A feasibility study is designed to provide an overview of the primary issues related to a business idea. The purpose is to identify any "make or break" issues that would prevent any business from being successful in the marketplace. In other words, a feasibility study determines whether the business idea makes sense. A thorough feasibility analysis provides a lot of information necessary for the business plan. For example, a good market analysis is necessary in order to determine the project's feasibility. This information provides the basis for the market section of the business plan. By doing the feasibility study, one can make sure that there are no major roadblocks facing his/her business idea before making that investment. A feasibility study should not do in-depth long-term financial projections, but it should do a basic break-even analysis to see how much revenue would be necessary to meet ones operating expenses. Identifying such roadblocks is the purpose of a feasibility study [17, 18].

A feasibility study looks at three major areas:

a) Market issues
b) Organizational/technical issues
c) Financial issues

The key questions that should be answered in the Market Analysis section of the feasibility study are presented below.

a) What is the demand for the proposed products or services?
b) What are the target markets for this product or service? What demographic characteristics do these potential customers have in common? How many of them are there?
c) What competition exists in this market?
d) Is the location of the proposed business or project likely to affect its success?

The market analysis should be conducted first because it is critical to the success of the business.
Once market issues have been addressed, it is time to take a look at key organizational and technology issues that are relevant to the project. The key things need to be clarified here is highlighted below

a) Which team will manage the business
b) What qualifications are needed to manage this business
c) What are the technology needs for the proposed business?
d) What equipment is needed for the proposed business?
e) Where to obtain this technology and equipment?
f) How much will the equipment and technology cost?

Once the analyses of marketing, organizational and technology issues have been completed, the third and final step of a feasibility analysis is to take a look at key financial issues.

a) Start-Up Costs: These are the costs incurred in starting up a new business, including "capital goods" such as land, buildings, equipment, etc. The business may have to borrow money from a lending institution to cover these costs.

b) Operating Costs: These are the ongoing costs, such as rent, utilities, and wages that are incurred in the everyday operation of a business. The total should include interest and principle payments on any debt for start-up costs.

c) Revenue Projections: How to price the goods or services? Assess what the estimated monthly revenue will be.

d) Sources of Financing: If the proposed business will need to borrow money from a bank or other lending institution, research has to be done for potential lenders.

e) Profitability Analysis: This is the "bottom line" for the proposed business. Given the costs and revenue analyses above, one can make the decision whether the business bring in enough revenue to cover operating expenses? Will it break even, lose money or make a profit? When is the Payback period? What is internal rate of return i.e. IRR? NPV is positive? Is there anything to be done to improve the bottom line?

Conducting a feasibility study is a good business practice. The feasibility study is a critical step in the business assessment process. If properly conducted, it may be the best investment one can ever make before launching a business. A feasibility study is an analysis of the ability to complete a project successfully, taking into account legal, economic, technological, scheduling and other factors. Rather than just diving into a project and hoping for the best, a feasibility study allows project managers to investigate the possible negative and positive outcomes of a project before investing too much time and money.

CHAPETER 02

MOBLE NETWORKING MARKET IN BANGLADESH

2.1 History of Mobile Communication in Bangladesh

Bangladesh was the first South Asian country to adopt cellular technology back in 1993 by introducing Advanced Mobile Phone System (AMPS). In fact, the first mobile license was issued back in 1989 but it took several years to launch the services.

In 1996, then the government considering the monopolistic environment prevailing in the sector awarded three GSM licenses to Garmeenphone, Sheba Telecom and AKTEL aimed at breaking the monopoly and making the cellular technology affordable to the general masses. Since then, the country's cellular industry has turned into the largest infrastructure provider during the last decade as sub sector within telecom sector. This sub-sector has created new opportunities by generating employment, facilitating education and health services for common people.

Later in the year of 2004, Teletalk joined as the fifth mobile operator in Bangladesh. Warid Telecom entered in Bangladeshi telecommunication industry as the sixth mobile carrier and it commenced commercial operations in May 10, 2007

Bangladesh Telecommunication Regulatory Commission, with the approval of the Government, issued 3G license in favor of Grameenphone Ltd, Banglalink Digital Communications Ltd, RobiAxiata Ltd and Airtel Bangladesh Ltd on 19-09-2013. The mobile communications sector in Bangladesh is one of the fastest growing industries and has helped boost the economic and social development in the country in three main ways:

a) By providing value-added services and creating employment from direct/indirect firms in the telecommunications sector
b) Increased productivity in businesses as a result of mobile phone usage
c) Increasing the involvement and engagement of its population with news and current affairs.

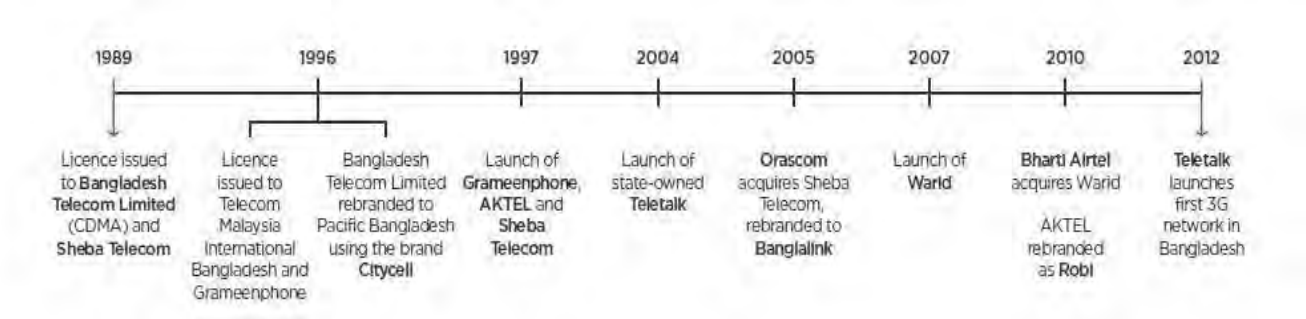

Figure 2.1 History of Mobile Communication in Bangladesh

2.2 Mobile Operators in Bangladesh

2.2.1 Citycell

In 1989 Bangladesh Telecom Limited (BTL) was awarded a license to operate cellular, paging, and other wireless communication networks. Then in 1990 Hutchison Bangladesh Telecom Limited (HBTL) was incorporated in Bangladesh as a joint venture between BTL and Hutchison Telecommunications (Bangladesh) Limited. HBTL began commercial operation in Dhaka using the AMPS mobile technology in 1993. Later that year Pacific Motors bought 50% of BTL. By 1996 HBTL was renamed as Pacific Bangladesh Telecom Limited (PBTL) and launched the brand name 'City cell Digital' to market its cellular products.

2.2.2 GrameenPhone

Grameenphone, the leading telecommunications operator of Bangladesh is part of Telenor Group which has presence in 13 markets across Europe and Asia. Before Grameenphone's inception, the phone was for a selected urbanized few. The cell phone was a luxury: a flouting accessory for the select elite. The mass could not contemplate mobile telephony as being part of their lives. Grameenphone started its journey with the Village Phone program: a pioneering initiative to empower rural women of Bangladesh. The name Grameenphone translates to "Rural phone". Starting its operations on March 26, 1997, the Independence Day of Bangladesh, Grameenphone was the first operator to introduce GSM Technology in this country. Grameenphone pioneered the then breakthrough initiative of mobile to mobile telephony and became the first operator to cover 99% of the country's people with network

Since its inception Grameenphone has built the largest cellular network in the country. Presently, nearly 99 percent of the country's population is within the coverage area of the Grameenphone network. Grameenphone has always been a pioneer in introducing new products and services in the local telecom market. Grameenphone was also the first telecommunication operator in Bangladesh to introduce the pre-paid service in September 1999. It established the first 24-hour Call Center, introduced value-added services such as VMS, SMS, fax and data transmission services, international roaming service, WAP, SMS-based push-pull services, EDGE, personal ring back tone and many other products and services. In October 2013 the company launched 3G services commercially. The entire Grameenphone network is 3G/EDGE/GPRS enabled, allowing access to high-speed Internet and data services from anywhere within the coverage area. There are currently over 15 million Internet users in the Grameenphone network. Today, Grameenphone is the leading and largest telecommunications service provider in Bangladesh with 56.95 million subscribers as of April, 2016.

2.2.3 Banglalink

Sheba Telecom (Pvt.) Ltd. was granted license in 1989 to operate in the rural areas of 199 upazilas. Later it obtained nationwide 15-year GSM license in November 1996 to extend its business to cellular mobile, radio telephone services. It launched operation in the last quarter of 1997 as a Bangladesh-Malaysia joint venture. In September 2004, Orascom Telecom Holdings purchased 100% of the shares of Sheba Telecom (Pvt.). In March 2008, Sheba Telecom (Pvt.) Limited changed its name as Orascom Telecom Bangladesh Limited, matching its parent company name. In July 2013, following the 2011 ownership restructuring in the parent company, the company name changed for the second time to Banglalink Digital Communications Ltd

Since Banglalink’s launch, its impact was felt immediately: overnight mobile telephony became an affordable option for customers across a wide range of market segments. Banglalink attained 1 million subscribers by December, 2005 and 3 million subscribers in October, 2006. Banglalink overtook Aktel In less than two years to become the second largest operator in Bangladesh with more than 7.1 million customers. Banglalink currently has 32.148 million subscribers as of April, 2016 which represents a market share of 24.4%. Banglalink’s growth over the preceding years have been fuelled with innovative products and services targeting different market segments, aggressive improvement of network quality and dedicated customer care, creating an extensive distribution network across the country, and establishing a strong brand that emotionally connected customers with Banglalink.

2.2.4 ROBI

Robi, the most dynamic and rapidly-growing telecommunications operator in Bangladesh, is developing its services to meet increasing customer needs - ranging from voice and high speed Internet services to tailor-made telecommunications solutions. It commenced operation in 1997 as Telekom Malaysia International (Bangladesh) with the brand name ‘Aktel’. In 2010 the company was rebranded to ‘Robi’ and the company changed its name to Robi Axiata Limited. Robi is a joint venture company between Axiata Group Berhad of Malaysia and NTT DoCoMo Inc. of Japan.

Robi draws from the international expertise of Axiata and NTT DoCoMo Inc. Services support 2G and 3.5G voice, CAMEL Phase II & III and 3.5G Data/GPRS/EDGE service with high speed internet connectivity. Its GSM service is based on a robust network architecture and cutting edge technology. The company has the widest International Roaming coverage in Bangladesh connecting 600 operators across more than 200 countries. Robi’s customer centric solution includes value added services (VAS), quality customer care, digital network security and flexible tariffs. Since its inception in 1996, Robi draws on leading edge technology to provide its service in Bangladesh, covering almost 100% of the population. Robi is committed to provide best data and voice quality and will continue to ensure that its customers are able to enjoy the best experience through leading edge technology and innovative products and services.

2.2.5 TELETALK

Teletalk Bangladesh Limited, whose brand name is 'Teletalk' is the only state-run GSM and 3G based mobile phone operator in Bangladesh that started operating in 2004. As on April, 2016, Teletalk is the fifth largest mobile operator in Bangladesh with a subscriber base of 4.365 million. Teletalk has 10 MHz 3G spectrum of 2100 MHz Band. Teletalk offers both prepaid and postpaid plans for its 3G and 2G users. The operator also offers 3G broadband devices such as Flash MODEM, Flash Router and MiFi Router. Teletalk Bangladesh Limited has continually expanded its network, to better accommodate its growing customer base as well as to keep the promise of providing better service. As of now, Teletalk has already established its network foothold in 64 Districts, 402 Upazilas, and most of the highways. Teletalk is continuing its network expansion to reach more corners of Bangladesh

2.2.6 AIRTEL

Airtel is the sixth mobile phone carrier to enter the Bangladesh market, and originally launched commercial operations under the brand name 'Warid' on May 10, 2007. In 2010, Warid Telecom sold a majority 70% stake in the company to India's Bharti Airtel Limited. Bharti Airtel Limited took management control of the company and its board, and rebranded the company's services under its own

Airtel brand from December 20, 2010. As of April, 2016, Airtel Bangladesh has 10.103 million subscribers.

Airtel Bangladesh Limited is one of the fastest growing mobile services providers in Bangladesh and is a concern of Bharti Airtel Limited, a leading global telecommunications services provider. The company offers a wide array of innovative mobile services, including voice, value added services, data and m-commerce products and is focused on expanding its state-of-the-art mobile network both for coverage and capacity. With a customer base of more than 10 million, Airtel Bangladesh is the most preferred youth brand of the country that thrives on excellent data service. To make customer's lives easier Airtel Bangladesh has Doorstep Service by which customers can enjoy all kinds of service at their preferred place. M-Commerce opened a new horizon in money transfer that gives Airtel customers the freedom to send money to their dear ones instantly from their mobile. Through M-health, customers can now reach professional doctors over phone 24/7 and get basic treatment.

2.3 Present Situation of Mobile Communication in Bangladesh

2.3.1 Market Share and Subscriber Base

Below is the number of subscribers and Market share for each of the operators as well as the total subscriber base in Bangladesh as of April, 2016.

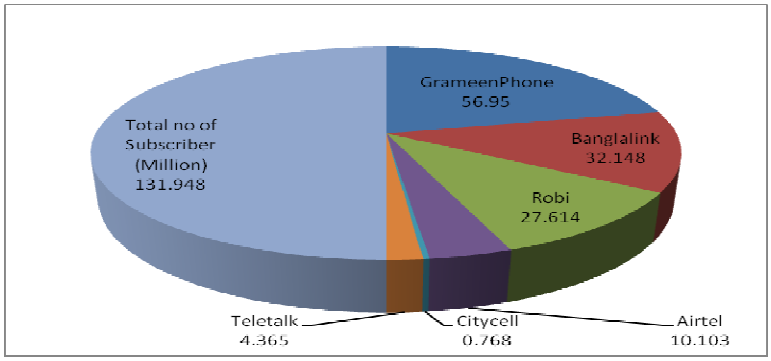

Figure 2.2: Subscriber of Mobile Operators in Bangladesh

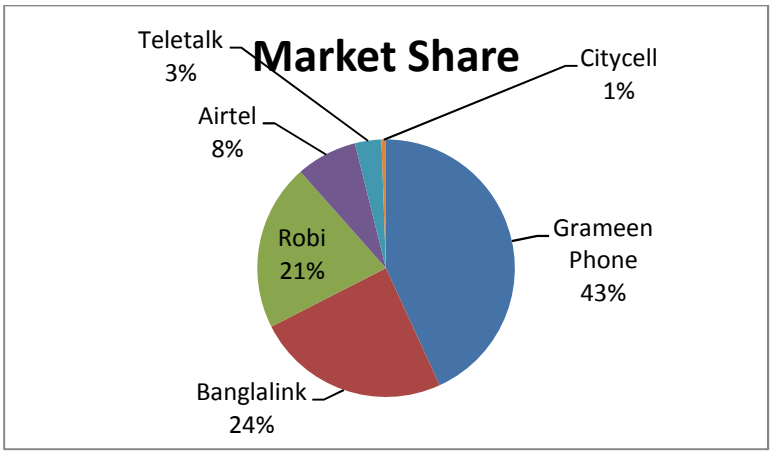

Figure 2.3: Market share of Mobile Operators in Bangladesh

Over the past nearly four years, the compound monthly growth rate of the total subscribers in Bangladesh is almost 1% and it has been seen on average over this period more than a million subscribers are being added to the market every month. By any standard, this is an impressive growth rate and is indicative of the mobile technology's affordability, ease of adoption, and of course the desire for society to use mobile technology. However, such a high growth rate cannot be sustained indefinitely. As of April 2016, the total number of subscribers is over 131.948 million; given that Bangladesh's population is about 160 million (with an annual growth rate of around 1%) and taking into account the addressable market of the population pyramid (e.g. excluding children), and that only a fraction of the population has multiple mobile subscriptions, the growth rate for mobile subscriptions is bound to slow in the coming years.

In terms of the individual operators of which there are six, we can see from Figure that Grameenphone is the dominant leader and its lead over its nearest rival Banglalink continues to widen. Banglalink's closest competitor is Robi and they have both been on a somewhat parallel trajectory with a current offset of ~5 million subscribers. Airtel comes in 4th with a substantially smaller subscriber base but its growth rate has been quite good over the past year.

Given that growth rate will ultimately slow, market share becomes an even more important factor. Figure 2.2 & Figure 2.3 shows the mobile operators and the number of their subscribers as well as their market share as of April, 2016. This tells us that the market share of the operators has been quite static and that it is very difficult for any operator to take away market share from any other operator.

2.3.2 Technology & Allocated Spectrum in Bangladesh

Currently Bangladesh Mobile operator has got 2G and 3G technology in place.

2.3.2.1 2G technology

2G technology is used to provide second generation mobile phone service to the people of the country. Using this service, subscriber can make voice calls and can use data service in a limited scale. According to NFAP, spectrum of 900 MHz and 1800 MHz bands are allocated for second generation mobile service. At present, five operators including state owned Teletalk Bangladesh Limited are providing this second generation mobile service by GSM technology. Airtel is providing their 2G service by ITU declared E-GSM band (900 MHz). The assigned spectrum of six operators who use GSM and CDMA technology are as follows:

Table 2.1: 2G Spectrum Allocation

Band	Operator Name	Assigned Spectrum (MHz)
900 MHz	Grameenphone Ltd.	7.4
	Robi Axiata Ltd.	7.4
	Banglalink Digital Communication Ltd.	5.0
	Teletalk Bangladesh Ltd.	5.2
	Airtel Bangladesh Ltd.	5
1800 MHz	Grameenphone Ltd.	14.6
	Robi Axiata Ltd.	7.4
	Airtel Bangladesh Ltd.	10
	Banglalink Digital Communication Ltd.	10
	Teletalk Bangladesh Ltd.	10
CDMA 800MHz	Pacific Bangladesh Telecom Ltd.	8.82 (For Dhaka Central Zone) 6.3 (Rest of the Country except Dhaka central Zone)

2.3.2.2 3G technology

3G is currently the state of the art technologies to spread high-speed mobile broadband service to the people of distant corners of the country. BTRC has taken initiative to implement this service countrywide through the mobile phone operators of the country. Government has taken step to issue 3G license in view to provide speedy internet service and video call, mobile TV, audio streaming, video health service, video conferencing service etc. in low cost. Ministry of the Post and Telecommunication on 12-02-13 approved

3G Cellular Mobile Phone Services Regulatory and Licensing Guidelines, 2013 and requested the Commission to take next necessary steps. 3G auction has held on 08-09-13.

In order to provide services through 3G technology, in the year 2013, 35 MHz frequency have been assigned by the commission to 5 (five) operators i.e. Grameenphone Ltd., Banglalink Digital Communication Ltd., Robi Axiata Ltd., Airtel Bangladesh Ltd. and Teletalk Bangladesh Ltd. through an auction where 1 (one) MHz bandwidth was sold at 21 (twenty one) million US dollar. State owned Mobile operator Teletalk is providing 3G facility to the end user since October, 2012 in Bangladesh. These spectrums are technology neutral. All the operators have achieved their 3G network rollout target before the deadline with the aid of the spectrum division of BTRC. As a result, 3G service is available in other cities including all districts headquarters of the country. 3G subscribers are availing high speed internet, enjoying television in mobile, video conferencing service and video on demand service. There have been created immense employment opportunity with the local and foreign investment in telecommunication and ICT sector by issuing 3G license. By having the 3G service, there have been opened the door of huge development in the education, health, agriculture, marketing and banking sector. Below is the figures of allotted block, spectrum and spectrum fee are as follows:

Table 2.2: 3G Spectrum Allocation & associated fees

SL No.	Name of organization	No. of block	Alotted spectrum	Spectru fee (per MHz)	Total spectrum fee
1	Grameen Phone Ltd.	2	1935-1945/ 2125-2135= 10 MHz	21 (Twenty one) million US dollar	210 (Two hundred and ten) million US dollar
2	Robi Axiata Ltd.	1	1950-1955/ 2140-2145= 5 MHz	21 (Twenty one) million US dollar	105 (One hundred and five) million US dollar
3	Airtel Bangladesh Ltd.	1	1945-1950/ 2135-2140= 5 MHz	21 (Twenty one) million US dollar	105 (One hundred and five) million US dollar
4	Banglalink Digital Communications Ltd.	1	1955-1960/ 2145-2150= 5 MHz	21 (Twenty one) million US dollar	105 (One hundred and five) million US dollar

After the introduction of 3G technology in Bangladesh, it's been observed that 3G subscriber is increasing at a significant higher rate whereas the subscriber in 2G is decreasing as expected. It shows that people are welcoming the new technology although they had to pay a premium for that. However, people are still using 2G and it's expected that the number of subscriber will go down drastically in next few years.

Table 2.3: Mobile Subscription as of March, 2016

Year	% Increase	3G Mobile Subscriber (Million)
2013		1.24
2014	804%	11.18
June, 2015	60.85%	17.99
March, 2016	42.63%	25.66

Year	% Decrease	2G Mobile Subscriber (Million)
2013		115.31
2014	-5.3%	109.17
June, 2015	-0.3%	108.88
March, 2016	-3.4%	105.22

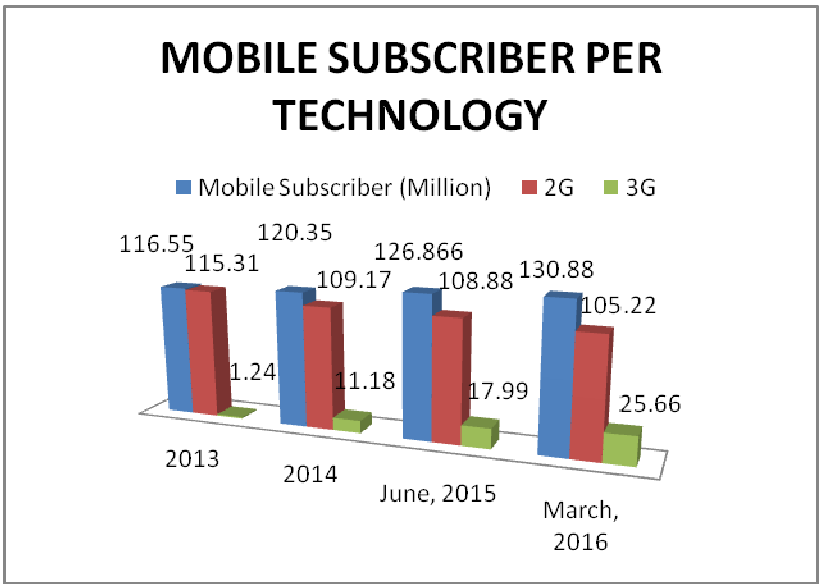

Figure 2.4: Mobile Subscription per Technology

CHAPETER 03

4G/LTE Overview, Business models and Mobile operator KPIs

3.1 4G/LTE Overview

3.1.1 4G/LTE technology primer

4G mobile broadband technologies will allow wireless carriers to take advantage of greater download and upload speeds to increase the amount and types of content made available through mobile devices. 4G networks are comprehensive IP solutions that deliver voice, data, and multimedia content to mobile users anytime and almost anywhere. 4G technology standards offer greatly improved data rates over previous generations of wireless technology. Faster wireless broadband connections enable wireless carriers to support higher-level data services, including business applications, streamed audio and video, video messaging, video telephony, mobile TV, and gaming.

The 3GPP body began its initial investigation of the LTE standard as a viable technology in 2004. In March 2005, 3GPP began a feasibility study whose key goals were to agree on network architecture and a multiple access method, in terms of the functional split between the radio access and the core network. The study concluded September 2006 when 3GPP finalized selection of the multiple access and basic radio access network architecture. 3GPP decided to use OFDMA in the downlink direction and use SC-FDMA in the uplink direction. The specifications for the LTE standard were approved by 3GPP in January 2007. The specifications are now under change control, leading to their inclusion in 3GPP Release 8. While the LTE requirements are finalized, the standard is not fully completed. LTE Release 8 was completed by late 2008.

3.1.2 4G/LTE supported Technologies

3.1.2.1 MIMO

The following information describes the various supporting technologies that make up LTE. MIMO

Multiple-input and multiple-output (MIMO) employs multiple transmit and receive antennas to substantially enhance the air interface. It uses space-time coding of the same data stream mapped onto multiple transmit antennas. This offers a substantial improvement over traditional reception diversity

schemes where only a single transmit antenna is deployed to extend the coverage of the cell. MIMO processing also uses spatial multiplexing, allowing different data streams to be transmitted simultaneously from different transmitter antennae. Spatial multiplexing increases the end-user data rate and cell capacity. In addition, when knowledge of the radio channel is available at the transmitter, such as through feedback information from the receiver, MIMO can implement beam-forming to further increase available data rates and spectrum efficiency. Multiple antennas are also used to transmit the same data stream, thus providing redundancy and improved coverage, especially close to cell edge.

3.1.2.2 OFDM

In the downlink, orthogonal frequency-division multiplexing (OFDM) was selected as the air interface for LTE. OFDM is a particular form of multicarrier modulation (MCM). In general, MCM is a parallel transmission method that divides a radio frequency channel into several, more narrow-bandwidth subcarriers and transmits data simultaneously on each subcarrier. OFDM is well suited for high data rate systems that operate in multipath environments because of its robustness to delay spread. The cyclic extension enables an OFDM system to operate in multipath channels without the need for a complex Decision Feedback Equalizer (DFE) or Maximum Likelihood Sequence Estimation (MLSE) equalizer. As such, it is straightforward to exploit frequency selectivity of the multipath channel with low-complexity receivers. This allows frequency-selective scheduling, as well as frequency-diverse scheduling and frequency reuse one-deployments. Furthermore, due to its frequency domain nature, OFDM enables flexible bandwidth operation with low complexity. Smart antenna technologies are also easier to support with OFDM, because each subcarrier becomes fl at faded and the antenna weights can be optimized on a per-subcarrier or block of subcarriers basis. In addition, OFDM enables broadcast services on a synchronized single frequency network (SFN) with appropriate cyclic prefix design. This allows broadcast signals from different cells to combine over the air, thus significantly increasing the received signal power and supportable data rates for broadcast services.

3.1.2.3 SC-FDMA

Single-carrier FDMA (SC-FDMA) was chosen to reduce Peak to Average Ratio (PAR), which has been identified as a critical issue for use of OFDMA in the uplink where power-efficient amplifiers are required in mobile devices. Another important requirement was to maximize the coverage. For each time interval, the base station scheduler assigns a unique time frequency interval to a terminal for the transmission of user data, thereby ensuring intra-cell orthogonality. Slow power control, for compensating

path loss and shadow fading, is sufficient as no near-far problem is present due to the orthogonal uplink transmissions. Transmission parameters, coding, and modulation are similar to the downlink transmission. The chosen SC-FDMA solution is based on using a cyclic prefix to allow high-performance and low-complexity receiver implementation in the eNodeB. As such, the receiver requirements are more complex than in the case of OFDMA for similar link performance, but this is not considered to be a problem in the base station. The terminal is only assigned with contiguous spectrum blocks in the frequency domain to maintain the single-carrier properties and thereby ensure power efficient transmission. This approach is often referred to as blocked or localized SC-FDMA.

3.1.3 Advantages of 4G/LTE Technology

LTE technology offers a number of distinct advantages over other wireless technologies. These advantages include increased performance attributes, such as high peak data rates and low latency, and greater efficiencies in using the wireless spectrum. Improved performance and increased spectral efficiency will allow wireless carriers using LTE as their 4G technology to offer higher quality services and products for their customers. LTE technology can offer the following benefits:

a) High peak speeds:
   - 100 Mbps downlink (20 MHz, 2x2 MIMO)—both indoors and outdoors
   - 50 Mbps uplink (20 MHz, 1x2)

b) At least 200 active voice users in every 5 MHz (i.e. support up to 200 active phone calls)

c) Low latency: < 5 ms user plane latency for small IP packets

d) Scalable bandwidth:

The 4G channel offers four times more bandwidth than current 3G systems and is scalable. So, while 20 MHz channels may not be available everywhere, 4G systems will offer channel sizes down to 5 MHz, in increments of 1.5 MHz

e) Improved spectrum efficiency:
   - Spectrum efficiency refers to how limited bandwidth is used by the access layer of a wireless network. Improved spectrum efficiency allows more information to be transmitted in a given bandwidth, while increasing the number of users and services the network can support.
   - Two to four times more information can be transmitted versus the previous benchmark, HSPA Release 6.

f) Improved cell edge data rates:

- Not only does spectral efficiency improve near cell towers, it also improves at the coverage area or cell edge.
- Data rates improve two to three times at the cell edge over the previous benchmark, HSPA Release 6.

g) Packet domain only

h) Enhanced support for end-to-end quality of service:

Reducing handover latency and packet loss is key to delivering a quality service. This reduction is considerably more challenging with mobile broadband than with fixed-line broadband. The time variability and unpredictability of the channel become more acute. Additional complications arise from the need to hand over sessions from one cell to another as users cross coverage boundaries. These handover sessions require seamless coordination of radio resources across multiple cells.

3.2 Business Models and Mobile Operator KPIs

3.2.1 LTE spectrum trends and strategies to improve spectrum availability

LTE network deployment is largely determined by spectrum availability. This has been a fundamental point in a number of markets, significantly affecting competitive dynamics and long-term positioning. The pursuit of the right spectrum is at the heart of operator LTE strategies and has resulted in high license costs, (particularly for low-frequency spectrum), significant acquisitions and for some operators a loss of market share.

In order to enhance 4G services, assignment of frequency from 700 MHz (703-748/758-803) band is under consideration by BTRC. Besides, BTRC is also planning to provide higher spectrum band to Mobile operators for 4G/ LTE services in the densely populated region [7].

As licensing cost is a huge factor for 4G/LTE feasibility analysis, Mobile operators needs to have a clear strategies on the spectrum allocation. Following things need to be considered by Mobile Operator

a) Purchase the Spectrum as per the requirement and at the right price.

b) As LTE can also use the same frequency as 2G and 3G i.e. 1800 MHz, Mobile operators can think of discontinuing a 2G Network spectrum and allocate the spectrum for 4G/LTE. Mobile operators can save lot of money for 4G/LTE spectrum cost by freeing up spectrum. Obviously it requires permission from BTRC. AT&T in the USA, KT Telecom

in Korea and NTT in Japan has already followed this strategy of discontinuing 2G network and investing it on the 4G/LTE.

3.2.2 Network Deployment Strategies and Best Practices

There is always a benefit to being the first mover. The faster the mobile operator can deploy the 4G/LTE network, the sooner they will be able to commercialize the products which they would like to sell it to end users. By delaying the network roll out, one can simply give the ball to the competitors hand as competitor can deploy the network faster so that they will be able to attract more subscribers by selling the new products and features.

The speed at which the network can be expanded nationwide is also a critical factor. It's been observed in some of the countries that the operators who were first to launch, they were not the first to reach nationwide coverage Achieving nationwide coverage rapidly not only allows the service provider to promise a higher quality of service, but it also simplifies a service provider's distribution and marketing efforts. Nationwide LTE coverage is also important for the launch of VoLTE services, as well as services with greater data needs.

3.2.3 LTE Devices and Key considerations for Mobile Operators

The availability of LTE devices is an important part of successful LTE adoption. This includes ensuring:

a) Availability of an attractive range of devices
b) Reduction in the impact of device costs on the end user
c) Optimal device adoption opportunities and upgrade paths

Mobile operators need to ensure the following:

a) 4G /LTE capable end user device are available and it's affordable for the consumers.
b) Having a close contact with the handset Suppliers. As LTE is available in a wide range of frequencies, it needs to be available with the right frequencies and specifications, in sufficient quantities and with the configurations the operators require.
c) Making low-cost LTE devices available by the mobile operators.

d) Financing options for a certain period to end users to increase the Smartphone installed base and data usage.
e) Providing large subsidies on LTE devices and attract more customers & sell more data services.
f) Enabling faster device upgrades i.e. enabling 24-month contract subscribers to upgrade consumer's devices every year.

3.2.4 Monetizing 4G/LTE based Services and LTE Pricing approaches

Services are Key to monetizing LTE. Services will drive demand for higher speed and better networks, thus helping consumer to migrate to LTE and increase data consumption and thus demand for higher value plans.

Video (sports and films) and music streaming are the key services on LTE. Mobile operators can price LTE at a premium and bundling premium content or providing free applications in order to drive the use of such services on mobile i.e. drive the data usage. Mobile operator's ownership of content enables exclusivity, but adoption must be high and well monetized. Typically it is only worthwhile for operators with fixed and mobile networks to own content. Mobile could become the primary channel for content in markets with less fixed infrastructure. Apps that help users discover and find content are another approach for operators to grow LTE usage. Mobile operator can also provide limited content bundling with no premium pricing. It will also help to drive the data usage by consumers.

In markets with strong demand for high-speed data, premium pricing makes sense, but premium pricing can contribute to slower adoption, low Smartphone penetration, limited appetite for higher data speeds and increased complexity and gives challengers the opportunity to undercut. The added complexity has also put off potential users, particularly in less technology savvy segments.

An important alternative approach is shared plans. Not only have these packages helped to drive adoption for additional devices and more data, they are also well suited to Mobile Operators that can benefit from a positive impact on churn. While these plans charge extra per device, higher-end packages can bundle a second device i.e. 4G tablet subscription with a substantial discount. Fixed-mobile bundling also improves loyalty and enables integrated services to be offered, such as content and personal cloud access across devices. Most LTE networks do not provide unlimited data plans for pre-paid packages as thus puts a ceiling on revenue while putting a strain on the network. However, some of the operators offer LTE unlimited data plans that will help to continue to drive Average revenue per service i.e. ARPS.

3.2.5 Positioning LTE as Fixed Broadband alternative

LTE can be positioned as a fixed broadband technology, but the size of the opportunity varies market by market, depending largely on the fixed infrastructure available. However, it's expected that in all the markets there is a not insubstantial segment of the market that chooses mobility with data caps over fixed broadband. Bangladesh with much more limited fixed network coverage and very limited DSL competition, LTE could be a strong alternative. Not only is DSL performance often poor (where it is available), but installation times can be long and cable theft continues to be a problem. Low-frequency LTE spectrum is the right product to replace WiMAX and drive broadband adoption overall. Some users particularly those that are price sensitive and do not make use of a lot of high-speed services such as video streaming, choose LTE over fixed broadband alternatives. In Bangladesh we don't have a widespread availability of high-speed fixed broadband infrastructure and that's why with low-frequency spectrum available, LTE could be positioned as a low end, rural fixed broadband alternative.

3.2.6 VoLTE over Circuit Switched Network

VoLTE is an important development in the evolution of LTE services. It is an especially tricky service because, across the board, the service is being positioned as a high-quality voice service, and as such it must deliver on this premise: as a data service. Mobile operators can be benefited from working together to attempt to launch VoLTE services around the same time to drive adoption. Positioning VoLTE as an enhanced voice service will help to differentiate it and drive device adoption. VoLTE will also ensure to diminish the dependence on circuit switched networks (2g/3G) and thus free more spectrums.

3.2.7 LTE ARPS Growth Strategies

In most markets LTE increases ARPS by 10-20% but it varies from country to country. For example, South Korea has enjoyed a significant boost in ARPS, with 4G increasing per subscriber spending by up to 63% whereas in some of the countries ARPS declines. Bangladesh with such a low ARPU i.e. 2USD, it's expected that pricing strategies and monetizing the services for LTE is crucial for mobile operators to increase the ARPS. In order to ensure high LTE ARPS Mobile operators must:

a) Provide good coverage.
b) Drive use of data-intensive and high-speed services.
c) Move the focus away from voice and text to data allowances.

d) Continue to invest in speed and capacity improvements.
e) Carefully position 3G vs. 4G plans.
f) Encourage adoption of higher-value plans.

3.2.8 Go-to-market strategies

Go-to-market strategies are very important for each and every mobile operator. In order increase the subscriber base and generate revenue by beating the competition, mobile operators has to include the following in their strategy.

a) Acquiring sufficient spectrum assets.
b) Being the first to launch, but more importantly not losing coverage leadership.
c) Continuing to invest in the network to remain competitive in terms of speed and capacity.
d) Choosing the right pricing strategies, such as shared-data plans, which are especially optimal for leaders as they improve churn rates.
e) Encourage adoption of data intensive services, whether through bundling, as a free service (incurring data charges) or offering a premium service at a discounted rate or for a limited period. While this is important for all operators, it is especially important for operators that are first to market with LTE.

CHAPETER 04

4G/LTE Market Demand in Bangladesh and Conjoint Analysis

4.1 4G/LTE Market Demand in Bangladesh

4.1.1 Questioner design and survey for Market Study

In order to better understand the market demand for 4G/LTE, I have gone through a market survey with a questioner design that helps me to find out the market demand of 4G in Bangladesh. As Data traffic is the key driver for 4G/LTE to kick off, I believe that Mobile operators should keep their main focus in the initial phase on the key cities i.e. Dhaka, Chittagong and Sylhet. However, if the business plan for 4G/LTE flies then the next step for the mobile operators should be to look into the nationwide coverage.

Here is the survey question format that was carried out and people responded accordingly.

Table 4.1: Questioner design and survey for market study

Gender	Male	Female							
AGE	16-20	21-25	26-30	31-35	36-40	40 & Above			
Profession	Service Industry	Student	Business	Unemployed	House Maker/House Wife	Technical Staff	Architect	Defense Service	Doctor
	Journalist	Marine Engineer	Military Service	NGO Official	Private Service	Teacher	Teacher, BUET	University	Researcher
Education	College	Doctor	University-Bachelor	University-Masters	Doctor of Philosophy (ph.D)				
Residence	Dhaka	Sylhet	Chittagong						
Income/Month	5,000 & below	5,001-10,000	10,001-20,000	20,001-30,000	30,001-50,000	50,000-100,000	100,000-200,000	200,000-300,000	300,000 & above
Average Exp.	100 & below	101-300	301-500	501-1500	1501-3000	3001-5000	5000 & above		
Smart Phone Usage	Yes	No							
4G Feature Awareness	Yes	No							
4G Feature	High Speed Internet	Video on Demand, High Quality HD Video Streaming	Multi Channel hi-fi TV Broadcast	High Quality Gaming	Video Conference				
Internet Usage in Mobile Phone	1-3 hour	3.1-5 hour	5.1-10 hour	10.1-15 hour	15 hours & above				
Package for Pesonal/Home	512kbps-10GB-1000BDT	1Mbps-20GB-2500BDT	2Mbps-30GB-4000BDT	4Mbps-30GB-6000BDT	8Mbps-40GB-8500BDT	10Mbps-50GB-10000BDT	10Mbps-60GB-11000BDT	12-15Mbps-80GB-15000BDT	
Package for Company	512kbps-10GB-1000BDT	1Mbps-20GB-2500BDT	2Mbps-30GB-4000BDT	4Mbps-30GB-6000BDT	8Mbps-40GB-8500BDT	10Mbps-50GB-10000BDT	10Mbps-60GB-11000BDT	12-15Mbps-80GB-15000BDT	
Technology Preference	4G (High Speed Internet, HD Video, Video on Demand, High Quality Games etc)+2G/3G Features	3G (Internet Browsing, Mobile Broadband, Video Calls etc) +2G Features	2G (Voice, Text)						
Premium on LTE Service	100-300 BDT	301-500 BDT	501-1000 BDT	1001-2000 BDT	2001-3000 BDT	3000 BDT & Above	Nothing		

4.1.2 Survey Findings and Result Analysis

In total 14 queries have been asked to respondents and 228 people have been responded where most of the respondents i.e. 215 are from Dhaka, Sylhet & Chittagong. That's why only respondents from Dhaka, Chittagong and Sylhet has been considered for the survey analysis as I believe that the initial focus of Mobile operators would be in these big cities and later on the nationwide. 117 respondents from Dhaka, 54 respondents from Chittagong and 44 respondents of Sylhet have taken part in this survey. Based on the survey analysis, it's been found that 82% people prefer 4G technologies however 30% of the overall respondent prefers to pay a less premium on 4G Service.

The first question on the survey was to find out whether a respondent was male or female. According to the result analysis, it's been found out that 79% of the respondent was male and 21% was female.

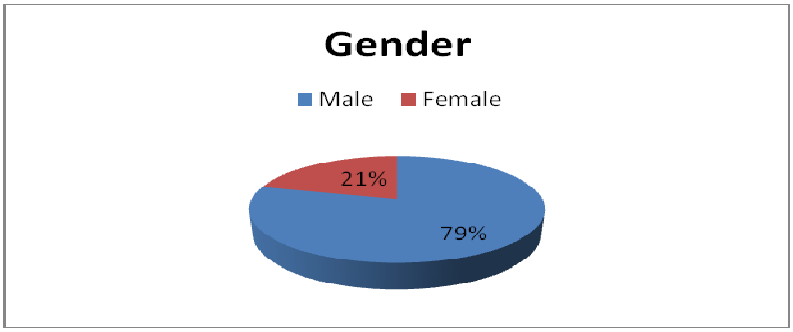

Figure 4.1: Market Survey questionnaire: Gender

The second question was related to the ages of the respondents as it's important to understand the taste of different age group of people for market analysis. I have found out that most of the respondents are in the age group of 21-40.

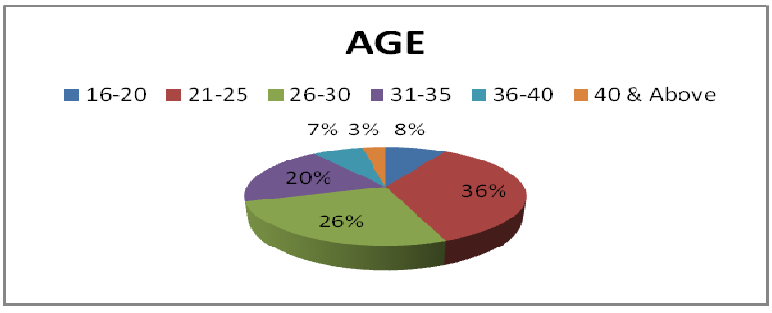

Figure 4.2: Market Survey questionnaire: Age

The third question was related to the profession of the respondents. I have found out that most of the respondents are students (37%) or they are working in service industry (27%) or having their own business (11%). Rest of the respondents was in different profession.

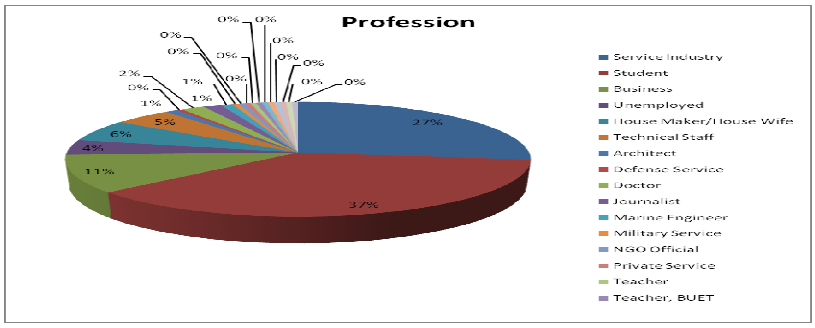

Figure 4.3: Market Survey questionnaire: Profession

The fourth question was related to the education of the respondents. I have found out that 56% of the respondents have a bachelor's degree, 27% of the respondents have a master's degree and 14% was in the college. Rest of them is having a doctorate degree or MBBS.

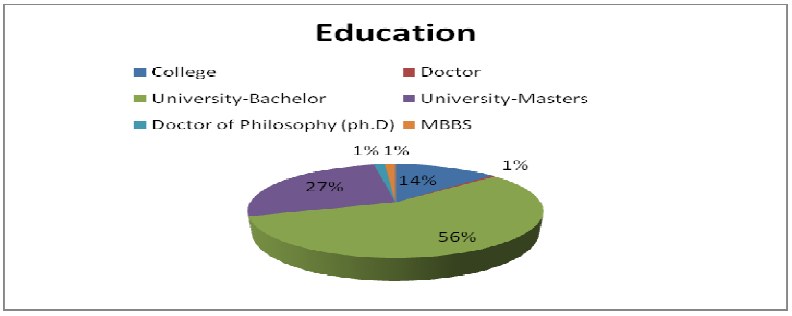

Figure 4.4: Market Survey questionnaire: Profession

The fifth question was related to the income per month of the respondents. I have found out that most of the respondents (33%) in this survey have an income of 5000 or less and 15% of the respondents have an income in between 30001-50000.

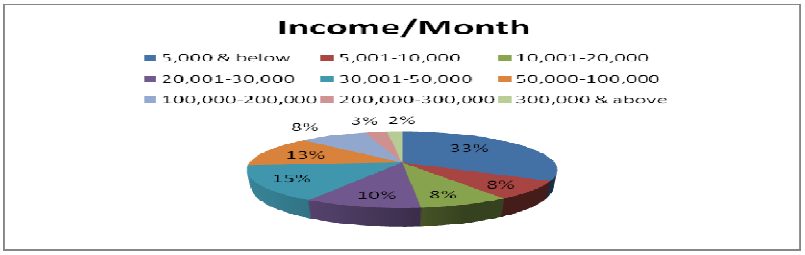

Figure 4.5: Market Survey questionnaire: Income/Month

The sixth question was related to the average expenditure on internet in Mobile phone. The response to this question was very crucial for my study as I will be able to understand by seeing the response whether people has the tendency to spend more money on the internet or not. This is also important for the mobile operator as they will be able to strategize the pricing model for LTE based on consumer's affordability on the internet in Mobile.

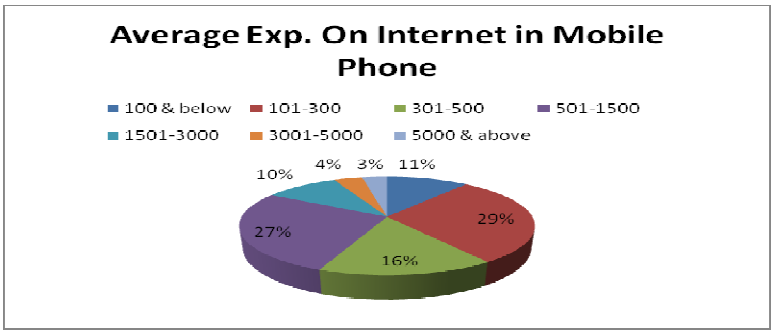

Figure 4.6: Market Survey questionnaire: Average Exp. on internet in Mobile Phone

The seventh question was related to the usage of smart phone. The response to this question was very crucial for my study as well as I will be able to understand by seeing the response whether people has the handset which is ready to support LTE frequencies. I have found out that 79% of the respondents have a smart phone whereas 21% of the respondents don't have it. With the availability of smart phones from Chinese vendors at a cheaper price makes it easier for the consumers at different age level to afford that.

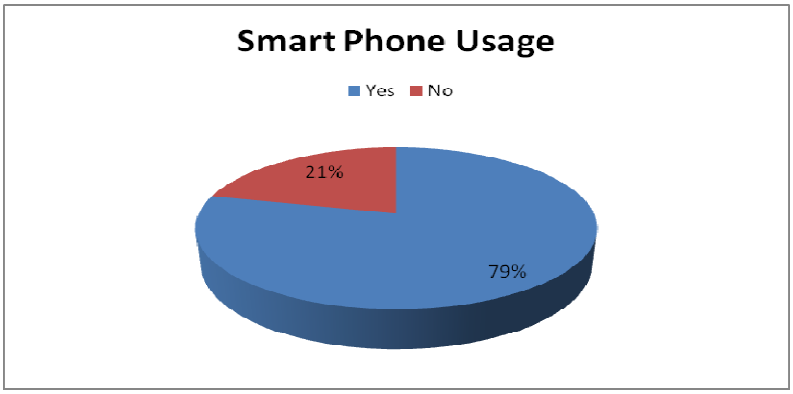

Figure 4.7: Market Survey questionnaire: Smart Phone Usage

The eights question was related to the 4G Feature awareness. The response to this question was astonished me as I have found out that 71% of the respondents is aware of the 4G/LTE technology so it shows that consumers are tech savvy.

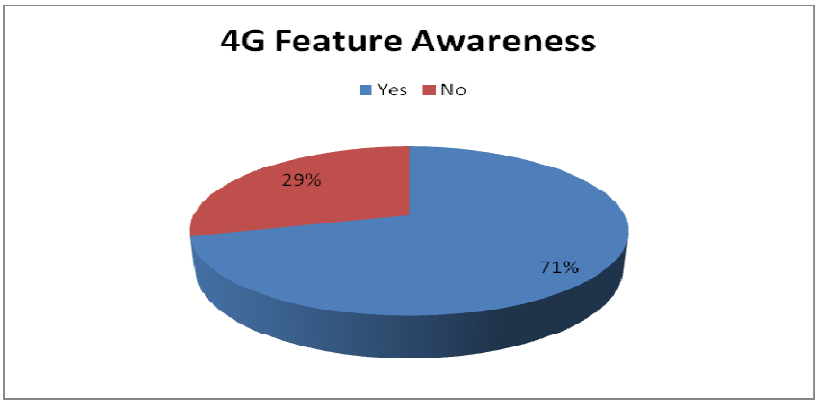

Figure 4.8: Market Survey questionnaire: 4G Feature Awareness

The ninth question was related to the consumer's interest of different 4G features. The response to this question was crucial as it will help mobile operators to monetize the LTE based services accordingly. I have found that 68% of the respondents were interested on High speed internet and 23% of the respondents are interested on Video on demand & high quality HD video streaming. As high speed internet is the most important factor for consumers as per the survey that means that LTE based Mobile broadband could be an additional option for Mobile operators to address and come up with a competitive product in against fixed broadband and Wimax operators.

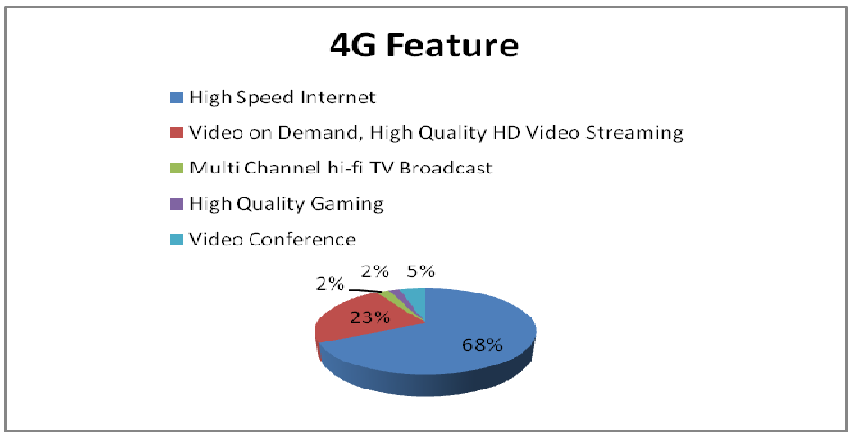

Figure 4.9: Market Survey questionnaire: Consumer's interest on 4G Feature

The tenth question was related to the consumer's time spending on internet in Mobile. The response to this question is also helpful for my study as well as Mobile operators as it shows how data traffic growth and drive their revenue. I have found that 39% of the respondents are using the internet in between 3.1-5 hours and 35% of the respondents use internet for 1-3 hours. As it's shown in the figure there are also a segment of people who are using internet for more than 15 hours. It helps for Mobile operators to monetize the services and come up with different products for different set of consumers.

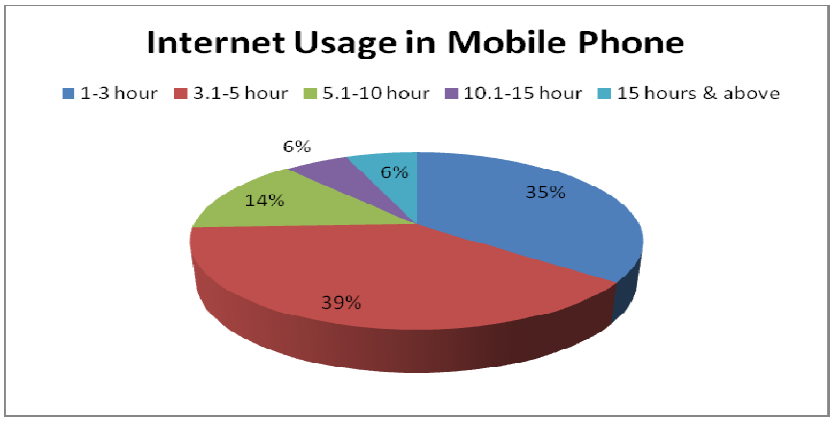

Figure 4.10: Market Survey questionnaire: Consumer's interest on 4G Feature

The eleventh was a hypothetical one. I put this question intentionally as I would like to understand whether LTE can be used as a Mobile broadband option or not in addition to the 4G features in Mobile phone & I also mentioned a price for each products to understand whether consumers are ready to pay for it or not. It's also important for Mobile operators to consider this business case for Mobile Broadband and commercialize the product set with the right price for different segment of consumers. I found that 62% of the respondents are quite happy to use 512kbps-10GB at the price of 1000BDT for their personal and home usage & 23% of the people would like to use 1 Mbps-20GB services at the price of 2500 BDT. There are 9% of the respondents who are ready to pay 4000 BDT for 2Mbps-30GB. There is small percentage of people who were even willing to pay 6000-1100 BDT for their personal/home usage. This responses shows consumers don't want to spend too much money for their personal/home usage broadband. That's why Mobile operators has to offer more lucrative services with the right price for consumers to drive the subscriber growth for Mobile Broadband in case of personal or home usage.

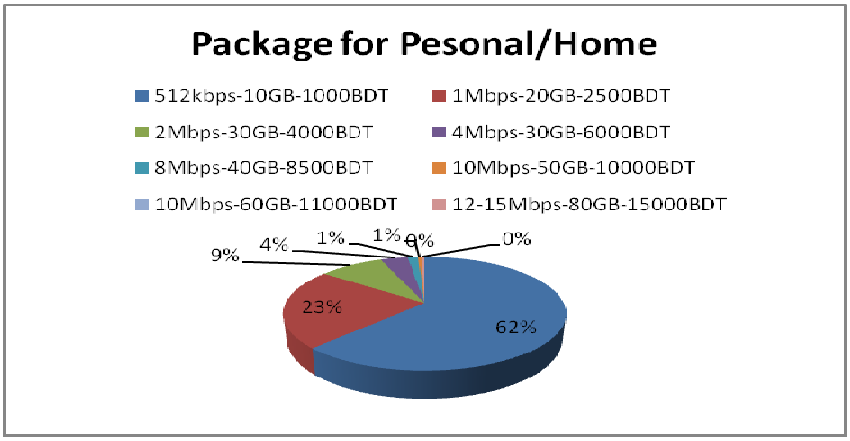

Figure 4.11: Market Survey questionnaire: Package for Personal/Home Usage

The twelfth question was a hypothetical one too. I put this question intentionally as I would like to understand whether LTE can be used as a Mobile broadband option or not in addition to the 4G features in Mobile phone for business and corporate usage. I also mentioned a price for each product to understand whether consumers are ready to pay for it or not. It's also important for Mobile operators to consider this business case for Mobile Broadband for business and corporate customers and commercialize the product set with the right price for different segment of consumers. I found that 24% of the respondents are quite happy to use 10 Mbps-50GB at the price of 10000 BDT & 21% of the people would like to use 12-15 Mbps-80GB services at the price of 15000 BDT. There are 20% of the respondents who are ready to pay 6000 BDT for 4Mbps-30GB. This responses shows consumers are ready spend money for their corporate & business usage. That's why Mobile operators has to offer more lucrative services with the right price for consumers to drive the subscriber growth for Mobile Broadband and to beat the fixed broadband competition.

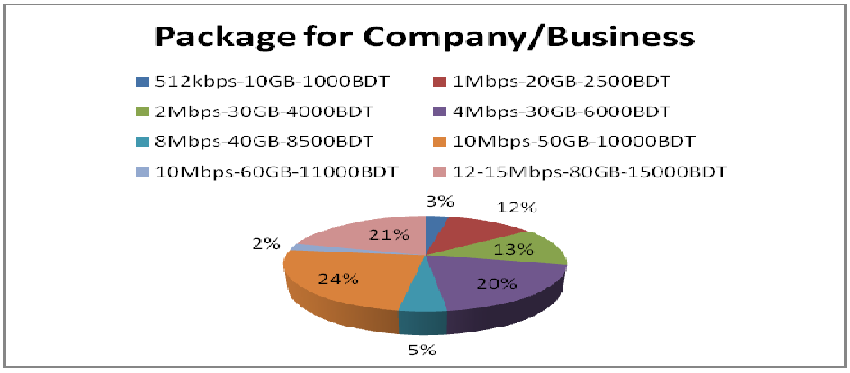

Figure 4.12: Market Survey questionnaire: Package for Company/Business Usage

The thirteenth question was in related to the technology preference. As expected, the 82% of the respondents prefers 4G technologies over 2G/3G technology and 17% respondents are happy with 3G technologies whereas only 1% of the respondents want to stick with 2G technology. This figure shows consumers would like to move to 4G technologies.

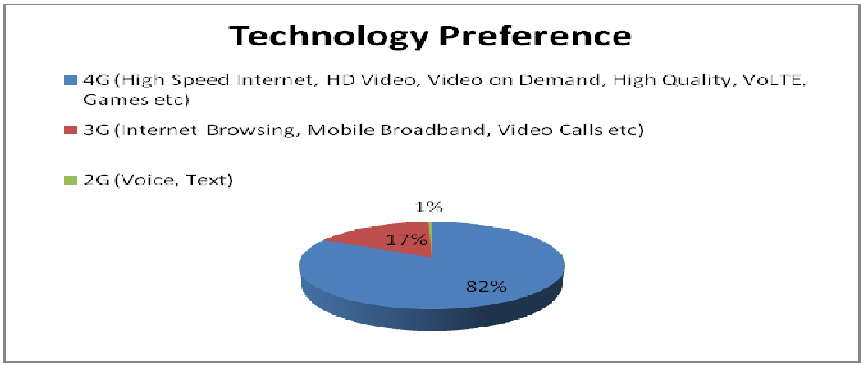

Figure 4.13: Market Survey questionnaire: Technology Preference

The last question was in related to the premium on the LTE services consumers want to pay. Although 82% of the respondents say their preference is 4G but on the contrary 44% of the respondents said they don't want to spend more than 500 BDT for the LTE services. So Mobile Operators needs think about how they would like to sell the LTE services to the consumer. Mobile operators might provide LTE service to post paid customers at the same cost as 3G service & driver customer to use more data services to increase their revenue.

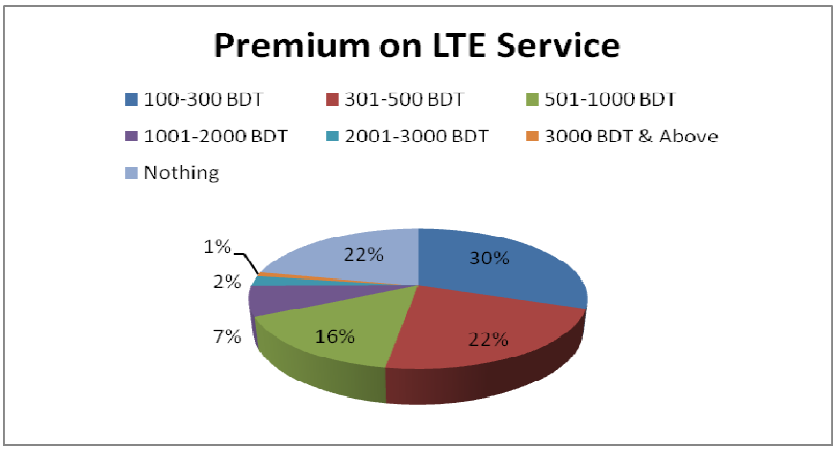

Figure 4.14: Market Survey questionnaire: Premium on LTE service

Detail response of the survey feedback is highlighted in Appendix A.

4.1.3 Limitations of the Survey

Although I have managed to get the responses from 228 responses from different cities in Bangladesh but I still believe there are limitations in my survey. I omitted the rural areas where a significant no of people lives and I believe it would be good if I was able to get their responses as well in order to get the complete picture. However considering the fact that the most of the people lives in villages are not really tech-savvy and have less economical strength so as long as they get voice and general services on internet, they are ok with it. So not getting the responses from rural areas might not give the complete picture for nationwide coverage but at least gives a platform for mobile operators to understand the market need in the big cities. Mobile operators should focus on the city areas preliminarily for 4G/LTE deployment as a Pilot project and as soon as they reach the profitability or reach break-even point, they can think about the nationwide coverage.

4.2 Conjoint Analysis

4.2.1 Conjoint Analysis Definition

Conjoint analysis is a statistical technique used in market research to determine how people value different attributes (feature, function, benefits) that make up an individual product or service. The objective of conjoint analysis is to determine what combination of a limited number of attributes is most influential on respondent choice or decision making. A controlled set of potential products or services is shown to respondents and by analyzing how they make preferences between these products, the implicit valuation of the individual elements making up the product or service can be determined. These implicit valuations (utilities) can be used to create market models that estimate market share of new designs [14].

4.2.2 Conjoint Analysis Steps

a) Step 1: Definition of Attributes

To replicate the decision-making process, it is necessary to understand each of the attributes consumers consider when making an actual purchasing decision. Experience, previous research, and/or the specific research objectives will determine which attributes are of particular importance, and whether all product features should be displayed or only those most relevant to differentiating a product from competitive offerings.

b) Step 2: Establishment of Attributes

Levels once attributes for the conjoint research have been defined, it must be determined how attributes will vary from one product concept to the next. This step involves the establishment of attribute levels. Attribute levels must be comprehensive enough to capture all of the products that exist, or soon exist, within the marketplace. However, as with the definition of attributes, care must be taken to avoid respondent fatigue, so only the most prevalent attribute levels will be chosen for testing (typically 3-5 attribute levels per attribute). Further, the number of attribute levels chosen has a direct impact on the number of concepts respondents will be asked to evaluate. The optimal number of attribute levels tested will be that which ensures research objectives are satisfied while minimizing the burden faced by respondents.

c) Step 3: Design of Experiment and Building the Profile

Having established the attributes, and attributes levels to be tested; now it's the time to build the profile. Generation of a design of experiments for building the profile is based on full factorial or fractional factorial method. Respondents are asked to evaluate a number of these profiles which includes the attributes and to rank each of the profiles as per their wish list. It is not necessary that every potential product offering be evaluated with the given attributes rather it's important to give only those profiles to respondents which match the product criteria to be evaluated. In fact, this would be quite impossible, as there are typically thousands of potential product configurations in any given study.

d) Step 4: Data Collection

Once the profile is build up, now it's time to get the responses from the respondents. Respondents are required to consider a great deal of information, allowing them to visually assess the stimuli results in more reliable findings & rank all the profiles accordingly.

e) Step 5: Conjoint Analysis

This step involves data analysis with specific regression methods - MONANOVA (monotone regression), multinomial logit, conditional logit, etc. Analysis of conjoint data yields a series of scores for each respondent for each attribute level. These scores may be likened to the unit which is an arbitrary measurement of utility consumers associate with a product and its attributes. Each score reflects the value the respondent associates with each attribute level, and is the building block from which all analysis is conducted. By doing this analysis, it's possible to find out which attributes has got the highest or lowest utility and which one has got the most or least importance. By comparing this to other potential products in the marketplace, we can begin to understand how consumers will choose products in the real world.

f) Step 6: Development of Market Simulator

While preliminary analysis of conjoint data results in valuable insight regarding consumers and their preferences, the real value of conjoint analysis comes from the market simulators developed at the conclusion of the research engagement. The market simulator is a software program, similar to a spreadsheet, which allows users to conduct "what-if" analyses with data collected during conjoint fielding. As mentioned above, respondents can be asked to evaluate only a small fraction of concept

profiles, yet still reveal how they would respond to any product offering. Therefore, it is possible to aggregate the preferences of all consumers to reveal how the market as a whole will respond to any product offering. Furthermore, it's possible to assess how the marketplace will respond to two or more competing products by calculating the market's share of preference for every product of interest.

4.2.3 Conjoint Analysis for 4G/LTE technology

a) Step 1: Definition of Attributes

Definition of attributes is the first step for conjoint analysis. As currently in Bangladesh, 2G and 3G technologies i.e. products are available, so these two products needs to be considered for conjoint analysis along with the new product i.e. 4G/LTE technology. These are the following attributes which is applicable for any generation technologies and I have used all these attributes for my conjoint analysis study.

- Technology
- Transmission Speed
- Price
- Value Added Services

b) Step 2: Establishment of Attributes

For the purpose of conjoint analysis, all these attributes has been Classified into different factors. It is the choice of the important characteristics to define a Technology. The selected factors are:

- Technology (2G, 3G, 4G)
- Transmission Speed (Slow, Medium, Fast)
- Price (Low-200 BDT, Medium- 400 BDT, Relatively Higher- 650 BDT)
- Value Added Services (Basic, Variety)

c) Step 3: Design of Experiment and Building the Profile

Using the XLSTAT (software), conjoint analysis uses experimental designs to select a number of profiles and it allows interviewed people to make their rankings. Based on the available profile by half factorial design, I have selected 11 profiles to interview people to make their rankings. Each of the profiles is

categorized as a specific product. I have considered 2 products for 2G, 4 products for 3G and 5 products for 4G in order to get the response from the respondents. As 2G is a declining technology that why I didn't consider too many product types with different attribute set as it has also got a very limited functionality. As 3G can offer more services and it can be a real completion to the new product i.e. 4G/LTE technology, that's why I selected more product types of 3G to be interviewed.

Table 4.2: Profiles for Conjoint Analysis

Observation	Technology	Transmission Speed	Price	Value Added Service
Profile1	2G	Slow	Low-200 BDT	Basic
Profile2	2G	Medium	Medium-400 BDT	Variety
Profile3	3G	Slow	Low-200 BDT	Basic
Profile4	3G	Medium	Medium-400 BDT	Variety
Profile5	3G	Medium	Medium-400 BDT	Basic
Profile6	3G	Fast	Relatively Higher-650 BDT	Variety
Profile7	4G	Slow	Low-200 BDT	Basic
Profile8	4G	Fast	Relatively Higher-650 BDT	Variety
Profile9	4G	Medium	Medium-400 BDT	Variety
Profile10	4G	Fast	Medium-400 BDT	Variety
Profile11	4G	Slow	Low-200 BDT	Variety

d) Step 4: Data Collection

I have received the responses from 30 people who have participated in this survey and gave their ranking for different profiles i.e. products from 1 to 11 as there are 11 profiles i.e. products in total. Responses from 30 respondents are highlighted below.

Table 4.3: Respondents response on different profiles

Observation	Profile1	Profile2	Profile3	Profile4	Profile5	Profile6	Profile7	Profile8	Profile9	Profile10	Profile11
Technology	2G	2G	3G	3G	3G	3G	4G	4G	4G	4G	4G
Transmission Speed	Slow	Medium	Slow	Medium	Medium	Fast	Slow	Fast	Medium	Fast	Slow
Price	Low-200 BDT	Medium-400 BDT	Low-200 BDT	Medium-400 BDT	Medium-400 BDT	Relatively Higher-650 BDT	Low-200 BDT	Relatively Higher-650 BDT	Medium-400 BDT	Medium-400 BDT	Low-200 BDT
Value Added Service	Basic	Variety	Basic	Variety	Basic	Variety	Basic	Variety	Variety	Variety	Variety
In- 1	11	10	3	6	7	9	2	8	5	4	1
In- 2	10	11	6	7	8	9	2	5	4	3	1
In- 3	10	11	9	5	6	3	8	1	4	2	7
In- 4	5	6	1	2	3	4	8	11	10	9	7
In- 5	1	5	2	6	7	10	4	11	9	8	3
In- 6	9	8	7	3	4	11	6	10	2	1	5
In- 7	11	10	3	6	7	9	2	8	5	4	1
In- 8	11	7	10	6	9	5	8	1	3	2	4
In- 9	10	11	9	5	6	3	8	1	4	2	7
In- 10	6	5	4	2	3	1	8	11	10	9	7
In- 11	9	8	7	3	4	11	6	10	2	1	5
In- 12	10	11	9	7	8	3	6	1	4	2	5
In- 13	11	10	3	6	7	9	2	8	5	4	1
In- 14	10	11	6	7	8	9	2	5	4	3	1
In- 15	11	7	10	6	9	5	8	1	3	2	4
In- 16	5	6	1	2	3	4	8	11	10	9	7
In- 17	10	11	9	5	6	3	8	1	4	2	7
In- 18	10	11	9	7	8	3	6	1	4	2	5
In- 19	11	10	3	6	7	9	2	8	5	4	1
In- 20	10	11	9	7	8	3	6	1	4	2	5
In- 21	10	11	6	7	8	9	2	5	4	3	1
In- 22	11	7	10	6	9	5	8	1	3	2	4
In- 23	11	10	3	6	7	9	2	8	5	4	1
In- 24	9	8	7	3	4	11	6	10	2	1	5
In- 25	5	6	1	2	3	4	8	11	10	9	7
In- 26	10	11	6	7	8	9	2	5	4	3	1
In- 27	11	10	3	6	7	9	2	8	5	4	1
In- 28	1	5	2	6	7	10	4	11	9	8	3
In- 29	10	11	9	5	6	3	8	1	4	2	7
In- 30	11	10	3	6	7	9	2	8	5	4	1

e) Step 5: Conjoint Analysis

After I received the responses, I have used XLSTAT software in order to do the conjoint analysis which uses regression method MONANOVA.

Based on the conjoint analysis, the higher utility scores indicate higher preference. From the conjoint analysis I have found the on technology attribute, 4G is the preferred technology from the respondents amongst 2G, 3G and 4G technologies. For other attributes, respondents prefer ‘fast’ on the transmission speed attribute, ‘Low’ on the price attribute & Variety services on the Value Added Service attribute. As expected, lower prices corresponding to higher utility. The faster transmission speed corresponds to a higher utility and the variety of value- added services corresponds higher utility. The result shows that respondents want 4G product with high transmission speed and verity value added services with a lower price.

Following table shows the utility (mean value) of different attributes

Table 4.4: Utility of different attributes

Source	Minimum	Maximum	Mean	Std. deviation	
Intercept	3.729	6.352	4.874	0.876	
Technology-2G	-4.567	1.452	-2.597	1.811	
Technology-3G	-0.726	3.786	1.246	1.380	
Technology-4G	-3.606	3.786	1.351	2.319	4G
Transmission Speed-Fast	-0.335	4.901	1.341	1.599	
Transmission Speed-Medium	-1.621	3.380	-0.017	1.377	
Transmission Speed-Slow	-8.280	1.005	-1.323	2.459	Fast
Price-Low-200 BDT	-1.399	9.125	2.552	3.069	
Price-Medium-400 BDT	0.000	0.000	0.000	0.000	
Price-Relatively Higher-650 BDT	-9.125	1.399	-2.552	3.069	Low
Value Added Service-Basic	-1.592	0.009	-0.692	0.649	
Value Added Service-Variety	-0.009	1.592	0.692	0.649	Variety

In terms of importance based on the respondents answer, technology is the most important attribute whereas Price is the 2nd most important and Transmission speed and Value Added Service are the third and fourth importance respectively. .

Table 4.5: importance of different attributes

Source	Minimum	Maximum	Mean	Std. deviation
Technology	12.500	98.188	42.020	17.187
Transmission Speed	0.740	51.771	18.507	16.989
Price	0.245	55.263	30.335	18.160
Value Added Service	0.198	32.759	9.138	9.687

f) Step 6: Development of Market Simulator

The result I have found in the conjoint analysis that the respondents i.e. consumer prefers to have 4G/LTE technology with Fast transmission speed and variety value added service with a lower price. So for the market simulation, I used this new product in addition to the 11 products I have already used for conjoint analysis. Using the conjoint Analysis table, I have done the Market Simulation using the XLSTAT tool. A new product with mix of consumer preferred variables of different attributes (4G, Fast, low, Variety) has been considered in simulation. Below is the result & as expected the new product will have a higher market share whereas the other products with different variable set will have different market share.

Table 4.6: Market Share of different profiles

Product ID	Utilities	Market share	Standard error
Product A	0.000	0.000	0.000
Product B	0.000	0.000	0.000
Product C	0.000	0.000	0.000
Product D	0.250	25.000	50.000
Product E	0.000	0.000	0.000
Product F	0.000	0.000	0.000
Product G	0.125	12.500	25.000
Product H	0.000	0.000	0.000
Product I	0.000	0.000	0.000
Product J	0.000	0.000	0.000
Product K	0.125	12.500	25.000
New Product	0.500	50.000	57.735

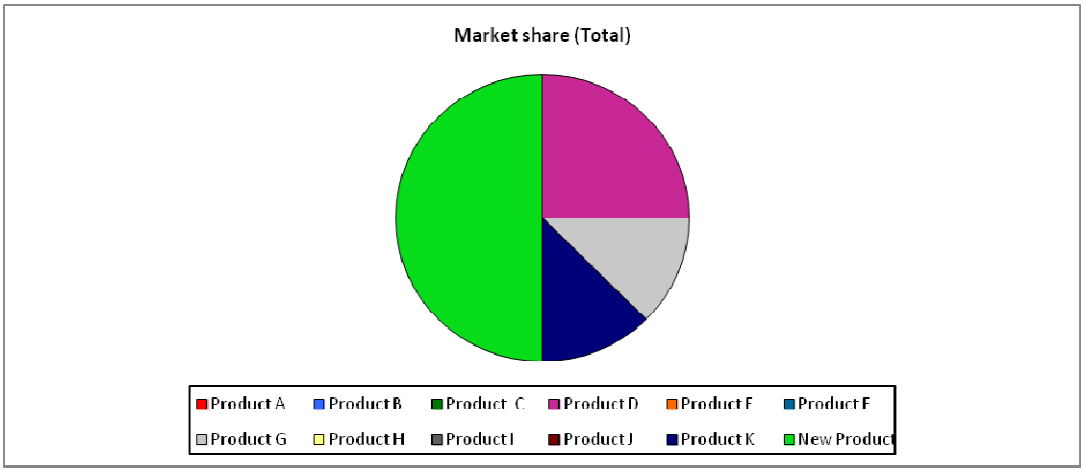

Figure 4.15: Market Share Simulation using conjoint analysis

Based on the analysis, the new product will have a 50% market share whereas the product G, Product K and Product D will have a market share of 25%, 12.50% and 12.50% respectively. The outcome from the market simulator is expected as the new product is consisting of the attributes which consumer prefers the most. That's why if a new product comes into the market with the set of preferred attributes from consumer, it will have a higher market shares in comparison to the other available products.

CHAPETER 05

FINANCIAL VIABILITY OF 4G/LTE IMPLEMENTATION

5.1 The Shift From old generation technologies to 4G/LTE

In today's market, the subscriber / end user is at the center of everything, and the services are driven by user demands. Initially end users were more focused on short message service (SMS), multimedia message service (MMS), and content downloading, the 3G market has moved rapidly toward video sharing, mobile video, and IPTV, all of which require very high data throughput and highly efficient radio. The latest UMTS evolution brings improved spectral efficiency at lower latency and higher data speeds with almost 100 times improvement from 3G – the new promise known as 4G. To achieve this, the air interface is making use of new modulation techniques which effectively target the issues seen with 3G, such as symbol efficiency. The radio interface has adopted some best-in-class methods for the air interface, namely Orthogonal Frequency Division Multiplexing (OFDM) and Multiple-Input Multiple-Output (MIMO) systems. To support the evolved UMTS Terrestrial Radio Access Network (UTRAN) with OFDM at radio access, the core has adopted a flatter IP-based architecture that gives better data performance. The 4G core shall support an open framework, allowing any kind of mobility protocol, quality of service (QoS), and Authentication, Authorization and Accounting (AAA) services with support for multiple access technologies, and be able to provide value-added services which are personalized and context-aware.

The new 4G architecture is evolving with fewer nodes and a flatter structure, thus giving lower latency. That brings in for a requirement of an all-IP-based core network to support the high data throughput and is general enough to be accessed by the different radio access networks through gateway interfaces. As a result, 4G is not so much about all new standards, but is instead based on existing technologies (e.g., WLAN, 2G, 2.5G, 3G, and satellite) being used to better advantage. 4G is the evolution beyond 3G which addresses the limitations seen so far while working to enhance the quality of service and increase the bandwidth to make better use of resources. The Evolved Packet System (EPS) architecture supports a base station and a core network component. The EPS supports 3GPP (3rd Generation Partnership Project) as well as non-3GPP access. The flexibility of providing access to different radio types makes it possible

for the core to evolve independently from access as a cost-effective IP environment. The 4G core addresses mobility, security, and QoS through reuse of existing mechanisms while still trying to work on some mobility and handover issues. This IP-based core architecture enables location and QoS-based services for the users. The radio networks access the core through IP; circuit switching is totally absent. Voice service will be transferred over IP as packets along with the signaling and data. The IP based infrastructure translates into lower setup cost.

5.2 4G/LTE Market Scenario worldwide

LTE network rollouts have been instrumental in driving 4G adoption, and have continued to grow in 2015. A total of 451 networks have been deployed in 151 countries. In recent years, the majority of 4G network launches were in developed markets, such as the US and Europe. However, the developing world is now seeing an acceleration of network rollouts: just under half of total live networks are now in developing markets, up from a third in 2013. In addition, more than half of the countries with a live 4G network are in the developing world. The growing number of LTE rollouts in these markets is driving rapid migration to mobile broadband in the developing world.

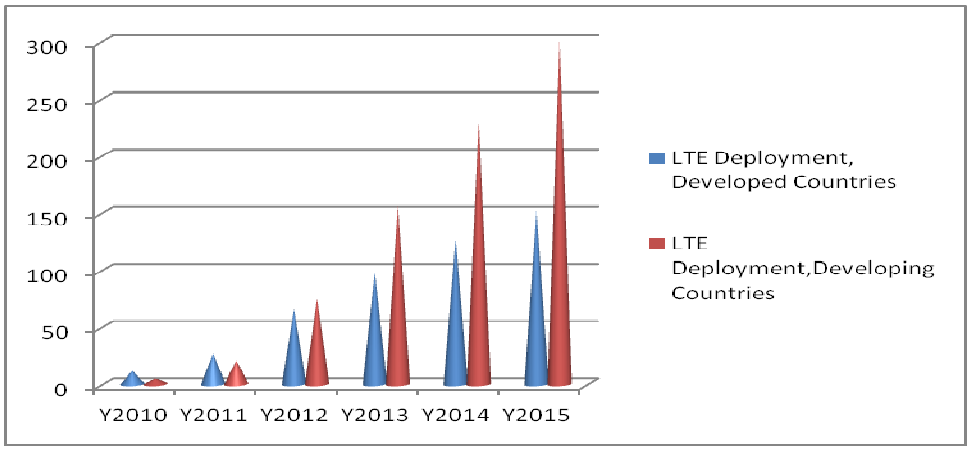

Figure 5.1: Global 4G/LTE Market as of Dec, 2015

5.3 4G/LTE Financial Viability in Bangladesh

In order to calculate the financial viability for 4G/LTE implementation in Bangladesh, I have considered GrameenPhone for the analysis. It would be ok to assume that in case the business case for GrameenPhone is viable for 4G/LTE implementation; same can also be applied for other key mobile operators i.e. Banglalink, Robi and Airtel Bangladesh. In terms of costing, it will be same for all the

mobile operators. Revenue and the no of cell sites and allocated spectrum is higher for GrameenPhone than any other mobile operator in Bangladesh.

5.3.1 CAPEX and OPEX for 4G/LTE Deployment

In order to do the financial analysis for viability calculation, the first step is to collect the data for all the costing related to 4G/LTE implementation. In order to deploy 4G/LTE following cost needs to be allocated by the Mobile operator:

a) CAPEX
   - BTS/eNodeB with Power Supply
   - BSC/EPC with Power Supply; 1*EPC supports 530 eNodeB
   - Backhauling (Fiber)
   - Backhauling (Microwave/IP Transport)
   - Front Hauling
   - Site Acquisition for Roof top sites
   - Site Acquisition for Green Field sites

b) OPEX
   - Annual Site rental (Rooftop)
   - Annual Site Rental (Green Field)
   - Annual Maintenance support

c) Spectrum allocation & Annual License Fee
   - Spectrum Allocation cost for 4G/LTE
   - Annual License fee to BTRC

d) Revenue Share to BTRC
   - 6.5% of the Revenue

Below is the CAPEX (Capital Expenditure) and OPEX (operational expenditure) cost of 4G/LTE and 3G sites implementation in USD and in BDT.

Table 5.1: CAPEX and OPEX of 4G/LTE and 3G Site Implementation

4G/LTE CAPEX & OPEX COST		4G/LTE		3G	
		Cost in USD	Cost in BDT	Cost in USD	Cost in BDT
CAPEX	1*BTS Cost (Includes power supply+NMS+Services)	37000	2,960,000	33,300	2,664,000
	1* BSC/EPC Cost (Includes power supply+NMS+Services)	702000	56,160,000	320000	25,600,000
	Backhaul (Fiber)/BTS	22000	1,760,000	22,000	1,760,000
	Backhaul (MW/IP Transport)/BTS	28000	2,240,000	28,000	2,240,000
	Front Haul Cost for LTE/BTS	1200	96,000		
	Site Acquisition+ Site Construction Cost (Roof top)	53,000	4,240,000	53,000	4,240,000
	Site Acquisition+ Site Construction Cost (Green Field)	86000	6,880,000	86,000	6,880,000
OPEX	Annual Site rental Cost (Roof top)	3000	240,000	3000	240,000
	Annual Site rental Cost (Green Field)	7200	576,000	7200	576,000
	Annual Maintenance Support	118,530	9,482,400	60,495	4,839,600

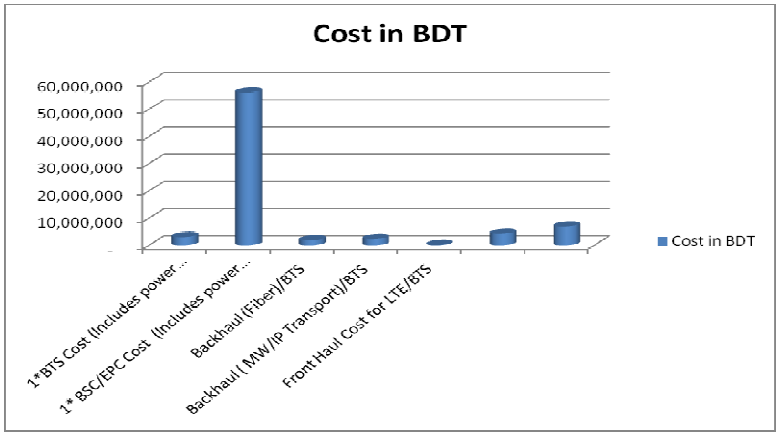

Figure 5.2: CAPEX of 4G/LTE Site Implementation

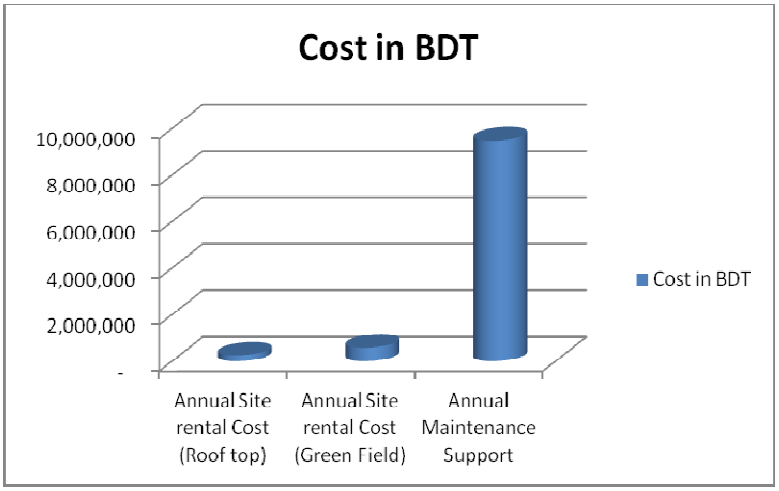

Figure 5.3: OPEX of 4G/LTE Site Implementation

There won't be any additional Cost for site Acquisition/Construction for 4G/LTE implementation as same site used for 2G/3G sites can be used for 4G/LTE. Generally the maintenance cost for Mobile Operator is in the range of 10-15% of the equipment cost. I assumed 15% maintenance cost in my analysis.

Mobile operators has to pay the following amount for 2G License renewal and 3G License award to BTRC. For the calculation purpose, I use same value for 4G/LTE license award as 3G License award although 4G/LTE licensing cost is generally lower than the 3G Licensing cost. In addition to that if it's permitted by BTRC, then mobile operators will also be able to free up their 2G traffic and use 4G traffic in the allocated 2G spectrum.

Table 5.2: Spectrum Allocation Fee

Spectrum Allocation	BDT	USD
2G Frequency Renewal-14.6MHz-15 Years, 2012	32,510,000,000	406,375,000
3G Frequency Award(10 MHz,15 Years, 2013)	16,800,000,000	210,000,000
4G Frequency Award (10 MHz, 15 Years)	16,800,000,000	210,000,000

In addition to the spectrum allocation fee, mobile operators also have to pay a annual license fee and a share of 6.5% of their revenue to BTRC.

Table 5.3: Annual Licensing Fee

Annual Licencing Fee	BDT
Annual Licencing Fee to BTRC (2G)	50,000,000
Annual Licencing Fee to BTRC (3G)	50,000,000
Annual Licencing Fee to BTRC (4G)	50,000,000

5.3.2 Revenue Forecast

GrameenPhone is the biggest and most successful mobile operator in Bangladesh. Data traffic is driving their revenue. Below figure shows the 4 year revenue of GrameenPhone.

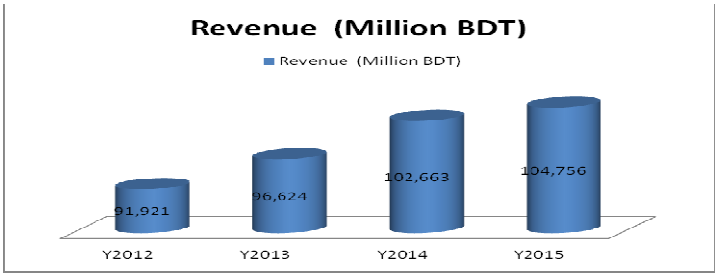

Figure 5.4: 4 years Revenue of GrameenPhone

Linear regression analysis has been done for future revenue projection of GrameenPhone in order to see that whether GarmeenPhone has a stable growth in their business or not considering the existing technology i.e. 2G and 3G technology they are using. Based on the 4 year annual revenue data from GrameenPhone. The result of the linear regression analysis shows that m=4454.4 and b=87855 of an equation, y= mx + b.

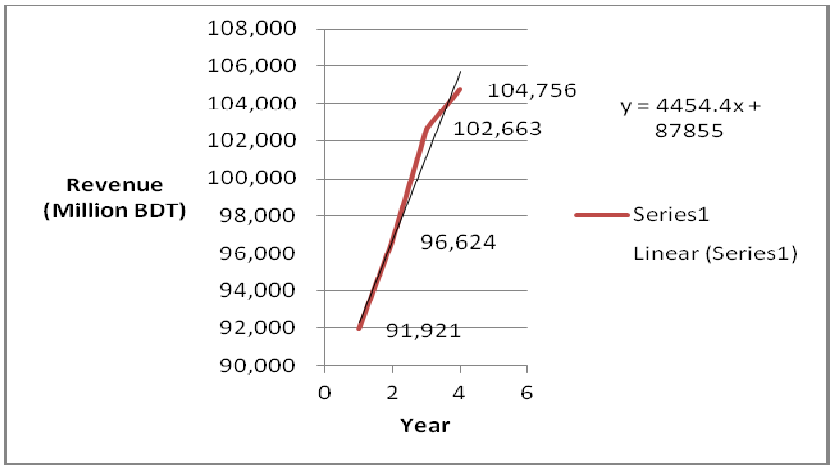

Figure 5.5: Revenue Growth in GrameenPhone

Table 5.4: AAGR as per Linear Regression Analysis

Year	Year Serial Since 2011	Revenue (Million BDT)	AAGR (Annual Growth)
Y2012	1	91921	
Y2013	2	96624	5.12%
Y2014	3	102663	6.25%
Y2015	4	104756	2.04%
Y2016	5	110127	5.13%
Y2017	6	114581.4	4.04%
Y2018	7	119035.8	3.89%
Y2019	8	123490.2	3.74%
Y2020	9	127944.6	3.61%
Y2021	10	132399	3.48%
Y2022	11	136853.4	3.36%
Y2023	12	141307.8	3.25%
Y2024	13	145762.2	3.15%
Y2025	14	150216.6	3.06%

As per the Annual growth information i.e. AAGR, it seems the revenue projection for GrameenPhone is very steady but at a flat rate. Implementing 4G/LTE will drive the data traffic growth and so as the

revenue growth for GrameenPhone. It has been observed that in Asian Countries the revenue growth rate for mobile operators are in the range of 4 to 7% after they commercialize the LTE products in the market.

In order to calculate the cash flow analysis for 4G/LTE implementation, I had to calculate the average revenue per cell site. The number of cell site for GrameenPhone is 10336 where the number of 2G base station is 2701 and the number of 3G base station is 7635. It shows that GrameenPhone is switching from 2G to 3G technologies as data traffic growth is the key driver for their revenue.

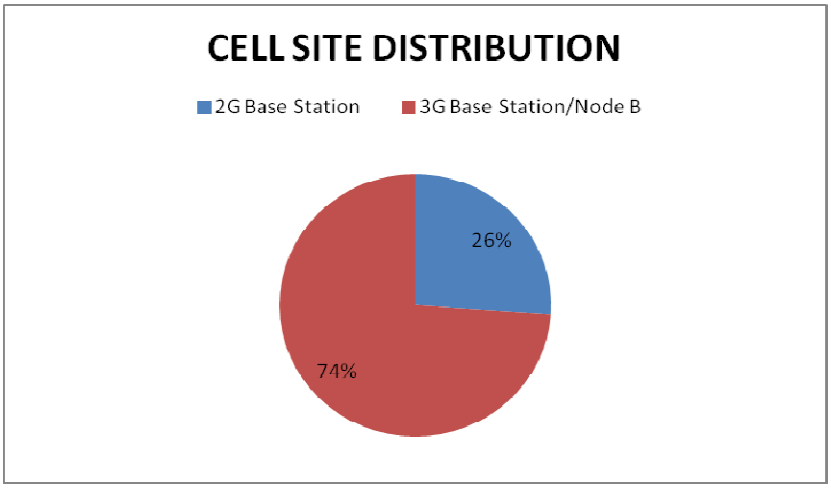

Figure 5.6: Cell Site distribution in GrameenPhone

Annual Revenue for GameenPhone in 2015 was 104,756 Million BDT. So now it's possible to calculate the average revenue per cell site for GrameenPhone which is 10.14 MBDT.

Table 5.5: Average Revenue for Cell Site

GrameenPhone-Average Revenue per cell Site	Y2015
No of Base Station	10,336
2G Base Station	2,701
3G Base Station/Node B	7,635
Total Revenue (Million BDT)	104,756
Average Revenue per Cell Site (Million BDT)	10.14

5.3.3 Cash Flow Analysis

A cash flow statement is one of the most important financial statements for a project or business. The statement can be as simple as a one page analysis or may involve several schedules that feed information into a central statement. A cash flow statement is a listing of the flows of cash into and out of the business

or project. A cash flow statement is a listing of cash flows that occurred during the past accounting period. A projection of future flows of cash is called a cash flow budget. A cash flow statement is not only concerned with the amount of the cash flows but also the timing of the flows. Many cash flows are constructed with multiple time periods. For example, it may list yearly cash inflows and outflows over multiple years' time.

5.3.3.1 Present Value, PV

Present value, also known as present discounted value, is the value of an expected income stream determined as of the date of valuation. The present value is always less than or equal to the future value because money has interest-earning potential, a characteristic referred to as the time value of money, except during times of negative interest rates, when the present value will be less than the future value.
Present value calculations, and similarly future value calculations, are used to value loans, mortgages, annuities, sinking funds, perpetuities, bonds, and more. These calculations are used to make comparisons between cash flows that don't occur at simultaneous times, since time dates must be consistent in order to make comparisons between values. When deciding between projects in which to invest, the choice can be made by comparing respective present values of such projects by means of discounting the expected income streams at the corresponding project interest rate, or rate of return. The project with the highest present value, i.e. that is most valuable today, should be chosen.

5.3.3.2 Net Present Value, NPV

The net present value (NPV) is a measurement of the profitability of an undertaking that is calculated by subtracting the present values (PV) of cash outflows (including initial cost) from the present values of cash inflows over a period of time. Incoming and outgoing cash flows can also be described as benefit and cost cash flows, respectively.

Time value of money dictates that time affects the value of cash flows. More technically, cash flows of nominal equal value over a time series result in different effective value cash flows that make future cash flows less valuable over time. A cash flow today is more valuable than an identical cash flow in the future because a present flow can be invested immediately and begins earning returns, while a future flow cannot.

Net present value (NPV) is determined by calculating the costs (negative cash flows) and benefits (positive cash flows) for each period of an investment. After the cash flow for each period is calculated, the present value (PV) of each one is achieved by discounting its future value (see Formula) at a periodic rate of return (the rate of return dictated by the market). NPV is the sum of all the discounted future cash flows. Because of its simplicity, NPV is a useful tool to determine whether a project or investment will result in a net profit or a loss. A positive NPV results in profit, while a negative NPV results in a loss. The NPV measures the excess or shortfall of cash flows, in present value terms, above the cost of funds. In the case when all future cash flows are positive, the only outflow of cash is the purchase price, the NPV is simply the PV of future cash flows minus the purchase price (which is its own PV). NPV can be described as the “difference amount” between the sums of discounted cash inflows and cash outflows. It compares the present value of money today to the present value of money in the future, taking inflation and returns into account.

$NPV = -C_0 + \sum_{i=1}^{T} \frac{Ci}{(1+r)^i}$;

Where,

$-C_0$= Initial Investment

C= Cash Flow

r= Discount Rate

T= Time

5.3.3.3 Internal Rate of Return

The internal rate of return on an investment or project is the "annualized effective compounded return rate" or rate of return that makes the net present value of all cash flows (both positive and negative) from a particular investment equal to zero. It can also be defined as the discount rate at which the present value of all future cash flow is equal to the initial investment or, in other words, the rate at which an investment breaks even. Equivalently, the IRR of an investment is the discount rate at which the net present value of costs (negative cash flows) of the investment equals the net present value of the benefits (positive cash flows) of the investment.

IRR is used in capital budgeting to measure and compare the profitability of investments. IRR calculations are commonly used to evaluate the desirability of investments or projects. The higher a project's IRR, the more desirable it is to undertake the project. Assuming all projects require the same

amount of up-front investment, the project with the highest IRR would be considered the best and undertaken first.

$NPV = \sum_{n=0}^{N} \frac{Cn}{(1+IRR)^n} = 0;$

Where,

n= Period, n is a positive Integer.

N= Total no of period

NPV= Net Present Value

IRR= Internal Rate of Return

C_n= Cash Flow

5.3.3.4 Discounted Payback Period

The discounted payback period is the amount of time that it takes to cover the cost of a project, by adding positive discounted cash flow coming from the profits of the project. The advantage of using the discounted payback period over the payback period is that it takes into account time value of money. When discounted payback period is used for decision making, one must determine a discount rate at which to discount the future cash flow values of a specified period of time.

5.3.3.5 Cash Flow Model Analysis for GrameenPhone

For the cash flow analysis, I have taken the following things into consideration:

a) LTE roll out has been considered in 2016 and the project is considered for 7 years i.e. until 2022.
b) Sites in LTE has been considered for Financial Analysis: 1060
c) 1*EPC is able to support 530 LTE sites, so for the financial purpose 2*EPC has been considered
d) Revenue Per Cell Site in Million BDT for GrameenPhone is 10.14 Million BDT (as per Y2015)
e) Revenue Sharing with Government: 6.5%
f) Discounting Factor: 13%
g) Annual Growth Rate for 4G implementation: 4%

Table 5.6: Cash-flow for 4G/LTE implementation

			0	1	2	3	4	5	6
		TOTAL	Y2016	Y2017	Y2018	Y2019	Y2020	Y2021	Y2022
CAPEX	4G Equipment (1000*BTS+ 2*EPC)		7,592						
	4G License Fee		16,800						
Total Capex		24,392	24,392	-	-	-	-	-	-
OPEX	Annual Maintenance Support for eNodeB			1,122	1,122	1,122	1,122	1,122	1,122
	Annual Maintenance Support for EPC			17	17	17	17	17	17
	Annual Licensing Fee		50	50	50	50	50	50	50
Total Opex		7,184	50	1,189	1,189	1,189	1,189	1,189	1,189
Investment (CAPEX+OPEX)		31,576							
REVENUE (Considering AAGR from Y2018)		73,156		11,029	11,470	11,929	12,406	12,903	13,419
Revenue Sharing with Govt (6.5%)		4,755		717	746	775	806	839	872
REVENUE AFTER Deduction		68,401		10,312	10,725	11,154	11,600	12,064	12,546
CASH FLOW for 4G			(24,342)	9,123	9,536	9,965	10,411	10,875	11,357

As the cash flow table is already done, the next step in my study is to see if the 4G/LTE implementation project is financially viable or not. To do that, I have calculated the PV, NVV, IRR and Discounting Payback method which can help to decide whether the project in financially viable or not.

Table 5.7: Cash-flow analysis for 4G/LTE implementation

Year	Cashflow	Present Value factor (PV)	Discounted Cashflow	Cumulative Discounted Cash Flow
0	(24,342)	1	(24,342)	(24,342)
1	9,123	0.885	8,074.07	(16,268)
2	9,536	0.784	7,476.02	(8,792)
3	9,965	0.694	6,915.52	(1,876)
4	10,411	0.614	6,392.28	4,516
5	10,875	0.543	5,905.05	10,421
6	11,357	0.481	5,462.92	15,884.17

Table 5.8: Discounted Payback Period, NPV and IRR

Discounted Payback Period	3.24
IRR	33%
NPV	15,849

After the cash flow analysis I have found that the NPV is positive, IRR is 33% and the discounted payback period is 3.24 years which can be further improved if more LTE sites can be deployed by GrameenPhone in a single year. For a mobile operator like GrameenPhone, if the discounted payback period is 3.24 years, it basically makes a profitable business case for them as they won't only deploy 1060 sites in a single year rather they will deploy more. Also as I highlighted before due to higher spectrum

cost, if GrameenPhone with the permission from BTRC can use their 2G spectrum for 4G/LTE traffic and reduce the overall cost of the implementation, they can gain more profitability from the 4G/LTE implementation. So in overall, my finding is this project of 1060 LTE sites are financially viable for GrameenPhone as NPV is positive and discounted payback period is 3.24 years with a discounting factor of 13%.

This financial analysis is also applicable for other mobile operators but discounted payback period, IRR and NPV will be different for different mobile operators as the revenue of them are not the same as GrameenPhone.

CHAPETER 06

KEY FINDINGS & OBSERVATIONS

6.1 Key findings and observations from Financial viability calculation

The key finding from the financial analysis is that the opportunity of implementing 4G/LTE is financially viable.

a) From the financial analysis, I have found out that, NPV is positive, IRR is 33% and the discounted payback period is 3.24 years. These figures give enough justification for GrameenPhone to consider the business case and move ahead with the 4G/LTE implementation. Although the financial analysis has been done for GrammenPhone, but the same finding is also applicable for other mobile operators as well.
b) Banglalink, Robi and Airtel also have a huge subscriber base and they are also financially capable to invest for the 4G/LTE technology and wait for 4-5 years to reach the breakeven point or the profitability. Teletalk doesn't have that much of subscriber base but it's a state owned company, so Teletalk can also see the mobile broadband option to increase their revenue by implementing 4G/LTE technology rather focusing on increasing the mobile subscriber base. For Citycell, going ahead with 4G/LTE technology would be difficult considering the financial situation of the company.
c) The business model I have used for the financial analysis is based on 1060 cell sites only. So if the mobile operator can deploy more LTE sites per years, in that case the possibility of getting the investment back even earlier.
d) Apart from GrameenPhone, other mobile operators can also think of buying a less spectrum for 4G to start with as they have done the same for the 3G. For 3G, we have seen that GrameenPhone has purchased a bandwidth of 10MHZ where the other mobile operator has purchased a bandwidth of 5MHz. so the other mobile operators can replicate the same strategy for 4G/LTE licensing as the licensing cost is the major cost i.e. 74% of the CAPEX for implementing the 4G/LTE technology.
e) Due to higher spectrum cost, Mobile Operators with the permission from BTRC can use their 2G spectrum for 4G/LTE traffic and reduce the overall cost of the implementation and they can gain

more profitability from the 4G/LTE implementation. As of 2014, 64% of the Mobile operators in Asia Pacific is using reframed 2G/3G spectrum for 4G/LTE traffic.

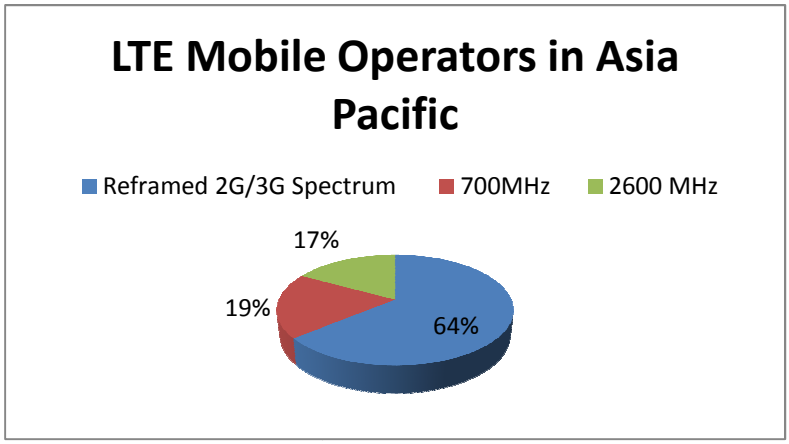

Figure 6.1: 4G/LTE Spectrum Usage for Mobile Operators in Asia Pacific

6.2 Key findings and observations from Conjoint Analysis

From the conjoint analysis, I have found out that the consumer preference is the new technology. But at the same time consumer prefer the same technology with the lower price as expected. Consumers also prefer to have a faster transmission speed and verity of value added services with the lower price which is expected as well. So there needs to be trade-off between the price and the technology and the mobile operators has got a big role here to understand and see how they can monetize the LTE based services to consumers and what sort of pricing strategies they should follow for different segment of customers. Bangladesh is a country where the ARPU is one of the lowest in the world i.e. 2USD and its declining year over year. In order to increase the ARPU level or to keep up the same ARPU level, Mobile operators has to meet the requirement of consumers and strategize the LTE based services accordingly for different segment of consumers. The market share I have found from the conjoint analysis is not realistic if I consider all the consumers in Bangladesh as still the people living in villages or sub-urban areas are happy with the voice services but it's realistic for the 30 respondents who have taken part on the survey.
So Mobile operators has to reach to those end user with the right product at the right price and find a way to increase the data usage which will ensure their revenue growth.

6.3 Key findings and observations from Market Survey

From the survey result I observed that, regardless of the people live in Dhaka, Chittagong or Sylhet, People prefers to have a 4G/LTE technology in Place. As its been seen that 82% of the respondents prefer to have a 4G/LTE technology whereas 17% of the respondents are happy with the existing 3G technology and 1% of the respondents are ok with 2G technology.

Although the preference for most of the respondents are 4G technology but 22% of the respondents don't want to pay anything extra for the LTE based services in comparison to what they are paying currently for the existing services and 52% of the respondents are ok to pay a premium for LTE services but not more than 500 BDT. So there is a challenge for Mobile operators on monetizing the services but if the right strategy in place for LTE pricing, Mobile operators can still grow their business as increase the data usage of consumers.

It's also clear on the survey that Mobile broadband could a good business option for Mobile operators as most of the respondents are ready to pay a high premium for LTE based mobile broadband for company/business usage. So like other countries i.e. India and Srilanka, Mobile operators in Bangladesh also position LTE as a Mobile broadband option as an alternative to Fixed broadband.
Detail responses on the survey questionnaire are highlighted in Appendix A.

6.4 Key findings and observations from Product Life cycle theory Analysis

From the product life cycle perspective, we are aware that each product has go through a different stages i.e. introduction, Growth, Maturity and Decline. From my study, I have seen that it's also applicable for the mobile industry. In Bangladesh, 2G has already reached its declining stage and 3G is on the growth stage and once the 4G/LTE technology will be implemented, it will be in their introduction stage. But looking at the global outlook, once the 4G will kick off, we will also see how fast 2G will start to decline and 3G will transform.

6.5 Limitations

Although I have tried to collect as much as information for the analysis, but there are some limitations of my study. Those are highlighted below.

a) From the conjoint analysis perspective, I only managed to get responses from 30 respondents as it's really hard to explain to respondents on the type of survey conjoint analysis require. As it includes 11 profiles i.e. products with different set of attributes for respondents to rank, it's not an easy task for respondents to response. If I could manage to get more responses, the result from the conjoint analysis might differ a bit.
b) From the financial analysis, I have only taken GrameenPhone data as a reference for financial viability calculation. However, the financial analysis can also be applicable for other mobile operators except Citycell.
c) From the market survey perspective, I have done the survey through a online survey form. So in that regard I missed the people who live in rural or sub-urban areas. Their thoughts and responses might give me a clearer picture.

CHAPETER 07

CONCLUSIONS & RECOMMENDATIONS

7.1 Conclusions

Bangladesh is, in many ways, a country ahead of its time in terms of mobile access. Despite being ranked as a low income country, over 82% of the population subscribes to mobile services and it has outpaced all its peers in terms of network coverage. The combination of limited disposable income and more mature mobile usage means the customers of Bangladesh are more discerning. Mobile network operators are continuously looking to innovative value added services (VAS) to remain competitive and respond to the slowing growth in core mobile services. Services that add value to and improve on the livelihoods of the consumer are more likely to support these goals.

Bangladesh is predominantly a prepaid and 2G market; 80% of the connections are 2G. After the introduction of 3G back in 2012, we have seen that the subscriber in Bangladesh has accepted the technology and the subscriber base for 3G is continuously growing whereas the subscriber base of 2G is declining year over year. Smartphone adoption is also accelerating in Bangladesh, helped by growing supply from local supplier and China. Data traffic is continuously growing and it's becoming the key driver for the mobile operators for their revenue growth.

From my study, I have also found out that the people in Bangladesh are interested to accept 4G/LTE technology. From the responses on the market survey it's also clear that people prefer 4G/LTE technology in Bangladesh. People from different segments has different view and concerns but in general I have found out that people are knowledgeable on the 4G/LTE technology and by understanding the benefits and advantages of it, they would like to have this technology in place in Bangladesh. So the market is feasible and ready to welcome 4G/LTE technologies in Bangladesh. I have also found out from the financial analysis that the business case for 4G/LTE implementation is financially viable for GrameenPhone and all the mobile operators except Citycell in my view considering the financial situation of Citycell.

With the introduction of 4G/LTE technology in Bangladesh, Government of Bangladesh will also be able to take a step ahead for Digital Bangladesh promotion and by the effective and useful use of 4G/LTE technology; they will also be able to make a revolution in the health, administration, education and public services segments.

7.2 Threats

a) As the People living in rural and Sub-urban areas don't have enough money to use data centric services, it will be really hard for Mobile operators to justify the implementation of 4G/LTE in such areas. To tackle this, 4G/LTE can be implemented in those areas focusing mainly on the mobile broadband services, IOT services for Government and Private Organizations to promote financial services, Medical services etc.
b) 4G/LTE enabled Smart Phones are still very expensive and most of the people don't have access to a smart Phone. Government and BTRC needs to allow Tax-free import for Smart Phones so that more people will have access to smart phones and the 4G/LTE technologies. Mobile Operators also need product low cost Smart Phones locally in order to provide Smart Phone services to consumers at a competitive price.
c) Spectrum Allocation cost is very expensive for Mobile Operators and this is the main barrier for Mobile operators most of the time to implement newer technologies. As the mobile operators has already paid a lot of money for 2G and 3G technologies, BTRC should allowed them to reuse those spectrum for 4G/LTE technologies and sell the additional spectrum of 700-800 MHz for 4G/LTE technologies at a cheaper rate.

7.3 Recommendations

Although the findings of my report shows positive outcome for 4G/LTE implementation in Bangladesh in both market feasibility and finically viability perspective, but as I highlighted there are some limitations in my study. Below are my recommendations.

a) Conduct the market survey in all the major cities in Bangladesh for initial deployments and later extend the market survey to rural and sub-urban areas for nationwide coverage.
b) Collect more responses on different type of profiles i.e. products for conjoint analysis

c) Mobile operators to do their financial viability calculation based on the overall market demand and responses from market from all segments.
d) Mobile Operators need to consider the cost of 4G/LTE enabled SIM, cost of additional Support staff for 4G/LTE implementation and quality improvement under OPEX in their financial Viability calculation.
e) Mobile operators to strategize on how they would like to monetize the LTE based services and what would be the pricing strategy for LTE based products for different segments.
f) Mobile operators to promote the LTE as Mobile broadband as an alternative of Fixed Broadband

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APPENDIX A

Residence	Total Survey Respondents	Total	Dhaka	Chittagong	Sylhet
			117	54	44
Gender	Male	170	98	40	32
	Female	45	19	14	12
Age	16-20	18	5	6	7
	21-25	77	45	24	8
	26-30	56	32	10	14
	31-35	42	21	9	12
	36-40	15	9	4	2
	40 & Above	7	5	1	1
Profession	Service Industry	58	34	14	10
	Student	79	43	22	14
	Business	23	4	7	12
	Unemployed	9	7	2	0
	House Maker/House Wife	13	5	3	5
	Technical Staff	10	9	1	0
	Architect	2	2	0	0
	Defense Service	1	1	0	0
	Doctor	4	1	2	1
	Journalist	3	2	0	1
	Marine Engineer	2	2	0	0
	Military Service	1	1	0	0
	NGO Official	1	1	0	0
	Private Service	1	1	0	0
	Teacher	1	1	0	0
	Teacher, BUET	1	1	0	0
	University	1	1	0	0
	Researcher	1	1	0	0
	Freelancer	1	0	1	0
	Lecturer	1	0	1	0
	Navy Officer	1	0	1	0
	Government Service	1	0	0	1
Education	College	29	2	16	11
	Doctor	1	1	0	0
	University-Bachelor	121	71	25	25
	University-Masters	58	40	11	7
	Doctor of Philosophy (ph.D)	3	3	0	0
	MBBS	3	0	2	1
Income/Month	5,000 & below	70	30	22	18
	5,001-10,000	17	13	4	0
	10,001-20,000	17	10	3	4
	20,001-30,000	22	9	6	7
	30,001-50,000	33	17	9	7
	50,000-100,000	28	19	6	3
	100,000-200,000	18	12	2	4
	200,000-300,000	6	4	1	1
	300,000 & above	4	3	1	0
Average Exp. On Internet in Mobile Phone	100 & below	23	6	10	7
	101-300	63	21	22	20
	301-500	35	22	10	3
	501-1500	58	41	8	9
	1501-3000	21	17	1	3
	3001-5000	8	5	1	2
	5000 & above	7	5	2	0
Smart Phone Usage	Yes	169	109	33	27
	No	46	8	21	17
4G Feature Awareness	Yes	153	98	33	22
	No	62	19	21	22
4G Feature	High Speed Internet	146	95	28	23
	Video on Demand, High Quality HD Video Streaming	50	9	21	20
	Multi Channel hi-fi TV Broadcast	5	4	0	1
	High Quality Gaming	4	0	4	0
	Video Conference	10	9	1	0
Internet Usage in Mobile Phone	1-3 hour	76	38	21	17
	3.1-5 hour	84	35	28	21
	5.1-10 hour	30	20	4	6
	10.1-15 hour	12	11	1	0
	15 hours & above	13	13	0	0
Package for Pesonal/Home	512kbps-10GB-1000BDT	134	69	37	28
	1Mbps-20GB-2500BDT	49	27	11	11
	2Mbps-30GB-4000BDT	19	9	5	5
	4Mbps-30GB-6000BDT	8	7	1	0
	8Mbps-40GB-8500BDT	3	3	0	0
	10Mbps-50GB-10000BDT	1	1	0	0
	10Mbps-60GB-11000BDT	0	0	0	0
	12-15Mbps-80GB-15000BDT	1	1	0	0
Package for Company/Business	512kbps-10GB-1000BDT	7	5	0	2
	1Mbps-20GB-2500BDT	26	22	1	3
	2Mbps-30GB-4000BDT	28	18	6	4
	4Mbps-30GB-6000BDT	42	18	14	10
	8Mbps-40GB-8500BDT	10	9	0	1
	10Mbps-50GB-10000BDT	52	17	18	17
	10Mbps-60GB-11000BDT	5	5	0	0
	12-15Mbps-80GB-15000BDT	45	23	15	7
Technology Preference	4G (High Speed Internet, HD Video, Video on Demand, High Quality Games etc)+2G/3G Features	177	106	40	31
	3G (Internet Browsing, Mobile Broadband, Video Calls etc) +2G Features	37	11	14	12
	2G (Voice, Text)	1	0	0	1
Premium on LTE Service	100-300 BDT	65	34	14	17
	301-500 BDT	48	28	10	10
	501-1000 BDT	33	22	9	2
	1001-2000 BDT	15	12	1	2
	2001-3000 BDT	5	5	0	0
	3000 BDT & Above	2	2	0	0
	Nothing	47	14	20	13