NTNU – Trondheim
Norwegian University of
Science and Technology

Tele-economics of Village Telco

Marte Berg Innset

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Supervisor: Harald Øverby, ITEM
Co-supervisor: Sjur Eivind Usken, Lyse Smart AS

Norwegian University of Science and Technology
Department of Telematics

Title: Tele-Economics of Village Telco

Student: Marte Berg Innset

Problem description:

Village Telco is a grass root solution for establishing communication where no other can or are willing to do so. The Village Telco project has developed the MeshPotato unit, based on the open-source, operating system OpenWRT. The MeshPotato uses standard WiFi technology combined with open-source telephony software and a state of the art mesh protocol. MeshPotato networks have no dependence on existing telecom infrastructure, and can relatively easily be deployed anywhere in the world, either as a stand-alone solution or as an extension to existing technologies. Village Telco's solution has been deployed in several countries around the world.

The Village Telco project focuses on local sustainable solutions. The solutions deployed today either charges a monthly subscription from each user (and free calling for everyone) or uses a pay-per-call setup. This is a revenue stream for local maintenance and pay for any external connections (Internet access and external calls).

This thesis will study Village Telco's business model as it is today, and how it can evolve in the future so that the company can serve as a service provider in addition to a hardware provider. In this thesis there will be conducted one or more case studies of existing villages and their business models. The objectives of the work are:

- Provide a background study of Village Telco and the revenue models that are in use in Village Telco today
- Discuss the different approaches to the local business model (e.g free calls internally to grow the network faster, pre-paid, post-paid etc..)
- Find threshold values for sustainable business for the villages
- Propose a business model for Village Telco to become a service provider

Assignment given: 15th of January 2014

Responsible professor: Harald Øverby, ITEM

Supervisor: Sjur Eivind Usken, Aarbakke Innovation AS

Abstract

This master's thesis is written in collaboration with Village Telco. Village Telco is a grass root solution for establishing communication where no other can or are willing to do so. The business has developed the MeshPotato, a wireless access point, which uses standard Wi-Fi technology combined with open-source telephony software and a state of the art mesh protocol, to provide low-cost telephony. Today, Village Telco serve as a hardware provider. The master's thesis provides a background study of Village Telco, the technology that Village Telco uses and some of the Village Telco networks that exist in the world today. An Excel model for calculating threshold values for sustainable businesses have been made, and a new business model for Village Telco is proposed. The aim for the new business model is that Village Telco can serve as a service provider in addition to selling hardware.

The main methods used for this thesis are Skype meetings with people in the Village Telco community, literature study, case studies of existing business models and mathematical calculations. For the case studies, and the proposal of the new business model, Osterwalder's business model canvas have been used as a tool.

The Excel model that has been made can be a helpful basis for a more complex service for the local entrepreneurs in the future. The studies of other business models shows that customer relationships and partnering with other telcos are the two most important aspects to consider for Village Telco as a service provider. Other factors are optional, and there are many possible combinations of solutions for how Village Telco can serve as service provider and which services they may provide.

Sammendrag

Denne masteroppgaven er skrevet i samarbeid med Village telco. Village Telco er en grasrotløsning for a etablere kommunikasjon der ingen andre har mulighet til eller er villige til å gjøre det. Firmaet har utviklet Mesh-Potatoen, et trådløst aksesspunkt, som bruker standard WiFi-teknologi kombinert med open-source programvare for telefoni og en mesh protokoll, for å tilby telefoni til en lav pris. I dag tilbyr Village Telco salg av hardware. Denne masteroppgaven innehar en bakgrunnsstudie av Village Telco, teknologien de bruker og eksisterene Village Telcoer i verden i dag. En Excelmodell for å regne ut grenseverdier for bærekraftig drift er laget og presentert, og en ny forretningsmodell for Village Telco er foreslått. Målet med den nye forretningsmodellen er at Village Telco skal kunne tilby telekommunikasjonstjenester i tillegg til å selge hardware.

Hovedmetodene som er brukt i arbeidet med denne masteroppgaven er møter på Skype med personer i Village Telco felleskapet, casestudier av eksisterende forretningsmodeller, literaturstudier og matematiske beregninger. For casestudiene og forslaget til ny forretningsmodell, er Osterwalders business model canvas brukt som et verktøy.

Excelmodellen som er blitt satt opp kan være en god basis for en mer kompleks tjeneste for de lokale entreprenørene i fremtiden. Studiene av eksisterende forretningsmodeller viser at kundeforhold og partnerskap med andre teleleverandører er de to viktigste aspektene som må sees på når Village Telco blir en tjenesteleverandør. Andre faktorer er frivillige, og det finnes mange kombinasjoner av løsninger for hvordan Village Telco kan bli en tjenesteleverandør og hvilke tjenester de skal tilby.

Preface

This paper serves as a master's thesis in the 10th semester of my Master of Science degree in Communication Technology at the Norwegian University of Science and Technology (NTNU). My specialisation is in the field of tele-economics at the Department of Telematics (ITEM), in the faculty of Information Technology, Mathematics and Electrical Engineering (IME).

First, I would like to thank my supervisor, Sjur Eivind Usken, for constant support and help throughout the process. Also a thank you to my professor, Harald Øverby, at the department, for useful tips and support in the first and final stages of the work with the thesis.

A great thank you is also directed to the Village Telco community, especially Stephen Song and those who helped answering my questionnaire. To Ida Malene Øveråsen and Esther Bloemendaal for collaboration on the background chapter of the thesis.

Lastly, I would like to thank my father, Tore Innset, for proofreading of my thesis, and the inspiration to choose NTNU and a civil engineering study program.

Trondheim, June 2013
Marte Berg Innset

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List of Abbreviations

2G Second Generation (mobile communications).

3G Third Generation (mobile communications).

4G Fourth Generation (mobile communications).

ADSL Asymmetric Digital Subscriber Line.

AODV Adhoc On-Demand Distance Vector.

AP Access Point.

ATA Analog Telephony Adapter.

B.A.T.M.A.N. Better Approach To Mobile Adhoc Networking.

CBC Customer Buying Cycle.

CD Compact Disc.

CDMA Code Division Multiple Access.

CPC Cost Per Click.

CPM Cost Per Thousand Impressions.

DSL Digital Subscriber Line.

DVD Digital Versatile Disc.

FXS Foreign eXchange Station.

GDP Gross Domestic Product.

GSM Global System for Mobile Communications.

ICT Information and Communications Technology.

IME Information Technology, Mathematics and Electrical Engineering.

IP Internet Protocol.

ISDN Integrated Services Digital Network.

ISIF International Society Innovation Fund.

ISOC Internet Society.

ISP Internet Service Provider.

ITEM Department of Telematics.

Kbps Kilobits per second.

LAN Local Area Network.

M. Sc. Master of Science.

MANET Mobile Ad-hoc Network.

Mbps Megabits per second.

MNO Mobile Network Operator.

MP Mesh Potato.

MP01 Mesh Potato Version 1.

MP02 Mesh Potato Version 2.

MR Mesh Routers.

NGO Non-Govermental Organisation.

NTNU Norwegian University of Science and Technology.

OLSR Optimized Link State Routing Protocol.

OS Operating System.

P2P Peer-to-Peer.

PLMN Public Land Mobile Network.

POTS Plain Old Telephone Service.

PPC Pay-Per-Click.

PSTN Public Switched Telephone Network.

SIP Seesion Initiation Protocol.

SMS Short Message Service.

SNS Social Networking Service.

SPUD Simple Unified Dashboard.

SSH Secure Shell.

TTL Time To Live.

VoIP Voice over Internet Protocol.

VSAT Very Small Aperture Terminal.

WISP Wireless Internet Service Provider.

WMN Wireless Mesh Networks.

Part I

Introduction and Background

1

Introduction

The first chapter of the thesis will present the motivation, contribution, scope, limitations and outline of the thesis.

1.1 Motivation and Contribution

In 2012, 6 billion mobile subscriptions were in use worldwide[1]. This number means that around three-quarters of the world's population had access to a mobile phone. Most of the people that do not have access to mobile phones lives in the undeveloped world.

Mobiles are contributing to social, economic and political transformation. Some places in Africa, for example, farmers may obtain information about pricing via text messages. They receive information that make them better informed about where they should sell their products. This saves them time and money. The mobile phone can also be used instead of a regular bank to send money to relatives, saving costs and increasing security[1, chapter 1].

Unfortunately, there exist a huge digital divide in the world today[2, chapter 1]. Many people are denied access to Information and Communications Technology (ICT), mainly in developing countries. The gap between these people and those who have access is referred to as the digital divide. In 2011, the United Nations stated Internet as a human right. Closing the digital divide is an important goal. Village Telco can help closing this gap with low-cost technology.

Figure 1.1 illustrates the percentage of the population that has access to the Internet. The countries shown in the graph is some of the countries that are mentioned and studied in this master's thesis. Timor-Leste and Liberia are the two countries with

almost no Internet users. The two countries will be looked at more closely in Chapter 2. Norway is included as a reference point from the developed world.

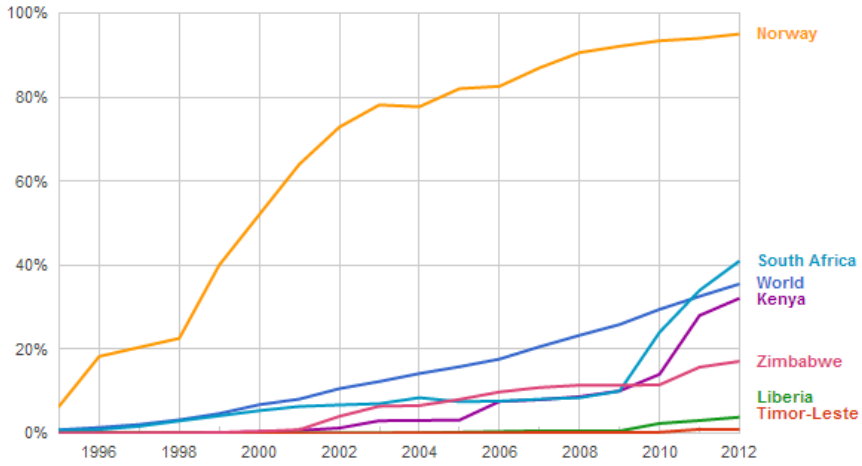

Figure 1.1: Internet users as percentage of population [3]

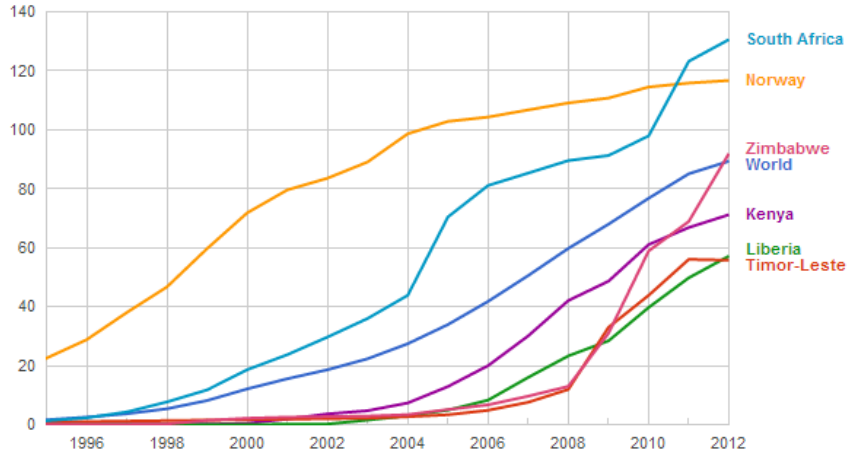

Figure 1.2: Mobile cellular subscriptions per 100 people [4]

Figure 1.2 presents the number of mobile cellular subscriptions per 100 users. The graph shows that the African countries and Timor-Leste all exceed 50 subscriptions per 100 users. The development of ICT started later in Africa and Timor-Leste than in for example Europe. This lead to the countries skipping a step in the development

of telecommunications technologies, and almost started directly on mobile cellular infrastructure. Both in Timor-Leste and Liberia the landline infrastructure suffered during wars in the beginning of the second millennium.

The graph over number of telephone lines per 100 people is shown in Figure 1.3. The figure shows that all the African countries and Timor-Leste always have had few telephone lines per 100 people. The graphs also show that Norway and the world have decreasing number of telephone lines per 100 people, and that there are an increase in the use of mobile cellular technology in the whole world.

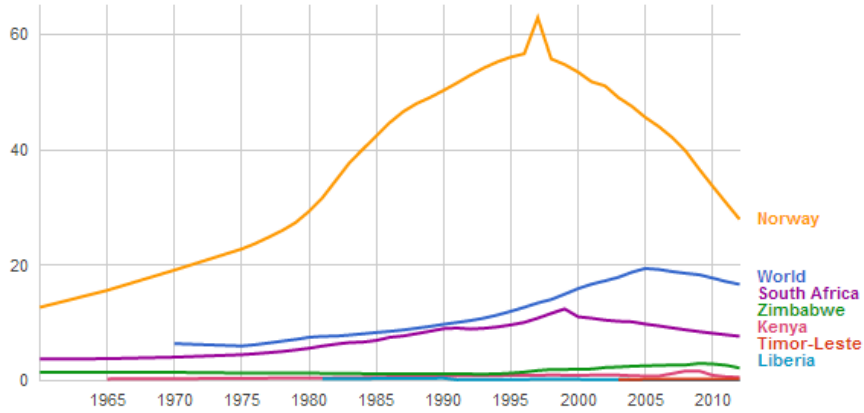

Figure 1.3: Number of telephone lines per 100 people [5]

In Kenya, many people spend more than 50% of their disposable income on mobile services[6]. Village Telco is an initiative that can contribute to reducing costs for telecommunication services in developing countries. The Village Telco project has developed the MeshPotato unit, which uses standard Wi-Fi technology combined with open-source telephony software. The networks have no dependence on existing telecommunication infrastructure, and are relatively easy to deploy as either a stand-alone solution or an extension to existing technologies such as the Internet.

This master's thesis will look at Village Telco as a company, and how their business model can emerge so that Village Telco can serve as a service provider in addition to selling hardware. The thesis will also look in to price strategies for the villages, and try to calculate threshold values for each of the price strategies that are presented for four different scenarios. The next section presents the objectives of the work.

1.2 Objectives

The project description proposes four main objectives for the thesis:

1. Provide a background study of Village Telco and the revenue models that are in use in Village Telco today
2. Discuss the different approaches to the local business model (e.g. free calls internally to grow the network faster, pre-paid, post-paid etc...)
3. Find threshold values for sustainable business for the villages
4. Propose a business model for Village Telco to become a service provider

Some of the objectives were met, and some of them were met to an extent with some adjustments. The scope and limitations of the thesis is described in the following section (Section 1.3), as well as the adjustments that have been done to the problem description throughout the process of writing this thesis.

1.3 Scope and Limitations

The problem description for this thesis was written in January 2014 in collaboration with my supervisor and professor. Some adjustments have been done while working with the thesis. The adjustments with explanations are presented in this section.

Liberia was thought to be a case study for this thesis. Currently a project is in its start phase, and is considering using Village Telco's technology. The idea was to use Liberia as an example in Chapter 6, and use data related to the project in the equations that are presented in the chapter. In addition to this, the plan was to set up a complete business model for the project. This was not done due to lack of resources in the project in Liberia. The people working on the project were busy, and the scheduled meetings kept being postponed and cancelled.

1.3.1 Objective 1

The background study and presentation of three villages are presented in Chapter 2. The revenue models that are in use today are not presented, but the price strategies that are looked at later in the thesis are presented in Section 4.4. Almost all the price strategies presented in Section 4.4 are revenue models found in Village Telcos today. The only two price strategies that are presented, which are not documented in any of the Village Telcos that have been looked at in conjunction with the work with this thesis are dynamic pricing and advertising.

1.3.2 Objective 2 and Objective 3

Objective two and three were merged together. In Chapter 4 different price strategies are presented. The terms pre-paid and post-paid are not used. Instead, the terms flat rate, usage charging, dynamic pricing, bundling, Freemium and advertising is used and studied. The reason for this is that the price strategies have emerged lately for Internet services, and can be relevant for Village Telco as well.

The threshold values are calculated and looked at in Chapter 6. As mentioned, the idea was to use a village in Liberia as an example, but time and difficulties obtaining all necessary data did not make this possible. However, mathematical expressions were obtained and the equations may be used for future villages to decide which price strategy they should use. An Excel workbook with the equations was set up for future villages to use to decide what price strategy they should use. The framework is presented in Appendix E.

The equations are simplified, and must most likely be customised for each village. Due to great differences in each country, it is difficult to set up equations that apply everywhere in the world. However, the equations are a good basis, and it is easy to add one or more variables.

1.3.3 Objective 4

The fourth objective is looked at in Chapter 7. Several case studies of existing business models were done to come up with ideas for Village Telco. Five of the business models are presented in the chapter, while four are presented in Appendix D. The proposed business model for Village Telco is summarised in Figure 7.8 in Section 7.3.

1.3.4 Limitations

In the work with the thesis, several limitations came up. This section will present the most important ones.

First of all, a trip to one of the villages would have been very helpful for an understanding of Village Telco and how the villages are driven. This was not possible due to lack of funding.

The lack of data made the calculation of threshold values for the price strategies more difficult. With more time, a simulation of the different price strategies and scenarios may have been set up.

Other challenges that have emerged are:

- Difficult to get hold of people in the Village Telco community since they are busy
- Difficult to calculate the threshold values without example data
- Difficult to estimate the different values used in the equations in Chapter 6

1.4 Outline

The thesis is divided into five parts, and eight chapters. The parts help the reader to easily understand the different phases of the work, for example, where the theory stops and the contribution starts. All the chapters contain sections and subsections to give a good structure of the work and ease the reading for the reader. The thesis is structured in the following way:

Part 1: Introduction and Background

Chapter 1: The first chapter is the introduction to the thesis. It contains the motivation for the thesis and scope and limitations.

Chapter 2: In the second chapter, a background of Village Telco is given. The technology is briefly explained, and some Village Telco deployments are presented. Chapter 2 is written in collaboration with Ida Malene Øveråsen and Esther Bloemendaal. Liberia is also presented in the chapter to give an idea of how the telecommunications are in one of Africa's poorest countries.

Part 2: Literature Review and Theoretical Background

Chapter 3: Alexander Osterwalder's business model canvas is presented in the third chapter. The business model canvas is used as a framework in the thesis.

Chapter 4: The fourth chapter presents theory related to pricing of communication networks. Important terms are explained, and price strategies are presented.

Part 3: Results and Discussion

Chapter 5: In chapter five the methods that have been used through the process of this master's thesis are presented.

Chapter 6: In chapter six, expressions for calculating threshold values are presented. Four different scenarios are looked at. An Excel model that is based on the equations are also presented.

Chapter 7: The seventh chapter has focus on Village Telco. First, their existing business model is presented. Five existing business models are presented with focus on ideas for a new business model for Village Telco to become a service provider. The last part of the chapter presents a proposal for a new business model for Village Telco serving as service provider.

Part 4: Conclusion and Further Work

Chapter 8: This chapter sums things up in a conclusion of the thesis. The chapter also proposes what can be looked at further.

Part 5: Appendices

The last part of the thesis is the appendices. The thesis contains six appendices, labelled A to F.

2

Background

This chapter is written in cooperation with Ida Malene Øveråsen and Esther Bloemendaal, two fellow students at NTNU, that also write their thesis in collaboration with Village Telco. This chapter will describe the invention of Village Telco and the Mesh Potato. The technology is explained briefly, and more information about the protocols in use is presented in Appendix A. Further, some of the Village Telco network deployments will be described, and Liberia will be described as an example of telecommunications in an undeveloped country.

2.1 Story of Village Telco

Village Telco is "an initiative to build low-cost community telephone network hardware and software that can be set up in minutes anywhere in the world"[7]. Village Telco produces the Mesh Potato (MP). The MP is a combination of a low-cost wireless Access Point (AP) and an Analog Telephony Adapter (ATA).

The Village Telco concept was developed in June 2008 during a workshop at the Shuttleworth Foundation in Cape Town, South Africa. The main goal was to develop an inexpensive system to provide affordable telephone communications in rural and under-served areas[8]. The workshop included participants like open hardware pioneer David Rowe and the developer of the Better Approach To Mobile Adhoc Networking (B.A.T.M.A.N.), Elektra Aichele[9] (for more information about B.A.T.M.A.N. see Section A.1.6 in Appendix A). The purpose of the workshop was to develop a business model, as well as a prototype for a Village Telco.

Initially the idea was to use low cost Voice over Internet Protocol (VoIP) headsets. At that time, it was the most viable and convenient way to deliver telephone services to the customers. The wireless VoIP telephones have small antennas, which became

a problem. The nodes could not be more than 100 meters away from each other in order to have a reliable connection. This required more nodes in order to cover the desirable area. This factor drastically increased the start-up costs for a village. In order to keep the costs down, it was also important to keep the number of APs down. A mesh network has a larger range, and one suggestion was to use a small mesh device, like an Open Mesh AP and connect a Seesion Initiation Protocol (SIP) phone to it. This solution would solve several of the problems regarding range, antenna and number of APs, but the idea was still an expensive option. The challenge was to create something that would be simple enough to be configured and scaled by local entrepreneurs with limited technical skills. In addition to this, it was important to keep the cost down.

The two key cost factors that emerged in the scale-up of a Village Telco were the cost of the customer's phone and the power supply. It was clear that the power supply was the most important factor, and that they had to look at other, and cheaper options regarding the customers phones [9]. During the debating, Rael Lissoos took an ATA and an Open Mesh AP, held them together and said *"we need these two devices in one"*. This point was the birth of the Mesh Potato, fully based on customised open hardware and open software design. The name "Mesh Potato" comes from combining the words mesh, Plain Old Telephone Service (POTS) and ATA. "Patata" is the Spanish word for potato, and hence the name Mesh Potato.

2.1.1 Mesh Potato 1.0 (MP01)

Figure 2.1: The first generation Mesh Potato, MP01

The Mesh Potato Version 1 (MP01) is a mesh enabled Wi-Fi device, with the possibility to connect any inexpensive regular phone and Internet Protocol (IP) device[10]. The first generation of the MP is shown in Figure 2.1. This device is designed to be used in rural areas. It can be deployed and run anywhere in the world, relying only on a low, but stable, power supply. The Ethernet port, the Foreign eXchange Station (FXS) ports and the power port are robust and designed in order to

handle all weather conditions, poor power conditions, lightening and static electricity. In addition to this, the MP comes in a waterproof box for outdoor mounting [11].

The MP01 combines the features of an 802.11bg Wi-Fi router with an ATA [12]. The ATA converts the signal from a standard telephone, into the digital signal needed to connect to the Internet and use the SIP protocol [8]. The device is based on the Atheros chipset and runs OpenWrt (see Section A.1.1 for more information) and B.A.T.M.A.N. (see Section A.1.6 for more information). Each MP01 provides a single fixed telephone line to the end user. The MP01s are connected together via a mesh Wi-Fi network, and configure themselves automatically to form a Peer-to-Peer (P2P) network, greatly extending the range of the network over AP mode WiFi. This enables the phone calls to be made independent of landlines and telephone towers, and creates the basis for the "plug-and-play" solution.

As mentioned, the MP01 is open and based on open hardware, as well as open software design. Everything is kept open in order for any third party to test, set standards, and give feedback. Key goals during the development were to minimise the binary blobs (a closed source binary-only driver that has no publicly available source code [13]), minimise closed software and make the hardware open.

The mesh network can be connected via a backbone link to the rest of the world by using VoIP gateways. No cell phone towers, no landlines, and no telecommunication companies are required. A Village Telco is a community owned telephone service, allowing a local entrepreneur to roll out the Village Telco system only needing a server and the wanted amount of MP01s. The mesh network is self-healing and self-organising, meaning if one node goes down, B.A.T.M.A.N. routes the calls through other available nodes in the network [14]. In order to provide Internet access, a super node has to be placed in connection with an Internet connection. The Internet signal enters the server in the Village Telco; this could for example be an existing Internet café, with a broadband, link or satellite connection. The signal is transmitted to the super node. The super node consists of three external access points, and is placed high over the ground, giving 360-degree coverage, with approximately 1 km range. The Internet signal is then carried through the network from one MP01 to another.

2.1.2 Mesh Potato 2.0 (MP02)

The first generation of the MP has sold over 2500 copies (2014), and is deployed all over the world. In order to keep up with time, the constant technical development and the demand from the users, a new version of the MP was introduced, Mesh Potato Version 2 (MP02). The second generation became available to users August 2013. This device comes in a smaller box, as shown in Figure 2.2, and is sold to half the price of the first generation, $39. One of the biggest differences is that the

second generation has two Ethernet ports and is built on a new, and faster, chip-set. It is also operating on new firmware.

The second generation MPs comes in three versions, where just the first one, MP02 Basic, is available on the market. In May/June 2014 Village Telco will release MP02 - Phone. This version will be identical to the MP02 - Basic with an FXS daughterboard, which enables the possibility to connect a phone to the MP. Village Telco will also release an advanced version of the second generation. This MP02 - AWD will be a full outdoor unit which are designed for rugged use and will have a PoE/TL adaptor which will carry voice, data and power. Time for release of this advanced version is still unannounced.

Figure 2.2: The second generation Mesh Potato, MP02.

2.1.3 Example Mesh network

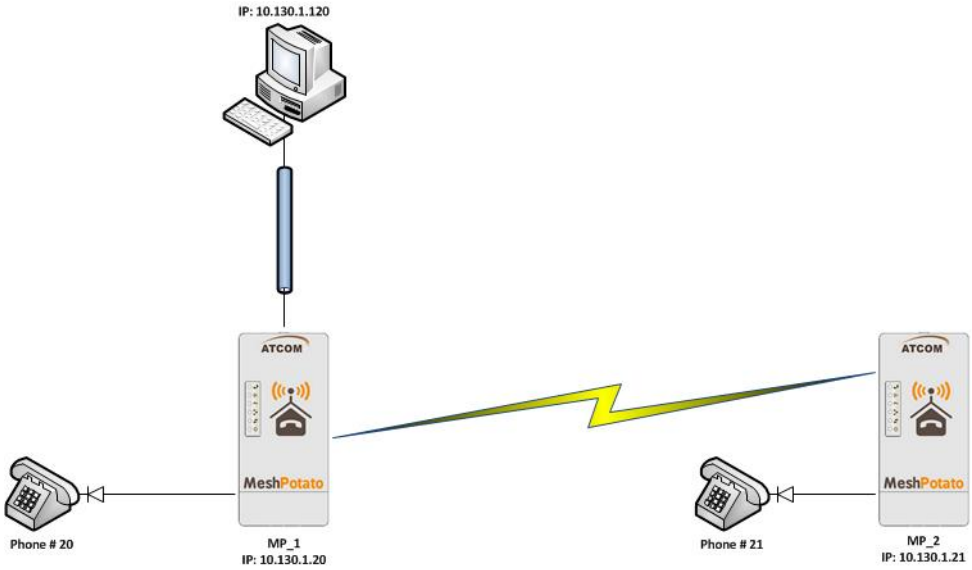

Figure 2.3: Simple mesh network. This figure illustrates a simple mesh network with the use of Mesh Potatoes.

An example of how to set up a simple network is shown in Figure 2.3. The network consists of two regular telephones connected to each their MP. The MP devices have been assigned static IP addresses. These addresses are not part of the Local Area Network (LAN) address space. The IP addresses are allocated in a predefined default address space 10.130.1.xxx. To administrate the MP devices one can use a workstation linked together with any of the MPs in the network (either by using an Ethernet cable or Wi-Fi). This workstation must be assigned a static address within the same address space as the MP devices. Phone calls may be done between the MPs by dialling the last octet or the whole IP address.

See the user guide for a more detailed description of how to set up the MPs and how different networks can be built. The user guides can be found on [15, 16, 17, 18].

2.2 Village Telco Network Deployments

There are Village Telcos in different places in the world. The first Village Telco network was established in Dili on Timor-Leste. There are also Village Telco networks in Brazil, South Africa, Nigeria, Nepal, Puerto Rico and other countries in the world. This section will present some of the villages that exist today. Figure 2.4 shows where some of the Village Telco deployments are located. Since the villages are not deployed by Village Telco itself, but by local entrepreneurs, it does not exist a complete overview over all the villages.

Figure 2.4: World map of Village Telco deployments

The information about the villages that are presented in this section is gathered from the Village Telco website[19] and a questionnaire that was sent out on Village Telco's mailing list in February 2014 (see Section 5.2 for more information).

2.2.1 Dili, Timor-Leste

Dili is the capital of Timor-Leste, one of the poorest countries in Asia [20]. There lives 193 000 (2010) in Dili. Over 70% of Timor-Leste's population lives in rural areas [21]. Timor-Leste gained its independence from Indonesia in 2002, but the telecommunications infrastructure was destroyed in the process.

Telecommunications in Timor-Leste

There exists some infrastructure for fixed and mobile telephone in Timor-Leste. However, the services are expensive and the regular Timorese cannot afford to use the services on a regular basis. After the independence of Indonesia, Timor-Leste's telecommunications sector has expanded, especially the mobile telephone sector. Figure 2.5 and Figure 2.6 show number of subscriptions/users per hundred people in Timor-Leste for cellular telephony and Internet. Figure 2.6 show that there is less than one in hundred people that uses the Internet. The main reason for these low numbers is the high costs for the services in combination with low income of Timor-Leste's inhabitants.

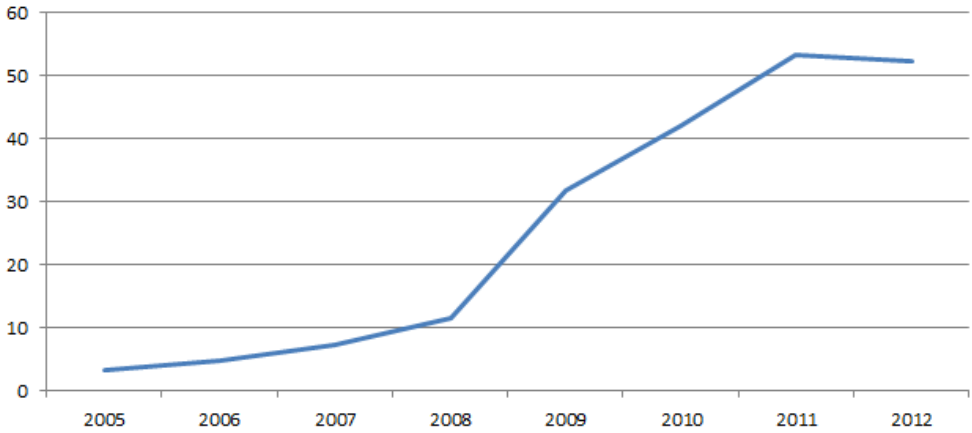

Figure 2.5: Number of cellular subscriptions per 100 people in Timor-Leste

Telephony: From 2002 to 2013, Timor Telecom (owned by Portugal Telecom) had monopoly. Portugal Telecom signed a contract with the government in 2002 to invest $29 million to rebuild and operate the phone system and giving them an exclusive license in the market until 2017 [22]. The contract was renewable, but in 2012, Portugal Telecom agreed with the government to end the monopoly earlier than planned[23]. In 2013, two new competitors entered the market. After this, the market changed rapidly. In addition to this, the government is in the process of setting up a new independent regulatory authority for the telecom sector.

Internet: There is only one Internet Service Provider (ISP) in Timor-Leste, Timor Telecom[22]. The Internet traffic is expensive because international traffic goes via expensive Very Small Aperture Terminal (VSAT) connections. This accounts for most of the national traffic as well [20]. For example it is not possible to send a IP packet from one side of Dili to the other without sending the packet overseas via VSAT connections.

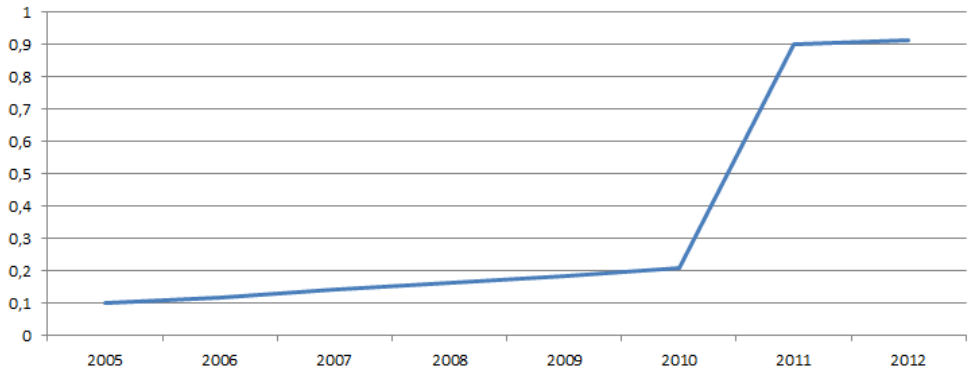

Figure 2.6: Number of Internet users per 100 people in Timor-Leste

The Deployment

The Village Telco deployment in Dili is planning to build a 100-node network. The project is collaboration between Rowotel [1] and Fongtil [2]. The project was funded by International Society Innovation Fund (ISIF) and Internet Society (ISOC) community grants.

The project has three main goals[20]:

- Train Timorese to roll out a Village Telco network and in technologies that are necessary (mesh Wi-Fi, VoIP, mesh node installation and maintenance).
- Deploy a 100-node Village Telco network to build a local telephone network.
- Use the mesh Wi-Fi network to provide a community IP backbone across metropolitan Dili to encourage local IP traffic and local content.

In May 2012, the project had 60 operating nodes, and Fongtil maintains the network. The network is a public resource; anyone in Dili has access to the bandwidth. Fongtil also trains people in MP set up.

Business Model

The business model for the Village Telco deployment in Dili is based on free internal calls, in addition to pre-paid usage charging.

[1] Rowotel is a business operated by David Rowe that focus on open telephony software and hardware

[2] Fongtil is the umbrella organisation for Timor-Leste's local, national and international Non-Govermental Organisations (NGOs)

2.2.2 Orocovis, Puerto Rico

Orocovis is a village in Puerto Rico with about 25 000 inhabitants. Orocovis is a rural and low-income town, the average income in the town is less than $14 000 annually, and most families require financial assistance from government funding.

In the village, there are landline telephone infrastructures that need repair and upgrades. The village is situated in a mountainous terrain, which are an obstacle for cellular telephony. Most of the cell phone users have to travel 30 to 40 minutes to get a stable cell phone connection [24, 25].

The Deployment

In 2012, Jose Soto rolled out a Village Telco network in the village. Jose Soto is the president of CoquiTel, a small Wireless Internet Service Provider (WISP). CoquiTel is a project created to improve the infrastructure of Puerto Rico especially in rural or the last mile areas. The hope through the project is to create and maintain the infrastructure at the same time stimulate the local economy and provide adequate means for students in school, patients in the medical care institutions and general public as a whole.

The network consists of 146 MPs and are still growing as there is a plan of an expansion to other villages close to Orocovis. The deployment is mainly funded by Jose Soto himself[24]. The initial roll out of 45 MPs took between eight and ten months. In the beginning, the focus of the project was telephony, but this changed to Internet connectivity because the project gained access to a microwave link with a large capacity.

Business Model

The business model of Orocovis is based on post-pay unlimited data plans and phone plans. 85% of the service is Internet and 15% is telephony.

2.2.3 Mataffin-Macadamia, Nelspruit South Africa

Mataffin-Macadamia is located in Nelspruit in northeast of South Africa. Mataffin-Macadamia is a retirement secure estate, and the inhabitants are of the upper middle class lifestyle. The estate consists of over 250 homes spread over a 17-hectare village.

The Deployment

Mataffin-Macadamia offers telephony and Internet with use of Village Telco's technology[26]. There are 45 MPs installed so far in the village.

Business Model

Mataffin-Macadamia is a for profit project. Their business model can be divided in three, the project offers:

1. Free internal calls
2. National and international calls via VoIP at about 35% below incumbent telco. (Post-pay)
3. Two Internet access levels: Low usage (about $26 per month) and high usage ($49 per month). (Post-pay)

2.2.4 Summary Deployments

There exist several Village Telco networks in the world today. This section has presented three of them. The three villages were chosen due to their inequalities. The networks are deployed in different type of areas and are used by people from different social conditions. Two of the deployments offer free internal calls, while the last one focuses on Internet connectivity. All the networks, presented in this chapter, are driven by local entrepreneurs with one person as a driving force.

2.3 Telecommunications in Liberia

In this section, Liberia will be presented with focus at the telecommunications and economics in the country. This section's aim is to give an impression of how telecommunications and economics are in one of Africa's poorest countries. Liberia was thought to be a case study for this thesis. The objective was to look at a new deployment in Liberia, and set up a business model for a village there. Why this is not the case, can be read in Section 1.3.

2.3.1 About Liberia

Liberia is located in the west of Africa, as shown in Figure 2.7. The country has a population of 4 million people (2014), where over half of the population lives in rural areas [28].

Figure 2.7: Map of Liberia [27]

Compared to developed countries such as for example Norway, Liberia has a young population. 43.6% of the population is between 0 and 14 years old [29], compared to Norway's 17.5% [30]. Figure 2.8 compares Liberia to Norway with respect to how many percent of the population that is in different age groups.

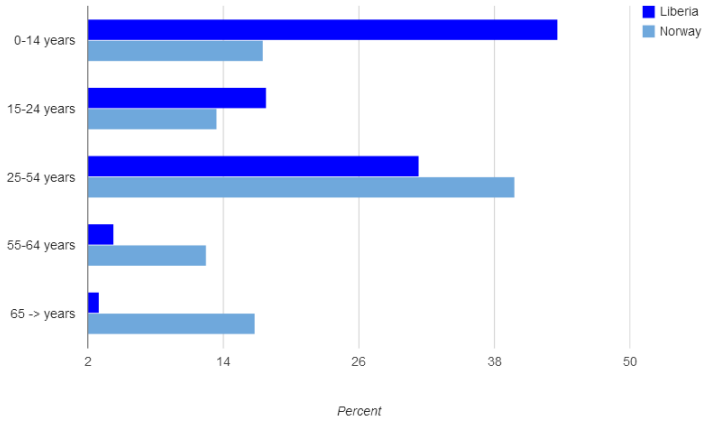

Figure 2.8: Age pyramid for Liberia and Norway [31]

The median age in Liberia is only 17.9 years (Norway: 40.6 years), and the population grows with a rate of 2.56% (Norway: 0.33 %). The Liberian numbers show a great difference from the Norwegian numbers. The same accounts for telecommunications that are presented in the following section.

The Gross Domestic Product (GDP) per capita in Liberia were $600 in 2012. Figure 2.9 shows how the GDP per capita has evolved since the year of 2000.

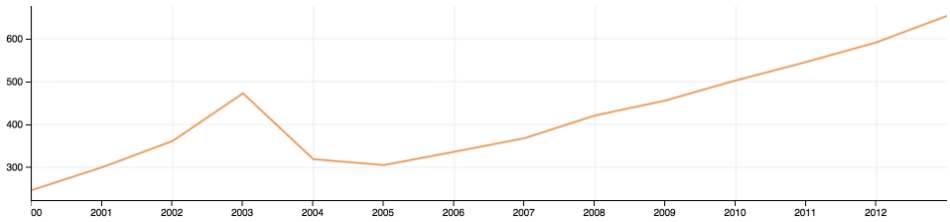

Figure 2.9: GDP per capita in Liberia 2000 - 2013 in USDs [32]

2.3.2 Telecommunications in Liberia

From 1989 to 2003, Liberia suffered a civil war. The war destroyed most of the fixed-line telephone infrastructure [33]. This is shown in Table 2.1 where the number dropped from year 1990 to 1991 and year 2002 to 2007. Today there exists one fixed-lined operator, namely the Liberian Telecommunications Corporation.

Due to a destroyed fixed-line infrastructure, mobile phones became a necessity. In 2003, the Liberia Telecommunications Authority was established to facilitate organisation and control of newly developed communication industry [34].

Year	Telephone Lines Liberia	Telephone Lines Norway
1990	0.44	50.27
1991	0.16	51.57
1994	0.22	55.24
1998	0.26	55.75
2002	0.23	51.08
2007	0.06	42.1
2010	0.15	34.85

Table 2.1: Number of telephone lines per 100 inhabitants [35]

In Liberia there are differences between the capital Monrovia and the rural areas when it comes to access to telecommunication services. Internet for example is almost only available in the capital mostly through Internet cafes and WISPs. As in Timor-Leste (see Section 2.2.1), only about 1% of Liberia's population have access to the Internet. This is due to high costs and poor infrastructure. As in Timor-Leste, there is lack of a backbone network facility, forcing the domestic Internet traffic to go via expensive VSAT connections [33].

Figure 2.10: Combined coverage for the four Mobile Network Operators (MNOs) in 2007 [33]

There exist four MNOs in Liberia (2013) [31, 34, 36]:

- Lonestar Communications Corporation
- LiberCell
- Novafone (Took over from Comium-Liberia)
- Cellcom

In 2005, Liberia had one of the lowest rates of cell phone ownership among African countries[34]. The increase of mobile phone users has been steady since then, and in 2008, the tele-density was 15 per 100 persons. 2.394 million mobile-cellular

subscriptions in 2012, what makes the tele density in Liberia of over 50 per 100 persons.

Figure 2.10 illustrates the combined coverage for the four MNOs. The figure illustrates that the coverage is best in Monrovia and the areas around the capital. Figure 2.11 shows Novafone's coverage six years later. The difference between the two figures illustrates a great development for infrastructure of the MNOs.

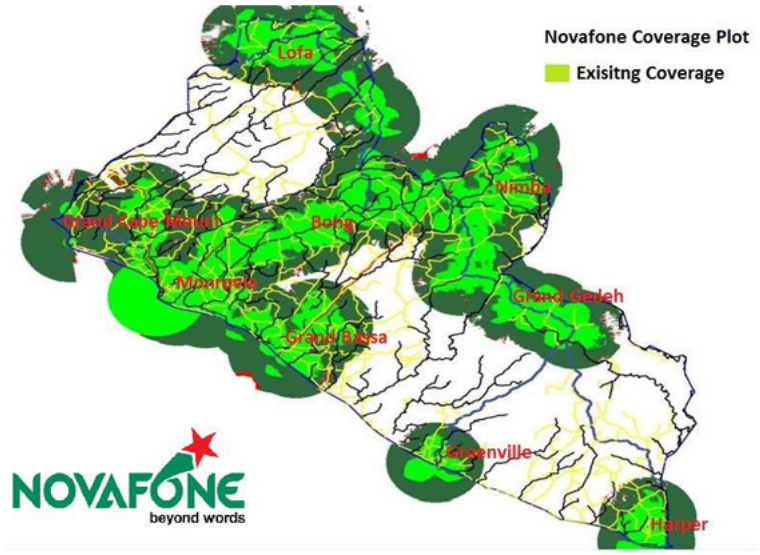

Figure 2.11: Novafone's coverage in Liberia

Novafone was chosen as a price example below. The reason for this is that Novafone was the MNO with most information accessible online. Novafone is the newest Global System for Mobile Communications (GSM) company in Liberia. It took over for Comium-Liberia. The company has GSM coverage in 10 of Liberia's 15 counties. They are planning to reach out to the other five in a few months[37]. Novafone's coverage is shown in Figure 2.11.

Price Example: Novafone

Below information about Novafone's price plans are shown. The information is gathered from Novafone's web pages [38]. Prices for international calls, recharge cards, devices and other services will not be presented here, but may be found on the website.

Voice Novafone's voice tariff plan is given in Table 2.2. There exist two types of pricing for voice, namely post-paid and pre-paid. Post-paid is cheaper than prepaid.

Destination	Rate prepaid customers	Rate post-paid customers
Novafone	$0.14	$0.05
To other networks	$0.18	$0.15

Table 2.2: Novafone's prices for calling

Short Message Service (SMS) The tariff plan for SMS is shown in Table 2.3.

Destination	Rate
Novafone	$0.05
To other networks	$0.08

Table 2.3: Novafone's prices for sending SMS

Data The tariff plan for data is shown in Table 2.4.

Package Name	Volume	Validity	Price
Pay as you go daily	50MB	24 hours	$1.0
Pay as you go weekly	100MB	7 days	$3.0
Pay as you go by weekly	300MB	14 days	$7.0
Pay as you go monthly1	500MB	30 days	$12.0
Pay as you go monthly2	1.0GB	30 days	$19.0

Table 2.4: Novafone's prices for data usage

Bundles Novafone also have bundles with voice, SMS and data in a package. The different bundles and prices for them are found in Table 2.5.

Package Name	Minutes	SMS	Data	Validity	Price
Data Bundle 50	50	50	50MB	30 days	$3.0
Data Bundle 100	100	100	100MB	30 days	$5.0
Data Bundle 250	250	250	250MB	30 days	$10.0
Data Bundle 500	500	500	500MB	30 days	$20.0
Data Bundle 1000	1000	1000	1000MB	30 days	$30.0

Table 2.5: Novafone's data bundle prices

2.4 The Evolution of Telecommunications Industry

The telecommunications pre date the telephony. It started in ancient times with visual signals, such as smoke signals; called optical telegraphs [39]. The first telephone was produced by Bell in 1875, and the first regular telephone call was established in 1878[40]. This Section focuses on the evolution of the telephony this century, especially the introduction of VoIP services.

2.4.1 Evolution of Telephony

In the period 1999 to 2003 telecommunications was one of the leading growth sectors in the world economy[39]. The mobile phone became more popular and cheaper to buy for the user. The coverage of the MNOs become better.

Up until 2003, when Skype launched their Freemium VoIP[3] service, a call was usually done over the Public Switched Telephone Network (PSTN) or the Public Land Mobile Network (PLMN). In 2003, Internet services such as e-mail and instant messaging had existed for several years. However, the household Internet connections did not have the capacity to transfer audio with good enough quality and latency[41]. As the Internet access became faster and more available for the end users, VoIP services emerged.

One of the advantages of VoIP services are that international calls can be made without paying toll charges. This had an impact on the pricing of telephone services, and allowed VoIP service providers to charge a smaller amount for international calls than traditional telephony. Another advantage is that IP networks can carry 5 to 10 times the number of voice calls over the same bandwidth than circuit-switched services.

The introduction of VoIP services, such as Skype, made the traditional telephony providers to change their revenue streams and business models. Telenor[4] changed their pricing strategy from usage charging to flat rate and bundle pricing strategies (see Section 4.4 and Section 7.2.1).

[3] Real-time transmission of voice signals using the Internet Protocol (IP) over the public Internet or a private data network. Also known as IP telephony

[4] Telenor dominates the Norwegian market space for telecommunication services

Part II

Literature Review and Theoretical Background

3

Osterwalder's Business Model Canvas

This chapter will introduce Osterwalder's business model canvas. The business model canvas is built on Alexander Osterwalder's business model ontology. Alexander Osterwalder developed the ontology based on his PhD thesis [42]. Osterwalder's business model canvas will be used as a framework in this thesis when looking at Village Telco, a more detailed description of this is found in Section 5.6.1.

This chapter is based on theory from the book "Business Model Generation" written by Alexander Osterwalder [43]. The business model canvas will be described briefly in this chapter, more detailed information can be found in the book and in Osterwalder's PhD thesis about the business model ontology [42].

Osterwalder defines business models in the following way: "A business model is a conceptual tool that contains a set of elements and their relationships and allows expressing a company's logic of earning money." The business model canvas consists of nine building blocks:

- **Customer Segments** - For whom are we creating value? Who are our customers?
- **Value Propositions** - How to satisfy the customer's needs?
- **Channels** - How to reach the customers?
- **Customer Relationships** - How to maintain customer relationship?
- **Revenue Streams** - Where does the revenue come from?

- **Key Resources** - What are the necessary assets?
- **Key Activities** - What are the important actions that must be taken?
- **Key Partnerships** - Who are the suppliers and partners?
- **Cost Structure** - Where does the costs come from?

Figure 3.1 illustrates the nine building blocks, and the relationship between them. The nine building blocks describe how a company intends to make money. Appendix B contains a more detailed figure of the business model canvas.

The business model canvas was created to make it easy to set up a business model. It is a tool that allows people to describe, design, challenge, invent and pivot their business model [43].

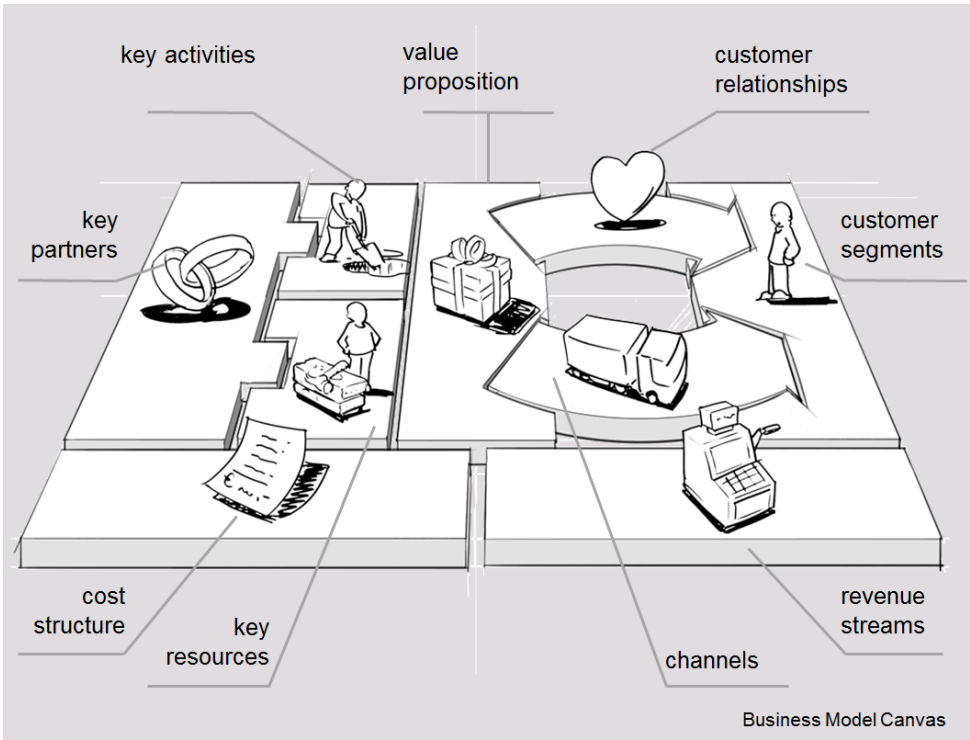

Figure 3.1: The Business Model Canvas[43]

3.1 Customer Segments

The customer segments building block describes the company's different groups of people or organisations it aims to reach and serve. A business model can define one or many small or large Customer Segments. The company must decide which Customer Segments it wants to serve and which it will ignore. When this decision is made, the company can design the rest of their business model around which types of customer they aim to reach and serve.

Customer groups represent different segments if they for example are reached through different Distribution Channels, have different willingness to pay or require different type of Customer Relationship. Facebook[1] for example has at least two customer segments, namely the users of the social network and the advertisers.

3.2 Value Propositions

Value propositions, Osterwalder defines as "an overall view of a company's bundle of products and services that are of value to the customer." A company can offer one or several Value Propositions.

The Value Proposition influences the customer's choice of one company over another. A Value Proposition may be new and innovative or similar to a product or service that already exists on the market.

A Value Proposition creates value for the Customer Segments through different elements or mix of elements. The values may be quantitative (e.g. customer experience) or qualitative (e.g. price). Examples of elements that contribute to a customer's value creation are:

- Innovativeness (e.g. no similar option on the market)
- Performance (e.g. better performance than the competitors)
- Price (e.g. lower price than the competitors)
- Risk reduction (e.g. insurance)
- Usability (e.g. high ease of use)
- Design (e.g. beautiful design)
- Brand (e.g. some brands signify wealth, health or are ecological)

[1] www.facebook.com

3.3 Channels

The definition of the Channels building block is that it "describes how a company communicates with and reaches its Customer Segments to deliver a Value Proposition" [43]. Channels can be divided in to five distinct phases that are described in Table 3.1.

Phase	**Description**
Awareness	Get known in the market, raise awareness about the company's Value Proposition(s)
Evaluation	Help customers to evaluate the company's Value Proposition(s)
Purchase	Make purchase and fulfilment convenient, the transaction process
Delivery	How is the Value Proposition delivered to the customers?
After sales	Do not "forget" the customer after transaction, provide post-purchase customer support

Table 3.1: Channel types

3.4 Customer Relationships

Customer Relationships describes the company's type of relationship with a Customer Segment. Customer Relationships can range from personal to automated, the company may have different relationships to different Customer Segments. For example airlines have a more personal relationship with their gold members[2] than others.

3.5 Revenue Streams

Revenue Streams represent the money a company generates from each Customer Segment. Willingness-to-pay is a central element in this building block. How much is a Customer Segment willing to pay for the Value Proposition? Each Revenue Stream may have different price strategies. Section 4.4 describes different price strategies.

A business model may involve two different types of Revenue Streams:

1. Transaction revenues resulting from one-time customer payments (e.g. purchase of a product)
2. Recurring revenues from ongoing payments (e.g. a subscription on a service)

[2]Gold members are those who e.g. fly often or business class customers

3.6 Key Resources

The Key Resources allow a company to create and offer a Value Proposition, maintain relationships with Customer Segments, reach markets and earn revenues. The building block describes the most important assets that are required to make a business model work.

The building block can be divided into four categories. Physical, intellectual, human and financial, which are described in Table 3.2.

Category	**Description**
Physical	This category include for example vehicles, machines, buildings distribution networks and manufacturing facilities.
Intellectual	Important for a strong business model. This category includes for example patents, copyrights, partnerships and customer databases.
Human	This category includes employees and experts. Human knowledge is crucial in many business models.
Financial	This category include cash, stock option for hiring key employees and funding.

Table 3.2: Categorisation of Key Resources

3.7 Key Activities

Like Key Resources, Key Activities is required to create and offer a Value Proposition, maintain relationships with Customer Segments, reach markets and earn revenues. The building block describes the most important things a company must do to make a business model work.

The building block can be divided into three categories. Production, problem solving and platform/network, which are described in Table 3.3.

Category	Description
Production	Activities that relate to design, making and delivering a product. For manufacturing companies this category dominates the business model.
Problem solving	Activities that relate to coming up with new solutions to customer problems. For consultant companies and hospitals this category dominates the business model.
Platform/Network	Platform/network activities are important in business models where the positive network externalities influence the value of the service/product. Social networks, software and brands are examples of companies where network/platform is a key activity.

Table 3.3: Categorisation of Key Activities

3.8 Key Partnerships

The Key Partnerships building block describes the network of suppliers and partners a company must have to make a business model work. This building block is becoming a cornerstone of many business models. Partnerships can be divided in to four groups:

- Strategic partnerships between competitors
- Strategic partnerships between non-competitors
- Joint ventures to create new businesses
- Buyer-supplier relationships

3.9 Cost Structure

The Cost Structure building block describes all the costs that occurs when operating a business model. Maintaining Customer Relationships, generating revenue and delivering value generates costs. These costs may be calculated easily after defining Key Resources, Key Activities and Key Partnerships.

There are to main classes of Cost Structures, namely cost-driven and value-driven. A cost-driven business model focus on minimising costs, while a value-driven business model focuses on creating value. Many business models fall in between these two extremes.

Cost Structures have four characteristics, fixed costs, variable costs, economies of scale and economies of scope. The characteristics are described in Table 3.4.

Characteristic	**Description**
Fixed Costs	A company's costs that are not dependent on the scope of the production. For example, lease of facilities.
Variable Costs	Costs that increase with the increase of production and decrease with the decrease of production. For example costs of raw material.
Economies of Scale	Cost advantages that a company obtains as its output expands. Average cost per unit decrease as output increases.
Economies of Scope	Cost advantages that a company obtains due to a larger scope of operations.

Table 3.4: Characteristics of costs

4

Pricing of Communication Networks

This chapter introduces theory related to pricing of communication networks. The two most important characteristics of data communication, with regard to economics, are high fixed cost and low marginal costs. It does not cost anything or very little, to connect one extra customer. The same accounts for information goods, e.g. Compact Discs (CDs), Digital Versatile Discs (DVDs) and newspapers. Communication services and information goods are on this topic comparable.This chapter will therefore also look into price strategies for information goods as well as for communication networks.

The telephone provider or Internet provider provides two main services [44]:

1. Connection of customers
2. Communication between customers

The communication between customers can have different prices and/or price strategies. This chapter will look into how a telephone service should be priced and what types of price strategies that exist for communication networks.

4.1 Network Externalities

The term network externalities is used to describe how the value of a product or a service increases with the number of users. This is called positive network externality. There are both positive and negative network externalities.

4.1.1 Positive Network Externalities

An example of a positive network externality is the telephone. For users it is more attractive to own a telephone if you know other users that you can call.

Networks of many users have greater utility for the user than smaller networks. Every user has access to more users. Metcalfe's law describes how many connections there are between a number of n users in a network, which also can be looked at as the value of the network. Equation 4.1 show Metcalfe's law, $V_{network}$ stands for value of the network in the equation, n is the number of nodes (users).

$$V_{network} = \frac{1}{2} * n * (n - 1) \tag{4.1}$$

Figure 4.1 shows three examples of connections between users. The figure illustrates how the network's value grows exponentially with the increase of number of users.

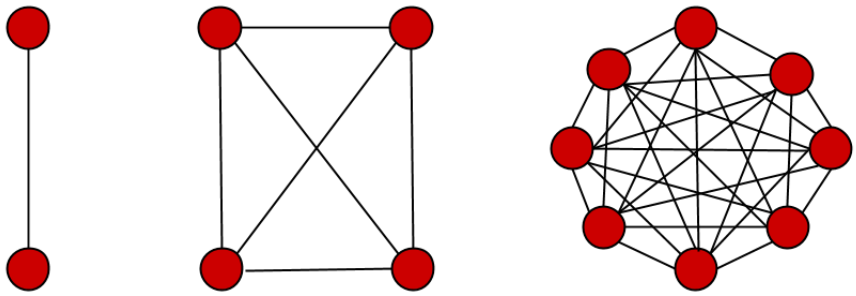

Figure 4.1: Metcalfe's law - Illustration of number of connections in networks with 2, 4 and 8 nodes

4.1.2 Negative Network Externalities

In addition to positive network externalities there are negative network externalities. A negative network externality is the principle that the value of a product or a service will decrease with the number of users. An example is congestion. If too many users are connected to the same AP, this will lead to congestion and users will disconnect due to reduction in service.

4.2 Pricing

When deciding a price for a service or a product there are several points to take in to account. One thing is that the price and demand affects each other. If the price is low, the demand increases. If the price is high, the demand decreases. If there are several companies on the market providing the same type of service/product, the competition between the companies will drive the price towards the marginal cost. For data communication, this means a price close to zero.

There are different motivations for setting prices. Examples of motivations are to cover costs, maximize profit, maximize social welfare and encouraging the efficient use of resources [45, chapter 5]. For Village Telco and the local entrepreneurs the motivation is to cover the costs and make a profit, or maximising social welfare. The motivation that will be considered for the rest of the thesis is covering costs and making a profit. This will be the fundamental assumption for all equations and calculations. The reason for this is that if Village Telco becomes a service provider, which is looked at in Chapter 7, their motivation is to make money.

4.2.1 Demand

Several factors determine demand for a service in addition to price. Figure 4.2 illustrates the different factors. The factors are divided in to two categories; controllable and uncontrollable. In developing countries, the two factors that have the highest impact on demand are price and income.

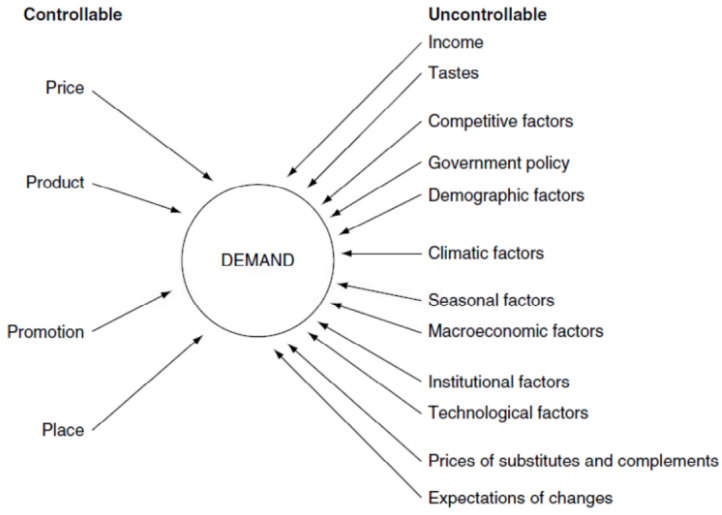

Figure 4.2: Factors determining demand [46, page 91]

4.2.2 Demand and Network Externalities

The demand for a service may be affected by the number of other people that are subscribed to the service. This refers to network externalities. Figure 4.3 illustrates an example of a demand curve with network externalities. The example is taken from [45, chapter 5].

There are N potential customers in the market, $i = 1, ..., N$. Customer i has the utility $u_i(n) = i * n$, given that n other customers subscribe to the service. In other words the customer number 75 has a willingness-to-pay equal to $75 * n$. If a customer believes that no one else would subscribe to the service, he values the service to zero.

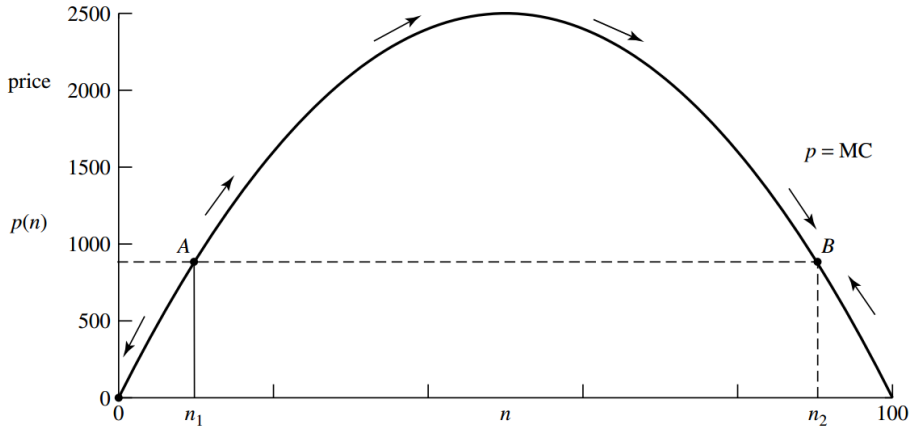

Figure 4.3: Demand curve for a service where a network externality is present [45, chapter 5]

Figure 4.3 plots an example where it is assumed that $u_i(n) = i * n \leq p$, that $N = 100$ and $p = 900$. The figure illustrates three equilibria points; 0, A and B. Point 0 is always a possible equilibrium, since the prior belief is that no customer will subscribe to the service. Point A and B are equilibria since $u(n_1) = u(n_2) = p$. In point A user $i = 90$ is indifferent to subscribing (10 users are subscribed), and in point B user $i = 10$ is indifferent (90 users are subscribed), this is shown in Equation 4.2 and Equation 4.3.

$$u_{90} = n * i = 10 * 90 = 900 = p \tag{4.2}$$

$$u_{10} = n * i = 90 * 10 = 900 = p \tag{4.3}$$

The network's total utility in point n may be calculated using Equation 4.4. The value of the network is of order 2, which accords with Metcalfe's law that was presented in Section 4.1.1.

$$U_{network} = n + 2 * n + 3 * n + ... + n * n = \frac{n+1}{2} * n \tag{4.4}$$

4.2.3 Demand for Telecommunication Services

The demand for telecommunication services can be described mathematically. In this section, an example with two types of consumers will be explained. The example is from [44, Chapter 5]. The first group of consumers, H, place high value on connecting to the service. The other group, L, place lower value for the connection. Both groups consist of the same number of homogeneous consumers, n. It is assumed the following network effect, namely if one consumer from a particular group connects to the service, all the consumers from that group connect.

The utility the consumers obtain when subscribing to the service, can be denoted by two utility functions. One for each group of consumers.

$$U_H = \begin{cases} \alpha q - p & \text{connected} \\ 0 & \text{disconnected} \end{cases} \tag{4.5}$$

$$U_L = \begin{cases} q - p & \text{connected} \\ 0 & \text{disconnected} \end{cases} \tag{4.6}$$

In the utility equations above, Equation 4.5 and Equation 4.6, the q denotes the quantity of consumers connected to the service, while the p denotes the price for connection. The α denotes the importance of the service for a consumer in group H. In this example it is assumed that $\alpha > 2$. If group L want to subscribe to the service, group H also want to subscribe since $U_H > U_L$ due to a $\alpha > 2$.

The demand will for three different price ranges be:

- **Low price range ($0 \leq p < 2n$):** At this range $2n$ consumers will subscribe to the service. Since $U_H = \alpha(2n) - p > 0$ and $U_L = 2n - p > 0$.
- **Medium price range ($2n < p \leq \alpha n$):** At this range only the consumers in group H will subscribe. Since $U_H = \alpha n - p > 0$ and $U_L = 2n - p < 0$
- **High price range ($p > \alpha n$):** At this range no one subscribes to the service. Since $U_H = \alpha(n) - p < 0$ and $U_L = 2n - p < 0$

The demand described mathematically above is illustrated in Figure 4.4. The α illustrates the critical mass. The critical mass at a price is the minimal number of customers needed, to ensure that at least this number of customers will benefit from subscribing to the service at that price [44].

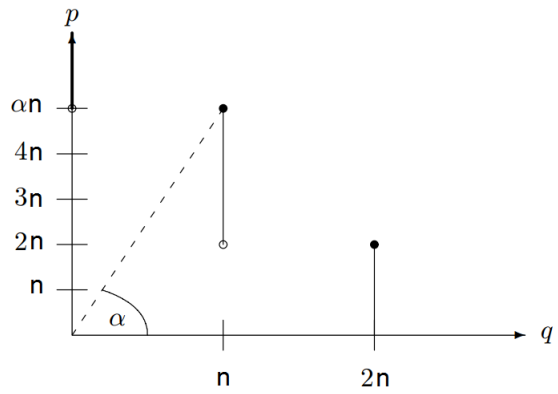

Figure 4.4: Demand for telecommunication services[44].

The example illustrates how price influence the demand for telecommunication services. An example with numbers is shown in Appendix C.

4.2.4 Market Entrants in Regulated Markets

The example here is a new telecommunication provider that enters the industry, a regulated market [44, Chapter 5]. A number of n consumers of type H have already subscribed to the service from the incumbent firm. This example will look at the profit and price the entrant can expect.

The residual demand, q_e, and the price for the service, p_e are given in Equation 4.7:

$$q_e = \begin{cases} n & \text{if } p_e \leq 2 * n \\ 0 & \text{if } p_e > 2 * n \end{cases} \tag{4.7}$$

Equation 4.7 gives that the entrant's profit-maximising subscription price is as given in Equation 4.8.

$$p_e = 2 * n \tag{4.8}$$

The entrant may expect a profit level as given in Equation 4.9. The Π_e represents the total profit, the VC_e stands for the variable costs, and the FC_e is the fixed costs.

$$\Pi_e = n * (2 * n - VC_e) - FC_e > 0 \tag{4.9}$$

4.3 Price Discrimination

Price discrimination is a concept that is important to know when looking at price strategies. Customers' willingness-to-pay varies from customer to customer. Thus, the willingness-to-pay is heterogeneous. This fact makes producers consider to charge different users different prices[47]. Producers that make use of price discrimination often give different social groups a discount. These groups often have a lower income and lower willingness-to-pay than average. Perfect price discrimination is obtained when everybody pays a price equal to his or her willingness to pay. This leads to maximum profit for the producers, in other words the consumer surplus is minimised.

An example of price discrimination is pricing of public transportation in Norway. There are different prices for different user groups, as for example seniors, children and students. These three user groups get on discount on tickets.

4.3.1 Mathematical Example

A mathematical example on price discrimination is given in this section. The example is of a telephone service that has operational costs of \$1.1. There are two consumers, X and Y. X is willing to pay \$1.5 and Y is willing to pay \$0.5 for the service. If both X and Y pay their maximum price, the total of \$2 exceed the total cost. However if the producer decides to charge each customer \$1, only X will subscribe to the service and the revenue will only be \$1. If the producer decides to charge only \$0.5 instead, both X and Y will subscribe, but the revenue will still be only \$1. If the producer can price discriminate, then he can obtain a sustainable business.

4.4 Price Strategies

As described in Section 3.5 there are different ways to price a service or a product. This section will introduce some of them.

4.4.1 Flat Rate

Flat rate is comparable with an all-you-can-eat restaurant. The customer has access to a service or a product for a given price and time period. In the time period the customer can use the service or product as much as he wants. When the time period is over, the customer may renew the subscription. The price for the service must cover the average user[45, chapter 1].

Pricing of Internet subscriptions in Norway follow this price model. The customer pay x NOK for y Megabits per second (Mbps). The advantage with this type of pricing for the producer is that the customers tend to overestimate their use. The revenues are predictable (number of customers subscription fee), and the risks are reduced.

For the customer the advantages are timesaving, freedom in terms of free use with no extra costs and the feeling of saving money. The disadvantage are producer lock-in, and switching costs.

There are different variations of flat rate, and some examples are:

- Pay a fixed amount every month and get unlimited use (e.g. Spotify Premium[1])
- Pay a fixed amount every month and get a limited number of products (e.g. a newspaper subscription)
- Pay for a subscription that includes a fixed amount, and the possibility to pay extra for the extra use. If the customer use less than the fixed amount, the customer still have to pay the subscription fee (e.g. Telenor XS[2])

[1] www.spotify.com, a digital music service.

[2] A mobile subscription with unlimited calling and SMS, and 200MB data traffic included in the monthly fee. It is possible to pay extra if one want more than 200MB.

Mathematical Expression

Flat rate has an uncomplicated mathematical expression, the expression is given in Equation 4.10. The a represents the fee of the subscription, and N the number of users subscribed to the service. The R is the revenue, given that there is no price discrimination and all the users pay the same for a subscription.

$$R = a * N \tag{4.10}$$

The price strategy has, as presented in the list above, three variations. The first and second one is given in Equation 4.10. The last one, where the user has the possibility to pay extra for extra use, is given in Equation 4.11. The p is the fee per extra unit x. This is a combination of flat rate and usage charging. Usage charging is presented in Section 4.4.2.

$$R = a * N + \sum_{i=1}^{N} p * x_i \tag{4.11}$$

4.4.2 Usage Charging

Usage charging is comparable with an á la carte restaurant, where the customer choose from a menu what he likes to eat[45, chapter 1]. An example of a company that use this price strategy is Microsoft Azure[3]. For example, the customer pays just for the number of Bytes he needs to store.

One disadvantage with this type of pricing is that the customer can "sit by the table without ordering anything". For telecommunications, this is known as resource reservation, which is expensive for the operator.

For the customer this price strategy is advantageous if he is not able to estimate his use. On the other hand, it is difficult to know how much the service will cost in the end. The service might end up more expensive than first expected. Customers tend to overestimate their use, and therefore they might not subscribe to the service because they think it is more expensive than it actually is.

Examples of usage charging are for example:

- Pre-paid mobile service
- Post-paid mobile service (per-use)

[3]www.azure.microsoft.com, a cloud service for e.g. storing

– Á la carte restaurant

Mathematical Expression

Assume that there is one service, and N users using the service. The revenue, R is given in Equation 4.12. The p is the fee per unit. x_i is the number of units customer i has used.

$$R = \sum_{i=1}^{N} p * x_i \tag{4.12}$$

4.4.3 Dynamic Pricing

Dynamic pricing means that the prices for a service varies during the day[45, chapter 1]. An example is higher pricing for public transportation in the rush hours than during the day. Thus higher prices for the service during the most popular hours of the day.

This type of pricing can for example be used for an Internet café, to make the more unpopular hours of the day more attractive for the customers.

Mathematical Expression

Equation 4.13 represents the equation for dynamic pricing. The $x_{i,t}$ are for example the number of calling minutes done by customer i in time-period t. N are the number of customers, while T is the number of different pricing periods. The same equation can be set up for data and SMS.

$$R = \sum_{i=1}^{N} \sum_{t=1}^{T} p_t * x_{i,t} \tag{4.13}$$

4.4.4 Bundling

People have different utility associated to a product or service. Social conditions also affects the willingness to pay for a customer. Bundling relates to selling several products together as a package. Microsoft Office[4] is an example of bundling where several softwares are sold together as one product. Another example of bundling is cable TV companies that sell bundles of TV channels together. Some companies even sell cable TV and Internet together.

[4] A package from Microsoft consisting of Excel, PowerPoint, Word, OneNote, Outlook and Lync.

Bundling is a variant of price discrimination which is explained in Section 4.3. All customers has a price they are willing to pay for a product or a service. The customer will buy the product or service only if the price is equal to or lower than the price he is willing to pay. In other words, he is will buy the product or service if the consumer surplus is greater than or equal to zero. Bundle pricing is built on this principle, and is an attempt to capture more of the customer's consumer surplus [48].

There are two types of bundling:

1. Pure bundling - The customer have the choice of buying the bundle or nothing
2. Mixed bundling - The customer have the choice of buying the bundle or parts of the bundle separately. If all the products are bought separately, the total price will be higher than buying the bundle

Mathematical Expression

Bundling may be combined with both Freemium and flat rate. The mathematical expression for bundling will be the same as for the given price strategy, but the product or service the customer buys consists of several products or services instead of one.

For example bundling can be used in flat rate. The mathematical expression for this will be the same as presented in Section 4.4.1. The only difference is that the user gets access to more than one service for the fee b. The mathematical expression for bundling is given in Equation 4.14.

$$R = M * b \tag{4.14}$$

4.4.5 Freemium

The price strategy Freemium is based on one free version and one upgraded version that costs money. The upgraded version often has more functionality than the free version. Spotify use this price strategy. The free Spotify free version is made possible by advertising; it includes less functionality than the Premium version. The premium version costs $9.99 a month, and let you have offline playlists in addition to listen to music online.

The advantage with this price strategy is that you gain a great user mass with the free version. This increases the network externalities and makes the service more attractive, especially for telecommunication services. In addition to this, the price strategy also targets those who have a greater willingness to pay and wants more functionality. Freemium is a form of price discrimination (see Section 4.3).

LinkedIn[5] is another good example of a business, which has made use of the Freemium price strategy. The Social Networking Service (SNS) has over 300 million registered users worldwide and a revenue stream of $473.2M in the first quarter of 2014[49]. LinkedIn has different subscriptions; free, premium, business, business plus and executive. Where the four latter costs money. Figure 4.5 shows LinkedIn's revenue streams in Q1 2014. The figure shows that the premium subscriptions stand for 20% of LinkedIn's revenue, and just under $100M.

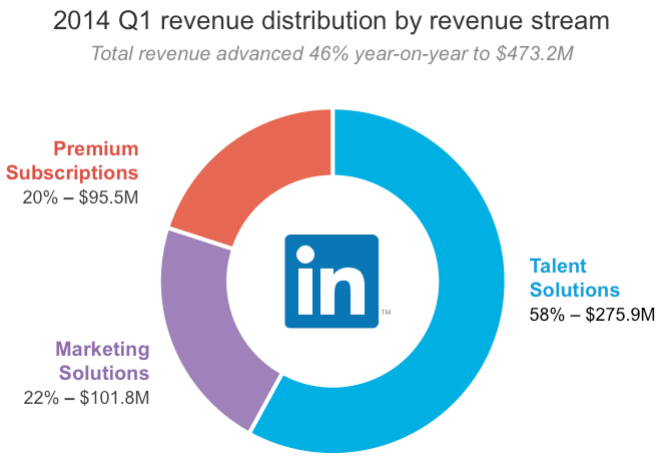

Figure 4.5: LinkedIn's revenue streams for Q1 2014 [49]

Free Internal Calling

Village Telco could use this price strategy in form of free internal calling in the network. This will increase the number of users, and the network externalities, in the beginning and make the network more attractive. The first step of a Village Telco network installation is to get a local network up and running. After this, the network can connect with either a telephony provider, an Internet provider or even both. At this stage, Village Telco may offer an extra service that cost money. This service may be charged using one of the other price strategies explained in this chapter.

Demand, Network Effects and Freemium

The smart thing of Freemium is that it attracts customers with different willingness-to-pay. The use of this price strategy will increase the number of users faster in the beginning than some of the other price strategies. This can be shown using the

[5] A professional business-oriented social network for job seekers and recruiters

example in Section 4.2.2. If the price is set to zero, a smaller amount of users needs to be connected to the service for an other user decides to connect. In principle, all users that have a positive utility will subscribe to the service. A negative utility may occur for example when a customer finds it time-consuming to subscribe and the service useless.

Some of the users that choose to subscribe since the service is free and initially would not subscribe if they had to pay a fee, may subsequently get a higher willingness-to-pay if they find the service useful. Then they can easily upgrade their subscription. This is often the case with mobile applications that combine Freemium with advertising. After a while some of the users find the advertising annoying and decides to buy a premium version of the application that does not contain any advertising.

Thus, this price strategy is useful in cases where there are a heterogeneous market with customers who differ in willingness-to-pay. It can also be useful in cases where the potential users does not have a familiarity to the type of service, and does not know if they would appreciate the service or not. This type of scepticism towards the service can also be solved by giving the users a free trial period.

Mathematical Expression

In equations in this section, the N stands for the total number of users in the network, while M is the number of users of the premium service. Freemium may be combined with all the price strategies presented in this chapter. The b in Equation 4.18 represents the fee for the bundle. Equation 4.15 to 4.18 presents the mathematical expressions for different types of Freemium.

Freemium with Flat Rate:

$$R = N * 0 + M * a \tag{4.15}$$

Freemium with Usage Charging:

$$R = N * 0 + \sum_{i=1}^{M} p * x_i \tag{4.16}$$

Freemium with Dynamic Pricing:

$$R = N * 0 + \sum_{i=1}^{M} \sum_{j=1}^{T} p_j * x_{i,j} \tag{4.17}$$

Freemium with Bundling:

$$R = N * 0 + M * b \tag{4.18}$$

4.4.6 Advertising

The main source to revenue comes from advertisers and not from users for this price strategy. Mobile applications and Facebook are examples of products and services that use this type of pricing. These products and services are characterised by a low price (often close to zero). The reason for this is that they are dependent on a great user mass to be attractive for the advertisers. With few or no user, the advertiser will not buy ads. Thus, the users of the product/service have positive network externalities on the number of advertisers. However, there is an important balance to be aware of. The number of advertiser have negative network externalities on the number of users. If there are too much advertising, the product/service will lose users, and the willingness to pay for the advertisers will decrease.

There exist different models for pricing of advertising. As mentioned, Facebook use this type of pricing. Facebook has made their advertising user-specified; this has increased the willingness-to-pay for the advertisers. Facebook has two priced models for advertising that the advertisers may choose, namely Cost Per Click (CPC) and Cost Per Thousand Impressions (CPM) [50, 51].

The advantages of this type of pricing is that it is easy to combine with other price strategies, and it is easy for the users to start using the product/service if it is free. This strategy can be used when a great user mass is important. The Spotify example in Section 4.4.5, is an example of this price strategy combined with flat rate that is explained in Section 4.4.1.

4.4.7 Pre-Paid Pricing

A user buy an amount of, for example, calling minutes that last for a given timeframe. The remaining credit after the timeframe has elapsed is cancelled. A study in Sweden showed that 15 to 20 percent of the bought cards were not even activated. There is reason to believe that the number for developing countries will be lower due to lower incomes than in Sweden. However, it is possible that pre-paid cards will lead to some income due to cancellation of remaining value on the cards.

This price strategy will not be looked in to further, since all the price strategies can be combined with it. The only difference is that the cancellation of remaining value on the cards may contribute to a higher revenue. How big the contribution to the revenue is, will not be estimated or discussed in this thesis.

4.4.8 Summary of the Price Strategies

A summary of the mathematical expressions for the price strategies presented in this chapter is given in Table 4.1.

Price strategy	**Mathematical Expression**
Flat rate	$R = a * N$
Usage charging	$R = \sum_{i=1}^{N} p * x_i$
Dynamic pricing	$R = \sum_{i=1}^{N} \sum_{j=1}^{T} p_j * x_{i,j}$
Bundling	$R = b * N$
Freemium Flat Rate	$R = N * 0 + M * a$
Freemium Usage Charging	$R = N * 0 + \sum_{i=1}^{M} p * x_i$
Freemium Dynamic Pricing	$R = N * 0 + \sum_{i=1}^{M} \sum_{j=1}^{T} p_j * x_{i,j}$
Freemium Bundling	$R = N * 0 + M * b$

Table 4.1: A summary of the mathematical expressions for the price strategies presented in this chapter.

Part III

Results and Discussion

5

Methodology

This chapter describes the methods used for this thesis. Several methods have been used; literature study, questionnaire, interviews, Skype meetings, case studies and brainstorming.

5.1 Literature Study

The first step in the research was a background study of Village Telco and the technology that they have developed. This was done by reading about the technologies on Village Telco's website [1] and on their wiki pages [2].

In addition to reading about Village Telco, literature study has been used throughout the process of writing the thesis. Both the telecommunications industry and framework for business model generation was studied. In addition to this, telecommunication in developing countries has been studied using literature study.

It is important to be critical to the sources found on the Internet. The quality of e.g. papers and articles varies. There are a considerable amount of incorrect information online. People who do not have any knowledge in the field, may have written the literature or the information may be outdated and by this means wrong.

5.2 Questionnaire

In addition to literature study, a questionnaire was sent out to get an overview over the different Village Telco deployments in the world. The questionnaire was sent

[1] www.villagetelco.org
[2] http://wiki.villagetelco.org/

out on Village Telco's mailing list, posted on Village Telco's Facebook page [3]. The questionnaire was also distributed with help from Steve Song[4]. The questionnaire is shown in Appendix F.

The questionnaire was produced in collaboration with Ida Malene Øveråsen and Esther Bloemendaal, who are writing a master's thesis for Village Telco with a more technical perspective.

The idea of the questionnaire was to get an overview of which Village Telcos that exist today, and what their business models look like. Six people connected to six different deployments answered the questionnaire. Some of the deployments are presented in Section 2.2. The results of the questionnaire are not given in the Appendix due to sensitive data and a none disclosure agreement with the respondents.

5.3 Interviews and Skype Meetings

The third method that was used to get knowledge about Village Telco, was interviews and Skype meetings. Especially the two meetings with Stephen Song was helpful in the beginning, to get an overview over the project and the Village Telco community. The interviews also helped form the problem description of this thesis.

Interviews can be time consuming. First of all it takes time to find a time that suits all the participants. Since most of the interviews have been with people living in other time zones, it has been difficult to find a suiting time. This has led to planning, and sometimes meetings have been postponed and even cancelled.

When having interviews it is important to be well prepared, and make good notes during the meetings. It is difficult to document the interviews and use them as citeable references. For this reason the interviews has been mostly used to get an overview over the business, and later documentation have been found on the Internet, in articles or in books.

[3] Village Telco social group - https://www.facebook.com/groups/villagetelco/
[4] Founder of Village Telco

5.4 Modelling Threshold Values

Working with the threshold values was a process with several steps. The steps are presented in Figure 5.1.

Figure 5.1: Process for work with the excel model for calculating threshold values for sustainable business

First, the scenarios were decided and the variables were set up. After this the work with the equations started. The equations started simple, and became more complicated after several reviews. First general equations for all the price strategies were set up. These equations were later adapted to each scenario. This especially accounts for the cost functions, which are different for all scenarios. When the equations were finished, the work with the Excel model started. The equations were implemented in Excel for each scenario. Equations for profit for all price strategies in each scenario were also added to the model.

5.5 Case Study

Figure 5.2: Method used to come up with a new business model for Village Telco

A case study of Village Telco has been performed. First of all the business have been studied as it is today, secondly Village Telco has been looked at for future evolution towards becoming a service provider. The progress of the study is shown in Figure 5.2. First a background study of the business was done. The focus was the technology and how it works. After the technical study, a study of different existing villages and their business models started. This was done with information from the questionnaire (see Section 5.2) and meetings on Skype.

Further Village Telco was studied as a business. Their current business model was drawn up using Osterwalder's business model canvas. Conversations with my supervisor and Stephen Song was helpful to get a good overview over the business.

After the study of Village Telco as it is today, the focus was turned to other existing business models. The focus was businesses that have some common features with Village Telco. For example mobile telcos, Skype and WhatsApp were studied. The last step was to summarise all the findings and start to work with a proposal for a new business model for Village Telco so that they could serve as service provider in addition to selling hardware.

5.6 Brainstorming

In the case study phase, and especially in the phase of coming up with a business model for Village Telco a lot of brainstorming was done. The brainstorming has been the most time consuming period of the master's thesis. To make the brainstorming easier and more structured tools was used. Especially two tools was useful; business model canvas and board of innovation.

5.6.1 Business Model Canvas

The business model canvas is explained in Chapter 3, and shown completely in Appendix B. The business model canvas was used to look at already existing business models in Section 7.2, as well as a tool to brainstorm throughout the work of the thesis.

5.6.2 Board of Innovation

Board of innovation [52] is a tool that makes it easier to look at business models and visualise value exchange in ecosystems. As business model canvas, this tool was used for brainstorming throughout the process. The tool was also used to look at already existing business models to get ideas for Village Telco.

5.7 Summary

The main methods for this thesis have been interviews, case studies, mathematical calculations and brainstorming with business model canvas and board of innovation. There has not been done much research on the field, so the amount of literature is very limited. Nevertheless, there has been done some literature study, especially in the field of business models.

6

Threshold Values for Different Pricing Strategies

This chapter will look into the different pricing strategies that were presented in Chapter 4 for different scenarios. The goal of the chapter is to achieve one of the four objectives of this thesis: "Find threshold values for sustainable business for the villages."

The price strategies are presented in Chapter 4, and are summarised in Table 4.1. Advertising is not presented here, since this price strategy is not best suited for Village Telco at this moment. However, advertising may be combined with all the other price strategies in the future.

The assumptions for the different scenarios and price strategies are presented in Section 6.2. The equations have been simplified to be able to compare the different price strategies.

The following sections aim to calculate threshold values for when the different price strategies are most suitable. For all the scenarios profit will be looked at. Profit, Π, can be calculated using Equation 6.1. For a business to be sustainable, the profit should be greater than zero. In other words, the revenues must be greater than the total costs, as shown in Equation 6.2

$$\Pi = R - C = R - (FC + VC) > 0 \tag{6.1}$$

$$R > FC + VC \tag{6.2}$$

The equations for the price strategies in the different scenarios all look at the amount of customers the service need to be sustainable. All the equations can be turned around to look at the prices instead. This is not done in this thesis.

All the equations for the different scenarios and price strategies are the basis for an Excel model. The model may be used as a tool of the local entrepreneurs, or others that are deploying a Village Telco network, to decide how the revenue streams of the project should be.

6.1 Presentation of the Scenarios

This section will present the four scenarios that will be used for calculations to find threshold values for the different price strategies. Table 6.1 gives a summary of the four scenarios.

Scenario 1: The first scenario is a local network that is not connected to any Internet or telephony operator. Internal calling in the village is the only service provided.

Scenario 2: The second scenario, the local network is connected to a telephony network operator.

Scenario 3: This scenario includes a local network connected to an Internet network operator.

Scenario 4: The last scenario includes a local network connected to both a telephony network operator and an Internet network operator.

Scenario	**Description**
Scenario 1	Internal calling
Scenario 2	Internal calling + connected to Internet network operator
Scenario 3	Internal calling + connected to telephony network operator
Scenario 4	Internal calling + connected to Internet and telephony network operator

Table 6.1: A summary of the scenarios that will be used for calculations in this chapter

6.2 Constraints and Assumptions

There are done several constraints and assumptions to be able to set up expressions for the different scenarios and price strategies. The constraints and assumptions will be presented in this section.

To be able to compare the different price strategies, average values are used for use of the services. More precise expressions for all the price strategies may be found in Appendix E. Freemium is only considered for free internal calling combined with bundling. In Appendix, equations for Freemium with flat rate, usage charging and dynamic pricing is shown for all scenarios.

SMS is not considered for any of the scenarios, since the MPs do not support SMS. If the equations should have been used in conjunction with other technology that support SMS, SMS can be added the same way as external call, but with separate variables for use, price and costs to the operator.

None of the variables can have a negative value, all the variables and constants in the equations in this chapter are positive. For example, it is not possible to have a negative cost or a negative number of users. It is also assumed that the costs to network operators are less than the fee for the customers. In other terms $p_k >= C_k$ for $k = 1, 2, 3$.

The costs are simplified. Maintenance costs are considered a fixed cost. However, it is most likely a cost that will increase with the number of users. The variable costs therefore only consist of the costs to the network operators. The investment costs are not considered. It is assumed that the investment costs are covered by funding and that the costs does not need to be covered by the operation of the network. In the questionnaire(see Section 5.2) that was sent out, four of the six deployments were funded from external organisations. The two other networks were funded by the driving force of the project.

Demand is not considered for the scenarios. However, it is reasonable to believe that the demand is higher for price strategy 5, Freemium, than the other price strategies. The reason for this is network externalities. This does not mean that the price strategy generates higher revenue, since many of the users may only use free internal calls and not generate any revenue. How network externalities affect demand is looked at in Section 4.2.2.

The assumptions that are not applicable for all the scenarios and all the price strategies are explained in the specific section.

6.3 The Variables

Table 6.2 presents the variables that are used in the calculations/expressions in the following sections. The table is divided into sections. First the indexes are presented, then the constants followed by the variables for usage. The third section presents the variables for profit and revenue, the next the costs and the last the prices Village Telco decides. The variables, i, x_i, y_i and z_i are only used in the equations in the appendix.

Variable	**Description**
i	Customer
j	Price strategy
k	Type of service (1=internal call, 2=data, 3=external call)
t	Time period
N	Number of customers
M	Number of paying customers
T	Number of different periods of time
x_i	Number of internal calling minutes for customer i
y_i	Number of Megabytes for customer i
z_i	Number of external calling minutes for customer i
$\bar{x}$	Average use of internal calling minutes per customer
$\bar{y}$	Average use of Megabytes per customer
$\bar{z}$	Average of external calling minutes per customer
$\Pi_{i,j}$	Profit for scenario i, pricing strategy j
R	Revenue
FC	Total fixed costs
VC	Variable costs
C_k	Cost per unit to operator
$p_{k,t}$	Price per unit of type k in time period t.
ic	Fee for subscription for internal calling
ec	Fee for subscription for external calling
b	Fee for bundle subscription
d	Fee for data subscription

Table 6.2: Presentation of the variables used for calculations in this chapter

6.4 Overall Equations for the Scenarios

For all the calculations that follow in this section, the aim is to have a positive profit, Π. To be able to look at the profit, Equation 6.1 and the equation for a given price strategy (presented in Table 4.1) must be combined. The variables used in the equations are presented in Table 6.2 in Section 6.3.

The costs for the different scenarios will vary from scenario to scenario. The cost functions will be presented in Section 6.5.

The price strategies that are dependent on the usage of the users are presented in this section with average values for usage. In Appendix E, mathematical expressions using sums, instead of average values, are presented.

6.4.1 Price Strategy 1

The equation for profit for price strategy 1 is given in Equation 6.3. Π_1 is the profit for price strategy 1.

$$\Pi_1 = N * (ic + ec + d) - C \tag{6.3}$$

To get a positive profit, the number of users must be greater than the costs divided with the subscription fee. This is illustrated in Equation 6.4.

$$N > \frac{C}{ic + ec + d} \tag{6.4}$$

6.4.2 Price Strategy 2

For usage charging the profit is given in Equation 6.5.

$$\Pi_2 = N * [p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}] - C \tag{6.5}$$

Equation 6.6 presents the condition that must be held to gain a positive profit.

$$N > \frac{C}{p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}} \tag{6.6}$$

6.4.3 Price Strategy 3

Π_3 is the profit for price strategy 3, Equation 6.7 is the expression for the profit for dynamic pricing.

$$\Pi_3 = N * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] - C \tag{6.7}$$

Equation 6.8 shows the condition for a positive profit for dynamic pricing.

$$N > \frac{C}{\sum_{t=1}^{T} (p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t})} \tag{6.8}$$

6.4.4 Price Strategy 4

Bundling will be looked at for scenario 2, 3 and 4, where there are more than one service offered. Bundling is in this thesis a flat rate with more than one service. The bundle fee is denoted as b, and is always less than the sum of the prices for the different services. For example $b < ic + ec + d$ for scenario 4. The ic is the subscription fee for internal calling, the ec is the subscription fee for external calling and the d is the subscription fee for data.

Equation 6.9 and Equation 6.10 are the mathematical expressions for bundling. The first equation presents the profit, while the second is the condition that must be held to gain a positive profit.

$$\Pi_4 = N * b - C \tag{6.9}$$

$$N > \frac{C}{b} \tag{6.10}$$

6.4.5 Price Strategy 5

Freemium is only applicable for Scenario 2, 3 and 4. The price strategy will only be looked at in conjunction with free internal call (see Section 4.4.5 on page 48) and bundling. Equations for Freemium with flat rate, usage charging and dynamic pricing are found in Appendix E.

Same equation as for bundling, Equation 6.10, the only difference is that the number of customers, N, is replaced with the number of paying customers, M, where $M <= N$. The equations for bundling are Equation 6.11 and Equation 6.12.

$$\Pi_5 = M * b - C \tag{6.11}$$

$$M > \frac{C}{b} \tag{6.12}$$

6.4.6 Summary

The equations that will be used in the different scenarios that are considered in the following sections, are presented in Table 6.3.

Price strategy 1	$N > \frac{C}{ic+ec+d}$
Price strategy 2	$N > \frac{C}{p_1*\bar{x}+p_2*\bar{y}+p_3*\bar{z}}$
Price strategy 3	$N > \frac{C}{\sum_{t=1}^{T}(p_{1,t}*\bar{x_t}+p_{2,t}*\bar{y_t}+p_{3,t}*\bar{z_t})}$
Price strategy 4	$N > \frac{C}{b}$
Price strategy 5	$M > \frac{C}{b}$

Table 6.3: Summary of the general equations for the price strategies

6.5 Cost Functions

The cost functions vary from scenario to scenario. This section presents the cost functions for the different scenarios. The cost functions will be combined with the equations presented in Table 6.3, this way equations for each price strategy in all the scenarios can be derived.

Scenario 1

For scenario 1, there are no costs to other service providers, only internal calling in the network is possible. The costs for scenario 1 can be calculated by use of Equation 6.13.

$$C = FC + VC = FC \tag{6.13}$$

Scenario 2

The costs for scenario 2 may be calculated using Equation 6.14. For this scenario, costs for external calls must be included in the cost equation.

$$C = FC + N * C_3 * \bar{z} \tag{6.14}$$

Scenario 3

The costs for scenario 3 can be calculated using Equation 6.15. The total costs consist of fixed costs and the costs for data usage from an Internet provider.

$$C = FC + N * C_2 * \bar{y} \tag{6.15}$$

Scenario 4

The costs for Scenario 4 are given in Equation 6.16. The equation includes both costs for external calls and data. .

$$C = FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] \tag{6.16}$$

6.6 Summary of the Equations

The expressions for each price strategy in four different scenarios are summarised in Table 6.4. The N is the number of customers that has subscribed to the service, while M is the number of paying customer that have subscribed when looking at the Freemium price strategy. The other variables that are used in the equations are presented in Table 6.2.

The equations presented in Table 6.4 are the foundation behind the model presented in Section 6.7.

Scenario 1	Price strategy 1	$N > \frac{FC}{ic}$
	Price strategy 2	$N > \frac{FC}{p_1 * \bar{x}}$
	Price strategy 3	$N > \frac{FC}{\sum_{t=1}^{T} p_{1,t} * \bar{x_t}}$
	Price strategy 4	Not applicable
	Price strategy 5	Not applicable
Scenario 2	Price strategy 1	$N > \frac{FC}{ic+ec-C_3 * \bar{z}}$
	Price strategy 2	$N > \frac{FC}{\bar{x} * p_1 + \bar{z} * (p_3 - C_3)}$
	Price strategy 3	$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{3,t} * \bar{z_t}] - C_3 * \bar{z}}$
	Price strategy 4	$N > \frac{FC}{b - C_3 * \bar{z}}$
	Price strategy 5	$M > \frac{FC}{ec - C_3 * \bar{z}}$
Scenario 3	Price strategy 1	$N > \frac{FC}{ic+d-C_2 * \bar{y}}$
	Price strategy 2	$N > \frac{FC}{p_1 * \bar{x} + \bar{y} * (p_2 - C_2)}$
	Price strategy 3	$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t}] - C_2 * \bar{y}}$
	Price strategy 4	$N > \frac{FC}{b - C_2 * \bar{y}}$
	Price strategy 5	$M > \frac{FC}{d - C_2 * \bar{y}}$
Scenario 4	Price strategy 1	$N > \frac{FC}{ic+ec+d-C_2 * \bar{y} - C_3 * \bar{z}}$
	Price strategy 2	$N > \frac{FC}{\bar{x} * p_1 + \bar{y} * (p_2 - C_1) + \bar{z} * (p_3 - C_3)}$
	Price strategy 3	$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] - C_1 * \bar{x} - C_2 * \bar{y}}$
	Price strategy 4	$N > \frac{FC}{b - C_2 * \bar{y} - C_3 * \bar{z}}$
	Price strategy 5	$M > \frac{FC}{b - C_2 * \bar{y} - C_3 * \bar{z}}$

Table 6.4: Summary of the equations found in Chapter 6

6.7 Excel Model

All the equations for the scenarios and price strategies are presented and calculated in Appendix E, and summarised in Table 6.4. From all the equations, an Excel model has been made. The model calculates threshold values for sustainable business for all the scenarios and price strategies. In addition to this, the model calculates the profit. The Excel model may be used by local entrepreneurs that are planning to set up a Village Telco network, or by employees in Village Telco. The model will be presented in this section, and are presented in Appendix E and attached to the master's thesis as a zipped Excel file.

The model is presented in an Excel workbook. The workbook consists of five sheets; 'General data for all scenarios', 'Scenario 1', 'Scenario 2', 'Scenario 3' and 'Scenario 4'. All the sheets are tied together with equations, so it is not possible to use only one of the sheets.

6.7.1 General data for all scenarios

The sheet called 'General data for all scenarios' contains variables that are the same for all the scenarios. This includes fixed costs and costs to other telcos for external calling and access to the Internet. The sheet is shown in Figure 6.1. The data presented in the figure are only test data, and do not contain any real values. This also accounts for Figure 6.2.

I1 fx

	A	B	C
1	**General data for all scenarios**		
2			
3	Costs		
4	Fixed Costs	400	
5			
6	Costs to other telco:		
7	Cost per external calling minute	0,05	
8	Cost per Megabyte	0,05	
9			
10	Other variables		
11	Number of users	100	*Optional*
12	Number of paying users	150	*Optional*
13			

Figure 6.1: The sheet for general data for all the scenarios in the Excel workbook for calculating threshold values for sustainable business

The sheet also contains two optional variables. The number of users and the number of paying customers. These two variables are only used for calculating the profit, and is not needed to calculate the threshold value for number of users. The number of paying users are only used for price strategy 5, Freemium.

The user, for example a local entrepreneur, fills in all the fields in the sheet. The variables are used in calculations in the four other sheets in the Excel workbook.

6.7.2 The scenarios

All the scenarios have their own sheet for calculations. The user provides most of the data, this includes all the fees and prices and the costs. The calculations are done in the grey cells for each price strategy (see e.g. Figure 6.2). The equations presented in Table 6.4 are implemented in the grey cells under 'Number of users for sustainable business'. Under this table, the profits are calculated. To be able to calculate the profits, the 'Number of users' and 'Number of paying users' fields in the sheet 'General data for all scenarios' must be filled in. To achieve a positive profit, these fields must be greater than the threshold values that are found.

The sheet for scenario 1, Figure 6.2, is presented as an example. The sheets for the other scenarios may be found in Appendix E, and are similar to the one for scenario 1 but with other variables.

A26

	A	B	C	D	E	F	G	H	I	J	K	L
1	**SCENARIO 1**											
2												
3	Fees and prices:			Costs								
4	**Subscription fees (flat rate)**			Fixed costs	400			**Number of users for sustainable business (the numbers must be positive):**				
5	Internal calling	10		Variable costs per user	0				Price strategy 1	Price strategy 2	Price strategy 3	
6									Flat rate	Usage charging	Dynamic pricing	
7	**Usage charging**			Estimated use per user per month					40	5	5	
8	Price per internal calling minute	0,2		Number of internal calling mintues	400							
9								**Profit per month (remember to fill in number of users in 'General variables')**				
10	**Dynamic pricing**			Estimations for dynamic pricing:					Price strategy 1	Price strategy 2	Price strategy 3	
11	Price per calling minute, period 1	0,1		Number of internal calling minutes period 1	100				Flat rate	Usage charging	Dynamic pricing	
12	Price per calling minute, period 2	0,2		Number of internal calling minutes period 2	200				600	7600	7600	
13	Price per calling minute, period 3	0,3		Number of internal calling minutes period 3	100							
14												
15	**Bundling**											
16	Not applicable											
17												
18	**Freemium**											
19	Not applicable											

Figure 6.2: Excel sheet for scenario 1

6.8 Summary

This chapter has presented the results for the threshold values. Equations to calculate threshold values for each price strategy in four scenarios have been set up. The equations are presented in Table 6.4.

The equations are the basis for an Excel model that has been set up. The model may be used by local entrepreneurs to help them decide what price strategy to use. The model is simplified, and in some cases, the model must be customised to fit a specific Village Telco project. However, the model gives the entrepreneurs a basic tool that may be helpful to decide how the project's revenue streams should be.

7

Village Telco

This chapter will present Village Telco's current business model as a hardware provider. By looking at business models for other companies, it will be investigated how Village Telco can bundle their services and evolve into a service provider as well as selling hardware.

7.1 Business Model of Village Telco

This section will present Village Telco's business model as it is today. The business model are summarised in Figure 7.1 as a business model canvas in Section 7.1.

7.1.1 Customer Segments

Village Telco's customer segments are local entrepreneurs and NGOs. They buy the MPs for a village, and sets up and maintains the network themselves.

7.1.2 Value Propositions

A simple and low-cost solution for telephony and Internet over Wi-Fi, namely the MP is Village Telco's value proposition.

7.1.3 Channels

Village Telco reach their customer's through the Internet; their webpage, a group on Facebook and several mailing lists. In addition to a webpage, Village Telco has put together a wiki with useful information about, for example, the hardware, software and Village Telco projects around the world. The wiki also provides user guides.

7.1.4 Customer Relationships

Village Telco works as a community. The channels presented in Section 7.1 makes it easy to ask questions and get answers from either one of the developers/hardware designers connected to Village Telco, or another entrepreneur that have experienced the same problem. Village Telco is a network, where the business is the central node connecting all its customers with each other.

Village Telco also provides delivering of the MPs and an online store[1] to make purchases easy for the customers. The customers make a purchase online and Village Telco sends the order to a given address.

7.1.5 Revenue Streams

The revenue of Village Telco comes from selling hardware to local entrepreneurs and NGOs. The customers can buy MPs and other equipment that may be necessary to set up a network, for example solar panel kits. The MP02 is sold for $39.

7.1.6 Key Resources

There are two main resources, namely design programmers and marketing. The design programmers work to improve the MP further. Marketing is essential to be known on the market.

7.1.7 Key Activities

This building block is strongly related to key resources. Village Telco's key activities is to improve and design new features, and marketing.

7.1.8 Key Partnerships

Village Telco is driven by core volunteers. The volunteers contribute with for example ideas for further development of Village Telco and knowledge about the technologies in use.

In addition to the volunteer community, they also partner with SwitchVoice[2] Ltd. and Dragino[3] Technology Co. SwitchVoice is a company that contributes with hardware and software developers for the MP, while Dragino produces the MP02. Dragino is

[1] http://store.villagetelco.com/
[2] http://switchvoice.com/
[3] www.dragino.com

located in China, and are specialists in product design, developing and manufacturing. They are focused on the telecom field[53]. Village Telco pays $30 per MP02.

7.1.9 Cost Structure

As mentioned in Section 7.1 the business is driven by volunteers. These volunteers are not paid. This means that Village Telco does not have any salary costs. This is an important factor for Village Telco and its' development.

The production costs are $30 per MP. This gives a margin per MP of about $9.

7.1.10 Summary Village Telco Business Model

This section summarise Village Telco's business model in a business model canvas in Figure 7.1.

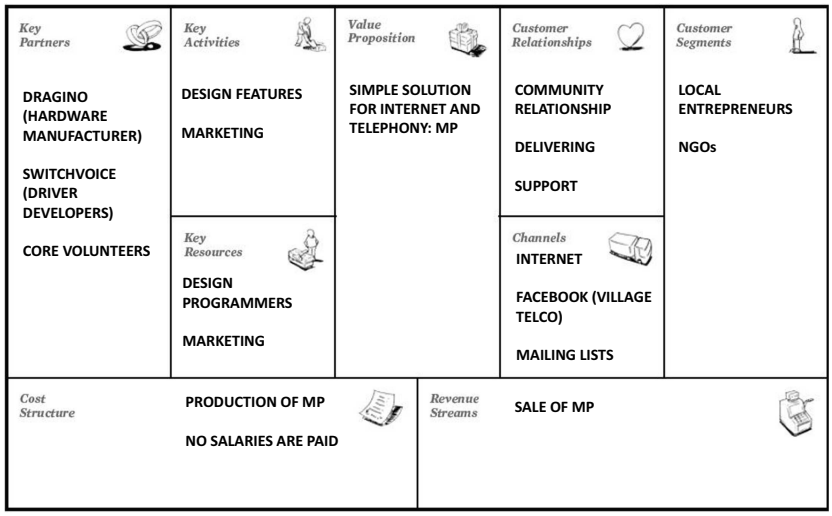

Figure 7.1: Village Telco business model canvas

7.2 Ideas From Existing Business Models

This section will present different existing business models, and look at what Village Telco can learn from the businesses. The business models are presented using Osterwalder's business model canvas as explained in Section 5.6.1. The focus has been on businesses that are similar to Village Telco. The different business models was used in the brainstorming process for Village Telco as a service provider.

7.2.1 Mobile Telco

The mobile telecommunication companies' business models have changed over the last years. They have started to unbundle their businesses [43]. Figure 7.2 shows the traditional business model for a mobile telco.

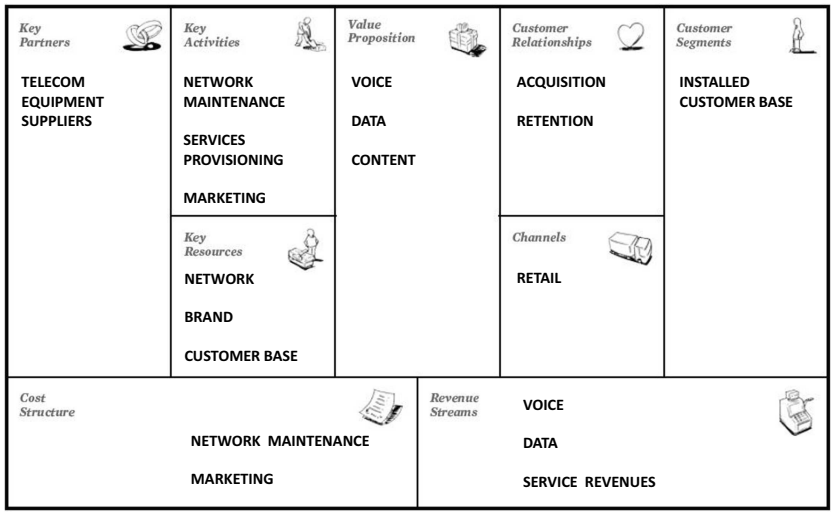

Figure 7.2: Mobile telco business model canvas [43]

Traditionally the telcos competed on network quality and coverage. Now they have realised that their key asset has changed to their brand and their customer relationships. Nowadays the telcos have network sharing deals with their competitors and outsource network operations to equipment manufacturers [43].

The traditional mobile telecommunication business model can be unbundled into three separate business models, namely equipment manufacturers, unbundled telco and content providers. These business models are illustrated, with help of business model canvas, in Appendix D.

The main results after unbundling are:

1. The unbundled telco can focus on its core competence, namely customer relationships.
2. An equipment manufacturer benefits from economies of scale, since it can serve several telcos at a time and therefore run the networks at lower cost than the traditional telco.
3. Innovation. Content providers can concentrate on supply of new services and media content (games, video and music).

Unbundled Telco: After the unbundling, the telcos have focused on the customer relationships, which has become the key asset and its core business. Bharti Airtel in India was one of the first telcos in the world to unbundle their business [43]. They are now one of India's leading telcos. They turned their focus to their core competency namely building customer relationships. To make this possible, they outsourced the network operations to Ericsson and Nokia Siemens Networks and infrastructure to IBM.

Figure 7.3, illustrates a simplified business model for the unbundled telcos. Business model canvases for equipment manufacturer and content provider are shown in Appendix D.

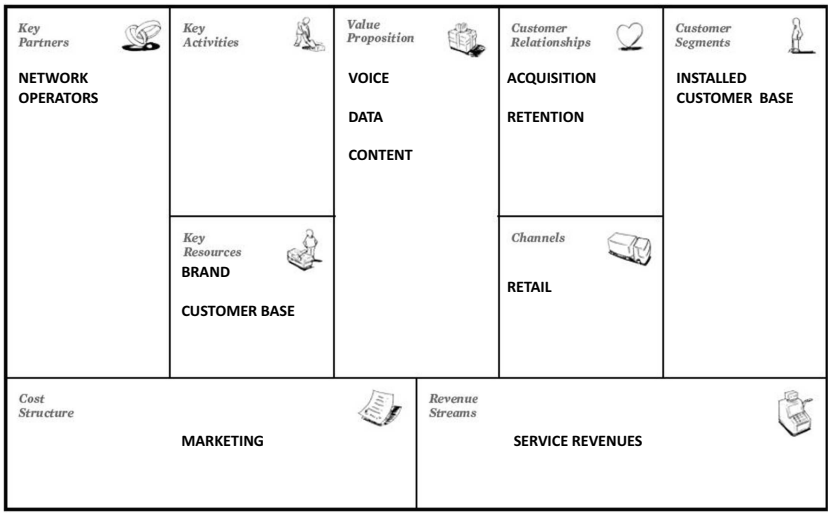

Figure 7.3: Unbundled telco business model canvas [43]

Ideas for Village Telco

Customer Relationship: Village Telco has to establish a good customer relationship to be able to compete with the unbundled telco. As explained in Section 7.1, this is one of the key attributes Village Telco has today with its existing customers. However, it is important to note that the number of customers will increase, in addition to a new customer segment that will acquire another type of customer relationship than the customer relationships that already exist in the business.

Office in the Village: A Village Telco network needs maintenance. To be able to do this, Village Telco may open an office in each village they deploy a network. The office may have one or more employees that have had training in the technologies that Village Telco use. Most of the customers in the villages are new to the technologies, and may never have used a regular telephone. This makes it important for them to have access to people that have technical training, and that can fix technical problems that may occur. The office can also contribute to a good customer relationship.

7.2.2 Skype

Skype[4] offers free calling services via Internet. Skype also allows you to call regular phones (landlines and mobile phones) if you pay a small fee. This service is called SkypeOut. To be able to use SkypeOut, you either charge your account with an amount or you have a subscription. The users are charged only slightly more than the termination costs Skype incurs for calls routed through other telecommunication networks.

Figure 7.4 shows Skype's business model. Skype has two user groups, namely web users and those who want to call phones and pay for it. Skype has a big mass of users, with over 280 million registered users in 2013[54]. Only 10% of the total usage is paid SkypeOut calls, while 90% just sign up for the free service. Skype's price strategy is an example of Freemium.

Even though 90% of the users do not pay for use of the service, Skype reported a revenue of $550M in 2008[55].

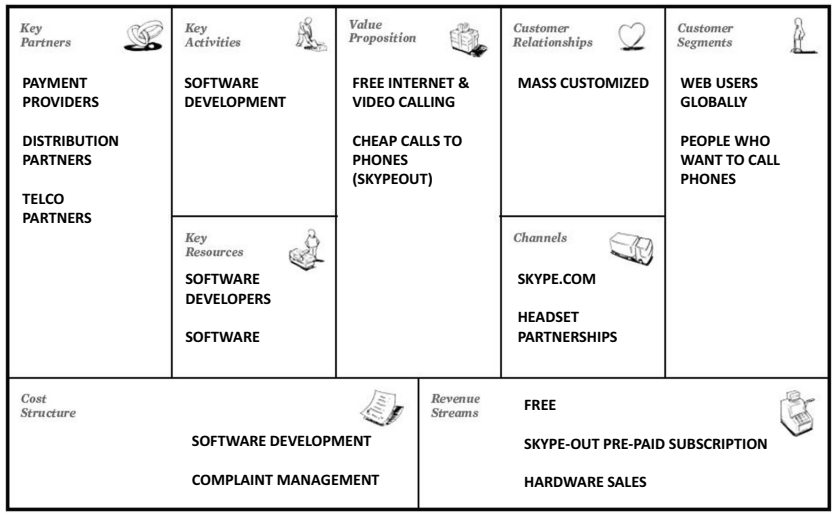

Figure 7.4: Skype business model canvas [43]

[4]www.skype.com

Skype Versus Telco

Figure 7.5 compares Skype with a regular telco. Skype is a voice calling service company operating under the economics of a software company [43].

The main differences between a regular telco and Skype are:

- More outsourcing
- No need for infrastructure and network maintenance
- Software development
- Cost structure of a software company (e.g. low marginal costs)
- Greater user mass

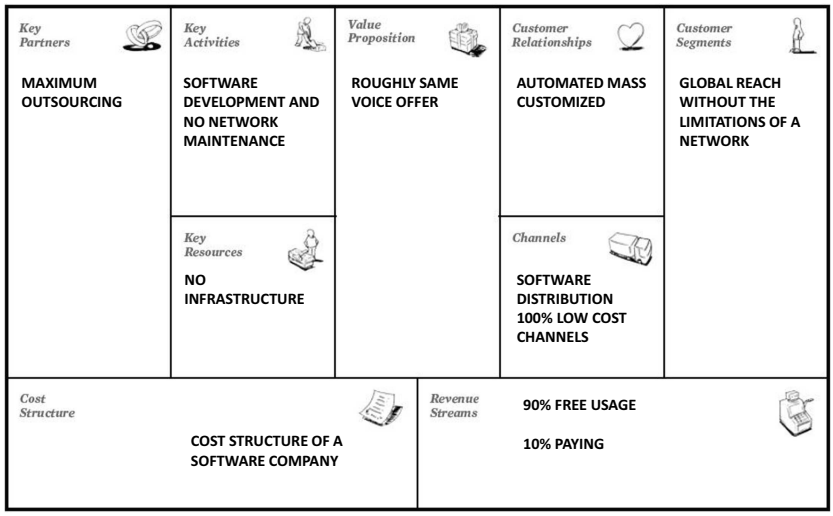

Figure 7.5: Comparison of Skype versus telco business model canvas [43]

Skype has managed to drive the voice communication costs close to zero. This made Skype attractive, and they managed to attract customers. More and more

people wanted to make their international calls with use of Skype instead of traditional telephony. Skype is today the world's largest provider of cross-border voice communication services. This is an important and lucrative carrier revenue source.

Ideas for Village Telco

Free Internal Calls: As Skype, Village Telco can offer a free service in addition to a service that costs money as Skype's SkypeOut. Village Telco can offer free internal call in the village or in the Village Telco network. In addition to the free internal calls, they can offer external calls for a fee. This price strategy is looked at in Chapter 6, under price strategy 5, Freemium with Bundling.

Economies of Scale: Village Telco has many similarities to SkypeOut, especially connected to the Internet where it works as a VoIP service. A Village Telco network has some infrastructure. The infrastructure is simple compared with the infrastructure of an Internet or cellular provider. Village Telco is dependent on connection with another service provider to be able to give the customers the same type of service as Skype does. If Village Telco becomes a service provider, they will most likely serve more customers than the local entrepreneurs do today. Village Telco can therefore benefit from the economies of scale. They can make agreements with both Internet service providers and cellular service providers with good prices for termination in their networks.

Hardware Sales: Village Telco will still sell hardware after becoming a service provider. They might even broaden their hardware selection. Mobile phones, analogue phones can be ideas for what hardware they can sell.

7.2.3 Bait & Hook: Free Mobile Phones

Bait & Hook's business model is shown in Figure 7.6. In this thesis the Bait & Hook business model is illustrated from a telecommunication point of view. The business model is based on an attractive initial offer that encourages continuing future purchases of related services or products. The initial offer helps the company to establish a great number of customers. In this example, the initial offer is a free mobile phone, which can be an idea for the business model of Village Telco.

The business model is an example of a combination of Freemium and subscription with either flat rate or usage charging. This type of business model is also known as "loss leader", which refers to a subsidised initial offer. The initial offer may even be money losing. The intention of the offer is to generate profits from later purchases.

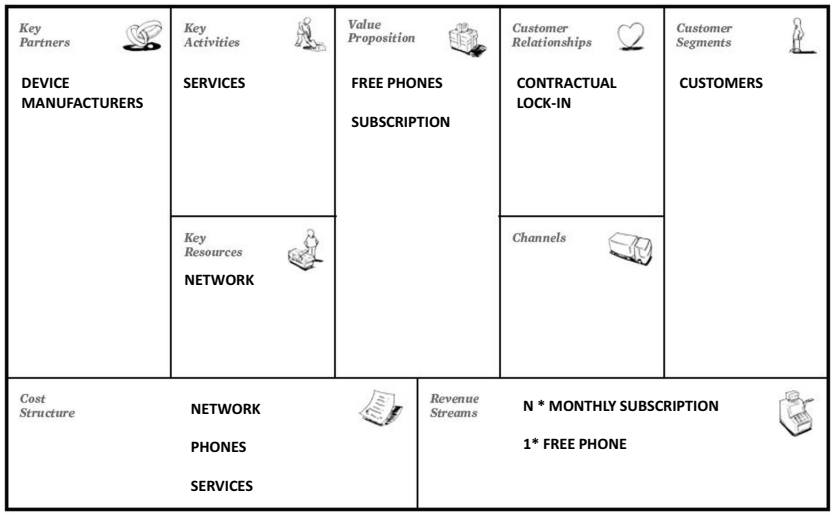

Figure 7.6: Bait & Hook business model canvas [43]

Ideas for Village Telco

Free Telephone: Village Telco may offer a free telephone. The cost for the telephone can be covered by down payments included in the subscription fee. The free phone will enable more people to subscribe to the services provided by Village Telco.

7.2.4 WhatsApp

WhatsApp's[5] business model is based on free use the first year, and the main aim is to connect people not make money. After the first year, the users pay $0.99 for a year subscription. In the beginning of 2014, WhatsApp had 450 million customers[56].

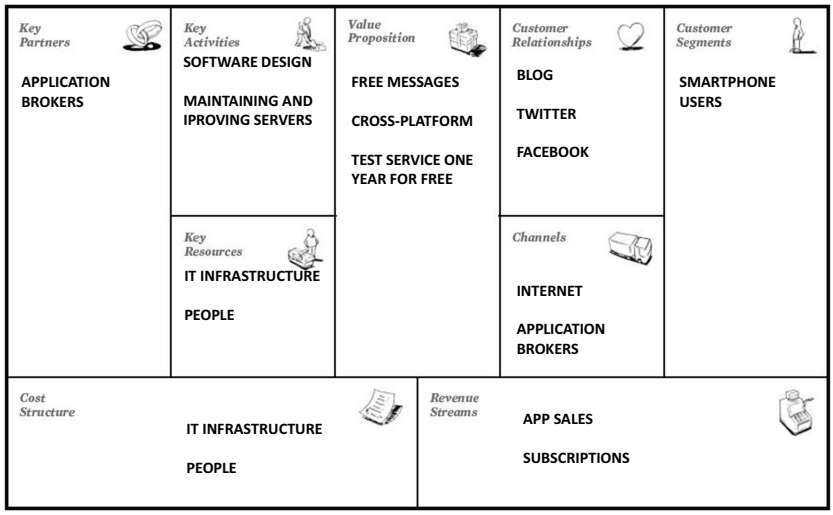

Figure 7.7: WhatsApp business model canvas

Ideas for Village Telco

Free Trial Period: From WhatsApp Village Telco can bring the free trial period. A trial period can make users attached to a service they were sceptical to make use of. As explained in Section 4.4.5, this initiative can make the willingness-to-pay of the user increase. The service can become more attractive for the user after a trial period.

7.2.5 Other Services and Ideas

Information Services

In addition to offering telephony and Internet access, Village Telco may offer some other services. Information availability is key in developing countries[57]. An idea for

[5]Mobile application for multiple mobile platforms for sending messages over IP

Village Telco is to offer an easy way to access important information. For example weather forecast when calling #1, or information about where to sell and how much to charge vegetables on #2. Different services for different keys on the telephone is a possibility.

Internet Café

If Village Telco decides to set up an office in each village, as proposed in Section 7.2.1, Village Telco may combine this office with a simple Internet café. This way Village Telco can reach out to those who cannot afford their own equipment, but have some money to spend on telecommunication services. The Internet café may need one or two extra employees, which result in extra costs.

The Internet café can use all the price strategies presented in earlier chapters. Especially dynamic pricing may be a good fit. This will enable more people to make use of the service. It may also ensure use throughout the day, not only in the most popular hours.

Mobile Banking

Only a small part of the developing world has access to banks or bank accounts. Mobile banking is becoming a popular alternative in developing countries. However, mobile banking is a complex service that requires special software and systems. If Village Telco wants to offer this service, the software and systems for this must be developed or acquired from a provider. The investment costs for this must be looked at closely, and calculations must be done to see if the investment can be covered through more use.

7.3 Village Telco Service Provider Business Model

This section will look into how Village Telco may become a service provider and how their business model must evolve to achieve this. Ideas from the previous section, Section 7.2, will be combined with Village Telco's business model as it is today (presented in Section 7.1).

7.3.1 Customer Segments

There will be a new customer segment, namely the subscribers to the services provided. The subscribers will be the inhabitants of the villages where Village Telco establishes a Village Telco network.

7.3.2 Value Propositions

Village Telco will, in addition to selling hardware, provide services, which are of value for the customers. The services may be a combination of internal calling within the villages, external calling to the rest of the country/world, access to the Internet or all of the aforementioned. The availability of these services will be restricted by infrastructure available to the village.

7.3.3 Channels

The channels for Village Telco as a service provider can be the same as they are today, as explained in Section 7.1. New channels may be added in the future. An example of new a channel can be an office in the village, which employs one or more employees that provides helpdesk services to the customers.

7.3.4 Customer Relationships

As mentioned in section 7.2.1, it is important for a telco to establish a good customer relationship. This can be done through some of the channels Village Telco use today. A close and personal relationship can be established by opening an office in the village. The office does not need to be open 24-hours, but in the time periods that it is most likely that customer will visit the office. When the office is not open, it is important to have additional support services available, such as support over e-mail or telephone. Good user manuals should also be distributed.

To be able to have a good customer relationship over time, an employee living in the village is essential. Since the inhabitants of the villages are likely to lack experience with telecommunications services, a Village Telco employee with good training is important. This is important in case of failures in the network or if the users experience trouble with their equipment.

7.3.5 Revenue Streams

The revenue will come from the subscribers using the services. The services may be priced using one or more of the price strategies that were presented in Chapter 4 and studied in Chapter 6. The excel model can be helpful in the process for deciding which price strategy to use.

Free Internal Calling: Free internal calling may lead to a faster increase of the network in the beginning. This type of price discrimination will lead to that the service is a possibility for more people, as explained in Section 4.3. The free use of the service in the beginning may also lead to that the users gain a higher willingness-to-pay for the service and after a while upgrade their subscription, this is described in Section 4.4.5. The higher number of users in the network will also attract more users, since the value of the service increases with the number of subscribers (see Section 4.2.2).

Free Telephone: A free telephone may have some effects as free internal service. This will lead to that more people have the opportunity to subscribe to the service. An example of how the telephone may be repaid through an extra fee in the subscription is shown in Table 7.1. The example is based on an analogue telephone that costs $10 on Amazon[58].

Number of months	Monthly extra fee
3	$3.33
6	$1.67
9	$1.11
12	$0.83
24	$0.42

Table 7.1: Down payment on free telephone

Internet Café: An Internet café can contribute to extra revenue streams for Village Telco. If an office is opened for support and services for the customers, it is relatively easy to set up a simple Internet Café. This service may be priced using dynamic pricing as described in Section 4.4.3.

7.3.6 Key Resources

The main new resource Village Telco has after becoming a service provider, is a relatively simple telecommunications network compared to other telcos.

7.3.7 Key Activities

A key activity will be support and maintenance of the networks. The support may be done by opening an office in each of the villages. Technical skilled people may be employed to maintain the network.

7.3.8 Key Partnerships

An additional partner are added after Village Telco becomes a service provider, namely other telcos. The telcos makes it possible for Village Telco to provide external calling and/or access to the Internet.

7.3.9 Cost Structure

The additional costs after becoming a service provider for Village Telco are:

- Maintenance costs
- Termination costs[6]
- Salaries to employees in the offices

Maintenance costs: Village Telco must maintain the networks they deploy. The local entrepreneurs that deploy the networks today cover these costs.

Termination costs: If the network is connected to either a mobile cellular operator or an Internet operator, Village Telco must pay termination costs. Village Telco can benefit from economies of scale, and obtain good agreements with the telcos.

Salaries: If Village Telco decides to have an office in each village; they must pay salaries to the employees. For the community it is positive that new work places are established, and this increases the social welfare in the villages in addition to increasing the costs for Village Telco.

[6]Termination costs are the costs the telecommunications operator charges to Village Telco for terminating calls on its network

7.3.10 Summary and Evaluation of Proposed Business Model

This chapter has presented several ideas for services that Village Telco can provide if they decides to become a service provider. Figure 7.8 wraps up the proposed business model.

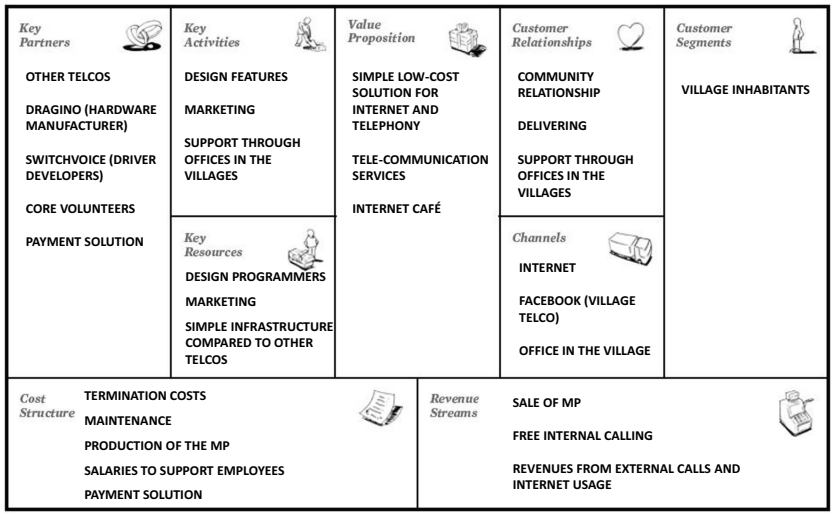

Figure 7.8: Proposed business model for Village Telco to become a service provider

The proposed business model can even be simplified and include less of the ideas presented in this chapter. The most important new parts of the proposed business model are customer relationship and partnering with other telcos.

The customer relationship factor can, as previously mentioned, be covered by opening offices in the villages. Such offices can also serve other needs such as marketing, customer support, Internet cafés and point of sales. Opening of offices will an initial and possible recurring investment in office spaces. Opening of offices will also lead to another cost, namely salaries to the employees. However, these costs are not necessarily high due to low average incomes in developing countries. The offices can have limited opening hours to reduce costs. However, this may not desirable since it can have a negative effect on the customer relationship. The costs should be calculated and looked at carefully, and is not done in this thesis.

Partnering with other telcos is crucial for Village Telco to be able to provide the customers with external telephony and Internet access. Agreements with other telcos can give Village Telco discounts if the user mass is great. Compared with the today's local entrepreneurs that maintains Village Telco networks, Village Telco as a service provider has a greater chance to obtain good deals with the telcos and benefit from economies of scale.

Part IV

Conclusion and Further Work

8

Conclusion and Further Work

8.1 Conclusion

The master's thesis has studied Village Telco as a business, and a new business model has been proposed. In addition to this, mathematical expressions for threshold values for sustainable business in the villages have been set up, and an Excel model has been implemented.

A background study of the business has been performed. The technology Village Telco uses has been briefly explained in the second chapter of the thesis. Further, a framework for drawing up business models, Osterwalder's business model canvas, has been presented and used in the later chapters.

Chapter 6 presents equations for calculating threshold values for sustainable businesses. The equations are, as mentioned, simplified. The Excel model can be helpful for new villages to decide how the revenue streams for the business should be. The Excel model can be a helpful basis for a more complex service for the local entrepreneurs in the future.

In Chapter 7, a new business model, for evolving Village Telco into becoming a service provider, is proposed. Several existing business models are presented and several ideas for Village Telco are shown and discussed. The studies of other business models shows that customer relationships and partnering with other telcos are the two most important aspects to consider for Village Telco as a service provider. Other factors are optional, and there are many possible combinations of solutions for how Village Telco can serve as service provider and which services they may provide.

8.2 Further Work

There are several topics that can be looked at further. This chapter presents three ideas for further work.

First of all, it is possible to study Village Telco on a more detailed level. Case studies of existing villages can be conducted. An idea is to visit one village and also get more detailed information about the economics and further make calculations on the business. What can be done better, what price strategy fits best and a more innovative look at the deployments.

The results presented in chapter 6, can be looked at further. The equations can be more complex and contain some of the constraints and assumptions that are presented in the chapter. An idea is to look at the investment costs, and how these can be covered. A question that may be answered are for example: How long does it take before the business is sustainable? The model, or a more complex one, can even be made as a service that people in the Village Telco community can access online.

Another suggestion for the threshold values is to set up a simulation of the different scenarios and price strategies. The simulation may help to see in which cases the different price strategies are favourable.

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Part V

Appendices

A

Technology

This chapter in the appendix is written in cooperation with Ida Malene Øveråsen and Esther Bloemendaal, two fellow students at NTNU, that also write their thesis in collaboration with Village Telco.

A.1 Relevant Technologies

This section will go through some of the most relevant technologies used to develop and run the Mesh Potatoes. In order to understand how the Mesh Potato works, it is important to have a certain knowledge about the underlying technology.

A.1.1 OpenWrt

OpenWrt is an embedded open-source operating system for routers distributed by Linux [59]. It is extensible and can easily be modified to suit any application, since it offers a file system with a package manager. OpenWrt provides (1) Free and open-source, (2) Easy and free access, and are (3) Community Driven [59]. This means that the source code is free and available to everyone, and that everyone has the opportunity to contribute to it.

A.1.2 Telnet and SSH

Telnet is a TCP/IP protocol that enables the opportunity to remotely connect to a computer/device. In order to do this, telnet client software is necessary. The client becomes a virtual terminal, and through command line prompt one can remotely work with files and data [60].

Secure Shell (SSH) offers the same services as telnet, but is a more secure alternative. With SSH all data sent to and from the server is encrypted [61].

A.1.3 Mobile Ad Hoc Networks

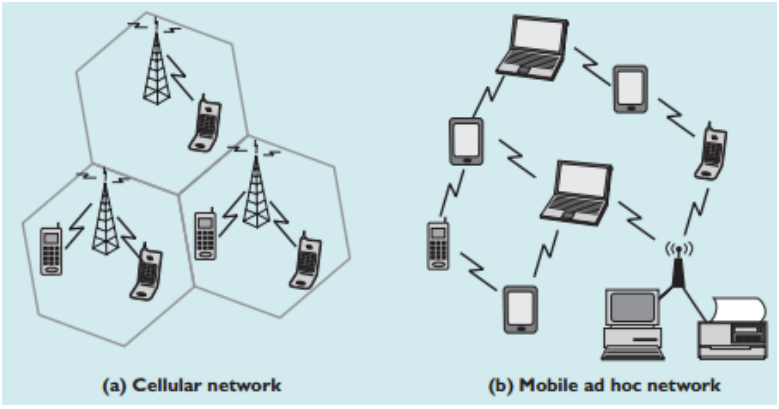


Figure A.1: Cellular network vs. MANET. This figure illustrates the difference between a regular cellular network and a mobile ad hoc network [62].

Mobile Ad-hoc Networks (MANETs) are networks that do not rely on an underlying and fixed infrastructure (access points and routers), in other words "infrastructure-less". MANETs acts in a shared wireless media [63]. The structure of these networks change dynamically. Key factors describing MANETs is self-configuration, self-organization, self-discovery, and self-healing [64]. The members of the network are mobile and free to join, or leave, the network at any time [62]. MANETs are based on multi-hop forwarding. Each node acts not only as a host, but also as a router. The nodes themselves establish and maintain routes, and forward packets to other nodes if necessary. This enables communication between nodes that are originally not within each other's range [62]. MANETs are suited for use in situations where there are no fixed underlying infrastructure. A MANET can operate as a stand-alone solution, but can also be attached to the Internet.

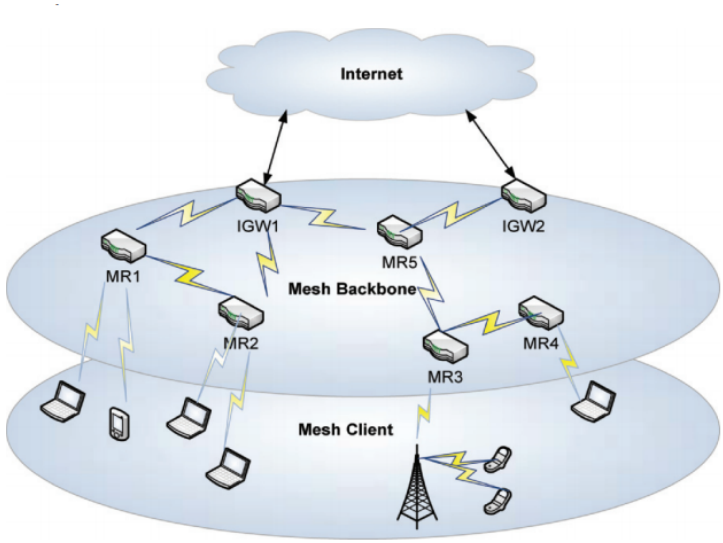


Figure A.2: Example of a Wireless Mesh Network. This figure illustrates the architecture of a typical WMN [64].

A.1.4 Wireless Mesh Networks

A Wireless Mesh Networks (WMN) is a type of MANET [64]. The objective of a WMN is to serve a larger number of users with high bandwidth access. As mentioned before, MANETs are "infrastructure-less" and they have self-configuration, self-organizing, self-healing and self-discovering features. WMNs share all these characteristics, except from the infrastructure part. WMNs are often a collection of routers called Mesh Routers (MR). These MR are usually stationary. The MR can be employed for different use. One MR could for example be connected via cable to Internet, and then become an Internet gateway. Then this MR can provide Internet connectivity to the other MR in the mesh network. A wireless mesh network consists of two parts; the backbone of the mesh (the MR) and the clients of the mesh [64]. An example of a WMN architecture is shown in Figure A.2.

A.1.5 Routing Protocols

Ad hoc networks and mesh networks creates several challenges when it comes to routing protocols. The routing protocols must be able to adapt quickly due to the topology changes. Figure A.3 shows the different groups of the ad hoc protocols that exist. It is important that a routing protocol do not cause excessive overhead (extensive use of computer resources). Under the category flat routing, there are two types of routing protocols; proactive and reactive. *Proactive routing protocols* (e.g. OLSR) are table driven [65]. Every network node has a routing table for forwarding

of data. To obtain stability, each node broadcasts and modifies the routing table periodically. Proactive routing protocols are suitable when there are few nodes in the network. The routing table is periodically updated, hence the overhead exceeds the desired value when there are a high number of nodes in the network. In contrary to the proactive routing protocols, *reactive routing protocols* (e.g. AODV) are on demand. Since they are on demand, the overhead is significantly lower. These protocols utilize flooding. The network is flooded with the route request (RREQ) in order to set up the route. The reactive routing protocols do not have a up-to-date routing table like proactive routing protocols [65]. Routes are only set up to nodes they communicate with, and these routes are only kept alive while they are needed [62]. As shown in Figure A.3, there are several different protocols under proactive and reactive.

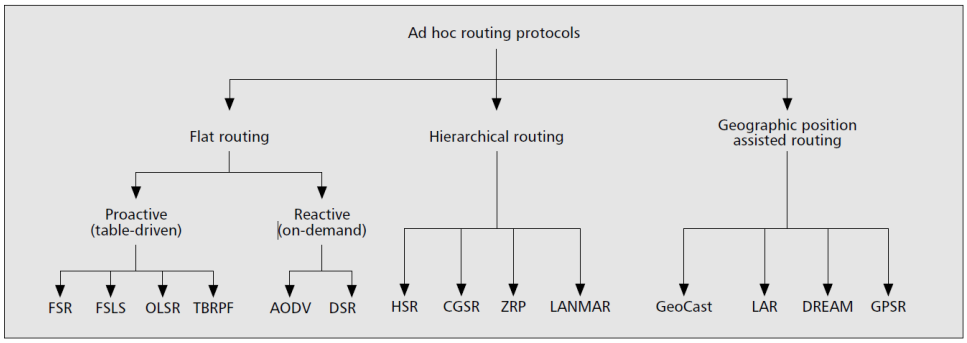


Figure A.3: Different groups of ad hoc routing protocols [63].

A.1.6 B.A.T.M.A.N

Better Approach To Mobile Adhoc Networking (B.A.T.M.A.N.) is the routing protocol utilized in the networks formed by the MPs. B.A.T.M.A.N. is a proactive routing protocol for wireless ad hoc networks. This includes MANETs [66]. This protocol was developed as an alternative to Optimized Link State Routing Protocol (OLSR) [67]. Like mentioned before, routing protocols must be able to adapt quickly to topology changes. B.A.T.M.A.N was made to be a more efficient routing protocol in this area, since it employs a new method for discovering routes. The nodes in the network broadcasts a OGM periodically, like shown in Figure A.4. A OGM is a Originator Message which contains:

- The address of the node
- Sequence number
- Time To Live (TTL)

The address and the sequence number enables identification of a packet and duplicate detection.

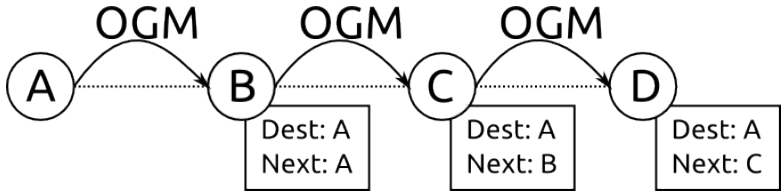


Figure A.4: Originator Message used in B.A.T.M.A.N [67].

Information about the nodes that are accessible via single-hop or multi-hop are maintained and updated [66]. Every node updates its routing table each time it receives an OGM. The routing table includes information about [67]:

- **Originator Address:** This is the source address of the node that sent the OGM.
- **Current Sequence Number:** The sequence number of the last OGM. This is used to discover if there are any duplicates or any information that is outdated.
- **Sliding Window:** A list of sequence numbers that is stored for each originator and each previous hop, i.e. for the neighbour node that forwarded or originated the OGM, as shown in Figure A.4. This is used to decide which next hop is best for each destination.

When a node receives an OGM it will decrease the TTL, and then forward it to the neighbour nodes. The same OGM can arrive to a node, but from different paths. In this case, only the first copy is preserved.

Simple Unified Dashboard for mesh networks

Simple Unified Dashboard (SPUD) for mesh networks is a tool for visualization made for B.A.T.M.A.N. mesh networks, and for the users of the networks [68]. SPUD is, like the name indicates, a dashboard based on PHP which is designed to be simple. It communicates with the B.A.T.M.A.N. visualization server. The dashboard makes it possible to monitor the link status of the networks, by displaying real time wireless link status. Other features are client management and customization. The software is written in CakePHP and for visualization SPUD uses Google Maps API 1.3 [68].

A.2 Up-Links

Our main focus when deploying the emergency box, is to provide Internet to the mesh network. This because it is crucial to have the possibility to communicate with the local community and the outside world during an emergency situation. In 2011, UN declared Internet access a human right [69]. This says something about the extent of the Internet, and the importance of connectivity. In order to provide Internet to the mesh network formed by the emergency boxes, at least on the Mesh Potatoes must be connected to an access network via an uplink. An uplink connects a device or a LAN to a larger network [70]. Which type of access network that is available depends of the location. Some places there might exist a stable landline, other places not. Then an option could be to use satellite or cellular networks. It is therefore important that the emergency box has high adaptability in order to fit different scenarios. The availability of the different uplinks is not the only thing that vary. The up-link speed and the price also varies from place to place, and between the types of uplinks. In the following sections, some of the uplinks available will be looked at, and how Internet access can be provided to the mesh network.

A.2.1 Internet via Telephone-line

The most common way of getting Internet access is via a landline. The telephone lines are most often used for this, since they can be converted to broadband. In this way it can be used for phone calls and Internet simultaneously [71]. The line is usually in the form of twisted pairs (copper lines). These lines support broadband up to 10 Mbps, and are often in form of ADSL, or other digital subscriber line of type x (xDSL) technologies [72]. Internet via telephone lines can be provided as a stand-alone solution, or it can be provided together with television or/and phone service. The latter option is usually cheaper. Internet through landlines have a high reliability [73] in comparison to satellite and cellular network. Now, some technologies for getting Internet access via a telephone line will be briefly described; dial-up Internet connection, ISDN, and DSL. Although dial-up Internet connection is practically extinct in developed countries, it will be included here due to the different application scenarios for the emergency box that Ida Malene Øveråsen and Esther Bloemendaal are looking at in their thesis.

Dial-up Internet connection

Dial-up is an analogue technology that utilizes the telephone line. A telephone wall jack is used as a fixed point of connection, and the computer is connected to a voiceband modem. With this technology, the data is transmitted over the same frequencies used for phone calls. Hence, if you only have one telephone line, you cannot take a phone call and use Internet at the same time [74]. The absolute maximum speed is 56 Kilobits per second (Kbps). Along with the digital era, better

Internet technologies were introduced; Integrated Services Digital Network (ISDN) and Digital Subscriber Line (DSL).

ISDN

ISDN is a fixed Internet connection, which also utilizes the telephone lines. When using ISDN, as with dial-up, a telephone wall jack is used as a fixed point of connection. But ISDN utilizes a ISDN terminal adapter instead of voiceband modem. This ISDN terminal adapter sends out digital signals. The data speed varies between 64 Kbps - 129 Kbps. The speed of the data is symmetric, which means upstream and downstream data rates are the same. In contrary to dial-up, ISDN allows voice calls and transmission of data simultaneously. ISDN is faster than dial-up, but the speed is nothing compared to the speed obtained using DSL [74].

DSL

DSL is, like the name indicates, a digital high-speed technology for Internet access that allows simultaneous voice and data transfer. Like dial-up and ISDN, DSL also run over the telephone lines. With DSL the data is not converted between analogue and digital signals. Despite this, the signals are modulated in order to be transferred on non-voice frequencies. DSL is an always-on technology, and in this way differ from the previous technologies mentioned. Only a small part of the telephone line is used for voice signals. The DSL technology allows utilization of a unused frequency spectrum of a telephone line, hence making it possible to transmit data faster. When the voice and data signals arrive at the telephone company's local switching station, they are separated and routed differently; voice to regular telephone system and data to the ISP, and then the Internet. A connection must be within approximately 5 kilometres of a station in order for DSL to work. The speed depends on many factors. Data can be transported up to 6 Mbps (distance of approximately 2 kilometres). Relevant factors that have an impact on the speed is distance to the switching station, and the quality of the telephone line. Like mentioned earlier, there are different types of DSLs. The most common is Asymmetric Digital Subscriber Line (ADSL), where the A stands for asymmetric; the downstream speed is faster than the upstream speed [74].

A.2.2 Cellular Network Technologies

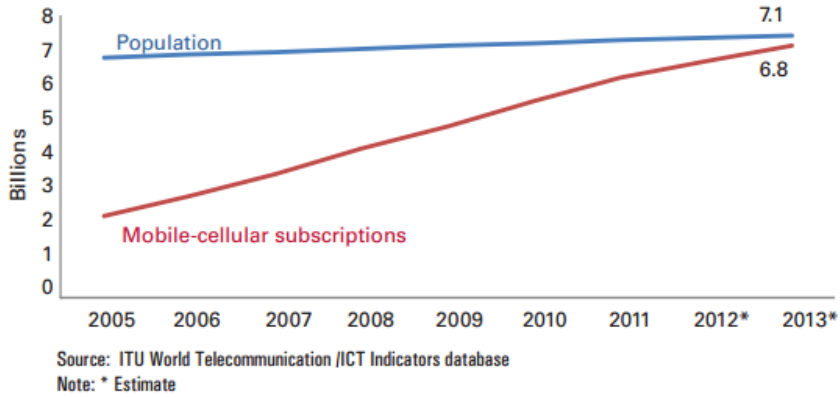


Figure A.5: Number of mobile-cellular subscriptions The figure shows that the growth of mobile-cellular subscriptions have increased drastically during the last decade, and show that there are almost as many as there are people in the world [75].

It is getting more and more common to use cellular technologies for broadband. Around 2011 the number of mobile-broadband subscriptions grew to twice as many as the number of fixed-broadband subscriptions. In developed countries it is common to have a fixed-broadband connection, and use a mobile-broadband network in addition to the fixed. In developing countries on the other hand, it is not a given that there is access to a fixed-broadband connection. Then mobile-broadband can be the only method of access available. In 2011, 90 % of the world's population had Second Generation (mobile communications) (2G) coverage, and 45 % had Third Generation (mobile communications) (3G) coverage [76]. By 2013, the number of mobile-cellular subscriptions had reached a high level, and were approaching the number of people in the world, like shown in Figure A.5. From 2011 to 2013, the number of mobile-broadband subscriptions more than doubled in developing countries [75].

Through mobile network technologies, high-speed Internet access can be provided via portable devices. In order to get mobile broadband, there must be a cellular network (GSM or Code Division Multiple Access (CDMA)) service available). The key technologies when talking about mobile broadband is 3G and Fourth Generation (mobile communications) (4G) [77]. With 3G the average speed is 0.5 to 1.5 Mbps, and with 4G the average speed is 2 to 12 Mbps. These vary, due to different versions of each technology, underlying service etc. Like with everything else, the actual and realistic speed differ from the peak speed [78].

A.2.3 Satellite

Internet from satellites are offered by a satellite Internet provider [73]. The satellite are orbiting the Earth, and get signals from a land based Internet connection. To get Internet broadband via satellite you need a satellite dish. The main advantage of using satellite is that it provides an universally available Internet access [79]. Since it is universally available, it is fitted for use in rural regions where there exists no landlines or other options for connecting to the Internet. There also exists disadvantages with using satellite-Internet. Since it is a shared medium, privacy concerns arise, and the speed are dependent of simultaneous use. Also the connection can be affected by bad weather, unlike for a wired connection, hence it is not as reliable as cable.

A.2.4 Summary Up-Links

Up-links	**Advantages**	**Disadvantages**
Landline/xDSL	High reliability, cost effective, good speed.	Low availability in rural areas.
Cellular networks	High availability, fitted for "on the move"-use.	Expensive, slower than xDSL.
Satellite	High availability.	Unreliable, expensive, slower than landline.

Table A.1: Advantages and disadvantages - Up-links [80]

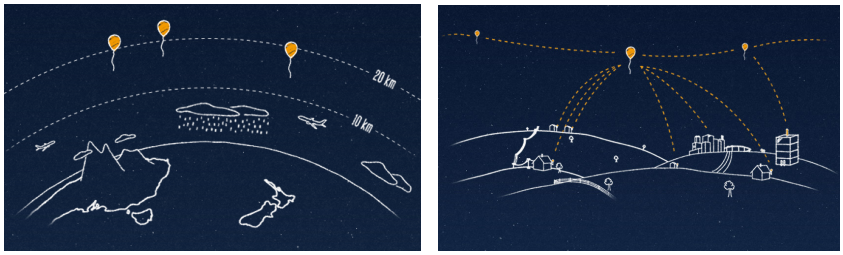
A.3 Future Internet Access Methods

Different methods of distributing Internet is always under development. The previous up-links described is well established, but in many parts of the world not fully developed or not affordable to the average person. The large technology companies, like Google, are experimenting with different ways of distributing Internet.

A.3.1 Google's Internet Balloons

The majority of the world today is not connected to the Internet. Two thirds of the worlds population does not have access. Project Loon, a Google project, is a network of high altitude balloons travelling in the stratosphere, and through this network be able to give Internet to the Entire world. Cost effective, reliable and inexpensive

Internet connection to everybody. The project started in June 2013 as a experiment in New Zealand [81].



(a) The Balloons are situated in the stratosphere. **(b) Connecting to the Internet**

Figure A.6: Project Loon: Balloon-powered Internet for everyone.

The balloons are 15 meter in diameter. They travel about 20 km up in the air, in the stratosphere, twice as high as airplanes and weather, this is shown in Figure A.6a. At this altitude there are many layers of wind, each varies in direction and speed. By regulating which wind the balloons are flying in it is possible to control their position, and steer them in the desired direction. Figure A.6b show that people can connect to the Internet shared by the balloons by having a special antenna attached to their house. From this antenna the signal bounces to one balloon which again bounces through the other balloons and down to the Local Internet Provider on earth. This creates a network in the sky.

In order to control the altitude of the balloon, it is a specially designed control system. The system is managed remotely from the ground. By either pumping air in, or letting air out of the balloon, one can decide in what layer of air the balloon should be in. Letting air in and out is not the only way to decide whether the balloon should go up or down, but it is the only way to do so in huge scale. A GPS is attached to each balloon in order to keep track of precise positions and see how the winds are changing. There are enormous amounts of data collected, and some of this information is given to meteorologists. The balloons are flying at the same speed as the wind.

The balloons contains specially designed antennas and radio systems. This in order to receive signals from Project Loon only, and to achieve high bandwidth over long distances. Satellites stay at the same place and at the same altitude. This means that the satellite dish can be mounted in the right direction. This is not the case with the balloons, they are in constant movement and they also vary in attitude. A fixed pointing dish would therefore not work. The antenna needs more sensitivity to

an angle than it does straight up, which results in a uniform signal strength.

Since the balloons are in constant movement, it is important to make sure that there always is a balloon available and one ready to move in when one move out so that the connectivity always are available. If not this project would not be of much use. Every balloon contains information about all the other balloons in order to spread out nicely. Think of it as a flock of birds, they always look at the one next to them and space out perfectly.

The balloons are solely run on solar power. The balloon works as a communication tower in the sky. The solar panels catches the sunlight that is available during the day, as well as charging up the lithium-ion battery to last the night. In the stratosphere it is -70 degrees Celsius, these extreme cold conditions are not ideal fro the lithium battery. In order to make sure that the battery does not loose its effective battery capacity it is important that the battery is kept warm. The battery pack is insulated to reflect the heat that comes of the electronics to stay warm. This is still under development.

When it comes to lifetime, the goal is that the balloons stay alive for 100 days, or 3 laps around the globe. It is important to make sure that the balloon is leak free. The material is under a lot of stress, air is constantly being pumped in and out to control the position. As well as the extreme cold and warm temperatures.

Both on the way up and down the air traffic control in the specific country have to be contacted since the balloons go through airspace. Project loon requested permission to land on Norwegian soil according to Teknisk Ukeblad, a Norwegian science magazine. This permission was approved [82].

The area of usage is enormous. Situations where the Internet infrastructure has not been built out, either because it is too expensive or just not possible. Emergency situations, natural disaster and other situations where the cellphone-towers are down. Project Loon is still a project in development with extensive testing taking place. The project are taking into use what everybody have in common, namely the sky, to reach out to all the areas where access has not been possible. It is expensive to have enough balloons in the sky in order to have good enough coverage. Also the speed is not really high. And even though a specialized antenna is required to get access, this is breakthrough in order to get the whole world connected [83, 84].

Although this solution is not an option for distributing Internet as of today, it could be a good option in the near future. The solution is affordable and well compatible with our emergency box solution.

Iridium satellite consultation is a large group of satellites providing data and and

voice services to specialized satellite phones. The consultation exists of 66 active satellites in orbit. Iridium are considered to be low-orbit satellites and are situated at a hight of 781 km. The Iridium network is unique in the fact that it covers the whole earth, including oceans, airways and poles. The low orbit satellite differs from the balloons in the way that the satellites travel almost 40 times higher above earth and that they stay in a fixed position over the earth [85]. To be able to utilize the satellite one would need a specialized satellite phone or a satellite dish in order to receive signal. With the balloons there are only need for an antenna to receive the signal. But then again the balloons does not offer a voice service. The balloons are intended as a cheaper, easier and simpler solution to the satellites.

A.4 Apple's Mesh Network

In March 2014 a new iOS app was released, FireChat. FireChat utilizes Apple's Multipeer Connectivity Framework introduced in iOS7 [86]. This app enables the possibility to chat with people "off-the-grid" [87]. Applications that communicates through this framework creates a mesh network similar to the one created by the Mesh Potatoes.

The Multipeer Connectivity framework provides support for discovering services provided by nearby iOS devices using peer-to-peer Wi-Fi, infrastructure Wi-Fi networks and bluetooth to communicate with those services. This communication could either be message-based data, streaming data and resources such as files [88]. These technologies have a short range, but this range can be greatly extended by a chain of users that creates a mesh network, see section A.1.4 for more information about mesh networks. AirDrop is a product that have been on the market for a while and also utilizes mesh networks. The main difference is that FireChat is fully decentralized and peer-to-peer. When there are multiple users in one area FireChat relay messages in the same way as Internet, from node to node, just in this case it is from phone to phone. This, not only, enables two users to chat with each other without Internet connection, but also far beyond Wi-Fi and Bluetooth range from each other, using the chain of users (phones). For example if Bob is connected to Alice, and Alice is connected to Carol, Bob and Carol can send messages to each other. This chain can be indefinitely long. As long as no one device goes out of Wi-Fi range, all the devices can communicate with each other.

This new framework will mainstream wireless mesh networking. This could open for a future way of spreading Internet access. This could for example be a hotel basement, cave or rural areas where there are no cellphone towers, or disaster situations where Wi-Fi or mobile broadband is no longer available. There are many benefits with the use of mesh networks. Mesh networks does not require a centralized infrastructure, there are no need for all the devices to be connected to Internet (as a router). Another

benefit is that the mesh network is really easy to set up - everybody just uses the app FireChat (or similar applications like AirDrop), the network is created and everybody is connected. Simple as that!

The possibilities for this feature are enormous. Both in the creation of applications but also the area of usage. In a lot of countries Internet and mobile broadband connection is extremely expensive, people might afford a used cellphone but not the cost to connect. With this new feature, Internet connectivity can be spread through the mesh network needing only one node (phone) to have Internet access. This way of spreading connectivity can open the possibility for people in rural, poorer areas like slums and small villages to stay connected. But not only the poor and rural areas can benefit from this new mesh-networking feature. Young people that does not have a phone can use an iPad or similar to talk to their friends. Or teens with restricted cell contracts can still connect with their friends, just with the help of the neighbours kids phone. Since FireChat enables communication without the use of Internet it can be a useful tool to communicate privately and also to send sensitive data.

It is not only Apple that is seizing the enormous potential in main-streaming mesh networking. Google has also expressed that they are working on a home mesh network [89]. FireChat and AirDrop is just the beginning. Most likely, more extensive and mind blowing applications are to come.

B

Osterwalder's Business Model Canvas

The Business Model Canvas

Designed for:	Designed by:	Date:	Version:

Key Partners

Who are our Key Partners?
Who are our key suppliers?
Which Key Resources are we acquairing from partners?
Which Key Activities do partners perform?

MOTIVATIONS FOR PARTNERSHIPS
Optimization and economy
Reduction of risk and uncertainty
Acquisition of particular resources and activities

Key Activities

What Key Activities do our Value Propositions require?
Our Distribution Channels?
Customer Relationships?
Revenue streams?

CATERGORIES
Production
Problem Solving
Platform/Network

Key Resources

What Key Resources do our Value Propositions require?
Our Distribution Channels? Customer Relationships?
Revenue Streams?

TYPES OF RESOURCES
Physical
Intellectual (brand patents, copyrights, data)
Human
Financial

Value Propositions

What value do we deliver to the customer?
Which one of our customer's problems are we helping to solve?
What bundles of products and services are we offering to each Customer Segment?
Which customer needs are we satisfying?

CHARACTERISTICS
Newness
Performance
Customization
"Getting the Job Done"
Design
Brand/Status
Price
Cost Reduction
Risk Reduction
Accessibility
Convenience/Usability

Customer Relationships

What type of relationship does each of our Customer Segments expect us to establish and maintain with them?
Which ones have we established?
How are they integrated with the rest of our business model?
How costly are they?

EXAMPLES
Personal assistance
Dedicated Personal Assistance
Self-Service
Automated Services
Communities
Co-creation

Channels

Through which Channels do our Customer Segments want to be reached?
How are we reaching them now?
How are our Channels integrated?
Which ones work best?
Which ones are most cost-efficient?
How are we integrating them with customer routines?

CHANNEL PHASES
1. *Awareness*
   How do we raise awareness about our company's products and services?
2. *Evaluation*
   How do we help customers evaluate our organization's Value Proposition?
3. *Purchase*
   How do we allow customers to purchase specific products and services?
4. *Delivery*
   How do we deliver a Value Proposition to customers?
5. *After sales*
   How do we provide post-purchase customer support?

Customer Segments

For whom are we creating value?
Who are our most important customers?

Mass Market
Niche Market
Segmented
Diversified
Multi-sided Platform

Cost Structure

What are the most important costs inherent in our business model?
Which Key Resources are most expensive?
Which Key Activities are most expensive?

IS YOUR BUSINESS MORE
Cost Driven (leanest cost structure, low price value proposition, maximum automation, extensive outsourcing)
Value Driven (focused on value creation, premium value proposition)

SAMPLE CHARACTERISTICS
Fixed Costs (salaries, rents, utilities)
Variable costs
Economies of scale
Economies of scope

Revenue Streams

For what value are our customers really willing to pay?
For what do they currently pay?
How are they currently paying?
How would they prefer to pay?
How much does each Revenue Stream contribute to overall revenues?

TYPES
Asset sale
Usage fee
Subscription Fees
Lending/Renting/Leasing
Licensing
Brokerage fees
Advertising

FIXED PRICING
List Price
Product feature dependent
Customer segment dependent
Volume dependent

DYNAMIC PRICING
Negotiation (bargaining)
Yield Management
Real-time-Market

Strategyzer
strategyzer.com

C

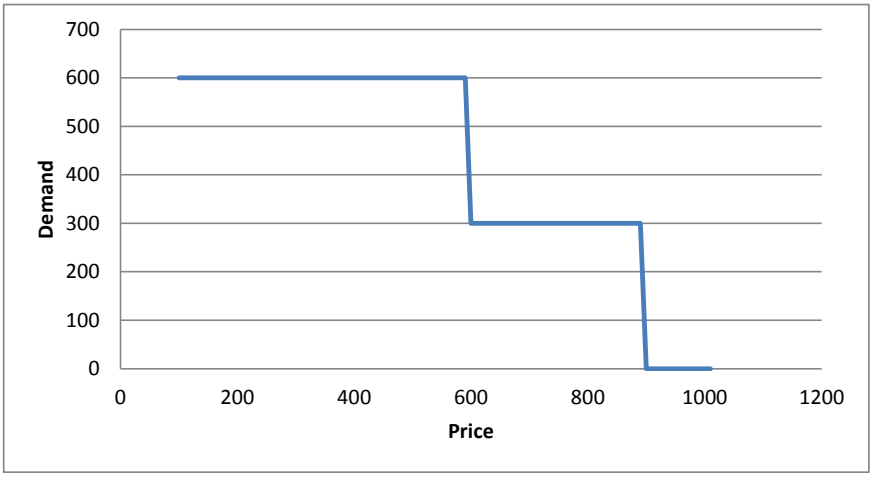
Example of Demand Telecommunication Service

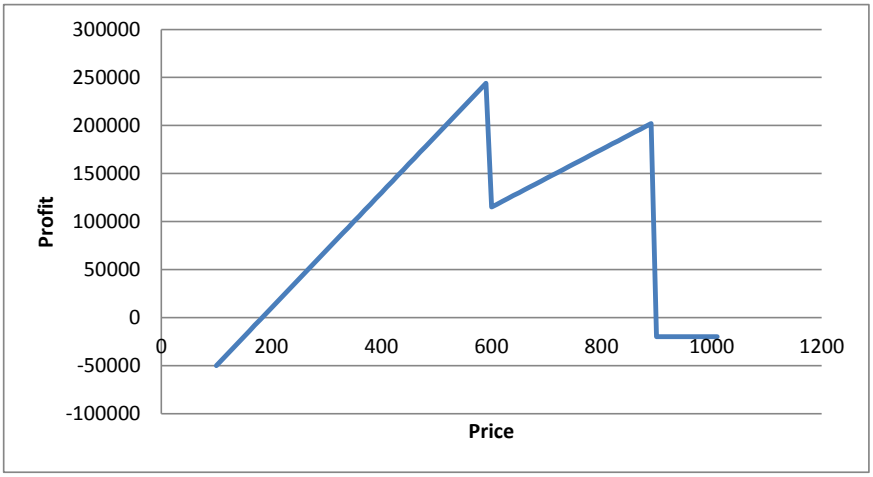
alpha	3
number of consumers in each group (n)	300
Fixed costs	20000
Variable Costs	150

p	q	Profit
100	600	-50000
110	600	-44000
120	600	-38000
130	600	-32000
140	600	-26000
150	600	-20000
160	600	-14000
170	600	-8000
180	600	-2000
190	600	4000
200	600	10000
210	600	16000
220	600	22000
230	600	28000
240	600	34000
250	600	40000
260	600	46000
270	600	52000
280	600	58000
290	600	64000
300	600	70000
310	600	76000
320	600	82000
330	600	88000
340	600	94000
350	600	100000
360	600	106000
370	600	112000
380	600	118000
390	600	124000
400	600	130000
410	600	136000
420	600	142000
430	600	148000
440	600	154000
450	600	160000
460	600	166000
470	600	172000
480	600	178000
490	600	184000
500	600	190000

510	600	196000
520	600	202000
530	600	208000
540	600	214000
550	600	220000
560	600	226000
570	600	232000
580	600	238000
590	600	244000
600	300	115000
610	300	118000
620	300	121000
630	300	124000
640	300	127000
650	300	130000
660	300	133000
670	300	136000
680	300	139000
690	300	142000
700	300	145000
710	300	148000
720	300	151000
730	300	154000
740	300	157000
750	300	160000
760	300	163000
770	300	166000
780	300	169000
790	300	172000
800	300	175000
810	300	178000
820	300	181000
830	300	184000
840	300	187000
850	300	190000
860	300	193000
870	300	196000
880	300	199000
890	300	202000
900	0	-20000
910	0	-20000
920	0	-20000
930	0	-20000
940	0	-20000
950	0	-20000
960	0	-20000
970	0	-20000
980	0	-20000
990	0	-20000
1000	0	-20000

Welfare - Only H Connects	205000
Welfare - All Connect	610000





D

Business Models Examples

D.1 Mobile Telco

Equipment Manufacturers

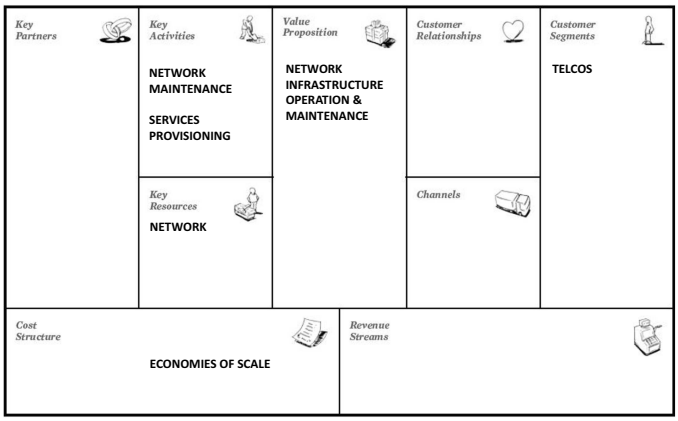


Figure D.1: Equipment manufacturers - Business model canvas [43]

Content Providers

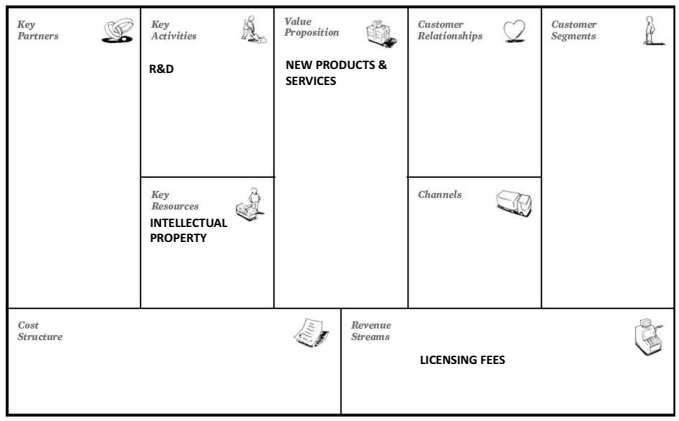


Figure D.2: Content provider - Business model canvas [43]

D.2 Android

Android[1] is an open source mobile Operating System (OS). The OS is suitable for multiple hardware devices. Android was bought by Google in 2005. For mobile OSs, Android had 80% market share in the first quarter of 2014[90].

Figure D.3 presents Android's business model canvas. The main revenue for Android is Pay-Per-Click (PPC) advertising on search traffic generated through android devices. For device manufacturers it does not cost anything to implement Android to their hardware.

[1] www.android.com

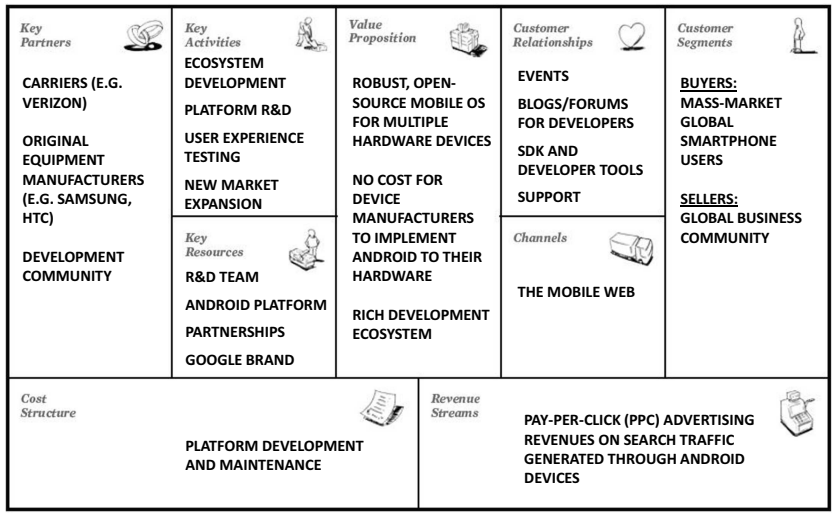


Figure D.3: Android - Business model canvas

D.3 Facebook

Facebook was released in 2006 by Mark Zuckerburg. Facebook is a SNS, with over 1.3 billion monthly active users in 2014[91].

Figure D.4 shows Facebook's business model canvas. Facebook's revenue comes mostly from advertiser and payment revenues from applications developed on Facebook's developer platform. Facebook offers a payment service for applications, and then gets some percent of revenue from the application that uses the payment service. However over 85% of Facebook's revenue comes from advertisers [92].

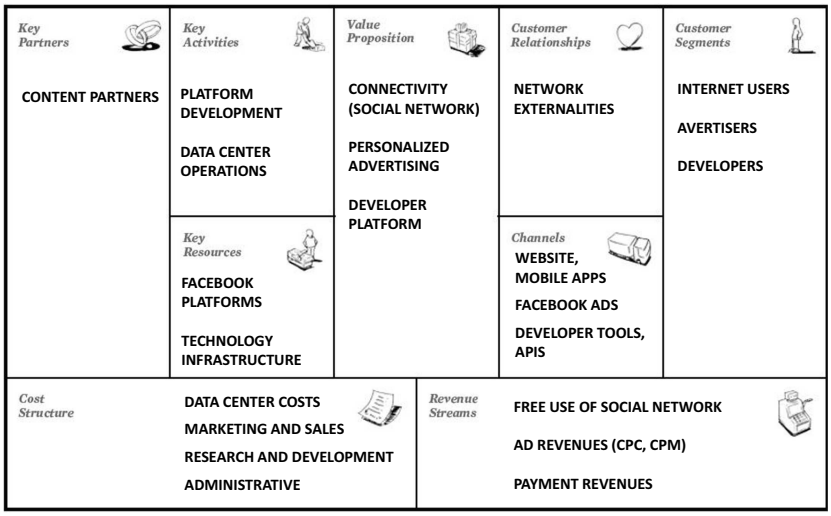


Figure D.4: Facebook - Business model canvas

E

Threshold Values

This appendix contains all the equations and calculations for the threshold values presented in Chapter 6, as well as a version of the Excel-sheet. The variables that are used in the equations are presented in Table 6.2 on page page 62.

E.1 Excel-sheet for Calculations

The data shown in the figure, are only example data, and do not contain real data. The data presented should not be looked in to. The Excel-sheet is attached to the master's thesis.

General data for all scenarios

Costs

Fixed Costs	400	

Costs to other telco:

Cost per external calling minute	0,05	
Cost per Megabyte	0,05	

Other variables

Number of users	100	*Optional*
Number of paying users	150	*Optional*

SCENARIO 1

Fees and prices:

Subscription fees (flat rate)

Internal calling	10

Usage charging

Price per internal calling minute	0,2

Dynamic pricing

Price per calling minute, period 1	0,1
Price per calling minute, period 2	0,2
Price per calling minute, period 3	0,3

Bundling

Not applicable

Freemium

Not applicable

Costs

Fixed costs	400
Variable costs per user	0

Estimated use per user per month

Number of internal calling mintues	400

Estimations for dynamic pricing:

Number of internal calling minutes period 1	100
Number of internal calling minutes period 2	200
Number of internal calling minutes period 3	100

Number of users for sustainable business (the numbers must be positive):

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing
40	5	5

Profit per month (remember to fill in number of users in 'General variables')

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing
600	7600	7600

SCENARIO 2

Fees and prices:

Subscription fees (flat rate)	
Internal calling	10
External calling	10
Usage charging	
Price per internal calling minute	0,2
Price per external calling minute	0,1
Dynamic pricing	
Price per internal calling minute, period 1	0,05
Price per internal calling minute, period 2	0,1
Price per internal calling minute, period 3	0,15
Price per external calling minute, period 1	0,1
Price per external calling minute, period 2	0,2
Price per external calling minute, period 3	0,3
Bundling	
Bundle fee	15
Freemium	
Freemium fee	15

Costs

Fixed costs	400

Estimated use per user per month

Number of internal calling minutes	400
Number of external calling minutes	200

Estimations for dynamic pricing:

Number of internal calling minutes period 1	100
Number of internal calling minutes period 2	200
Number of internal calling minutes period 3	100
Number of external calling minutes period 1	50
Number of external calling minutes period 2	50
Number of external calling minutes period 2	50

Number of users for sustainable business (the numbers must be positive):

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
40	4,444444444	6,4	80	80

Profit per month (remember to fill in number of users in 'General variables')

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
600	8600	5850	100	350

SCENARIO 3

Fees and prices:

Subscription fees (flat rate)	
Internal calling	10
Internet	10
Usage charging	
Price per internal calling minute	0,1
Price per Megabyte	0,1
Dynamic pricing	
Price per calling minute, period 1	0,1
Price per calling minute, period 2	0,2
Price per calling minute, period 3	0,3
Price per Megabyte, period 1	0,05
Price per Megabyte, period 2	0,1
Price per Megabyte, period 3	0,15
Bundling	
Bundling fee	18
Freemium	
Freemium fee	15

Costs:

Fixed costs	100

Estimated use per user per month

Number of internal calling mintues	400
Number of Megabytes	250

Estimations for dynamic pricing:

Number of internal calling minutes perio	100
Number of internal calling minutes perio	200
Number of internal calling minutes perio	100
Number of Megabytes, period 1	100
Number of Megabytes, period 2	100
Number of Megabytes, period 3	100

Number of users for sustainable business (the numbers must be positive):

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
13,33333333	1,904761905	1,052631579	18,18181818	40

Profit per month (remember to fill in number of users in 'General variables')

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
650	5150	9400	450	275

SCENARIO 4

Fees and prices:

Subscription fees (flat rate)	
Internal calling	10
External calling	10
Internet	20
Usage charging	
Price per internal calling minute	0,2
Price per external calling minute	0,2
Price per Megabyte	0,2
Dynamic pricing	
Price per internal calling minute, period 1	0,1
Price per internal calling minute, period 2	0,2
Price per internal calling minute, period 3	0,3
Price per external calling minute, period 1	0,1
Price per external calling minute, period 2	0,2
Price per external calling minute, period 3	0,3
Price per Megabyte, period 1	0,1
Price per Megabyte, period 2	0,2
Price per Megabyte, period 3	0,3
Bundling	
Bundle fee	37
Freemium	
Freemium fee	36

Costs

Fixed costs	400

Estimated use per user per month

Number of internal calling minutes	200
Number of external calling minutes	200
Number of Megabytes	500

Estimations for dynamic pricing:

Number of internal calling minutes period 1	100
Number of internal calling minutes period 2	50
Number of internal calling minutes period 3	50
Number of external calling minutes period 1	100
Number of external calling minutes period 2	50
Number of external calling minutes period 2	50
Number of Megabytes, period 1	200
Number of Megabytes, period 2	100
Number of Megabytes, period 3	100

Number of users for sustainable business (the numbers must be positive):

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
80	2,75862069	3,636363636	200	400

Profit per month (remember to fill in number of users in 'General variables')

Price strategy 1 Flat rate	Price strategy 2 Usage charging	Price strategy 3 Dynamic pricing	Price strategy 4 Bundling	Price strategy 5 Freemium
100	14100	10600	-200	-250

E.2 Equations for the Scenarios

E.2.1 Overall Calculations for the Scenarios

This section presents all the calculations done for the results presented in Section 6.4.

Price Strategy 1

The equation for profit using price strategy 1 is given in Equation E.1. Π_1 is the profit for price strategy 1.

$$\Pi_1 = N * (ic + ec + d) - C \tag{E.1}$$

To get a positive profit, the number of users must be greater than the costs divided with the subscription fee. This is illustrated in Equation E.2 and Equation E.3.

$$C < (ic + ec + d) * N \tag{E.2}$$

$$N > \frac{C}{ic + ec + d} \tag{E.3}$$

Price Strategy 2

For usage charging the profit is given in Equation E.4.

$$\Pi_2 = \sum_{i=1}^{N} [p_1 * x_i + p_2 * y_i + p_3 * \bar{z}] - C \tag{E.4}$$

$$C < \sum_{i=1}^{N} [p_1 * x_i + p_2 * y_i + p_3 * z_i] \tag{E.5}$$

Equation E.5 can be simplified with use of average values for x, y and z. The simplified expressions are shown in Equation E.6, E.7 and E.8.

$$\Pi_2 = N * [p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}] - C \tag{E.6}$$

$$C < N * [p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}] \tag{E.7}$$

$$N > \frac{C}{p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}} \tag{E.8}$$

Price Strategy 3

The profit for price strategy 3 is given in Equation E.9.

$$\Pi_3 = \sum_{i=1}^{N} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] - C \tag{E.9}$$

A positive profit is obtained if Equation E.10 is fulfilled.

$$C < \sum_{i=1}^{N} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] \tag{E.10}$$

As for price strategy 2, the equations may be simplified, this is shown in Equation E.11, Equation E.12 and Equation E.13.

$$\Pi_3 = N * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] - C \tag{E.11}$$

$$C < N * [\sum_{t=1}^{T} (p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * z_{i,t} + p_{3,t} * \bar{z_t}] \tag{E.12}$$

$$N > \frac{C}{\sum_{t=1}^{T} (p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t})} \tag{E.13}$$

Price Strategy 4

The equation for profit for bundling is given in Equation E.14 and Equation E.15, the expressions are almost the same as for price strategy 1. The only difference is the fee. See chapter 6 for explaination.

$$\Pi_4 = b * N - C \tag{E.14}$$

$$N > \frac{C}{b} \tag{E.15}$$

Price Strategy 5

The equations for Freemium are listet below. In chapter 6, only Freemium with bundling is considered. This section presents expressions for Freemium combined with other price strategies, flat rate, usage charging and dynamic pricing.

Freemium with flat rate:

$$\Pi_5 = a * M - C \tag{E.16}$$

$$C < a * M \tag{E.17}$$

$$M > \frac{C}{a} \tag{E.18}$$

Freemium with usage charging:

$$\Pi_5 = \sum_{i=1}^{M} [p_1 * x_i + p_2 * y_i + p_3 * z_i] - C \tag{E.19}$$

$$C < \sum_{i=1}^{M} [p_1 * x_i + p_2 * y_i + p_3 * z_i] \tag{E.20}$$

$$C < M * [p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}] \tag{E.21}$$

$$M > \frac{C}{p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}} \tag{E.22}$$

Freemium with dynamic pricing:

$$\Pi_5 = \sum_{i=1}^{M} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] - C \tag{E.23}$$

$$C < \sum_{i=1}^{M} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] \tag{E.24}$$

$$C < M * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] \tag{E.25}$$

$$M > \frac{C}{\sum_{t=1}^{T}[p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}]} \tag{E.26}$$

Freemium with bundling:

$$\Pi_5 = b * M - C \tag{E.27}$$

$$C < b * M \tag{E.28}$$

$$M > \frac{C}{b} \tag{E.29}$$

E.2.2 Scenario 1

The costs for scenario 1 can be calculated by use of Equation E.30.

$$C = FC + VC = FC \tag{E.30}$$

All the equations for the scenario is derived by combining E.30 and the equations for profit presented for each price strategy in Section E.2.1.

Price Strategy 1

The equations for price strategy 1 is given in Equation E.31 and E.32.

$$FC < ic * N \tag{E.31}$$

$$N > \frac{FC}{ic} \tag{E.32}$$

Price Strategy 2

The equation for price strategy 2 is given in Equation E.33.

$$FC < \sum_{i=1}^{N} p_1 * x_i \tag{E.33}$$

Equation E.33 may be simplified to Equation E.34, and makes it possible to set up Equation E.35.

$$FC < N * p_1 * \bar{x} \tag{E.34}$$

$$N > \frac{FC}{p_1 * \bar{x}} \tag{E.35}$$

Price Strategy 3

$$FC < \sum_{i=1}^{N} \sum_{t=1}^{T} p_{1,t} * x_{i,t} \tag{E.36}$$

Equation E.36 may be simplified to Equation E.37.

$$FC < N * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t}] \tag{E.37}$$

Equation E.37 makes it possible to set up Equation E.38.

$$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t}} \tag{E.38}$$

E.2.3 Scenario 2

The costs for scenario 2 may be calculated using Equation E.39.

$$C = FC + VC = FC + \sum_{i=1}^{N} C_3 * z_i \tag{E.39}$$

Equation E.39 may be simplified to Equation E.40

$$C = FC + N * C_3 * \bar{z} \tag{E.40}$$

Price Strategy 1

The equation for price strategy 1 is given in Equation E.41.

$$FC + \sum_{i=1}^{N} [C_3 * z_i] < (ic + ec) * N \tag{E.41}$$

Equation E.41 may be simplified to Equation E.42, and makes it possible to set up Equation E.43.

$$FC + N * C_3 * \bar{z} < N * (ic + ec) \tag{E.42}$$

$$N > \frac{FC}{ic + ec - C_3 * \bar{z}} \tag{E.43}$$

Price Strategy 2

The equation for price strategy 2 is given in Equation E.44.

$$FC + \sum_{i=1}^{N} C_3 * z_i] < \sum_{i=1}^{N} [p_1 * x_i + p_3 * z_i] \tag{E.44}$$

Equation E.44 may be simplified to Equation E.45, and makes it possible to set up Equation E.46.

$$FC < N * [\bar{x} * p_1 + \bar{z} * (p_3 - C_3)] \tag{E.45}$$

$$N > \frac{FC}{\bar{x} * p_1 + \bar{z} * (p_3 - C_3)} \tag{E.46}$$

Price Strategy 3

The equation for price strategy 3 is given in Equation E.47.

$$FC + \sum_{i=1}^{N} C_3 * z_i < \sum_{i=1}^{N} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{3,t} * z_{i,t}] \tag{E.47}$$

Equation E.47 may be simplified to Equation E.48, and makes it possible to set up Equation E.49.

$$FC + N * C_3 * \bar{z} < N * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{3,t} * \bar{z_t}] \tag{E.48}$$

$$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{3,t} * \bar{z_t}] - C_3 * \bar{z}} \tag{E.49}$$

Price Strategy 4

The equation for price strategy 4 is given in Equation E.50.

$$FC + \sum_{i=1}^{N} C_3 * z_i < b * N \tag{E.50}$$

Equation E.50 may be simplified to Equation E.51, and makes it possible to set up Equation E.52.

$$FC + N * C_3 * \bar{z} < N * b \tag{E.51}$$

$$N > \frac{FC}{b - C_3 * \bar{z}} \tag{E.52}$$

Price Strategy 5

Freemium with flat rate:

$$FC + \sum_{i=1}^{M} C_3 * z_i < ec * M \tag{E.53}$$

Equation E.53 may be simplified to Equation E.54, and makes it possible to set up Equation E.55.

$$FC + M * C_3 * \bar{z} < M * ec \tag{E.54}$$

$$M > \frac{FC}{ec - C_3 * \bar{z}} \tag{E.55}$$

Freemium with usage charging:

$$FC + \sum_{i=1}^{M} C_3 * z_i < \sum_{i=1}^{M} p_3 * z_i \tag{E.56}$$

Equation E.56 may be simplified to Equation E.57, and makes it possible to set up Equation E.58.

$$FC + M * C_3 * \bar{z} < M * p_3 * \bar{z} \tag{E.57}$$

$$M > \frac{FC}{\bar{z} * (p_3 - C_3)} \tag{E.58}$$

Freemium with dynamic pricing:

$$FC + \sum_{i=1}^{M} C_3 * z_i < \sum_{i=1}^{M} \sum_{t=1}^{T} p_{3,t} * z_{i,t} \tag{E.59}$$

Equation E.59 may be simplified to Equation E.60, and makes it possible to set up Equation E.61.

$$FC + M * C_3 * \bar{z} < M * \sum_{t=1}^{T} p_{3,t} * \bar{z_t} \tag{E.60}$$

$$M > \frac{FC}{\sum_{t=1}^{T} p_{3,t} * \bar{z_t} - C_3 * \bar{z}} \tag{E.61}$$

Freemium with bundling: Since internal calling is free, only external calling is in the bundle. Therefore *ec* is used as the bundle fee.

$$FC + \sum_{i=1}^{M} C_3 * z_i < ec * M \tag{E.62}$$

Equation E.62 may be simplified to Equation E.63, and makes it possible to set up Equation E.64.

$$FC + M * C_3 * \bar{z} < M * ec \tag{E.63}$$

$$M > \frac{FC}{ec - C_3 * \bar{z}} \tag{E.64}$$

E.2.4 Scenario 3

Scenario 3's costs can be calculated using Equation E.65.

$$C = FC + VC = FC + \sum_{i=1}^{N} C_2 * y_i \tag{E.65}$$

Equation E.65 may be simplified to Equation E.66.

$$C = FC + N * C_2 * \bar{y} \tag{E.66}$$

Price Strategy 1

$$FC + \sum_{i=1}^{N} C_2 * y_i < ic * N + d * N \tag{E.67}$$

Equation E.67 may be simplified to Equation E.68, and makes it possible to set up Equation E.69.

$$FC + N * C_2 * \bar{y} < N * (ic + d) \tag{E.68}$$

$$N > \frac{FC}{ic + d - C_2 * \bar{y}} \tag{E.69}$$

Price Strategy 2

$$FC + \sum_{i=1}^{N} C_2 * y_i < \sum_{i=1}^{N} [p_1 * x_i + p_2 * y_i] \tag{E.70}$$

Equation E.70 may be simplified to Equation E.71, and makes it possible to set up Equation E.72.

$$FC + N * C_2 * \bar{y} < N * [p_1 * \bar{x} + p_2 * \bar{y}] \tag{E.71}$$

$$N > \frac{FC}{p_1 * \bar{x} + \bar{y} * (p_2 - C_2)} \tag{E.72}$$

Price Strategy 3

$$FC + \sum_{i=1}^{N} C_2 * y_i < \sum_{i=1}^{N} \sum_{t=1}^{T} [p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t}] \tag{E.73}$$

Equation E.73 may be simplified to Equation E.74, and makes it possible to set up Equation E.75.

$$FC + N * C_2 * \bar{y} < N * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t}] \tag{E.74}$$

$$N > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t}] - C_2 * \bar{y}} \tag{E.75}$$

Price Strategy 4

$$FC + \sum_{i=1}^{N} C_2 * y_i < b * N \tag{E.76}$$

Equation E.76 may be simplified to Equation E.77, and makes it possible to set up Equation E.78.

$$FC + N * C_2 * \bar{y} < N * b \tag{E.77}$$

$$N > \frac{FC}{b - C_2 * \bar{y}} \tag{E.78}$$

Price Strategy 5

Freemium with flat rate:

$$FC + \sum_{i=1}^{M} C_2 * y_i < d * M \tag{E.79}$$

Equation E.79 may be simplified to Equation E.80, and makes it possible to set up Equation E.81.

$$FC + M * C_2 * \bar{y} < M * d \tag{E.80}$$

$$M > \frac{FC}{d - C_2 * \bar{y}} \tag{E.81}$$

Freemium with usage charging:

$$FC + \sum_{i=1}^{M} C_2 * y_i < \sum_{i=1}^{M} [p_2 * y_i] \tag{E.82}$$

Equation E.82 may be simplified to Equation E.83, and makes it possible to set up Equation E.84.

$$FC + M * C_2 * \bar{y} < M * [p_1 * \bar{x} + p_2 * \bar{y}] \tag{E.83}$$

$$M > \frac{FC}{p_1 * \bar{x} + \bar{y} * (p_2 - C_2)} \tag{E.84}$$

Freemium with dynamic charging:

$$FC + \sum_{i=1}^{M} C_2 * y_i < \sum_{i=1}^{M} \sum_{t=1}^{T} p_{2,t} * y_{i,t} \tag{E.85}$$

Equation E.85 may be simplified to Equation E.86, and makes it possible to set up Equation E.87.

$$FC + M * C_2 * \bar{y} < M * \sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t}] \tag{E.86}$$

$$M > \frac{FC}{\sum_{t=1}^{T} [p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t}] - C_2 * \bar{y}} \tag{E.87}$$

Freemium with bundling:

$$FC + \sum_{i=1}^{M} C_2 * y_i < b * M \tag{E.88}$$

Equation E.88 may be simplified to Equation E.89, and makes it possible to set up Equation E.90.

$$FC + M * C_2 * \bar{y} < M * b \tag{E.89}$$

$$M > \frac{FC}{b - C_2 * \bar{y}} \tag{E.90}$$

E.2.5 Scenario 4

The costs for Scenario 4 are given in Equation E.91.

$$C = FC + VC = FC + \sum_{i=1}^{N} [C_2 * y_i + C_3 * z_i] \tag{E.91}$$

Equation E.91 can be simplified to Equation E.92.

$$C = FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] \tag{E.92}$$

Price Strategy 1

$$FC + \sum_{i=1}^{N} [C_2 * y_i + C_3 * z_i] < N * (ic + ec + d) \tag{E.93}$$

Equation E.93 may be simplified to Equation E.94, and makes it possible to set up Equation E.95.

$$FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] < N * (ic + ec + d) \tag{E.94}$$

$$N > \frac{FC}{ic + ec + d - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.95}$$

Price Strategy 2

$$FC + \sum_{i=1}^{N}[C_2 * y_i + C_3 * z_i] < \sum_{i=1}^{N}[p_1 * x_i + p_2 * y_i + p_3 * z_i] \tag{E.96}$$

Equation E.96 may be simplified to Equation E.97, and makes it possible to set up Equation E.98.

$$FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] < N * [p_1 * \bar{x} + p_2 * \bar{y} + p_3 * \bar{z}] \tag{E.97}$$

$$N > \frac{FC}{\bar{x} * p_1 + \bar{y} * (p_2 - C_1) + \bar{z} * (p_3 - C_3)} \tag{E.98}$$

Price Strategy 3

$$FC + \sum_{i=1}^{N}[C_2 * y_i + C_3 * z_i] < \sum_{i=1}^{N}\sum_{t=1}^{T}[p_{1,t} * x_{i,t} + p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] \tag{E.99}$$

Equation E.99 may be simplified to Equation E.100, and makes it possible to set up Equation E.101.

$$FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] < N * \sum t = 1^{T}[p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] \tag{E.100}$$

$$N > \frac{FC}{\sum_{t=1}^{T}[p_{1,t} * \bar{x_t} + p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.101}$$

Price Strategy 4

$$FC + \sum_{i=1}^{N}[C_2 * y_i + C_3 * z_i] < N * b \tag{E.102}$$

Equation E.102 may be simplified to Equation E.103, and makes it possible to set up Equation E.104.

$$FC + N * [C_2 * \bar{y} + C_3 * \bar{z}] < N * b \tag{E.103}$$

$$N > \frac{FC}{b - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.104}$$

Price Strategy 5

Freemium with flat rate:

$$FC + \sum_{i=1}^{M}[C_2 * y_i + C_3 * z_i] < M * (ec + d) \tag{E.105}$$

Equation E.105 may be simplified to Equation E.106, and makes it possible to set up Equation E.107.

$$FC + M * [C_2 * \bar{y} + C_3 * \bar{z}] < M * (ec + d) \tag{E.106}$$

$$M > \frac{FC}{ec + d - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.107}$$

Freemium with usage charging:

$$FC + \sum_{i=1}^{M}[C_2 * y_i + C_3 * z_i] < \sum_{i=1}^{M}[p_2 * y_i + p_3 * z_i] \tag{E.108}$$

Equation E.108 may be simplified to Equation E.109, and makes it possible to set up Equation E.110.

$$FC + M * [C_2 * \bar{y} + C_3 * \bar{z}] < M * [p_2 * \bar{y} + p_3 * \bar{z}] \tag{E.109}$$

$$M > \frac{FC}{\bar{y} * (p_2 - C_1) + \bar{z} * (p_3 - C_3)} \tag{E.110}$$

Freemium with dynamic pricing:

$$FC + \sum_{i=1}^{M}[C_2 * y_i + C_3 * z_i] < \sum_{i=1}^{M}\sum_{t=1}^{T}[p_{2,t} * y_{i,t} + p_{3,t} * z_{i,t}] \tag{E.111}$$

Equation E.111 may be simplified to Equation E.112, and makes it possible to set up Equation E.113.

$$FC + M * [C_2 * \bar{y} + C_3 * \bar{z}] < M * \sum_{t=1}^{T}[p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] \tag{E.112}$$

$$M > \frac{FC}{\sum_{t=1}^{T}[p_{2,t} * \bar{y_t} + p_{3,t} * \bar{z_t}] - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.113}$$

Freemium with bundling:

$$FC + \sum_{i=1}^{M} [C_2 * y_i + C_3 * z_i] < M * b \tag{E.114}$$

Equation E.114 may be simplified to Equation E.115, and makes it possible to set up Equation E.116.

$$FC + M * [C_2 * \bar{y} + C_3 * \bar{z}] < M * b \tag{E.115}$$

$$M > \frac{FC}{b - C_2 * \bar{y} - C_3 * \bar{z}} \tag{E.116}$$

F

Questionnaire

Village Telco Master Thesis

We are three students in Norway, that are writing our master thesis on topics related to Village Telco. We are interested to get in touch with people that have set up a village or are planning to do so. Answers to this form will be highly appreciated and a great help for our thesis. If you have any questions, you can contact us here:

Marte Berg Innset - marte@innset.net
Esther Bloemendaal - esther.bl@gmail.com
Ida Malene Øveråsen - idam.overaasen@gmail.com

If you have any documents or data that could be of interest, don't hesitate to e-mail us.

The data from this survey will not be reprinted in detail without approval from you, and will be used anonymised. The survey will be used to get an overview over different village telcos.

General

Where is the village located?
Name of village and country

What type of organisation are you?
NGO, for-profit, non-profit

When was the network rolled out in the village?

Is it still operational?

How many nodes and users does the network consist of?

How did the network idea start?
Community need, entrepreneurial spirit, research etc.

Economy

What was the costs related to the roll out of the network?
What did you use money on, how much money did you use, what was the greatest costs?

How do the people in the village get their routers?
Do they pay for them?, once-off, do they pay a monthly fee as a rental?, etc.

Did you have funding for the project? How much, and from who?

Can you please write a little bit about the social conditions in the village
E.g. how is the income of the people, how much do they have to spend on telephony etc.

What is your business model? How does the people pay for the services?
Different pricing for internet and telephony? Do you have free internal call, pre-pay, post-pay, free usage etc. Profits, margins,

Do you have any regular expenses except from the costs related to the equipment?
Operational costs, maintenance costs, staff expenses (how many employees in the village telco) etc.

Do you have other services than calling and internet in your business model?

Technical

Is the network connected to internet?

- ○ Yes
- ○ No, but we are planning to connect
- ○ No

If yes: How are you connected to the internet?

ADSL, fiber, sattelite etc

How are you connected to the telecommunications network?
VOIP, local linking via a gateway etc.

How long did it take to roll out the network? Where there any technical issues during the roll out, if so, which problems occured?

What technical problems with the Mesh Potatos occur most frequently?

How is the telephone numbers distributed?
How do you know which number belongs to whom? If one node is added to the network, how are the other nodes notified?

Have your village ever experienced an emergency situation? If so, did your village use the Mesh Potatos and how?

Emergency situations like a fire, crime, illness etc

Other

Contact information

If I have any follow-up questions it would be great to get in touch with you. If you want you can leave your contact information here

Do you have anything else to add that can be of interest for my master thesis?

Submit

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