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Market for the Sales of Wireless Broadband in Trondheim

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Problem Description

Wireless Trondheim is today mainly a service for nomadic and mobile broadband in other words, for use outside the home. However, many places have good or excellent coverage and many people are using Wireless Trondheim as their primary access at home. Is there a potential to compete with fixed broadband such as ADSL and broadband via cable TV? The thesis will examine the market potential and the ability to use Wireless Trondheim as the primary internet access in the home?

Assignment given: 18. January 2010
Supervisor: Thomas Jelle, ITEM

Preface

This study was performed as a Master thesis in TTM4541 Networks and Services – Tele-economics, as a part of the Communication Technology program at Norwegian University of Science and Technology (NTNU). The work was carried out from 15th January 2010 to 14th June 2010 at the Department of Telematics in cooperation with Wireless Trondheim. The thesis description was outlined by the project supervisor and CEO for Wireless Trondheim, Thomas Jelle.

I would like to thank Mr. Jelle for his input on the structure of this report and for the support during the whole period.

Trondheim, June 14, 2010

Awais Ejaz Ahmed

Summary

Wireless Trondheim is today mainly a service for nomadic and mobile broadband in other words, for use outside the home. The major goal of this study was to examine the market potential and the ability to use wireless broadband offered by Wireless Trondheim, as the primary internet access in the home. The study started with an introduction to the Wireless Trondheim, before introducing the different types of broadband technologies available in the Norwegian market. This study further looked into some successful city-wide Wi-Fi based network initiatives in the Europe, specifically City of Luxembourg and City of Westminster in London. Their objectives, business models, pricing strategies and broadband networks were examined. It provided us with a good insight about the market strategies these wireless cities are using and the achievement they have made. However, it was difficult to inspect how much these networks were used for internet connection at home.

To justify the goal of this study, a quantitative random sampling method through structured web-based questionnaire was carried out. The respondents or targeted population was those residents in Trondheim who do not have free access to Wireless Trondheim's network. A number of hypotheses were observed in order to understand the market of wireless broadband. Questionnaire emphasized on the inhabitant's awareness and willingness towards the wireless broadband subscription. The satisfaction level regarding the coverage provided by Wireless Trondheim and the amount of people using their network as the primary access at home was examined. Results indicated that more than half of the respondents did not have access to the Wireless Trondheim at home. One-fourth of the respondents had access to both wireless broadband and other types of connection interfaces, such as fixed or mobile broadband. Majority of the respondents reported that they did not use Wireless Trondheim to connect internet at home. More than half of the respondents were not satisfied with the coverage provided to them. Also very few people knew about the wireless broadband offer, leading to the fact that minority was willing to buy a wireless broadband subscription. However, it is important to remember that majority of the respondents were living outside of Midtbyen. Hence, only few of these had coverage provided by Wireless Trondheim. However, results were divided into two categories according to the respondent's residential status. It was clear in the end that in addition to increase the coverage, marketing on the wireless broadband service is highly needed to increase the demand.

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Chapter 1

INTRODUCTION

This chapter presents the background, problem description, refinements & challenges, outline and a brief overview on previous work.

1.1 Background

The internet plays a major role in today's communications, especially when its efficient and cost effective manner is considered. Unlike other communication tools, internet has been decentralized in such a way that any user can share, retrieve, sell or exchange goods and services with any other internet user within seconds. Earlier in the 1970s to the late 1980s, the internet was mainly used for government communication and research activities, which was highly restricted to academic and military purposes. Today the internet has touched our life in a significant manner. It became part of our daily routine due to the huge benefits we gain. Most companies went online and used the internet to apply e-commerce, which includes advertising, selling, buying, distributing products and providing customer services. In addition, companies use the internet in business-to-business and business to consumer transactions. Individuals also use the internet for communication, entertainment, sharing information, buying and selling goods and services.

Technologies such as ADSL and cable-TV have been providing broadband internet for a while. These technologies are generally accepted and daily used by thousands of households in Norway for internet connection. The enormous growth in mobile data applications and new developed technologies in the cellular communications world have also made mobile broadband very much available via HSDPA, Wimax and now LTE. The advantage of mobile broadband technologies is primarily that people can browse the internet on the move as well as in their homes. Wi-Fi is another technology used to provide wireless broadband connections in the wireless zones, and the best thing is that it is fast. In fact, it is several times faster than the fastest cable modem connection. WiFi enables computers to send and receive data indoors and outdoor; anywhere within the range of a base station. This is the technology often used to deploy

city-wide wireless networks around the world, offering internet access for low prices compared to fixed and mobile broadband.

Wireless broadband has rapidly become popular and there are many wireless technologies on the market today. Wireless technology has been replacing the wired networks and gradually taken over the network market. With Wireless networking, the cables are eliminated, the networks are more compatible, and the connections become easier. The flexibility of wireless technology allows users greater access without the expense of cabling new buildings or areas. Therefore, the question is whether those cities providing Wi-Fi coverage are able to sell wireless broadband to the citizens for usage at home.

1.2 Problem description

Wireless Trondheim is today mainly a service for nomadic and mobile broadband in other words, for use outside the home. However, many places have good or excellent coverage and many people are using Wireless Trondheim as their primary access at home. Is there a potential to compete with fixed broadband such as ADSL and broadband via cable TV? The major goal of this study is to examine the market potential and the ability to use Wireless Trondheim as the primary internet access in the home. In this connection, it is important to observe the interest of the citizens for a monthly subscription of wireless broadband from the Wireless Trondheim. The following three research questions are developed to understand the above mentioned major goal of the study:

1) How is the coverage provided by Wireless Trondheim experienced by the citizens?
2) How is the market for Wireless Trondheim for sales of wireless broadband subscriptions?
3) How is the competition for Wireless Trondheim from other broadband types, such as fixed and mobile broadband?

1.3 Outline of the thesis

This thesis is divided into four main parts consisting 8 chapters:

I. Introduction & Background
II. Pre-study
III. Research
IV. Discussion & Conclusion

All the four parts consists of two chapters each, starting from chapter one and ending at chapter 8.

Chapter 2 gives an introduction of the Wireless Trondheim
Chapter 3 gives an overview of existing broadband technologies in the Norwegian market
Chapter 4 gives an overview of some successful Wi-Fi citywide network initiatives
Chapter 5 gives and overview of the research methodology used
Chapter 6 Results
Chapter 7 Discussion
Chapter 8 Conclusion

1.4 Challenges of the study

Some challenges were faced during the period this research was carried out. The biggest challenge faced, was related to the limited information available for the citywide wireless networks of Luxembourg and Westminster in London. Especially, in the case of Westminster, it was hard to find information about the competition of wireless broadband. Due to this limitation in relation to the availability of the information, most of the information which we used in thesis was retrieved from the literature survey. It was also hard to find information about the number of users who subscribed wireless broadband for internet usage at home, inhibited in the Luxembourg City and Westminster in London.

1.5 Previous work

This thesis is a continuation of the project delivered by Brage Rønning Tukkensæter in December 2008. His project elaborated possible technical solutions for extended indoor coverage using Wi-Fi and possible solutions for secure subscription handling in the Wireless Trondheim network. A brief summary of these indoor coverage solutions is given in the table 1.1. The table consists of the technical approaches together with its Pros and Cons.

After having discussed with Managing Director for Wireless Trondheim, Thomas Jelle, it became clear that they are not applying any of these approaches. Jelle believes that many homes, especially in Midtbyen, are getting wireless signals into their homes from their citywide network. Wireless Trondheim intends to focus on these residents in addition to increase coverage in other density areas, instead of focusing on above-mentioned expensive approaches. According to Jelle, Wireless Trondheim does not

want their customer's to buy and install any equipment on their own, in order to access their network from inside home. This is the reason for neglecting the "repeater inside the home" approach. Thus, new technical approaches will not be examined in this thesis. Instead, this thesis will focus on doing a market research for sales of wireless broadband subscriptions for Wireless Trondheim.

Table-1.1: Different indoor coverage approaches

Indoor coverage approach	**Pros**	**Cons**
Citywide indoor coverage	- Convenient for the users	- Extremely expensive - Can't connect with Ethernet
Mesh connectors in the home	- Extends the coverage of citywide network. - Easy management.	- Expensive, cost must be shared - Must be installed by operator - Can't connect with Ethernet
Repeater inside the home	- Cheap - Customers can install itself - Can connect with Ethernet	- May be difficult to manage - Each customer must have their own device

Chapter 2

Wireless Trondheim: An Overview

2.1 Background

Wireless Trondheim is the company operating and owning the citywide Wi-Fi network in the Trondheim, Norway. Wireless Trondheim started as a research and development project initiated by the Norwegian University of Science and Technology (NTNU) in 2005. In the autumn of 2006, several public and private partners came together to set the project in motion. September 1st 2006 became the day when Trådløse Trondheim AS (Wireless Trondheim) was founded. Just 3 weeks later on September 26th the wireless network was officially made available, making Trondheim one of Europe's first wireless cities.

Initially, the network was opened for students at NTNU and few others. However, considering the demand of users, the network was accessible for everyone as a paid service since September 2007. Founders and owners of Wireless Trondheim are: NTNU (35.0 %), Adresseavisen (25.0 %), Trondheim municipality (10.0 %), South-Trøndelag County Council (10.0 %), Sparebank 1 SMN (10.0 %) and Trondheim Energi (10.0 %) [1]. While managing the network is perhaps the most obvious of its activities, Wireless Trondheim also maintains several research projects.

2.2 Objectives

Wireless Trondheim's network uses wireless technology, often referred to as "Wi-Fi" or "WLAN", which makes it possible for users to use portable devices such as laptops or smartphones to gain access to the internet anywhere in the covered area. The major objectives of the Wireless Trondheim are to:

1. Build and deliver wireless internet coverage in Trondheim in order to make Trondheim more attractive for students and also for technology-based business;

2. Carryout research and development of new wireless and mobile services in order to contribute to a future-oriented Norwegian business and industry with expertise in wireless technologies, products and services; and

3. Together with NTNU, to facilitate and accommodate for research and development of new products and services by offering a platform for innovation called Wireless Trondheim Living Lab. This lab is providing a test platform for new products and services. In the WTLL network, students and researches can place their projects in an environment with real users and real world conditions. This combination of infrastructure and user base makes WTLL a unique test bed.

2.3 Coverage

Wireless Trondheim's network covers large parts of the downtown and surrounding areas of Trondheim (Figure 2.1). Today the network has outdoor coverage in the city of Trondheim, with around 150 access points and is spread around to almost 500 locations. One access point typically covers a radius of 20-50 meters indoors depending on building structure [1]. Coverage is overlapping, so that the user does not notice when he/she moves between the wireless zones. This also means that the user can log on the same network when inside the coverage area. Wireless Trondheim's network is mostly coverage oriented, meaning that the network is covering as large areas as possible with fewer access points. However, some places like "Torvet" and "Nordre gate" are built with more capacity in mind, thus the cell sizes are smaller and more access points are needed to cover the same area as coverage oriented one.

Figure 2.1: Coverage area of Wireless Trondheim in Trondheim City [1]. The green balloons show cafes or restaurants with wireless coverage in most of the premises. The yellow balloons mean that most of the premises have wireless coverage.

2.4 Services & Pricing

In addition to internet access, services concerning mobility, security and those based on user location are provided as well. Access is free for students and employees at NTNU, students at high schools in South-Trøndelag and employees in Adresseavisen and Trondheim municipality. Other users may purchase access. There is no need for subscription and everyone can buy access when connecting to the Internet.

Wireless Trondheim offer paid access for 3 or 24 hours. The price is 10 NOK for 3 hours access and 30 NOK for 24 hours access. Users will then get 500 kbit/s in capacity for this time-based login. During the time of writing, Wireless Trondheim has started offering a monthly subscription for 199 NOK with a capacity of 2048 kbit/s. Users pay with SMS for the 3 hour access and by using Visa/PayPal for the other access types.

2.5 Wireless broadband network

Wireless Trondheim is mostly using 802.11g on their sites, but 802.11b is also deployed in some locations. Wireless Trondheim is using both fiber optics and Wimax for the backhaul network supporting a number of access points. Fiber optics has a much larger capacity than the Wimax solution and it is widespread in the centre of Trondheim city, even though the connectors are quite few.

Between 50 % - 60 % of the access points in the Wireless Trondheim network are connected as mesh nodes, while the rest are connected through Ethernet cables. The mesh nodes are connected through 802.11a standard. However, an overview of wireless broadband technology will be given in Chapter 3.

Chapter 3

Broadband technologies in the Norwegian market

This chapter highlights the broadband technologies existing in the Norwegian market and mentions the patterns of broadband market in Trondheim.

3.1 Definition of broadband

The Norwegian Government's definition of broadband, as reflected in the ICT message[1] and broadband message[2] is *"Broadband is a two-way communications network that can carry various forms of data such as text, sound and moving images and must be able to carry new services and allow many users to use the Internet simultaneously"*[2]

The ITU (International Telecommunication Unit) definition of broadband sourced from the ITU's terms and definitions database is as follows: *"A term applied to telecommunications systems capable of simultaneously supporting multiple information formats at relatively high speeds such as voice, high-speed data services and video services on demand. Overall transmission speeds are typically hundreds to thousands of times faster than those of Narrowband systems and it has transmission channels supporting rates greater than the primary (ISDN) rate"* [3].

3.2 Classification of broadband types

Market participants often use the terms wireless broadband, mobile broadband and nomadic wireless broadband in different ways. According to The Norwegian Post and Telecommunications Authority (NPT), there exists no unified definition neither

[1] St.meld. nr.17 (2006-2007) Eit informasjonssamfunn for alle
[2] St.meld. nr.49 (2002-2003) Breiband for kunnskap og vekst

nationally nor internationally of the terms. NPT's definitions of these terms are as follows:

Wireless broadband: defined as an access capacity in which the end user, wirelessly connected to a public mobile network or public fixed network, has access to data transmission services with an experienced bit rate of at least 640 Kbit/s downstream and 128 Kbit/s upstream [4].

Mobile broadband*:* defined as an access capacity in which the end user, connected to a public mobile network, has access to data services with an experienced bit rate of at least 640 Kbit/s downstream and 128 Kbit/s upstream. Services are enjoyed without interruption, over a large coverage area [4].

Nomadic wireless broadband*:* defined as an access capacity in which the end user, connected wirelessly to a public fixed network, has access to data services with an experienced bit rate of at least 640 Kbit/s downstream and 128 Kbit/s upstream. Services are provided without a cable connection within a limited area [4].

Fixed broadband: High-speed data transmission to homes and businesses using technologies such as T1, cable, DSL and Fiber [5].

3.3 Fixed Broadband

Fixed broadband is associated to internet with cables. It can be via ADSL, cable-TV or fiber. The fact that cables are involved means that cables exists in the house connecting one through the above mentioned technologies. ADSL and broadband via cable-TV are most common ways to connect internet at home today. ADSL is most widespread, since every household in Norway can get this connection, but broadband via cable-TV happens to be more reasonable in price compared to ADSL. In the end of 2008, 98.8 % of the households in Norway had access to fixed broadband and among them 67 % of households were subscribing it [6].

3.3.1 Broadband via ADSL

ADSL (Asymmetric Digital Subscriber Line) is from the family of DSL (Digital Subscriber Line) technology used for Internet connection and is the most popular one among xDSL technologies. It is a technology for transmitting digital information at a high bandwidth on existing telephone lines to homes and businesses [7]. Meaning that more data is allowed to be sent over existing copper telephone lines compared to traditional modem lines. ADSL is asymmetric in a way that it uses most of the channel

to transmit downstream to the user and only a small part to receive information from the user (upstream) [7]. A special filter, called a microfilter, is installed on a subscriber's telephone line to allow both ADSL and regular voice (telephone) services to be used at the same time [8].

ADSL technology requires a special ADSL modem and subscribers must be in close geographical locations to the provider's telephone exchange to receive this service. Typically this distance is within a radius of 2 to 2.5 miles [8]. Each user is given a dedicated line from the telephone exchange, with a given capacity. Transmission capacity does not become lower for existing users even if the number of users increases. Capacity into and out of the exchange, however, will be charged more and can thus become a bottleneck.

ADSL supports data rates from 1.5 to 9 Mbps on the downstream and from 16 to 640 Kbps on the upstream [8]. Almost all households in Norway today have connectivity to ordinary phone lines [9]. Although, there are a large number of broadband providers selling ADSL and about 42 who are building their own infrastructure based on ADSL, proportion of ADSL subscriptions are decreasing [10]. The trend is an increase in the number of connections with fiber and coaxial.

3.3.2 Broadband via cable-TV

An upgraded cable-TV network is a broadband network that can be used to transmit voice, data and television signals. Cable networks are traditionally based on coaxial cable, but cable-TV providers now prefer to use a variant called HFC (Hybrid Fiber Coax), which is a combination of fiber optic and coaxial cable [9]. The theoretical capacities of the coaxial cables are several hundred times as big as twisted pair-cables used in ADSL, but for a cable modem huge part of this capacity is used to transmit cable-TV. The capacity is also strongly dependent on the number of users that are connected to a cable segment. In other words, the capacity of existing users will be reduced when new users buy the subscription.

Cable-TV networks are largely upgraded to provide internet access, in addition to television distribution. As the networks are digitized, the opportunities for higher broadband speeds are increasing. However, not all networks are upgraded to provide broadband access. Huge network parts of the major players have been upgraded to broadband, with high speed in both directions (upstream and downstream), based on HFC. Still, there are many cable-TV providers that only distribute television over their lines. It is estimated that approx. 45 % of the households in Norway get broadband

access via cable-TV[2] [11], which corresponds to 800,000 households [12]. There are around 30 providers of broadband via cable-TV [10]. With broadband via cable-TV, one can achieve capacities up to 7 Mbit/s.

3.3.3 FTTH (Fiber-to-the-home)

It is becoming more important to be able to move large amounts of data faster. A fiber line has very high capacity and can transfer vast amounts of information at much higher speeds than traditional TV and broadband cables. This is not only a much faster solution than the current alternatives, but also safer and more stable. Fiber line has a core of glass, and all data is transported as light signals. With fiber optic technology, broadband, broadband telephony and TV can be delivered in a single line at high speed. Fiber is the future solution for communication, information and entertainment in the home. With broadband over fiber, experiencing the maximum speed when online becomes possible. We can today with modern fiber transport bandwidths of approx. 14 Tbit/s (Terabit) over 160 miles distance [9]. With fiber, opportunities for many other services, such as HDTV and VoD (Video on Demand) become easy to achieve. A disadvantage is that the costs associated with the deployment of fiber in general are very high. The cost can be estimated between NOK 10,000-20,000 per household in dense regions [13]. The cost will be twice if one is living at countryside.

Scandinavia has the highest market share for fiber access in Europe. Fiber increases significantly in scope in Norway as well. Like Cable-TV, fiber is being deployed in central areas. In Norway, the power companies have been responsible for most of the development. Fiber win market share and participants have due to high capacities opportunity to offer advanced and bandwidth-intensive services, especially IPTV and VoD.

3.4 Mobile Broadband

This part of the chapter will give an introduction to radio technologies which use the mobile communication network for accessing the internet. Mobile Broadband refers to a data connection that can provide speeds according to the definition of broadband stated under section 3.2, and which is based on mobile communication technology. Technologies, which fall under this category, are mainly HSDPA and CDMA450. Common to both of the mentioned radio technologies is that the total capacity of a base station will have to be shared among all active customers within the geographic range of

[2] The figure is from the end of 2008.

the base station. This means that the customer experienced data speeds will vary depending on the number of simultaneous users and usage patterns of customers. Teleplan [11] estimates that 95 % of the country's households can get mobile broadband access. In June 2007 the same figure was 73 %.

UMTS (3G) is not included here as a mobile broadband technology, since it does not meet the speeds according to the broadband definition.

3.4.1 HSDPA (Telenor and NetCom)

HSPA (high speed packet access) is a combined name used for both HSDPA (high speed downlink packet access) and HSUPA (high speed uplink packet access). HSDPA is an extension of the UMTS standard for 3rd generation-mobile communications, which can provide higher downstream speeds than traditional mobile communications (GSM, GPRS, etc.). Data speeds that are attainable are comparable to those offered in today's ADSL solutions and HSDPA may be an option also as a broadband solution.

Theoretically, the overall capacity in one HSDPA cell is 14.4 Mbit/s for each 5 MHz carrier. However, the more likely capacities based on simulations are 2-3 Mbit/s in macro-cells (large cells) and 5-6 Mbit/s in micro-cells (small cells). This capacity is a shared resource that must be shared by all users in the cell. Typical end-user speeds will be from 700 Kbit/s and upwards, but this depends on a number of factors. There is also a rapid development of technology to continuously improve performance.

3.4.2 CDMA450 (ICE)

CDMA450 uses 450 MHz frequencies that were previously used by cellular system NMT450. This technology is based on CDMA family of cellular communications, which is the second largest group of systems after the GSM family (which also includes UMTS and HSDPA) and is used mostly in America and partly in Asia. ICE (formerly known as Nordic Mobile telephony) is the one to deploy this technology in Norway.

One CDMA450 cell has three sectors with nine carriers (1.25 MHZ x 9), which gives maximum theoretical download rate at 3.1 Mbit/s per carrier. It means that each sector can, in theory, offer 3x3.1 Mbit/s to customers [10]. Similarly, the upload speeds are 1.8 Mbit/s per carrier, a total of 3x1.8 Mbit/s to customers. According to ICE, a typical user is experiencing download speeds of 500-1500 Kbit/s. Compared with other mobile communication technologies, CDMA450 has the biggest advantage of covering greater areas. This is due to the relatively low radio frequencies, which has better propagation characteristics than the frequencies used in other mobile communications networks.

3.4.3 LTE (NetCom)

LTE is part of the GSM evolutionary path, following EDGE, UMTS, HSPA and HSPA Evolution (HSPA+) [14]. LTE describes standardization work by Third Partnership Project (3GPP), an industry trade group, to define a new high-speed radio access method for mobile communication systems.

LTE specifies a new OFDMA-based air interface, which will require operators to deploy new base stations with higher-bandwidth backhauls. New end-user devices will also be required to take advantage of this new technology [15]. LTE will also be able to operate in a number of frequency ranges, allowing operators to choose the options suitable for them.

LTE offers higher speeds and lower latency compared to its predecessors. Coupled with more efficient use of operators' spectrum assets, the technology enables richer and more compelling mobile service environment. LTE is made to accommodate increasing data usage and new multimedia applications such as VoIP, videoconferencing, online gaming, M2M and other real-time services.

3.5 An overview of the broadband market

The broadband penetration rate in private households increased from 70% to 71% in the last quarter in 2009. Private fixed broadband subscriptions as a percentage of households for only Trondheim were 82.9% in the same quarter [16]. Only in the county of South-Trøndelag, the total coverage with fixed broadband was 99.4% in the end of 2008, and if one is to include mobile broadband as well, than the total coverage is almost 100% [11]. The annual growth rate in the number of fixed broadband subscriptions was 5% in the last quarter of 2009 [16].

The table-3.1 shows the coverage for each of the broadband technologies with corresponding number of providers at the end of 2008. These numbers are retrieved from Teleplan [11].

Table-3.1: Coverage and providers for broadband technologies

Broadband technology	Coverage in percentage	Total number of Providers
xDSL	94.1	24
Mobile broadband	92.3	3
Cable-TV	45	29
Radio (Wimax and Wi-Fi)	30.5	26
Fiber	15.1	57

Mobile broadband market is shared by three operators – Telenor (59.6 per cent of all subscribers), NetCom (26.5 per cent) and Nordic Mobile telephony operating under the brand ICE (11.6 per cent). At the end of 2008 there were about 266,000 mobile broadband subscribers, an increase of about 173,000 since the end of 2007. About 70% of all new customers were signed up by Telenor. By the end of March 2009, Telenor alone reached 200,000 subscribers [6].

Capacity rate for Norwegian households is in average 4 Mbit/s. Nine households out of ten have the opportunity to purchase a connection with this capacity. 83% of the households have the opportunity to purchase a broadband connection with capacities over 8Mbits/s, but only 8% have acquired such a broadband access [10]. The average capacity for private broadband subscriptions increased to 5.9 Mbit/s from 4 Mbit/s in 2008 [16].

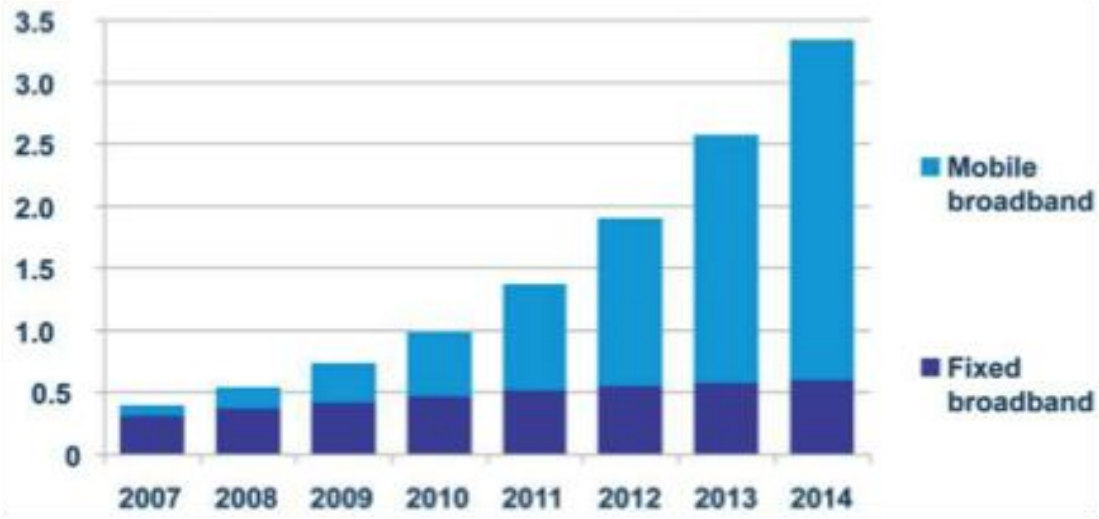

Figure 3.1: Broadband growth 2007-2014 [17]

Figure 3.1 shows that per day, fixed broadband has more subscribers than mobile broadband, considering the worldwide broadband market. However, this would change and take the contrary direction from 2010 and increase the subscriber numbers harshly for the mobile broadband throughout 2014. It can be seen that fixed broadband subscribers will remain the same, while enormous growth will take place on the mobile broadband side.

3.6 Wireless Broadband

The term wireless broadband will throughout this report be used for city-wide Wi-Fi based networks, and specifically for Wireless Trondheim in the latter part (in chapter 6). Wireless broadband service is considered (by consumers) to be a nomadic broadband service, because it does not have the sufficient signal coverage to be considered as a mobile broadband service. However, a consumer can reasonably expect to find signal coverage in some urban areas, and can therefore use the connection in more than one fixed location, but not necessarily stay connected in between urban areas [18].

Mobile Wimax will not be discussed due to its limited utilization as an access technology for wireless broadband in Norway. However, Wimax is several places used in the backbone network to transfer data to its destination. Wimax networks are also not as widely available as Wi-Fi, although a few cities have implemented Wimax networks.

3.6.1 Wi-Fi

Over the last couple of years, Wireless Fidelity or "Wi-Fi" has quickly grown to become the dominant wireless LAN standard. Wi-Fi is being deployed in public places to create what is called hotspots, where Wi-Fi capable users can obtain broadband internet access. Wi-Fi is a local-area networking standard which is developed by Institute of Electrical and Electronics Engineers' (IEEE) 802.11 families of standards, which include 802.11, 802.11a, 802.11b, 802.11g and 802.11n. This numbering system is used to classify these standards. It is designed to be used indoors at short range (e.g. where cellular network signals are having difficulties penetrating) to distribute internet access to a bunch of devices in homes, at offices, hotels, airports, restaurants, bookstores, schools, theatres, convention centres, health clubs, and other public venues. It is also used to cover the black spots from cellular networks at outdoor and to cover dense areas in cities where more capacity is needed.

Understanding the potential impact of ubiquitous internet connectivity, many cities have moved to create citywide wireless access infrastructure. Usually, the solution involves Wimax or fiber optic as the backbone network, supporting a number of Wi-Fi access points. Wireless Trondheim is one example of this type of infrastructure, as explained in chapter 2. The company is using 802.11g which can provide capacities up to 54 Mbit/s. The range of 802.11g can reach up to 50 m at indoor[3] and 110m at outdoor.

[3] The distance depends on impediments like walls, materials, environment and other obstacles. Frequency band used decides transmitting power and thus affect the range.

Wi-Fi is attractive because it is well deployed global standard and operates in the unlicensed spectrum; therefore no fee has to be paid for spectrum usage. It is integrated into the majority of laptops, mobile phones, PDA's, music players and even playstation and cameras today includes this interface. The other advantages of Wi-Fi network is that the availability of Wi-Fi products in the market. Many companies strive to ensure that users get the most updated software and hardware equipment in order to allow them to access a Wi-Fi network. Due to the wide availability of products in the market, the issue of pricing plays a significant role. Apparently, market forces are a major determinant of the prices available on products today. In addition, taking into account mobility is an advantageous aspect of a Wi-Fi network. People will be able to move about the given hotspot without loosing the network connection of Wi-Fi [19].

The biggest challenge of Wi-Fi is the limitation in roaming. International global roaming has proven to be one of the key success factors of the cellular industry (GSM etc.). However, several companies offer their subscribers a roaming service, as we will see in the next chapter, although this applies only to pay networks. There were nearly 252,000 free and pay Wi-Fi locations in 139 countries by January 2009 [20].

Chapter 4

City of Luxembourg and Westminster, London: An example of successful Wi-Fi city network initiatives

It is estimated that more than 1 000 cities have plans to deploy wireless city networks throughout the whole world [21]. The underlying motivation is that wireless city networks are cheap and flexible alternatives for fixed broadband networks. These initiatives are part of the broader city policies related to the digital divide, city renewal, innovation, encouragement of tourism and strengthening the economic fabric of the city. No doubt, wireless city networks also give Government personnel faster access to information and databases [22].

This chapter brings up two noteworthy examples of cities, which are leading the way towards becoming one of Europe's most advanced wireless cities. The cities to be described are, City of Luxembourg and City of Westminster, London. Their objectives, business models, pricing strategy, wireless broadband network, services and marketing strategy will be highlighted. The focus will mainly be on City of Luxembourg. This is due to two reasons; 1) limited information available about Westminster's project (especially marketing strategy was not possible to find anything about) and 2) Luxembourg's project is more comparable to Wireless Trondheim than Westminster's.

No doubt, Wireless Trondheim is one of the cities, which belong to this category as one of the first and most innovative wireless cities in Europe. An introduction to Wireless Trondheim was given in chapter 2. There are many other cities, which are deploying citywide wireless networks, but they will not be mentioned because of the limited time and space.

This chapter will be divided into two main parts. First part will be regarding City of Luxembourg and the latter is about City of Westminster.

4.1 City of Luxembourg

Ville de Luxembourg, or City of Luxembourg, is the capital of Luxembourg. The city is an economic and cultural capital of the greater Saar-Lor-Lux region, with 11 million inhabitants [23]. It is an important centre for finance and the seat of many European Union (EU) institutions and NATO. It is also a centre of political decision-making. Furthermore, this city is located in a country, which is the smallest metropolis in the world [24].

4.1.1 HotCity – Wi-Fi city network in City of Luxembourg

HotCity project is an initiative of the City of Luxembourg to build a municipal wireless internet infrastructure [25]. This project was for first time launched in July 2007 and has since expanded to cover almost whole of the city [26].

HotCity is part of the e-City vision, whose aim is to create a virtual city allowing the citizens to access a means of public and private services via fixed or mobile infrastructure [25]. HotCity is an open project inviting public services, businesses, application editors and independent stakeholders to join in with applications offering benefit services to all types of users [25]. By doing so, HotCity will revolutionise efficiency and transparency in all contacts with the City in the future.

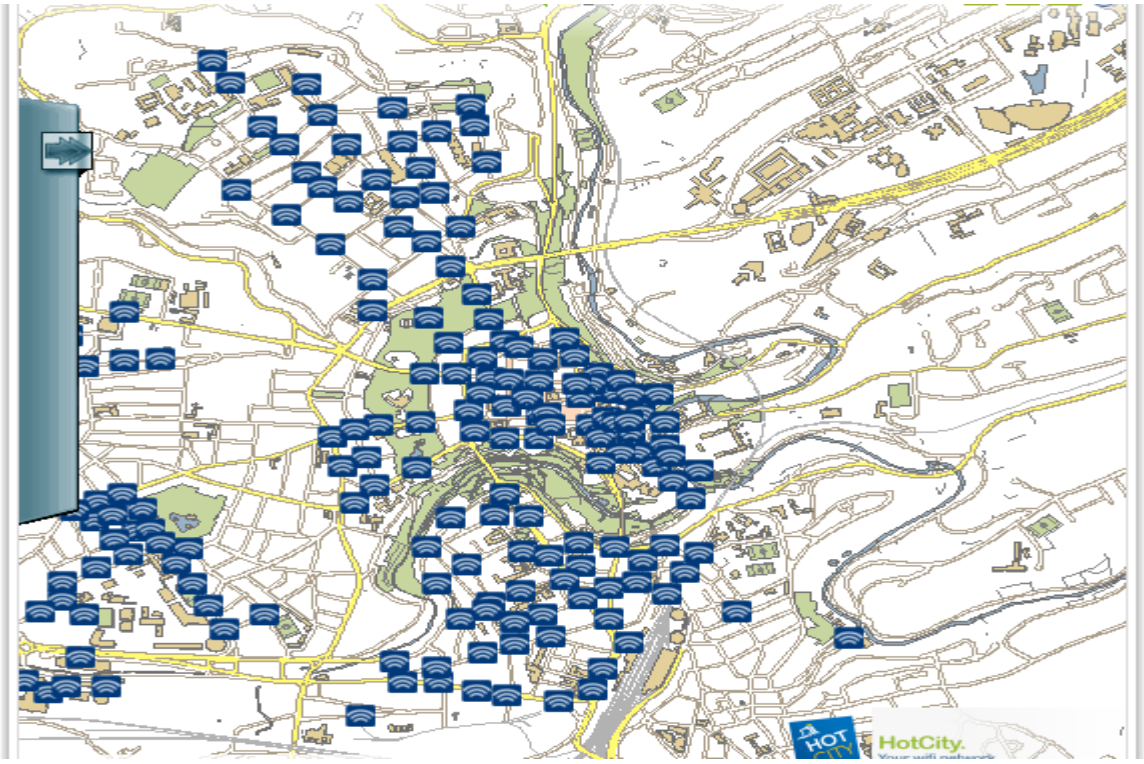

Figure 4.1: Coverage of wireless broadband in the Luxembourg City [30]

The city currently has some 400-access points and is becoming Europe's most advanced municipal Wi-Fi network. HotCity covers the city's 52-km2 area around the city and the plan is to provide seamless services (mobility provided by iPass) across Luxembourg (Figure 4.1). A lot is available on HotCity, such as city commune information and services, community groups and secure networks for closed user groups. Network is available at all travel locations including the airport, train stations etc. HotCity expect their network to grow to over 500 hotspots by the end of 2010 [23]. Having invested 3 million euro, the city expects the network to serve 85,000 inhabitants and 200,000 visitors a day by the end of the year of writing [23]. HotCity has 12,000 registered users per today and at times, the network gets close to 4000 people accessing its services in one day [6].

4.1.2 Objectives

HotCity have several objectives [25, 27]:

- Improve communications for the day-to-day operations of municipal workers.
- Give all citizens better mobile access to municipal resources and services. This is achieved by offering a wide range of specific web services that will enhance life and the experience within the territories of Luxembourg City. These services are free of charge.
- Open the network to a large set of commercial services. Open internet access is offered via different internet providers. A fee will be charged for this (section 4.1.7).

Mayor of the City of Luxembourg gave some statements related to goals and visions this project had in mind: *"Luxembourg has set itself a very ambitious task: the task of creating the most advanced communication infrastructure in Europe. HotCity will result in Luxembourg being recognised as one of the most connected and dynamic cities in the world."* [27]

Paul Helminger, Mayor of the City of Luxembourg also stated*: "We understood that the majority of failures in municipal network developments all around the world was a result of (1) either the network being limited to the users of one operator or (2) the network delivering only one or few specific services".* [26]

4.1.3 Business model

Without a plan that clearly describes policies, a city cannot make the right business model. For citywide wireless networks, municipalities are typically contracting with the

private sector to build and operate the network, which may be owned by the municipality itself. The business model developed for HotCity is globally unique in its inclusion of the number of diverse public and private partners offering a range of services. This diversity also ensures financial sustainability, causing by the high number of revenue streams. These revenue streams include [27]:

- Fees from ASP's (Applications Service Providers) and ISP's (Internet Service Providers)
- Advertising
- User access fees, roaming charges and DNS resolvers
- Revenue-sharing from application partners
- Platform leasing, for example by other cities
- Access to international roamers

P&T Luxembourg, who owns most of the fixed network infrastructure in City of Luxembourg, agreed to split the network infrastructure together with the city. The municipality created its own network in some parts of the city, but uses the incumbent's network in other areas. The network infrastructure is owned by the municipality, which makes it available to HotCity SA, company who manages and supports the network. The municipality keeps a majority stake in HotCity, which is managed by P&T Luxembourg [26].

The beauty of HotCity is its simplicity or ease-of-use and it has been an important selling point for the network. Having login windows as simple as possible has been encouraging for elderly people, who are not as confident with new technology [27]. This user-friendliness has been a key factor behind the massive user registrations growth.

4.1.4 Marketing strategy

HotCity has an ongoing market research programme including quantitative CATI (Computer Aided Telephone Interviews), CAPI (Computer Aided Personal Interviews) and CAWI (Computer Aided Web Interviews) modules, combined with qualitative modules, such as focus groups and face-to-face interviews [27].

These market research activities are intended for existing and future user groups, such as residents, travellers, business people and tourists. Doing so, HotCity will gain a good insight of the perception of these different user groups regarding the actual services delivered. This way, HotCity will continue to improve the future development strategy concerning convenience, services, applications and pricing.

Like any other network, HotCity's potential is directly proportional to the number of its users. In order to increase this number, good marketing schemes are required. There are many methods, which can be used, but not all methods are suitable in every geographical area. In City of Luxembourg, conventional communication methods are very limited, since 60.0 % of the city's residents are foreigners [27] and language issues mean that only a minority of these follow the national media. Furthermore, advertising in public places will be directed towards potential users with no previous knowledge of the product (business travellers, tourists, etc.).

In this type of environment, traditional advertising suffer too much from dilution. For these reasons, management of HotCity project has decided to use marketing strategies such as brochures, websites, street marketing, printed media, posters, conferences and buzz marketing [27]. Last mentioned is also called word-of-mouth marketing and is based on traditional word- of-mouth advertising. It is performed by people, who personally recommend the product to others.

Setting up social networks (blogs, forums, seminars etc.) of people with experience from projects similar to this has been another strategy for marketing purposes [27]. The objectives of this strategy have been to 1) make the project known at home and abroad 2) increase the number of users and 3) exchange of information to improve the types of services which will become relevant in the future.

When first launched, HotCity equipped schools with computers and started to educate people on how to use the HotCity portal. The next step was taken to allow people to log onto the city's website while they are on the go, thus several hot spots were installed for this objective [27].

4.1.5 Wireless broadband network

Availability, performance and coverage have been primarily the succeeding factors for this project so far. HotCity has a close development partnership with Cisco for this project, which ensures the network to have the most advanced technology at each time. Wi-Fi network of HotCity is also relying on the wireless mesh technology from Cisco, which uses two radio systems, one for interconnecting access points via 802.11a and other for broadcasting 802.11b/g/n cells for access [27]. This topology is same as used by Wireless Trondheim (see section 2.5). Use of mesh network brings connectivity to larger areas outdoor and interconnects most nodes by radio instead of cable. Cisco's service platform is probably the most important offering to HotCity and is called Cisco Intelligent Service Gateway (ISG). ISG allows the city to set up a professional network access to any private or public content provider [23]. The backhaul network used for

HotCity is totally based on City's fibre optic infrastructure [27], thus no Wimax base stations are deployed in addition, as in the case with Wireless Trondheim.

Regarding indoor coverage, the following is clearly stated on HotCity's webpage: "*The HotCity Network is an outdoor network. We do not guarantee any connection inside buildings"* [25]. However, indoor coverage exists at commercial ground floors (cafes, shops, etc.) as well as in key locations such as airport, railway stations, hospitals, etc.

4.1.6 Services

The location-based services hosted on HotCity provide a number of push applications designed to promote city centre businesses. These services are free and 60.0 % of the residents access these services [26]. For example, local services would be able to recognise the user in town and then alert them. Additionally a user can access the HotCity network to locate a certain city centre business or a particular brand. As the network knows the exact location of the user, it can not only direct him or her to that business, or some shops selling that particular brand, but it will also be able to give directions including details of any public transport required [27]. Prepaid car parking fees or SMS bus tickets are some other provided services.

HotCity applications have created user communities and social networks, which was one of the main goals of this project. Types of mobile applications provided are such as; tourist guide, students, business, neighbourhood, health, find, fun, city services, control and surveillance, mobility and information [27].

HotCity encourages individuals, students, companies and other organizations to come up with their ideas for new value-added services or other features/content that can help the visitors and residents of this city. To show that they are serious about this, "HotCity development competition" was held in 2008 [25]. A jury composed by independent professionals and HotCity staff responded to each participant. The initiators of the best ideas were granted access to the HotCity development platform in order to test their ideas**.** The jury awarded the best idea with a 5000 € money price in spring 2009 [25]. This is definitely a great way to stimulate innovation.

4.1.7 Pricing strategy

For citywide Wi-Fi networks, the revenue models are typically based on: 1) free services with advertising, 2) subscription services and 3) free services in some areas or only for some user groups.

In the case of HotCity, use of the network was free to all users for a short period after the launch in 2007. During the period when none of the services was chargeable, rapid growth of users and sessions took place on the network. Since November 2008, the city has been offering both paid and free access [27]. HotCity has been very careful when it comes to pricing the access, so that it does not become an entry barrier for users. Table 4.1 shows the current rates offered by HotCity for different types of subscriptions [28].

Table-4.1: Access rates for different subscription types.

Subscription period	Post-paid (Credit card)	Prepaid (Scratch card)
2 hours	4 €	5 €
2 days	8 €	9 €
30 days (month)	14,90 € (25 GB limit)	-

It can be seen from the table that both "time-based" and "subscription based" payment models are being used by HotCity, which is very normal and was the case for Wireless Trondheim. HotCity experienced that users do not like the 2-hour minimum pricing, because they mostly use it just to get access to certain specific information at one time [26]. It is of course the monthly subscription, which is relevant among the subscriptions. Converted to NOK, we can see the difference in price between HotCity at one side and Wireless Trondheim on the other hand. However, it is of course not sufficient to just convert the currency in order to see which of the service providers might be offering the cheapest access.

There are also other providers who are offering internet access in Luxembourg City. Tango and LuxGSM are the biggest among them. Tango is an operator with 245.000 subscribers in Luxembourg. In addition to providing 3G/HSDPA services, the company also provide households with ADSL connection. LuxGSM is 85.0 % owned by P&T Luxembourg and has 250.000 subscribers [7]. Some areas within the greater area of Luxembourg City have no Wi-Fi coverage. In these areas, 3G/HSDPA network will probably be most used.

HotCity is offering subscribers of these operators a great deal. A user paying 50 Euro monthly fees to LuxGSM can use the wireless broadband network of HotCity for free. While Tango subscribers have to pay 5 euro a month to HotCity. Monthly fee for Tango subscription is 45 euro, so in the end users of both networks end up paying 50 euro a month. The subscription price includes voice calls via cellular network, SMS, etc. Common for both operators is that one needs to have iphone subscription to get benefits of this offer [29].

4.2 City of Westminster, London

Westminster is a town and city in central London. It includes most of the West End, London's theatre district. Westminster is also the seat of British government, including the Houses of Parliament, Palace of Westminster and the royal family's official residence, Buckingham Palace [31]. The density of the district is high and huge part of the region is residential. In 2008, Westminster was estimated to have a population of 236,000. It is though noteworthy that population grows by around 1.1 million people (people who comes for work and etc.) on a typical weekday [32]. A total area of 28 square kilometres is covered by City of Westminster and it provides a workplace to more people than any other region in the UK [32, Figure 4.2]. Shopping areas around Oxford Street, Regent Street and Bond Street and the nighttime entertainment district of Soho (containing 2600 pubs, clubs, restaurants and theatres) also belongs to the City of Westminster.

Figure 4.2: Coverage of wireless broadband in the Westminster, London [36]

4.2.1 Wi-Fi city network driven by CCTV

The wireless network project follows the launch in July 2002 and its objective was to transform council services, whilst delivering significant cost savings and develop new services, and has been hailed as "*one of the most exciting developments in Westminster's history*", Leader of Westminster Council, Sir Simon Milton [32]. It is a key part of the One City vision, a five-year programme to build strong communities, supported by excellent council services.

From the start, the network was intended to provide internet access to borough residents, though its early phases would be restricted to Council applications, such as CCTV surveillance and monitoring noise pollution. By deploying wireless CCTV cameras on the existing network infrastructure, city officials have been able to actively monitor areas with high rate of crime. This has resulted with a decrease in criminal activity to its lowest level since April 2004 [10]. Already in 2003, the street crime was reduced with 54.0 % [32]. No other local authority has such advanced technology at their disposal and Westminster can be proud of having one of the world's most sophisticated CCTV systems.

4.2.2 Objectives

The aim of Westminster initiative was to make it easier to do business with the Council, renew the infrastructure of the City and deliver sustained improvements in education in addition to keep the City streets clean by reducing crimes. These objectives are included in the following:

1. Mainly a network for Government personnel.
2. Mainly a platform for e-Government services.
3. Specifically to provide CCTV application.
4. High ROI (return on investment) from mobile workforce applications within Government.

4.2.3 Business model

Westminster has developed a comprehensive public-private partnership, whereby the government, Westminster Council, has the role of orchestrator, while the network is owned and operated by a private party (e.g. service provider). Westminster Council offers service provider the right to use its physical infrastructure (such as lampposts, telephone boxes and towers) for a fee and agrees to act as the initial and largest customer of the network, running its own services on top of the infrastructure. In this

way, the government ensures a revenue stream strong enough to reduce the service provider's risk of an insufficient customer base among other businesses and citizens [33]. Service provider invests in and installs access points, routers, and antennas on the city's physical infrastructure. A number of municipalities in the United Kingdom in addition to Westminster have implemented this business model, including Birmingham, Edinburgh, Leeds, Liverpool and Cardiff, all of which have agreements with BT (British Telecom), the national incumbent service provider and a leading telecommunication provider [33].

Wi-Fi network needs to generate cash inflow streams and these are important for sustainability of the city's wireless network. For Westminster, there are three primary sources of revenue [33]; the general public/residents, the business community and the government. Secondary sources for revenue can flow in from the connectivity services, such as web browsing and e-mail, as well as from value-added services (high-speed internet access, VOIP calling, etc.). These services can be targeted towards mobile workers (logging onto public Wi-Fi hotspots) or residential and business users (using wireless to connect homes and offices directly) [33].

4.2.4 Wireless broadband network

BT Openzone is the name given to a network of Wi-Fi hotspots deployed by BT. with BT Openzone, one can access the wireless broadband network at over 190,000 wireless hotspots in the UK and Ireland, including Starbucks, Hilton Hotels, and all major UK rail stations and airports [34]. The coverage is widespread across 12 major city centers (e.g. City of Westminster) and at more than 50,000 international locations. BT's network accounts for 40.0 % of the UK's Wi-Fi hotspot population [35]. Wireless broadband network deployed by BT is faster than 3G/HSDPA and great for downloading music, movies and transferring data-rich files. It is beneficial for users compared to 3G/HSDPA, as charges are based on time spent online, not download limits, as is the case with 3G /HSDPA.

4.2.5 BT Openzone-Pricing strategy

This section will describe the pricing strategy used by BT Openzone towards wireless broadband subscribers. Westminster council is not involved in pricing the internet access, since BT is the one to offer this subscription. BT Openzone has many offers, but only monthly subscription options will be mentioned here. Monthly subscriptions are great if user wants to be online regularly. Table 4.2 shows the current rates offered by BT Openzone for different types of monthly subscription [34].

Table- 4.2: Access rates for types of monthly subscriptions with BT Openzone

Monthly subscription type	Monthly charge (ex. VAT)	Inclusive minutes	Minimum period
BT Openzone Original	£5	500 minutes on BT Openzone network	12 months
BT Openzone Together	£12.50	Unlimited minutes on BT Openzone network. 500 minutes UK roaming.	18 months
BT Openzone Global	£28	Unlimited minutes on BT Openzone network. 500 minutes UK roaming. 500 minutes international roaming.	12months

From the table we can see that three types (Original, Together and Global) of monthly subscriptions are offered by BT Openzone. BT Openzone original is cheapest, but the access is limited to only 500 minutes a month, an average of only 17 minutes per day. BT Openzone together will most likely be the option if the user wants to have regularly access without any limitation on amount of access time. The price for this subscription is almost the same as offered by HotCity in the case of Luxembourg City. Also, 500 minutes for roaming within UK are included, but there is entry barrier with these subscriptions and that is the minimum period a user has to subscribe for, when entering this monthly subscription. For BT Openzone Together, this period is 18 months, which is a lot. BT Openzone Global is the last option, and the only difference compared to above mentioned subscription type is the 500 minutes included for international roaming. The price is more than doubled, but this could anyway be a good option for those who travel a lot.

BT is also offering vouchers, which are ideal for occasional work trips or if one need to get online at short notice. Monthly voucher costs BGP 39 and it includes 4000 minutes [34]. Cash, debit card or credit cards are accepted for purchases of all BT Openzone Vouchers (cash only within selected BT Openzone hotspots) [34].

Chapter 5

Research Methods

The success of the analysis mostly depends on the research methodology on which it is carried out. The appropriate methodology will improve the validity of the findings and make things easier to analyze. In this chapter, we will look at the method, which is used to answer the research questions mentioned in the introduction. The chapter will start with presenting the overall strategy and then dig into the various sections.

5.1 Research design

The research design chosen to answer the research questions consists of the following four components:

1. Formulation of hypothesis.
2. Quantitative data collection.
3. Statistical analysis of data.
4. Discussion about results.

This research methodology corresponds to a common approach in research [37]. First, one must formulate appropriate hypothesizes. The next step will be to decide data collection methods and tools for collecting this data. After collecting data, analysis will be done by using appropriate software, and the results are then to be discussed at last.

5.2 Formulation of Hypothesis

In contrast to theories that provide general statements, the hypothesis claim specifically about a phenomenon, which makes it possible to test its validity empirically by an experiment. It is a non-fully tested claim. A slightly more accurate definition of the term is: "a *hypothesis is a concrete assumption about a fact"*. Hypothesis function is to determine what type of data to be collected in order to illustrate a problem, and will associate the connection between the data collected and the theory we want to test [38].

In our case, we want to examine the wireless broadband market for Wireless Trondheim, and in order to do so a number of hypotheses have to be tested. It is important to plan what kind of information we want to retrieve from respondents and which hypothesis we want to test. Making hypothesis will make it easier to make questions for the survey used to collect data. Several hypotheses can be made and one or more questions will be asked to cover one single hypothesis.

After having discussed with Thomas Jelle, we decided to test the following nine hypotheses:

Table-5.1: Description of the Hypotheses

Hypothesis number	**Description**
Hypothesis-1	Indoor coverage of wireless broadband is better in Midtbyen, than the outside of Midtbyen.
Hypothesis-2	The access of Wireless Trondheim in the market is highly competitive due to the attractive mobile broadband offers provided by Telenor, NetCom/NextGentel, and ICE etc.
Hypothesis-3	The respondents are not aware of the monthly wireless broadband subscription offered by Wireless Trondheim.
Hypothesis-4	Many respondents will be interested to receive the advantage of a monthly subscription from Wireless Trondheim, in addition to have fixed connection via ADSL or Cable-TV.
Hypothesis-5	Many respondents use Wireless Trondheim as their primary connection at home and they are willing to subscribe for monthly wireless broadband subscription.
Hypothesis-6	Respondents who use ADSL are more interested in a wireless broadband subscription than those using Cable-TV, as a connection at home.
Hypothesis-7	The price of wireless broadband subscription has much to say with regard to competing offers. (The price that respondents' are interested to pay significantly influences the willingness of respondents to buy the monthly wireless broadband subscription).
Hypothesis-8	Capacity is important for respondents and will be evaluated with respect to competing offers. (The level of expectation to the capacity of broadband will vary between the respondents).
Hypothesis-9	Simplicity is important for the respondents and will be evaluated with respect to competing offers.

5.3 Quantitative method

There are two methods in research, which can be used for collecting data and these are respectively quantitative methods and qualitative methods. First mentioned will be used in our study. Quantitative methods are research techniques that are used to gather quantitative data - information dealing with anything that is measurable. This method might test some hypothesis, and tend to produce results that can be generalised. The aim is to classify important variables and construct statistical models in an attempt to explain what is observed. This method is chosen because we want to analyze the wireless broadband market and therefore need to gather maximum number of answers.

5.3.1 Survey

Previous research has revealed that the survey method is most appropriate when investigating technology adoption [39]. The method used in investigating the market for wireless broadband was a web-based survey (also called Computer Aided Web Interviewing). The advantage of this method is that it requires less time than it is required using other methods (e.g. interviews, etc.) to reach out to thousands of people in a convenient way. Another advantage is that the survey is anonymous, which should contribute to greater honesty from respondents. It allows us to collect the data within a short period of time from the majority of respondents [40]. Lastly, it allows one to follow-up the data in real time. By using a survey it was possible to find out whether there is a market for selling wireless broadband subscriptions for Wireless Trondheim and eventually the size of this market.

The tool used to make the questionnaire and for gathering this data is LimeSurvey, open source survey application. A website where the scripts will reside and a database for saving all the incoming data were needed, to be able to use the LimeSurvey application. Following URL was used for hosting the scripts: *http://folk.ntnu.no/awaiseja/limesurvey/* and a server on NTNU was setup for saving all data. The answers for the questionnaire are transported immediately to this server so the data collection and the results can be tracked continuously.

5.3.2 Respondents

The respondents or targeted population was those residents in Trondheim who do not have free access to Wireless Trondheim's network. Thus, NTNU students, in addition to students from all the high schools in South-Trøndelag, employees in Adresseavisen and Trondheim municipality, are not considered as objects for this survey.

It was vital to reach out to the inhabitants in areas where Wireless Trondheim has coverage. Basically, it includes the Central area "Midtbyen" and other places where sufficient coverage is being provided.

5.3.3 Distribution channels for data collection

Survey was distributed to several institutions such as South-Trøndelag University College (HiST), Trondheim Business School (TØH), Norwegian School of Management (BI) and Queen Maud University College (DMMH). Both BI and DMMH distributed an e-mail with a link to the survey onto the mailing lists consisting of students and employees (Teachers etc.).

While BI and DMMH spread the message through e-mail on the request, HiST and TØH denied doing so. Instead, they used other channels to spread the word. TØH posted the e-mail as news on the homepage of STØH (student association for TØH), while HiST announced it onto the student portal on their intranet.

The contact with these institutions was made through both telephone and e-mail. Respondents were first given two weeks to respond and then a new e-mail was sent as a reminder, giving another two weeks till the deadline. This was done in order to increase the number of received answers. In total, a month was spent for the collection of data. Overall, the response was greatest from BI and DMMH, while the numbers of answers from HiST and TØH were below the expectations.

5.3.4 Types and classification of questions

The survey took approx. 5-8 minutes to complete and it was not possible for the respondents to cache the answers. The survey had to be completed once it was started. For each question the respondent had to choose the answer most convenient to him/her regarding the current issue. For all the questions, except question eight ('How respondents connected to internet at Midtbyen'), only one option could be selected. For question eight, one could select multiple answers. All the questions excluding question nr. 6, 10 and 15 were made mandatory. Norwegian was used as a language to make it easier for the recipients of this survey. It was definitely not a disadvantage to use Norwegian as the language since the colleges and schools targeted do not constitute a big number of students who do not know this language.

Simple and short questions are used in the survey, which are formulated so precisely that the respondent knows what she or he responds to. We have, for example, avoided using relative terms such as little or much in the questions. Rather, the question has

been specified, for example, daily, weekly or monthly. If a question can be interpreted in many ways, it is a bad question, because then it will be difficult to know what the respondent actually meant by his answer.

The survey holds in total 17 questions and these can be grouped into following five categories:

1. Demographic information (About the respondent).
2. Access and satisfaction towards Wireless Trondheim and internet connectivity/usage at Midtbyen and in the home.
3. Interest in monthly wireless broadband subscription and willingness to pay.
4. Mobile broadband subscription.
5. Importance of capacity and simplicity.

First category collects general information about the respondent. It provides demographic information that is needed to characterize the respondents' residential status. We have included questions, such as gender, age, residence and institution. It was especially useful to know whether the respondent lives in Midtbyen or not.

Second category of question group checks respondent's familiarity, experience and satisfaction with Wireless Trondheim in terms of coverage. This category also investigates how the respondent connects to the internet at home and when he or she is at Midtbyen.

Third category checks the popularity of a wireless broadband subscription offered by Wireless Trondheim among the respondents and their willingness to pay. It also finds out whether the respondents have knowledge about the monthly subscription.

Fourth category retrieves information from respondents about their relationship to mobile broadband and whether they subscribe to it, and the corresponding reasons. Fifth and last category of the question group examines how much capacity the respondents want to have on their broadband, and about the importance of simplicity.

All the seventeen questions fall into one of the following five question groups:

- Question 1-4: Demographic information.
- Question 5-10: Relation and satisfaction towards Wireless Trondheim and internet connectivity/usage at Midtbyen and in the home.
- Question 11-13: Interest in monthly wireless broadband subscription and willingness to pay.
- Question 14-15: Mobile broadband subscription.
- Question 16-17: Importance of capacity and simplicity.

5.4 Quality Assurance

Before the survey was completed and sent out, its quality, objectivity and magnitude were assured. It was first made a draft of the questionnaire, and then sent to the Professor for a review. Changes were then made based on the feedback that was given, and the survey was finally ready to be distributed. The major changes from the first version were the total number of questions. This number was halved at the time of completion. Figure 5.1 shows the whole process in a block diagram.

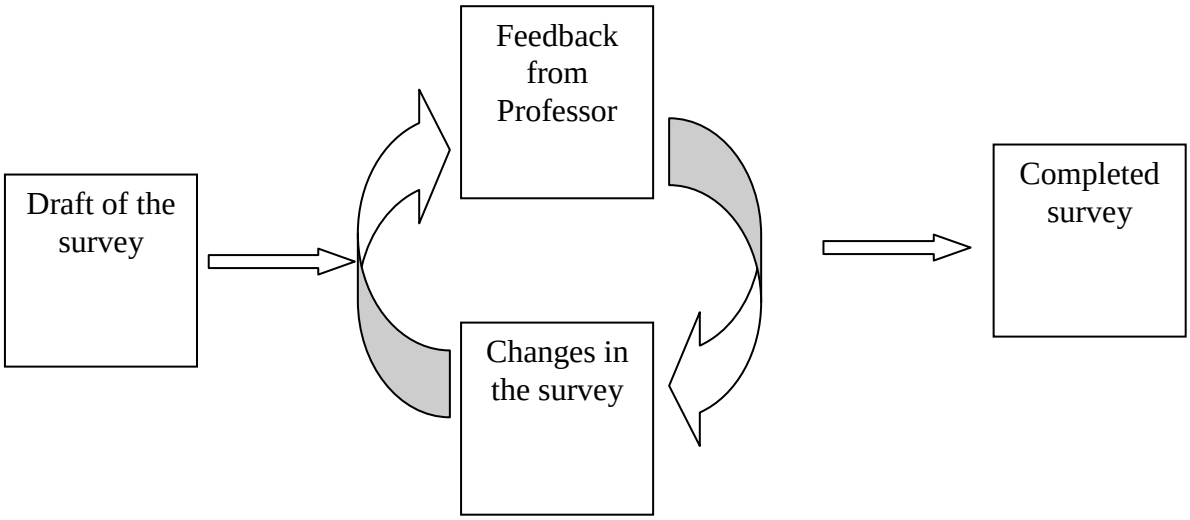

Figure 5.1: Survey quality assurance process

5.5 Analysis Method

SPSS 16.0 version for Windows was used to analyse the collected data. The chi-square statistic allows us to test hypotheses using nominal or categorical data. Stepwise regression includes regression models in which the choice of predictive variable is carried out by an automatic procedure. Linear regression was used in one section to examine the respondent's attitude. P-values were calculated in order to show the statistically significance of important variables. Hypotheses were accepted or rejected according to the P-value. Typically, P values less than 0.05 are deemed statistically significant, resulting in rejection of the Null Hypothesis. Null hypothesis is presumed to be true until statistical evidence nullifies it for an alternative hypothesis [41].

CHAPTER 6

RESULTS

6.1 Demographic analysis

Among the respondents (N=264) 33.7% were males and 66.3% were females (Figure 6.1). The sex ratio of males and females among the respondents was approximately 1:2. Majority of the respondents (N=192) resided at the outside of Midtbyen while the remaining (N=72) lived in the Midtbyen. The age distribution of respondents is largely covered by the interval between 20-25 (Figure 6.2). This is because data samples consisted of many students under this age class, which is significant statistically (Table 6.1). Among the respondents (N=264), 97.3% (N=257) were students, while 2.3% (N=6) were involved in job (Figure 6.3). The proportion of respondents' opinion was mostly received from BI and DMMH, while less percentage of respondents participated in the survey at HiST, TØH and other institutions[4] (Figure 6.4).

Table-6.1: Percentage of respondents according to age class, their involvement with the institutions in Trondheim, and the location of their residence. P indicates the significance value.

Demographic variables		Occupation of respondents				Statistics		
		Student (N=259)	Teacher (N=1)	Employee (N=6)	Total (N=266)	χ^2	df	P ≤
Age	<20	4.6	0.0	0.0	4.5			
	20-25	79.2	0.0	0.0	77.1			
	25-30	6.2	0.0	33.3	6.8			
	30-40	6.2	100.0	33.3	7.1			
	>40	3.9	0.0	33.3	4.5	41.8	8	0.001
Institution	BI	55.6	0.0	0.0	54.2			
	TØH	1.6	0.0	0.0	1.5			
	HiST	5.1	0.0	0.0	4.9			
	DMMH	35.4	100.0	16.7	35.2			
	Other institutions	2.3	0.0	83.3	4.2	98.5	8	0.001
Location of residence	Midtbyen	28	0.0	0.0	27.3			
	Not Midtbyen	72	100	100	72.7	2.7	2	0.260

[4] These respondents have probably responded to the survey from STØH's homepage, but they do not belong to TØH.

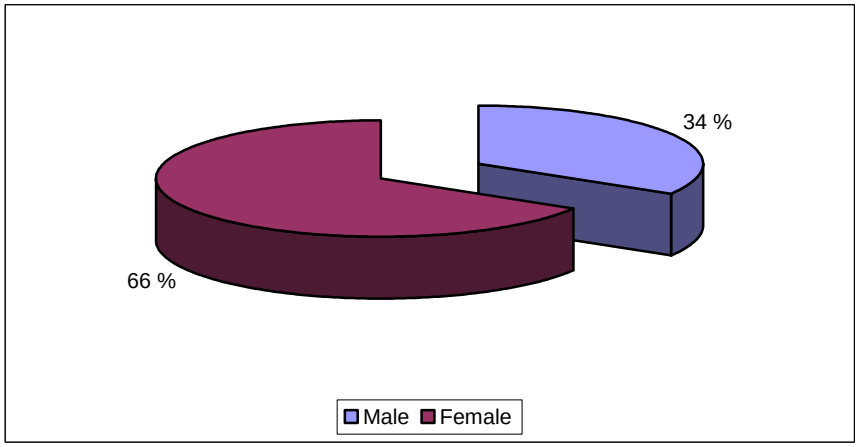

Figure 6.1 - Distribution of gender among the respondents

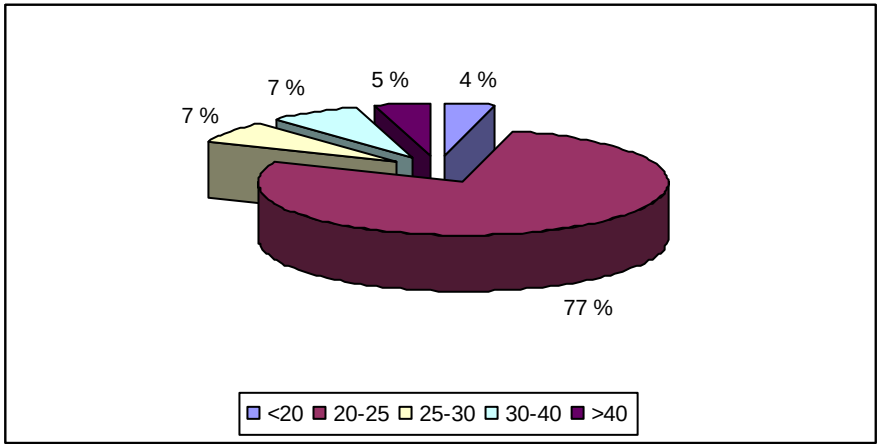

Figure 6.2 - Distribution of age among the respondents

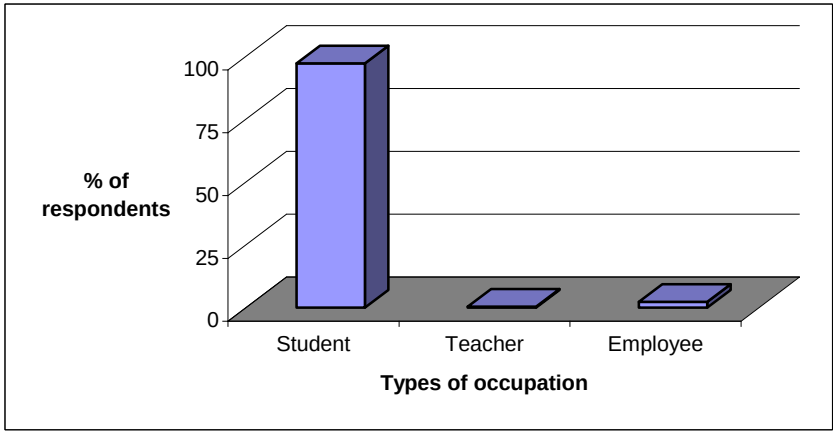

Figure 6.3 - Occupation of respondents

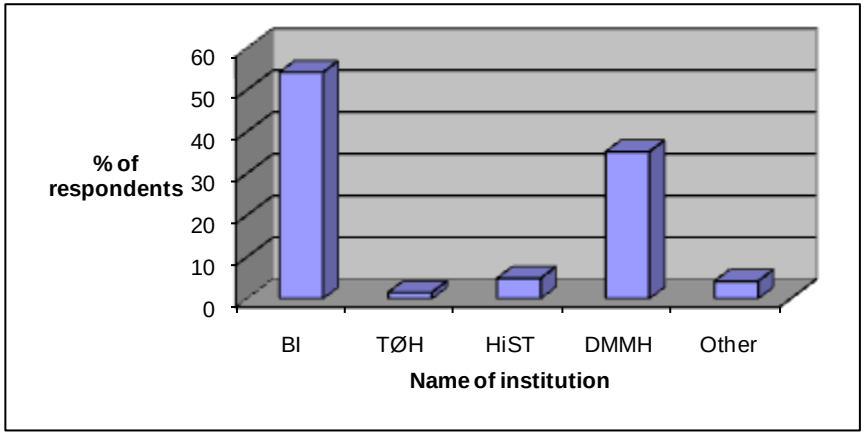

Figure 6.4 - Distribution of respondents by institution

6.2 Access to Wireless Trondheim at home

We asked respondents, 'Do you have access to Wireless Trondheim at home?' Figure 6.5 show that more than half of the respondents (53.4%) did not have access to the Wireless Trondheim at home. Among the respondents who resided at Midtbyen, 36.1% did not have this access (Table 6.2). No more than 15.9% of the respondents have had access to this connection interface, of which only 5.7% used it as the main connection at home and most of them resided at Midtbyen. This scenario, proved the hypothesis-1 statistically significant (Table 6.2). The remaining 30.7% totally ignored about the type of connection interface they used to connect internet at home. Among these respondents resided at Midtbyen, 26.4% had access of both wireless broadband and other types of connection (such as fixed or mobile broadband), but only 11.1% used wireless broadband as the main connection.

Table-6.2: Percentage of respondents having access to Wireless Trondheim at home, in relation to the location of their residence. P indicates the significance value.

Category of responses	Location of residence of respondents			Statistics		
	Outside Midtbyen (N=192)	Midtbyen (N=72)	Total (N=264)	χ^2	Df	P ≤
No, do not have coverage	59.9	36.1	53.4			
Yes, but I mainly use a different connection	4.2	26.4	10.2			
Yes, I use it as the only connection	3.6	11.1	5.7			
Don't know about the connection interface	32.3	26.4	30.7	36.6	3	0.001

6.2.1 Frequency of use

To the following question; 'How often do you use Wireless Trondheim to connect to internet at home'?, 85.5% of the respondents reported that they did not use Wireless Trondheim to connect internet at home, while 5.5% of the respondents rarely used Wireless Trondheim (Figure 6.7). Only 4.7% of the respondents used Wireless Trondheim to connect internet at home on daily basis, while 2.0% used this connection interface as more than 3 times in a week (0.8%), at weekly basis (0.8%), or at monthly basis (0.4%). More than 2.0% of the respondents could not mention the name of connection interface that they used to connect internet at home (Figure 6.7).

6.2.2 Satisfaction level

On the question about the level of satisfaction of respondents towards the coverage of Wireless Trondheim in their home, 55.8% replied "Not at all" indicating their

dissatisfaction with the coverage (Figure 6.6). Among the remaining respondents, 22.8% expressed their satisfaction level as "Some extent", while 19.2% reported it as "Lower extent". Only 2.2% were satisfied (to great extent) with the coverage of Wireless Trondheim.

Table-6.3 Percentage of respondent's satisfaction about the coverage of wireless broadband at home provided by Wireless Trondheim. P indicates the significance value.

Level of satisfaction	Location of residence of respondents			Statistics		
	Outside Midtbyen (N=157)	Midtbyen (N=67)	Total (N=224)	$\chi 2$	df	P ≤
Not at all	63.1	38.8	55.8			
To lower extent	14.6	29.9	19.2			
To some extent	19.7	29.9	22.8			
To a great extent	2.5	1.5	2.2	12.9	3	0.005

Table 6.3 shows that the respondents (63.1%) resided outside of Midtbyen show higher level of dissatisfaction to the coverage level of Wireless Trondheim than those resided in Midtbyen (38.8%). Respondents' satisfaction towards the coverage of Wireless Trondheim was highly significantly correlated with their access to Wireless Trondheim at home (Table 6.4).

Table-6.4: Percentage of respondent's satisfaction level towards the coverage provided by Wireless Trondheim in their homes. P indicates the significance value.

Level of satisfaction	Do you have access to Wireless Trondheim at your home?				
	None (N=131)	Yes, but use different connection (N=25)	Yes, use as main connection (N=14)	Don't know about connection interface (N=54)	Total (N=224)
Not at all	77.1	12.0	7.1	37.0	55.8
To lower extent	14.5	20.0	28.6	27.8	19.2
To some extent	8.4	64.0	50.0	31.5	22.8
To a great extent	0.0	4.0	14.3	3.7	2.2

Statistics: $\chi 2$= 82.6, df= 9, P ≤ 0.001

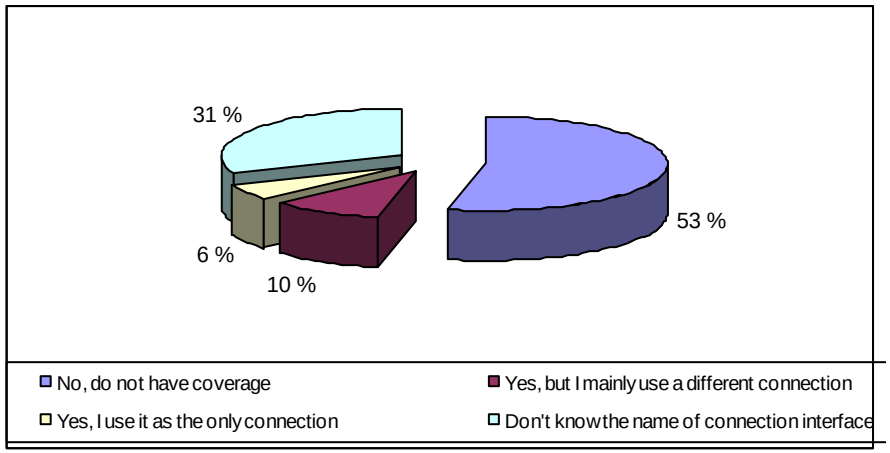

Figure 6.5- Access to Wireless Trondheim at home

Figure 6.6- Level of satisfaction with the coverage of Wireless Trondheim at home

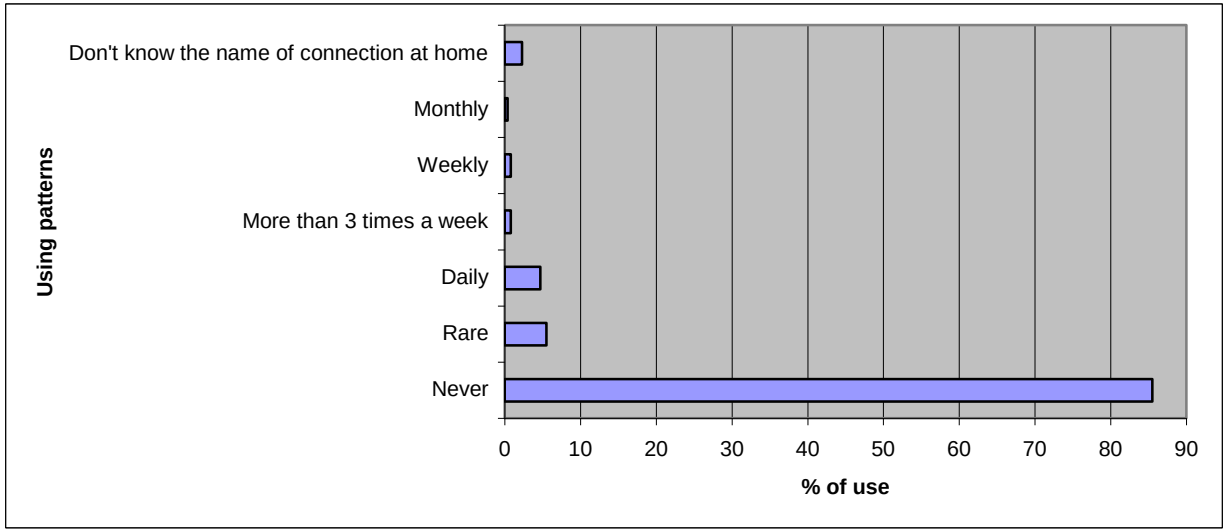

Figure 6.7 – Frequency rate of using Wireless Trondheim at home

6.3 Internet connection

6.3.1 Internet connection at Midtbyen

In response to the question, 'How do you connect to internet in Midtbyen?' Around 78.0% used internet in Midtbyen, while the remaining 22.0% did not (Figure 6.8). Unsecured (open) networks were mostly used to connect to the internet at Midtbyen compared to other connection interfaces such as via café, Wireless Trondheim, and mobile broadband. Wireless Trondheim (14.0%) was almost as widely used as mobile broadband (15.0%) from various providers. More than 10.0% of the respondents could not mention the name of the connection interface, which they use in Midtbyen (Figure 6.8).

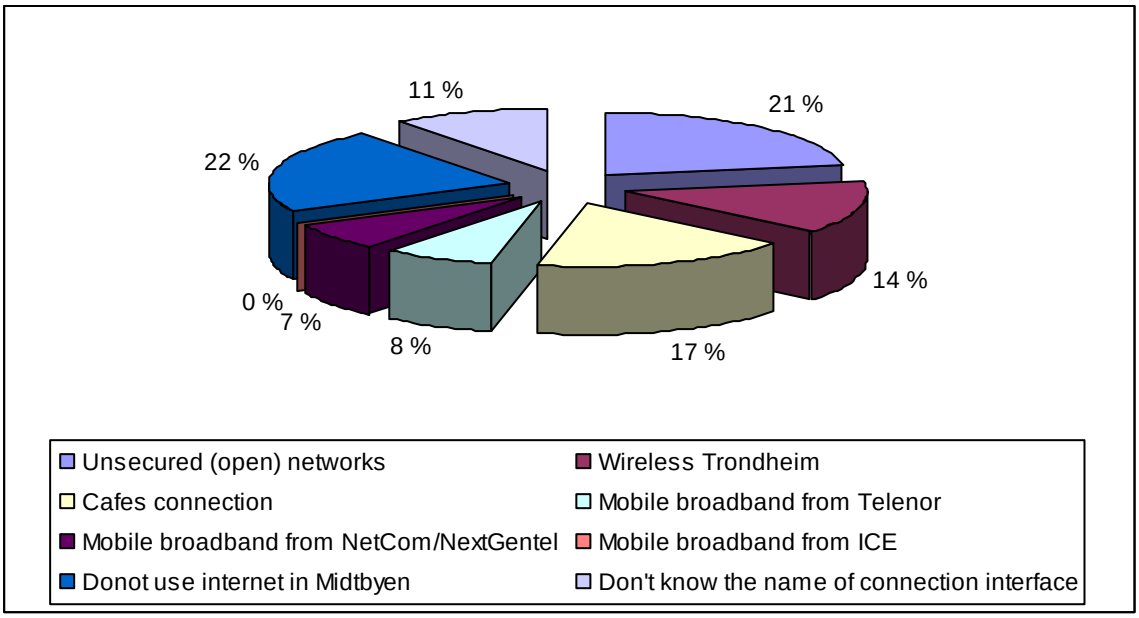

Figure 6.8 - Connection interfaces used in Midtbyen in order to connect to internet

The respondents who resided outside of Midtbyen mainly use cafés connection (24.5%), unsecured (open) network connection (18.2%) or Wireless Trondheim (10.9%) in order to use internet in Midtbyen. The remaining 19.8% used mobile broadband and unknown connection interfaces to connect internet (Table 6.5).

Among the respondents resided in the Midtbyen, 26.4% used unsecured (open) networks, 16.7% Wireless Trondheim, 20.8% mobile broadband, 9.7% cafés connection and the remaining 9.7% used unknown connection interfaces (Table 6.5).

Table-6.5: Percentage of respondents using different connection interfaces for internet usage in relation to the location of their residence

Connection interfaces	Location of residence of respondents		
	Outside Midtbyen (N=192)	Midtbyen (N=72)	Total (N=264)
Unsecured (open) networks	18.2	26.4	22.3
Wireless Trondheim	10.9	16.7	13.8
Cafes connection	24.5	9.7	17.1
Mobile broadband from Telenor	5.7	9.7	7.7
Mobile broadband from NetCom/NextGentel	2.6	11.1	6.85
Mobile broadband from ICE	0	0	0
Don't use internet in Midtbyen	26.6	16.7	21.65
Don't know the name of connection interface	11.5	9.7	10.6

6.3.2 Internet connection at home

Respondents were asked about the main connection interface, which they used in their home in order to connect internet. Connection through ADSL and Cable-TV was mostly used in home compared to other types of connection interfaces such as mobile broadband, unsecured (open) networks, Wireless Trondheim, community networks etc. (Figure 6.9). The respondents living in Midtbyen are more dependent on ADSL (31.9%) than Cable-TV (22.2%) for internet connection at home, while the residents living outside of Midtbyen almost equally use both technologies. Among the respondents, who used Wireless Trondheim as the main connection at home, 5.6% resided in the Midtbyen and 0.6% outside of Midtbyen (Table 6.6).

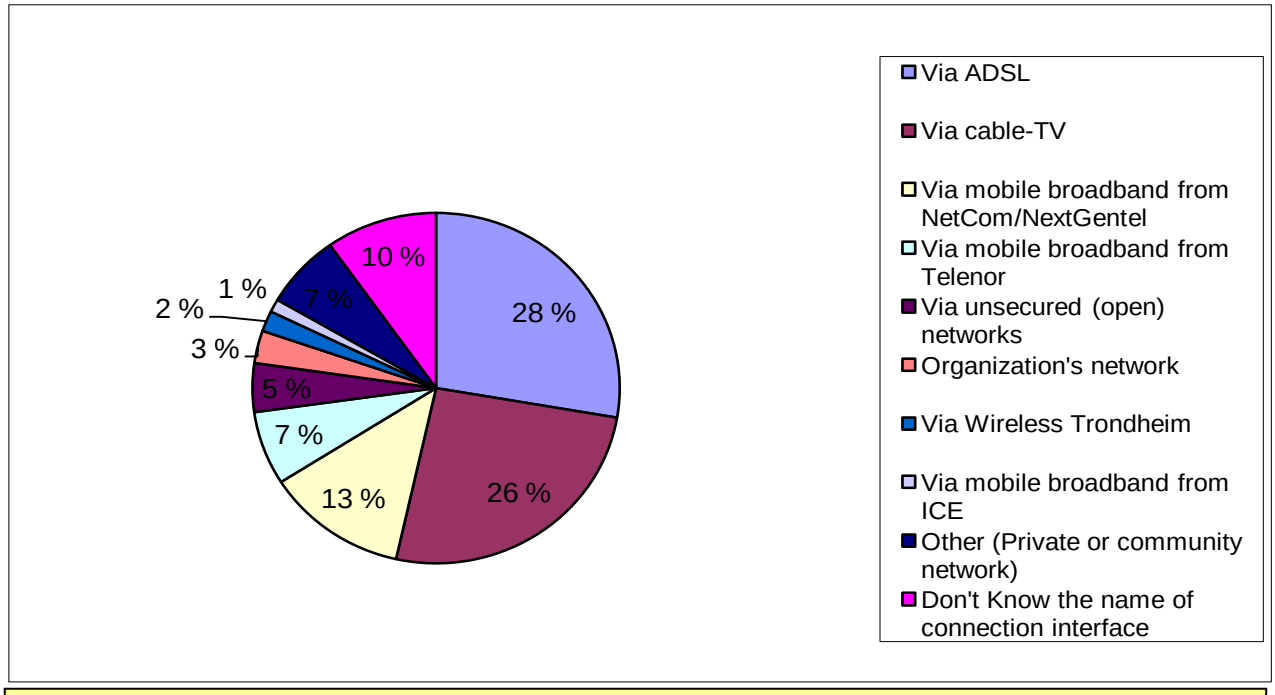

Figure 6.9 - Main connection interface used at home by the respondents

Among the mobile broadband networks that are available in Trondheim, NetCom/NextGentel was largely used, compared to Telenor and ICE. However, 9.8% of the respondents did not know which connection interface they used in their home. Organization's networks were also used as the main connection at home. The percentage was almost 3.0% for both those who lived in Midtbyen and for respondents living outside of Midtbyen (Table 6.6). Organization's network is a term used for those who were involved with one of the following networks: NTNU, NTEBB, NTE, ITEA and get. This option was included in the analysis after examining the collected survey data.

Table-6.6: Percentage of respondents using different connection interfaces as the main connection at home in relation to the location of their residence.

Connection interfaces	Location of residence of respondents		
	Outside Midtbyen (N=192)	Midtbyen (N=72)	Total (N=264)
Via ADSL	26.0	31.9	27.7
Via cable-TV	27.1	22.2	25.8
Via mobile broadband from NetCom/NextGentel	12.0	13.9	12.5
Via mobile broadband from Telenor	7.8	4.2	6.8
Via unsecured (open) networks	3.6	6.9	4.5
Organization's network	3.1	2.8	3.0
Via Wireless Trondheim	0.6	5.6	1.9
Via mobile broadband from ICE	1.0	1.4	1.2
Other (Private or community network)	6.8	6.9	6.8
Don't Know the name of connection interface	12.0	4.2	9.8

6.4 Mobile broadband subscription and reasons to acquire it

Respondents were asked if they were subscribing to mobile broadband and what the reason was to acquire such connection interface. The majority of the respondents were not subscribing to mobile broadband (Figure 6.10). The respondents resided outside of Midtbyen used mobile broadband (15.6%), Talkmore (1.6%), Community network etc. and unknown connection interfaces (4.2%). Among those who lived in Midtbyen 15.3% used mobile broadband, while 12.5% used others and unknown connection. We assumed that the access of Wireless Trondheim in the market was highly competitive due to the attractive offer(s) provided by the mobile broadband (Hypothesis-2). The respondents (N=59) who used mobile and wireless broadband, among them only 8.5% used wireless Trondheim, which indicated significantly highly competitive market for the Wireless Trondheim compared to mobile broadband service providers such as Telenor, NetCom/NextGenTel and ICE ($\chi 2$=8.1, df=3 and P$\leq$ 0.044).

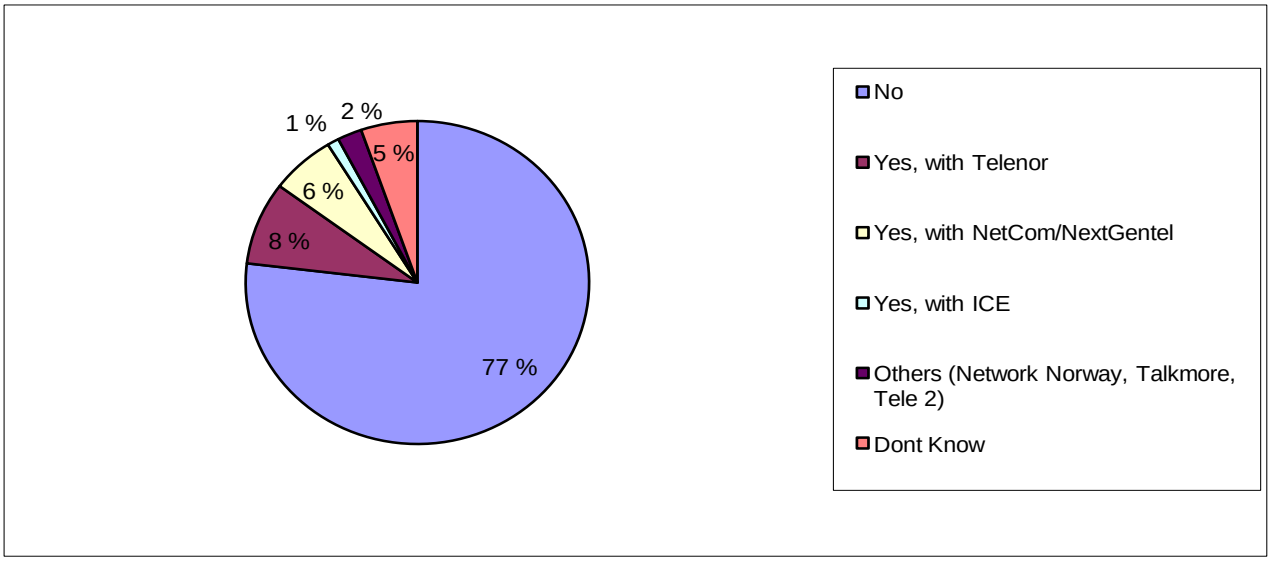

Figure 6.10 - Have you subscribed for mobile broadband?

However, among those subscribing to mobile broadband the reasons were many; such as mobility & access to internet outside of home (38.0%), portability (24.0%), and if there was less possibility of fixed connection at home (8.0%), which is statistically significant (Table 6.7). Telenor and Netcom/NextGentel were mostly used compared to other mobile broadband providers such providers such as ICE, Network Norway, Talkmore, and Tele 2.

Table-6.7: Percentage of respondents who subscribed mobile broadband in relation to the reasons of subscription. P indicates the significance value.

Have you subscribed for mobile broadband?	Reasons to acquire a mobile broadband subscription					
	Mobility and access at outside (N=23)	Portable (N=15)	No fixed connection in home (N=5)	Less expensive (N=7)	Don't know (N=12)	Total (N=62)
No	13.0	0.0	60.0	42.9	75.0	29.0
Yes, with Telenor	47.8	53.3	0.0	28.6	0.0	33.9
Yes, with NetCom/NextGentel	21.7	33.3	20.0	28.6	25.0	25.8
Yes, with ICE	4.3	6.7	20.0	0.0	0.0	4.8
Other (Network Norway, Talkmore, Tele 2)	13.0	6.7	0.0	0.0	0.0	6.5

Statistics: $\chi 2 = 33.1$, df= 16, $P \leq 0.007$

6.5 Interest in wireless broadband and willingness to pay

6.5.1 Knowledge about monthly subscription

We assumed that the respondents were not aware about the monthly subscription of wireless broadband (Hypothesis-3). This assumption was accepted by the statistical analysis ($\chi 2$=9.8, df=3 and P≤ 0.021). Our study shows that more than two-third (78.8%) of the respondents have no idea about the monthly wireless broadband subscription offered by the Wireless Trondheim (Figure 6.11), whereas only 8.0% knew about it. The knowledge of respondents related to the monthly wireless broadband subscription is significantly influenced by the place where they live ($\chi 2$= 9.8, df= 3, P ≤ 0.021). The respondents who answered 'Yes' in relation to the knowledge of a monthly subscription were mainly living in Midtbyen (16.7%), whereas the percentage was 5.2% for those living outside of the Midtbyen.

6.5.2 Willingness to buy monthly subscription

However, when the respondents were asked if they were willing to buy a monthly wireless broadband subscription from Wireless Trondheim, only 16.3% replied 'Yes', while 6.1% agreed under certain terms and conditions such as subscription price, capacity and stability (Figure 6.12). The percentage of respondents willing to buy monthly subscription was almost same for those resided at Midtbyen and those living outside of Midtbyen (Table 6.8).

Table-6.8: Percentage of respondent's willingness to buy monthly wireless broadband subscription in relation to their residential status.

Willingness of respondents	Location of residence of respondents		
	Outside Midtbyen (N=192)	Midtbyen (N=72)	Total (N=264)
No	36.5	37.5	36.7
Yes	15.6	18.1	16.3
Other	6.2	5.5	6.1
Don't know	41.7	38.9	40.9

Our hypothesis-4 was that many respondents would be interested to receive the advantage of Wireless Trondheim related to monthly subscription, in addition to have ADSL or Cable-TV connection. However, more than half of the respondents (54.0%) were not interested to subscribe wireless broadband in addition to have other connection interfaces at home. This rejects our above-mentioned hypothesis statistically ($\chi 2$=7.2, df=6 and P≤ 0.301). Only 1.0% of the respondents were really willing to subscribe wireless broadband, but conditionally 42.6% agreed to subscribe wireless broadband (Figure 6.13).

Among the respondents who already use Wireless Trondheim as the primary connection at home 40.0% were interested to pay subscription for wireless broadband (Figure 6.14), which rejected the hypothesis-5 ($\chi 2$=50.2, df=45 and P≤ 0.274). Here we sum up the response 'Yes' and 'Conditional acceptance' for ranking the willingness of respondents to subscribe wireless broadband as an additional connection at home. The respondents who used other connection interfaces (such as Talkmore, community networks etc.) as a main connection for internet at home, among them the user of other connection interfaces (38.9%) show more willingness to pay subscription for wireless broadband, as an additional connection. The user of mobile broadband from Telenor (33.4%), broadband user of organization's network (25.0%), NetCom/NextGentel (24.2%), Cable-TV (22.0%), unsecured (open) networks (16.7%) and ADSL (15.0%) shows willingness to pay monthly subscription for wireless broadband provided by Wireless Trondheim. We expected that the people who used ADSL were more interested to take advantages of Wireless Trondheim than those using Cable-TV, as a connection at home (Hypothesis-6), but it was also rejected statistically ($\chi 2$=37.0, df=27 and P≤ 0.094).

Respondents who agreed to subscribe wireless broadband emphasized mainly on the subscription price, than stability and capacity of broadband. However, Figure 6.15 shows that 57.6% of the respondents agreed to pay subscription price of NOK 100 per month, while 18.0% were willing to pay NOK 150 and 14.0% were eager to pay NOK 200 per month. The amount that respondents' interested to pay significantly influenced the willingness of respondents to buy the monthly subscription of wireless broadband (Hypothesis-7) (Table 6.9).

Table 6.9: Percentage of respondents willing to buy monthly subscription of wireless broadband in relation to their willingness to pay. P indicates the significance value.

Willingness of respondents to buy a monthly subscription on wireless broadband							**Statistics**		
Willingness of respondents to pay for a monthly subscription from Wireless Trondheim	**NOK**	**No (N=97)**	**Don't Know (N=108)**	**Yes (N=43)**	**Conditional acceptance (N=16)**	**Total (N=264)**	**$\chi 2$**	**df**	**P ≤**
	100	78.4	49.1	39.5	37.5	57.6			
	150	14.4	23.1	30.2	25.0	21.2			
	200	5.2	21.3	23.3	25.0	15.9			
	250	2.1	4.6	7.0	6.2	4.2			
	300	0.0	0.9	0.0	6.2	0.8			
	350	0.0	0.9	0.0	0.0	0.4	38.5	15	0.001

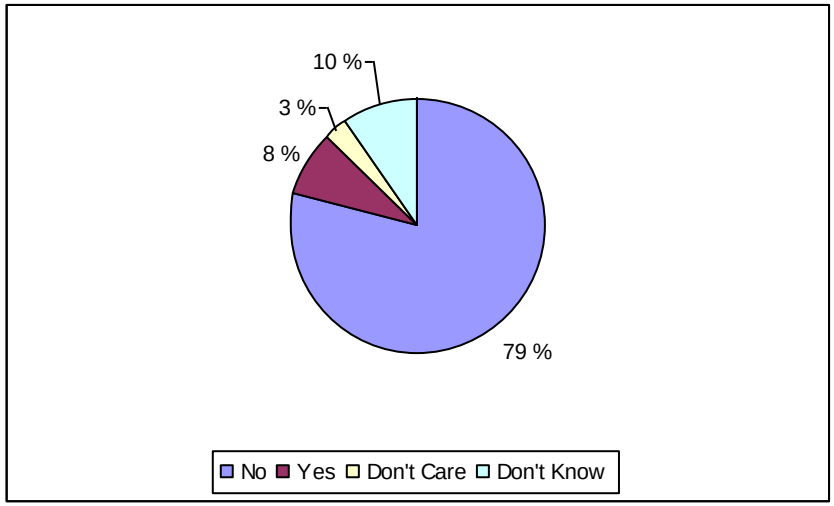

Figure 6.11 - Respondents knowledge about the monthly subscription offered by Wireless Trondheim

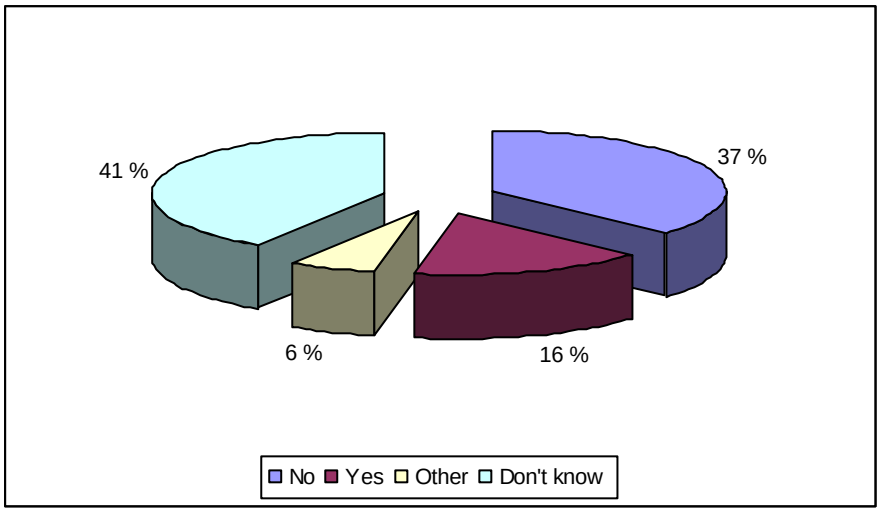

Figure 6.12 - Willingness to buy a monthly wireless broadband subscription from Wireless Trondheim

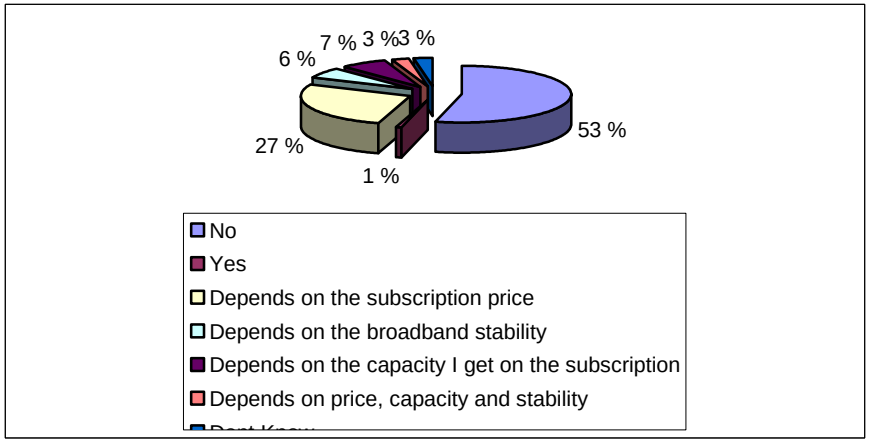

Figure 6.13 - Willingness to subscribe wireless broadband in addition to having fixed broadband as a main connection at home

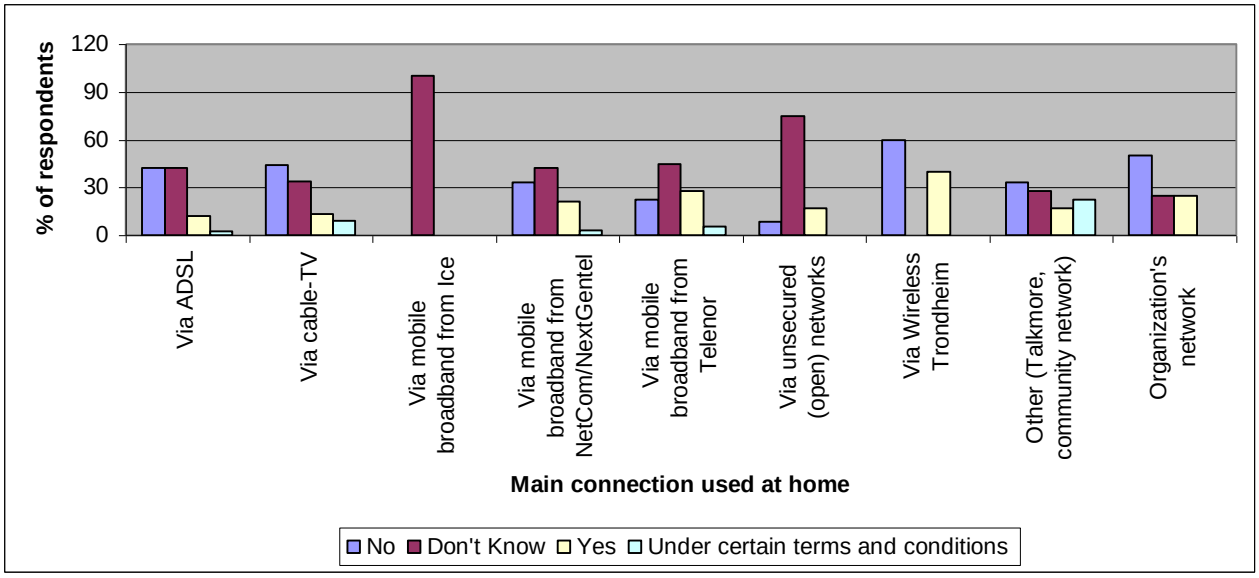

Figure 6.14-Willingness to buy a monthly wireless broadband subscription from Wireless Trondheim, as a secondary connection

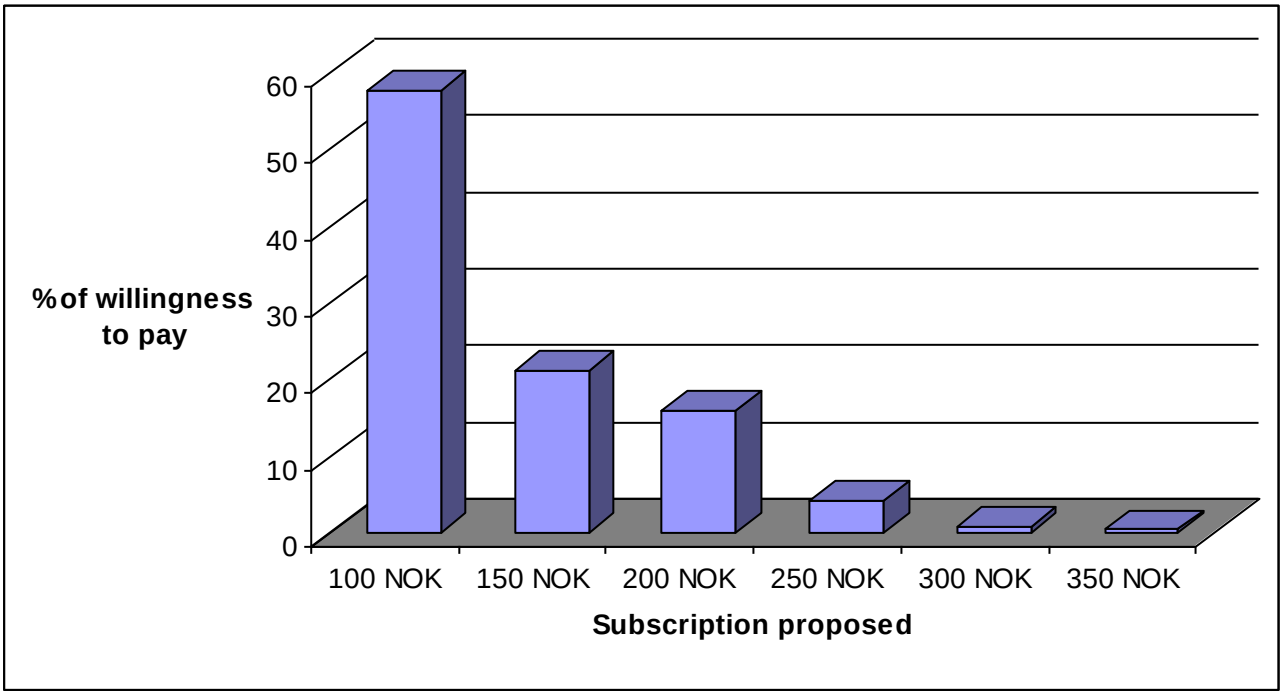

Figure 6.15 - Willingness to pay for a monthly wireless broadband subscription (NOK)

6.6 Importance of capacity and simplicity when choosing a broadband

6.6.1 Capacity demand for broadband

Majority of the respondents (53.4%) could not mention the capacity of broadband that they desired. One-third of the respondents (28.8%) desired capacity of broadband more than 2 Mbit/s; while 13.6% expected 2 Mbit/s of capacity. Very few (4.2%) expected the capacity of broadband less than 2 Mbit/s (Figure 6.16).

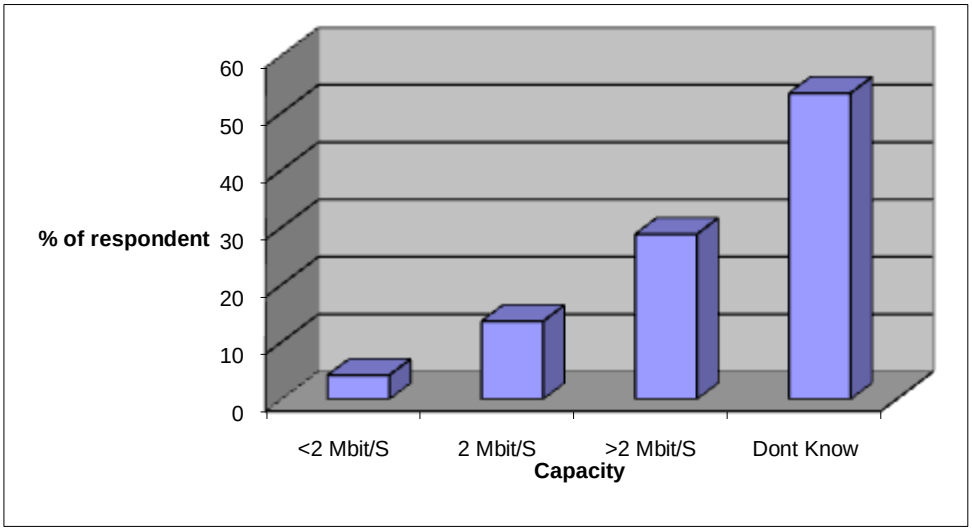

Figure 6.16 - Capacity demand for broadband

The level of expectation to the capacity of broadband significantly varied with the gender and age of the respondents (Table 6.10) which accepted our assumption significantly (Hypothesis-8). Males expected higher capacity of broadband than females. Similarly, the respondent's between 20-25 years expected higher capacities compared to other age classes (Table 6.10).

Table-6.10: Percentage of respondent expectations regarding capacity in relation to gender and age. P indicates the significance value.

Gender	Capacity of Broadband				Statistics		
	<2 Mbit/S (N=11)	2 Mbit/S (N=36)	>2 Mbit/S (N=76)	Don't know (N=141)	χ^2	df	P ≤
Male	6.7	16.9	60.7	15.7			
Female	2.9	12	12.6	72.5			
Total	4.2	13.6	28.8	53.4	86.3	3	0.001
Age							
<20	0.0	20.0	10.0	70.0			
20-25	3.4	13.7	33.2	49.7			
25-30	0.0	22.2	5.6	72.2			
30-40	21.1	5.3	15.8	57.9			
>40	0.0	8.3	25.0	66.7			
Total	4.2	13.6	28.8	53.4	27.3	12	0.007

6.6.2 How important is it for your choice of broadband that you do not need to install software or to buy new hardware?

We asked respondents, 'How important is it for your choice of broadband that you do not need to install software or to buy new hardware?' Figure 6.17 shows that among the respondents, 45.8% said 'Important' and 34.8% expressed their opinion as 'Very important' while the remaining 19.7% replied as 'Less important' (13.6%) or as 'Not important at all' (5.7%).

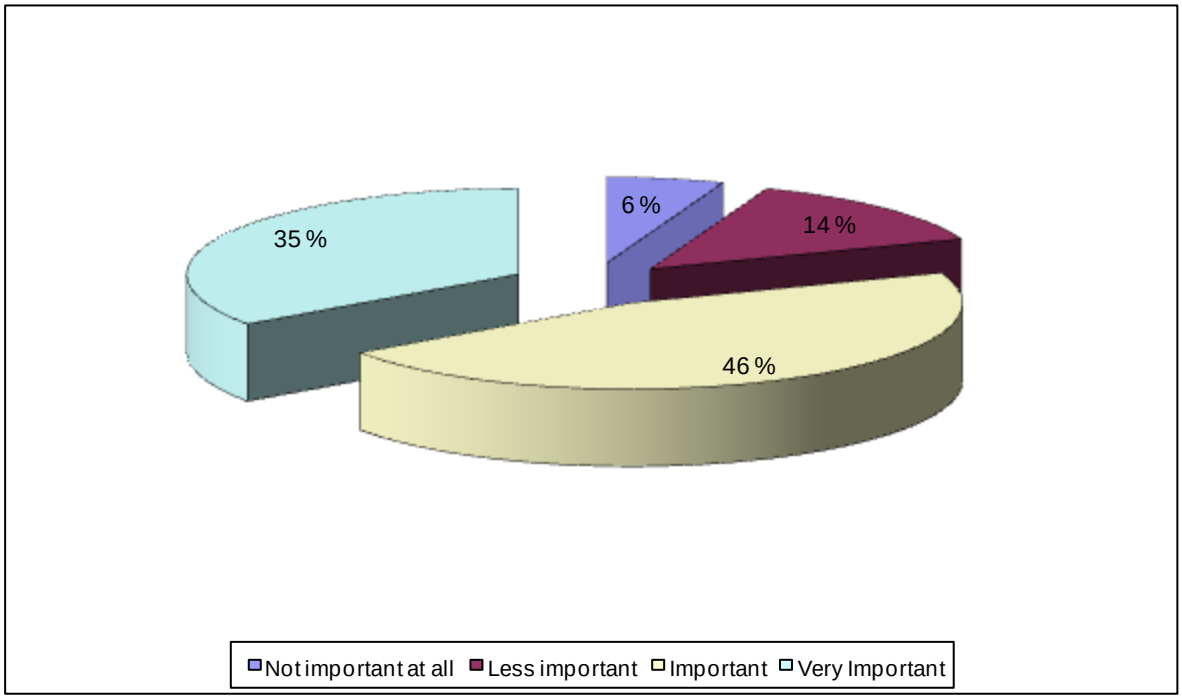

Figure 6.17 – Importance of simplicity when choosing a broadband.

A stepwise linear regression analysis with the question 'How important is it for choice of broadband that do not need to install software or buy new hardware?' (Hypothesis-9) as the dependent variable, was used to test how much of the variation in this variable was explained by ten independent variables (Table 6.11). Only two of them proved to be significant contributors to explain the variation. The variable explaining most of the variation in this attitude was the occupation of the respondents. Students prefer more simplicity in using broadband than others. Gender of the respondent was the most important predictor. Females prefer more simplicity in the choice of broadband than males. Settlement status, age, access to wireless broadband, satisfaction with the coverage provided by Wireless Trondheim, frequency rate of using Wireless Trondheim, willingness to pay monthly subscription, benefits of mobile broadband and the expected level of capacity of broadband by the users were insignificant variables.

All the independent variables explained 22.0 % of the variation of people's perception towards the simplicity of using wireless broadband.

Table-6.11: Results of stepwise linear regression analyses of the question 'How important is it for your choice of broadband that you do not need to install software or buy new hardware?' as dependent variables in relation to various independent variables (R = rank, t = t value and P indicates the significance value).

Independent variables	R	t	P ≤
Occupation of Respondent	1	-3.059	0.004
Sex of Respondent	2	2.034	0.047
Location of Respondent	8	-0.216	0.830
Age of Respondent	4	1.167	0.249
Access to Wireless Trondheim at home	3	1.177	0.245
Satisfaction with the coverage provided by Wireless Trondheim at home	6	-0.435	0.666
Use of Wireless Trondheim to connect internet at home	9	-0.138	0.891
Willingness to pay for a monthly subscription for wireless broadband	10	0.061	0.952
Reason (s) to acquire a mobile broadband subscription	5	-0.822	0.415
Capacity expected by the users for broadband	7	0.365	0.716
R^2		0.220	0.002
Constant		5.156	0.001

Chapter 7

DISCUSSION

This chapter will discuss the results presented in previous chapter. Discussion will mainly be about the most important findings, regarding the hypothesis. Among other points to be discussed are; to which extent Wireless Trondheim should pursue with monthly subscription offers, and the improvements which can be made in order to increase the wireless broadband demand. A marketing research strategy for Wireless Trondheim will be proposed and those factors leading to larger market for Luxembourg compared to Wireless Trondheim will be shed a light on. However, the discussion will start with explaining the sample size of respondents involved in this survey.

7.1 Respondents

Since most of the residents in central areas of Trondheim are mainly students, they are an obvious group to target. We expected to get data from minimum 200 respondents, which we achieved. More data would have been beneficial, but the amount collected was good enough to do the analysis and to draw some conclusions.

The survey was distributed to a lot more than those who responded. The mailing list of DMMH consists of 870 students and 106 employees, giving a total number of 976 people. BI forwarded the e-mail to approximately 1.000 people, including students and employees (only 14 employees were contacted). 7.000 students and 700 employees had access to portal at HiST, where the survey was resided. STØH has in total 900 members and all of these, in addition to other interested, had the possibility to access their website and respond to the survey. In whole, the survey was made available to approximately 11,000 inhabitants in Trondheim and we know for sure that 2,000 out of these received the survey on e-mail. This was also reflected in the results (almost 90% of the respondents were among these 2,000 belonging to either BI or DMMH). This is the positive effect of sending the survey on e-mail to the students. We are sure that we would have received at least twice number of respondents if HiST and TØH had been able to use e-mails to reach the students.

As mentioned in section 5.3.2, a huge size of the population in Trondheim was excluded as the target group for this survey. This huge group consisting of almost 30,000 people is definitely one of those groups, which most frequently accesses services provided by Wireless Trondheim. This is a very significant factor explaining the total number of respondents involved in this survey.

Majority of the respondents were living outside of Midtbyen. Knowing the fact that Wireless Trondheim has good coverage in Midtbyen[5] (section 2.2) and limited outside of Midtbyen, gives us the reason to be cautious about the total result. Even though, those living outside of Midtbyen could be living anywhere, we can still assume that majority among them are not living far from their institution. Since BI is very close to Midtbyen and DMMH is on a distance of approximately 3 km from "Torvet", it could be predicted that a lot of respondents within this category could be living very close to Midtbyen area. We can thus draw conclusions from the results, which are responded by those who are living at Midtbyen, thereby having coverage from Wireless Trondheim.

7.2 Indoor coverage and competition for Wireless Trondheim

Our finding in section 6.2 was that indoor coverage is higher at Midtbyen than outside of Midtbyen. This result is not a new finding and neither is it a shocking outcome, since Wireless Trondheim has their major coverage in areas at and around Midtbyen (section 2.3). However, the dissatisfaction towards the coverage from Wireless Trondheim provided at homes for respondents living at Midtbyen was very high. These respondents are most probably living in those spots where the signal strength is not sufficient enough to get the coverage inside home. Those respondents who had access to Wireless Trondheim at home were a lot more pleased than those not having this availability, although majority of the respondents who had access to this network at home used some other connection interfaces. The reasons could be many, such as availability of other free networks, internet connection included in the house rent, demand for more capacity and competition from fixed and mobile broadband. Last mentioned is to be discussed next.

Competition for Wireless Trondheim is hard from providers of both fixed and mobile broadband. It seems that respondents are happy with broadband provided through ADSL and Cable-TV, since only one respondent was willing to pay for a monthly wireless broadband subscription in addition to having fixed connection. As mentioned

[5] A report released by Wireless Trondheim in 2008 reported that 35,000 residents are living inside their coverage area. This number is probably higher today. Today Trondheim has approximately 170,000 inhabitants, and among these there are only 40,000-50,000 living in the central areas.

in section 3.3, fixed broadband technologies such as ADSL and Cable-TV are mostly used in the homes as the main connection for internet access. It is mainly because these fixed technologies have been there for a while and is widespread all over the country, as explained in section 3.3. Almost every house in Norway today has a telephone line and it is a good policy developed by providers, which has been able to "lock" many customers. Another reason could be insecurity associated with trying and adapting to a new technology.

It is obvious from the results that competition from Telenor and NetCom/NextGentel is high for Wireless Trondheim. There were actually more people using broadband via NetCom/NextGentel as a connection at home, than during their visit to Midtbyen. It was seen from the results in section 6.3.2 that portion of respondents who used NetCom/NextGentel at home, was six times the number of Wireless Trondheim users. Market shares for NetCom/NextGentel are increasing and it is the partnership between them, which is the reason their customer base is almost twice than Telenor. Respondents might have been more interested in purchasing wireless broadband from Wireless Trondheim if the competition from these providers was less.

7.3 Monthly subscription

Since the monthly subscription on wireless broadband is a service offered by Wireless Trondheim very lately[6] it has still not reached to the public, which was obvious from the results. The results show that the respondent's knowledge about the subscription had an increase of 70% for those living at Midtbyen, compared to those living outside of Midtbyen.

We can see from section 6.5.2 that among the respondents who are using Wireless Trondheim as their primary access at home, less than half of them were willing to pay a monthly subscription for wireless broadband offered by Wireless Trondheim. Among those resided outside of Midtbyen and who did not have this coverage, a percentage was willing to pay for the same subscription. It might be that these respondents are not using internet very much, thus the desire for more capacity, which comes with a subscription is irrelevant.

Monthly subscription price seems to be one of the main triggers behind the decision regarding purchase of the wireless broadband from Wireless Trondheim. From the results we could see that whenever the price was decreasing, thus the amount of respondents willing to buy the subscription was increasing. Even though charge of NOK 199 is not expensive compared to other offers, the main factor could be that; since

[6] March 2010.

almost all the respondents are students and assuming many of them are living in the student villages (Moholt, Voll, Berg, Steinan etc.) they probably already have an internet connection included in the rent. While at the campus, the corresponding network can be used for free. Thus, they have less need to buy wireless broadband subscription from Wireless Trondheim in addition. Typical rates for a broadband connection are per today 200-400 per month. The price respondents were willing to pay was expected to be low, since majority of them are students and want the cheapest and best offer in the market. The fact that competition is very high from other broadband providers (both fixed and mobile) do not make the matter easier when it comes to attracting people to wireless broadband offered by the Wireless Trondheim.

The interest in subscription is linked with more factors then just the price. Capacity on the broadband and simplicity which comes with the subscription is also very important, as confirmed by the results. However, more than half of the respondents did not know what capacity they wanted on their broadband. This question could have been difficult to interpret for a portion of respondents and maybe that is why so many responded with "Don't know". Overall, 18% expected capacity of 2 Mbit/s or less. Among those who expected more than 2 Mbit/s in capacity, approx. 80% were having fixed connection via ADSL or Cabel-TV at home. These broadband technologies, including fiber, are providing consumers higher capacity internet connections. It is therefore becoming more difficult to satisfy the customer in regard to capacity, since also the average capacity rate in Norway is increasing in a high pace as mentioned in section 3.5.

We could analyse from the results that simplicity is very important for respondents in their choice of broadband. This is an advantage Wireless Trondheim has compared to other offers/connection interfaces, since the customer does not have to install any software or buy any new equipment (only a device is needed). This is especially true for fiber and cable-TV, where the customer in some cases has to pay for the new line up to the household (excavation costs) or own user equipment must be connected (for example, the antenna on the wall). This can be a barrier for many to connect up to broadband. The service provider can of course do this, but it is for the majority of people relaxing to know that this is not an issue. Even for the mobile broadband subscription, one needs to have a USB dongle to be able to connect internet.

7.4 Recommendations for marketing strategy

Customer Satisfaction helps every firm to keep the existing customers and to get new customers. From the results, it can be seen that satisfaction level among the respondents is not positive at all. Thus, Wireless Trondheim should progress in a high pace to improve this satisfaction by increasing the number of access points, while engaged in wireless broadband market.

It became very clear from the results that wireless broadband offer has to be highlighted as much as possible through different marketing schemes. Wireless Trondheim may follow some of the marketing methods used in the HotCity project, as mentioned in section 4.1.4. The Company can make brochures, which informs about the wireless broadband subscription offer and distribute it to the public. This can be done by either sending post to the residents living at Midtbyen and other places with coverage, or by having stands at Midtbyen and advertise in this way. Even though the HotCity project is having a lot of success, it is difficult to measure it or directly compare it with Wireless Trondheim. This is mainly due to the difference in total area of the respective cities. While City of Luxembourg is only consisting an area of 52 km2, Trondheim is covering 342 km2, which is almost seven times the area of Luxembourg City. This is the reason why the whole city is being provided by wireless coverage. However, HotCity project will reach deployment of 500 access points in the near time, which corresponds to just about five access points per km2. This reflects the management's willingness to provide high quality coverage. It is much easier for HotCity to do so, than for Wireless Trondheim because of the high costs related to the infrastructure needed to cover such a large area of 342 km2.

Chapter 8

Conclusion

Considering only those respondents living at Midtbyen, we can conclude that many of them are unhappy with the coverage provided to them, excluding large number of those who had coverage from Wireless Trondheim at home. Majority of respondents who had access to Wireless Trondheim at home connected to internet via other connection interfaces. Cable-TV and ADSL were mostly used to connect internet at home, while NetCom/NextGentel was right behind. Unsecured (open) networks were mostly used to connect internet at Midtbyen (outside home). Results revealed that most of the respondents were not aware of the wireless broadband subscription offered by the Wireless Trondheim. Thus, the proportion of the respondents who wanted to buy a subscription was low, but equal for both residential locations. Majority was not interested in a subscription, in addition to have a fixed broadband connection at home per today. Among those who used Wireless Trondheim at home, most of them were unlikely to buy a monthly subscription. But, respondents who were interested in a subscription implied some sorts of conditions regarding price, capacity and stability of the wireless network. Majority of respondents were willing to pay NOK 100 or more for a subscription.

Competing with ADSL and cable-TV is not an easy task for Wireless Trondheim, as already seen. Coverage has to be improved and more capacity can be offered to create more interest around the service. That is how Wireless Trondheim will be able to take part in this battle, for delivering primary internet access to the homes. The price (NOK 199) for monthly subscription which is being offered at the moment by Wireless Trondheim is competitive with other offers and even cheaper in many cases. The Company has an advantage considering the simplicity and flexibility they are offering to the customer, when he or she subscribes wireless broadband. The main factors are stable network with high level of coverage together with good marketing activities. Furthermore, Wireless Trondheim should increase the number of access points. By investing in these areas, Wireless Trondheim can get higher recognition and be more than able to compete. In addition, Wireless Trondheim should improve the existing marketing policy following the successful business model (e.g., HotCity project). Moreover, educating the community about the potential benefits of wireless broadband

service and systematic assessment and prioritization of the community's needs for broadband service, are also important consideration for the sustainability of wireless broadband business.

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Appendix

Undersøkelse av marked for trådløst bredbånd

Dette er en undersøkelse for å finne ut om populariteten og betalingsviljen blant folk til å abonnere på trådløst bredbånd, som tilbys av Trådløse Trondheim. Undersøkelsen vil også kartlegge folks interesse til å bruke Trådløse Trondheim for å koble til internett hjemme. Takk for at du tok deg tid til å delta i denne undersøkelsen. Undersøkelsen tar ca. 5 min å fullføre og det er ikke mulighet for å mellomlagre svarene. Undersøkelsen må derfor fullføres når den først er påbegynt. Ved hvert spørsmål (unntak av ett spørsmål) skal du sette kryss i det svaralternativet som stemmer mest overens med din oppfatning av det aktuelle spørsmålet.

Det er 17 spørsmål i denne undersøkelsen.

Respondenten

[1] Kjønn *

Velg kun en av følgende:

- ○Kvinne
- ○Mann

[2] Alder *

Velg kun en av følgende:

- ○Under 20
- ○20-25
- ○25-30
- ○30-40
- ○Over 40

[3] Bosted *

Velg kun en av følgende:

- ○Midtbyen
- ○Ikke-Midtbyen

[4] Hva gjør du til daglig? *

Velg kun en av følgende:

- ○Student ved HiST
- ○Student ved TØH
- ○Student ved DMMH
- ○Student ved BI
- ○Annet

[5] Har du tilgang til Trådløse Trondheims nett hjemme? *

Velg kun en av følgende:

- ○Ja, bruker det som eneste tilkobling
- ○Ja, men bruker hovedsaklig annen tilkobling
- ○Nei, har ikke dekning
- ○Vet ikke

[6] Hvor fornøyd er du med dekningen som tilbys av Trådløse Trondheim i ditt hjem idag?

Velg kun en av følgende:

- ○I stor grad
- ○I noe grad
- ○I mindre grad
- ○Ikke i det hele tatt

[7] Visste du at du nå kan kjøpe månedsabonnement på trådløst bredbånd fra Trådløse Trondheim? *

Velg kun en av følgende:

- ○ Ja
- ○ Ja, jeg abonnerer på det
- ○ Ja, jeg har tenkt å abonnere på det
- ○ Nei
- ○ Bryr meg ikke
- ○ Vet ikke

[8] Hvordan kobler du deg til internett i Midtbyen? (Her kan du krysse av for flere svar) *

Vennligst velg alle som passer:

- ☐ Via usikrede (åpne) nett
- ☐ Via Trådløse Trondheim
- ☐ Via kafeers tilkobling
- ☐ Via mobilt bredbånd fra Telenor
- ☐ Via mobilt bredbånd fra NetCom/NextGentel
- ☐ Via mobilt bredbånd fra Ice
- ☐ Bruker ikke internett i Midtbyen
- ☐ Vet ikke
- ☐ Annet:

[9] Hvordan kobler du deg til internett hjemme (hovedtilkobling)? *

Velg kun en av følgende:

- ○ Via usikrede (åpne) nett
- ○ Via Trådløse Trondheim
- ○ Via mobilt bredbånd fra Telenor
- ○ Via mobilt bredbånd fra NetCom/NextGentel
- ○ Via mobilt bredbånd fra Ice
- ○ Via ADSL
- ○ Via kabel-TV
- ○ Vet ikke
- ○ Annet

[10] Hvor ofte bruker du Trådløse Trondheim for å koble til internett hjemme?

Velg kun en av følgende:

- ○Daglig
- ○Mer enn 3 ganger i uka
- ○Ukentlig
- ○Månedlig
- ○Sjelden
- ○Aldri
- ○Annet

[11] Vil du være villig til å kjøpe månedsabonnement på trådløst bredbånd fra Trådløse Trondheim? *

Velg kun en av følgende:

- ○Ja
- ○Nei
- ○Vet ikke
- ○Annet

[12] Hva ville du vært villig til å betale for et månedsabonnement fra Trådløse Trondheim på trådløst bredbånd? *

Velg kun en av følgende:

- ○100 kr
- ○150 kr
- ○200 kr
- ○250 kr
- ○300 kr
- ○350 kr

[13] Er du villig til å abonnere på trådløst bredbånd fra Trådløse Trondheim, i tillegg til det du bruker som hovedtilkobling hjemme idag? *

Velg kun en av følgende:

- ○ Ja
- ○ Nei
- ○ Avhenger av prisen på abonnementet
- ○ Avhenger av hvor mye kapasitet jeg får på abonnementet
- ○ Avhenger av stabiliteten på bredbåndet
- ○ Vet ikke
- ○ Annet

[14] Har du abonnement på mobilt bredbånd? *

Velg kun en av følgende:

- ○ Ja, hos Telenor
- ○ Ja, hos NetCom/NextGentel
- ○ Ja, hos Ice
- ○ Nei
- ○ Vet ikke
- ○ Annet

[15] Hva er årsaken til at du valgte å anskaffe abonnement på mobilt bredbånd? (Svar kun på dette hvis du svarte "Ja" på forrige spørsmål)

Velg kun en av følgende:

- ○ Mobilitet og tilgang utenfor hjemmet
- ○ Ikke mulighet for fast tilknytning der jeg bor
- ○ For å ha med på reise/feriested
- ○ Interessert i å prøve ny teknologi og nye tjenester
- ○ Vet ikke
- ○ Annet

[16] Hvor mye kapasitet trenger du for bredbåndet ditt? *

Velg kun en av følgende:

- ○ Under 2 Mbit/s (2048 kbit/s)
- ○ 2 Mbit/s
- ○ Over 2 Mbit/s
- ○ Vet ikke
- ○ Annet

[17] Hvor viktig er det for ditt valg av bredbånd, at du slipper å installere programmer/drivere eller kjøpe nytt utstyr (hardware)? *

Velg kun en av følgende:

- ○ Veldig viktig
- ○ Noe viktig
- ○ Mindre viktig
- ○ Ikke viktig i det hele tatt

Takk for å ha fullført undersøkelsen.