Hochschule
Bonn-Rhein-Sieg
University of Applied Sciences

Hochschule Bonn-Rhein-Sieg

University of Applied Sciences

Department of Management Sciences

Sankt Augustin

Bachelor thesis

(4 months of work)

to acquire

the grade of

Bachelor of Science (BSc)

in the discipline of International Business

Comparison of Different Technologies in the Telecommunication Market – Analysis of the Willingness to Pay for Fiberglass

BREKO
Bundesverband
Breitbandkommunikation e.V.

Examiner:	Prof. Dr. Jens Böcker
Co-examiner:	Anna Nass
Date of Submission:	01.09.2023
Submitted by:	Sophia Theresa Martha Staib
Matriculation number:	9037726
Address:	Dechenstr. 2
	53115 Bonn
E-mail:	sophia.staib@smail.wis.h-brs.de

Table of Contents

List of Figures

List of Tables

List of Abbreviations

KPI	Key Performance Indicator
BREKO	Bundesverband Breitbandkommunikation e.V.
DSL	Digital Subscriber Line
HFC	Hybrid-Fiber-Coax
FTTH/B	Fiber To The Home/Building
OECD	Organisation for Economic Co-operation and Development
AI	Artificial Intelligence
VR	Virtual Reality
IEEE	Institute of Electrical and Electronics Engineers
STEP	Sociocultural, Technological-Ecological, Economic, Political-Legal
WTP	Willingness To Pay
Telco	Telecommunication
Bps	Bytes per second
bps	Bit per second
EIA/TIA	Electronic Industries Alliance/ Telecommunications Industry Association

WDM	Wavelength Division Multiplexing
DWDM	Dense Wavelength Division Multiplexing
CWDM	Coarse Wavelength Division Multiplexing
FTTx	Fiber To The x
FTTH	Fiber To The Home
FTTB	Fiber To The Building
FTTC	Fiber To The Curb
FTTN	Fiber To The Node
FDM	Frequency Division Multiplexing
DOCSIS	Data Over Cable Service Interface Specification
EMI	Electromagnetic Interferences
RFI	Radio Frequency Interference
STP	Shielded Twisted Pair
UTP	Unshielded Twisted Pair
CAT	Category
HDSL	High Data Rate Digital Subscriber Line
ADSL	Asymmetric Digital Subscriber Line

SDSL	Symmetric Digital Subscriber Line
SHDSL	Symmetric High-Speed Digital Subscriber Line
RADSL	Rate Adaptive Digital Subscriber Line
VDSL	Very High Speed Digital Subscriber Line
ISDN	Integrated Services Digital Network
CMTS	Cable Modem Termination System

1 Introduction

1.1 Context and Relevance of the Topic

Communication has permanently been part of the human existence. Over the years, particularly the means and accessibility of informational exchange altered. Rapid transformations in correspondence between individuals were especially caused by digitization. One might additionally take into consideration that humanity relies heavily on the existing telecommunication infrastructure and declare it a necessity. This can be underlined by the great amount of various areas in which communication is involved nowadays. These comprise for instance public transport infrastructure and logistics, the health care and educational sector, economical and governmental institutions (cf. Verma; Zhang 2020, p. ii). Methods of interchanging information have tremendously evolved over the past 200 years. Outdated techniques like sending smoke signals or producing specified sounds from the ancient days were first replaced by communicating through Morse Code signaling, then telephony and lastly by the internet. The majority of these technological developments can be assigned to the time period between 1901 and 2000 (cf. Grubesic; Mack 2016, p.12). This progress can be traced back to the basic need for communication between humans. It fuels scientists' and economists' motivation to improve existing technologies and systems and to create new ways of communicating with each other (cf. Verma; Zhang 2020 p. 1). In recent years, the demand for telecommunication services, in particular broadband subscriptions, maintains a constant growth. An increase in the average amount of data volume per broadband connection in Germany can be observed. Certain drivers enhance the need for connectivity and data volume, such as the Covid-19 pandemic. Partially, network providers noticed a 60% leap in internet communication (cf. OECD digital economy outlook 2020 p. 58). This leap was caused by entire nations being forced into a lockdown. Individuals had to stay at home and rely on their current internet connections. These lockdowns introduced a rather uncommon concept of working remotely. Ever since these measures were taken, home office has become part of many people's prerequisites for job descriptions.

However, it requires a stable, safe, and fast operating network connection to ensure on time communication and an effective output. The demand for more bandwidth is further supplied by advancements in technologies and services, such as ultra-high definition and virtual reality, streaming, cloud computing and videoconferencing (cf. TechTarget 2012).

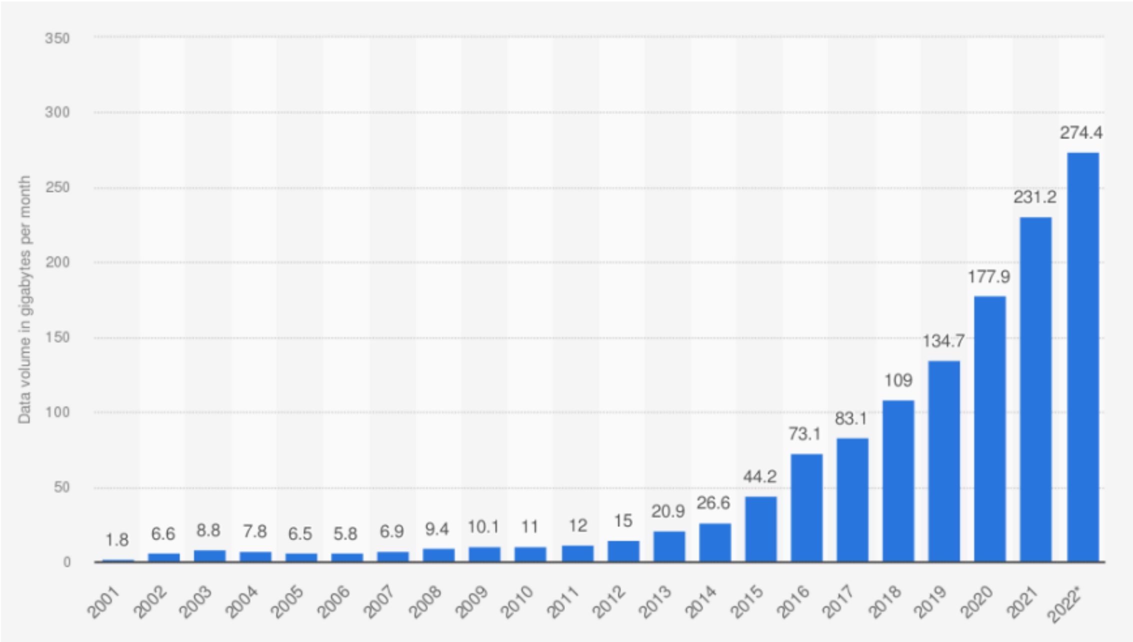


Figure 1: Average Data Volume per Broadband Connection in Germany from 2001 to 2022 (in gigabytes)

Source: VATM 2022

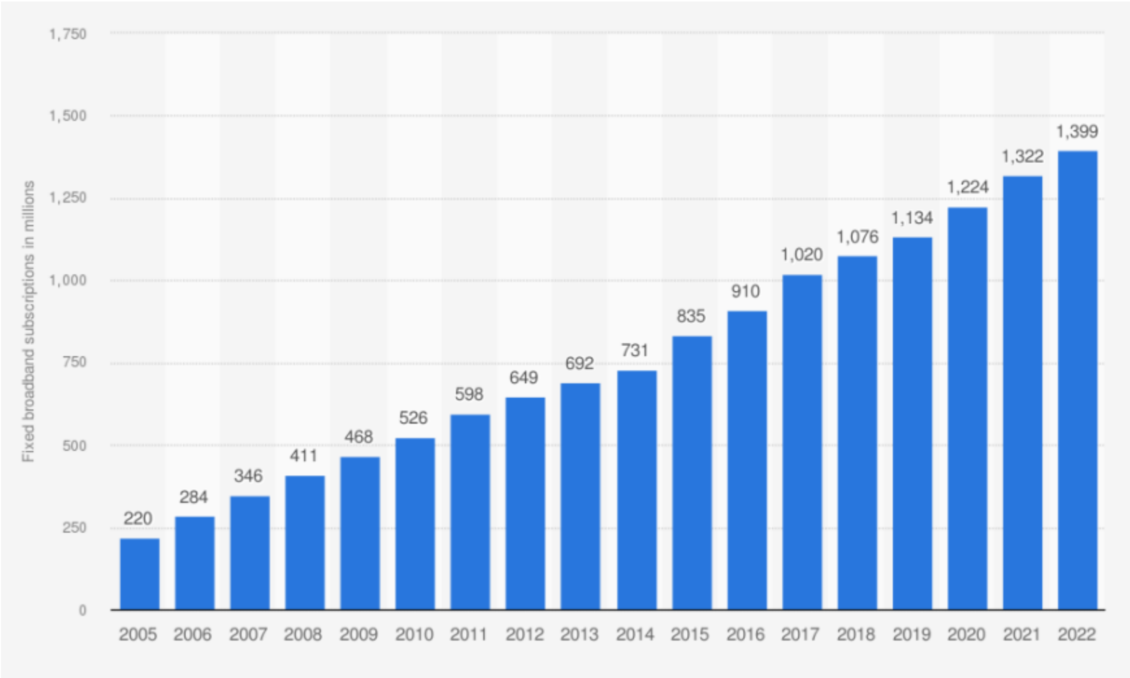


Figure 2: Number of Broadband Subscribtions all over the World from 2005 to 2022 (in millions)

Source: ITU 2023

The figures above clearly demonstrate that broadband connections and data volume usage increase continuously, which leads to the conclusion that this upwards trend might continue in the future accordingly. This growth can be further intensified by outside influences like recurring pandemics and more technological advancements.

One of these technological developments is the usage of smart home devices in the daily business or personal life. Smart home technology requires a stable connection to the internet and the more devices involved the more data volume is required. The figure below shows a forecast of the number of smart home users worldwide up until the year 2027. It shows a strong upward sloping curve which again underlines the need for more bandwidth, especially in the future.

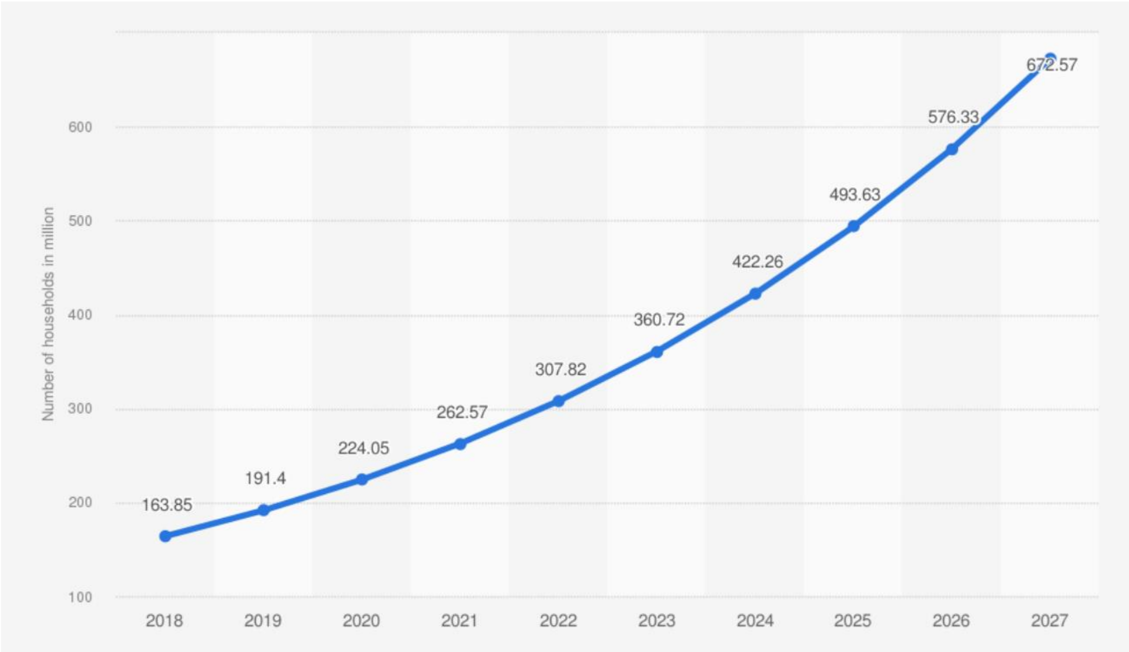


Figure 3: Number of Users of Smart Homes all over the World from 2018 to 2027 (in millions)

Source: Statista 2023a

Other technological advancements such as AI and VR additionally strengthen the demand for higher bandwidths, increased data volume usage and more stable connections (cf. AI in Virtual Reality – IEEE Digital Reality n.d.).

The latest technological change that has appeared and still carries on in the telecommunication market is the development and introduction of fiberglass.[1] Since optical fiber obtains several advantages, which will be discussed in this paper, that are of high relevance to the market and its members, network providers are working intensely on the extension of the fiberglass network. Cumulated in all OECD[2] countries, the amount of optical fiber of total subscriptions of fixed broadband climbed from 12% in 2011 up to 27% in 2019 (cf. OECD digital economy outlook 2020 p. 58).

[1] 'Fiberglass' and 'optical fiber' will be used and considered as synonyms: the telecommunication technology optical fiber in the telecommunication sector.
[2] Organisation for Economic Co-operation and Development which contain 38 member countries. The OECD supports all kinds of activities like improving educational systems, advancing health and safety and reforming the economy in more than 100 countries. (cf. OECDE n.d.).

An ever-increasing request for more speed, stability, and safety requires stable surroundings, meaning a well-structured and regulated market. Closely related to this are the market's members and service users. When introducing a new technology, customers define the product's or service's success in the market. In this context, the willingness to accept and to pay are key concepts to measure and forecast the performance of introducing a new technology to the market. The German BREKO association[3], which focuses its business activities on creating and promoting a fair market for optical fiber and expanding the fiberglass network, is the leading association for fiber optics. Their 455 member companies include about more than 240 network providers offering optical fiber lines. These connections account for 80% of Germany's total fiber connections (cf. BREKO Verband n.d.).

Problem Statement

In 2022, Germany's population measured around 84.4 million people (cf. Statistisches Bundesamt n.d.). In the very same year, 91% of the total amount of households had a connection to the internet, which is 5.5 % more than ten years before (cf. Eurostat. 2023). The majority of fixed internet connections are DSL (digital subscriber line) connections, which can be provided through the existing copper cable network. As previously mentioned, the telecommunication sector is facing a technological shift. This is evidently visible in the fact that the number of DSL connection has been decreasing in the past years, due to the rising availability of more efficient broadband technologies. Since 2004 to 2021, the share of connected DSL lines out of the entire broadband connections in Germany dropped by 28.38% (cf. Europäische Komission 2023).

[3] Bundesverband Breitbandkommunikation e.V.

Broadband's significance is further stressed by the survey results of a study conducted by 'seven.one.media GmbH' in 2019 which involved 2,302 participants. Out of all respondents, 98% stated that they mainly make use of an internet connection when they are at home (cf. Seven.One Media GmbH 2019).

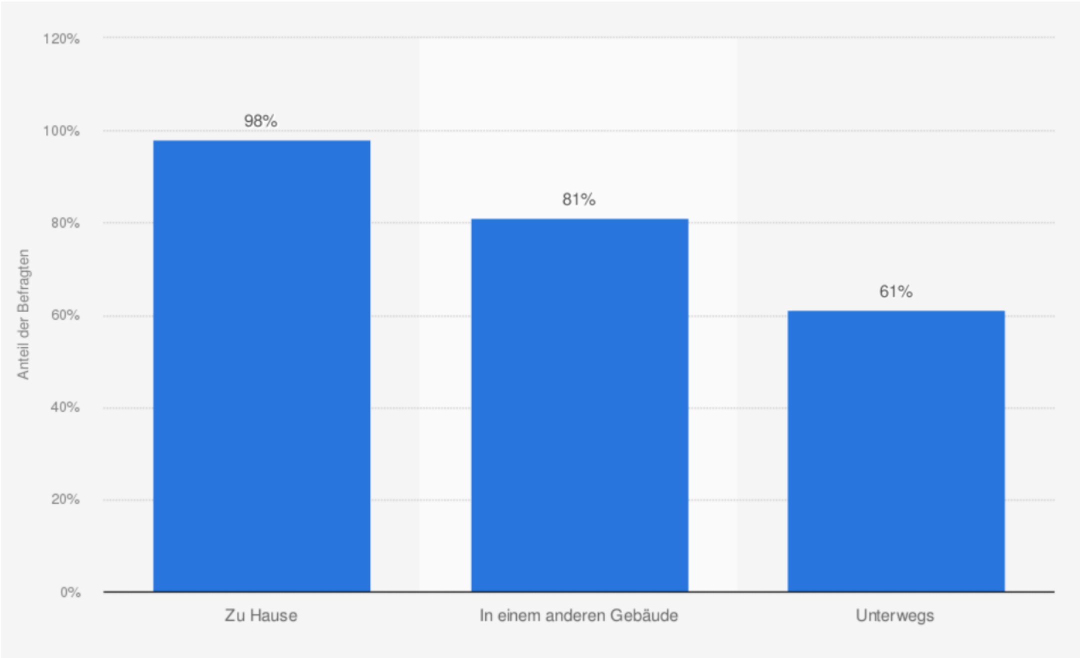


Figure 4: Places of Internet Usage in Germany in the Year 2019

Source: Seven.One Media GmbH 2019

Striking in this context is that not only the accessibility of high speed fixed internet connections is steadily rising, but also the subscriptions to broadband internet connections that obtain much more bandwidth. Between 2001 and 2022 the average monthly data volume was estimated to have increased from 1.8 gigabytes[4] to 274.4 gigabytes. Especially the last ten years, the growth can be described as rather exponential (cf. VATM 2022).

Conventional methods, like DSL and coaxial cables, are facing competitive pressure due to the introduction of better technologies with higher capacity and operating levels.

[4] Gigabyte is a form of measuring the amount of data that can be transmitted. These units of measuring will be explained in detail in chapter 2 (theoretical background)

The existing telecommunication networks are reaching their limits in terms of data transmissions and will not be able to hold the future demand (cf. Advanced Technologies for Industry, Sectoral watch: Technological Trends in the Telecommunication Industry 2021).

Several technologies provide broadband connections in the telecommunications market. The three main ones are DSL (Digital Subscriber Lines), HFC networks (Hybrid Fiber Coax Networks) and the latest entry to the market, optical fiber, FTTH/B (Fiber to the Home/Building). Out of 37.5 million broadband connections in Germany, 24.7 million were DSL connections, 8.7 million were HFC, 3.4 million were FTTH/B and 0.7 million were others (cf. Federal Network Agency 2023). The before mentioned BREKO Association and its members are following the goal of extending the optical fiber network in Germany. Hence, it is of high relevance to the association to explore the nature of the willingness to pay for fiberglass in order to maximize the growth in optical fiber connections in Germany.

1.2 Goals, Research Questions and Structure

This thesis aims to discuss various existing technologies in the telecommunications market and investigate the willingness to pay for optical fiber while comparing the three main technologies DSL, HFC and FTTH/B, their advantages, disadvantages as well as the availability of each the certain services. For the purpose of this thesis, the center of attention will be on these three technologies. A consumer survey and in depth analysis of the willingness to pay for fiberglass are conducted to work out clear and effective recommendations for the BREKO association and its members. The recommendations should deliver suggested actions to take into consideration in order to improve and facilitate the optical fiber network in Germany. These suggested actions consider the private consumers and their incentives to switch to a fiberglass broadband connection.

The following objectives and research questions can be derived:

- Identify, quantify and analyze the telecommunications market including its different technologies
- Are German telecommunication users willing to pay for an optical fiber broadband connection?
    - Explore/investigate/analyze the willingness to pay for fiberglass broadband connections of German telecommunication users by conducting a consumer survey
- Examine the nature of the individual’s willingness to pay in terms of price sensitivity or other motivators
- Work out specific recommended actions for network providers of the BREKO association on how to deal with marketing and pricing for optical fiber connections

Methodology

Measures taken to achieve these goals include a mix of literature review and primary data collected through an online survey. A thorough review of scientific reports, papers, articles, and industry related books serve as a base for establishing a comprehensive overview on the basic telecommunication terminology, developments of the market and the different technologies. In addition to that, a detailed online survey and empirical analysis will be conducted to investigate the keenness to pay for fiberglass and explore possible reasons and relationships between certain variables.

This combined methodological approach will support an extensive examination and understanding of the research topic of this paper. The methodology will be discussed accurately in a later chapter.

Scope and limitations

Obviously, this study cannot provide a complete and detailed picture of the telecommunication market and its entire history, current state and future developments. On top of that, some technological aspects will be discussed sufficiently, yet simplified to support the reader's understanding and to closely stick to the business perspective this thesis aims to depict. Since the telecommunication market is continuously evolving and growing, it may not be possible to cover every part in concrete with the restrictions stated above. Nonetheless, the author takes necessary actions to portray a profound overview of the essential background information, milestones in telecommunications history and its technologies.

Structure of the thesis

This study focuses on the German telecommunications market and its substantial technologies copper cables (DSL), coaxial cables (HFC) and optical fiber (FTTH/B). This paper is structured into seven main chapters which will be organized in the best logical and coherent way to show the nature of the research topic and its findings.

After this first introductory chapter, a new section is dedicated to the theoretical environment of this study. This part will be separated into several subsections to differentiate between the technological and business terminology. These subsections will firstly deal with the theory of analyzing a market and what factors are significant to define one. The next paragraph will dive into the three selected technologies by giving a brief historical summary, their basic setup and an insight into their data transmission capacities. Lastly, the key performance indicators will be defined to create the needed economical foundation for understanding the analysis and findings of this project.

The chapter creates a framework for the overall thesis and sets boundaries to the scope of the analysis and gives reasons why certain values and characteristics are taken into account. The third chapter is going to deal with the methodology of this paper. It aids in clarifying the approach of data gathering and to deepen the understanding of how actions are taken and why certain conclusions are drawn on the basis of what specific data. The analysis will be the fourth chapter and main part of this thesis. The focus here lies on a profound analysis of the telecommunications market and of the survey results, using descriptive and inferential statistics to examine the willingness to pay for optical fiber. Moreover, the added value and suitable communicative actions will be derived from the survey results in order to create the foundation for the next chapter. This will be chapter five, recommendations. This section's content is drawn from the previous one and offers suggested actions in terms of communication possibilities, pricing options and product developments concerning network providers offering fiberglass connections. Next, the findings and recommendations are summarized in chapter six, the conclusion, to highlight the main and most important aspects and results of this paper. Finally, an outlook in chapter seven is given to present future possibilities and further developments concerning the telecommunications market and the latest technological development, optical fiber connections.

2 Theoretical Background

In the following chapter, the theoretical concepts for the technical approach, the analysis as well as for the recommended actions will be displayed and defined. These will include the telecommunications market, separated into market analysis, supply and demand, and the BREKO association. On top of that, the different technologies fiber optic, coaxial cable and copper cable will be discussed. The definition of the chosen KPI's comprise pricing strategies, in particular value-based pricing and the concept of willingness to pay. These concepts are suitable because they incorporate a detailed analysis of how and why consumers make certain choices. Furthermore, they stress the user's preferences, which are necessary in order to establish fiberglass in the market.

2.1 The BREKO Association

Since this thesis is going to give recommendations for future actions in terms of increasing the fiber optic usage in the German population, it is written in cooperation with the BREKO Association. BREKO stands for the German phrase 'Bundesverband Breitbandkommunikation e.V.'. These terms can be translated to 'federal aassociation of broadband communication'.
The BREKO Association consists of approximately 455 member companies which are all focusing on expanding the optical fiber network and supply in Germany (cf. BREKO Association n.d.).
The association and its members currently maintain an 80% coverage of fiberglass connections in Germany. In 2021, 3.2 billion euros were invested in the expansion of fiber lines and a revenue of 5.2 billion euros was documented. BREKO has become a strong purchasing and service company in the market over the past years (cf. BREKO Association, n.d.)
The organization conducts a yearly market analysis which concentrates on the current developments in the fiber optic branch and its coverage in the German market.

This analysis is conducted by the CEO, Dr. Stephan Albers, the head of strategy and finances, Anna Nass, senior consultant, Nicholas Hayer, and academic advisory counsellor, Prof. Dr. Jens Boecker (cf. BREKO Association e.V. et al. 2022). The market analysis of 2022 will be used as an analytical tool to shape the overview of the telecommunications market and its current state of development in chapter 4, the analysis.

2.2 Telecommunications market

2.2.1 STEP – Analysis

To adequately produce a broad overview of a market, it is necessary to define some key measurements and tools. Firstly, the STEP – Analysis method is chosen to describe the telecommunication (telco) market as a whole and present determining conditions and key numbers.

The STEP – Analysis considers sociocultural, technological-ecological, economic and political-legal aspects.

This evaluation creates the basis for further investigation with the aid of other analytical tools. Due to the scope of this study, the emphasis of the market analysis will remain on the STEP analysis since the main considerations lie in the changes of the market dynamics and its technologies and most importantly on the willingness to pay for fiberglass (cf. Pepels 2016b, p. 463-464).

Statistics and analyzes from certain corporations assist in shaping a comprehensive picture of the telecommunications market.

Sociocultural

The first critical characteristic to shape the outline of a market are all factors concerning social and cultural framework. These incorporate age distribution, demand behavior, situation, and area of living and the willingness to pay. The section below explains how the willingness to pay (WTP) and demand behavior is influenced through direct and indirect factors (cf. Pepels 2016b, p. 463f.) (cf. Pepels 2016a, p.90). The macro environment presents the framework of a market that cannot be controlled by the companies which are the political situation, overall economic environment, technological developments, sociocultural changes and regulatory and legal developments. These can enable new opportunities but also restrict companies in the way they operate. These aspects affect the customer's purchasing power, usage behavior and patterns of spending their savings. For example, the economic crisis in 2008 had a major effect on people's consumption and priorities. Other instances are the Covid-19 pandemic, which forced many businesses to shut down due to the involuntary change in buying and consumption manner of consumers. Today, the rising inflation impacts people's purchasing power negatively. Prices rise and people can afford less for their money (cf. Kotler; Armstrong 2020, p. 97f.)

Technological-Ecological

The second criterion describes every natural and technological aspect which include technological orientation, know-how, geographical structure of the country and state of innovation. In terms of a market that incorporates different types of technology for the same service such as the telecommunication market, it is vital to show the distribution of each technology and its developments (cf. Pepels 2016a, p.64). Especially important for this thesis is the aspect of technological change because it is a crucial and current topic in the telecommunications market. On top of that, other environmental factors and changes such as a pandemic or other environmental disasters play a vital role for markets (cf. Kotler, Armstrong 2020, p. 98).

Considering the environmental aspect, it is mentionable that due to climate change, the risk of environmental disasters rises and natural resources available are shortening. These factors also affect the consumers in their buying behavior in terms of environmental awareness and the companies way of doing business might need adaption to be more ecologically friendly and sustainable to meet the upcoming demand for more sustainable and reliable products (cf. Kotler, Armstrong 2020, p. 98f.). Referring to the previously mentioned aspect of technological innovations in the market, it is necessary to add that this factor shapes a market drastically and forces its participants to adapt and include new technological achievements in their business processes (cf. Kotler, Armstrong 2020, p.98ff.).

Economic

This measure comprises all infrastructural and microeconomic elements. These can be specified in purchasing power, market volume, infrastructure, market structure and price level. Additional key numbers that should be evaluated in a market analysis are the market volume, market potential and market growth. Market size and revenue are likewise relevant factors (cf. Kühn et al. 2006, p. 101ff.). The microenvironment can be directly stirred by the actors in the market through their own actions. This includes the direct players in the market, the companies their customers and their suppliers. These act interchangeably and immediately react to price and quality changes of the offered products (cf. Scharf et al. 2015, p.38ff). For the operating companies in a market, the customers are the most important part of the microenvironment. Their entire business activities evolve around their customers, and their goal is to increase their customer base and sales. To achieve this, they need to understand their customers and act closely with them to ensure good communication and not miss any critical developments in their mindsets towards their products or services (cf. Kotler; Armstrong 2020, p.89).

Political-Legal

The last criterion contains the entire regulatory, administrative and legal components. These are the political systems, level of regulatory intensity, company and industrial laws (cf. Pepels 2016b, p.464). Taking the political environment of a country and a market into consideration, it is mentionable that any modifications in regulations and laws can affect business procedures massively. Still, the need for legislation is given to ensure a fair and safe market for the participating companies and their customers. Legislation continues to increase, especially in the technological sector to guarantee the user's safety. It obliges firms to act ethically and socially responsible with their resources and approaches of offering services and products for a certain price (cf. Kotler; Armstrong 2020, p. 101f.).

2.2.2 Supply and Demand

The second common concept is the one of supply and demand. According to Kotler and Armstrong, the concept of demand is very closely related to the price that is charged. The demand is the requested amount of the given product in a market by the consumers (cf. Scharf et al. 2015, p.3). Hence, if one decreases the price the demand increases and the higher the price the less demand is in the market. Supply and demand are depicted in the demand and supply curve. The demand curve shows the number of units consumers buy at different prices charged in a certain time frame (cf. Boyle; Simms 2019, p.62ff.). The relationship between price and demand can be described as inverse. The demand in a market is also driven by the consumer's willingness to pay. This concept will be discussed in the pricing section and is a crucial key measurement for the purpose of this study. The actors in a market additionally need to be aware of the price elasticity of demand. This concept explains how the demand reacts to price alterations. Inelastic demand depicts the situation that the demand barely alters with small changes in price. The demand is considered elastic if the demand changes radically with small changes in pricing.

Elastic demand drives actors in the market to lower their prices to maximize revenue. In recent years, it has become apparent that consumers tend to be rather price sensitive which also affects the users' willingness to pay and thus affects the success of a company (cf. Kotler; Armstrong 2020, p.309). Factors that might alter the given demand in a market are changes in price expectations and preferences, substitutes, changes in income or political situation and technological developments (cf. Hillman 2014, p.75f.). Mukherjee defines supply as "the amount that producers are willing and able to produce and offer for sale in the market at each and every price, all other things remaining unchanged". Moreover, he states that the supplied units of a service or good are related to its price in the market considering all other things stay unchanged such as the input cost, technology, and laws and regulations. As well as for the demand, the supply can be presented in a curve. This is usually an upward sloping line, representing that for firms to be willing to produce and offer more they request a higher price. This underlies the premise that profit increases with increasing prices and greater produced and offered units (cf. Mukherjee 2020, p.189ff.). Circumstances that have an influence on the supply are changes in input prices and availability of materials, technological innovation and changes in expectations and laws and regulations (cf. Hillman 2014, p.78).

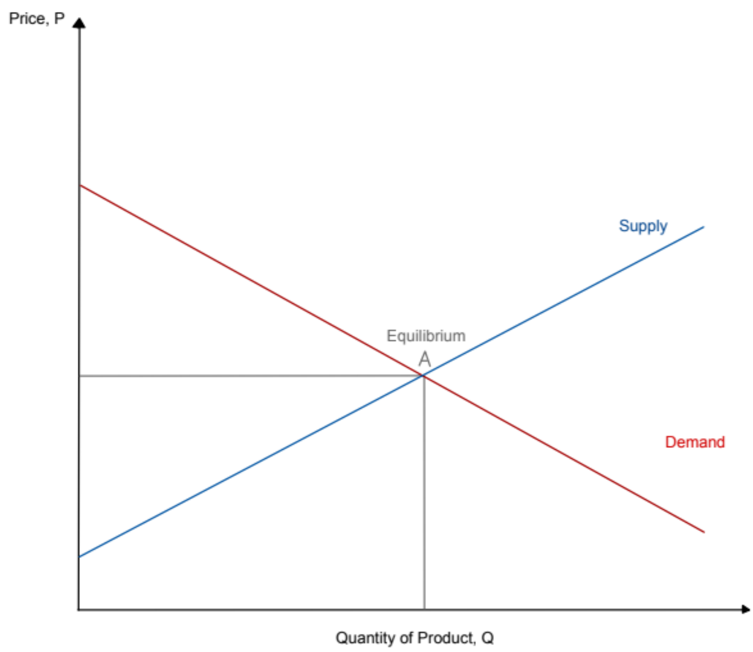


Figure 5: Supply and Demand Curve and Market Equilibrium

Source: author's own diagram following Mukherjee 2020, p. 80, 189ff.)

Since the central focus of this paper evolves around the technology of optical fiber which is the newest telecommunication services available in Germany, it is striking to present the basic terminologies used in the telco sector to ensure a basic understanding of how values concerning the telecommunication industry are presented. This will be the center of attention for the following paragraph.

2.3 Technological Terminology

2.3.1 Concept of Bandwidth

One of the main concepts in the telco market is ‘bandwidth’. In simple terms one can say that the more width a band obtains, the more data can be transmitted. The pace at which this data is carried is usually measured and displayed in bits per second. The table below shows the transfer rate of various bandwidths.

Unit	**1 (unit) in bps and Bps respectively**
Bit per second (bps)	1 bps
Byte per second (Bps)	1 Bps = 8 bps
Kilobit per second (Kbps)	1,000 bps
Kilobytes per second (KBps)	8,000 bps
Megabit per second (Mbps)	1,000,000 bps
Megabyte per second (MBps)	8,000,000 bps
Gigabit per second (Gbps)	1,000,000,000 bps
Gigabyte per second (GBps)	8,000,000,000 bps
Terabit per second (Tbps)	1,000,000,000,000 bps
Terabyte per second (TBps)	8,000,000,000,000 bps

Table 1: Transfer Rates of Various Bandwidths

Source: author’s own diagram following Goleniewski; Jarrett 2006, Introduction: understanding the broadband evolution)

In order to get an insight on how these units are linked to real time speed, the following table will display how long it would take to download the entire library of congress[5] with different unit sizes.

Data Rate	Transfer Time
2400 bps	1,900 years
56 Kbps	81.5 years
1.5 Mbps	3 years
1.7 Gbps	23.5 hours
10 Gbps	2.35 hours
100 Gbps	14.1 minutes
1 Tbps	1.41 minutes

Table 2: Various Data Rates and Transfer Times for Downloading the Entire Library of Congress
Source: Goleniewski; Jarrett 2006, Introduction: Understanding the broadband ecolution

There are three classifications of bandwidth. The first one is narrowband.
This represents the so-called digital signal level 0 which created the basis for the minimum rate needed to transmit voices digitally. Narrowband can transmit with a data rate of 64 Kbps. If several of these narrowband channels are combined, wideband is possible (cf. Goleniewski, Jarrett 2006, chapter 1). The second specification is wideband. As mentioned before, wideband results from the combination of narrowband channels, thus, its transmission rate can be determined with n (numbers of narrowband channels) x 64 kbps. This combination is possible up to 45 Mbps. The services that are supported through this network are T-carrier, E-carrier and J-carrier services (cf. Goleniewski, Jarrett 2006, chapter 1).

[5] The library of congress incorporates around 175.77 million items. These are a collection of catalogued books, reports, photographs, posters, manuscripts, newspaper and many more (cf. General Information, About the Library, Library of Congress n.d.).

The third category is broadband and is today's standard norm for describing bandwidth. There are many ways to define the term broadband, especially depending on which part of the industry one is referring to. Nowadays, it is common to refer to broadband as the transmission rate capacity a connection obtains, in 1970 this referred to a minimum capacity of 2 Mbps which is outdated today due to the enormous technological improvements especially looking at fiber optics the term broadband refers to high capacity transmission rates (cf. Goleniewski, Jarrett 2006, chapter 1).

2.3.2 Fiber Optic

Optical transmission via fiber was introduced to the telecommunications market around 1970 (cf. Huurdeman 2003, p. 605).
Optical fiber transmission works within the visible light spectrum. The wavelength is considered a measure to determine the width of the wave being transported. There are three different EIA/TIA standards for wavelength for fiberglass technologies, 850, 1,300 and 1,550 nanometers (nm). Every single one of these wavelengths is 200 nm wide and maintains an output of 25 THz totaling to 75 THz with all three. Hertz is the measure in which wavelengths are being displayed and depicts the amount of waves per second. The bandwidth of fiberglass is set by the amount of wavelength that can be supported and the accumulated bits per second each of the bands transmit. Wavelength division multiplexer support the increase in wavelengths being carried (cf. Goleniewski, Jarrett 2006).
Fiber enables transmitting over 800 to 6,400 kilometers. Fiberglass cables are offered in various sizes. They can incorporate one single strain of fiber or much bigger pairs with up to 500 strains of optical fiber. These categories are specified as single mode and multimode fiber. Each of the strains is protected with a cladding to ensure that the light energy stays inside and does not escape. Another plastic shielding around the cladding is used to keep the cable in place and makes sure it does not bend too much.
This coat is additionally supported with a Kevlar reinforcing material which protects the line further from exterior destruction (cf. Goleniewski, Jarrett 2006).

This material is five times harder and more powerful than steel. That layer is wrapped with an outer jacket. How many outer jackets are surrounding the cable relies on where the cable is supposed to be placed which determines the need for further protection (cf. Goleniewski, Jarrett 2006).

Figure 6: Inside of an Optical Fiber Cable
Source: Brickwedel 2016

A special repeater created the possibility of wavelength division multiplexing (WDM) which can separate several wavelengths out of one single strain of fiberglass and enable transmitting different signals at the same time over one single optical fiber. There are two different segments of WDM: dense wavelength division multiplexing (DWDM) and coarse WDM (CWDM). DWDM uses a more expensive laser than CWDM and is therefore able to support more wavelengths than the coarse technology. The system behind these two types is the same as for the general WDM, but they differ in material, wavelength capacity and light source utilized. Generally the potential exists to support about 15,000 wavelengths on one individual optical fiber (cf. Goleniewski; Jarrett 2006). There are plenty of different FTTx (Fiber to the x) solutions which specify different fiber connections. FTTH (fiber to the home) means that the optical fiber line is set up directly into the private households, enabling very high transmission rates.

FTTB (fiber to the building) define fiberglass wires that are located up to the building. The further connection ensures via internal wires set up in the building. FTTN (fiber to the node) makes use of the existing copper network and extents its data transmission capacity. The optical fiber line is placed up to a node close to the building that is being supplied. From this point on the existing infrastructure is used to transfer the signal (cf. Goleniewski; Jarrett 2006). FTTC (fiber to the curb/cabinet) standard describes the optical fiber lines that are built to the point of control boxes close to the building being supplied. The rest of the distance is being covered by the existing copper lines like DSL (cf. Goleniewski; Jarrett 2006). Due to the fact that this thesis focuses on the private consumers and is restricted in its scope, the center of attention is on the FTTH/B technique to simplify the comparison of different technologies.

2.3.3 Coaxial Cable

In the middle of 1920 the second telecommunication technology was developed and launched in the market, coaxial cables. These cables are set up with a copper conductor. This wire is bigger than the one in the traditional copper cables. Coaxial cables are not disturbed by other wires, fueling electromagnetic inferences. The transmission capacity is additionally higher than the one in twisted pair wires. The inner copper conductor is covered in a plastic insulation coat. This layer is surrounded by a return path, which most often consists of a braided-copper shielding. Lastly, these components are protected with an outer jacket. Here the same system applies as for optical fiber, the number of outer jackets depends on where the cable is supposed to be placed (cf. Goleniewski; Jarrett 2006).

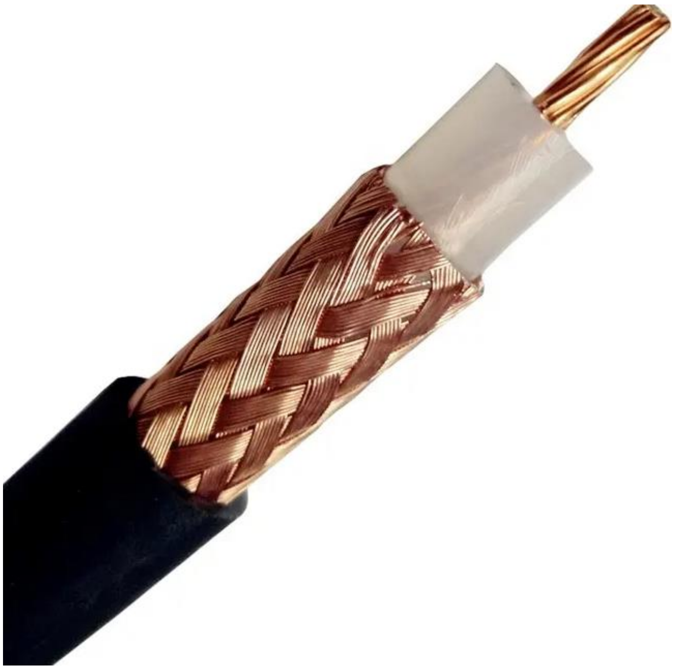


Figure 7: Inside of a Coaxial Cable

Source: Rg213 Rg8 Lmr400 Stranded Coaxial Cable For Telecommunication - Buy Rg213,Coaxial Cable Rg213,Rg213 Coaxial Cables Product on Alibaba.com n.d.

Currently, an optimized combination of fiber and coaxial cables is established in the market which is called hybrid fiber coax (HFC). These obtain capacities of up to 1,000 MHz. This technology offers the possibility of implementing a frequency division multiplexing (FDM) technique to improve its performance. Required amplifiers are placed every 2.5 kilometers, which is further than the ones set up for copper cables. Originally, coaxial cables were introduced to transmit cable TV. The development of transmitting more than just cable TV via coaxial wires was enabled through DOCSIS (Data over cable service interface specification). It is an international standard that requires two main components. Firstly, the cable modem which the customer connects to his technical device. Secondly, the CMTS (cable modem termination system) executes the hosting of down- and upstream connections and directs data traffic between the HFC network and the internet port. Additionally, the CMTS can be adapted according to the contract requirements of a customer. These two components are connected through the HFC network. There are various generations of the DOCSIS standard. These are DOCSIS 1.0, 1.1, 2.0 and 3.0. (cf. Goleniewski; Jarrett 2006).

DOCSIS 1.0 was first established to offer high speed data transmission through coaxial cables. These supply an access possibility to the internet in two-way form. The upstream capacity is up to 10 Mbps and the download rate is 40 Mbps. DOCSIS 1.1 was developed in order to support VoIP (Voice over internet protocol). This standard set the dynamic for quality of service (QoS) and made real time communication like phone calls over the internet possible. DOCSIS 2.0 increased the downstream data rate to 40 Mbps and the upstream rate to 30 Mbps. This standard expanded the amount of different services and tariffs that network providers were able to offer in the market. DOCSIS 3.0 enables a transmission rate of 200 Mbps in downstream and 100 Mbps in upstream (cf. Goleniewski; Jarrett 2006).

2.3.4 Copper Cable

During the beginning of the 19th century, copper cables were introduced together with the invention of electrical telegraphy. Copper cables continued to be used as telephones and were introduced to the market and created the fundament for the telephony network (cf. Huurdeman 2003, p.314f.). Twisted pair cables can be traced back to the public switched telephone network (PSTN) which created the basis for broadband connections. Due to its maximum bandwidth of 1 MHz, it is being replaced by other technological improvement such as DSL which can increase the frequency spectrum to up to 2.2 MHz. Twisted pair cables are the most efficient on short distances and the longer the distance of the connection gets the more errors occur which limits the options for transmitting reliably. Possible disturbances can be caused by electromagnetic interferences (EMI), radio frequency interference (RFI) and moisture and other environmental factors. On top of that, the maintenance of these cables need to be secured, and older parts are an increased factor of distortion. There are two different twisted pair cables that can be used for data transmission unshielded twisted pair (UTP) and shielded twisted pair (STP) cables (cf. Goleniewski; Jarrett 2006).

The shielded twisted pair cables have an additional metallic layer around the wire pairs which are reducing the influence of external forces. However, the UTP is most commonly used today (cf. Goleniewski; Jarrett 2006).

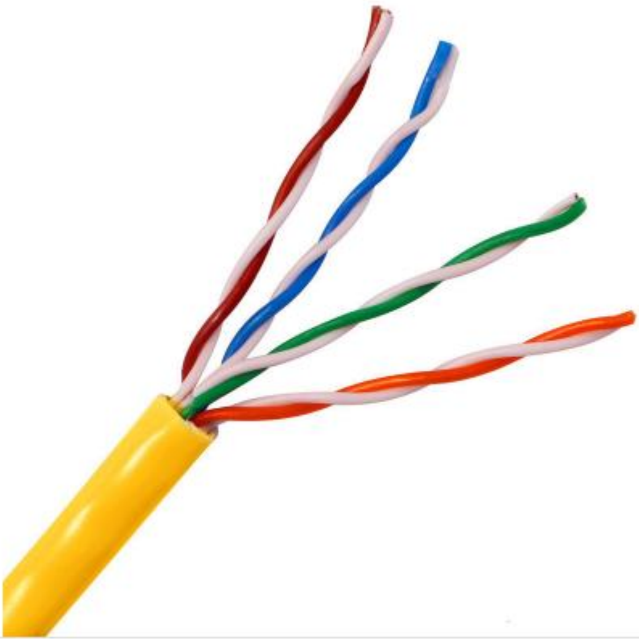


Figure 8: Inside of a Twisted Pair Cable

Source: Solid Copper high speed utp cat5e cable Lan cable 4 Pair Twisted Pair Copper Cable n.d.

There are eight different categories in which twisted pair cables can be divided into. These are specified as the type ANSI/TIA/EIA 568-A which are the commercial building telecommunications cabling standards. Category 1 (Cat 1) was initially introduced for voice transmission and can now transmit DSL and long-range Ethernet up to 10 Mbps due to technological developments. Category 2 (Cat 2) is capable of carrying up to 4 Mbps. The Category 3 (Cat 3) maintains a bandwidth of 16 MHz on unshielded twisted pair cables and transmit with up to 10 Mbps. The fourth Category (Cat 4) has a bandwidth of 20 MHz and transmits up to 16 Mbps. Cat 5 obtains a bandwidth of 100MHz and carries up to 100 Mbps. Cat 5e is an improved version of Cat 5 with more standards. Cat 6 is categorized under ANSI/TIA/EIA – 568 – B.2-1 and has a bandwidth of 400 MHz and is able to carry 1 Gbps. Cat 3 to Cat 6 have a transmission range of 100 meters. The last category, Cat 7 has a range of 1 MHz to 600 MHz and is specified under ISO/IEC11801:2002.

This defines that this technology is used for transmitting high speed Ethernet. Today, the most widespread categories are Cat 3 and Cat 5e. Cat 4 and Cat 5 are mostly out of traffic (cf. Goleniewski; Jarrett 2006). To establish a standard for completely digital network, the narrowband type ISDN (N-ISDN, integrated services digital network) was invented in 1983. It obtains two different specifications. The first one is Basic Rate Interface (BRI) which incorporates two different channels, two time B and one-time D. The B channels is responsible for transmitting voice, data, and fax transmissions. The delta channel takes care of the signaling part. In combination, the three channels offer 144 kbps which can be carried over one twisted pair on a maximum length of 5.5 kilometers. The second specification is PRI, primary rate interface. This type is most common for business systems. Two standards have been established. One is 23-times B channels and one-time D channel and the other one is 30 B channels and one D. Both of these standards are transmitted over two twisted pairs and individually the first standard carries 23 of 64 kbps channels and 1 of 64 kbps D channels. The second standard carries 30 of 64 kbps channels and one of 64 kbps channel. Technological developments enabling high speed internet have mostly replaced the BRI type (cf. Goleniewski; Jarrett 2006).
The DSL technology was introduced in 1988 and had the purpose of eliminating noises on copper cables and provide more stable connections. This technology consists of a DSL modem, which is responsible for converting digital signals into voltage signals. For simplicity reasons, the modems have been improved and adapted in the way that users can install and plug them in themselves. The second component of DSL is the DSL access multiplexer (DSLAM). This part is responsible for ending several subscriber lines and dividing voice and data traffic and directing it to the correct network (cf. Goleniewski; Jarrett 2006). The group of DSL technologies includes six main clusters. DSL stands for digital subscriber line. The first one is High-Bit-Rate DSL (HDSL), the second cluster is asymmetrical DSL which included ADSL, ADSL2 and ADSL2+. The third group is symmetrical/single line DSL (SDSL). Fourth is symmetric high-bit-rate DSL (SHDSL). The second last cluster is Rate-Adaptive DSL (RADSL).

The last cluster includes very-high-bit-rate DSL, which are VDSL and VDSL2. Mentionable in this context is that not every form of DSL is available in all locations and by all carriers (cf. Goleniewski; Jarrett 2006). VDSL makes it possible to transmit high bit rates over short distances via twisted pair cables, but it is not a sustainable solution, simply a modification to prolong the useful life of the already existing copper based network (cf. Goleniewski; Jarrett 2006). This technology is quite common and broadly used in Germany due to its possibility of transmitting up to 250 Mbit/s (cf. Bundesnetzagentur 2022, p.14).

2.4 Definition of KPI's

2.4.1 Pricing

In the field of business economics, there are several concepts of pricing. The pricing of a service or product differs and can be based on different qualities and goals of the company offering their goods or services. Since this thesis focuses on the technological change in the telecommunication market and changing offerings of the market's goods and services, the pricing plays a vital role in this scenario. Directly linked to the aspect of pricing is the willingness to pay of existing and future customers. This determines the supply and demand in a market (cf. Philips 2021, p.1). The relevance of the price is linked to many aspects. The price is often a crucial factor influencing the consumer's choice to buy. Over the past years, other aspects, not related to the price of a good or service, have gained importance. The price charged by companies also most often directly influences the organization's share in the market and its gained profit. Pricing is considered a key tool to create customer value and small changes in price have major effects on an organization's bottom line (cf. Kotler; Armstrong 2020, p. 296f.). The main pricing strategies that are established in the business world are value-based pricing, cost-based pricing and competition-based pricing which are described and compared in the table below.

The telecommunication market is a sector that is strongly influenced by customer's perception of the offered services and technological developments in the market. Hence, the emphasis lies on value-based pricing which will be discussed in the following paragraph to willingness to pay which is a key factor involved in this pricing strategy (cf. Kotler; Armstrong 2020, p. 297). There are several steps that need to be taken in order for a company to make a pricing decision. The first step is to set the pricing goal. These contain the following five survive, maximum current profit, maximum market share, maximize possible market skimming and market leadership in product quality. 'Surviving' presents a short-term goal, which is mainly existent to ensure a certain part of variable and fixed costs are covered, and the company stays in business. This strategy is often used if organizations act in a highly competitive market. The goal of 'maximizing current profit' presupposes that firms know their customers demand behavior. The company assumes the best possible price to maximize their short term profit based on numerous price alternatives. However, this goal might affect the company's long term goals negatively. When deciding for a 'maximizing the market share' goal, companies hope to make use of economies of scale[6] and gain the biggest possible market share by offering the lowest price. 'Maximizing market skimming' requires the firm to set their prices higher first and then reducing them over time. This strategy contains the risk of unsatisfied customers if they bought the product at an earlier state for a higher price. Setting this as a main goal might be useful and profitable if the offered product is highly requested in the market. 'Maximizing the market leadership in product quality' contains the premise of offering quality for an affordable price. These combine quality, luxury and special prices. These are justified by the exclusive image the brand sets through smart marketing decisions (cf. Kotler et al. 2017, p. 584ff.).

[6] Reducing the cost per produced unit by producing more units

2.4.2 Value-Based Pricing

Value-based pricing describes the concept of including the customers' understanding of value into the product making and price setting process. This requires an analysis of customer's interests in depth, before taking any further marketing measures. Seller's costs are put behind the buyer's perception of value. A complicated process results from this to consider both making a profit and meeting the consumer's needs. Since there have been changes in customer's understanding and need for quality and prices, another concept has been established, good value pricing. This technique ensures a fair combination of price and quality, which could be achieved by redesigning a brand or offering a new product line where customers get more quality for more money or less quality for less money. Good-value pricing incorporates not only the customer's willingness to pay for a certain good or service but also adding additional features or services to be competitive and justify their prices (cf. Kotler; Armstrong 2020, p. 297-299). To understand the differences between pricing strategies, a comparison is drawn from value-based pricing to the two other most important principles competition based and cost based pricing. The key aspects are summarized in the table below.

Characteristic	Value-based Pricing	Cost-based Pricing	Competition-based Pricing
Basic Idea	Price is set based on how the customers perceives value. First this is evaluated and then the product is created and the price is set.	Setting the price focusing mainly on the cost of producing and distributing a product. This includes variable and fixed costs.	the price is determined while considering the competitor's offers, prices and costs for equal products or services.
Advantages	Takes customers WTP into consideration while looking at the macroenvironment	easy to calculate	Supports the process of increasing market share quickly
Disadvantages	time consuming, value perception might differ a lot and therefore hard to determine,	Does not consider the market and their customers. Does not allow for offering different prices for various segments.	Restricts the profit making if competitors set prices even if customer value the product as much more important

Table 3: Comparison of the Three Main Pricing Strategies

Source: author's own table following (cf. Philips 2021, p. 24ff.) and (cf. Kotler; Armstrong 2020 p. 297ff.)

2.4.3 Willingness to Pay

Bowles S. et al (2017), defines the willingness to pay as “an indicator of how much a person values a good, measured by the maximum amount he or she would pay to acquire a unit of the good.” (Team; Press 2017, p.281). Directly linked to this concept is the willingness to accept, which is specified as “the reservation price of a potential seller, who will be willing to sell a unit only for a price at least this high.”(Team; Press 2017, p.315). This study aims to answer the question of willingness to pay for optical fiber, which is why this is the core focus here and the subject of interest in the later discussed and conducted survey. The willingness to pay is often used to determine the derived perceived quality a certain product or service has for the customer. However, there is a key difference between the consumers’ willingness to pay and their acceptance of a price in the market. This can also be influenced by the amount of people who perceive high quality as important and or if customers even recognize the quality and advantages of a certain good or service (cf. Pepels 2016, p.387). To measure and conduct an analysis on the extent of consumer’s willingness to pay, the correlation analysis and descriptive statistic is chosen here.

3 Methodology

The following chapter is going to focus on the research methods of this thesis in order to provide a proper understanding of the process of gathering the required information and data needed to appropriately answer and analyze the previously stated research questions and objectives.

Research Design

This paper employs a mainly quantitative/descriptive mixed with an explanatory research design approach (cf. Saunders et al. 2019, p.174). Those research methods are selected to deeply explore the changes in the German telecommunications market and to identify the readiness of Germany's population to accept a technological shift and hence its additional cost. This requires textual sources to describe the nature of the telecommunication market and its technologies, as well as numerical and statistical data to draw comparisons and measure the willingness to pay for optical fiber. The necessary information that was used in the process of writing this thesis can be allocated to different sources and databases. To begin with, the introductory part utilizes knowledge found in various books, articles, and websites which can be accessed via the university's library's access and databases such as Google Scholar. These sources provided the necessary input for initializing the research gap this study is focusing on. The second chapter dealing with the theoretical background supposes to achieve a general understanding of the telecommunication industry in Germany. Accordingly, this section needed current information on supply, demand and the basic concepts of the technologies of copper, coaxial and fiber. To display the current supply of telecommunication services, various websites of different network providers such as Telekom, Vodafone and NetCologne were used. Sources for presenting the demand and the underlying concepts of the technologies were books such as Telecommunication Essentials and Economics: a Crash Course. On top of that, articles and websites served as resources of suitable figures and explanations to visualize and effectively explain the different telecommunications.

To ensure a correct description and understanding of the analyzed market, the BREKO market analysis, which is conducted every year, and the Broadband Atlas are utilized in the theoretical part of this paper. As the theoretical part also focuses on the definition of the KPI's that are relevant for this paper, it is necessary to define these based on reliable and valuable information. Principles of Marketing book focusing on almost all relevant marketing concepts was a strong source of input as well as Marketing Management. Essentially, the input included in the first two chapters of this thesis can be redirected to scientific books, online newspapers and articles as well as economic and scientific websites which categorize as secondary data. Secondary data can be defined as "secondary literature sources [are] formally published items such as journals and books" (Saunders et al. 2019, p.83). Since this study aims to find a solution to a measurable variable, the willingness to pay for optical fiber, the collection of primary data in form of a cross-sectional survey is required additionally. Therefore, a structured questionnaire is being created and send out.

Sampling Technique

For this study, the target population includes individuals living in Germany aged 18+ years who are capable of and legally allowed to sign a contract for a telecommunication service. Germany's population of people above the age of 18 amounts to 69,373,865. Since this number also incorporates people above the age of 80 an adjustment can be made by reducing the population size by 6,088,142 (cf. Population by Age Groups, Destatis n.d.). This adaption is made in order to account for elderly people who are not capable of conscious decision-making. This results in a target population size of 63,285,723. Because of the large population size, a convenience sampling technique is chosen for the survey. This way of sampling is picked due to the fact that is easily accessible (cf. Saunders et al. 2019, p.324). Therefore, the questionnaire is sent out to numerous contacts via WhatsApp and published on various social media platforms such as Instagram.

During the data gathering phase for this thesis, an online survey consisting of 20 questions via Google Forms is employed as an analytical tool. To prevent misunderstandings, a pilot survey is sent out to some test participants. Their feedback in terms of bias and clarity of the implemented questions is utilized to optimize the survey for the final publishing. The collected primary data is analyzed with the aid of the software RStudio which supports the calculation process of the descriptive or inferential statistics analysis. To better visualize the questionnaire results of the participants, the created diagrams of Google Forms are included in this study. In order to ensure that the survey results can be used in statistical analysis, the questionnaire mainly includes closed questions. The scale to measure the respondent's tendencies towards the presented statement or question is the Likert scale. This scaling style requests the respondents to rate how strongly they agree or disagree with a presented statement. The selection options include strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree (cf. Saunders et al. 2019, p. 524ff.). Using one scale consistently ensures the comparability of the question's answers, which is highly important in this thesis since relationships and correlations are tested. Demographic questions such as age, sex, circumstances, and region of living as well as the currently used telecommunication service are part of the survey. Since the aim of the questionnaire is to find out about the knowledge telecommunication users have about their services, the focus here is mainly optical fiber, and to test consumer's tendencies in their willingness to pay for fiber glass. The survey was sent out on the 09th of June 2023 and was online for two weeks to collect a sufficient amount of responses.

Ethical Considerations

Another essential aspect is the privacy terms and conditions of the data gathering process. A short section of the survey's introduction is dedicated to this topic and informs the participants that their data is being used anonymously and only for the purpose of this paper and to establish recommended actions for the BREKO association and its members.

Limitations

Naturally, this type of data collection contains limitations to a certain extent. As mentioned previously, the convenience sampling technique can be applied the easiest but also comes with most limitations such as the fact that the selected people groups might not be equally distributed and not represent the total population accurately (cf. Saunder et al. 2019, p.324). It is also mentionable that the questionnaire does not focus on the actual need for more bandwidth in the average household and the current supply of Mbit/s the participants obtain. Further limitations of the survey are that more conditions could be requested while choosing the tariffs and looking at the respondents' current working position and salary and time they spend in home office and the actual need for more bandwidth and how many people are in their household.

4 Analysis

4.1 Analysis of the Telecommunication market

4.1.1 Initial State of the Market

Since the central focus of this paper evolves around the technology of optical fiber which is the newest telecommunication services available in Germany, it is important to present a broad view on the telecommunication market itself. This will be the focus of the following section.

Historical Background

The beginning of the telecommunications sector can be traced back to the invention of the optical telegraph. On the 15th of August 1794 Claude Chappe successfully installed the first optical telegraph connecting Paris and Lille. This was closely followed by the development of electrical telegraphy in the 1830s.

These technical devices had many inventors, but Samuel F. B. Morse's electrical telegraph created the basis for its worldwide utilization. The Revolution of the telecommunication industry began with the introduction of telephony by Alexander Graham Bell in 1876. Guglielmo Marconi initiated the radio era by sending a radio signal over a couple of kilometers with success in 1896. However, his succession was based on Heinrich Rudolf Hertz's radio transmission experiments, which could not be continued by himself due to his illness. In 1906, the independent invention of Lee de Forest and Robert von Lieben, the triode, which made the enlargement of weak radio signals possible began the electronic era. In the following years up until 1933, problem-solving changes were made for instances by adding additional grids between certain parts of the construct which resulted in the final development, the octode, which was eventually replaced by the transistor. Those electronic devices created the basis for further creations in new telecommunication devices and services, and especially in long-distance telephony. In 1990, the World Wide Web was invented by Tim Berners-Lee (cf. Huurdeman 2003, pp. 227f., 605). At the start of the 20^{th} century, the worldwide usage of telephones accumulated to around two million. This number increased to ten million by the year 1910. Important here is that the majority of telephones, approximately 70%, were located in the United States and the rest was mainly European counties. By the middle of the 20^{th} century, 75 million telephones around the world were counted. After World War II, a lot of the existing telecommunications network was destroyed. In France, for example, over 90,000 kilometers of open-wire lines were cut and more than ten thousand telephone sets had to be renewed. The Marshall Plan Aid which was granted by the U.S. government to rebuild Europe's infrastructure supported the quick reconstruction of the telecommunications network. Another milestone in telecommunications history was the introduction of the satellite technology in 1965. The second half of the 20^{th} century was dominated by liberalization and privatization of the telecommunication industry, which enhanced competition in the market. By the end of the 20^{th} century the number of telephone subscribers accounted to nearly 1 billion worldwide (cf. Huurdeman 2003, pp. 229f.,363f.).

4.1.2 Current Situation

At the end of 2022 37.5 million broadband connection were counted. This means around 91% of German's private households obtained an internet connection. 66%, 24.7 million, of those connections are still based on copper cable technologies (DSL) and the rest of the connections, 12.8 million are split in 8,7 million of HFC and 3,4 million of FTTH/B and 0.7 million belong to minor technologies such as satellite. In 2022, about 16.8 million broadband connections had a minimum transmission rate of 100 Mbit/s which accounts for about 45 % of the total connections in Germany. On top of that, about two million connections showed a transmission rate of 1 Gbit/s or more. Only 1.7 million connections had a maximum transmission rate of 10 Mbit/s at the end of 2022 (cf. Bundesnetzagentur 2022, p.11ff.). The BREKO market analysis states that as of the 30th of June 2022, the optical fiber connection coverage of homes passed[7] accounts to 26% which are 12.7 million homes passed. Relevant factors that are pointed out in the market study are that the average growth of data volume is increasing and only 5% of households in Germany do not have a fixed network connection. Further noticeable is the rise in subscriptions by speed, which will be emphasis in a later section as well. Compared to other technologies, the increase in fiber connection is the most striking. Which can be highlighted in the rising demand for fiberglass. The advantages of optical fiber are progressively known by consumers. The general take-up rate in Germany is 47% which is below the average of the European Union which is 49%. The take up rate of BREKO network operators is 54% (cf. BREKO Association e.V. et al 2022, pp. 4-6, 12-14,16-19). The report to the broadband atlas from the federal ministry for digital and transport displays a comprehensive insight view to the broadband supply in Germany. For all private households in Germany, the availability of broadband connection can be represented as the following, 98.5 % of all households have a connection equal to or more than 16 Mbit/s. 96% obtain a connection equal to or more than 30 Mbit/s. 95.1% use a transmission rate equal to or more than 50 Mbit/s.

[7] Describes the state of an internet connection implying that no further substantial installation is necessary for connecting the fiber line (cf. FTTH Council Global Alliance – FCGA 2016, p.3).

89.6% use a broadband connection equal to or more than 100Mbit/s. 79.7% have a broadband connection that transmits a rate equal to or more than 200 Mbit/s. 70.5% of all private households use a transmission rate equal to or more than 400 Mbit/s. 62.1% have a broadband connection equal to or more than 1000Mbit/s. This information is including all types of technologies in the German telecommunication market (cf. Federal ministry for digital and transport 2021, p.7).

The next paragraph will focus on the availability of the three main technologies of copper cables, coaxial cables and optical fiber. Out of all private households in Germany, the broadband availability of a connection with a transmission rate equal to or more than 16 Mbit/s is 95.9% for copper technologies, 68% for coaxial technologies and 15.8% for fiberglass technologies. For a connectivity to rate equal to or greater than 100 Mbit/s the accessibility for copper is 79.4%, for coaxial it is 67.2% and for optical fiber technologies it is 15.8%. The supply of a transmission rate equal to or greater than 200 Mbit/s is 54.1% for copper, 66.9% for coaxial and 15.7 for fiberglass. Transmission rates equal to or more than 1000Mbit/s are accessible 56.5% via coaxial technology and 15.4% via fiber technology (cf. Federal ministry for digital and transport 2021, p.8). The chart shows the broadband supply for all technologies in different areas in Germany. The variables are identified as urban, semi urban, and rural.

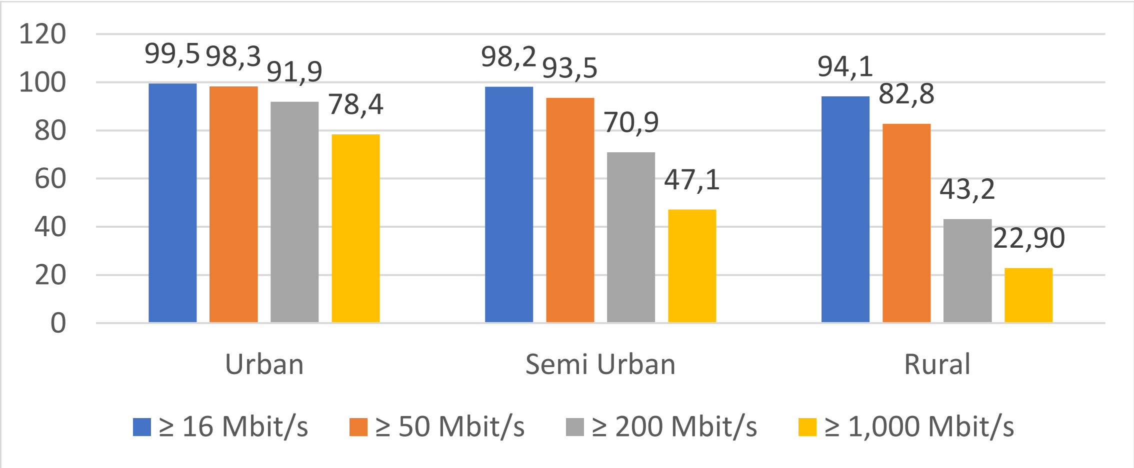


Figure 9: Broadband Availability of all Technologies in Different Areas in Germany

Source: author's own diagram following the Federal ministry for digital and transport 2021, p.10

This diagram shows clearly that there is still a difference in supply of broadband in rural and urban areas. Additionally, striking here is that the decrease in broadband accessibility of connection with more than 200 Mbit/s is a lot stronger in rural areas than in urban areas. For the different technologies, the distribution is the following. In urban areas, 93.9% of households have a VDSL connection equal to or greater than 50 Mbit/s. 19.1% of private households have a fiber to the home/building connection with the same transmission rate spectrum. 85.7% have a CATV connection with a transmission equal to or more than 50Mbit/s. In semi urban areas, the availability of VDSL in private households in Germany is 86.8% and offers a connection with a transmission rate of 50Mbit/s and more. Out of the households, 11.7% have such a transmission rate via a fiber to the home/building connection. 53.7% maintain a transmission of 50 Mbit/s and more through a CATV connection. In rural areas, the dispersion looks as follows. 76.1% of private households have VDSL connection with 50Mbit/s and more. 11.5% are connected to a fiber to the home/building line with 50 Mbit/s and more. 17.5% have CATV line with 50 Mbit/s and more (cf. Federal ministry for digital and transport 2021, p.11). The supply of telecommunication services in terms of broadband connection can also be shown in the size of towns all over Germany. In Germany, around 15.4 million private household can be categorized into the category of big cities which are cities that have a minimum of 100,000 inhabitants. Out of those, 93.7 to 94.6% are connected via a VDSL connection with 50 Mbit/s and more. 14.1 to 28.9% have a fiber to the home/building connection with the same transmission rate. 86 to 92.6% have a CATV connection with a similar rate. Around 11.3 million households can be assigned to the category of medium-sized towns in Germany, which have 20,000 to 100,000 citizens. In these medium-sized towns, 91.3. To 92.3 % are connected through a VDSL connection with a transmission rate of 50 Mbit/s and more. 14.3 to 14.7% have a fiber to the home/building connection with the same speed. 71.6 to 82.5% is the percentage for CATV connection with a rate of 50Mbit/s and more. Approximately 10.3 million households belong to the category of small towns, which have 5,000 to 20,000 inhabitants. The dispersion in these towns is 84.8 to 87.8% of VDSL connections with a speed of 50Mbit/s and more. 9.9 to 10.7% are FTTH/B connection with the same transmission rate. 42.8 to 59.5% have a connection to a CATV line with

50mbit/s and more. Rural communities account for 5.3 million of German private households and have less than 5,000 citizens. In these areas, 79.2% have a 50Mbit/s VDSL connection. There are 12.6% FTTH/B connection with a speed of 50Mbit/s and 23.1% of CATV lines with the same rate (cf. Federal ministry for digital and transport 2021, p.12f.). The broadband availability in Germany is steadily increasing over the years. For example, in 2018, 27.3% out of private households had access to a broadband connection of 1000 Mbit/s and more. In the middle of 2021 the amount had already risen to 62.1%. Due to the high utilization of higher speed broadband connection and the limitations of copper cables this technology is limited to a maximum bandwidth (cf. Federal ministry for digital and transport 2021, p.14ff.). To fully understand the dynamics of the telecommunications market in Germany, it is necessary to consider the developments in demand for broadband services. As mentioned earlier, there are certain drivers that fuel the demand, for example the Covid-19 pandemic. The figure shown below displays the percentage increase in broadband availability on municipal level. The broadband availability focuses here on a transmission speed between 50 and 100 Mbit/s. The time frame presented in this figure is the end of 2018 until the middle of 2021. Concluding from this presentation, it is safe to say that there is a high increase in demand for broadband services for an average bandwidth. Mainly this demand focuses on the north-east of Germany and the north-west (cf. Federal ministry for digital and transport 2021, p.54ff.).

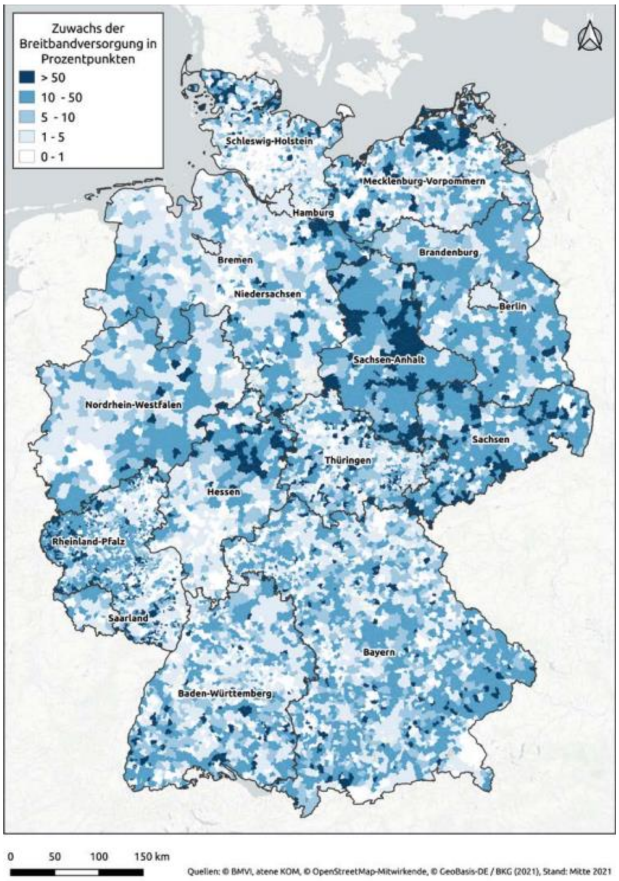


Figure 10: Broadband Availability Increase of Connection between 50 and 100 Mbit/s during 2018 and 2021

Source: Federal ministry for digital and transport 2021, p.55

The next illustration presents the percentage increase in broadband accessibility of bandwidths of more than 100 Mbit/s at community level in the time from the end of 2018 until mid-2021. Directly noticeable is that the main areas of north-east and north-west and also south-east are more extended and darker blue, which means that the percentage increase in those areas is between 10 and 50 % and in many communities even above 50 %. This high rise in demand is also fueled by new technological developments that require higher bandwidth. Conventional technologies such as twisted pair cables have limited capacities and will not be able to satisfy the upcoming demand for even higher transmission rates. Therefore, the demand for optical fiber connections increases parallelly to the general demand for higher bandwidth (cf. Federal ministry for digital and transport 2021, p.56ff.).

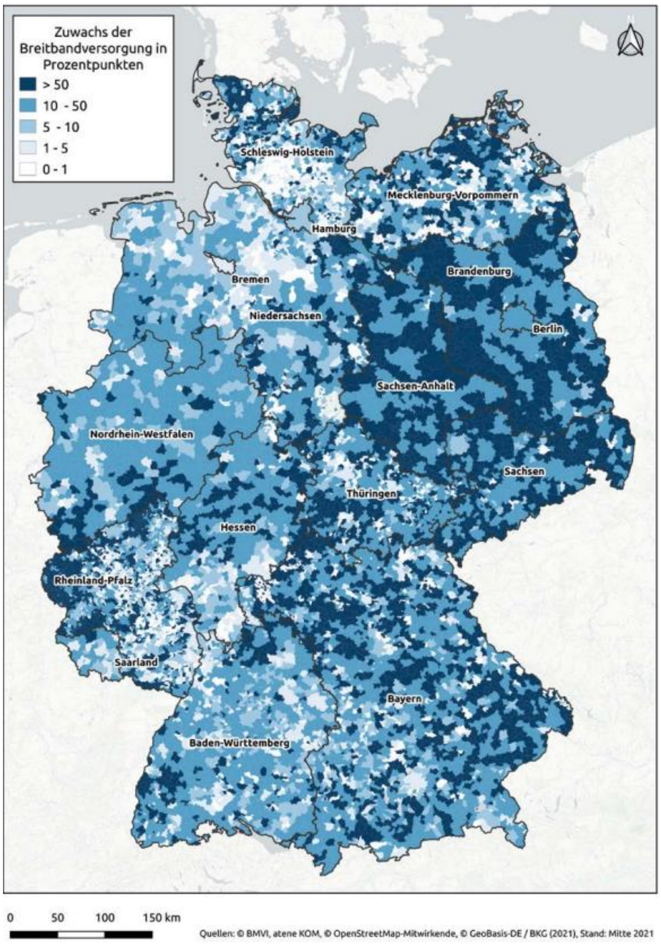


Figure 11: Broadband Availability Growth of Connections with more than 100 Mbit/s during 2018 and 2021

Source: Federal ministry for digital and transport 2021, p.56

Highlighting the previous, the next image shows the percentage increase in broadband availability of transmission rates of more than 1,000Mbit/s at county level from the second half of 2020 until the middle of 2021 (cf. Federal ministry for digital and transport 2021, p.65).

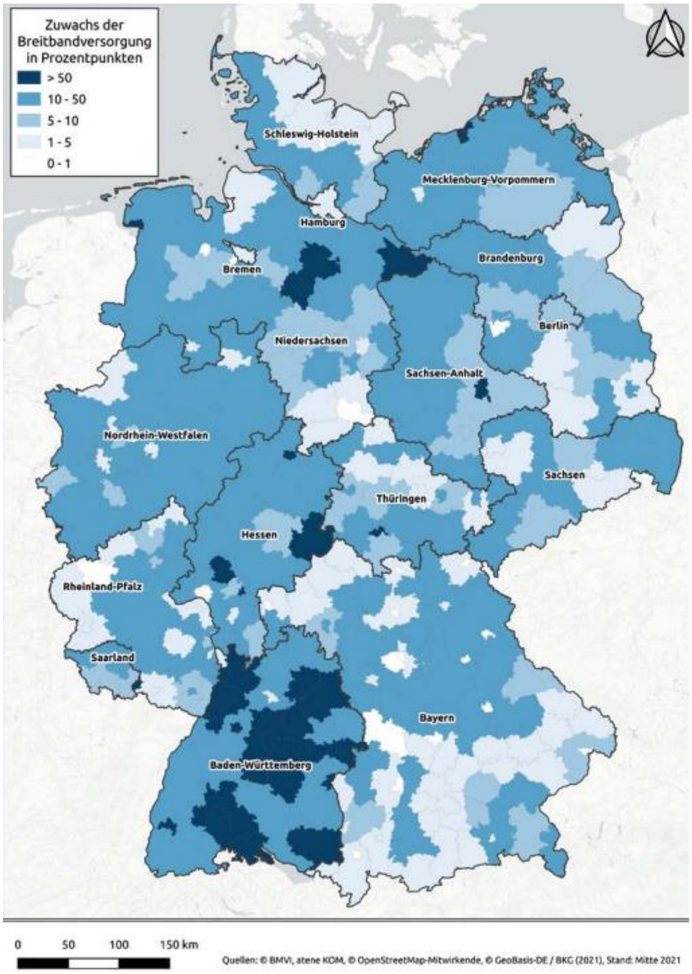


Figure 12: Broadband Accessibility Increase in Connections with more than 1.000 Mbit/s from 2020 to 2021

Source: Federal ministry for digital and transport 2021, p.65

Conclusions drawn from this picture can be summarized as follows. The percentage increase of transmission rates above 1,000 Mbit/s are almost nationwide, around 10 to 50 %. This underlines the current and future need for higher bandwidth which will continue to rise in the future due to technological advancements (cf. Federal ministry for digital and transport 2021, p.65).

4.1.3 Regulations

To give a sufficient overview of the telecommunications market, the following paragraph is dedicated to the laws and regulations in the telecommunications industry. Up to the middle of 1980 telecommunication services were monopolies owned by the country's government in the majority of markets. These lead to high entry barriers, which resulted in the formation of a natural monopoly. These enable network providers to raise their prices with no restrictions at the cost of consumers' welfare. Those barriers to entry were reduced through several measures (cf. Verma; Zhang 2020. P.72, 84). The following means were taken in order to support the liberalization and privatization of the former monopoly telecommunication market, the telecommunications act of 1997 which focused on deregulation and the digital millennium copyright act which encompassed the topic of intellectual property. The need for regulations also lies in the limitless possibilities of telecommunications. Telecommunication creates an efficient platform to handle business both in the private sector and in the economic sector. The internet and new technologies continuously create new paths and options for entertainment, jobs, and businesses. Thus, an intensive policy regulation seems useful in order to protect the telecommunication user's and their data (cf. Goleniewski, Jarrett 2006, chapter 1).

4.1.4 Main Carriers and Their Pricing Tariffs

The most common German telecommunication companies are 'Deutsche Telekom', 'Vodafone', '1&1', 'Telefonica O2', and 'Tele Columbus/PYUR' (cf. DSLWEB. 2022). The following tables present the different tariffs of various network providers. These network providers are 'Deutsche Telekom', 'NetCologne', and 'Vodafone'.

The Table below presents the fiberglass tariffs of ‘Deutsche Telekom’.

Product-name	**Magenta-Zuhause M**	**Magenta-Zuhause L**	**Magenta-Zuhause XL**	**Magenta-Zuhause XXL**	**Magenata-Zuhause GIGA**
Max. download (Mbit/s)	50	100	250	500	1,000
Max. Upload (Mbit/s)	10	40	50	100	200
Price (monthly)	19,95 €	19,95 €	19,95 €	19,95 €	79,95 €
Price (from month x on)	from 7th month on 42,95 €	from 7th month on 47,95 €	from 7th month on 54,95 €	from 7th month on 59,95 €	/
Bonus	70 € (Router)	70 € (Router)	70 € (Router)	70 € (Router)	/
Duration (months)	24	24	24	24	24

Table 4: Fiberglass Tariffs of Telekom

Source: author’s own table data from Glasfaser: Highspeed – internet zu Hause, Telekom n.d.

The next table shows the fiberglass tariffs of NetCologne in the area of Bonn.

Product-name	**NetSpeed 250**	**NetSpeed 500**	**NetSpeed 1,000**
Max. download (Mbit/s)	250	500	1,000
Max. Upload (Mbit/s)	50	50	100
Price (monthly)	39,95 €	49,95 €	69,95 €
Shipping Cost	9,99 € + 9,95 € + if necessary	9,99 € + 9,95 € + if necessary	9,99 € + 9,95 € + if necessary
Bonus	220 € (100€ welcome bonus (10x10€ monthly) 50€ fiber bonus (10x5€ monthly) 70€ credit start-up cost)	270 € (150€ welcome bonus (10x15€ monthly) 50€ fiber bonus (10x5€ monthly) 70€ credit start-up cost)	320 € (200€ welcome bonus (10x20€ monthly) 50€ fiber bonus (10x5€ monthly) 70€ credit start-up cost)
Duration (months)	24	24	24

Table 5: Optical Fiber Tariffs by NetCologne in the Area of Bonn

Source: author's own table data from Bonn, NetCologne n.d.

Below the price tariffs of 'Vodafone' for optical fiber are displayed.

Product-name	**GigaZuhause 100 Glasfaser**	**GigaZuhause 500 Glasfaser**	**GigaZuhause 1,000 Glasfaser**
Max. download (Mbit/s)	100	500	1,000
Max. Upload (Mbit/s)	50	250	500
Price (monthly)	39,99 €	39,99 €	39,99 €
Price (from month x on)		from 13th month on 49,99 €	from 13th month on 74,99 €
Regional surcharge (monthly)	5 €	5 €	5 €
Additional Cost	1 x 49,99 € start-up cost 99 € Installation cost	1 x 49,99 € start-up cost 99 € Installation cost	1 x 49,99 € start-up cost 99 € Installation cost
Duration (months)	24	24	24

Table 6: Fiber Optic Offerings by Vodafone

Source: author's own table data from Glasfaser – Internet mit bis zu 1000 Mbit/s Highspeed, Vodafone n.d.

This table presents the DSL products of ‘Deutsche Telekom’.

Product-name	**Magenta-Zuhause S**	**Magenta-Zuhause M**	**Magenta-Zuhause L**	**Magenta-Zuhause XL**
Max. download (Mbit/s)	16	50	100	250
Max. Upload (Mbit/s)	2.4	10	40	50
Price (monthly)	19,95 €	19,95 €	19,95 €	19,95 €
Price (from month x on)	from 7th month on 37,95 €	from 7th month on 42,95 €	from 7th month on 47,95 €	from 7th month on 54,95 €
Bonus	70 € (Router)	170 € (70€ Router 100€ online sale)	170 € (70€ Router 100€ online sale)	170 € (70€ Router 100€ online sale)
Duration (months)	24	24	24	24

Table 7: DSL Tariffs by Telekom

Source: author’s own table data from DSL – Tarife: schnelles Internet fuer Zuhause, Telekom n.d.

The DSL tariffs of ‘NetCologne’ can be depicted as follows.

Product-name	**NetSpeed 50**	**NetSpeed 100**	**NetSpeed 250**	**NetSpeed 500**	**NetSpeed 1,000**
Max. download (Mbit/s)	50	100	250	500	1,000
Max. Upload (Mbit/s)	10	40	50	50	100
Price (monthly)	29,95 €	36,95 €	39,95 €	49,95 €	69,95 €
Shipping Cost	9.99 €	9.99 €	9.99 €	9.99 €	9.99 €
Bonus	70 € (start-up cost)	140 € (70€ start-up cost 70€ welcome bonus 10x7€ monthly)	170 € (70€ start-up cost 100€ welcome bonus 10x10€ monthly)	220 € (70€ start-up cost 150€ welcome bonus 10x15€ monthly)	270 € (70€ start-up cost 200€ welcome bonus 10x20€ monthly)
Duration (months)	24 (or 0 with additional 69.95€)	24 (or 0 with additional 69.95€)	24 (or 0 with additional 69.95€)	24 (or 0 with additional 69.95€)	24 (or 0 with additional 69.95€)

Table 8: DSL Tariffs of NetCologne

Source: author’s own table data from Tarifvergleich, NetCologne n.d.

The table underneath includes the DSL options of 'Vodafone'.

Product-name	GigaZuhause 16 DSL	GigaZuhause 50 DSL	GigaZuhause 100 DSL	GigaZuhause 250 DSL
Max. download (Mbit/s)	16	50	100	250
Max. Upload (Mbit/s)	2.4	10	40	40
Price (monthly)	9.99 €	19,99 €	19,99 €	19,99 €
Price (from month x on)	from 7th month on 34.99 €	from 7th month on 39.99 €	from 7th month on 44.99 €	from 7th month on 54.99 €
Bonus	50 €	100 €	120 €	175 €
Duration (months)	24	24	24	24

Table 9: Vodafone DSL Offerings

Source: author's own table data from DSL – Angebote – Internet & Festnetz ab 9,99euro mtl., Vodafone n.d.

This last table summarizes the coax products of ‘Vodafone’.

Product-name	**Giga Zuhause 50 Kabel**	**Giga Zuhause 100 Kabel**	**Giga Zuhause 250 Kabel**	**Giga Zuhause 500 Kabel**	**Giga Zuhause 1,000 Kabel**
Max. download (Mbit/s)	50	100	250	500	1,000
Max. Upload (Mbit/s)	25	50	50	50	50
Price (monthly)	9.99 €	19.99 €	19.99 €	19.99 €	19.99 €
Price (from month x on)	from 7th month on 34.99 €	from 7th month on 39.99 €	from 7th month on 44.99 €	from 7th month on 49.99 €	from 7th month on 59.99 €
Bonus	50 €	100 €	100 €	120 €	175 €
Duration (months)	24	24	24	24	24

Table 10: Cable Tariffs by Vodafone

Source: author’s own table data from Kabel Internet Angebote – Tarife bis 1.000 Mbit/s, Vodafone n.d.

4.2 Findings and Analysis of Survey Results

4.2.1 Descriptive Analysis

To appropriately explore the nature of the collected primary data through the online survey, several statistical measures are taken into account. To get an overview of the variables, and the distribution of the relevant variables each of them is considered individually. For time and relevance purposes, the focus will lie on various selected parameters. Afterward, the relationship between the relevant variables is examined. These are scanned with the Spearman Correlation Coefficient because it is less restricting and more suitable for ordinal scales than the Pearson Correlation Coefficient (cf. Baldock 2014, Chapter 5).
The process of analyzing and using the primary data for statistical calculation requires some data cleaning and coding as a prerequisite.[8] 204 people answered the questionnaire. Out of these, one person is cut out due to the fact that that person is under the age of 18 and does not belong to the target population. The open question, number 8 'moegliche Vorteile von Glasfaser sind:' (possible advantages of optical fiber are:) is cut out of the data that is used for calculation purposes because it is not numerical data. The data from the survey is extracted in an Excel sheet and then the words are coded into numerical terms and the question are renamed and summarized to give each variable a name. Most important is the coding for the Likert scale scheme, which is shown in the table below.

Likert Scale in Survey	**Coding for Calculations**
Stimme voll und ganz zu / strongly agree	2
Stimme zu / agree	1
Stimme weder zu noch lehne ich ab / neutral	0
Stimme nicht zu / disagree	-1
Stimme ueberhaupt nicht zu / strongly disagree	-2

Table 11: Coding of Likert Scale Measurement

Source: author's own diagram

[8] The full codebook can be accessed in the appendices of this thesis.

The variables from the survey question can be derived as the following

- Question 1: ‘Please state your age’ = Q1
- Question 2: ‘Please state your gender’ - Q2
- Question 3: ‘In what kind of housing do you currently live?’ = Q3
- Question 4: ‘In what residential area do you currently live?’ = Q4
- Question 5: ’What kind of internet connection to you have?’ = Q5
- Question 6: ‘What do you currently pay monthly for your internet connection?’ = Q6
- Question 7: ‘I know about the advantages of optical fiber against other existing technologies’ = Q7
- Question 8 will not be coded because it is an open statement
- Question 9: ‘I prefer a lower price to a faster internet connection’ = Q9
- Question 10: ‘I prefer a lower price to a stable and safe internet connection’ = Q10
- Question 11: ‘I am willing to pay six euros more for double speed’ = Q11
- Question 12: ‘I am willing to pay six euros more for more safety and stability’ = Q12
- Question 13: ‘I am willing to pay a onetime installation fee for a fiberglass connection’ = Q13
- Question 14: ‘I am willing to switch to another network provider for an optical fiber connection’ = Q14
- Question 15: ‘I am willing to sign a long-term contract to gain from special sale offerings’ = Q15
- Question 16: ‘I expect additional services for the higher cost of optical fiber’ = Q16
- Question 17: ‘I prefer tariff A with 500 Mbit/s for 49.99 euros to B with 250 Mbit/s for 44.99 euros’ = Q17
- Question 18: ‘I prefer tariff A with HIGH stability and safety for 49.99 euros to tariff B with average stability and safety for 44.99 euros’ = Q18
- Question 19: ‘I am willing to pay 10 euros more for more speed, stability, safety if current tariff is 39.99 euros for 25o Mbit/s’ = Q19
- Question 20: ‘I am willing to pay 11-20 euros more for more speed, stability, safety if current tariff is 29.99 euros for 50 Mbit/s’ = Q20

The data of the individual variables in demographic terms can be evaluated as shown below.

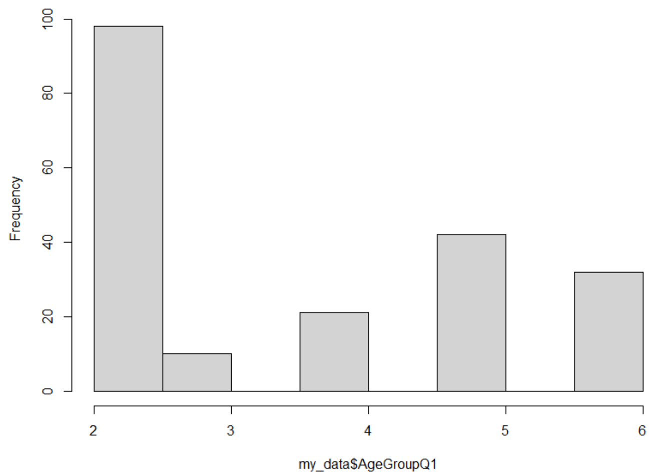


Figure 13: Histogram Showing the Distribution of Age Groups Q1

Source: author's own diagram created with software Rstudio with survey data

48% of the questioned people belong to the age group of 18 to 29 years. About 15% are in the age group of 30 to 39 and 40 to 49 years. 37% are in the age groups 50 to 59 and 60+ years. 55% of the survey respondents are female and 45% are male. Most of these live in a single family home and about one third lives in flats. Almost half of these have their homes in the outskirts and one third in the city center, and about 20% live in rural areas. In terms of the internet connection, the distribution can be seen in the diagram below. It becomes apparent that most (41.7%) of the respondents are equipped with a digital subscriber line connection, and 26% use a cable connection. 17.2% have an optical fiber connection. Mentionable here as well is the fact that about 12.3% do not know the type of technology their internet connection is.

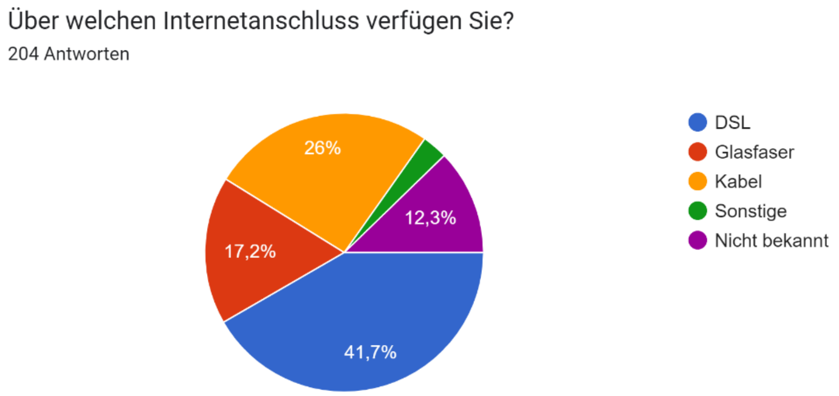


Figure 14: Pie Chart Displaying the Distribution of the Different Internet Connections

Source: Author's own diagram created with Google Forms with survey data

The sixth question says that about half of the individuals pay between 21 and 40 euros monthly for their internet connection. About 17.2% of the respondents do not know how much they pay monthly. Question seven and eight are dedicated to the advantages of optical fiber. In the seventh question, the individuals were asked to what extent they agree with the given statement 'I know about the advantages of optical fiber against other technologies'. The eighth question asked the respondents to provide possible positive aspects of fiberglass. 70% out of the questioned people claim to know the advantages' fiberglass obtains. In the open follow-up question, the majority states the aspect that optical fiber is much faster. Some add the characteristic stability and more resistance to outer disturbances. Considering the willingness to pay, the question of preferring a lower price over a faster internet connection concludes in the fact that about 40% do not agree with this statement and about 25% are indifferent. More than 80% disagree with the statement that a lower price is more important than a stable and reliable internet connection. On top of that, around 70% are willing to pay 6 euros more monthly for double speed and 80% would pay 6 euros more monthly to be equipped with a much more stable and reliable internet connection. Often, it is necessary to pay installation cost for a fiberglass line, which about 46% are willing to pay for.

However, 30% would not be willing to pay such extra cost. Loyalty wise, approximately 50% would switch their internet provider for an optical fiber line and 30% are indifferent. Almost 60% are willing to sign a long term contract in order to profit from special sales offers. The respondents agree to 90% with the fact that they expect additional services in form of more customer support, entry bonus and easy tariff switches for the higher cost of an optical fiber connection. While comparing and trading off between two tariffs, 80% would choose the more expensive tariff with more speed and more stability and safety. 60% would pay up to 20 euros more for more speed stability and safety if their current tariff would cost 29.99 euros.[9]

4.2.2 Correlation analysis

To cover all possible correlations between the studied parameters, the author created a correlation matrix in which every correlation between two variables is tested. The Spearman method was picked for reasons explained earlier in this chapter. The intensity of the relationship between two parameters can be described as follows. A perfect positive correlation is represented with a +1. A perfect negative correlation is depicted in a correlation coefficient of -1 (cf. Donnelly; Abdel-Raouf 2016, Bonus Chapter 3). Most of the combinations resulted in very low correlation, which include the values between -0.29 to 0.29. Moderate correlation is defined in a range from -0.69 to -0.3 and 0.3 to 0.69. High correlation is specified in the range from -1 to -0.7 and 0.7 to 1. Highly correlated are the parameters Q12 and Q11. The Spearman Correlation Coefficient here is 0.72701762 and the scatter plot and regression line is shown below. A scatter plot shows the relationship between the data points of two variables (cf. Donnelly; Abdel-Raouf 2016, p.597).

[9] All Histograms can be viewed in the Appendices.

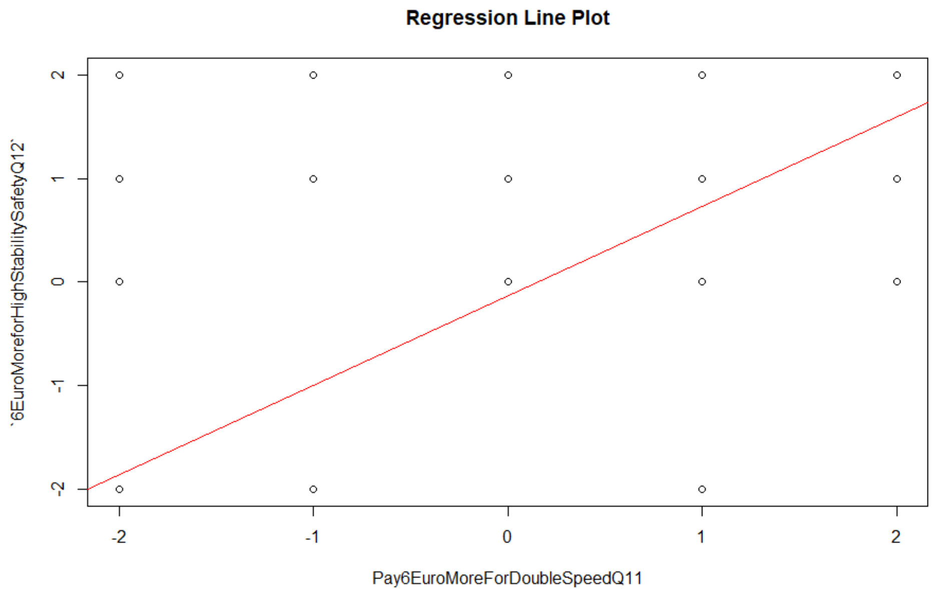


Figure 15: Scatter Plot with Regression Line Presenting the Correlation Q12 and Q11

Source: author's own diagram created with survey data in Rstudio

This correlation means that the people who would pay 6 euros more for double speed are most likely to pay 6 euros more for high stability and safety. Relevant moderate correlations are between the variables Q17 and Q18. The correlation coefficient here is 0.68260777. This means the two variables are positively correlated, and the people who are willing to pay more for double speed also would pay more for high stability and safety. Another relevant correlation is between the variables Q19 and Q20. These two are also positively correlated, with a Spearman Correlation Coefficient of 0.58546437. This can be interpreted that the more people would pay 10 euros more for more Speed if their current tariff is now 250MBIT for 39.99 euros, the more people would pay 11 to 20 euros more for the same reasons if their current price is 29.99 euros. The next table shows the most significant correlation coefficient in a matrix format.[10] The table includes the analyzed question. Yellow marked boxes show moderate correlation. Green highlighted boxes present moderate to high correlation. The red marked boxes show the correlations that can be described as strong.

[10] The full correlation matrix including all variables except for question eight can be viewed in the Appendices.

	Q11	Q12	Q17	Q18	Q19	Q20
Q11		0.72701762	0.36914981	0.342649606	0.353114108	0.35383363
Q12	0.72701762		0.41219518	0.491911402	0.399338189	0.39922902
Q13	0.35792100	0.39420211		0.319671004	0.388270820	0.37584654
Q14	0.30192377	0.35699996				
Q15						
Q16						
Q17	0.36914981	0.41219518		0.682607775	0.456805037	0.42200379
Q18	0.34264961	0.49191140	0.68260777		0.461866168	0.49869564
Q19	0.35311411	0.39933819	0.45680504	0.461866168		0.58546437
Q20	0.35383363	0.39922902	0.42200379	0.498695637	0.585464366	

Table 12: Most Important Correlation Coefficient of Survey Data

Source: author’s own diagram created with Excel based on survey data

4.3 Analysis of Added Value of Fiber Optic

The next section is dealing with a comparative perspective on advantages and disadvantages of fiberglass against DSL and coaxial cables. This will support the understanding of the added value of the optical fiber technology. One major factor that still makes DSL rule the telecommunication market is that it has the highest availability and built out network of all technologies. This is also due to the fact that twisted pair cables were introduced with the beginning stages of telecommunication and therefore have been the major source all over the world whereas, optical fiber is a rather new technology that has not reached its peak in the market. This is why fiberglass is not yet available everywhere. It still keeps growing progressively. Comparing the installation process and its cost, it becomes apparent that copper cables require relatively low construction costs, whereas optical fiber still has comparatively large installation cost and requires trained personnel and superior equipment to perform testing. However, twisted pair technologies need to have a small space between repeaters, which results in the need for more components that need to be maintained.

In the long run, this causes greater operational cost. Coaxial cables have the ability of bigger distances between repeaters. This technology still requires high cost of installation. This problem is not incorporated in the optical fiber solution. The cables are much lighter in comparison to all other technologies and much thinner and smaller, which results in less needed personnel power for construction. One major advantage of optical fiber technology is its high bandwidth capacity. The limits have yet to be set, and it is possible to add additional equipment to existing fiber lines with the same generation in order to increase its capacity. This exceeds twisted pair limits by far. Copper cables require short distances in order to maintain a higher data rate, which means the longer the transmission distance, the fewer data rate. Even though coaxial cables have greater capacity for higher transmission rates, they do not exceed the limitless options of optical fiber. Another major factor that plays an important role in the telecommunication sector is the error rate of a technology. Copper cables are highly affected by external destruction, especially radio frequency interferences. In contrast, optical fiber can be characterized as virtually sound free and has an extremely low error rate, which makes it much less vulnerable to electromagnetic disturbances. Mentionable is that this technology is still susceptible to physical damage caused while installation or by wildlife. Continuous monitoring of the fiberglass network enables detecting these damages at very early stages and prevent major destruction of the network. Coaxial lines have a lower error rate than copper than twisted pair. But they are not noise free and vulnerable to destruction by lightning strikes. (cf. Goleniewski; Jarrett 2006, chapter 2). Optical fiber creates a great fundament for the future telecommunication sector. It has a nearly limitless transmission capacity and obtains a minimum of possible errors and advanced security. The one major factor slowing down the implementation of fiberglass into the telecommunications market is that construction requires special trained staff and is quite expensive compared to other existing service technologies (cf. Goleniewski; Jarrett 2006, Chapter 2).

4.4 Analysis of the Willingness to Pay for Fiber Optic

The next section is dedicated to the value-based pricing analysis. In previous chapters, the theoretical background and the data collection process as well as the data analysis have been explained. Based on this, an evaluation of customer value perception can be conducted. The survey data highlights that the main focus and satisfaction of respondents can be drawn from a stable, reliable, and safe internet connection. They are willing to pay more in order to increase the presence of these attributes. A slightly less, yet relevant factor is the speed an internet connection offers. Here, the questioned people value speed as their second-highest attribute and choose to accept more cost to have higher speed connectivity. The survey also shows that fixed line users are somewhat price sensitive, but value the stated above attributes as more valuable than a lower price. This is a good prerequisite for network providers offering optical fiber tariffs. 30 % of the respondents are currently paying between 31 and 40 euros and 23% between 21 and 30 euros. Most of these are willing to pay at least 6 euros more for their internet connection, and some are willing to pay up to 20 euros more. The companies Telekom, Vodafone and NetCologne currently offer fiberglass tariffs starting at about 40 euros. The survey results show that 56% already obtain a contract which obliges them to pay 40 euros monthly or even more. Significant survey results in terms of the willingness to pay are the responses of Question 11 and 12 which are displayed in the two pie charts below.

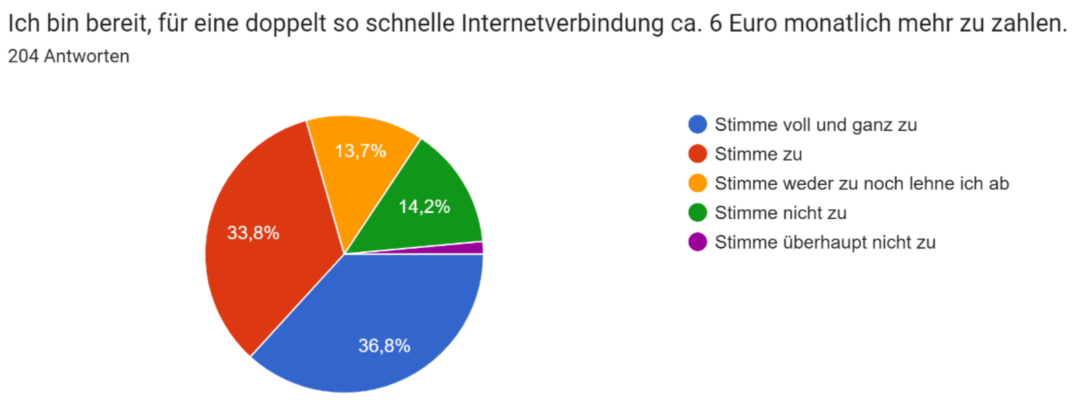


Figure 16: Pie Chart of Survey Question 11

Source: author’s own diagram created with Google Forms based on survey data

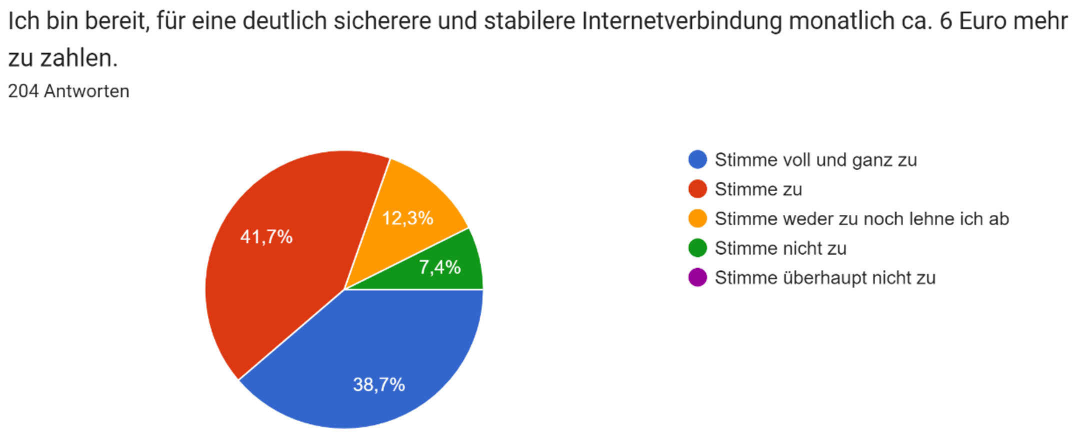


Figure 17: Pie Chart of Survey Question 12

Source: author's own diagram created with Google Forms based on survey data

The results show that in both cases more than 60% are willing to pay 6 euros more for speed, stability, and safety. These are key motivators for the respondents, which is underlined by the results of Questions 17 and 18. These highlight that almost 70% are ready to pay about 5 euros more than their current tariff of 44.99 euros if this offers them more stability, speed, and safety.

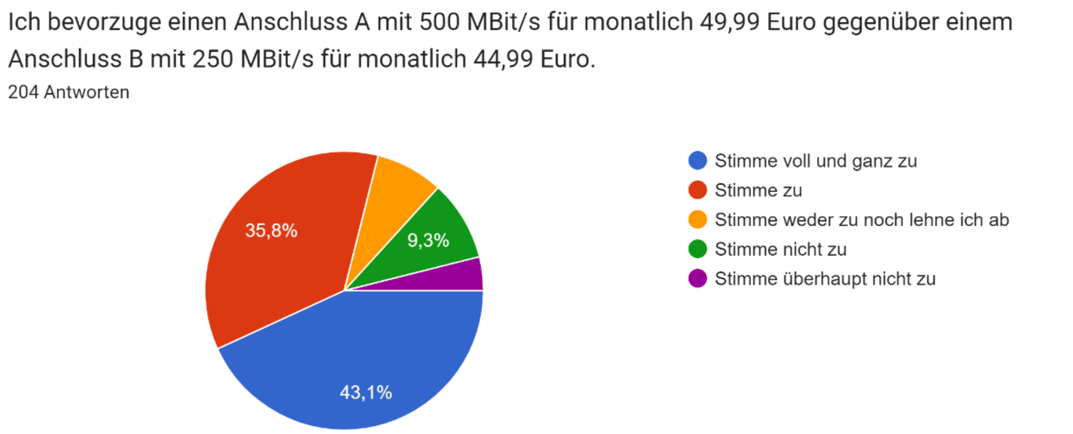


Figure 18: Pie Chart to Survey Question 17

Source: author's own diagram created with Google Forms with survey data

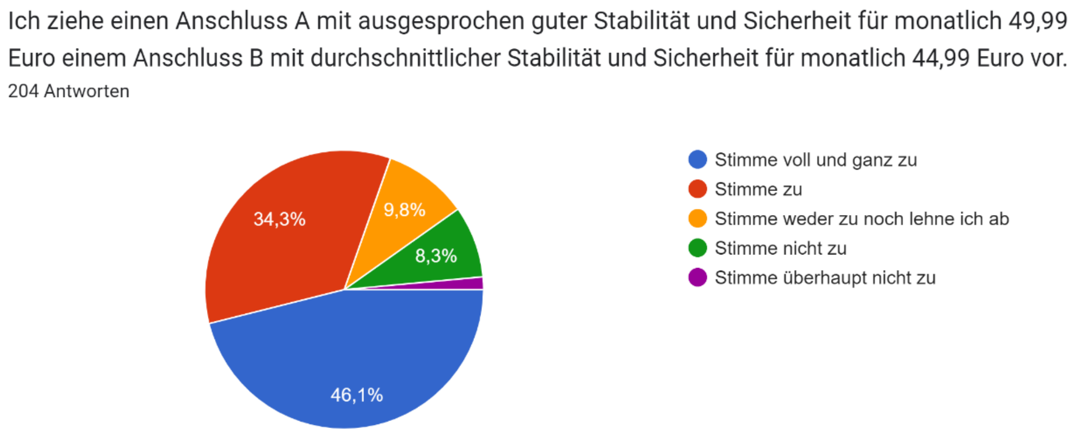


Figure 19: Pie Chart to Survey Question 18

Source: author's own diagram created with Google Forms with survey data

The question arises to what extent do customers value these key characteristics in monetary terms. Noticeable here is that in the last question, where the willingness to pay 11 to 20 euros more for the stated key characteristics the willingness does not significantly reduce compared to the previous question 19 which asks if the respondent is willing to pay 10 euros more. Almost 2% more are keen to pay up to 20 euros more than in the previous question.

One can conclude that the willingness to pay for optical fiber is definitely given and is in the range of 5 to 20 euros more for additional offered services such as higher speed, stability, and safety.

5 Recommendations

In this part, the suggested recommended actions based on the results of the online survey for the BREKO association are presented. The focus here is on the user's willingness to pay for fiberglass and what actions or changes might be taken in order to meet user expectations. The individuals who were handed the online survey were offered a variety of choices and preferences to choose from. The emphasis here laid on the strengths that an optical fiber line obtains, which are high speed, stability, and safety.

Different price options were put into perspective and the respondents were asked for their preferences. The results of the questionnaire show a high overall tendency that people are willing to pay for a fiber glass connection. They would even pay more in order to have additional bandwidth, reliability, and safety. Especially important here is the fact that reliability and safety seems to be of higher relevance to the respondents than obtaining more speed. People would also agree to long term contracts if they are offered special sales options. Moreover, most of the questioned people expect special services for the higher cost of optical fiber. Network providers should ensure a smooth transition if customers are willing to switch their internet connection as well as their provider. In concrete, this means that a temporary fall out of connection is not in the interest of the user and should be kept to a minimum. Additionally, vital here is to ensure a highly reliable customer support service which is frequently available does not leave customers in a waiting for too long.

Communication Strategies

Considering the digital society, it is of high importance to communicate with the audience correctly. The survey showed that many people do not even know what internet connection they have or what they currently pay. Measures that could be taken into account could be to enlarge the Q&A section of the network provider's websites, where the differences and advantages of each of the technologies are presented and can be easily accessed by customers. Furthermore, increase the communication and closeness to customers, offer workshops and YouTube shorts[11] in which optical fiber is explained and visualize it with appealing animations. Emphasize the stability and safety aspect to the users and include these in campaigns and ensure stable connections.

[11] A short five to ten second video/sequence that is published on YouTube.

Show why optical fiber is superior and describe how this technology might be the future. Create futuristic models in which digitization has become even more important and virtual reality and AI and other superior technologies are even more relevant for the daily life which requires a high-quality network connection which can be offered via optical fiber. The fact that the sample population is willing to pay more if they get more and would sign long term contracts for fiberglass connections if they can profit from special sale options and bonuses is significant. Network providers need to ensure to display all necessary cost and what they are needed for in their offerings. ‘Family and friends’ options or tariffs could be offered to increase the demand in a certain neighborhood. For example, not only getting a bonus from recruiting another customer, but also getting a permanent percentage increase for a year for both parties which will put additional cost into perspective. Moreover, one might consider strengthening the social media presence of the BREKO association and its member companies. An Instagram account could be useful in order to present the consumers with valuable information about networks. An Instagram story could look like the following illustrations. One could further include short quizzes in order to investigate the knowledge of viewers and motivate them to find out more about the certain content.

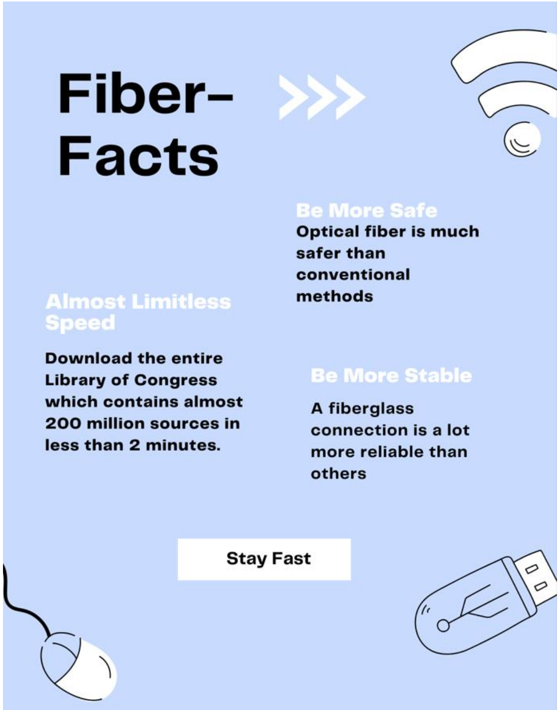


Figure 20: Instagram Story about FiberFacts

Source: author's own illustration following Goleniewski; Jarrett 2006

Figure 21: Instagram Frequently Asked Questions Story

Source: author's own diagram created with Canva

6 Conclusion

In conclusion, this thesis concentrated on the comparison of different technologies in the telecommunications market: copper and fiber (coaxial), and the in depth analysis of the willingness to pay for fiberglass connections. To cover these topics comprehensively, the telecommunications market's historical and current situation were analyzed, and an online survey was used to gather primary data for evaluating and drawing conclusions from on German's telecommunications user base and their willingness to pay for optical fiber. The results of this study are presented to the BREKO association, which is the cooperation partner of the author. This study aims to aid in the development and improvement of customer understanding and coverage of optical fiber in the German market.

The following objectives were derived from this overall goal.

1. Identify, quantify and analyze the telecommunications market including its different technologies
2. Are German telecommunication users willing to pay for an optical fiber broadband connection?
   – Explore/investigate/analyze the willingness to pay for optical fiber broadband connections of German telecommunication users by conducting a consumer survey
3. Examine the nature of the individual's willingness to pay in terms of price sensitivity or other motivators
4. Work out specific recommended actions for network providers of the BREKO association on how to deal with marketing and pricing optical fiber connections

In terms of the first objective, one can summarize that twisted pair technology still rules the overall market, but tendencies in the growth development of fiberglass show the possibility of replacing traditional media such as DSL, cable and satellite.

The second and third objective can be viewed together. The overall result of the conducted survey and this thesis is that many individuals are indeed willing to pay for an optical fiber connection and are even willing to pay 6 to 20 euros more monthly if they are ensured a network that offers high speed, stability, and safety. These are the top motivators for customers of the telco market and reduce the buyer’s price sensitivity significantly.

The last objective results in several recommendations in terms of communication strategies and pricing tariff options. Major measures here are the development of social media presence in terms of YouTube shorts, TikTok and Instagram videos which explain and visualize the benefits and techniques behind fiber. This is especially appealing to younger generations, which are possibly the most affected by the increase in digitization and data usage in the future and therefore in current or future need of an optical fiber connection. Another measure taken into consideration is to establish a collected customer support service, so waiting times and technical issues can be reduced. Lastly, special bonuses and ‘family and friends’ offerings should be taken into account. These can be styled as recruiting bonuses and additional percentage decreases of the monthly cost.

Making use of the recommendations should improve the overall market coverage of fiberglass connections in the German market and motivate customers to switch their internet provider or internet connection.

7 Outlook

The limits of this bachelor thesis in terms of scope and extend leave room for some topics to be explored further which could be the topic of follow-up studies.

A topic to be considered for further investigation could be the relationship between wages and willingness to pay, so customer clusters can be formed and individually addressed. To further examine the willingness to pay for fiberglass in the telecommunications market, a follow-up questionnaire could be sent out to customers which contain different product combinations with various attributes. These are then to be ranked according to the respondents preferences.

Based on this, a conjoint analysis can be conducted, and a concrete utility value can be developed. It is safe to say that the dynamics of the telco market are going to keep changing in the future and optical fiber will gain more market share. Interesting in context would be the investigation of the future of the other technologies and how to handle the existing networks and if there are any ways to recycle these materials or networks as a whole. Moreover, the conjoint analysis can be used as a basis for conducting further value-based pricing calculations and create a new price delta for optical fiber market.

Bibliography

Advanced Technologies for industry, Sectoral watch: Technological Trends in the Telecommunication Industry (2021)

Baldock, Sarah (2014): Using R for statistics, Apress, Chapter 5

Begg, David/Gianluigi Vernasca/Stanley Fischer/Rudiger Dornbusch (2014): Economics, McGraw-Hill Higher Education.

Boyle, David. Simms/Andrew Simms (2019): Economics: a Crash Course, pp.62ff.

Donnelly, Robert A., Jr PhD/Fatma Abdel-Raouf PhD (2016): Statistics, 3E, Penguin, p. 597, Bonus Chapter 3

Goleniewski, Lillian/Kitty Wilson Jarrett (2006): Telecommunications Essentials, Second edition: The Complete Global Source, Pearson Education.

Hillman, Terry (2014): Economics, Alpha Books, pp. 75f., 78

Huurdeman, Anton A. (2003): The worldwide history of telecommunications, [online] doi:10.1002/0471722243, pp. 227f., 229f., 314f., 363f., 605

Kotler, Philip/Gary Armstrong (2020): Principles of Marketing, Global edtion, pp. 89f, 97ff. 101f., 296 – 299, 309

Kotler, Philip/Kevin Lane Keller/Marc Oliver Opresnik (2017): Marketing-Management: Konzepte - Instrumente – Unternehmensfallstudien, pp.584ff.

Kühn, Richard/Anja Reimer/Roger Fasnacht (2006): Marketing: System, Strategie und Instrumente, pp. 101ff.

Mukherjee, Sampat (2020): Microeconomics, Londond: New Central Book Agency, p.189ff.

Pepels, Werner (2016a): Handbuch des Marketing, Teilband I. A. Marketing als Denkhaltung – B. Käuferverhalten – C. Marktforschung., [online] doi:10.3790/978-3-428-54929-0, pp. 64, 90

Pepels, Werner (2016b): Handbuch des Marketing, Teilband III. H. Sektorales Marketing – J. Spezielles Marketing – K. Marketingmanagement., [online] doi:10.3790/978-3-428-54931-3, pp. 387, 463ff.

Phillips, Robert L. (2021): Pricing and revenue optimization, Stanford University Press eBooks, [online] doi:10.1515/9781503614260, pp. 1, 24ff.

Saunders, Mark N. K./Philip Lewis/Adrian Thornhill (2019a): Research methods for business students, Pearson Higher Ed., pp. 83, 174, 324, 525ff.

Scharf, Andreas/Bernd Schubert/Patrick Hehn (2015): Marketing: Einführung in Theorie und Praxis, pp. 3, 38ff.

Team, Core/Oxford University Press (2017): The economy: Economics for a Changing World, Oxford University Press, USA, pp. 281, 315

Verma, Pramode/Fan Zhang (2020a): The Economics of Telecommunication Services: An Engineering Perspective, Springer Nature, pp. ii, 1, 72, 84

Online sources

AI in Virtual Reality - IEEE Digital Reality (n.d.): [online] https://digitalreality.ieee.org/publications/ai-in-virtual-reality [accessed on 25.08.2023].

Bonn (n.d.): NetCologne, [online] https://www.netcologne.de/privatkunden/bonn/ [accessed on 06.06.2023].

BREKO Association e.V./Jens Böcker/Anna Nass/Stephan Albers/Nicholas Hayer (2022): BREKO Marktanalyse 2022, [online] https://www.brekoverband.de/site/assets/files/24389/breko_marktanalyse_2022.pdf, pp. 4-6, 12-14,16-19

BREKO Association (n.d.): BREKO, [online] https://www.brekoverband.de/en/breko/breko-verband/ [accessed on 17.05.2023].

BREKO Verband (n.d.): BREKO, [online] https://www.brekoverband.de/breko/breko-verband/ [accessed on 15.08.2023].

Bundesnetzagentur (2022): *Jahresbericht Telekommunikation 2022*, [online] https://www.bundesnetzagentur.de/SharedDocs/Mediathek/Berichte/2023/JB_TK_2022.pdf?__blob=publicationFile&v=4, pp. 11ff, 14

Brickwedel, Stefanie (2016): SIKORA: Quality assurance at the production of optical fiber cables, in: Sikora, [online] https://sikora.net/en/sikora-quality-assurance-at-the-production-of-optical-fiber-cables/.

DSL-Angebote - Internet & Festnetz ab 9,99€ mtl. | Vodafone (n.d.): [online] https://www.vodafone.de/privat/internet/dsl.html [accessed on 06.06.2023].

DSL-Tarife: schnelles Internet für Zuhause | Telekom (n.d.): [online] https://www.telekom.de/festnetz/tarife-und-optionen/dsl-tarife [accessed on 06.06.2023].

DSLWEB. (2022). Marktanteile der führenden Anbieter an den Breitbandinternetanschlüssen in Deutschland von 2011 bis 2021. Statista. Statista GmbH. https://de.statista.com/statistik/daten/studie/196770/umfrage/marktanteile-der-fuehrenden-breitband-anbieter-in-deutschland/ [accessed on 21.07.2023].

Europäische Kommission. (2023). Anteil der DSL-Anschlüsse an allen stationären Breitbandanschlüssen in Deutschland von Dezember 2004 bis Dezember 2021. Statista. Statista GmbH. https://de.statista.com/statistik/daten/studie/300000/umfrage/anteil-der-dsl-anschluesse-an-allen-breitbandanschluessen-in-deutschland/ [accessed on 11.07.2023].

Eurostat. (2023). Anteil der Haushalte in Deutschland mit Internetzugang von 2002 bis 2022. Statista. Statista GmbH. https://de.statista.com/statistik/daten/studie/153257/umfrage/haushalte-mit-internetzugang-in-deutschland-seit-2002/ [accessed on 11.07.2023].

Federal ministry for digital and transport (2021): Report to the Broadband Atlas Part 1: Ergebnisse, [online] https://bmdv.bund.de/SharedDocs/DE/Anlage/DG/Digitales/bericht-zum-breitbandatlas-mitte-2021-ergebnisse.pdf?__blob=publicationFile, pp. 7-14, 54-65

Federal Network Agency. (2023). Number of fixed-line broadband connections in Germany from 2001 to 2022, by connection type (in millions). Statista. Statista Inc. https://www.statista.com/statistics/459874/broadband-number-of-connections-by-type-germany/ [accessed on 12.07.2023].

FTTH Council Global Alliance – FCGA (2016): FTTH Council - Definition of Terms, [online] http://www.ftthcouncilap.org/wp-content/uploads/2016/08/FCGA-Definition-of-Terms-Revisions2016.pdf#:~:text=%E2%80%9CHomes%20Passed%E2%80%9D%20is%20the%20potential%20number%20of%20Premises,to%20an%20FTTH%2FFTTB%20network%20in%20a%20service%20area. [accessed on 26.08.2023].

General information | About the Library | Library of Congress (n.d.): The Library of Congress, [online] https://www.loc.gov/about/general-information/ [accessed on 28.08.2023a].

Glasfaser: Highspeed-Internet zu Hause | Telekom (n.d.): [online] https://www.telekom.de/netz/glasfaser?ActiveTabID=glasfaser-tarife&wt_mc=ii_sososoxx_navi-glasfaser-tarife-und-produkte-glasfaser-tarife [accessed on 06.06.2023].

Glasfaser-Internet mit bis zu 1000 Mbit/s Highspeed | Vodafone (n.d.): Vodafone, [online] https://zuhauseplus.vodafone.de/internet-telefon/glasfaser/ [accessed on 06.06.2023].

Grubesic, Tony H./Elizabeth A. Mack (2015): Broadband telecommunications and regional development, [online] doi:10.4324/9781315794952, p.12

ITU. (2023). Number of fixed broadband subscriptions worldwide from 2005 to 2022 (in millions). Statista. Statista Inc. https://www.statista.com/statistics/273015/number-of-fixed-broadband-subscriptions-worldwide-since-2005/ [accessed on 25.08.2023].

Kabel Internet Angebote – Tarife bis 1.000 Mbit/s | Vodafone (n.d.): Vodafone, [online] https://zuhauseplus.vodafone.de/internet-telefon/kabel/ [accessed on 06.06.2023].

OECD (n.d.): About OECD, [online] https://www.oecd.org/about/. [accessed on 25.08.2023].

OECD Digital Economy Outlook 2020 (2020): OECD eBooks, [online] https://doi.org/10.1787/bb167041-en, p.58

Population by age groups (n.d.): Federal Statistical Office, [online] https://www.destatis.de/EN/Themes/Society-Environment/Population/Current-Population/Tables/population-by-age-groups.html [accessed on 04.07.2023].

Rg213 Rg8 Lmr400 Stranded Coaxial Cable For Telecommunication - Buy Rg213,Coaxial Cable Rg213,Rg213 Coaxial Cables Product on Alibaba.com (n.d.): [online] https://www.alibaba.com/product-detail/RG213-RG8-lmr400-stranded-coaxial-cable_1600057995665.html [accessed on 28.08.2023].

Solid Copper high speed utp cat5e cable Lan cable 4 Pair Twisted Pair Copper Cable (n.d.): [online] https://www.crownnetcom.com/sale-8480996-solid-copper-high-speed-utp-cat5e-cable-lan-cable-4-pair-twisted-pair-copper-cable.html [accessed on 28.08.2023].

Seven.One Media GmbH (Ein Unternehmen der ProSiebenSat.1 Media SE). (2019). Orte der Internetnutzung in Deutschland im Jahr 2019. Statista. Statista GmbH. https://de.statista.com/statistik/daten/studie/320931/umfrage/orte-der-internetnutzung-in-deutschland/ [accessed on 25.08.2023].

Statista (2023a): Number of users of smart homes worldwide 2018-2027, Statista, [online] https://www.statista.com/forecasts/887613/number-of-smart-homes-in-the-smart-home-market-in-the-world [accessed on 25.08.2023].

Statistisches Bundesamt - Statistisches Bundesamt (n.d.): [online] https://www.destatis.de/DE/Themen/Gesellschaft-Umwelt/Bevoelkerung/Bevoelkerungsstand/Tabellen/zensus-geschlecht-staatsangehoerigkeit-2022.html?view=main[Print] [accessed on 11.07.2023].

Tarifvergleich (n.d.): [online] https://www.netcologne.de/privatkunden/internet-tarife/ [accessed on 06.06.2023].

TechTarget (2012): Need for increased network bandwidth is IT's biggest datacentre pain-point, in: ComputerWeekly.com, 26.09.2012, [online] https://www.computerweekly.com/news/2240163911/Need-for-increased-network-bandwidth-is-ITs-biggest-datacentre-pain-point [accessed on 25.08.2023].

VATM. (2022). Average data volume per stationary broadband connection and month in Germany from 2001 to 2022 (in gigabytes). Statista. Statista Inc. https://www.statista.com/statistics/469117/broadband-average-data-volume-per-connection-germany/ [accessed on 21.07.2023].

Appendices

Appendix 1: Survey Layout

The following section shows the survey layout in German, as it was sent out like this to the respondents.

Umfrage zur Preisbereitschaft für Glasfaser

Hallo zusammen!

Mein Name ist Sophia Staib und ich bin International Business Studentin der Hochschule Bonn-Rhein-Sieg.
Im Rahmen meiner Bachelorarbeit, in der ich verschiedene Telekommunikationstechnologien, wie zum Beispiel Kupferkabel und Glasfaser, vergleiche, führe ich eine Umfrage bezüglich der Preisbereitschaft für Glasfaser in Deutschland durch.

Telekommunikation begegnet uns täglich, deshalb wird immer mehr an Ausbau und Verbesserung dieser gearbeitet.
Der aktuelle Trend geht zunehmend zur Glasfasertechnologie. In Zusammenarbeit mit dem BREKO Verband, der mit seinen zahlreichen Mitgliedern den Großteil des deutschen Glasfasernetzwerkes repräsentiert und stets am weiteren Ausbau und Innovation arbeitet, führe ich diese Umfrage durch.

Mehr zum BREKO Verband finden Sie hier:
brekoverband.de

Wozu ich Ihre Daten sammle und verwende:

Ihre Antworten in dieser Umfrage werden **anonym** für meine Bachelorarbeit behandelt, bewertet und illustriert und um Handlungsempfehlungen für den BREKO Verband und seine Mitglieder herauszuarbeiten.

Für die Umfrage müssen Sie lediglich 5 Minuten einplanen :) .
Ein riesiges Dankeschön für die Teilnahme!

Sophia Staib

Bitte geben Sie Ihr Alter an.

Kästchen

- [ ] Unter 18 Jahre
- [ ] 18 - 29 Jahre
- [ ] 30 - 39 Jahre
- [ ] 40 - 49 Jahre
- [ ] 50 - 59 Jahre
- [ ] 60 Jahre oder älter
- [ ] Option hinzufügen oder "Sonstiges" hinzufügen

Pflichtfrage

Bitte geben Sie Ihr Geschlecht an. *

- Männlich
- Weiblich
- Divers
- Andere

Welche Art von Behausung bewohnen Sie aktuell? *

- Einfamilienhaus
- Mehrfamilienhaus
- Wohnung
- Wohngemeinschaft / Studentenwohnheim

In welcher Wohngegend wohnen Sie zurzeit? *

- ◯ Ländliches Gebiet
- ◯ Stadtrand / Vorstadt
- ◯ Innenstadt / Zentrum
- ◯ Neubaugebiet

Über welchen Internetanschluss verfügen Sie? *

- ◯ DSL
- ◯ Glasfaser
- ◯ Kabel
- ◯ Sonstige
- ◯ Nicht bekannt

Wie viel zahlen Sie aktuell **monatlich** für Ihre Internetverbindung? *

- Unter 20 Euro
- Zwischen 21 - 30 Euro
- Zwischen 31- 40 Euro
- Zwischen 41 - 50 Euro
- Über 51 Euro
- Nicht bekannt

Mir sind die Vorteile von Glasfaser anderen Technologien gegenüber bekannt. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Mögliche Vorteile von Glasfaser sind: *

Kurzantwort-Text

Ich ziehe einen niedrigen Preis einer schnelleren Internetverbindung vor. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Mir ist ein niedriger Preis wichtiger als eine stabile und zuverlässige Internetverbindung. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, für eine doppelt so schnelle Internetverbindung ca. 6 Euro monatlich mehr zu zahlen. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, für eine deutlich sicherere und stabilere Internetverbindung monatlich ca. 6 Euro mehr zu zahlen. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, eine einmalige Installationsgebühr für einen Glasfaseranschluss zu zahlen. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, meinen aktuellen Internetanbieter zu wechseln, um einen Glasfaseranschluss zu nutzen. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, einen langfristigen Vertrag abzuschließen, um von besonderen Rabatten und Preisangeboten zu profitieren. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich erwarte für die höheren Kosten eines Glasfaseranschlusses zusätzliche Dienste wie zum Beispiel: einen nahtlosen Übergang beim Wechsel des Anschlusses, ohne lange auf Internet zu verzichten, eine Einstiegsprämie, einen einfachen Tarifwechsel während der Vertragslaufzeit oder verstärkten Kundensupport. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Erläuterung zu den nächsten Fragen:

MBit/s steht für Megabit pro Sekunde und dient als Maßeinheit zum Messen der Geschwindigkeit der Datenübertragung. Demnach folgt: Je mehr MBit/s, desto schneller ist folglich die Datenübertragung.

Ich bevorzuge einen Anschluss A mit 500 MBit/s für monatlich 49,99 Euro gegenüber einem Anschluss B mit 250 MBit/s für monatlich 44,99 Euro. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich ziehe einen Anschluss A mit ausgesprochen guter Stabilität und Sicherheit für monatlich 49,99 Euro einem Anschluss B mit durchschnittlicher Stabilität und Sicherheit für monatlich 44,99 Euro vor. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, monatlich bis zu 10 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahlen, wenn mein aktueller monatlicher Tarif 39,99 Euro für 250 MBit/s beträgt. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Ich bin bereit, monatlich 11 - 20 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahlen, wenn mein aktueller monatlicher Tarif 29,99 Euro für 50 MBit/s beträgt. *

- Stimme voll und ganz zu
- Stimme zu
- Stimme weder zu noch lehne ich ab
- Stimme nicht zu
- Stimme überhaupt nicht zu

Appendix 2: Survey Codebook

The following section presents the coding of the online survey that was conducted for the purpose of this thesis. This codebook was used in order to replace the words in the survey data in Excel to calculate the necessary measures.

1) **Bitte geben Sie ihr Alter an. (Please select your age)**
   1. Unter 18 Jahre
   2. 18 – 29 Jahre
   3. 30 – 39 Jahre
   4. 40 – 49 Jahre
   5. 50 – 59 Jahre
   6. 60 Jahre oder älter

2) **Bitte geben Sie Ihr Geschlecht an.**
   1. Männlich
   2. Weiblich
   3. Divers
   4. Andere

3) **Welche Art von Behausung bewohnen Sie aktuell?**
   1. Einfamilienhaus
   2. Mehrfamilienhaus
   3. Wohnung
   4. Wohngemeinschaft / Studentenwohnheim

4) **In welcher Wohngegend wohnen Sie zurzeit?**
   1. Ländliches Gebiet
   2. Stadtrand / Vorstadt
   3. Innenstadt / Zentrum
   4. Neubaugebiet

5) **Über welchen Internetanschluss verfügen Sie?**

1. DSL
2. Glasfaser
3. Kabel
4. Sonstige
5. Nicht bekannt

6) **Wie viel zahlen Sie aktuell monatlich für Ihre Internetverbindung?**

1. Unter 20 Euro
2. Zwischen 21 – 30 Euro
3. Zwischen 31 – 40 Euro
4. Zwischen 41 – 50 Euro
5. Über 51 Euro
6. Nicht bekannt

7) **Mir sind die Vorteile von Glasfaser anderen Technologien gegenüber bekannt.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

8) **Mögliche Vorteile von Glasfaser sind:**

____

9) **Ich ziehe einen niedrigen Preis einer schnelleren Internetverbindung vor.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

10) **Mir ist ein niedriger Preis wichtiger als eine stabile und zuverlässige Internetverbindung.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

11) **Ich bin bereit, für eine doppelt so schnelle Internetverbindung ca. 6 Euro monatlich mehr zu zahlen.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

12) **Ich bin bereit, für eine deutlich sicherere und stabilere Internetverbindung monatlich ca. 6 Euro mehr zu zahlen.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

13) **Ich bin bereit, eine einmalige Installationsgebühr für einen Glasfaseranschluss zu zahlen.**

2 Stimme voll und ganz zu
1 Stimme zu
0 Stimme weder zu noch lehne ich ab
-1 Stimme nicht zu
-2 Stimme überhaupt nicht zu

14) **Ich bin bereit, meinen aktuellen Internetanbieter zu wechseln, um einen Glasfaseranschluss zu nutzen.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

15) **Ich bin bereit, einen langfristigen Vertrag abzuschließen, um von besonderen Rabatten und Preisangeboten zu profitieren.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

16) **Ich erwarte für die höheren Kosten eines Glasfaseranschlusses zusätzliche Dienste wie zum Beispiel: einen nahtlosen Übergang beim Wechsel des Anschlusses, ohne lange auf Internet zu verzichten, eine Einstiegsprämie, einen einfachen Tarifwechsel während der Vertragslaufzeit oder verstärkten Kundensupport.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

17) **Ich bevorzuge einen Anschluss A mit 500 Mbit/s für monatlich 49,99 Euro gegenüber einem Anschluss B mit 250 Mbit/s für monatlich 44,99 Euro.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

18) **Ich ziehe einen Anschluss A mit ausgesprochen guter Stabilität und Sicherheit für monatlich 49,99 Euro einem Anschluss B mit durchschnittlicher Stabilität und Sicherheit für monatlich 44,99 Euro.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

19) **Ich bin bereit, monatlich bis zu 10 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahlen, wenn mein aktueller monatlicher Tarif 39,99 Euro für 250 Mbit/s beträgt.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

20) **Ich bin bereit, monatlich 11 – 20 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahlen, wenn mein aktueller monatlicher Tarif 29,99 Euro für 50 Mbit/s beträgt.**

2 Stimme voll und ganz zu

1 Stimme zu

0 Stimme weder zu noch lehne ich ab

-1 Stimme nicht zu

-2 Stimme überhaupt nicht zu

Appendix 3: Variable Names in Excel

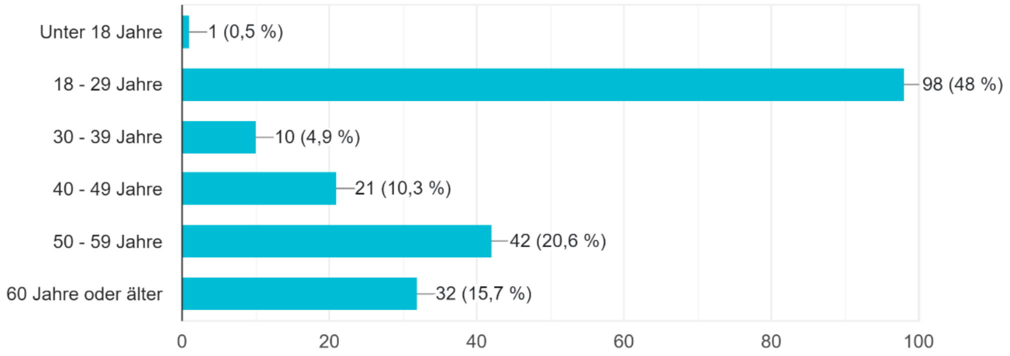
The variables in the Excel sheet are stated as the following:

- Please state zpAgeGroupQ1
- GenderQ2
- livingcircumstancesQ3
- residentialAreaQ4
- InternetConnectionTypeQ5
- CurrentPriceICQ6
- KnowProsofFiberQ7
- LowerPriceoverSpeedQ9
- LowerPriceOverStabilityQ10
- Pay6EuroMoreForDoubleSpeedQ11
- 6EuroMoreforHighStabilitySafetyQ12
- PayInstallationCostForFiberQ13
- SwitchProviderForFiberQ14
- LongtermContractForPriceReductionQ15
- ExtraServiceForHigherPriceFiberQ16
- Prefer500MBITSfor49,99EuroTo250MBITSFor44,99EuroQ17
- PreferHighstabilitySafetyFor49,99EuroForAverageFor44,99EuroQ18
- Pay10EuromoreForMoreSpeedStabilitySafetyWhenNow250MBITSFor39,99EuroQ19
- Pay11to20EuroMoreForHighSpeedStabilitySafetyIfNow50MBITSFor29,99EuroQ20

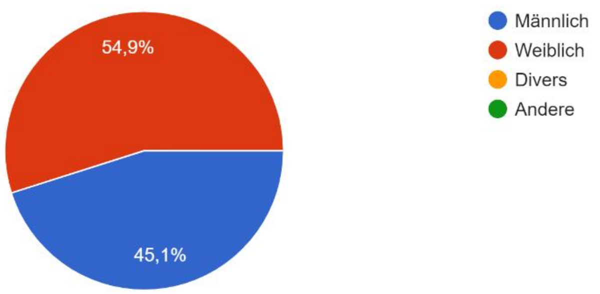
Appendix 4: Survey Responses

The following illustration show the survey results evaluated with Google Forms.

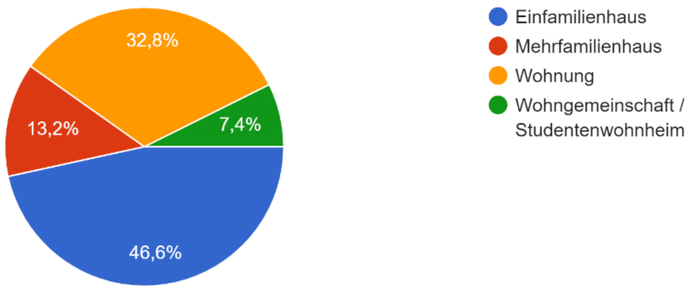
Bitte geben Sie Ihr Alter an.
204 Antworten



Bitte geben Sie Ihr Geschlecht an.
204 Antworten

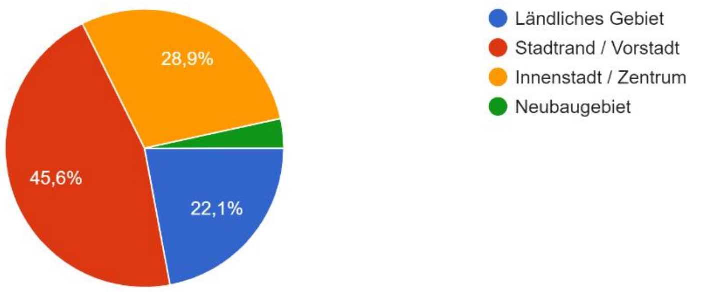


Welche Art von Behausung bewohnen Sie aktuell?
204 Antworten



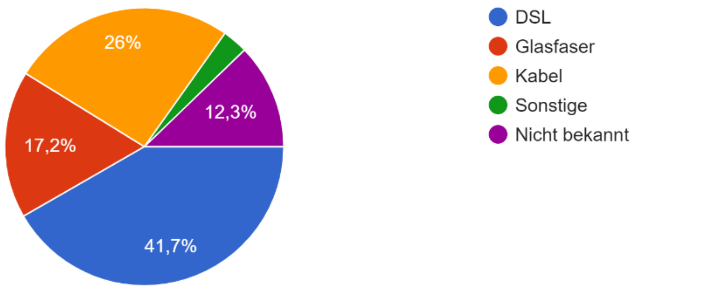
In welcher Wohngegend wohnen Sie zurzeit?

204 Antworten



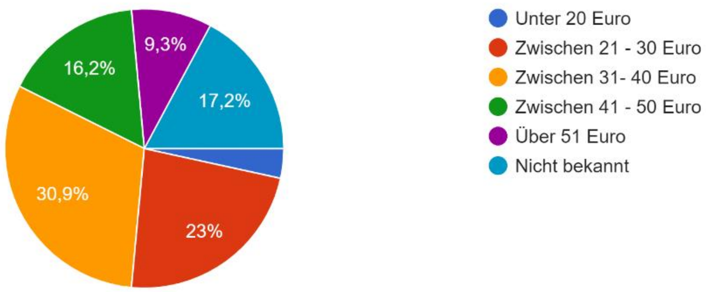
Über welchen Internetanschluss verfügen Sie?

204 Antworten

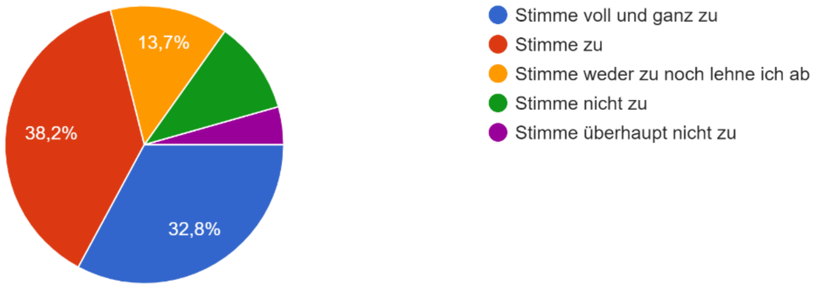


Wie viel zahlen Sie aktuell monatlich für Ihre Internetverbindung?

204 Antworten



Mir sind die Vorteile von Glasfaser anderen Technologien gegenüber bekannt.
204 Antworten

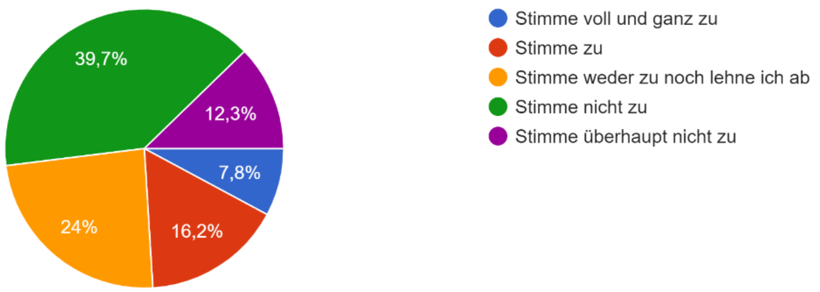


Mögliche Vorteile von Glasfaser sind:

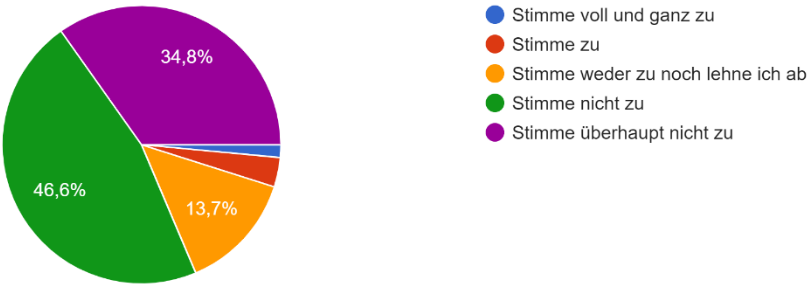
Häufigsten Antworten:

- Schneller
- Sicherer
- Stabiler

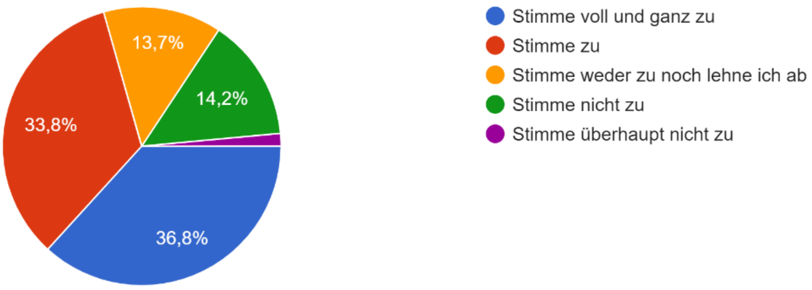
Ich ziehe einen niedrigen Preis einer schnelleren Internetverbindung vor.
204 Antworten



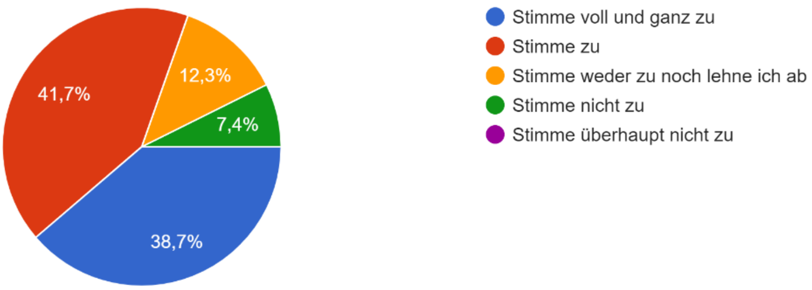
Mir ist ein niedriger Preis wichtiger als eine stabile und zuverlässige Internetverbindung.
204 Antworten



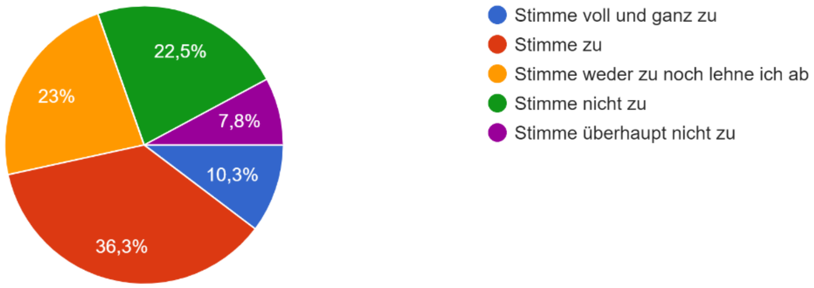
Ich bin bereit, für eine doppelt so schnelle Internetverbindung ca. 6 Euro monatlich mehr zu zahlen.
204 Antworten



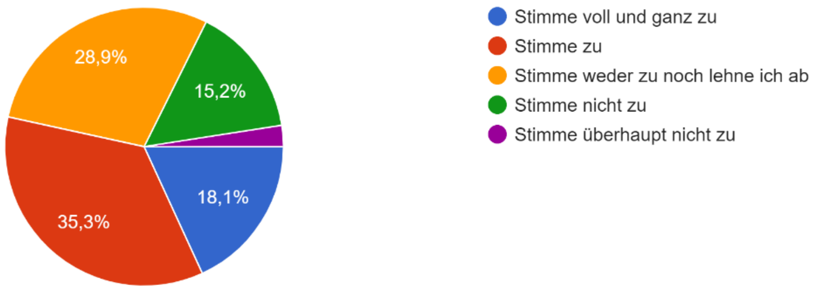
Ich bin bereit, für eine deutlich sicherere und stabilere Internetverbindung monatlich ca. 6 Euro mehr zu zahlen.
204 Antworten



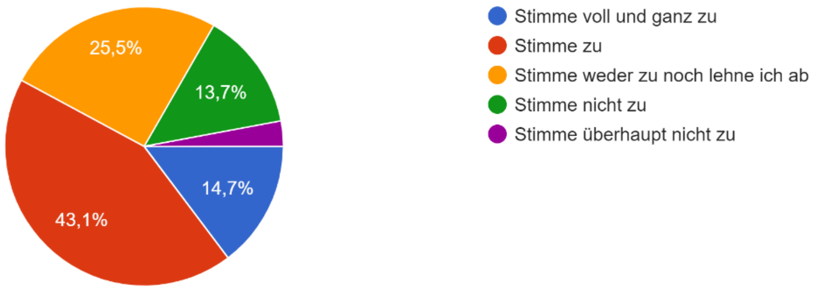
Ich bin bereit, eine einmalige Installationsgebühr für einen Glasfaseranschluss zu zahlen.
204 Antworten



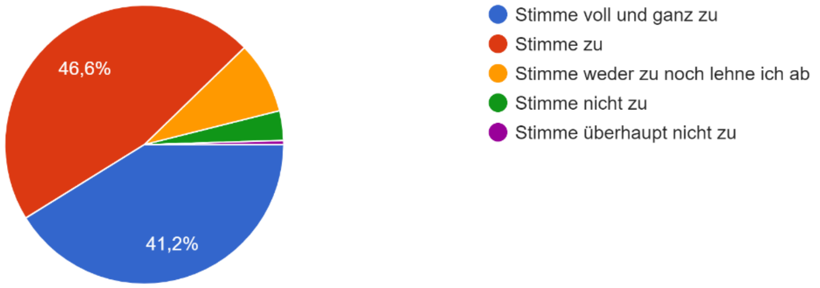
Ich bin bereit, meinen aktuellen Internetanbieter zu wechseln, um einen Glasfaseranschluss zu nutzen.
204 Antworten



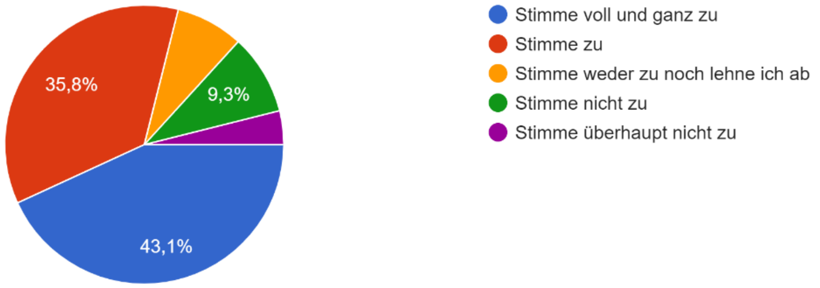
Ich bin bereit, einen langfristigen Vertrag abzuschließen, um von besonderen Rabatten und Preisangeboten zu profitieren.
204 Antworten



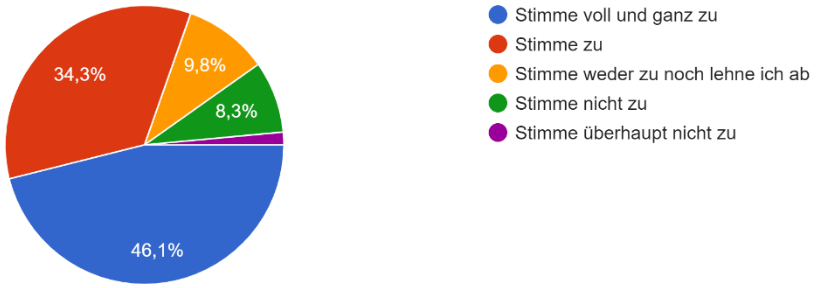
Ich erwarte für die höheren Kosten eines Glasfaseranschlusses zusätzliche Dienste wie zum Beispiel: einen nahtlosen Übergang beim Wechsel d... Vertragslaufzeit oder verstärkten Kundensupport.
204 Antworten



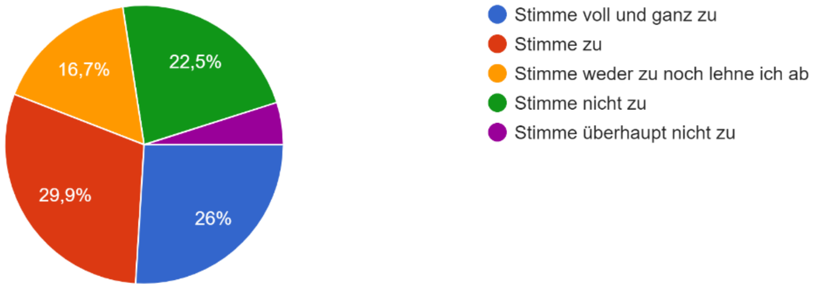
Ich bevorzuge einen Anschluss A mit 500 MBit/s für monatlich 49,99 Euro gegenüber einem Anschluss B mit 250 MBit/s für monatlich 44,99 Euro.
204 Antworten



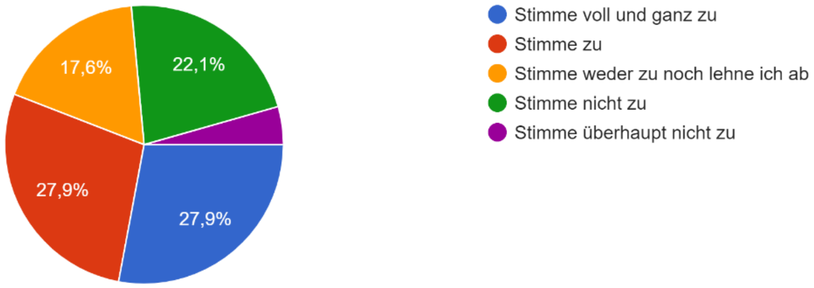
Ich ziehe einen Anschluss A mit ausgesprochen guter Stabilität und Sicherheit für monatlich 49,99 Euro einem Anschluss B mit durchschnittlicher Stabilität und Sicherheit für monatlich 44,99 Euro vor.
204 Antworten



Ich bin bereit, monatlich bis zu 10 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahlen...onatlicher Tarif 39,99 Euro für 250 MBit/s beträgt.
204 Antworten

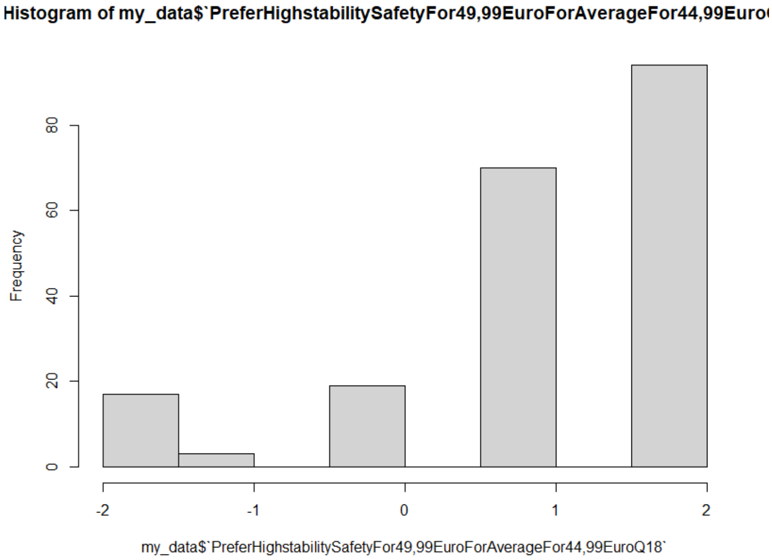


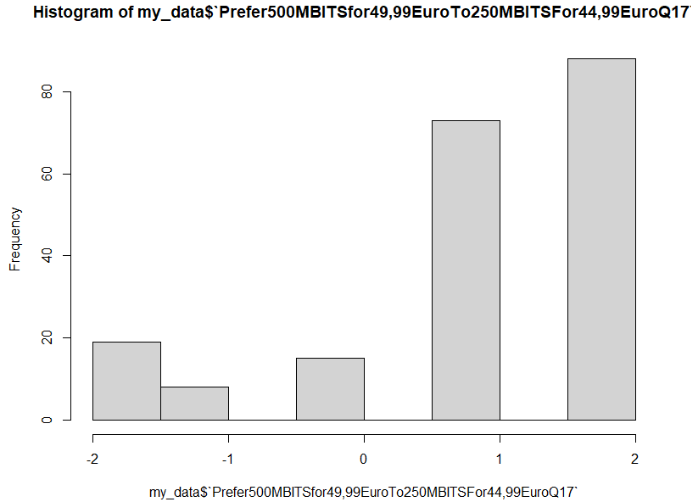
Ich bin bereit, monatlich 11 - 20 Euro mehr für einen Internetanschluss mit höherer Geschwindigkeit, Stabilität und Sicherheit zu zahle...monatlicher Tarif 29,99 Euro für 50 MBit/s beträgt.
204 Antworten

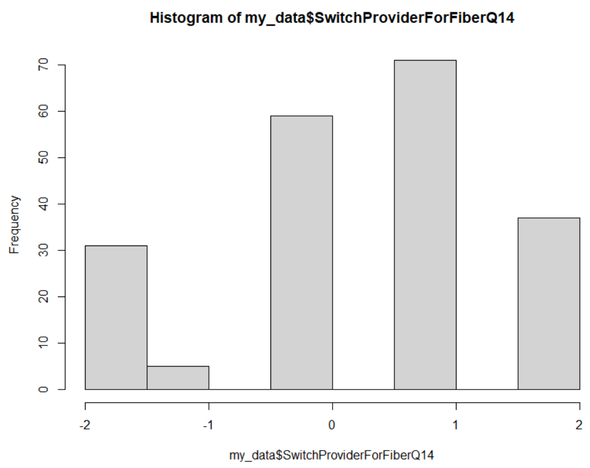


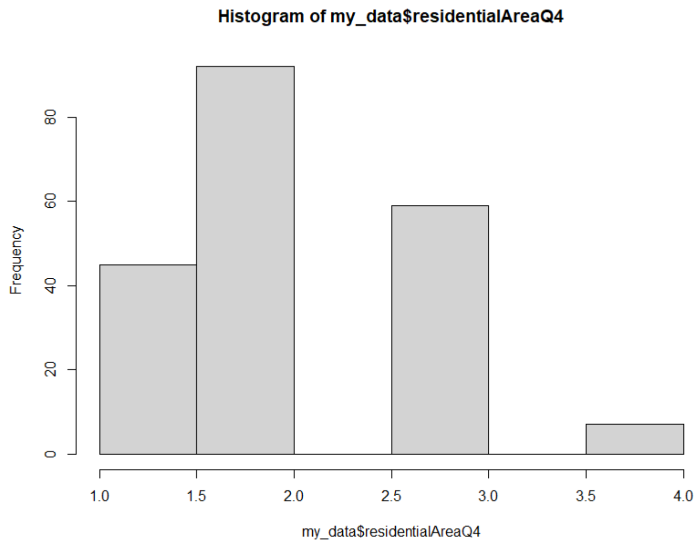
Appendix 5: Histograms to all Variables

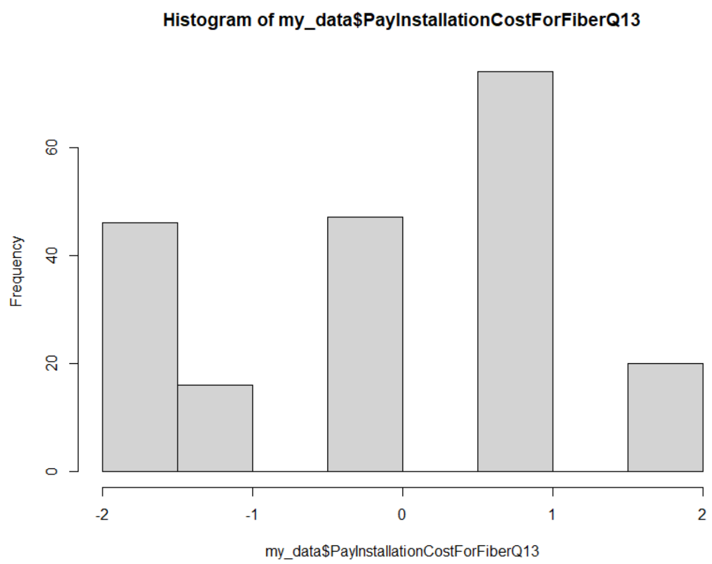
Underneath, a full demonstration of all histograms that were being created based on the individual survey variables is given.

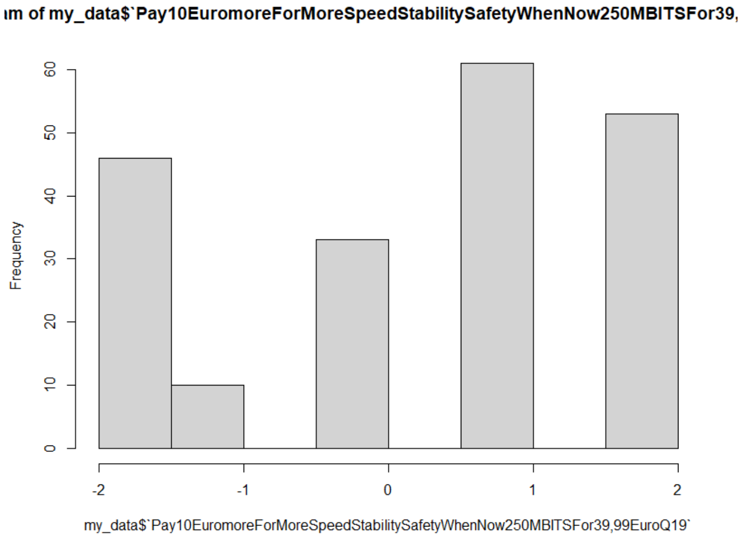


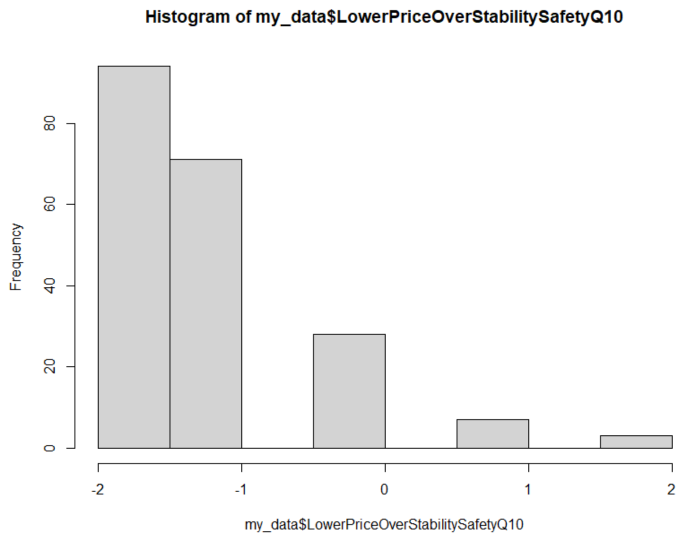


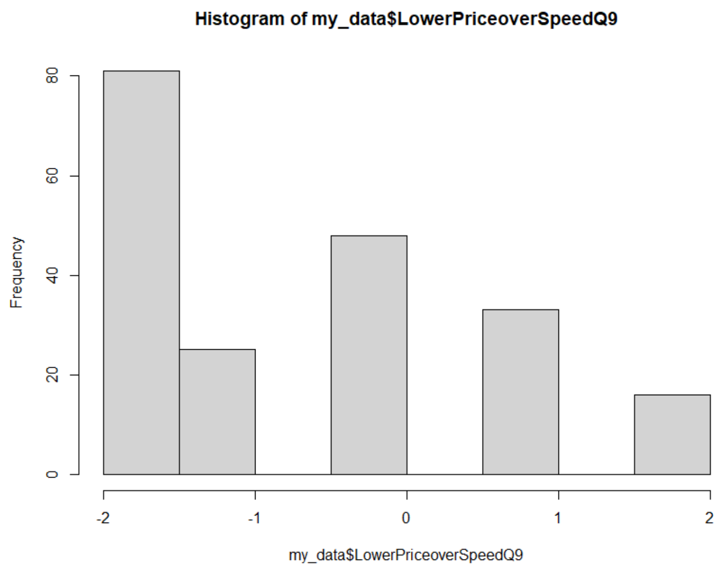

Histogram of my_data$SwitchProviderForFiberQ14
Frequency
0
10
20
30
40
50
60
70
-2
-1
0
1
2
my_data$SwitchProviderForFiberQ14

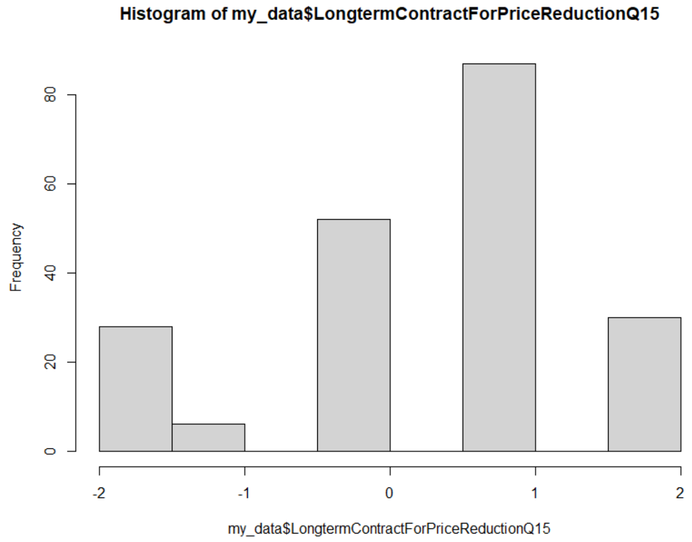

Histogram of my_data$residentialAreaQ4
Frequency
0
20
40
60
80
1.0
1.5
2.0
2.5
3.0
3.5
4.0
my_data$residentialAreaQ4

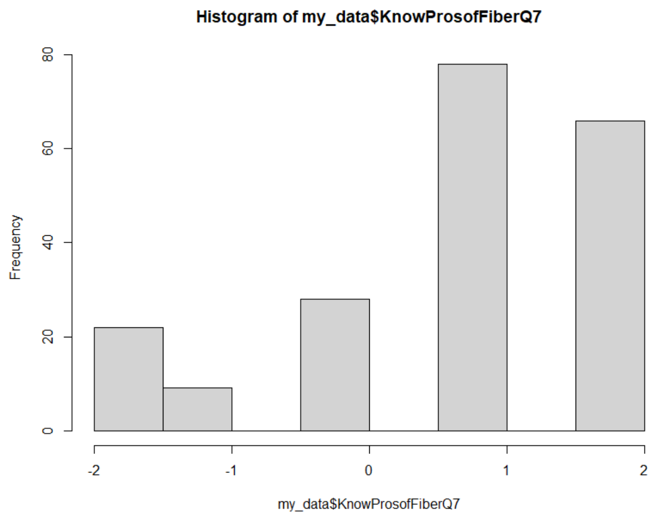

Histogram of my_data$PayInstallationCostForFiberQ13
Frequency
0
20
40
60
-2
-1
0
1
2
my_data$PayInstallationCostForFiberQ13

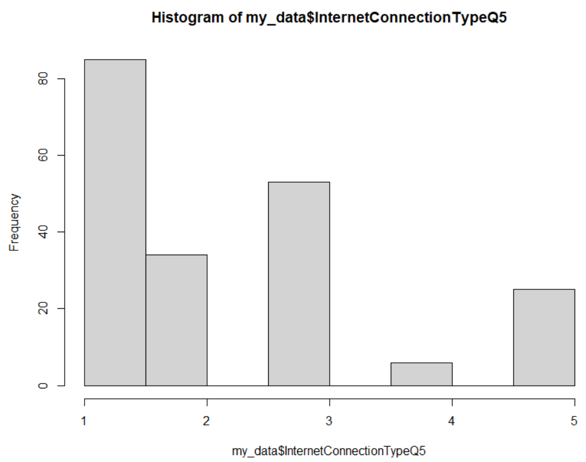

ım of my_data$`Pay10EuromoreForMoreSpeedStabilitySafetyWhenNow250MBITSFor39,
Frequency
0
10
20
30
40
50
60
-2
-1
0
1
2
my_data$`Pay10EuromoreForMoreSpeedStabilitySafetyWhenNow250MBITSFor39,99EuroQ19`

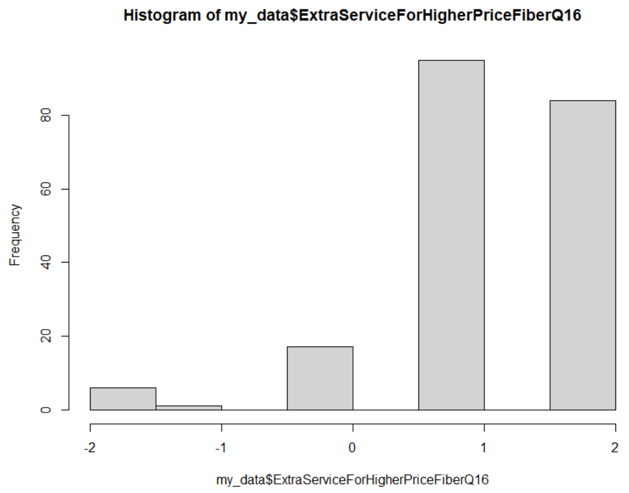

Histogram of my_data$LowerPriceOverStabilitySafetyQ10
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$LowerPriceOverStabilitySafetyQ10


Histogram of my_data$LowerPriceoverSpeedQ9
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$LowerPriceoverSpeedQ9

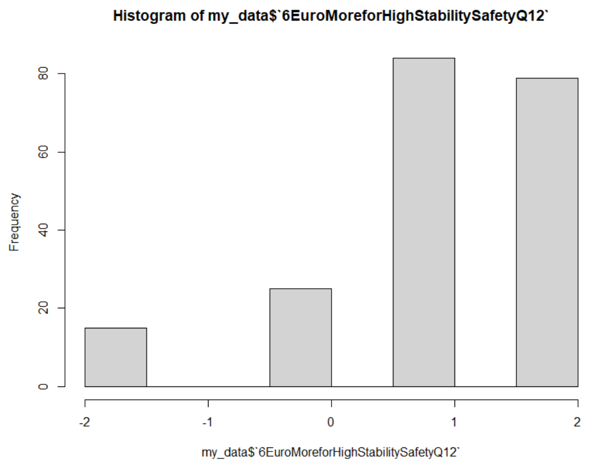

Histogram of my_data$LongtermContractForPriceReductionQ15
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$LongtermContractForPriceReductionQ15


Histogram of my_data$KnowProsofFiberQ7
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$KnowProsofFiberQ7

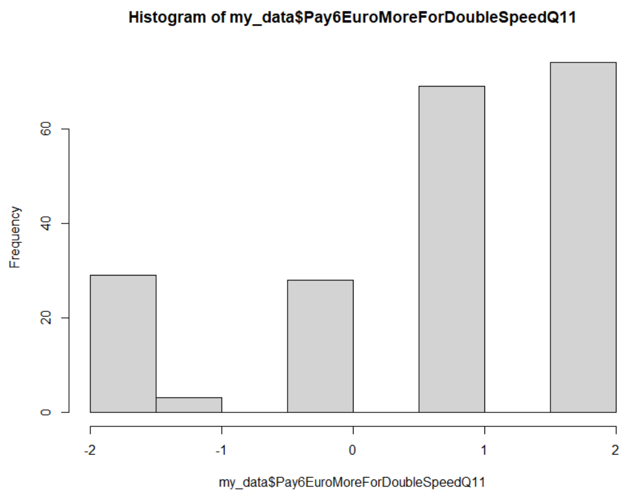

Histogram of my_data$InternetConnectionTypeQ5
Frequency
0
20
40
60
80
1
2
3
4
5
my_data$InternetConnectionTypeQ5



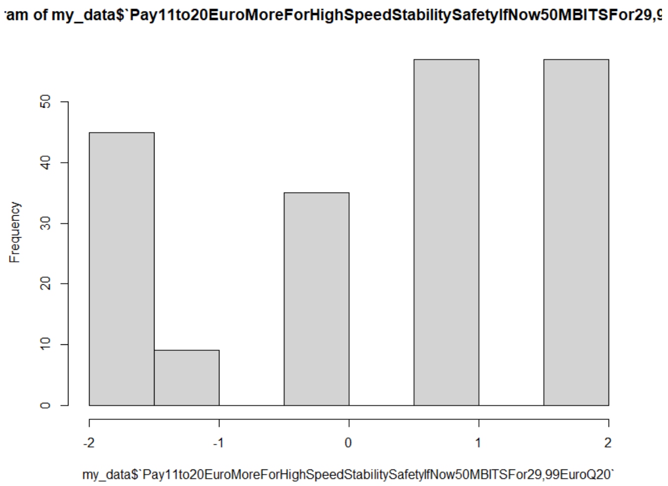
Histogram of my_data$ExtraServiceForHigherPriceFiberQ16
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$ExtraServiceForHigherPriceFiberQ16

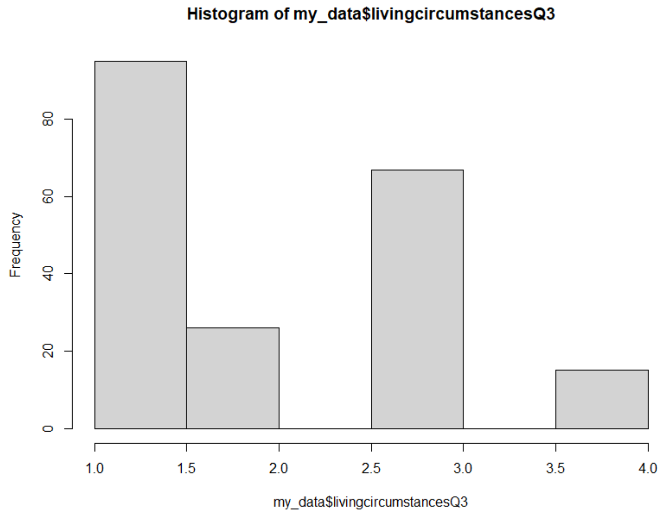


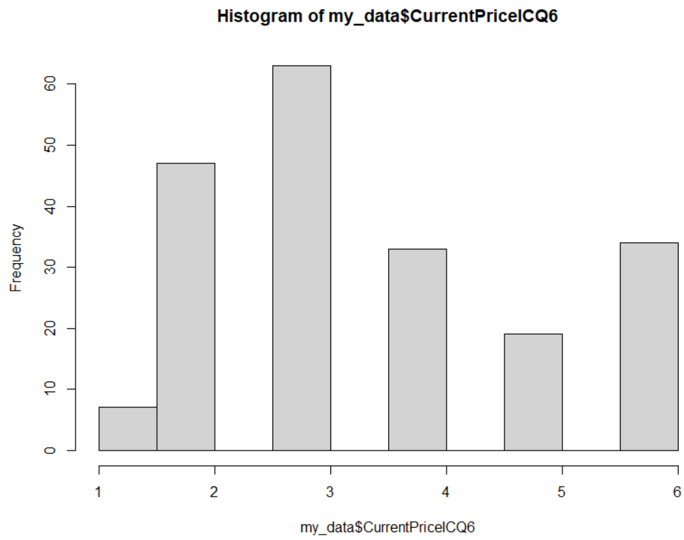
Histogram of my_data$`6EuroMoreforHighStabilitySafetyQ12`
Frequency
0
20
40
60
80
-2
-1
0
1
2
my_data$`6EuroMoreforHighStabilitySafetyQ12`



Histogram of my_data$Pay6EuroMoreForDoubleSpeedQ11
Frequency
0
20
40
60
-2
-1
0
1
2
my_data$Pay6EuroMoreForDoubleSpeedQ11


am of my_data$`Pay11to20EuroMoreForHighSpeedStabilitySafetyIfNow50MBITSFor29,9
Frequency
0
10
20
30
40
50
-2
-1
0
1
2
my_data$`Pay11to20EuroMoreForHighSpeedStabilitySafetyIfNow50MBITSFor29,99EuroQ20`


Histogram of my_data$livingcircumstancesQ3
Frequency
0
20
40
60
80
1.0
1.5
2.0
2.5
3.0
3.5
4.0
my_data$livingcircumstancesQ3


Histogram of my_data$CurrentPriceICQ6
Frequency
0
10
20
30
40
50
60
1
2
3
4
5
6
my_data$CurrentPriceICQ6

Appendix 6: Correlation Matrix

The following table shows the complete Spearman Correlation matrix of all possible correlations between the variables of the survey data.

	A	B	C	D	E	F	G
1		AgeGroupQ1	GenderQ2	livingcircumstancesQ3	residentialAreaQ4	InternetConnectionTypeQ5	CurrentPriceQ6
2	AgeGroupQ1	1	0.04507967	-0.45235461	-0.267868332	-0.07175581	0.085925140
3	GenderQ2	0.045079670	1	0.02623565	-0.038801632	0.02266722	0.115516797
4	livingcircumstancesQ3	-0.452354611	0.02623565	1	0.390086264	0.12511721	-0.168658396
5	residentialAreaQ4	-0.267868332	-0.03880163	0.39008626	1	0.09549847	-0.139413726
6	InternetConnectionTypeQ5	-0.071755807	0.02266722	0.12511721	0.095498470	1	0.245500118
7	CurrentPriceQ6	0.085925140	0.11551680	-0.16865840	-0.139413726	0.24550012	1
8	KnowProsofFiberQ7	0.072945032	-0.39053193	-0.16200173	0.007692784	-0.15548835	-0.011194189
9	LowerPriceoverSpeedQ9	0.121661977	0.04294856	-0.11103839	-0.187066351	-0.04127407	-0.188651119
10	LowerPriceoverStabilitySafetyQ10	0.064840671	-0.12489538	-0.06440134	-0.109684604	-0.03796295	-0.002762246
11	Pay6EuroMoreforDoubleSpeedQ11	-0.169705862	-0.19710860	0.03126801	-0.045716448	-0.01061142	0.061401759
12	6EuroMoreForHighStabilitySafetyQ12	-0.125972698	-0.13875213	0.02067900	-0.012390875	0.06416088	0.027138038
13	PayInstallationCostForFiberQ13	-0.122051170	-0.13643265	-0.11824730	-0.163172429	0.06428463	0.136740639
14	SwitchProviderForFiberQ14	-0.159136307	-0.03814084	0.02864543	-0.032638972	-0.02978493	-0.045770720
15	LongtermContractForPriceReductionQ15	0.009550436	-0.08702044	0.02148892	-0.045563020	-0.10130587	-0.044892847
16	ExtraServiceForHigherPriceFiberQ16	-0.092682593	0.12643447	-0.02866186	0.091208662	-0.03311548	-0.047522374
17	Prefer500MBITfor49,99EuroTo250MBITfor44,99EuroQ17	-0.142524596	-0.01402472	0.01714517	-0.031360876	0.20337055	0.211763706
18	PreferHighStabilitySafetyFor49,99EuroForAverageFor44,99EuroQ18	-0.007513976	-0.05386134	-0.02407621	-0.025376241	0.16507357	0.111119003
19	Pay10EuromoreForMoreSpeedStabilitySafetyWhenNow250MBITFor39,99EuroQ19	0.099975572	-0.06386692	-0.23691069	-0.158725382	0.07303447	0.282002221
20	Pay11to20EuroMoreForHighSpeedStabilitySafetyIfNow50MBITFor29,99EuroQ20	-0.022942550	-0.09494232	-0.12949165	-0.168724889	0.01453687	0.115068480
21							
22							
23							
24							
25		high correlation					
26		moderate correlation					

	H	I	J	K	L	M	N
1	KnowProsofFiberQ7	LowerPriceoverSpeedQ9	LowerPriceoverStabilitySafetyQ10	Pay6EuroMoreforDoubleSpeedQ11	6EuroMoreForHighStabilitySafetyQ12	PayInstallationCostForFiberQ13	SwitchProviderForFiberQ14
2	0.072945032	0.12166198	0.064840671	-0.16970586	-0.12597270	-0.12205117	-0.15913631
3	-0.390531928	0.04294856	-0.124895375	-0.19710860	-0.13875213	-0.13643265	-0.03814084
4	-0.162001727	-0.11103839	-0.064401339	0.03126801	0.02067900	-0.11824730	0.02864543
5	0.007692784	-0.18706635	-0.109684604	-0.04571645	-0.01239087	-0.16317243	-0.03263897
6	-0.155488348	-0.04127407	-0.037962950	-0.01061142	0.06416088	0.06428463	-0.02978493
7	-0.011194189	-0.18865112	-0.002762246	0.06140176	0.02713804	0.13674064	-0.04577072
8	1	-0.12085862	0.025555891	0.14741351	0.20439606	0.16687986	0.14803111
9	-0.120858624	1	0.313879777	-0.33446782	-0.27205331	-0.17083041	-0.16094082
10	0.025555891	0.31387978	1	-0.04097724	0.02525470	-0.01666485	-0.11147815
11	0.147413508	-0.33446782	-0.040977242	1	0.72701762	0.35792100	0.30192377
12	0.204396059	-0.27205331	0.025254695	0.72701762	1	0.39420211	0.35699996
13	0.166879860	-0.17083041	-0.016664853	0.35792100	0.39420211	1	0.37984665
14	0.148031106	-0.16094082	-0.111478152	0.30192377	0.35699996	0.37984665	
15	0.152335784	-0.01800260	0.007451280	0.15900259	0.21236935	0.21337622	0.29067899
16	0.059210548	0.05201130	-0.055049439	0.15375487	0.16796532	0.05804679	0.24661924
17	0.060145880	-0.16474040	-0.024144250	0.36914981	0.41219518	0.29303485	0.17429595
18	0.182205458	-0.17292965	-0.056737978	0.34264961	0.49191140	0.31967100	0.27264000
19	0.144624792	-0.34992497	-0.008169917	0.35311411	0.39933819	0.38827082	0.26036418
20	0.102979384	-0.29160576	0.037605790	0.35383363	0.39922902	0.37584654	0.25652042
21							

	O	P	Q	R
1	LongtermContractForPriceReductionQ15	ExtraServiceForHigherPriceFiberQ16	Prefer500MBITfor49,99EuroTo250MBITfor44,99EuroQ17	PreferHighStabilitySafetyFor49,99EuroForAverageFor44,99EuroQ18
2	0.009550436	-0.09268259	-0.14252460	-0.007513976
3	-0.087020436	0.12643447	-0.01402472	-0.053861342
4	0.021488916	-0.02866186	0.01714517	-0.024076210
5	-0.045563020	0.09120866	-0.03136088	-0.025376241
6	-0.101305875	-0.03311548	0.20337055	0.165073569
7	-0.044892847	-0.04752237	0.21176371	0.111119003
8	0.152335784	0.05921055	0.06014588	0.182205458
9	-0.018002603	0.05201130	-0.16474040	-0.172929652
10	0.007451280	-0.05504944	-0.02414425	-0.056737978
11	0.159002589	0.15375487	0.36914981	0.342649606
12	0.212369355	0.16796532	0.41219518	0.491911402
13	0.213376221	0.05804679	0.29303485	0.319671004
14	0.290678989	0.24661924	0.17429595	0.272640002
15	1	0.19302521	0.19470973	0.252440335
16	0.193025205	1	0.17884500	0.139214424
17	0.194709734	0.17884500	1	0.682607775
18	0.252440335	0.13921442	0.68260777	1
19	0.237168024	0.06919535	0.45680504	0.461866168
20	0.196714498	0.10721806	0.42200379	0.498695637
21				

L

	S	T
1	Pay10EuromoreForMoreSpeedStabilitySafetyWhenNow250MBITFor39,99EuroQ19	Pay11to20EuroMoreForHighSpeedStabilitySafetyIfNow50MBITFor29,99EuroQ20
2	0.099975572	-0.02294255
3	-0.063866915	-0.09494232
4	-0.236910692	-0.12949165
5	-0.158725382	-0.16872489
6	0.073034469	0.01453687
7	0.282002221	0.11506848
8	0.144624792	0.10297938
9	-0.349924971	-0.29160576
10	-0.008169917	0.03760579
11	0.353114108	0.35383363
12	0.399338189	0.39922902
13	0.388270820	0.37584654
14	0.260364182	0.25652042
15	0.237168024	0.19671450
16	0.069195355	0.10721806
17	0.456805037	0.42200379
18	0.461866168	0.49869564
19	1	0.58546437
20	0.585464366	1

Affirmation in lieu of oath

I hereby declare in lieu of oath that I have written this paper on my own. Any passages taken literally or analogously from other published or unpublished works are indicated as such. Any sources and aids used for this paper have been referenced appropriately. This work has not been submitted with the same content resp. in substantial parts to any other examination office.

Place	Date	Signature