Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Information Security and Communication Technology

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Exploring the Relation Between Mobile Network Type and Mobile Application Usage

Master's thesis in Communication Technology
Supervisor: Katrien De Moor
December 2019

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Problem description:

Usage of mobile phones has skyrocketed in the past decade, and the number of applications available for users is higher than ever. Traditionally there has been a dominating focus on technological aspects in this context, with e.g., Quality of Service (QoS) and performance measurement as key. These past years development however has forced providers to consider the users experience to a larger extent, as users expect pleasurable and positive experiences and as users' expectations have increased in line with market developments. Meeting these expectations has become one of the most critical measures for an applications' success. Users care about utility, how easy it is to use the application or service and the experience it enables, thus research studies on User Experience and Quality of Experience (QoE) have increasingly gained importance.

Most of the studies done in this area so far are lab studies, which take the user out if its natural habitat and context of use, and users can be affected by this (e.g., behaving in a different way than usual). There is also a variety of tools that allows users to use their phone in their day-to-day life, but which interrupts the user during the day with questions (e.g., how the user rates the QoE, how the user feels). This gives an immediate reaction from the user, but at the same time users get interrupted in their natural use and ongoing use experiences. Neither of these methods mirrors the actual use, and other types of studies which take a natural setting-approach are still a minority. At the same time, there has been a large expansion of network and network coverage the last decade, which makes it possible to use applications almost everywhere. There can for example be a difference in speed between different networks such as WiFi and 4G for instance, that may have an impact on the QoE and usage over time. However, there is a lack of longitudinal and real-life studies investigating whether and how type of network may influence actual use behavior.

This thesis will therefore focus on real environments by making use of the application mobileDNA. This is an application developed as part of the Kop Op Campaign, which aims to investigate the relationship between people and their smartphone. The end users will through the application see an overview of how they use their phone, and mobileDNA will track both usage and which network the user is connected to. The real-life experiment will be conducted with a test panel, using a longitudinal setup. An intake survey will be conducted with the panel members to gather QoE- and profile-relevant information, before they start using the application for several weeks.

The following tasks are planned:

- Review QoE and its relation to network parameters
- Investigate whether mobile network type has an impact on mobile usage through surveys and behavioral data collection (logging of app usage)
- If so, are there specific types of applications that are more vulnerable than others to network changes

Responsible professor: Katrien De Moor
Supervisor: Katrien De Moor

Preamble

When the work on this master thesis started, we got strong indications that more application parameters were going to be collected through the mobileDNA application by the end of October. This was because of a planned study in collaboration with Google (and as part of a Ghent University - NTNU collaboration) which also needed a number of network parameters. However, the planning of this was delayed and we therefore did not get the parameters as planned. We knew that this was a potential risk as the work started, but chose this application for data collection because we received strong indications that this would work out time-wise. In addition, the desire to conduct a study with this type of application (which does not interrupt the user and which provides additional value to the user through the dashboard).

In the course of October, we were notified that new update including the network parameters would be available from end of October, and this was initially further delayed until Mid-November. However, in the end the whole Google study and the implementation of the new parameters was pushed to early 2020. As we did not get to collect any network parameters from behavioral data collection, the scope of the master thesis changed a bit during the semester. The plan of linking information from a survey on impact of network-related issues on the usage of applications with data collected via mobileDNA had to be modified, as the application could not yet provide information about e.g type of network in use. The main focus of this thesis has therefore been on information from the survey, as the information gathered from mobileDNA did not give as useful information as planned. However, the results from the limited data collection through mobileDNA is presented, and the various opportunities that mobileNDA can bring in future studies.

One of the things that was done to gather additional information in the data gathering process was to send out questions during the period. However, this leads to some other challenges which are also discussed further throughout the thesis. The fact that the setup of the study in the mobileDNA application also took more time than expected, lead to less time for the final work on the finishing interview and analyzes.

Abstract

In today's society, use of smartphones and applications is a big part of peoples' day to day lives. The development through the last years with a large increase in the prevalence of both smartphones and number of applications, has lead to a greater focus on users' experience. Research studies on Quality of Experience (QoE) have increasingly gained importance, and it's particularly important to gain insight into what is the main factors that contributes to having a good experience when using a particular application.

In this master thesis we try to contribute to the existing literature and previous research studies done on the field. This is done by looking at a number of application groups, and if/how the use of these are influenced by the mobile network type in use. Furthermore, the goal is to investigate to which extent network factors play a role in the usage pattern. This study was chosen as there is a lack of longitudinal and real-life studies investigating these questions. To achieve this, a mixed-methods research design has been adopted. The research has been conducted by a literature review, survey (N=125), behavioral data collection through logging of app usage and finishing interviews.

An evaluation of the findings indicates that factors such as delays and lagging, which leads to or are caused by slow applications or network, are particularly important. This is also in line with findings of existing studies, but it's difficult to distinguish whether problems are related to limitations of the network that is in use or the application itself. Usage of applications such as video streaming seem to be influenced by what type of network the user is connected to. However, as findings also indicates that people with less GB's included in their subscription are more vulnerable than those with a large amount of GB's, it's hard to conclude. In general, it is shown that people with less GB's are influenced by the limitations of their mobile subscription. The differences in the views of the importance of a stable network between different age groups are also interesting, as the oldest group seems to care less. Most participants also had expectations towards that applications should work just as well when traveling from one place to another as at home. It could therefore be interesting to conduct the study in another country with less developed data coverage than what is the case in Norway.

Sammendrag

I dagens samfunn er bruk av smarttelefoner og applikasjoner en stor del av folks daglige liv. Utviklingen gjennom de siste årene med en stor økning i utbredelsen av både smarttelefoner og antall applikasjoner, har ført til et større fokus på brukernes opplevelse. Forskningsstudier om Quality of Experience (QoE) har i økende grad fått betydning, og er spesielt viktig for å få innsikt i hva som er viktig for å ha en god opplevelse når du bruker en bestemt applikasjon.

I denne masteroppgaven prøver vi å bidra til eksisterende litteratur og tidligere forskningsstudier gjort på feltet. Dette gjøres ved å se på et antall applikasjonsgrupper, og om/hvordan bruken av disse påvirkes av type mobilnett som er i bruk. Videre er målet å undersøke i hvilken grad nettverksfaktorer spiller en rolle for bruksmønsteret. Denne studien ble valgt fordi det mangler lengregående og virkelighetsnære studier som undersøker disse spørsmålene. For å oppnå dette er et forskningsdesign med metodetriangulering valgt. Forskningen er utført ved en litteraturstudie, spørreundersøkelse (N = 125), adferdsdatainnsamling gjennom logging av bruk av applikasjoner og avsluttende intervjuer.

En evaluering av funnene indikerer at en faktor som forsinkelse, som fører til eller er forårsaket av treghet i applikasjonen eller på nettverket, er spesielt viktig. Dette er også i tråd med funnene i eksisterende studier, men det er vanskelig å skille mellom om problemene er knyttet til begrensninger i nettverket som er i bruk eller selve applikasjonen. Bruk av applikasjoner som videostrømming ser ut til å være påvirket av hvilken type nettverk brukeren er koblet til. Ettersom resultatene også indikerer at personer med mindre GB inkludert i abonnementet er mer sårbare enn de med en stor mengde GB inkludert, er det vanskelig å konkludere. Generelt viser resultatene at personer med mindre GB inkludert blir påvirket av begrensningene i data inkludert i mobilabonnementet. Forskjellene i viktigheten av et stabilt nettverk mellom forskjellige aldersgrupper er også interessant, ettersom den eldste gruppen ser ut til å bry seg mindre. De fleste deltakerne hadde også forventninger til at applikasjonene skulle fungere like bra ved reise fra et sted til et annet som ved bruk hjemme. Det kan derfor være interessant å gjennomføre studien i et annet land med mindre utviklet mobildekning enn hva som er tilfellet i Norge.

Preface

This thesis has been submitted as the final part of my Master's degree in Communication Technology at the Norwegian University of Science and Technology (NTNU). The main research and writing was carried out between August and December 2019.

I would like to thank my supervisor Katrien De Moor for exceptional guidance, contribution and support throughout this process. I would also like to thank everyone who participated in the survey and who took their time to use the mobileDNA application and answer questions related to this.

Katarina Hokstad
Trondheim, 18th of December 2019

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List of Acronyms

ADSL Asymmetric Digital Subscriber Line

CIF Context Influence Factor

ESM Experience Sampling Method

FITB Fill-in The Blank

HIF Human Influence Factor

IF Influence Factor

ISO International Organization for Standardization

ITU International Telecommunication Union

MOS Mean Opinion Score

NSD Norwegian Centre for Research Data

NTNU Norwegian University of Science and Technology

QoE Quality of Experience

QoS Quality of Service

SIF System Influence Factor

SPSS Statistical Package for the Social Sciences

UE User Engagement

UX User Experience

Chapter 1
Introduction

Today's users of smartphones are currently in an extraordinary situation, and have been for some years now. Strong competition in the market for smartphones and applications sets users' in a strong position as the selection pool is almost inexhaustible and as there is an abundance of apps to be found in any kind of category (e.g., videochat apps, instant messaging apps, games, etc.). Hence, they can easily change either e.g their phone or application if they are not fully satisfied. However, as the entire ecosystem depends on attracting and retaining customers and users, churn is something most providers want to avoid. It is therefore important to understand not only which aspects are important for users' satisfaction with a specific type of application, but also which barriers to satisfying user experiences may exist and how they can be taken into account. The current market competition has therefore lead to a growing interest in what factors contributes to what type of applications becomes a success and not.

Following this, it's important to quickly react to users' perceived experience and expectations, hence Quality of Experience (QoE) is increasingly important [19]. The previous well-established Quality of Service (QoS) measurement is no longer enough to meet users' requirements as it doesn't consider the subjective experience. By studying what contributes to a high perceived QoE we will get a better understanding of what is the most important factors to take into consideration. This knowledge can then lead to better services and applications in the future.

The field of QoE is quite broad and this master thesis will focus on technical factors such as mobile network type to see how this potentially impacts users' experience and use behavior related to mobile applications. It's interesting to make an in-depth investigation over some time, to get a better insight into how users are influenced by these factors.

1.1 Motivation

Smartphones are something almost everyone owns and are a big part of people's life, in particularly in developed and increasingly also in developing countries. With the rise of smartphones, a large variety of applications have also come to life, and they all have different requirements when it comes to network parameters. While most people are spoiled with good quality network connections at home, the quality of their mobile network connections may vary. It is therefore interesting to see whether people's use of smartphone applications changes with the context and in regards to network parameters. Existing studies in the field are under-represented in the state of the art, in particular because most studies are done either as a lab study or by interrupting the user in the middle of use. Therefore, a study done by use of an application without interruption in addition to a survey may be a useful contribution to the existing literature.

It's of great interest to gain insight into whether mobile network type influences application usage, thus to see if, what and to which extent specific type of applications are more vulnerable than others. It's expected that this may vary between different people depending on their own characteristics and needs, and it will be interesting to see what the main reasons for this may be, e.g. economical aspects (e.g., price), type of applications that are most used in varying settings, or application not working as expected on certain networks.

1.2 Objectives

The main objective of this study is to investigate whether smartphone application usage changes due to or in relation to technical factors. If so, to which extent and what type of applications are especially vulnerable? To narrow the scope the following research questions are addressed in this master thesis:

1. Review QoE and its relation to network parameters
2. Investigate whether mobile network type has an impact on mobile usage through surveys and behavioral data collection (logging of app usage)
3. If so, are there specific types of applications that are more vulnerable than others to network changes

Smartphones and application use, in addition to network parameters, is a broad term and there are a lot of different aspects one can decide to focus on. As this master thesis is limited in time and resources, the focus is therefore mainly on the broader aspects. This means that we won't go into detail on specific types of applications, but only present a general result on the different types of applications, as an exploration that may point to interesting directions to be further investigated. Given its limited focus and sample, the thesis will not draw any hard conclusions, but will hopefully provide interesting results on how users' are influenced by mobile network type, which in turn can be of interest to further studies on the field.

1.3 Outline

This master thesis is divided into six chapters. Given the introduction the following chapters are structured as follows:

- **Chapter 2: Background**
  Relevant background and theory relevant for the scope of this master thesis is presented. Related work on the field is also introduced.
- **Chapter 3: Methodology**
  Gives a brief presentation of methodology as a term and presents the chosen methods. The research methods are presented and explained.
- **Chapter 4: Results**
  Presents and analyzes the results from the collected data.
- **Chapter 5: Discussion**
  Discusses the results and limitations of the research, in light of the research questions.
- **Chapter 6: Conclusion and Future Work**
  Conclusive remarks on the results and proposed future work.

Chapter 2
Background

The number of applications available for smartphones are almost endless and they are all there to try to fulfill a need for the user, whether it is just pure enjoyment or something more practical. This may be something the user did not even know he needed, and engaging in an application may be motivated by a number of things. An application or service is worth nothing without its users, and for companies developing these kind of services it is therefore highly important to take the perspective of the user into account. Nowadays people living in developed countries are spoiled with a well developed access to mobile networks almost anywhere they go, and an application that for instance is slow risks to lose the user's interest. However, the performance of an application is not only affected by the application itself, but also by network factors such as delay and errors. When streaming a video for instance, network delays may lead to lagging which causes a bad experience for the user. Whether bad performance of an application is related to the application itself or network factors is still for most users almost impossible to know. Regardless, this may be considered irrelevant by most users as they only care whether the application works as expected or not. This leads to the fact that most users will point their frustration directly at the application, regardless of if the bad experience is caused by the application itself or the network connection for instance. Network parameters are therefore important to take into consideration when looking at perceived QoE related to an application.

The aim of this chapter is to present the theoretical background of this thesis. The chapter starts by introducing the concept of QoE and different aspects on how QoE is measured. Influence Factors (IFs) which are important for the perceived QoE as well as the importance of User Engagement (UE) is also presented, in addition to a presentation of related studies conducted. An introduction to the mobileDNA application which is used in this thesis is provided to get an understanding of how it works and why it has been chosen as the preferred tool.

2.1 Central Concepts of Quality and User Experience

To develop a successful application or service it is important to gain insight into the users' experience and the perceived quality. Throughout the years several different methods and concepts have been developed as tools to gain important insights. These have grown from different angles from the type of service or application that is in focus.

2.1.1 Definitions

Definitions of concepts of importance to gain insight into user experience and quality which is essential for this master thesis follows.

User Experience

Human-Computer Interaction saw its light during the introduction of personal computing in the 1980s and is a study that focuses on the interaction between users and computers. It has expanded throughout the years and one of the concepts that has developed from this is usability, which is the predecessor of User Experience (UX). Compared to usability UX takes a more holistic approach with the perspective being human-oriented. This is a relatively new concept and there exists many interpretations and definitions, which made Law et al. conduct a study to gain insight into how researchers viewed and understood UX [36]. They found that UX is dependent on the potential benefits users might get from a product, and is both subjective and context-dependent. International Organization for Standardization (ISO) defines it as:

> UX: A person's perceptions and responses that result from the use or anticipated use of a product, system or service [22].

This includes all emotions and responses that occur both before, during and after the interaction. These feelings may be influenced by both the brand image and interactive behavior.

Quality of Service

QoS is related to telecommunication and its introduction in the early 1990s has lead to a lot of research on the field of network architecture. QoS is defined as:

> QoS: The totality of characteristics of a telecommunications service that bear on its ability to satisfy stated and implied needs of the user of the service [47].

QoS is quite specific as it measures the performance of a service by parameters such as packet loss, jitter and delay [48].

Quality of Experience

As user perceptions have emerged and matured to be a more important aspect, QoS is no longer enough to find the actual quality as it does not include the user perspective. As a result QoE was defined as a concept and now plays an important role in the industry, and will also be the main perspective of this master thesis.

There are many different definitions of what QoE is, and it's an important and complex concept. One of the reasons as to why it's so challenging to compute is that it is subjective, inconsistent and may be hard to track, among other reasons. It is still evolving, although the common denominator is that it focuses on how the user perceives the quality and which benefits users get from the application. Qualinet white paper defines it as:

> QoE is the degree of delight or annoyance of the user of an application or service. It results from the fulfillment of his or her expectations with respect to the utility and/or enjoyment of the application or service in the light of the user's personality and current state [11].

According to this definition QoE depends on the emotional state of the person, and its positive and negative feelings experienced when using an application or service. This definition was further adopted and redefined by International Telecommunication Union (ITU) and released as a recommendation in 2017. The definition is:

> QoE: The degree of delight or annoyance of the user of an application or service [47].

User Engagement

In addition to an application needing to have a high degree of usability, it is also important that applications engages the user so that the user wants to use it again and again. There exists many different descriptions of what UE is, and there have been different views on what lies within it. Hence, what makes a success in relation to UE may be hard to understand [43]. In 2008, O'Brien et al. reviewed and analyzed research done on the field of UE before conducting their own study [42]. Their work has been important for further research done on the field, and a later research conducted by Lehman et al. describes UE as:

> User engagement is the quality of the user experience that emphasises the positive aspects of the interaction, and in particular the phenomena associated with being captivated by a web application, and so being motivated to use it [37].

2.1.2 Relation Between the Different Concepts

As UX and QoE are both referring to users and their experience, hence they are often confused with each other [65], we find it important to present the inequalities and eliminate any misunderstandings. One of the main differences is that QoE does not only take the use of an application into account, but the content itself is also of high importance [11]. UX has more focus on understanding and evaluating the process of experiencing, whilst QoE focuses more on what contributes to the perceived quality. In addition, customer loyalty is of importance in QoE thus making UE a factor, though this is not in consideration when dealing with UX [52].

UE is related to the quality of the user experience, and QoE and UE are therefore interrelated [35]. As there are a so many choices of applications to use, UE and QoE is getting more important as users experiencing a low QoE and UE by use of an application may find other alternatives. A study done by Molodvan et al. observed that QoE and UE are strongly correlated as an increase in one of them lead to an increase in the other [40]. This shows that to achieve a high QoE it's important to monitor UE as well, as the experience the user gets by using the application must be engaging to achieve a high perceived QoE. This thesis will primarily focus on QoE, but as they are dependent on each other it's important to take into consideration.

QoS is the predecessor of QoE and although the definitions on QoE and QoS is quite different it can be challenging to understand the actual difference, as they both in many ways measures performance. The difference can be illustrated by figure 2.1, showing that QoS can be a part of the QoE definition. QoS focuses on the system and network performance, whilst QoE focuses on the user and application in use. Network delays and losses can have a strong influence on the perceptual aspects of QoE though[62]. QoS is purely technical and dependent on performance factors hence being an objective method, whilst QoE are influenced by both technical and non-technical factors making it more related to the perspective of the user and is therefore subjective.

In evaluation of services and applications during operation, perceived quality is a key factor, thus QoE provides important insights [46]. A reduction in QoS may affect the users experience of the system, hence QoE is dependent on QoS [11] [19]. This thesis will focus on QoE and aspects of QoS is just one of many factors that

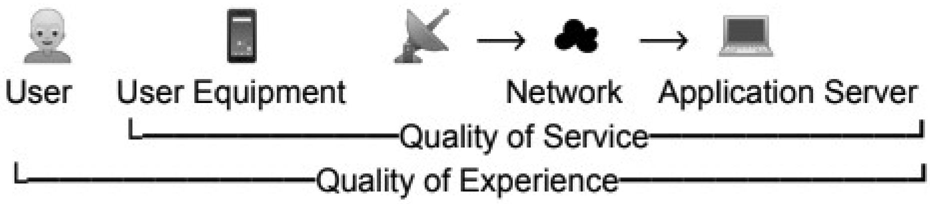

Figure 2.1: Illustration of QoE compared to QoS

influences the users perceived QoE.

2.2 Quality of Experience

Since QoE represents the subjective perspective on the user's perceived quality it's a multi-dimensional concept. Considering this there are many different aspects that may contribute to the user's experience and they must all be taken into account when evaluating QoE. Requirements may change dependent on the application domain and both influence factors and other features of QoE are useful to take into consideration when choosing the frameworks or tools to be used [11].

2.2.1 Influence Factors

Different aspects may be important for different applications and users, however when evaluating the quality it's always influenced by something. A definition of factors that may influence QoE is:

> IF: Any characteristic of a user, system, service, application, or context whose actual state or setting may have influence on the Quality of Experience for the user [11].

IFs varies from the simple and straightforward to the more complex dependent on the situation [49]. This can be in aspect of the application in use, who the user is and the context of which it is used. They are often dependent on each other and does not always come alone, as illustrated in figure 2.2. IFs may be divided into three different categories with a number of subcategories. The IFs and some of the subcategories are presented in table 2.1.

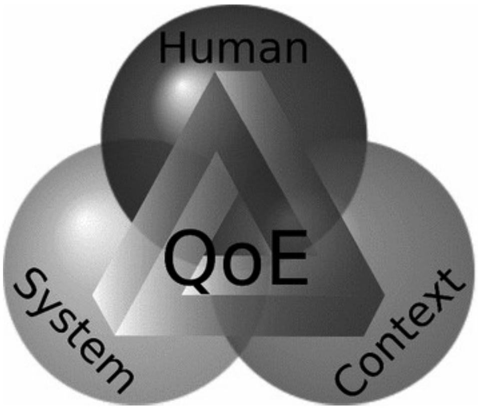

Figure 2.2: Factors influencing QoS, obtained from Reiter et al. [49]

Influence Factors	
Human IF	Low-level
	High-level
System IF	Content-related
	Media-related
	Network-related
	Device-related
Context IF	Physical Context
	Temporal Context
	Social Context
	Economic Context
	Task Context
	Technical/Informational Context

Table 2.1: Overview of influence factors based on Reiter et al. [49]

Human Influence Factors

Human Influence Factors (HIFs) are defined as:

> A HIF is any variant or invariant property or characteristic of a human user. The characteristic can describe the demographic and socio-economic background, the physical and mental constitution, or the user's emotional state [11].

Based on this one can see that HIFs includes the differences between users such as background, motivation and personality [11]. Considering this there will be differences in regards to the users skills, needs and emotional state, hence HIFs are very complex as it is dependent on the user's inner feelings and ideas. The different HIFs also bears an additional complexity due to the fact that they are strongly connected to each other and to other IFs [49]. At a low-level there are aspects such as the user's gender, age and motivation, whilst high-level aspects includes the knowledge the user has that may be related to educational or social background.

System Influence Factors

System Influence Factors (SIFs) are defined as:

> SIFs refer to properties and characteristics that determine the technically produced quality of an application or service. They are related to media capture, coding, transmission, storage, rendering, and reproduction/display, as well as to the communication of information itself from content production to user. [11].

Technical characteristics which may be affected by different network properties or devices are thus SIFs, and are determined by how the produced quality is in regards to the technical properties [7]. These can in some ways relate to QoS when it comes to the network-related factors, thus as mentioned earlier QoE may be dependent on QoS. Network-related factors are related to e.g. delay and bandwidth which depends on the mobile network technology in use. As usage has shifted from use of computers to doing almost everything needed on the mobile devices, other requirements and challenges also present themselves [67]. Both screen size, methods on user input and battery limitations may vary between different devices, thus the device used may also be a factor.

Context Influence Factors

Context Influence Factors (CIFs) are defined as:

> CIFs are factors that embrace any situational property to describe the user's environment in terms of physical, temporal, social, economic, task, and technical characteristics [11].

In other words, they are related to any situational factor that sets the user's environment, and can be related to both location, time of day as well as the price of usage. The user may have other preferences depending on the physical location for instance when using an application on a cabin in the mountains as opposed to use in the city centre [49]. Economic context such as cost and which subscription type the user has may be a factor, as well as the user's location or activity [11] [49]. The difference in the user's context may vary depending on the time of day, and may also affect the social context as relation to others may vary during the day [49].

2.2.2 Measuring QoE

There are a variety of methods and tools which aim and are used to get a measurement on QoE. The different methods may be divided into instrumental measurement approaches and methods that involves actual users [20].

Evaluation by Instrumental Methods

Instrumental measurement methods involves collection of data that are related to experience which are then used to estimate QoE [20]. This involves everything from measurement of observing how the user behaves when interacting with a service or application, to measuring parameters such as throughput and delay. The latter are related to QoS and the correlation between QoS and QoE is studied and used to creating a variety of different models on how to measure QoE based on the QoS score.

Evaluation Methods Involving Users

The other measurement approach involves the actual user. Lab studies are well-known in research, hence users are put in a context and get some tasks to complete. These includes methods that combine results from monitoring the network with the users feedback, and those who only takes one of these into account. User feedback may be measured through the Mean Opinion Score (MOS) which let the user rate the experience by a numeric value from 1 to 5. One of the drawbacks by this may be the time taken from the test starts until it ends, as humans tend to not remember what

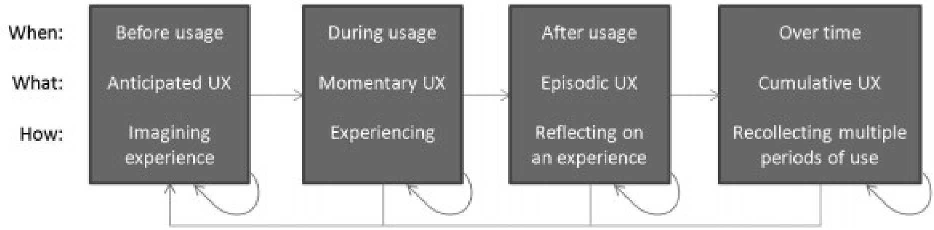

Figure 2.3: Time spans of UX, obtained from Roto et al. [53]

happened after some time and the experience at the end will to a large extent then influence the result [50]. Using feedback from the user to provide a measure of QoE is a subjective method as the exact same experience may be scored differently by different users.

Perceived quality and QoE can also vary and change throughout time. How QoE measurement is defined varies between different studies, as the duration of an event which is examined can vary. This depends for instance on what service or application you want to research. Roto et. al. defines four different time spans of UX as shown in figure 2.3. Even though QoE and UX is not the same, the time span views may be defined similarly and the definitions are also used in studies done on QoE. Measurement is thus related both to how you define the event, for example the duration of the observation as well as the method used for measurement.

Momentary

Momentary QoE is measured over a short time interval, and indicates the first and immediate experience [53]. These experiences may be directly influenced by QoS. One of the benefits of this approach is that you get a measure on the users immediate reaction and experience. The perception of QoE may change over time, and as we tend to remember the last experience the most this should be measured as soon as possible after the experience [9].

Episodic

Episode QoE consists of a wider time span which have many momentary QoE values [54]. Evaluation of an episode is usually done directly after the episode has taken place, i.e right after a certain type of use of an application [66]. If the evaluation is done some time after the episode the results may differ from the instant reaction directly after the episode took place.

Multi-episodic

This can be measured after a long time of use or after several episodes, and there can go some time between the last episode and the observed QoE. This is because multi-episodic QoE reflects the totality of the experience. The evaluation of multi-episodic QoE is important for how usage will develop in the future, and if the user will continue using the application [66]. The challenge however, is that it's very dependent on the user itself as well as how and when the application is used. This may influence the results as the measurements are subjective, thus it may be challenging to get a measure of QoE that may be particularly useful for the developer of the application. There are a variety of different models that may be used to get a good result.

User Experience Over Time

User experience over time is much more vulnerable to external changes and must be taken into consideration. Karapanos conducted a longitudinal study to find and validate how the user experiences the different phases of experience, and how each phase contributes to the UX [31]. The motivation behind the study was to look at how the experience changes over time from the user starts using a product and after it has been used for some time. The study shows that there are an important correlation between the perceived UX and time, with different factors of an application being important at different times. Figure 2.4 illustrates the experience over time, and goes from the momentary to the episodic and multi-episodic and thus shows some of the factors that are important for UX and QoE.

2.2.3 User Engagement

Another thing that may influence how the user perceives quality is how the user gets engaged by the service or application. UE is a constant process, and O´Brien et al. did a research which indicated that the engagement process consists of four different stages [42]. These stages are illustrated in figure 2.5. Each of these stages are dependent on a number of characteristics that are important for the user. A simplified model of the characteristics and the relationship between engagement factors is shown in figure 2.6. This is a rather simple model but it illustrates some of the most important aspects of the UE process.

Attfield et al. have done a literature review where they classified different views on which characteristics that are discussed in the different papers [8], and O´Brien er al. did an exploratory study resulting in characteristics for each of the engagement stages. A selection of these results are combined and presented in table 2.2.

The characteristics that are of importance in the engagement process are many of the same that are important in the user's perceived QoE. HIFs may relate to

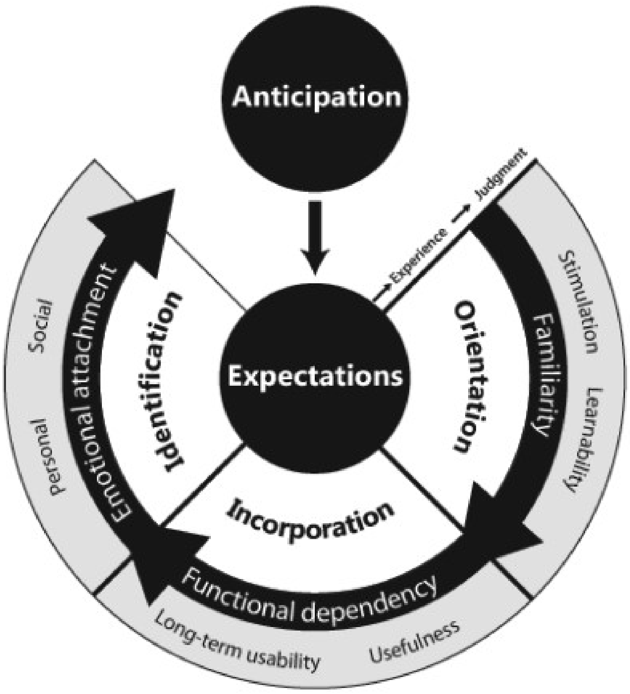

Figure 2.4: Phases of User Experience adopted by Karapanos [31]

aesthetics of the application and the goal which the user has. SIFs can lead to interruptions and then dis-engagement, and CIFs can vary depending on focused attention due to e.g. social context.

2.3 QoE, Mobile Applications and Network Parameters

This thesis focuses on application usage on smartphones and how network parameters may affect perceived QoE. In this section, aspects that are specifically important in consideration of QoE and mobile usage will be presented. Related studies done on the field are also presented, thus providing an overview of the tools and frameworks employed.

2.3.1 Frameworks for Evaluating QoE

A number of frameworks have been developed to try to provide an easier way of predicting perceived QoE. Some of them are presented here, and they also show the complexity related to QoE.

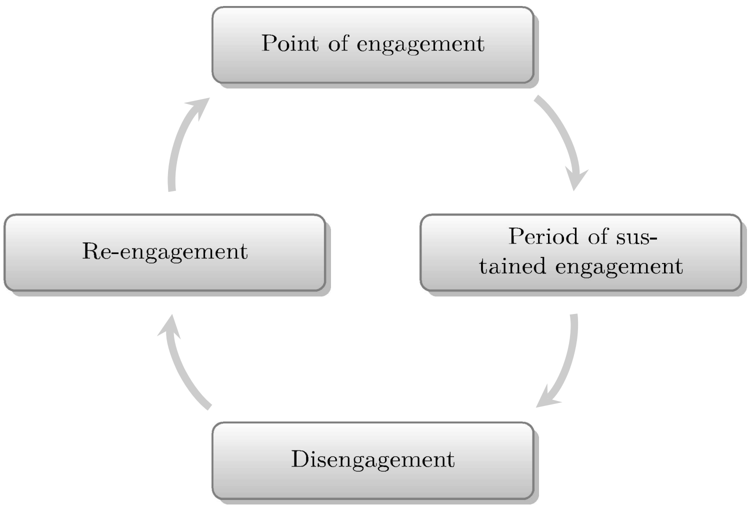

Figure 2.5: The Engagement Cycle

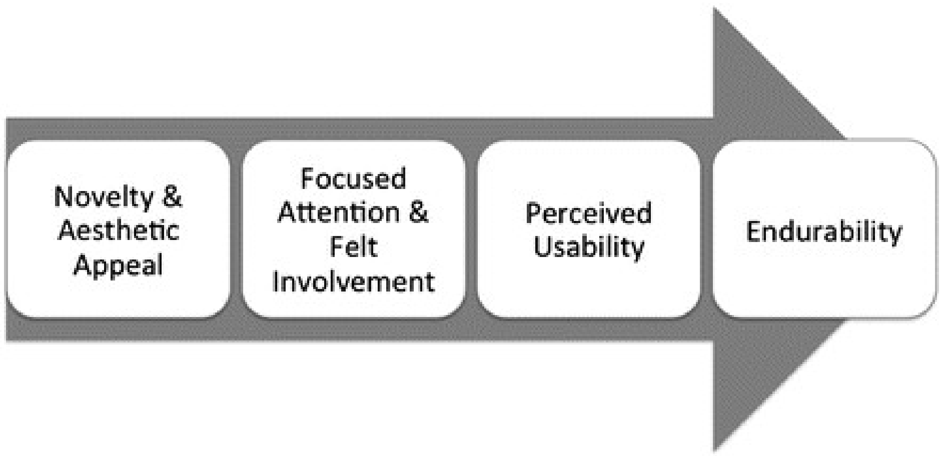

Figure 2.6: Relationship between engagement factors, obtained from O'Brien [44]

Geerts et al. proposed a framework that integrates both technical and user oriented definitions on QoE [23]. The framework presented is shown in figure 2.7. A person has the role of user, and usage of a service and the perceived value relates to e.g the personality and general values of the user. An Information Communications Technology (ICT) product is considered to have a variety of aspects and characteristics. These are for instance economic related to the market strategy and certain characteristics specific for that particular product. In addition, technical factors such as the device and application in use, as well as the network itself. It

User Engagement

Attributes	**Characteristics**	**Description**
Point of engagement/ Re-engagement	Aesthetics	Visual appeal that is pleasing
	Novelty	Unexpected or unfamiliar experiences
	User Context	Users' motivation, benefits and interests
	Reputation and Expectation	The trust users have on a given entity
	Goal	Specific or experimental goal by usage
Period of sustained engagement	Aesthetics	Graphics that keep the users' attention
	Richness and Control	The level of richness and control
	Focused Attention	Focused attention to the exclusion of other things
	Endurability	The likelihood to remember an experience and eager to repeat it
	Challenge and Interactivity	Challenges and interactivity that motivates
	Positive Effects	Enjoyment
Dis-engagement	Positive Affects	Accomplishment and success
	Negative Affects	Frustration or bad feelings linked to usage
	Challenge and Interactivity	Lack of/too much challenge and lack of ability to interaction
	Interruptions	Getting distracted and interrupted
	Technical Issues	Usability issues with the technology

Table 2.2: Characteristics of UE based on Attfield et al. [8] and O'Brien et al. [42]

also takes into account the fact that a user's perception may change over time, and the importance of understanding why users stop using a certain application. The context is also important, and the different aspects of context are dependent on the user him-/herself and the social aspect, the situation the user is in, as well as the user's interaction with the actual product.

Another proposed framework is shown in figure 2.8. This model highlights three important aspects. The first one is related to technical factors such as network transport which depends on e.g delay or response time. In addition the user's background and the interaction itself with the application are crucial parts.

A QoE framework for network services are proposed by Laghari et al. and takes both subjective and objective measures into account [33]. The idea behind this

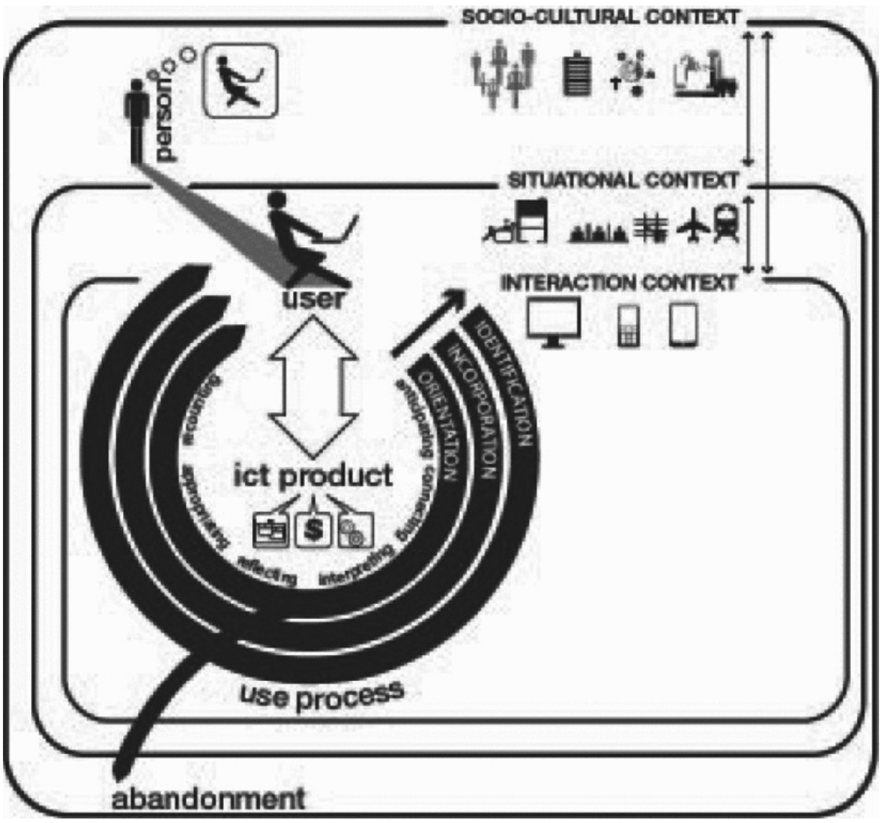

Figure 2.7: Proposed QoE framework obtained from Geerts et al. [23]

framework is constant monitoring of system configurations, network parameters and usage patterns in addition to user feedback and rating. The user feedback is done in such way that the user must choose to file a complaint if not satisfied. The information gathered from the monitoring can then be used to change service parameters so that they are satisfactory for the user's needs.

There are also frameworks that evaluates quality based on measurements of QoS. One example is Kawano et al. which focuses on videos and estimated QoE by taking network parameters for video quality into account [32]. By testing the model on a number of persons and making them give a subjective score they found that the model estimation is quite good.

Figure 2.8: Proposed QoE framework [41]

2.3.2 Influence Factors and Studies Done on the Field

In addition to having many different frameworks to choose from, there are many studies done on the field of QoE in relation to use of different applications and services. They have different areas of focus and methods in use to gain insight into what they are researching. An overview of some studies are presented in table 2.3, and are further presented to more extent in this section.

Although HIFs such as the user's background are not directly linked to network parameters, the user's expectation may nevertheless play an important role. Smartphones are used almost everywhere and at all times, thus the context changes throughout the day. Users' expectation may vary depending on if they are at home or on their way from one place to another, which is related to the fact that depending

Overview of Studies on The Field

	User expectation	Network parameters	Cost	Different networks	User's location	MOS	Lab study	Instrumentation toolkit	Longitudinal study	ESM	Survey/interview
Sackl et al. (2012)	X			X		X	X				
Ickin et al. (2012)	X	X				X		X	X	X	X
Sackl et al. (2013)	X	X	X	X		X	X				
Vucic et al. (2015)	X	X									X
De Pessemier et al. (2012)		X		X		X	X				X
Agboma & Liotta (2012)		X	X					X			
Hosek et al. (2013)		X				X	X				
Barmpounakis & Wac. (2013)		X			X				X		
Casas et al. (2015)		X				X	X				

Table 2.3: Factors in focus and methods in studies done on the field

on where the user is located different network properties may be available which may influence the perceived quality. The fact that most mobile subscriptions either have limited gigabytes included or charges the users by how much data they use, may be a factor as well. It is therefore interesting to see if usage patterns are different when connected to WiFi than to a mobile network, and if users' expectations changes and thus influences perceived QoE depending on the available networks. To meet all of the requirements in the best way possible, Dong et al. states that attractiveness, energy-awareness and lightweight is the key factors in design for success [17].

A study conducted by Sackl et al. focuses on how user expectations influence QoE [55]. This is done by letting users' do the same experiment using 3G vs wire-line Asymmetric Digital Subscriber Line (ADSL), and results shows that expectations can have a huge influence on the perception of QoE. Further Sackl et al. wrote a paper based on this study with further investigation. It shows that economy is a factor, and that the user must determine the trade-off between better quality and larger cost [56]. This decision is also highly dependent on the expectations the user have which is shown in figure 2.9. This figure shows the difficulty of knowing what really contributes to the users choices and quality evaluation, as expectations are not a measurable feature.

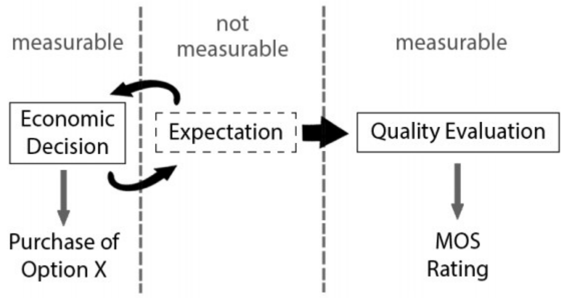

Figure 2.9: Relationship between expectation, economy and perceived QoE obtained from Sack et al. [56]

A study done by Ickin et al. included what users themselves meant was important factors for QoE and some users expressed higher tolerance for poorer performance when traveling from one place to another [27]. The study also shows that performance of the access network was not an issue [27] with the exception of multimedia streaming applications such as YouTube. However, many users had an expectation of these limitations and was understanding, thus it did not have a strong influence on the QoE. The study have limitations as it can not differentiate between 3G and 4G though, as well as not being able to measure QoS metrics. This shows that the users expectations is very important when it comes to QoE. Applications using a lot of battery is not a good thing for QoE, as well as if they are slow or freeze during use. It may be difficult to know if a slow application happens due to bad performance of the application or if it's the network itself that contributes to a poorer QoE. It is therefore important to look at usage over time in relations with network to measure the QoE as precisely as possible. One of the factors identified in the study is the social context e.g. whether the user is surrounded by people and other disturbances, or if the user is alone and able to fully concentrate on the application in use. It is particularly important to understand the context as changes in aspects related to context often influence human behavior [34].

Vucic et al. did a study on QoE for mobile video conferencing which lead to the suggestion of three ways to improve perceived quality, where two of them were related to processing capabilities [63]. This shows that the user's device may be a factor as the various smartphones have different processors.

De Pessemier et al. investigated how buffering interruptions influenced perceived QoE during watching videos an a smartphone [16]. It was conducted as a lab study where the users' watched videos both through WiFi and 3G (UMTS) to see what impact network throughput and video quality has on perceived QoE. The number of buffering incidents as well as the duration plays a crucial role on the perceived QoE, thus low-quality videos with less interruptions are rated higher than high quality videos with multiple interruptions. The study thus highlighted the importance of how network parameters and the applications throughput demands are closely related to give the user a good experience, but as this study is from 2012 this may have changed since then.

Frame rates and video encoding bit can be reduces without impacting the user's perceived quality, according to a study done by Agboma and Lietta [6]. They developed a network optimization procedure with goal not to affect the users, although different content types are vulnerable to different parameters.

Hosek et al. did a lab study where they investigated a selected range of network parameters [25]. Perceived quality went down with increasing delay and increased as the bit rate went up. They also analysed differences between web sites with different content. They found that users were more critical when accessing pages with news content than for instance a web shop, which may be related to users expectations and mood being different for these distinct situations.

Barmpounakis & Wac conducted a longitudinal study to investigate whether location and type of network the user is connected to influences patterns of use [10]. This was used by analyzing application logs in addition to network parameters to derive the user's location and which network the user was connected to when using the application. Results shows that patterns are different both between different users as well as on what type of application it is. However, application usage seems to be highly dependent on where the user is and what kind of network is available for connection.

Another research conducted by Staelens et. al highlights the shortcomings of conducting lab studies as the users' are highly influenced by the context and setup of the experiment [59]. They therefore recommended doing studies that can relate more to real-life.

This overview shows that there are a number of studies considering network parameters, but most of them are only looking at bandwidth and not in relation to different access networks [13] [63] [6] [25].

2.4 Tools For Measuring Smartphone Usage and QoE

As mentioned earlier smartphone usage has sky rocketed the past decade, and some may say to an extent that is not healthy. This section will present some tools that exist to log smartphone usage, and provides the background for the chosen application MobileDNA as well as its features.

There are different tools which can be used to log the usage of smartphone usage in order to measure QoE, and one of them is AWARE framework. This is an instrumentation toolkit to capture usage on mobile devices, and is an open platform which makes it possible to develop research tools that builds on previous development [18]. The framework makes it possible to select the data you want to collect, but in addition it's possible to trigger mobile Experience Sampling Method (ESM) questionnaires [5]. The advantages of this in relation to studies is that you get more information from the user during usage, therefore it may be more accurate. The challenge on the other hand, is that the user gets interrupted during usage which may affects the natural usage by the user. Other tools are i.eg. YoMoApp which monitors YouTube [64] and QoE Doctor that measures QoE by automatically replaying user interaction sequences [14].

Another tool is MobileDNA which tracks how people use their phone, but without interruptions as it's not developed with the intent of providing a tool for research studies. The application gives the users an overview of how they use their phones, thus there's something of value in it for the user. As it's hard to recruit people to this kind of studies MobileDNA was chosen as the preferred tool, as it provides the user with important information and intends to provide self-awareness. The application was developed as part of the Kop Op Campaign in Belgium and became a success in relation to raising awareness of people's smartphone usage.

2.4.1 Kop Op Campaign

A number of studies shows that applications and smartphone usage has invaded all aspects of our lives. Studies have shown that a large number of users think that smartphones are a distraction in social contexts such as when spending time with friends or watching TV [4]. As a reaction to this, the *Provinciaal Veiligheidsinstituut Antwerpen* in Belgium launched the Kop Op ("cheer up") campaign in January 2018 in cooperation with the University of Ghent and the University of Antwerp among others [4]. The Kop Op slogan can be translated and understood as "Cheer up, keep your head up" and is referring to both the physical and mental aspects by using smartphones. The Kop Op campaign is meeting the increasing challenges people have by usage of smartphones, as many want a better balance when it comes to sleep, family, work and so on.

One of the main goals is to give users tools to gain better self-awareness and balance on their smartphone usage. As a tool in the process of gaining this, there are a variety of things that have been developed. They have a web page which includes many tips and challenges related to smartphone usage. In addition there is a self test that users may take which intends to give you a profile that describes your usage. It will also recommend different challenges you may take in order to change the pattern

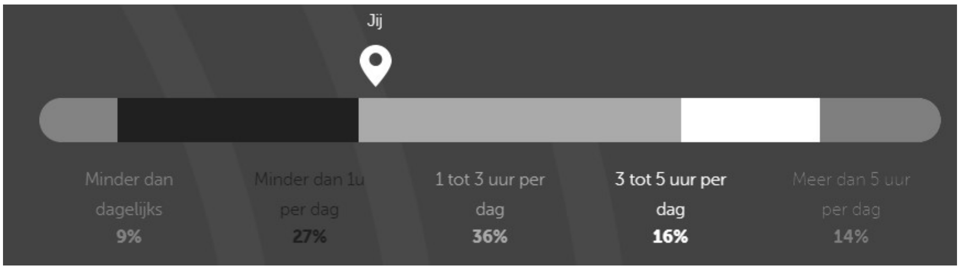

Figure 2.10: Presentation of estimated usage each day compared to other people

of usage. One of the main benefits achieved by following these challenges is that the users may discover how much extra time they have to experience real-life situations, as the challenges encourages to less smartphone usage. The hope is that this new knowledge leads to a behavioral change that will last, hence experiencing a better balance in life [4].

There is also another test to estimate your usage and dependence on your smartphone by answering a number of questions [2]. This then results in a profile that describes your relationship to your smartphone as well as the challenges related to your smartphone usage. You will also see the estimation of where you lie compared to others, which may be an eye opener for many. An illustration of one of the insights you may gain and how this is presented can be seen in figure 2.10. At the end of the result page, the application MobileDNA is recommended to help you chart your actual habits, as we tend to believe we are using our smart phones less than what is the actual truth.

2.4.2 MobileDNA

The application is currently only available for Android as iOS limits the access to the system and other applications which is needed for the application to work [1]. The purpose is for the application to present a mirror of the user's actual application usage, thus the user gets the facts presented in a clear form. This is done by presenting an overview of your usage divided into different categories, some examples follows here [1][3]:

- Time spent on each application
- Number of applications used
- Number of applications running concurrently
- Number of times you unlock your phone

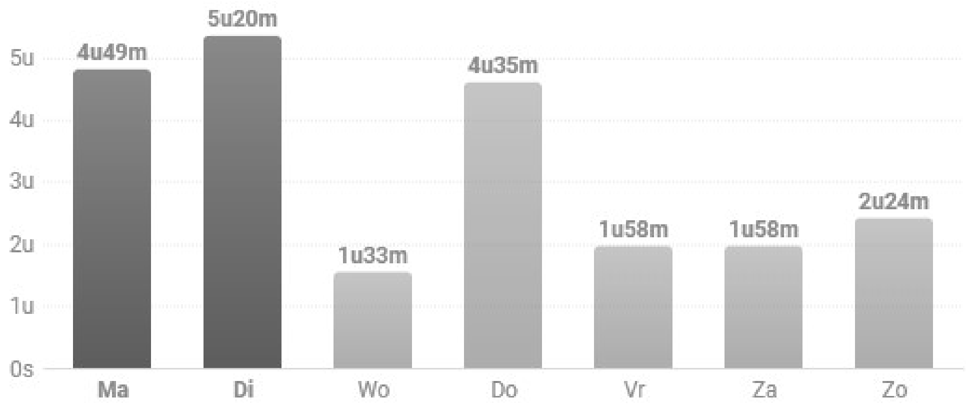

Figure 2.11: Time smartphone is in use each day of the week

- Number of notifications each day
- Percentage of time spent on different applications
- What time of day your usage is concentrated
- Total time spent on your smartphone each day, as illustrated in figure 2.11

In addition it presents you a mobile diagnose after two weeks of usage, hence giving you an even clearer view of your usage. This includes information about [1][3]:

- If you are a diffuse or a concentrated user
- If you have a mobile biorhythm
- If you are a creature of habit
- If you are a compulsive or conditional user of your smartphone or a specific application
- If you have triggered behavior

Biorhythm refers to e.g. if you use your phone differently during the weekend than the weekdays, and if there are specific time of the day that stands out on an average. As MobileDNA tracks notifications given by the various applications on your phone, it also provides an insight into if this triggers usage by not only the application who gave the notification but other applications as well. People often have a habit of checking specific applications when they open their phone because of a notification.

Collected Data

The application collects a number of variables in order for the users to get the information given by MobileDNA. It does not track all possible variables and does not track constantly but tracks by a certain interval. They cannot retrieve all parameters every second for instance as it consumes too much battery, thus resulting in a frustrated user. Most parameters are therefore logged per "app event". An overview of the data variables and descriptions is given in table 2.4.As seen by the parameters in the table, it does not track any information on the content of the applications in use or what the user types on its phone. The main thing the data collection set is interested in is which applications are being used and when, as well as tracking notifications given by the various applications.

Category	Variable	Description
Appevents		Appevent = the period of uninterrupted app use
	application	The bundle_id of the application. This is the ID chosen by the developer
	battery	Battery percentage at moment of appevent
	endTime	End time of the event in ISO date/time notation (w/o timezone)
	endTimeMillis	End of the event in epoch (milliseconds from 1-1-1970)
	startTime	Start time of the event in ISO date/time notation (w/o timezone)
	startTimeMillis	Start of the event in epoch (milliseconds from 1-1-1970)
	id	The device ID
	latitude	Geolocation of device (latitude). Not included in sample set.
	longitude	Geolocation of device (longitude). Not included in sample set
	model	Model of the device
	notification	Describes if the app-event started because of a notification (True/False)
	notificationId	Internal id of the notification, makes it possible to link the app-event to a specific notification
	session	The session ID
Notifications		This data set contains all notifications on the device, including updates of existing notifications (eg: google maps directions updating)
	application	The bundle_id of the application. This is the ID chosen by the developer
	id	The device ID
	notificationID	Internal id of the notification, to see if an notification was updated.
	posted	Only "True" is being used. These are notifications in the foreground, which have an impact on the user
	time	Moment of notification in ISO date/time notation (w/o timezone)
	ongoing	Boolean indicating whether the notification is new (False) or ongoing (True)
	priority	Shows the type of priority Android gives to the notification
Sessions		Sessions are pickups, divided in two parts: beginning and end of pickup. Used to construct the session duration
	id	The device ID
	session on	Describes beginning or end of a session (True/False)
	timestamp	Moment of notification in ISO date/time notation (w/o timezone)
Logs		Not included
	id	Not included
	date	Not included
	logging enabled	Not included
General		
	data_version	The mobileDNA app version

Table 2.4: Parameters retrieved through mobileDNA

Chapter 3
Methodology

Method means to reach a goal by following a certain road. To conduct a satisfactory research it is important to decide which road to take, implicitly which method to use to reach the goal in the best possible way [29]. Essentially, methods are different tools for collecting, processing and interpreting data, but it's important to define the research questions before choosing how to proceed forward. The methodology process can be described by figure 3.1.

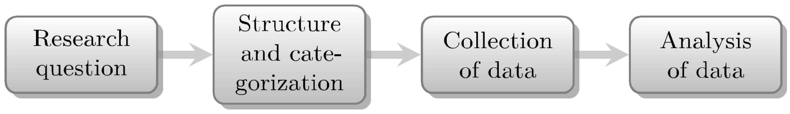

Figure 3.1: Methodology process [28]

This chapter will present the research questions and the methods for collection of data that are chosen. Arguments for the chosen methods as well as challenges and limitations will also be presented and discussed.

3.1 Goal and Research Questions

As presented in chapter 1 the goal of this thesis is to investigate how technical factors may influence usage of smartphones. It's important when selecting the methods to be used to have a clear picture of what we want to achieve. This can be done by looking at the planned tasks:

– **Review QoE and its relation to network parameters**
There's a lot of studies done on QoE [46], although many studies focus on other things than smartphones and network parameters. What are the findings in existing studies regarding network parameters and QoE?

- **Investigate whether mobile network type has an impact on mobile usage through surveys and behavioral data collection (logging of app usage)**
  It's interesting to see if there is any correlation between the network connection being used and how the smartphone is used. To which extent does network type impact the user, and is there something that recurs in the majority of the users?

- **If so, are there specific types of applications that are more vulnerable than others to network changes**
  This is considered as an important question as it may be interesting for application developers to know what is important for users. What are the reasons as to why some applications are used differently on different network types? Are prices and data consumption a limitation, or is it network speed or anything else?

3.2 Research Design

In order to choose which methods to be used, it is useful to have an overview and deeper understanding of the different types of methods that exists.

Quantitative Methods

Quantitative methods collects data in form of numbers and statistics and the methods are often standardized [15]. The use of standardized methods makes it easier to compare results and reproduce the same design, thus making reproducibility of research and results possible. This can be done by researchers to support and gain confidence in their conclusion [38]. A quantitative method is good at testing hypothesis but contextual details may be missing. However it is much easier to get a large sample of data in comparison to qualitative methods. Examples of quantitative methods are questionnaires that are not open-ended or data collection using instruments and tools that provide data that can be processed by means of statistical analyses (e.g., logging of behavior, gathering of physiological data).

Qualitative Methods

It can be defined as *"any kind of research that produces findings not arrived by means of statistical procedures or other means of quantification"* [60]. Its aim is to understand the users by not basing it on numbers and data for analysis, hence it can be viewed as a subjective method. Some of the challenges are related to how valid and reliable the data are, however this group of methods also allows for a closer interaction and a level of trust between the researcher and participant that may lead to findings that are often missed by quantitative methods. Examples of qualitative methods are observation of participants, interviews or open-ended questions through surveys.

Mixed Methods Methodology

Mixed methods methodology is simply a combination of quantitative and qualitative methods and integrates the data together [12]. According to Creswell, the mixed method approach could start with a broad survey to get generalized results, before focusing on open-ended interviews to get detailed information from some of the participants [15]. By combining the two types of methods you get the best from both worlds as they complement each other in such a good way which makes the analysis and results more robust [39] [61] [24].

3.2.1 Planning of Research Design

The first task of reviewing QoE and its relation to network parameters is done to review what kind of previous studies have been done. The goal of this literature review is to look at the current literature on QoE and to extract the most important results and outcomes of these studies. What network parameters may influence QoE according to existing studies?

To gain insight into whether mobile network type has an impact on mobile usage, I decided that gathering data through the use of a survey would be suitable. The survey questions focus on how users use applications on their smartphone, and how technical factors may influence how it's used. In addition to the survey, behavioral data is collected through the application mobileDNA. The choice of collecting data in addition to the survey was done to get more accurate data to analyze. There is always some subjective bias related to surveys and people usually don't have an accurate memory of how they actually use their smartphone (memory bias). The ability to link results from the survey to the collected data from mobileDNA can help provide more accurate results. In addition, an interview of a few of the participants is done after the data collection. This is to gain more insight into how the user actually feels about application usage connected to different network parameters, and to look at how this corresponds with the data collected from the survey and mobileDNA application.

There are other methods that also could have been used, such as observational methods or diary methods. Observational methods were considered to not fit the goal of this thesis, as I wanted to gain results from actual usage during a normal day-to-day life. I did not want the users to be influenced in any way on how they actually use their smartphones, and wanted the study to be done in their natural environment. Diary methods such as Experience Sampling Method (ESM) was also considered, but given the limited time and resources on this thesis it was considered to be too difficult to find both enough time and participants willing to go through with such a study. Logging of ESM may be done using frameworks such as AWARE which may also log technical factors [5]. However, this demands the user to get interrupted during the daily usage to collect user feedback. I therefore decided to collect usage data and user feedback independently, thus assuring normal and uninterrupted usage, with the drawback of not getting an instant user feedback.

3.3 Mixed Method Research

The survey had both open-ended and multiple choice questions thus it may be regarded as a combination of quantitative and qualitative. Data collection through mobileDNA is a quantitative method and gave supporting information to the results from the survey. The concluding interview is a qualitative method and gave a chance to dig a bit deeper and get understandings and information that was not collected through the survey and application. Combining these methods was useful to gain a better understanding and more complete results.

It's possible to use a mixed method that focuses primarily on either qualitative or quantitative methods, or it may be equally studied, this can be seen in figure 3.2 based on [30]. This depends on the project and what aspects are most important to the researcher and thus wants to prioritize [15]. There are also a variety of different strategies that can be used in a mixed methods study [15]. The design most suitable for my goal was the explanatory sequential methods design which can be seen in figure 3.3. It starts by collecting quantitative data through survey and data collection through mobileDNA, before using a follow-up qualitative method as the concluding interviews. The participants in the qualitative study must also be in the sample of participants from the quantitative study.

3.3.1 Survey

The survey was designed after studying some of the results gathered from the literature review as well as some theories on how network parameters can influence how the users use their smartphone. I wanted to reach out to as many people as possible and therefore used some time to make the survey easy, understandable and less time consuming. This was done to try to avoid that participants would quit in the middle of the survey.

There are different types of surveys available but I decided to go for the Fill-in The Blank (FITB) which can combine check-off boxes and open-ended questions [45]. The open-ended questions are important to gain insight into the topic, however this kind of rich information is harder to process and analyze though. It was decided to go for a self-completing survey as this makes it less time-consuming and easier to recruit

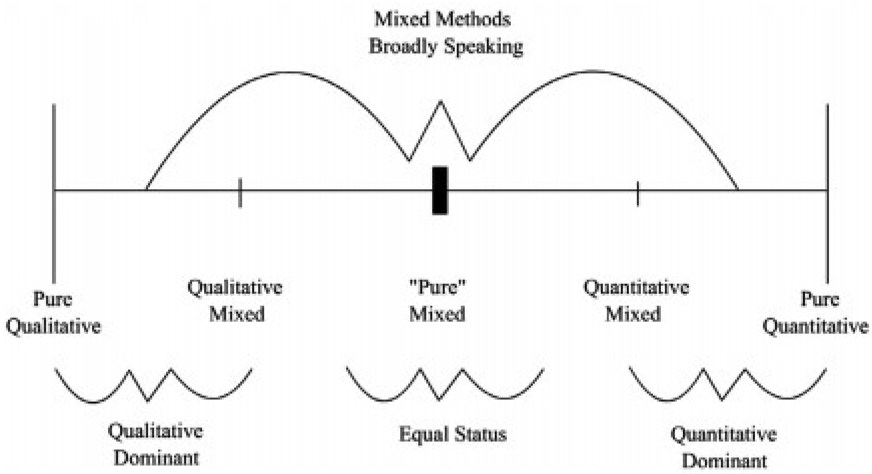

Figure 3.2: Different research paradigms [30]

participants [51]. This makes it easier to get a large data set to work with in the short time frame I had, as well as giving participants the option of being completely anonymous. Response bias may occur as people can pretend to be someone else, and it may be hard to get a representative selection [51]. In addition, the response rate may be low and fuzzy questions could also occur and may not be detected.

As the aim is high-quality data, it's important that the respondents have enough information to give a clear answer to the questions being asked, and to avoid unclear and incomprehensible questions. To take these risks down to a minimum I pre-tested the survey on five persons before distributing it. The survey included questions on general usage of smartphones as well as any challenges experienced with use of applications that may be related to network parameters. Information about the purpose of the survey and estimated time to finish it was presented on the first page of the survey. Information about privacy and confidentiality was also presented, and at the end the respondents were asked if they wanted to participate further in data collection through a mobile application. The survey may be seen in Appendix A.

The survey was conducted by a tool called SelectSurvey which Norwegian University of Science and Technology (NTNU) manages. Since the research demanded collection of personal data a permission from the Norwegian Centre for Research Data (NSD) was needed. The confirmation given from NSD is found in Appendix B. Participants were recruited through a combination of a convenience selection and self-selection, that is, selection of respondents that are useful for the survey in a random and non-representative way or respondents who joined themselves [58]. The

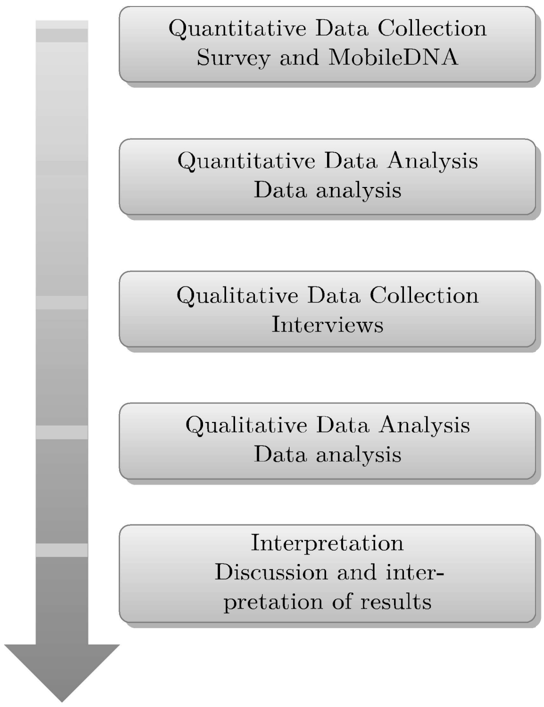

Figure 3.3: Explanatory Sequential Method

selection was made through own network by channels such as Facebook, SnapChat and co-workers in addition to voluntary participants at NTNU, recruited through the Innsida-channel "Forskningsstudier - deltagere ønskes".

The results from the survey were exported to Excel, cleaned and imported into Statistical Package for the Social Sciences (SPSS) which is a tool to do statistical analysis on the results. A number of analyses and statistical tests were conducted to analyze the data. Primarily, the used tests analyse whether there are significant differences between different groups (for instance men vs. women, different age groups). This happens when the significance level α is less than 0.05 and means that the chance that this occurred by chance is less than 0.05. The methods in use are Chi-Square, Mann-Whitney and Kruskall Wallis which are all non-parametric statistical tests: they allow to analyze the relation between nominal variables, two independent groups of ordinal variables and more than two independent groups of ordinal variables, respectively.

The Pearson's chi-square test is used to see whether there is a relationship between two variables, by comparing the frequencies observed with the frequencies expected by chance on different categories [21]. The test then looks to see if there are any significant differences between them, hence if α is less than 0.05. The Mann-Whitney tests to see if there are any differences between two independent samples [21], for instance if the sample collected from men are the same as women, or if there's a significant difference. The Kruskal-Wallis test checks the same thing, but for more than two independent groups. The results from these analyzes are presented in chapter 4.

3.3.2 MobileDNA

MobileDNA was chosen as an appropriate application to collect data about the users smartphone habits. The application is developed for the users to gain insight into their use, not for research studies, which we considered would make it a bit easier to recruit people to participate in the study. One limitation though, is that it's only available on Android phones at the moment which made the possible participant pool smaller.

The application gathered data on how the users used their smartphones, and by combining these results with the answers given in the survey a better insight into the topic could have been gained. The application developers had planned to implement collection of network variables before November 2019 (upon request of and as part of a collaboration between the supervisor of this thesis and Ghent University) but this was delayed. Because of this, I didn't get all the data I wanted to collect from the application. To try and compensate for this, I sent out some questions to the participants throughout the time they used the application. To avoid people quitting in the middle of the study, these questions were not required. They were sent out once a week and encouraged the participants to tell about a negative experience they have had related to network parameters during the last few days, if they have had any. They were asked about where it happened, at which time and what they were doing at the time. However, none of the participants answered to these questions, and I therefore didn't get any additional information as wanted.

The participants were given a unique identifier which connected their survey results with the application data. After two weeks of collecting data through MobileDNA all data were collected from the developers of the application and analyzed in connection to the survey results.

3.3.3 Finishing Interviews

After the data collection was finished, the participants were asked if they would contribute in a short finishing interview (primarily conducted via email). The questions provided were based on results from the survey and application to both see if it was specific things that the data collection had missed as well as how the user experienced application use in connection to type of network.

3.3.4 Challenges and Limitations

One of the challenges with the survey was that a large number of participants answered the two first pages, but when they came to the open-ended questions they closed the survey and didn't finish. This shows how difficult it may be to gather qualitative data. In addition, the survey was not sent out until November as the process with NSD took some time. This meant that the survey couldn't be open as long as I hoped as the analysis of the results had to start. The survey was distributed on my personal Facebook page as well as at NTNU Innsida and by posting it on the Slack-page of my workplace. This means that the selection of people taking the survey is not representative for the society as a whole. However the findings give insight into smartphone use as stated in the research questions, and are valuable.

The process of developing the survey was also challenging as I wanted as many participants as possible, which reduces the number of questions that can be asked. In addition I wanted the questions to be understandable and not ambiguous, and wanted as little bias as possible by not asking leading questions. The survey was tested on a number of persons before it got distributed which lead to some minor changes, however some participants might still have find some of the questions ambiguous.

When the work started we got strong indications from the people behind mobileDNA that parameters such as type of network, network strength and so on would be implemented during October. This was unfortunately delayed which meant that we didn't gather exact network information from the participants as wanted. Even though this was solved by sending out questions to the participants during the time they had the application installed, this demanded more from the participants and gives less valuable information. If the application had gathered information directly it could have provided more accurate results. In addition there were some delays in the communication and setup of the research through the application. This meant that the results from the data gathering didn't come back to us until a week before finishing up the thesis.

This also meant that there was little time to conduct finishing interviews. This was handled by choosing a few questions which were then asked by e-mail to the participants. This was to get qualitative data to support the data gathered from mobileDNA, but because of the delays the scope ended up being much smaller than originally planned.

The questions sent out during the collection of behavioral data from mobileDNA didn't result in any findings. The participants did not report any negative experiences, and this was further confirmed in the finishing questions where all participants reported that they hadn't had any negative experiences during the last two weeks.

Chapter 4

Results

The different methods used to investigate the research questions were presented in the previous chapter. This chapter provides the results from the survey, data collection and finishing interviews.. The results are further discussed in chapter 5.

First, the results from the survey will be presented. This sub-section starts by presenting some general information about the participants, and their smartphone habits. The results are thoroughly presented and figures are used to illustrate the findings, and important findings are highlighted. After that, the results from the behavioral data collection and the finishing interviews are presented, as well as some limitations and challenges faced during the process.

4.1 Results from the Survey

4.1.1 Overview of the sample

After the survey was distributed, it was active for one and a half weeks and resulted in a total of 125 people that completed the entire survey. 185 respondents started to fill out the survey and completed the first two pages. However, two out of three aborted when they reached the open-ended questions, showing how difficult it may be to get respondents for a survey like this.

Data cleaning reduced the total respondents to 124, and the distribution between the genders was relatively similar with 51,6 % female and 48,4 % male. Only 2,4 % of the respondents were from other countries than Norway which is natural considering the channels where the survey was distributed. When it comes to occupation a large group were employees, 84,7 %. The distribution between what kind of smartphone the participants had was pretty evenly distributed with 53,2 % having an Android phone whilst 46,8 % swore to iPhone. The average age was 34,8 with the largest groups in their last 20's and early 30's. The distribution is shown in figure 4.1. The

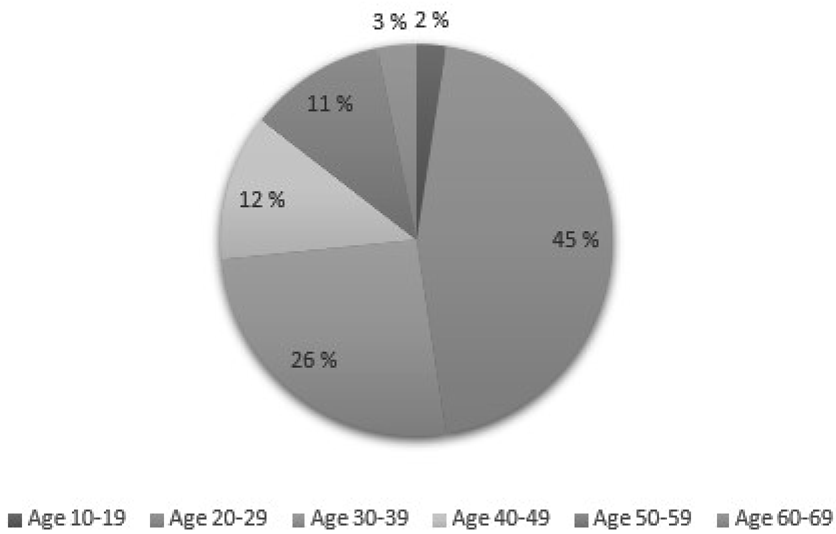

Figure 4.1: Participants by age (in percent)

participants were then asked about how they generally use their smartphone, and the results are presented here.

4.1.2 General Usage of Applications and Smartphone

There were eight groups of applications that were asked about throughout the entire survey, and the number of people saying they had used those kind of applications during the last two weeks are presented in figure 4.2. We can see that five of the application types are used by most participants, whereas video chat and playing games are not that widespread. Streaming of videos is also less common than most of the other application types.

In order to verify whether there are differences in terms of application usage between different age groups represented in the sample (with the last two weeks as reference period), Chi-square tests were performed. A selection of the tests conducted can be found in Appendix D. The three age-groups used for the analysis were up to the age of 28, between 29 and 35 and the ones over 35. Systematic checks were performed to compare the respondents in terms of basic variables such as gender, age group, how much data included in mobile subscription, type of smartphone. A comparison of the respondents into three age-groups shows some differences that are meaningful from a statistical point of view. Those over the age of 35 use applications for streaming sound (e.g., Spotify) significant less than the other two groups. There

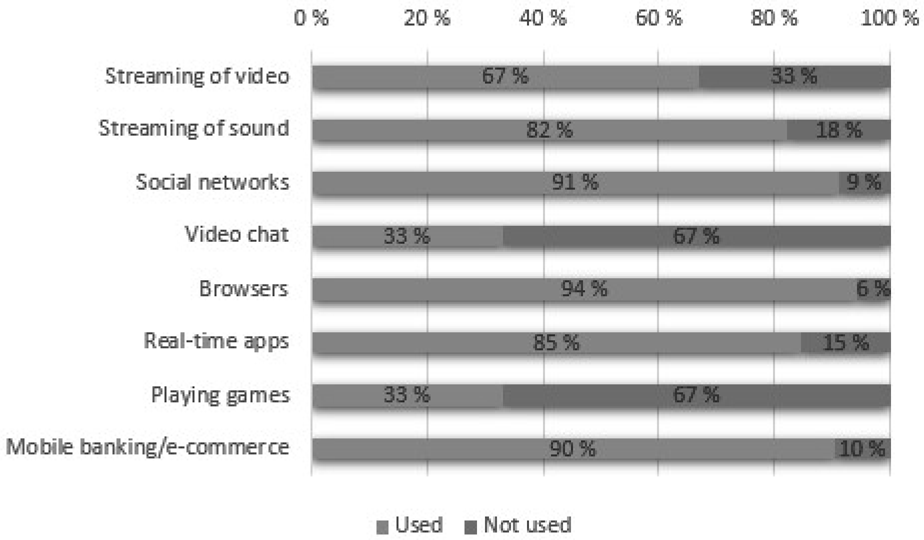

Figure 4.2: Used this type of applications during the last two weeks

is also a tendency towards that the ones over 35 are over-represented among those who have not used social media during the last two weeks. However, despite this clear tendency the number of respondents is low and this difference was not significant.

When it comes to what kind of applications they use the most, the distribution changes though. Social media and browsers stand out, in addition to streaming of sound. This is shown in figure 4.3, where the X-axis represents the number of participants in percentage. There are significantly more people in the oldest age group than the two other groups who uses browsers most. This may indicate that that the oldest age groups tends to use the web browser for accessing a range of services, whereas the younger age may rather fall back on dedicated applications (however further research is needed to verify whether this is actually the case). There are also significantly more people in the youngest age-group than in the oldest where streaming sound is the most used type of application, implying that applications for streaming music/sound such as Spotify are more popular amongst the younger respondents.

We were also interested in how much time they think they spend on their phone and on a specific type of application during an average day. More than 66 % of the respondents said that they spend more than two hours on their phone during an average day, however in this respect the Chi-square test yielded a significant difference between the ones over 35 and the younger age-groups. The oldest group are underrepresented in the group of heavy-users and over-represented in the group

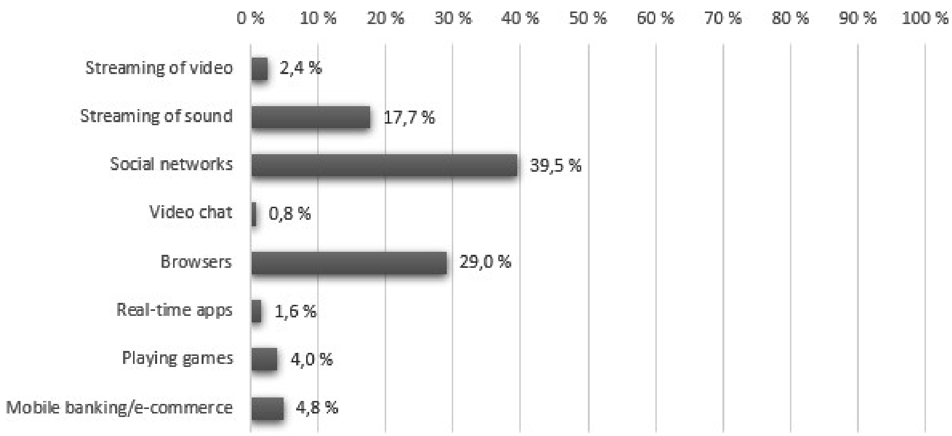

Figure 4.3: Type of applications used most during the last two weeks

who spends less than an hour on their phone on an average day. The chi-square test was also conducted to check whether there are any significant differences between different groups in terms of the time spent on the different application types. Earlier we found that those over 35 years old use music/sound streaming apps significant less than the other two groups, and this finding was supported by the analysis showing that the youngest age group uses significantly more time on sound streaming than the older ones. There was also a significant difference in time spent on video-streaming: the ones over 35 spend less time on this type of applications, compared to the two youngest age groups.

Time spent on different applications was also analyzed in terms of potential gender differences. The analyses show that women report to spend significantly more time on social media and video-chat than men. No other significant differences were found, and there were no significant difference in how much time each gender spend on their phone during an average day.

We also cross-checked whether there is a correlation between gender and the type of subscription the participant had, and there was a clear tendency that women have less GB included in their subscription than men, however the findings were not significant. We also checked if there were significant differences in the usage patterns of participants with different amounts of data included in their subscription. This in connection with the use of different types of applications based on location and what network they were connected to, but found no significant differences.

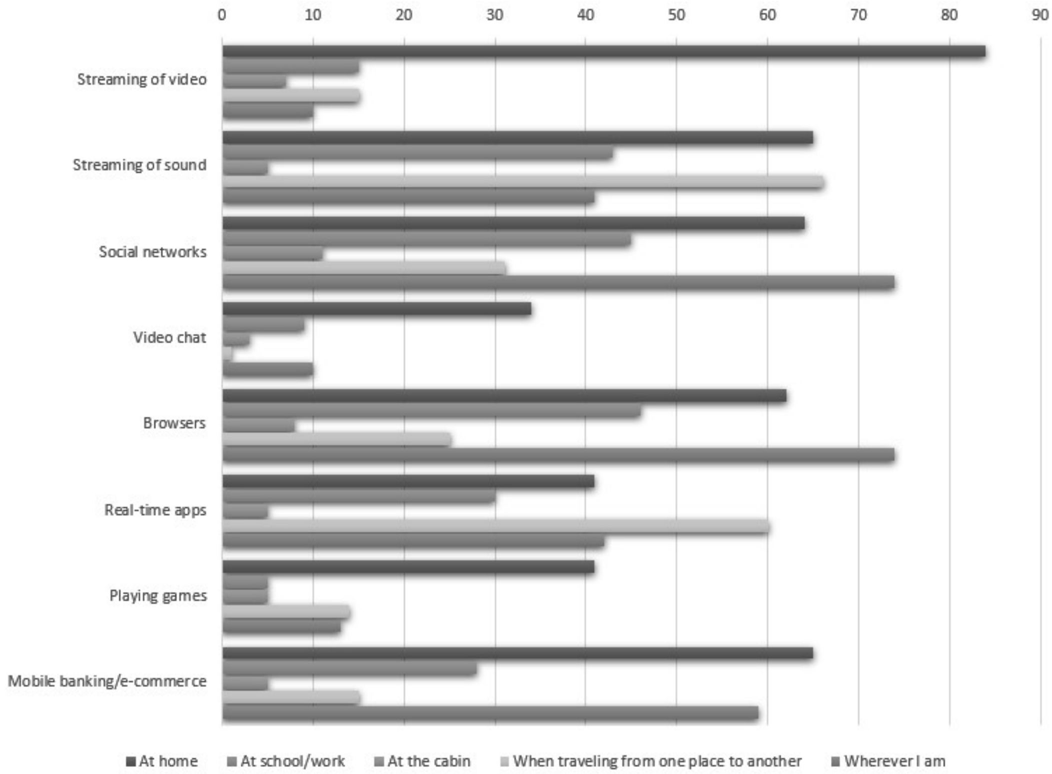

Figure 4.4: Where the different type of applications have been used during the last two weeks (in absolute numbers)

4.1.3 Application Experience and Important Factors

Where and on what type of network are applications used?

The participants were asked where they use the different types of applications, and the results are shown in figure 4.4. Although there are no significant differences from a statistical point of view, we can see that the tendency is towards using heavy data-consumption applications such as video streaming and video-chat while at home, where most people have WiFi. Less heavy data-consumption applications have a tendency towards that the location of the user doesn't influence how the application is used.

These findings can also relate to what type of network the participants are on when they use the different type of applications. The results are illustrated in figure 4.5 and shows that there is a tendency towards that streaming of videos on mobile

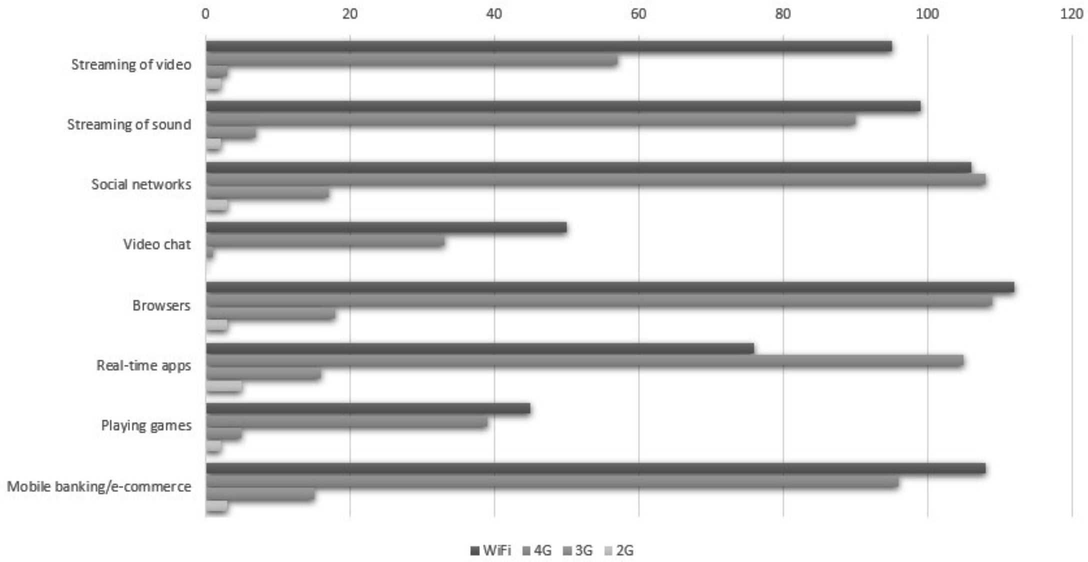

Figure 4.5: What type of network different type of applications have been used on during the last two weeks (in absolute numbers)

networks are less common, and that there is a larger gap between people using it on WiFi vs mobile networks than for the other application types. Even though we found no statistical evidence in the data sample supporting this tendency, it is relevant and interesting in view of the research questions underlying this work.

The participants were also asked about if they prefer not to use a type of application when connected to a certain network. The results are shown in figure 4.6 and we can see that the grey columns which indicates that it doesn't matter what type of network one is connected to, is by far the most common one. However, we can see that for heavier data-consumption apps such as video-streaming more people seem to care, and prefers not to use this type of applications when connected to mobile network. Actually, 35.8 % prefers to not stream videos when connected to mobile networks, indicating a potential discrepancy between what people say they do (when asked in general) and what they respond when they have a particular type of application in mind.

The ones with less data included are more influenced by what type of network they are connected to and this may be natural as there is a high cost of buying additional data on the subscription. Chi-square tests shows that the type of data subscription (mobile data included in subscription) has a significant impact on the use of certain types of applications (i.e., streaming videos and video-chat) in a given

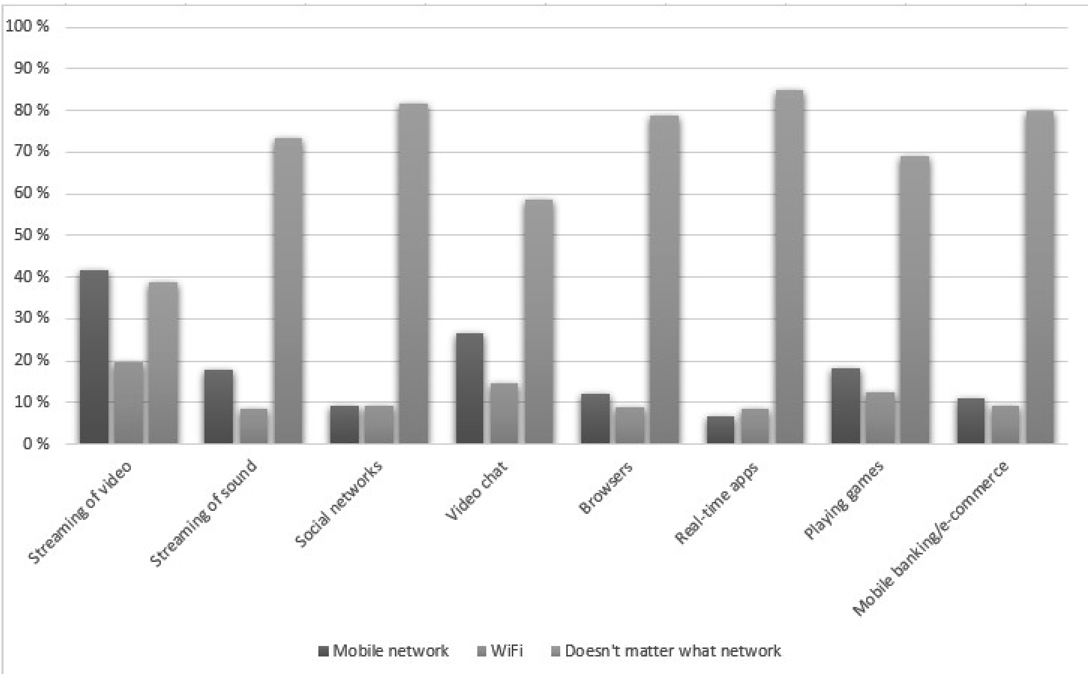

Figure 4.6: What type of network participants prefer to not use this type of applications (in percent)

network context (type of network that one is connected). People with less than 6GB included in their subscription prefer not to use these heavy data consumption applications when connected to a mobile network. The ones who have more than 6GB included in their subscription care less about what type of network they are connected to. The amount of data also influences how much time people spend on their phone as the more data included, the more people think they spend too much time on their phone. Mann-Whitney test shows this as there is a significant difference between how the ones with more than 10GB included in their mobile subscription think they spend too much time on their phone compared to the ones with less than 6GB included. The result from the test conducted can be seen in Appendix D.

Qualitative results

The survey had a number of open-ended questions where different aspects as to what contributes to positive or negative experiences with applications were requested.

The question about what factors contribute to a positive experience were answered by 93 out of the 124 respondents. In addition the question were asked more specifically

Factors	**Type of Applications**
Easy to use	Streaming sound Social media Real-time apps Playing games Mobile banking and -e-commerce
Fast network	Streaming video Streaming sound Social media Video chat Web-browsing Real-time apps
Reliability/no app crashing	Social media Real-time apps Mobile banking and -e-commerce
Response time/no delay	Streaming video Streaming sound Social media Video chat Web-browsing Real-time apps
Design	Social media Playing games
Price/Economical aspects	Streaming sound
Entertaining	Playing games
Security/Privacy	Mobile banking and -e-commerce

Table 4.1: Factors associated with having a good experience

about the different types of applications. In order to analyze the answers I coded them into different categories to see what stood out as important to a large number of respondents. The findings and connection to the various type of applications are shown in table 4.1.

The illustrated results show that in general, the most important factors for having a good experience is that the app does not lag and are fast and easy to use. Statements like *"That the application do not crash. Runs smoothly and fast. Good design and easy to understand."* and *"The app working smoothly"* highlights that it shouldn't be too difficult to please the users. The most important factor is that the app runs smoothly and doesn't crash. Applications that freeze during usage are also not appreciated, *"Fast. No freezing of application. Easy application."*. In addition, loading time is important as well. *"It's important to me that it's fast and not loading to long."*

We were also interested in what contributes to negative experiences, and 65 out of the 124 respondents answered this question. The main findings from the respondents are shown in table 4.2.

The results illustrates that slow internet connections are an important factor for having a negative experience, regardless of what type of application are in use. This can also be seen in correlation with how lagging and buffering are factors negatively influencing the experience with respect to applications that require a large throughput, such as video and sound streaming as well as video-chat. For instance, one user responded *"Fast network, no lagging, good quality on sound and picture."* Negative experiences related to this can in some scenarios lead to that the user shuts down the application, *"Not a lot of loading. If it loads to much I turn it of."*, thus clearly having an immediate behavioral response. All kinds of ads are also something most people find annoying. When streaming videos, the amount of data consumed is a very important attribute that contributes to a negative attitude towards streaming of videos. Having too little GB included in the subscription may be a factor, *"Fast internet and enough GB."*

The respondents were also asked whether they could recall a negative experience that happened due to one or more technical issues.

> *"App crashed caused by to much ads"*
> *"Application did crash and i had to re-install the application for it to work again. This takes time."*
> *"Sometimes the app just stops responding and I need to close it and start it again which is annoying"*

These are some examples of the responses given. The main thing the respondents noted was that the application freezes or crashes and must be shut down for it to start working again. This closely matches what was found from statements of what was important for having a good experience with an application.

View on how different factors influence usage

The participants were asked how important different factors are with respect to how they use different types of applications. The results including 95% confidence intervals are shown in figure 4.7. As shown here, there is a tendency towards that

Factors	**Type of Applications**
Poor internet connection	Streaming video Streaming sound Social media Video chat Web-browsing Real-time apps Mobile banking and -e-commerce
Auto-play/Pop-up messages	Streaming video Web-browsing
Commercials/ads	Streaming video Streaming sound Social media Web-browsing Playing games
Slow response time	Social media Web-browsing Real-time apps Mobile banking and -e-commerce
Lagging/Buffering	Streaming video Streaming sound Video chat
Data consumption	Streaming video Web-browsing (auto-play of videos i.e)
Bad quality	Streaming video Streaming sound Video chat
Bad layout	Social media Web-browsing
Downtime	Mobile banking and -e-commerce
Push-notifications	Social media
Hard to understand	Mobile banking and -e-commerce

Table 4.2: Factors associated with having a negative experience

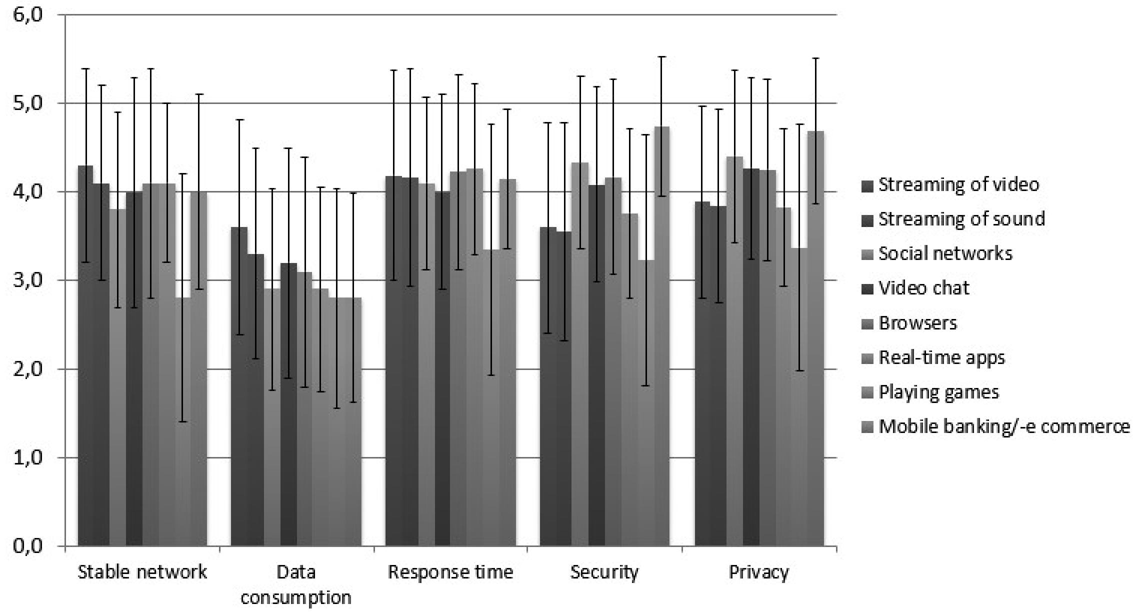

Figure 4.7: Average importance of different factors with 95 % confidence intervals (from very unimportant to very important)

security and privacy are more important for mobile banking and mobile e-commerce, which is not that surprising. When it comes to data consumption there is also a tendency that it is most important for streaming of videos, and also a little bit for streaming of sound and video chat.

In addition, Mann-Whitney and Kruskall-Wallis tests were conducted to check whether the importance of the five different factors when using the different types of applications also varies depending on certain characteristics of the respondents. This was done in regards to both type of smartphone, gender and how much data the participants had included in their mobile subscriptions. These analyses yielded no significant findings. However, when looking at the results from the comparison of different age-groups, there are some significant differences. The older age group does not care as much about a stable network connection as the younger ones, which may indicate that they are more tolerant. In addition, response time for streaming of sound and video are more important for the youngest age group.

When we look at the final statements illustrated in figure 4.8 we see for instance that most people expect applications to work just as well when traveling from one place to another as at home. This puts large demands on mobile networks and connections available.

Mann-Whitney U tests were conducted on the final statements, more concretely, to check whether there are significant differences within the population. The results indicated those with less than 6GB data included in their subscription agree to higher extent that the network they're connected to influences how they use their smartphone than those with more than 6GB included. This is also supported by findings on that those with less data included prefers to not stream heavy data-consumption applications when connected to mobile data. However, on the statement "I stream videos regardless of which network I'm connected to", no significant differences were found.

There were also some significant differences between the genders. Males are much more likely to stream videos regardless of what type of network they are connected to. In addition, females have another view than men on how much time they spend on their phone. There are significantly more women than men that think that they spend too much time on their phone, however as reported previously in this chapter, there are no significant differences on how much time each gender reports to spend on their phone.

4.2 Results from Behavioral Data Collection

Through the survey there were 13 people who signed up to participate in data collection through the application mobileDNA. When the research was set up however, there were only seven people who actually downloaded the application, and several of these did not give the application permission to track data. The time taken from the survey respondents agreed to participate further and the information e-mail was sent out might have been a crucial factor for the dropout rate. It took more time than expected for the research study to be set up by the developers of the application, but in addition it is to some extent expected that a few would withdraw from this kind of study. The fact that some people didn't give the application the right permissions could maybe have had a better outcome if the e-mail sent out was even more specific than it was, the e-mail can be seen in Appendix C. In addition, the information text presented in the application stated that the target group were people between 18 and 30. Even though this was discovered not long after the first e-mail was sent out and a clarification e-mail was sent out, at least one person did not participate because of this.

There were six people who gave the application permission to collect data, but two of them gave permission one week after downloading the app and one stopped after one week, so there are only three where data have been collected during two whole weeks. This is obviously not enough data to draw any conclusions, but the

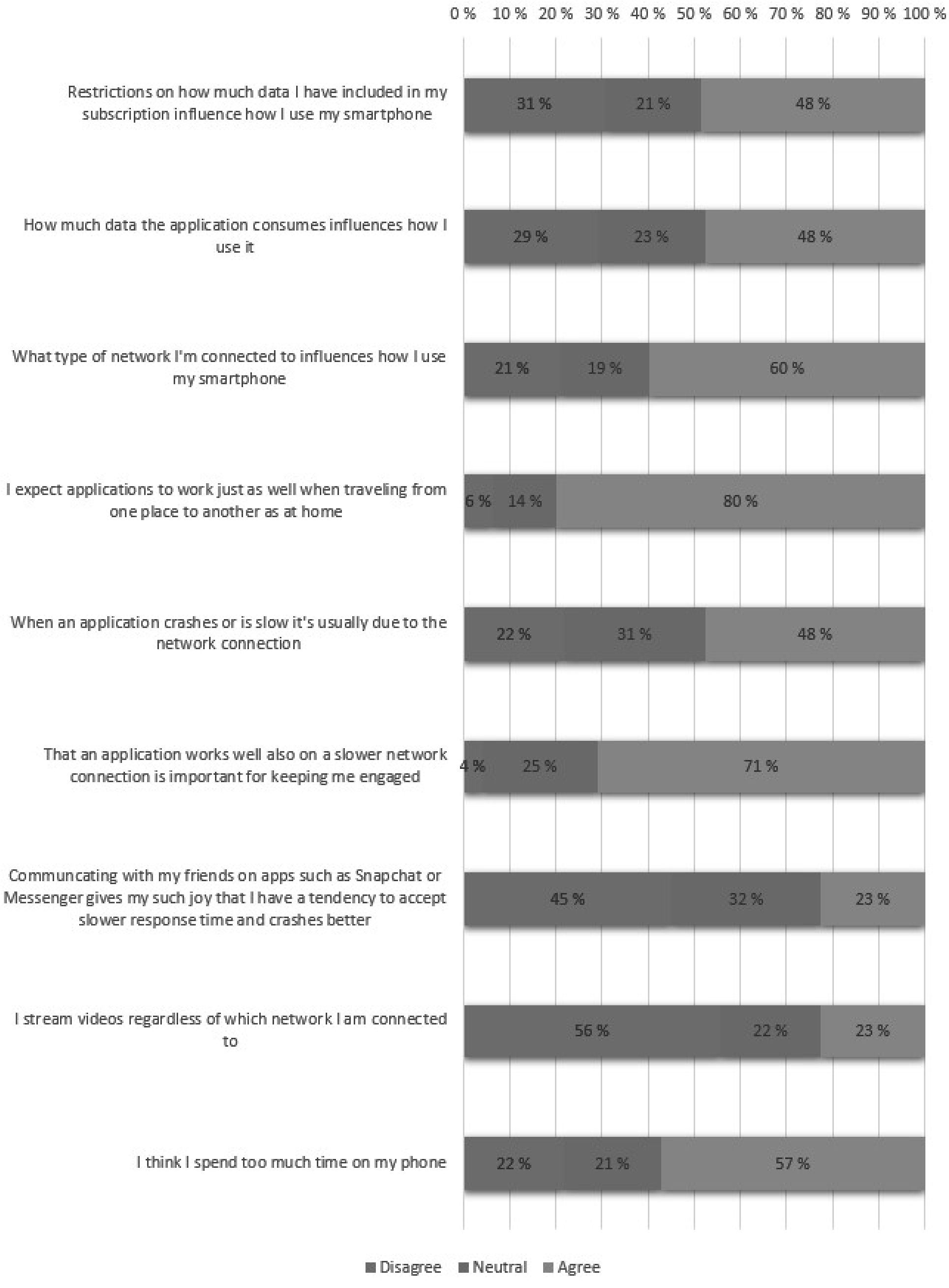

Figure 4.8: View on statements in percent

	MobileDNA	Survey
Average user	3h 4min	
U1	2h 39min	4-5h
U2	2h 37min	1-2h
U3	3h 50min	4-5h

Table 4.3: Average usage of smartphone each day

results and the connection to the survey will be presented.

4.2.1 MobileDNA

The MobileDNA application provides average numbers for some of the data collected by taking the average of every person who are using the application. The parameters of data collected which is used for these computations is shown in table 2.4. The three users as well as the average user reported by mobileDNA are represented in table 4.3, with numbers from the data collection compared to the answers given in the survey. This allows to check for potential discrepancies between what respondents say they do and what they actually do.

The results show that respondent 2 (U2) is using the smartphone more than he/she reported through the survey, whilst it's the opposite for the other two users. It's the two that considers themselves as heavy users who have used less time on their phone than they reported through the survey. Time spent on the phone each day varies very much though, as can be seen in figure 4.9.

MobileDNA also tracks what applications are used and gives an overview of the most used applications. An example from U1 is seen in figure 4.10. One of the questions in the survey was what application you have used the most during the last two weeks, and the answer from U2 was Spotify. However, this application is not even on the top five used applications. This illustrates how important it is to shed light on this from different perspectives, e.g self reporting ***and*** logging of behavior.

The application gives the users a DNA for each day which shows all applications that have been used and when, as well as notifications received from the different applications. This gives the user a thorough overview of everything that's happening on their phone, and can also give the user valuable insights. An example from U1 on a random day are given in figure 4.11.

We can see from the figure that U1 used Viaplay to stream videos this day. After asking the finishing questions to this participant it turned out that this is not usual. The participant told that this was because of the handball world cup which was

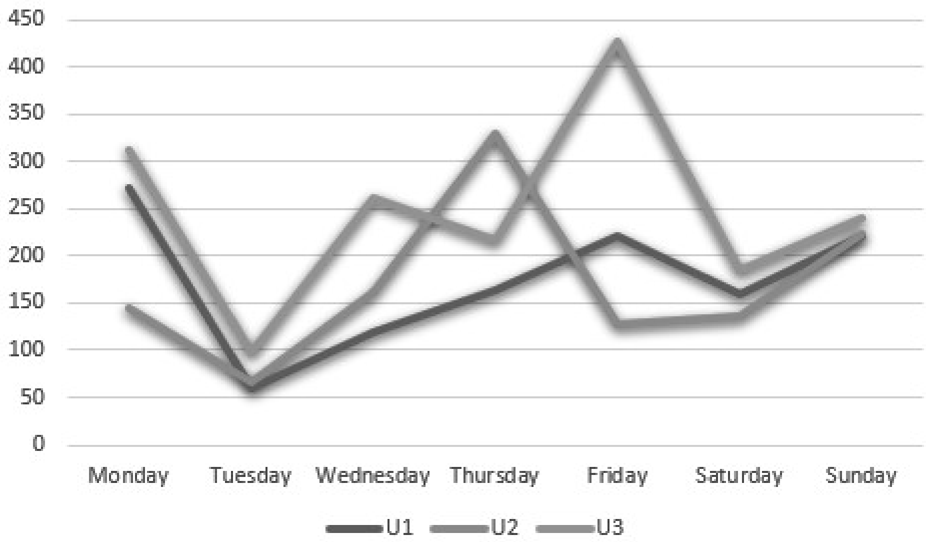

Figure 4.9: Usage each day during the last week (in minutes)

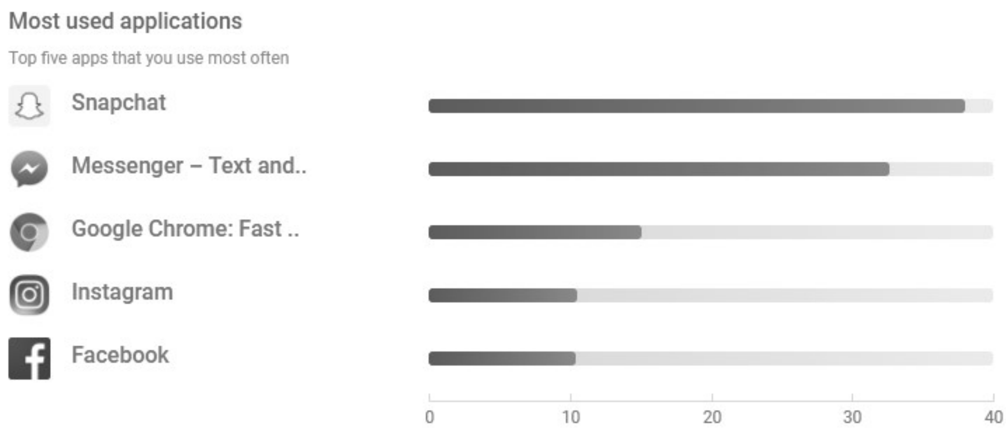

Figure 4.10: Overview of the most used applications (U1)

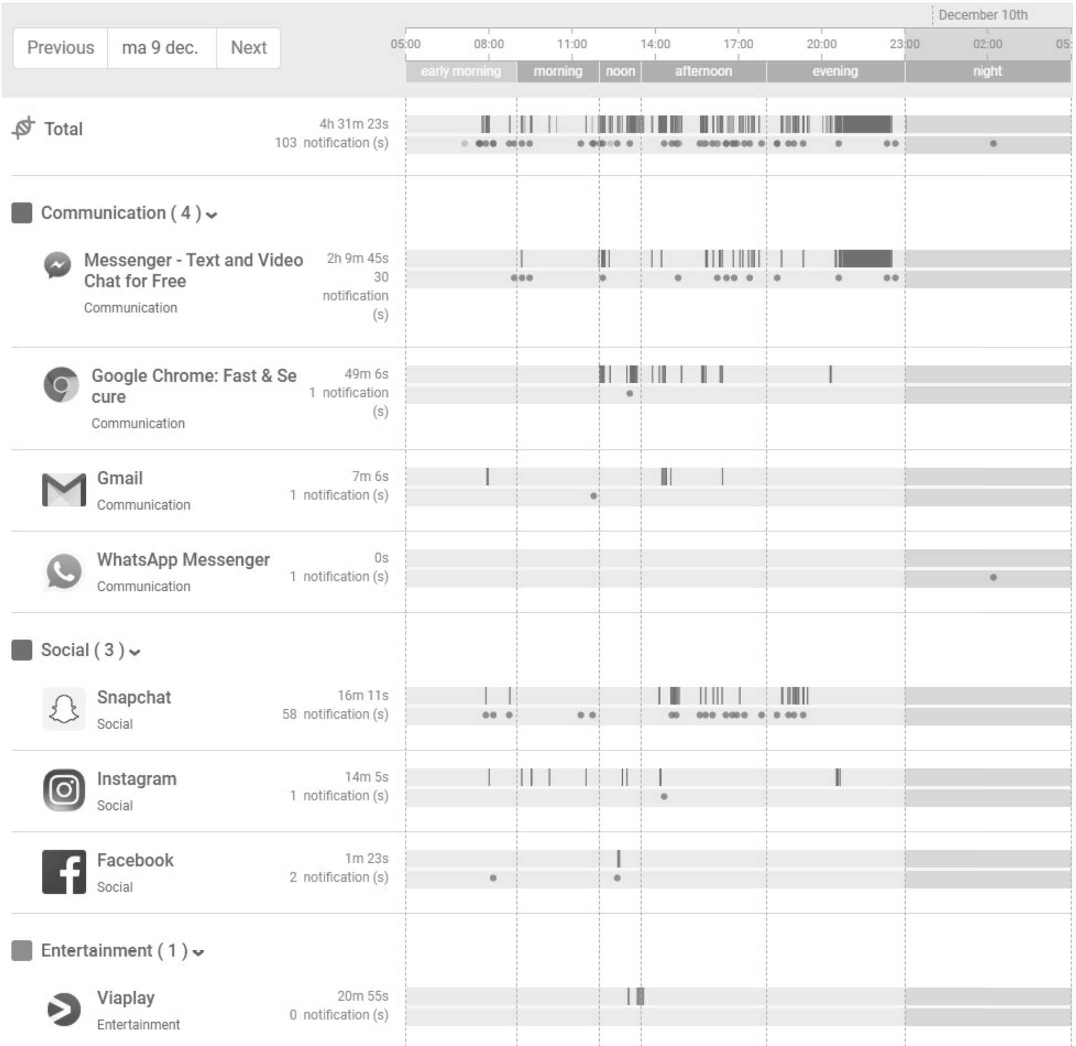

Figure 4.11: Example of DNA from one day, as presented in mobileDNA (U1)

broadcasted at that time. During the survey this participant said that streaming of videos has only been done on WiFi during the last two weeks, and preferred not to stream videos when connected to mobile network. However, the session on this day was done on a mobile network as the game being showed was of huge interest for the participant. The application was used when sitting on the bus, and the participant stated in the survey that it was expected that applications would work just as well when traveling from one place to another as at home. This was also the experience when streaming video that day, and as the participant was taking the bus in the middle of Trondheim city it's expected that it was 4G coverage during the whole session. For this particular episode it would have been interesting to actually see the actual network parameters, which may be possible in the near future.

During the two weeks of collecting data, questions about whether they have had any negative experiences related to network parameters were sent out, however none of the participants answered to these questions. It's hard to say whether this was because they actually didn't have any negative experiences, or because they just didn't take the time to answer the questions. However, at the end another email was sent out with several questions. They included questions about whether they had any negative experiences during the last two weeks and if they had been using their phone differently during this period. All three participants said they had used their phone as usual, and said that they had no negative experiences. The participants also claimed that they had forgotten about the application tracking their phone, which may be of great value to later studies.

Chapter 5
Discussion

In this thesis several different influence factors and other topics related to QoE have been presented. The focus has been on how network parameters may influence how people use their phones. This chapter discusses the results presented in chapter 4 and puts them in a broader context of theory presented in chapter 2. The research questions will be discussed separately throughout this chapter based on the results. At the end of the chapter reflections on the limitations of this research are presented.

5.1 Review of QoE and its relation to network parameters

As stated in chapter 2 QoE is a concept that are still evolving, and there are a number of challenges faced when trying to get a credible result. In general, it is shown that the users' expectations are one of the main factors that contributes to perceived QoE, and since subjective and inner feelings are hard to measure there is always some uncertainty involved. Studies also shows that UE are strongly correlated with QoE, and factors that contributes to UE are therefore also important factors to take into consideration when wanting to achieve a higher QoE.

When looking at previous studies done on the field in section 2.3.2 we see that there are a number of different factors that influences QoE. The most important factors and its relation to network parameters are shown in table 5.1.

Findings from these studies shows that expectations is an important factor, which may be influenced by if the user is connected to WiFi, 4G, 3G and so on. This is also affected by the location the applications are being used, as this is strongly linked to the network available. Research also shows that some people do not expect applications to work just as well when traveling from one place to another as at home, so expectations related to location can be quite important in relation to perceived QoE. The difference in expectations also affects differences in usage patterns, thus that application usage seems to be very dependent on the type of network and where the user is situated.

Influence Factors		Findings in existing studies	References
Human IF	Low-level		
	High-level	Expectations varies depending on what type of network for instance. May be influenced by previous experiences	[55] [56] [27]
System IF	Content-related		
	Media-related		
	Network-related	Delay and loss of data is very important. Videos buffering for instance	[16] [25]
	Device-related	Processing capabilities of the device	[63]
Context IF	Physical Context	Application usage varies depending on the location of the user. Often because of type of network available	[27] [10]
	Temporal Context		
	Social Context		
	Economic Context	Trade-off between quality and cost	[56]
	Task Context		
	Technical/ Informational Context		

Table 5.1: Influence factors and its relation to network parameters from existing research studies

Even if expectations can vary, delay and loss of data is especially important, as for instance buffering of videos highly influences perceived QoE. Problems related to this can occur for a variety of reasons. In addition to the possible speed and throughput of the network connection there can also be some limitations on the device in use, as they may have different processing capabilities. Possible solutions to this might be to turn down the quality of a video stream for instance, to avoid lagging and buffering. Even if this leads to e.g a lower picture quality, the overall perceived QoE might increase. This is also something that can be done in relation to having less data included in ones mobile subscription, where the user might accept a trade-off between quality and cost.

5.2 Does mobile network type impact how people use their phones?

By looking at the various influence factors presented in chapter 2, we can see which of these factors have emerged during this research. We can also see whether the findings are similar with those found in recent studies.

The main goal of this thesis was to investigate whether mobile usage are influenced by what type of network the user is connected to. As found in literature this can be both because of delays as well as because of economical reasons. The research was mainly done by conducting a survey where technical factors such as type of network were widely investigated. The results showed a lot of different things that people find negative in regards to using different type of applications, and the issues mentioned were related both to technical and non-technical factors. We will now take a look at the results and see which similarities there are between them and the literature, by connecting them to the overview in table 2.1.

The survey started by asking the participants where they have used different type of applications and on what type of network they are used, considering the last two weeks. Mobile coverage is well developed in Norway and most people have access to fast 4G network almost anywhere they are. This means that most applications work just as well almost anywhere they go, at least when they live in a big city. The results showed that generally, the respondents didn't really care what type of network they were connected to when using applications. The exception was video streaming which almost 40 % prefers to not use when connected to mobile networks. There can be several reasons for this, such as slow network connection or price of using that many GB's. However, tests shows that the group of people having less GB's included in their mobile subscription are much more restrictive when it comes to using applications with a heavier data consumption during usage. Streaming videos and video-chat are therefore more vulnerable to the type of subscription the user has.

Next, the participants were asked about aspects related to both positive and negative experiences in open-ended questions. No technical aspects were mentioned to avoid influencing them. The main findings of factors influencing usage in a negative way were presented in table 4.2. A number of factors are none-technical, but the main negative factor in common for all application types were having a bad internet connection. This is understandable as the main findings in regards to having a good experience was that the application runs smoothly. For most applications this is not the case when having a poor internet connection. Bad quality and buffering/lagging, which often comes in relation to a bad internet connection, is considered particularly important for streaming sound/video and video chat. This is perhaps the application types that are most dependent on a fast internet connection as problems caused by this gets very visible to the user. If there is some delay in delivery the user is far more likely to discover it as lag and buffering, which directly influences the sound or picture quality. It is well known that a bad network connection might lead to slow response-time and increased loading time and lagging in use of an application. However, it might be difficult to differentiate between this type of problems that are actually related to the network connection and the ones related to e.g the performance of the application itself. It is therefore of great value to get data about the actual network parameters in relation to a specific negative experience of this type. This might increase the understanding of limitations on a specific type of application versus network limitations, which may be specifically important for application developers. Information on this might give valuable information that can be used also in future applications, to increase the perceived QoE, and decrease the factor of this becoming a negative factor.

Finally, the participants were asked more directly questions linked to technical factors and how important different aspects are for them when using specific type of applications. No significant findings were found in relation to the five factors asked about (stable network, data consumption, response time, security and privacy). Still, there was a tendency towards data consumption being more important when using video streaming applications. As this is the heaviest consumer of GB's out of the application groups it may not be that surprising though. However, the importance of data consumption was not related with how much data was included in the subscription of the respondents. One can say that this contradicts the finding that the group with less data included is more restrictive to streaming videos when connected to mobile networks. Nevertheless, even if you have a lot of GB's included in your subscription, unless you have unlimited use, most people tend to care about how much data the application consumes. Battery consumption may also be a crucial factor, as Ickin stated in his doctorate from 2015 [26]. Applications such as video streaming often consumes a lot of energy when connected to mobile networks which can be a limiting factor, especially when the battery goes beyond a certain point. Even if the findings from Ickin are clear, this was not explicitly mentioned by the participants in this study.

The analysis also showed that if you have less data included in your subscription, it influences how you use your phone. This is not that surprising as it can be expensive to buy extra data and if you want to avoid having to do that, with less data included it's makes sense to be more restrictive. A little surprising though, was that even though those with less data included admitted to use their phone differently on different networks, there were no significant difference between them and those with more data included when it comes to streaming video regardless of type of network they were connected to. However, only 23 % answered yes to that question, which indicates that also people with a lot of GB's included in their subscription are more careful when it comes to this type of applications. This could also be of habit, as there are not that many years ago since use of GB's were much more expensive than today. Today's mobile subscriptions include much more data to a lower price than what was the case earlier (at least in Norway), in addition even if it's still expensive to buy extra data it's much cheaper than before. It might take some time for people to adapt to this, and to no longer be afraid to get huge mobile phone bills from this kind of use.

People in different age-groups also have different views on what is important, as results showed that the older age-groups care less about stable network connections than the younger ones. This is also something that was shown in a previous study conducted by Schmitt et al. in 2017 [57]. Their study shows that the youngest age groups are less influenced by technical factors when it comes to perceived QoE, which if proved true could be important for future studies. To increase the understanding of this, there is a need for more research to gain insight into how age as a human factor plays a role in different situations.

What was a little surprising though, was the difference between genders. Even though the survey showed no significant difference in how much time male and female respondents spend on their phone, there are significantly more women than men that think they spend too much time on their phone. Women are also more careful when it comes to streaming videos regardless of what network they are connected to. Even if these findings are a bit surprising, it reinforces the stereo-type of how women are more critical to them self as well as being more careful and responsible than their opposites.

The results from this study supports results from the previous study by Barmpounakis Wac conducted in 2012. Results from both studies indicates that usage patterns can differ both between different user groups and type of applications. The previous study however, provided results showing that application usage is highly dependent on the user's location. This was not that significant in this research study, so it could be interesting to look further into this. Is this because the study was conducted back in 2012, or are there other factors that may lead to different results.

5.3 Are there specific types of applications that are more vulnerable to network changes than others?

Findings from the survey were quite as expected when it comes to this question. Even if many people don't care what type of network they are connected to when using the different type of applications, one of the application groups stands out. When it comes to streaming of video, most people prefer to not do this when connected to mobile networks. From the open questions in the survey it was clear that buffering and slow applications is one of the main contributors to having a bad QoE. Since most video streaming applications need a higher bandwidth than most other applications, they are more vulnerable to network changes. However, findings show that most people experiences that video streaming works quite well when connected to 4G. As video streaming is also one of the application types that uses most data during usage this is a factor. The limitation then often are connected to the type of subscription the user has, and is especially a factor for those with less data included in their subscription.

Influence Factors		Found?	Comment
Human IF	Low-level	✓	Differences between gender/age
	High-level		
System IF	Content-related	✓	Different type of applications are used differently and have other demands to quality. E.g streaming of video/sound
	Media-related		
	Network-related	✓	Slow network connections and buffering/lagging
	Device-related		
Context IF	Physical Context		No difference in expectations or usage from different locations
	Temporal Context		
	Social Context		
	Economic Context	✓	Type of subscription influences usage
	Task Context		
	Technical/Informational Context		

Table 5.2: Influence factors found in research

This means that it's difficult to distinguish between those who tend not to use video applications on mobile networks because of e.g bad or unstable quality versus those who refrain from doing so for economic reasons. In addition, it is important to keep in mind that the situation in Norway is rather unique with very good coverage. This is also shown by the expectations from the respondents, as there is an expectation towards that applications should work just as well when traveling from one place to another as at home.

5.4 Reflections

There have been some challenges throughout the writing of this thesis, which may have influenced the findings. This section will reflect on the methods being used and some limitations related to the obtained results.

The choice of participants for the survey was limited to people from NTNU as well as people from my network. These are most likely not representative for the society as a whole. However, the goal was not to generalize the findings, but to collect information that could lead to interesting indications on how network type influences application usage, and which may be the basis of future studies. The more respondents, the more accurate results. Because of the limited time for writing this thesis and time taken to receive approval from NSD I only got 125 responses.

One of the things stated in the Methodology chapter (chapter 3), was that the combination of information from survey, data from mobileDNA and a finishing interview would provide a wide specter of information. By combining this information we would get a lot of data on one specific participant that could have been thoroughly analyzed to provide valuable insights.

Since we did not get to gather actual information about e.g. the network type being used, it is more challenging to get more accurate data. This is because it is known that information provided through self-reporting is uncertain, which is also shown in this research (e.g what type of application being used the most, time spent on phone). In addition, the scope of the finishing interviews was much smaller than planned. This was both because of less information from the mobileDNA application to develop valuable questions, as well as limited time because of delay from the developers of the application.

Chapter 6
Conclusion and Future Work

In this master thesis I have investigated whether different network parameters influence application usage on smartphones. The main goal was to investigate whether network parameters such as different network connections influence usage. In addition, if this was the case, to look at if there was any type of applications that is more vulnerable than others to network changes (from a user's point of view).

Findings from the survey and data collection showed many similarities with findings from existing research done in the field. The results showed that one of the main things annoying users are slow applications or network, and applications that lag due to e.g., delay. This was the main thing that came up during the open-ended questions in the survey, and these factors have also been highlighted in previous studies.

As these factors were the ones that especially stood out for most of the participants, it shows that network factors are important. However, this is mostly for heavy-loaded applications as most applications work just as well on 3G as 4G and WiFi, and network coverage is very good in the city of Trondheim where most participants are situated. Many people prefer to not stream videos when connected to a mobile network, but it's not entirely clear whether this is because of bad quality when streaming on mobile networks or whether there are any other factors contributing to this (e.g., no interest/need, battery constraints, aspects related to the context as such). Since the results showed that people with less data included in their subscription is more restrictive on use of heavy-loaded applications when connected to mobile networks, it's hard to say if this is one of the main factors or not.

However, it is clear that network does influence how people use their phone, and there are some type of applications that are more vulnerable than others. Videos and other heavy-loaded applications is used much less when connected to mobile networks than other type of applications. This can be both because these applications require higher throughput which can lead to the application using more time for loading and buffering, as well as the fact that data consumption are much higher which can cause extra costs for the user.

6.1 Future Work

Hopefully this master thesis has contributed to some further insight into what is important for the users to have good experience, and to which extent network parameters may influence usage. These insights are mostly gained from the survey, as mobileDNA didn't deliver tracking of network type as was expected at the start of this thesis. However, this should be implemented in the near future and leads to opportunities for follow-up studies.

As showed in section 4.2, the mobileDNA application presents usage in detail, and if this data could be connected to network parameters such as what type of network the phone is connected to it would provide important insight into usage. Usage patterns in combination with network parameters would be interesting to analyze, as this is currently not something that has been done to a wide extent. Existing approaches in that direction have typically interrupted users to gather feedback, which however entails several challenges and limitations. In my own study, the participants stated that they had forgotten about the application being installed, which is important information. Even though the three participants are not representative, it shows that there is a great potential that many people don't remember having the application installed and thus it does not influence usage. This is important as anything that influences usage in an unintended way creates potential bias in the data collected, and use of mobileDNA for this purpose can therefore be of great value.

The data collection from mobileDNA also highlighted some differences from the self-reporting through the survey. It would be interesting to see if this is a clear tendency, or if the small group of participants in this study differs from the rest of the society. It might be a hypothesis that most people seem to underestimate e.g the time they spend on their phone.

Results from this study highlights how most people (80 %) expect applications to work just as well when traveling from one place to another as at home. However, a study done by Ickin et al. states that there is a higher tolerance for poorer performance when traveling [27]. Ickin's study was done in 2012, and it could be interesting to see if the findings would have been the same today.

The network coverage in Norway is very well developed, and in some ways unique compared to many other countries. Because of this it would be interesting to do the same study in another country with less good network coverage or to do a comparative study across different countries. This would also allow to focus more closely on potential cultural differences.

O'Brien et al. stated that successful technologies are not just usable, they are also important for UE [42]. This is shown in table 2.2. It is therefore important to create engaging technologies, as technological issues might lead to poor QoE and possibly disengagement. It could have been interesting to study how technological issues and network parameters influences UE and QoE, and the relation between those.

The most important factor for a poor perceived QoE is shown to be slow applications/networks. It's hard to say whether an application that has a bad response-time or is lagging is because of the application itself or the network. It could therefore be of great value to use mobileDNA to track the actual network parameters when this has been implemented. The data collected, in conjunction with reports from the user might give important insights into whether a specific incident with a slow application is due to limited network connection or because of the application itself.

The difficulties of knowing whether habits of use is related to mobile subscription or factors such as the mobile network type, could be interesting to research further. However, it might be difficult to remove the economical factor. Even if the participants of a study for instance get a subscription with unlimited data, their habits will most likely not change over night. However, it could have been interesting to find two different group of users with the same background, but which have a different level of GB's included in their subscription. The results from these groups could then be compared and can give some valuable insights into the economical factor.

This study also provides results that indicates differences between different age groups. It could be valuable to further study this, as this could provide valuable information towards the future. The younger age-groups are more or less raised in a digital society, and how and if this will have an impact on older age groups throughout the next decades might be of great value.

It is also important to keep an eye on how expectations and actual use develops over time. Are there any changes? If there is, it could be of great value to understand this pattern to provide better applications and services in the future.

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Appendix A
Survey on Smartphone Usage

NTUU – Trondheim
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Science and Technology

Smartphone Usage

Page 1

Smartphone Usage

This survey on "Smartphone usage" is a part of my master thesis at Norwegian University of Science and Technology (NTNU). The main objective of the survey is to gain a better understanding of:
- How people are using their smartphones
- What influences usage of different applications
- If technical factors influences usage
All answers will be handled anonymous and confidential. It takes about 10 minutes to complete the survey. The project is reported to and approved by NSD (Norwegian Centre for Research Data).

Thank you in advance for your help and if you have any questions, please don't hesitate to contact me:
katarh@ntnu.no
Katarina Hokstad - Master student in Communication Technology, NTNU.

First, a couple of questions about yourself

1. How old are you?*

2. What is your gender?*
   - Female
   - Male
   - Other

3. What is your nationality?*
   - Norwegian
   - Other, please specify

4. What is your current occupation?*
   - Student
   - Unemployed
   - Self-employed
   - Employee
   - Other, please specify

5. What kind of smartphone do you have?
   - Android phone, e.g Samsung Galaxy S8 or newer, Sony Experia XZ1/A1 or newer, Huawei Mate 10/P10 or newer
   - Android phone, older model

- iPhone 8 or newer
- iPhone, older model
- I don't know
- Other, please specify

Smartphone Usage

How do you use your smartphone?

6. Considering the last two weeks, which of the following type of applications have you used on your smartphone? Several answers are possible*

- ☐ Streaming of videos such as Netflix, YouTube
- ☐ Streaming of sound (music, podcasts) such as Spotify
- ☐ Communication through social networks
- ☐ Video chat such as Skype, FaceTime
- ☐ Browser such as Chrome, Safari
- ☐ Real-time applications for travel information such as GoogleMaps, RuterReise or AtB Reise
- ☐ Playing games
- ☐ Mobile banking and mobile e-commerce (purchasing goods)
- ☐ Other, please specify

7. Considering the last two weeks, which type of applications do you think you have used the most?*

- ○ Streaming of videos such as Netflix, YouTube
- ○ Streaming of sound (music, podcasts) such as Spotify
- ○ Communication through social networks
- ○ Video chat such as Skype, FaceTime
- ○ Browser such as Chrome, Safari
- ○ Real-time applications for travel information such as GoogleMaps, RuterReise or AtB Reise
- ○ Playing games
- ○ Mobile banking and mobile e-commerce (purchasing goods)
- ○ Other, please specify

8. Considering the last two weeks, how much time do you think you have spent on your phone (e.g for using applications as the ones above) during an average day?*

- ○ Less than 30 minutes
- ○ 30 minutes up to 1 hour
- ○ More than 1 hour and up to 2 hours
- ○ More than 2 hours and up to 3 hours
- ○ More than 3 hours and up to 4 hours
- ○ More than 4 hours and up to 5 hours
- ○ More than 5 hours and up to 8 hours
- ○ More than 8 hours

9. Considering the last two weeks, how much time do you think you have used on these applications on an average day?*

	No time at all	Less than 30 minutes	30 minutes to 1 hour	1 - 2 hours	2 - 3 hours	3 - 4 hours	4 - 5 hours	5 - 6 hours	6 - 8 hours	More than 8 hours

Streaming of video	○	○	○	○	○	○	○	○	○	○
Streaming of sound	○	○	○	○	○	○	○	○	○	○
Communication through social media	○	○	○	○	○	○	○	○	○	○
Video chat	○	○	○	○	○	○	○	○	○	○
Web-browsing	○	○	○	○	○	○	○	○	○	○
Real-time applications to check travel information	○	○	○	○	○	○	○	○	○	○
Playing games	○	○	○	○	○	○	○	○	○	○
Mobile banking and mobile e-commerce	○	○	○	○	○	○	○	○	○	○

10. Considering the last two weeks, where have you used your smartphone for these types of applications? Several answers are possible*

	At home	At work/school	At the cabin	When traveling from one place to another	Use it wherever I am	I don't use this type of applications
Streaming of video	☐	☐	☐	☐	☐	☐
Streaming of sound	☐	☐	☐	☐	☐	☐
Communication through social media	☐	☐	☐	☐	☐	☐
Video chat	☐	☐	☐	☐	☐	☐
Web-browsing	☐	☐	☐	☐	☐	☐
Real-time applications to check travel information	☐	☐	☐	☐	☐	☐
Playing games	☐	☐	☐	☐	☐	☐
Mobile banking and mobile e-commerce	☐	☐	☐	☐	☐	☐

11. What type of network are you connected to when using these kind of applications? Several answers are possible*

	WiFi	4G (LTE)	3G (H, H+)	2G (EDGE, GPRS, E)	I don't know	I don't use this type of applications
Streaming of video	☐	☐	☐	☐	☐	☐
Streaming of sound	☐	☐	☐	☐	☐	☐
Communication through social media	☐	☐	☐	☐	☐	☐
Video chat	☐	☐	☐	☐	☐	☐
Web-browsing	☐	☐	☐	☐	☐	☐
Real-time						

applications to check travel information	☐	☐	☐	☐	☐	☐
Playing games	☐	☐	☐	☐	☐	☐
Mobile banking and mobile e-commerce	☐	☐	☐	☐	☐	☐

12. I prefer to not use these kinds of application when connected to..*

	Mobile network	WiFi	Doesn't matter what network I'm connected to	I don't use these type of applications
Streaming of video	○	○	○	○
Streaming of sound	○	○	○	○
Communication through social media	○	○	○	○
Video chat	○	○	○	○
Web-browsing	○	○	○	○
Real-time applications to check travel information	○	○	○	○
Playing games	○	○	○	○
Mobile banking and mobile e-commerce	○	○	○	○

13. How much mobile data do you have included in your mobile subscription?*

- ○ Nothing
- ○ Up to 1 GB
- ○ More than 1 GB and up to 2 GB
- ○ More than 2 GB and up to 3 GB
- ○ More than 3 GB and up to 4 GB
- ○ More than 4 GB and up to 6 GB
- ○ More than 6 GB and up to 10 GB
- ○ More than 10 GB and up to 20 GB
- ○ More than 20 GB
- ○ I don't know
- ○ Other, please specify

Smartphone Usage

Application Experience

The questions on this page are not mandatory so it's possible to skip right on to the next section, but would appreciate it if you took your time to answer them.
If you prefer, you can answer the questions in Norwegian.

14. What is important for you to have a good experience when using an application on your smartphone? Please try to be as concrete as possible

15. More specifically, which aspects are important for you to have a good experience with these kind of applications?

Streaming of video

Streaming of sound

Communication through social media

Video chat

Web-browsing

Real-time applications to check travel information

Playing games

Mobile banking and mobile e-commerce

16. We are also interested in better understanding of what contributes to negative experiences. Do you have examples of aspects that influence your experiences with mobile apps in a negative way? Please try to be as concrete as possible.

17. Have you had any negative experiences related to using some of these types of applications? Explain

Streaming of video

Streaming of sound

Communication through social media

Video chat

Web-browsing

Real-time applications to check travel information

Playing games

Mobile banking and mobile e-commerce

18. Can you try to recall one specific negative experience, due to one or more technical issues? What happened and why did it influence your experience in a negative way?

Smartphone Usage

Important Factors

19. To which extent is a stable network connection (un)important for you when using these types of applications?*

	Very Unimportant	Unimportant	Neutral	Important	Very Important
Streaming of video	○	○	○	○	○
Streaming of sound	○	○	○	○	○
Communication through social media	○	○	○	○	○
Video chat	○	○	○	○	○
Web-browsing	○	○	○	○	○
Real-time applications to check travel information	○	○	○	○	○
Playing games	○	○	○	○	○
Mobile banking and mobile e-commerce	○	○	○	○	○

20. To which extent is it (un)important for you how much data the application consumes during usage?*

	Very Unimportant	Unimportant	Neutral	Important	Very Important
Streaming of video	○	○	○	○	○
Streaming of sound	○	○	○	○	○
Communication through social media	○	○	○	○	○
Video chat	○	○	○	○	○
Web-browsing	○	○	○	○	○
Real-time applications to check travel information	○	○	○	○	○
Playing games	○	○	○	○	○
Mobile banking and mobile e-commerce	○	○	○	○	○

21. To which extent is the response time (un)important for you when using these types of applications?*

The time it takes from an action till a reaction in the app

	Very Unimportant	Unimportant	Neutral	Important	Very Important
Streaming of video					
Streaming of sound					
Communication through social media					
Video chat					
Web-browsing					
Real-time applications to check travel information					
Playing games					
Mobile banking and mobile e-commerce					

22. To which extent is security (un)important for you when using these types of applications?*

E.g to ensure that no other parts can get access to your information and data without your permission

	Very Unimportant	Unimportant	Neutral	Important	Very Important
Streaming of video					
Streaming of sound					
Communication through social media					
Video chat					
Web-browsing					
Real-time applications to check travel information					
Playing games					
Mobile banking and mobile e-commerce					

23. To which extent is privacy (un)important for you when using these types of applications?*

E.g that your personal information remains private, that you can decide on privacy settings yourself

	Very Unimportant	Unimportant	Neutral	Important	Very Important
Streaming of video					
Streaming of sound					

Communication through social media	○	○	○	○	○
Video chat	○	○	○	○	○
Web-browsing	○	○	○	○	○
Real-time applications to check travel information	○	○	○	○	○
Playing games	○	○	○	○	○
Mobile banking and mobile e-commerce	○	○	○	○	○

24. Below are a number of final statements related to how you use your mobile apps and which factors play role. Please indicate to which extent you (dis)agree with them.*

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Restrictions on how much data I have included in my subscription influence how I use my smartphone	○	○	○	○	○
How much data the application consumes influences how I use it	○	○	○	○	○
What type of network I'm connected to influences how I use my smartphone	○	○	○	○	○
I expect applications to work just as well when traveling from one place to another as at home	○	○	○	○	○
When an application crashes or is slow it's usually due to the network connection	○	○	○	○	○
That an application works well also on a slower network connection is important for keeping me engaged	○	○	○	○	○
Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	○	○	○	○	○
I stream videos regardless of which network I am connected to	○	○	○	○	○
I think I spend too much time on my phone	○	○	○	○	○

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Smartphone Usage

Page 5

Do you want to participate further?

If you have an android smartphone you can also participate further. You can get insight into how you use your smartphone by downloading an application on yor phone from Google Play. This application gives you an overview of how you use your phone and gives you a "diagnosis" on your use. It does not monitor any content on your phone, but e.g which applications are in use, time spent on each application. The information will be used anonymously in the master thesis. If this sounds interesting you will receive an email about the process forward.

Thanks a lot for participating!

25. Do you want to participate and get insight into how you use your smartphone?*

-- Please Select --

26. E-mail*

Appendix B
Confirmation from NSD

N

NSD Personvern

01.11.2019 11:34

Det innsendte meldeskjemaet med referansekode 225471 er nå vurdert av NSD.

Følgende vurdering er gitt:

Det er vår vurdering at behandlingen av personopplysninger i prosjektet vil være i samsvar med personvernlovgivningen så fremt den gjennomføres i tråd med det som er dokumentert i meldeskjemaet den 1.11.2019 med vedlegg. Behandlingen kan starte.

MELD VESENTLIGE ENDRINGER
Dersom det skjer vesentlige endringer i behandlingen av personopplysninger, kan det være nødvendig å melde dette til NSD ved å oppdatere meldeskjemaet. Før du melder inn en endring, oppfordrer vi deg til å lese om hvilke type endringer det er nødvendig å melde: nsd.no/personvernombud/meld_prosjekt/meld_endringer.html

Du må vente på svar fra NSD før endringen gjennomføres.

TYPE OPPLYSNINGER OG VARIGHET
Prosjektet vil behandle alminnelige kategorier av personopplysninger frem til 31.12.2019.

LOVLIG GRUNNLAG
Prosjektet vil innhente samtykke fra de registrerte til behandlingen av personopplysninger. Vår vurdering er at prosjektet legger opp til et samtykke i samsvar med kravene i art. 4 og 7, ved at det er en frivillig, spesifikk, informert og utvetydig bekreftelse som kan dokumenteres, og som den registrerte kan trekke tilbake. Lovlig grunnlag for behandlingen vil dermed være den registrertes samtykke, jf. personvernforordningen art. 6 nr. 1 bokstav a.

PERSONVERNPRINSIPPER
NSD vurderer at den planlagte behandlingen av personopplysninger vil følge prinsippene i personvernforordningen om:

- lovlighet, rettferdighet og åpenhet (art. 5.1 a), ved at de registrerte får tilfredsstillende informasjon om og samtykker til behandlingen
- formålsbegrensning (art. 5.1 b), ved at personopplysninger samles inn for spesifikke, uttrykkelig angitte og berettigede formål, og ikke viderebehandles til nye uforenlige formål
- dataminimering (art. 5.1 c), ved at det kun behandles opplysninger som er adekvate, relevante og nødvendige for formålet med prosjektet
- lagringsbegrensning (art. 5.1 e), ved at personopplysningene ikke lagres lengre enn nødvendig for å oppfylle formålet

DE REGISTRERTES RETTIGHETER
Så lenge de registrerte kan identifiseres i datamaterialet vil de ha følgende rettigheter: åpenhet (art. 12), informasjon (art. 13), innsyn (art. 15), retting (art. 16), sletting (art. 17), begrensning (art. 18), underretning (art. 19), dataportabilitet (art. 20).

NSD vurderer at informasjonen som de registrerte vil motta oppfyller lovens krav til form og innhold, jf. art. 12.1 og art. 13.

Vi minner om at hvis en registrert tar kontakt om sine rettigheter, har behandlingsansvarlig institusjon plikt til å svare innen en måned.

FØLG DIN INSTITUSJONS RETNINGSLINJER
NSD legger til grunn at behandlingen oppfyller kravene i personvernforordningen om riktighet (art. 5.1 d), integritet og konfidensialitet (art. 5.1. f) og sikkerhet (art. 32).

SelectSurvey er databehandler i prosjektet. NSD legger til grunn at behandlingen oppfyller kravene til bruk av databehandler, jf. art 28 og 29.

For å forsikre dere om at kravene oppfylles, må dere følge interne retningslinjer og eventuelt rådføre dere med behandlingsansvarlig institusjon.

OPPFØLGING AV PROSJEKTET
NSD vil følge opp ved planlagt avslutning for å avklare om behandlingen av personopplysningene er avsluttet.

Lykke til med prosjektet!

Kontaktperson hos NSD: Håkon J. Tranvåg

Tlf. Personverntjenester: 55 58 21 17 (tast 1)

Appendix C

E-mail to Participants MobileDNA

Katarina Hokstad <katarina.hokstad@gmail.com> søn. 24. nov., 17:08

til blindkopi: [redacted] blindkopi: [redacted] blindkopi: [redacted] blindkopi: [redacted] blindkopi: [redacted],

Hi,
Thanks a lot for wanting to participate further on getting data for my master thesis.

What you have to do is to install the app mobileDNA: https://play.google.com/store/apps/details?id=be.ugent.mobiledna&hl=en_US

After you have installed it you choose the option "I have a ResearchID", and follow the steps further. The researchID that you have to put in is: MT_KH
After this you have to allow mobileDNA to track other apps on your device. I would prefer if you kept the app on your phone for two weeks, but you can choose to interrupt and uninstall the app at any time.

Thanks a lot, and please ask if you have any questions.

Best regards,
Katarina Hokstad

Appendix D
Selection of Results from SPSS

Crosstabs

Used last two weeks: Streaming of video * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.801[a]	2	.149
Likelihood Ratio	3.721	2	.156
Linear-by-Linear Association	2.745	1	.098
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 13,23.

Used last two weeks: Streaming of sound * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	30.065[a]	2	.000
Likelihood Ratio	28.725	2	.000
Linear-by-Linear Association	21.750	1	.000
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 7,10.

Used last two weeks: Social networks * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	13.569[a]	2	.001
Likelihood Ratio	12.735	2	.002
Linear-by-Linear Association	9.816	1	.002
N of Valid Cases	124		

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is 3,55.

Used last two weeks: Video chat * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.066[a]	2	.356
Likelihood Ratio	2.098	2	.350
Linear-by-Linear Association	2.017	1	.156
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 13,23.

Used last two weeks: Browsers * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.390[a]	2	.823
Likelihood Ratio	.375	2	.829
Linear-by-Linear Association	.233	1	.629
N of Valid Cases	124		

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is 2,26.

Used last two weeks: Real-time apps * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.908[a]	2	.234
Likelihood Ratio	2.932	2	.231
Linear-by-Linear Association	.860	1	.354
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 6,13.

Used last two weeks: games * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.032[a]	2	.984
Likelihood Ratio	.032	2	.984
Linear-by-Linear Association	.000	1	1.000
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 13,23.

Used last two weeks: Mobile banking/e-commerce * Age group - thre e groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.565[a]	2	.062
Likelihood Ratio	6.198	2	.045
Linear-by-Linear Association	1.277	1	.259
N of Valid Cases	124		

a. 3 cells (50,0%) have expected count less than 5. The minimum expected count is 3,87.

Crosstabs

Time spent on phone last two weeks - comp * Age group - three groups Crosstabulation

			Age group - three ...	
			<=28	29-35
Time spent on phone last two weeks - comp	Less than 1h	Count	0	6
		Expected Count	4.8	5.3
		% within Time spent on phone last two weeks - comp	0.0%	40.0%
		% within Age group - three groups	0.0%	13.6%
		% of Total	0.0%	4.8%
		Standardized Residual	-2.2	.3
	1h-2h	Count	9	8
		Expected Count	8.7	9.6
		% within Time spent on phone last two weeks - comp	33.3%	29.6%
		% within Age group - three groups	22.5%	18.2%
		% of Total	7.3%	6.5%
		Standardized Residual	.1	-.5
	More than 2h	Count	31	30
		Expected Count	26.5	29.1
		% within Time spent on phone last two weeks - comp	37.8%	36.6%
		% within Age group - three groups	77.5%	68.2%
		% of Total	25.0%	24.2%
		Standardized Residual	.9	.2
Total		Count	40	44
		Expected Count	40.0	44.0
		% within Time spent on phone last two weeks - comp	32.3%	35.5%
		% within Age group - three groups	100.0%	100.0%
		% of Total	32.3%	35.5%

Time spent on phone last two weeks - comp * Age group - three groups Crosstabulation

			Age group - ..	
			>=36	Total
Time spent on phone last two weeks - comp	Less than 1h	Count	9	15
		Expected Count	4.8	15.0
		% within Time spent on phone last two weeks - comp	60.0%	100.0%
		% within Age group - three groups	22.5%	12.1%
		% of Total	7.3%	12.1%
		Standardized Residual	1.9	
	1h-2h	Count	10	27
		Expected Count	8.7	27.0
		% within Time spent on phone last two weeks - comp	37.0%	100.0%
		% within Age group - three groups	25.0%	21.8%
		% of Total	8.1%	21.8%
		Standardized Residual	.4	
	More than 2h	Count	21	82
		Expected Count	26.5	82.0
		% within Time spent on phone last two weeks - comp	25.6%	100.0%
		% within Age group - three groups	52.5%	66.1%
		% of Total	16.9%	66.1%
		Standardized Residual	-1.1	
Total		Count	40	124
		Expected Count	40.0	124.0
		% within Time spent on phone last two weeks - comp	32.3%	100.0%
		% within Age group - three groups	100.0%	100.0%
		% of Total	32.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.899[a]	4	.028
Likelihood Ratio	15.055	4	.005
Linear-by-Linear Association	9.129	1	.003
N of Valid Cases	124		

a. 2 cells (22,2%) have expected count less than 5. The minimum expected count is 4,84.

Crosstabs

Time spent on avg. day: Video streaming - comp * Age group - three groups

Crosstab

			Age group - three ...	
			<=28	29-35
Time spent on avg. day: Video streaming - comp	No time at all	Count	5	6
		Expected Count	8.7	9.6
		% within Time spent on avg. day: Video streaming - comp	18.5%	22.2%
		% within Age group - three groups	12.5%	13.6%
		% of Total	4.0%	4.8%
		Standardized Residual	-1.3	-1.2
	Less than 30min	Count	17	25
		Expected Count	19.0	20.9
		% within Time spent on avg. day: Video streaming - comp	28.8%	42.4%
		% within Age group - three groups	42.5%	56.8%
		% of Total	13.7%	20.2%
		Standardized Residual	-.5	.9
	30min-1h	Count	9	6
		Expected Count	5.5	6.0
		% within Time spent on avg. day: Video streaming - comp	52.9%	35.3%

Crosstab

			Age group - ..	
			>=36	Total
Time spent on avg. day: Video streaming - comp	No time at all	Count	16	27
		Expected Count	8.7	27.0
		% within Time spent on avg. day: Video streaming - comp	59.3%	100.0%
		% within Age group - three groups	40.0%	21.8%
		% of Total	12.9%	21.8%
		Standardized Residual	2.5	
	Less than 30min	Count	17	59
		Expected Count	19.0	59.0
		% within Time spent on avg. day: Video streaming - comp	28.8%	100.0%
		% within Age group - three groups	42.5%	47.6%
		% of Total	13.7%	47.6%
		Standardized Residual	-.5	
	30min-1h	Count	2	17
		Expected Count	5.5	17.0
		% within Time spent on avg. day: Video streaming - comp	11.8%	100.0%

Crosstab

			Age group - three ...	
			<=28	29-35
		% within Age group - three groups	22.5%	13.6%
		% of Total	7.3%	4.8%
		Standardized Residual	1.5	.0
	More than 1h	Count	9	7
		Expected Count	6.8	7.5
		% within Time spent on avg. day: Video streaming - comp	42.9%	33.3%
		% within Age group - three groups	22.5%	15.9%
		% of Total	7.3%	5.6%
		Standardized Residual	.9	-.2
Total		Count	40	44
		Expected Count	40.0	44.0
		% within Time spent on avg. day: Video streaming - comp	32.3%	35.5%
		% within Age group - three groups	100.0%	100.0%
		% of Total	32.3%	35.5%

Crosstab

			Age group - ..	
			>=36	Total
		% within Age group - three groups	5.0%	13.7%
		% of Total	1.6%	13.7%
		Standardized Residual	-1.5	
	More than 1h	Count	5	21
		Expected Count	6.8	21.0
		% within Time spent on avg. day: Video streaming - comp	23.8%	100.0%
		% within Age group - three groups	12.5%	16.9%
		% of Total	4.0%	16.9%
		Standardized Residual	-.7	
Total		Count	40	124
		Expected Count	40.0	124.0
		% within Time spent on avg. day: Video streaming - comp	32.3%	100.0%
		% within Age group - three groups	100.0%	100.0%
		% of Total	32.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.935[a]	6	.014
Likelihood Ratio	15.508	6	.017
Linear-by-Linear Association	8.680	1	.003
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,48.

Time spent on avg. day: Sound streaming - comp * Age group - three groups

Crosstab

			Age group - three ...	
			<=28	29-35
Time spent on avg. day: Sound streaming - comp	No time at all	Count	1	1
		Expected Count	4.5	5.0
		% within Time spent on avg. day: Sound streaming - comp	7.1%	7.1%
		% within Age group - three groups	2.5%	2.3%
		% of Total	0.8%	0.8%
		Standardized Residual	-1.7	-1.8
	Less than 30min	Count	2	8
		Expected Count	6.5	7.1
		% within Time spent on avg. day: Sound streaming - comp	10.0%	40.0%
		% within Age group - three groups	5.0%	18.2%
		% of Total	1.6%	6.5%
		Standardized Residual	-1.8	.3
	30min-1h	Count	9	12
		Expected Count	8.7	9.6
		% within Time spent on avg. day: Sound streaming - comp	33.3%	44.4%
		% within Age group - three groups	22.5%	27.3%
		% of Total	7.3%	9.7%
		Standardized Residual	.1	.8
	1h-2h	Count	10	12
		Expected Count	9.0	9.9
		% within Time spent on avg. day: Sound streaming - comp	35.7%	42.9%
		% within Age group - three groups	25.0%	27.3%
		% of Total	8.1%	9.7%
		Standardized Residual	.3	.7
	More than 2h	Count	18	11
		Expected Count	11.3	12.4
		% within Time spent on avg. day: Sound streaming - comp	51.4%	31.4%

Crosstab

			Age group - ..	
			>=36	Total
Time spent on avg. day: Sound streaming - comp	No time at all	Count	12	14
		Expected Count	4.5	14.0
		% within Time spent on avg. day: Sound streaming - comp	85.7%	100.0%
		% within Age group - three groups	30.0%	11.3%
		% of Total	9.7%	11.3%
		Standardized Residual	3.5	
	Less than 30min	Count	10	20
		Expected Count	6.5	20.0
		% within Time spent on avg. day: Sound streaming - comp	50.0%	100.0%
		% within Age group - three groups	25.0%	16.1%
		% of Total	8.1%	16.1%
		Standardized Residual	1.4	
	30min-1h	Count	6	27
		Expected Count	8.7	27.0
		% within Time spent on avg. day: Sound streaming - comp	22.2%	100.0%
		% within Age group - three groups	15.0%	21.8%
		% of Total	4.8%	21.8%
		Standardized Residual	-.9	
	1h-2h	Count	6	28
		Expected Count	9.0	28.0
		% within Time spent on avg. day: Sound streaming - comp	21.4%	100.0%
		% within Age group - three groups	15.0%	22.6%
		% of Total	4.8%	22.6%
		Standardized Residual	-1.0	
	More than 2h	Count	6	35
		Expected Count	11.3	35.0
		% within Time spent on avg. day: Sound streaming - comp	17.1%	100.0%

Crosstab

		Age group - three ...	
		<=28	29-35
	% within Age group - three groups	45.0%	25.0%
	% of Total	14.5%	8.9%
	Standardized Residual	2.0	-.4
Total	Count	40	44
	Expected Count	40.0	44.0
	% within Time spent on avg. day: Sound streaming - comp	32.3%	35.5%
	% within Age group - three groups	100.0%	100.0%
	% of Total	32.3%	35.5%

Crosstab

		Age group - ..	
		>=36	Total
	% within Age group - three groups	15.0%	28.2%
	% of Total	4.8%	28.2%
	Standardized Residual	-1.6	
Total	Count	40	124
	Expected Count	40.0	124.0
	% within Time spent on avg. day: Sound streaming - comp	32.3%	100.0%
	% within Age group - three groups	100.0%	100.0%
	% of Total	32.3%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	33.089[a]	8	.000
Likelihood Ratio	32.945	8	.000
Linear-by-Linear Association	23.107	1	.000
N of Valid Cases	124		

a. 3 cells (20,0%) have expected count less than 5. The minimum expected count is 4,52.

Time spent on avg. day: Social media - comp * Age group - three gro ups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.799[a]	8	.213
Likelihood Ratio	10.572	8	.227
Linear-by-Linear Association	3.099	1	.078
N of Valid Cases	124		

a. 3 cells (20,0%) have expected count less than 5. The minimum expected count is 2,26.

Time spent on avg. day: Browsing - comp * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.721[a]	8	.164
Likelihood Ratio	12.266	8	.140
Linear-by-Linear Association	2.773	1	.096
N of Valid Cases	124		

a. 3 cells (20,0%) have expected count less than 5. The minimum expected count is ,97.

Time spent on avg. day: Mobile banking - comp * Age group - three g roups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.641[a]	4	.457
Likelihood Ratio	3.852	4	.426
Linear-by-Linear Association	.000	1	1.000
N of Valid Cases	124		

a. 3 cells (33,3%) have expected count less than 5. The minimum expected count is 2,90.

Crosstabs

Time spent on avg. day: Video streaming - comp * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.117[a]	3	.773
Likelihood Ratio	1.118	3	.773
Linear-by-Linear Association	.403	1	.526
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 8,23.

Time spent on avg. day: Sound streaming - comp * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.121[a]	4	.714
Likelihood Ratio	2.128	4	.712
Linear-by-Linear Association	1.191	1	.275
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 6,77.

Time spent on avg. day: Social media - comp * Gender

Crosstab

			Gender	
			Female	Male
Time spent on avg. day: Social media - comp	No time at all	Count	0	7
		Expected Count	3.6	3.4
		% within Time spent on avg. day: Social media - comp	0.0%	100.0%
		% within Gender	0.0%	11.7%
		% of Total	0.0%	5.6%
		Standardized Residual	-1.9	2.0
	Less than 30min	Count	11	18
		Expected Count	15.0	14.0
		% within Time spent on avg. day: Social media - comp	37.9%	62.1%
		% within Gender	17.2%	30.0%
		% of Total	8.9%	14.5%
		Standardized Residual	-1.0	1.1
	30min-1h	Count	21	16
		Expected Count	19.1	17.9
		% within Time spent on avg. day: Social media - comp	56.8%	43.2%
		% within Gender	32.8%	26.7%
		% of Total	16.9%	12.9%
		Standardized Residual	.4	-.4
	1h-2h	Count	14	10
		Expected Count	12.4	11.6
		% within Time spent on avg. day: Social media - comp	58.3%	41.7%
		% within Gender	21.9%	16.7%
		% of Total	11.3%	8.1%
		Standardized Residual	.5	-.5
	More than 2h	Count	18	9
		Expected Count	13.9	13.1

Crosstab

			Total
Time spent on avg. day: Social media - comp	No time at all	Count	7
		Expected Count	7.0
		% within Time spent on avg. day: Social media - comp	100.0%
		% within Gender	5.6%
		% of Total	5.6%
		Standardized Residual	
	Less than 30min	Count	29
		Expected Count	29.0
		% within Time spent on avg. day: Social media - comp	100.0%
		% within Gender	23.4%
		% of Total	23.4%
		Standardized Residual	
	30min-1h	Count	37
		Expected Count	37.0
		% within Time spent on avg. day: Social media - comp	100.0%
		% within Gender	29.8%
		% of Total	29.8%
		Standardized Residual	
	1h-2h	Count	24
		Expected Count	24.0
		% within Time spent on avg. day: Social media - comp	100.0%
		% within Gender	19.4%
		% of Total	19.4%
		Standardized Residual	
	More than 2h	Count	27
		Expected Count	27.0

Crosstab

		Gender	
		Female	Male
	% within Time spent on avg. day: Social media - comp	66.7%	33.3%
	% within Gender	28.1%	15.0%
	% of Total	14.5%	7.3%
	Standardized Residual	1.1	-1.1
Total	Count	64	60
	Expected Count	64.0	60.0
	% within Time spent on avg. day: Social media - comp	51.6%	48.4%
	% within Gender	100.0%	100.0%
	% of Total	51.6%	48.4%

Crosstab

		Total
	% within Time spent on avg. day: Social media - comp	100.0%
	% within Gender	21.8%
	% of Total	21.8%
	Standardized Residual	
Total	Count	124
	Expected Count	124.0
	% within Time spent on avg. day: Social media - comp	100.0%
	% within Gender	100.0%
	% of Total	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	12.916[a]	4	.012
Likelihood Ratio	15.687	4	.003
Linear-by-Linear Association	9.719	1	.002
N of Valid Cases	124		

a. 2 cells (20,0%) have expected count less than 5. The minimum expected count is 3,39.

Time spent on avg. day: Browsing - comp * Gender

Crosstab

			Gender	
			Female	Male
Time spent on avg. day: Browsing - comp	No time at all	Count	3	0
		Expected Count	1.5	1.5
		% within Time spent on avg. day: Browsing - comp	100.0%	0.0%
		% within Gender	4.7%	0.0%
		% of Total	2.4%	0.0%
		Standardized Residual	1.2	-1.2
	Less than 30min	Count	15	18
		Expected Count	17.0	16.0
		% within Time spent on avg. day: Browsing - comp	45.5%	54.5%
		% within Gender	23.4%	30.0%
		% of Total	12.1%	14.5%
		Standardized Residual	-.5	.5
	30min-1h	Count	26	17
		Expected Count	22.2	20.8
		% within Time spent on avg. day: Browsing - comp	60.5%	39.5%
		% within Gender	40.6%	28.3%
		% of Total	21.0%	13.7%
		Standardized Residual	.8	-.8
	1h-2h	Count	8	18
		Expected Count	13.4	12.6

Crosstab

			Total
Time spent on avg. day: Browsing - comp	No time at all	Count	3
		Expected Count	3.0
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	2.4%
		% of Total	2.4%
		Standardized Residual	
	Less than 30min	Count	33
		Expected Count	33.0
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	26.6%
		% of Total	26.6%
		Standardized Residual	
	30min-1h	Count	43
		Expected Count	43.0
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	34.7%
		% of Total	34.7%
		Standardized Residual	
	1h-2h	Count	26
		Expected Count	26.0

Crosstab

			Gender	
			Female	Male
		% within Time spent on avg. day: Browsing - comp	30.8%	69.2%
		% within Gender	12.5%	30.0%
		% of Total	6.5%	14.5%
		Standardized Residual	-1.5	1.5
	More than 2h	Count	12	7
		Expected Count	9.8	9.2
		% within Time spent on avg. day: Browsing - comp	63.2%	36.8%
		% within Gender	18.8%	11.7%
		% of Total	9.7%	5.6%
		Standardized Residual	.7	-.7
Total		Count	64	60
		Expected Count	64.0	60.0
		% within Time spent on avg. day: Browsing - comp	51.6%	48.4%
		% within Gender	100.0%	100.0%
		% of Total	51.6%	48.4%

Crosstab

			Total
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	21.0%
		% of Total	21.0%
		Standardized Residual	
	More than 2h	Count	19
		Expected Count	19.0
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	15.3%
		% of Total	15.3%
		Standardized Residual	
Total		Count	124
		Expected Count	124.0
		% within Time spent on avg. day: Browsing - comp	100.0%
		% within Gender	100.0%
		% of Total	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.200[a]	4	.037
Likelihood Ratio	11.479	4	.022
Linear-by-Linear Association	.101	1	.750
N of Valid Cases	124		

a. 2 cells (20,0%) have expected count less than 5. The minimum expected count is 1,45.

Crosstabs

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.859[a]	2	.088
Likelihood Ratio	4.903	2	.086
Linear-by-Linear Association	4.631	1	.031
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 7,26.

Crosstabs

Notes

Output Created		03-DEC-2019 10:00:47
Comments		
Input	Data	/Users/katriend/Desktop/Dataset_v2_katarina.sav
	Active Dataset	DataSet1
	Filter	<none>
	Weight	<none>
	Split File	<none>
	N of Rows in Working Data File	124
Missing Value Handling	Definition of Missing	User-defined missing values are treated as missing.
	Cases Used	Statistics for each table are based on all the cases with valid data in the specified range(s) for all variables in each table.
Syntax		CROSSTABS /TABLES=Q6.1 Q6.2 Q6.3 Q6.4 Q6.5 Q6.6 Q6.7 Q6.8 Q7 BY Gender /FORMAT=AVALUE TABLES /STATISTICS=CHISQ /CELLS=COUNT EXPECTED ROW COLUMN TOTAL SRESID /COUNT ROUND CELL.
Resources	Processor Time	00:00:00,03
	Elapsed Time	00:00:00,00

Notes

	Dimensions Requested	2
	Cells Available	524245

Used last two weeks: Streaming of video * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.004[a]	1	.951		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.004	1	.951		
Fisher's Exact Test				1.000	.551
Linear-by-Linear Association	.004	1	.951		
N of Valid Cases	124				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 19,84.

b. Computed only for a 2x2 table

Used last two weeks: Streaming of sound * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.490[a]	1	.115		
Continuity Correction[b]	1.803	1	.179		
Likelihood Ratio	2.510	1	.113		
Fisher's Exact Test				.158	.089
Linear-by-Linear Association	2.470	1	.116		
N of Valid Cases	124				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 10,65.

b. Computed only for a 2x2 table

Used last two weeks: Social networks * Gender

Crosstab

			Gender		
			Female	Male	Total
Used last two weeks: Social networks	No	Count	2	9	11
		Expected Count	5.7	5.3	11.0
		% within Used last two weeks: Social networks	18.2%	81.8%	100.0%
		% within Gender	3.1%	15.0%	8.9%
		% of Total	1.6%	7.3%	8.9%
		Standardized Residual	-1.5	1.6	
	Yes	Count	62	51	113
		Expected Count	58.3	54.7	113.0
		% within Used last two weeks: Social networks	54.9%	45.1%	100.0%
		% within Gender	96.9%	85.0%	91.1%
		% of Total	50.0%	41.1%	91.1%
		Standardized Residual	.5	-.5	
Total		Count	64	60	124
		Expected Count	64.0	60.0	124.0
		% within Used last two weeks: Social networks	51.6%	48.4%	100.0%
		% within Gender	100.0%	100.0%	100.0%
		% of Total	51.6%	48.4%	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	5.402[a]	1	.020		
Continuity Correction[b]	4.033	1	.045		
Likelihood Ratio	5.762	1	.016		
Fisher's Exact Test				.026	.021
Linear-by-Linear Association	5.358	1	.021		
N of Valid Cases	124				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,32.

b. Computed only for a 2x2 table

Used last two weeks: Video chat * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	8.965[a]	1	.003		
Continuity Correction[b]	7.858	1	.005		
Likelihood Ratio	9.182	1	.002		
Fisher's Exact Test				.004	.002
Linear-by-Linear Association	8.893	1	.003		
N of Valid Cases	124				

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 19,84.

b. Computed only for a 2x2 table

Used last two weeks: Browsers * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.091[a]	1	.763		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.091	1	.763		
Fisher's Exact Test				1.000	.536
Linear-by-Linear Association	.090	1	.764		
N of Valid Cases	124				

a. 2 cells (50,0%) have expected count less than 5. The minimum expected count is 3,39.

b. Computed only for a 2x2 table

Used most last two weeks * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	15.363[a]	7	.032
Likelihood Ratio	17.931	7	.012
Linear-by-Linear Association	1.043	1	.307
N of Valid Cases	124		

a. 10 cells (62,5%) have expected count less than 5. The minimum expected count is ,48.

Crosstabs

Streaming video at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.075[a]	3	.254
Likelihood Ratio	4.178	3	.243
Linear-by-Linear Association	.594	1	.441
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,55.

Streaming video when traveling from one place to another * How mu ch data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.881[a]	3	.181
Likelihood Ratio	4.408	3	.221
Linear-by-Linear Association	1.934	1	.164
N of Valid Cases	124		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is 1,33.

Streaming video wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.430[a]	3	.330
Likelihood Ratio	3.621	3	.305
Linear-by-Linear Association	.595	1	.441
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,89.

Streaming sound at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.065[a]	3	.045
Likelihood Ratio	8.206	3	.042
Linear-by-Linear Association	.472	1	.492
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,23.

Streaming sound when traveling from one place to another * How mu ch data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.551[a]	3	.671
Likelihood Ratio	1.558	3	.669
Linear-by-Linear Association	.929	1	.335
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,15.

Streaming sound wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.341[a]	3	.148
Likelihood Ratio	5.527	3	.137
Linear-by-Linear Association	.972	1	.324
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,64.

Social media at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.979[a]	3	.577
Likelihood Ratio	1.983	3	.576
Linear-by-Linear Association	.004	1	.948
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,32.

Social media when traveling * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.365[a]	3	.500
Likelihood Ratio	2.386	3	.496
Linear-by-Linear Association	.639	1	.424
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 2,75.

Social media wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.291[a]	3	.731
Likelihood Ratio	1.328	3	.722
Linear-by-Linear Association	.467	1	.495
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 4,44.

Video chat at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.389[a]	3	.496
Likelihood Ratio	2.807	3	.422
Linear-by-Linear Association	.261	1	.610
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,02.

Video chat at work/school * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.156[a]	3	.104
Likelihood Ratio	6.398	3	.094
Linear-by-Linear Association	.230	1	.632
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,80.

Video chat at the cabin * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.632[a]	3	.304
Likelihood Ratio	4.208	3	.240
Linear-by-Linear Association	1.147	1	.284
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,27.

Video chat when traveling * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.117[a]	3	.548
Likelihood Ratio	2.280	3	.516
Linear-by-Linear Association	.006	1	.940
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,09.

Video chat wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	9.357[a]	3	.025
Likelihood Ratio	11.038	3	.012
Linear-by-Linear Association	2.101	1	.147
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,89.

Browsing at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.533[a]	3	.675
Likelihood Ratio	1.545	3	.672
Linear-by-Linear Association	1.441	1	.230
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,50.

Browsing at work/school * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.570[a]	3	.903
Likelihood Ratio	.590	3	.899
Linear-by-Linear Association	.407	1	.523
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 4,08.

Browsing at the cabin * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	4.167[a]	3	.244
Likelihood Ratio	4.652	3	.199
Linear-by-Linear Association	.025	1	.875
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,71.

Browsing when traveling * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.936[a]	3	.817
Likelihood Ratio	.926	3	.819
Linear-by-Linear Association	.928	1	.335
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 2,22.

Browsing wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	2.928[a]	3	.403
Likelihood Ratio	3.172	3	.366
Linear-by-Linear Association	2.062	1	.151
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 4,44.

Real-time apps when traveling * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.482[a]	3	.140
Likelihood Ratio	5.554	3	.135
Linear-by-Linear Association	1.507	1	.220
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,32.

Real-time apps wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.856[a]	3	.277
Likelihood Ratio	4.057	3	.255
Linear-by-Linear Association	1.891	1	.169
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,73.

Playing games at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.674[a]	3	.643
Likelihood Ratio	1.712	3	.634
Linear-by-Linear Association	.972	1	.324
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,64.

Playing games at work/school * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.639[a]	3	.887
Likelihood Ratio	1.076	3	.783
Linear-by-Linear Association	.409	1	.522
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is ,44.

Playing games wherever I am * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.485[a]	3	.323
Likelihood Ratio	3.576	3	.311
Linear-by-Linear Association	3.332	1	.068
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is 1,15.

Mobile banking/e-commerce at home * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.346[a]	3	.718
Likelihood Ratio	1.354	3	.716
Linear-by-Linear Association	.761	1	.383
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,23.

Mobile banking/e-commerce when traveling * How much data included - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.857[a]	3	.836
Likelihood Ratio	.820	3	.845
Linear-by-Linear Association	.067	1	.796
N of Valid Cases	124		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is 1,33.

Mobile banking/e-commerce wherever I am * How much data include d - comp

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.561[a]	3	.087
Likelihood Ratio	6.695	3	.082
Linear-by-Linear Association	6.432	1	.011
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,23.

Crosstabs

Prefer not to stream videos when connected to * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.680[a]	3	.298
Likelihood Ratio	3.730	3	.292
Linear-by-Linear Association	1.729	1	.189
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 8,71.

Prefer not to stream videos when connected to * Data subscription 2 cat

Crosstab

			Data ...
			< 6GB
Prefer not to stream videos when connected to	Mobile network	Count	20
		Expected Count	15.3
		% within Prefer not to stream videos when connected to	45.5%
		% within Data subscription 2cat	46.5%
		% of Total	16.1%
		Standardized Residual	1.2
	WiFi	Count	6
		Expected Count	7.3
		% within Prefer not to stream videos when connected to	28.6%
		% within Data subscription 2cat	14.0%
		% of Total	4.8%
		Standardized Residual	-.5
	Doesnt matter what network Im connected to	Count	7
		Expected Count	14.2
		% within Prefer not to stream videos when connected to	17.1%
		% within Data subscription 2cat	16.3%
		% of Total	5.6%
		Standardized Residual	-1.9
	I don't use these type of apps	Count	10
		Expected Count	6.2

Crosstab

			Data ...
			> 6GB
Prefer not to stream videos when connected to	Mobile network	Count	24
		Expected Count	28.7
		% within Prefer not to stream videos when connected to	54.5%
		% within Data subscription 2cat	29.6%
		% of Total	19.4%
		Standardized Residual	-.9
	WiFi	Count	15
		Expected Count	13.7
		% within Prefer not to stream videos when connected to	71.4%
		% within Data subscription 2cat	18.5%
		% of Total	12.1%
		Standardized Residual	.3
	Doesnt matter what network Im connected to	Count	34
		Expected Count	26.8
		% within Prefer not to stream videos when connected to	82.9%
		% within Data subscription 2cat	42.0%
		% of Total	27.4%
		Standardized Residual	1.4
	I don't use these type of apps	Count	8
		Expected Count	11.8

Crosstab

			Total
Prefer not to stream videos when connected to	Mobile network	Count	44
		Expected Count	44.0
		% within Prefer not to stream videos when connected to	100.0%
		% within Data subscription 2cat	35.5%
		% of Total	35.5%
		Standardized Residual	
	WiFi	Count	21
		Expected Count	21.0
		% within Prefer not to stream videos when connected to	100.0%
		% within Data subscription 2cat	16.9%
		% of Total	16.9%
		Standardized Residual	
	Doesnt matter what network Im connected to	Count	41
		Expected Count	41.0
		% within Prefer not to stream videos when connected to	100.0%
		% within Data subscription 2cat	33.1%
		% of Total	33.1%
		Standardized Residual	
	I don't use these type of apps	Count	18
		Expected Count	18.0

Crosstab

		Data ...
		< 6GB
	% within Prefer not to stream videos when connected to	55.6%
	% within Data subscription 2cat	23.3%
	% of Total	8.1%
	Standardized Residual	1.5
Total	Count	43
	Expected Count	43.0
	% within Prefer not to stream videos when connected to	34.7%
	% within Data subscription 2cat	100.0%
	% of Total	34.7%

Crosstab

		Data ...
		> 6GB
	% within Prefer not to stream videos when connected to	44.4%
	% within Data subscription 2cat	9.9%
	% of Total	6.5%
	Standardized Residual	-1.1
Total	Count	81
	Expected Count	81.0
	% within Prefer not to stream videos when connected to	65.3%
	% within Data subscription 2cat	100.0%
	% of Total	65.3%

Crosstab

		Total
	% within Prefer not to stream videos when connected to	100.0%
	% within Data subscription 2cat	14.5%
	% of Total	14.5%
	Standardized Residual	
Total	Count	124
	Expected Count	124.0
	% within Prefer not to stream videos when connected to	100.0%
	% within Data subscription 2cat	100.0%
	% of Total	100.0%

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	11.675[a]	3	.009
Likelihood Ratio	12.097	3	.007
Linear-by-Linear Association	.583	1	.445
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 6,24.

Prefer not to stream videos when connected to * Age group - three gr oups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.033[a]	6	.318
Likelihood Ratio	6.962	6	.324
Linear-by-Linear Association	4.575	1	.032
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,81.

Prefer not to stream sound when connected to * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	8.288[a]	3	.040
Likelihood Ratio	8.937	3	.030
Linear-by-Linear Association	4.482	1	.034
N of Valid Cases	124		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is 3,39.

Prefer not to stream sound when connected to * Data subscription 2c at

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.176[a]	3	.103
Likelihood Ratio	5.928	3	.115
Linear-by-Linear Association	3.645	1	.056
N of Valid Cases	124		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is 2,43.

Prefer not to stream sound when connected to * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	10.932[a]	6	.090
Likelihood Ratio	10.421	6	.108
Linear-by-Linear Association	3.069	1	.080
N of Valid Cases	124		

a. 6 cells (50,0%) have expected count less than 5. The minimum expected count is 2,26.

Prefer not to use social media when connected to * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.331[a]	3	.149
Likelihood Ratio	6.570	3	.087
Linear-by-Linear Association	.496	1	.481
N of Valid Cases	124		

a. 2 cells (25,0%) have expected count less than 5. The minimum expected count is 1,45.

Prefer not to use social media when connected to * Data subscription 2cat

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.462[a]	3	.691
Likelihood Ratio	1.376	3	.711
Linear-by-Linear Association	.014	1	.906
N of Valid Cases	124		

a. 4 cells (50,0%) have expected count less than 5. The minimum expected count is 1,04.

Prefer not to use social media when connected to * Age group - three groups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	3.581[a]	6	.733
Likelihood Ratio	4.323	6	.633
Linear-by-Linear Association	.758	1	.384
N of Valid Cases	124		

a. 9 cells (75,0%) have expected count less than 5. The minimum expected count is ,97.

Prefer not to video chat when connected to * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.694[a]	3	.128
Likelihood Ratio	5.811	3	.121
Linear-by-Linear Association	4.772	1	.029
N of Valid Cases	124		

a. 0 cells (,0%) have expected count less than 5. The minimum expected count is 5,32.

Prefer not to video chat when connected to * Data subscription 2cat

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	7.953[a]	3	.047
Likelihood Ratio	8.098	3	.044
Linear-by-Linear Association	1.244	1	.265
N of Valid Cases	124		

a. 1 cells (12,5%) have expected count less than 5. The minimum expected count is 3,81.

Prefer not to video chat when connected to * Age group - three group s

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	5.892[a]	6	.435
Likelihood Ratio	6.021	6	.421
Linear-by-Linear Association	5.317	1	.021
N of Valid Cases	124		

a. 3 cells (25,0%) have expected count less than 5. The minimum expected count is 3,55.

Prefer not to use browser when connected to * Gender

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	1.574[a]	3	.665
Likelihood Ratio	1.963	3	.580
Linear-by-Linear Association	.756	1	.384
N of Valid Cases	124		

a. 2 cells (25,0%) have expected count less than 5. The minimum expected count is ,48.

Prefer not to use browser when connected to * Data subscription 2ca t

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	.751[a]	3	.861
Likelihood Ratio	1.068	3	.785
Linear-by-Linear Association	.336	1	.562
N of Valid Cases	124		

a. 3 cells (37,5%) have expected count less than 5. The minimum expected count is ,35.

Prefer not to use browser when connected to * Age group - three gro ups

Chi-Square Tests

	Value	df	Asymptotic Significance (2-sided)
Pearson Chi-Square	6.163[a]	6	.405
Likelihood Ratio	6.375	6	.383
Linear-by-Linear Association	.937	1	.333
N of Valid Cases	124		

a. 8 cells (66,7%) have expected count less than 5. The minimum expected count is ,32.

Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Importance of stable network - video streaming	124	1	5	4.31	1.098
Importance of stable network - streaming sound	124	1	5	4.06	1.117
Importance of stable network - social media	124	1	5	3.77	1.068
Importance of stable network - video chat	124	1	5	4.02	1.278
Importance of stable network - browsing	124	1	5	4.06	.881
Importance of stable network - real-time apps	124	1	5	4.09	.988
Importance of stable network - playing games	124	1	5	2.76	1.445
Importance of stable network - mobile banking	124	1	5	3.99	1.078
Importance of data consumption - video streaming	124	1	5	3.65	1.211
Importance of data consumption - sound streaming	124	1	5	3.25	1.187

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Importance of data consumption - social media	124	1	5	2.94	1.132
Importance of data consumption - video chat	124	1	5	3.18	1.263
Importance of data consumption - browsing	124	1	5	3.09	1.148
Importance of data consumption - real-time apps	124	1	5	2.90	1.185
Importance of data consumption - playing games	124	1	5	2.79	1.245
Importance of data consumption - mobile banking	124	1	5	2.81	1.178
Importance of response time - streaming video	124	1	5	4.19	1.039
Importance of response time - streaming sound	124	1	5	4.16	.958
Importance of response time - social media	124	1	5	4.10	.999
Importance of response time - video chat	124	1	5	4.00	1.249
Importance of response time - browsing	124	1	5	4.23	.873
Importance of response time - real-time apps	124	1	5	4.26	.891
Importance of response time - playing games	124	1	5	3.35	1.449
Importance of response time - mobile banking	124	1	5	4.15	1.041
Importance of security - streaming video	124	1	5	3.60	1.189
Importance of security - streaming sound	124	1	5	3.56	1.232
Importance of security - social media	124	1	5	4.33	.977
Importance of security - video chat	124	1	5	4.08	1.101
Importance of security - browsing	124	1	5	4.17	.960
Importance of security - real-time apps	124	1	5	3.76	1.150

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Importance of security - playing games	124	1	5	3.23	1.419
Importance of security - mobile banking	124	1	5	4.74	.785
Importance of privacy - streaming video	124	1	5	3.89	1.084
Importance of privacy - streaming sound	124	1	5	3.84	1.100
Importance of privacy - social media	124	1	5	4.40	.979
Importance of privacy - video chat	124	1	5	4.27	1.029
Importance of privacy - browsing	124	1	5	4.25	.889
Importance of privacy - real-time apps	124	1	5	3.83	1.095
Importance of privacy - playing games	124	1	5	3.37	1.394
Importance of privacy - mobile banking	124	1	5	4.69	.820
Restrictions on how much data I have included in my subscription influence how I use my smartphone	124	1	5	3.18	1.141
Valid N (listwise)	124				

NPar Tests

Mann-Whitney Test

Test Statistics[a]

	How much data included in subscription	Importance of stable network - video streaming	Importance of stable network - streaming sound	Importance of stable network - social media
Mann-Whitney U	.000	1457.500	1619.500	1311.000
Wilcoxon W	946.000	2403.500	2565.500	2257.000
Z	-9.346	-1.719	-.685	-2.366
Asymp. Sig. (2-tailed)	.000	.086	.493	.018

Test Statistics[a]

	Importance of stable network - video chat	Importance of stable network - browsing	Importance of stable network - real-time apps	Importance of stable network - playing games
Mann-Whitney U	1597.000	1595.000	1692.000	1557.500
Wilcoxon W	2543.000	2541.000	2638.000	2503.500
Z	-.829	-.837	-.279	-1.001
Asymp. Sig. (2-tailed)	.407	.403	.781	.317

Test Statistics[a]

	Importance of stable network - mobile banking	Importance of data consumption - video streaming	Importance of data consumption - sound streaming	Importance of data consumption - social media
Mann-Whitney U	1608.000	1697.500	1563.000	1623.000
Wilcoxon W	2554.000	5018.500	4884.000	4944.000
Z	-.741	-.240	-.967	-.644
Asymp. Sig. (2-tailed)	.459	.810	.333	.519

Test Statistics[a]

	Importance of data consumption - video chat	Importance of data consumption - browsing	Importance of data consumption - real-time apps	Importance of data consumption - playing games
Mann-Whitney U	1613.500	1475.500	1459.000	1726.000
Wilcoxon W	4934.500	4796.500	4780.000	2672.000
Z	-.692	-1.443	-1.529	-.084
Asymp. Sig. (2-tailed)	.489	.149	.126	.933

Test Statistics[a]

	Importance of data consumption - mobile banking	Importance of response time - streaming video	Importance of response time - streaming sound	Importance of response time - social media
Mann-Whitney U	1374.500	1620.000	1682.000	1551.500
Wilcoxon W	4695.500	2566.000	2628.000	2497.500
Z	-1.991	-.693	-.337	-1.064
Asymp. Sig. (2-tailed)	.046	.489	.736	.287

Test Statistics[a]

	Importance of response time - video chat	Importance of response time - browsing	Importance of response time - real-time apps	Importance of response time - playing games
Mann-Whitney U	1715.500	1663.000	1668.000	1473.500
Wilcoxon W	2661.500	4984.000	4989.000	2419.500
Z	-.148	-.447	-.421	-1.446
Asymp. Sig. (2-tailed)	.883	.655	.674	.148

Test Statistics[a]

	Importance of response time - mobile banking	Importance of security - streaming video	Importance of security - streaming sound	Importance of security - social media
Mann-Whitney U	1682.000	1725.500	1726.000	1694.500
Wilcoxon W	5003.000	5046.500	5047.000	2640.500
Z	-.337	-.087	-.084	-.277
Asymp. Sig. (2-tailed)	.736	.931	.933	.782

Test Statistics[a]

	Importance of security - video chat	Importance of security - browsing	Importance of security - real-time apps	Importance of security - playing games
Mann-Whitney U	1582.500	1590.500	1661.500	1573.000
Wilcoxon W	2528.500	4911.500	4982.500	2519.000
Z	-.893	-.854	-.437	-.909
Asymp. Sig. (2-tailed)	.372	.393	.662	.363

Test Statistics[a]

	Importance of security - mobile banking	Importance of privacy - streaming video	Importance of privacy - streaming sound	Importance of privacy - social media
Mann-Whitney U	1695.500	1652.500	1721.000	1545.500
Wilcoxon W	2641.500	2598.500	2667.000	2491.500
Z	-.415	-.490	-.112	-1.204
Asymp. Sig. (2-tailed)	.678	.624	.910	.229

Test Statistics[a]

	Importance of privacy - video chat	Importance of privacy - browsing	Importance of privacy - real-time apps	Importance of privacy - playing games
Mann-Whitney U	1597.000	1651.000	1672.500	1696.500
Wilcoxon W	2543.000	2597.000	2618.500	2642.500
Z	-.843	-.517	-.378	-.243
Asymp. Sig. (2-tailed)	.399	.605	.706	.808

Test Statistics[a]

	Importance of privacy - mobile banking
Mann-Whitney U	1730.000
Wilcoxon W	5051.000
Z	-.091
Asymp. Sig. (2-tailed)	.928

a. Grouping Variable: Data subscription 2cat

NPar Tests

Mann-Whitney Test

Test Statistics[a]

	How much data included in subscription	Importance of stable network - video streaming	Importance of stable network - streaming sound	Importance of stable network - social media
Mann-Whitney U	1759.000	1820.000	1567.000	1795.500
Wilcoxon W	3839.000	3650.000	3397.000	3625.500
Z	-.823	-.577	-1.889	-.652
Asymp. Sig. (2-tailed)	.411	.564	.059	.515

Test Statistics[a]

	Importance of stable network - video chat	Importance of stable network - browsing	Importance of stable network - real-time apps	Importance of stable network - playing games
Mann-Whitney U	1594.000	1846.000	1836.000	1718.500
Wilcoxon W	3424.000	3926.000	3666.000	3798.500
Z	-1.782	-.403	-.450	-1.044
Asymp. Sig. (2-tailed)	.075	.687	.653	.297

Test Statistics[a]

	Importance of stable network - mobile banking	Importance of data consumption - video streaming	Importance of data consumption - sound streaming	Importance of data consumption - social media
Mann-Whitney U	1806.500	1819.000	1546.500	1882.500
Wilcoxon W	3636.500	3899.000	3376.500	3712.500
Z	-.600	-.525	-1.927	-.194
Asymp. Sig. (2-tailed)	.549	.600	.054	.846

Test Statistics[a]

	Importance of data consumption - video chat	Importance of data consumption - browsing	Importance of data consumption - real-time apps	Importance of data consumption - playing games
Mann-Whitney U	1821.500	1848.000	1842.500	1851.000
Wilcoxon W	3651.500	3928.000	3922.500	3681.000
Z	-.507	-.372	-.399	-.357
Asymp. Sig. (2-tailed)	.612	.710	.690	.721

Test Statistics[a]

	Importance of data consumption - mobile banking	Importance of response time - streaming video	Importance of response time - streaming sound	Importance of response time - social media
Mann-Whitney U	1891.500	1775.000	1811.000	1678.500
Wilcoxon W	3721.500	3605.000	3641.000	3508.500
Z	-.147	-.787	-.587	-1.288
Asymp. Sig. (2-tailed)	.883	.431	.557	.198

Test Statistics[a]

	Importance of response time - video chat	Importance of response time - browsing	Importance of response time - real-time apps	Importance of response time - playing games
Mann-Whitney U	1678.000	1817.500	1582.500	1775.000
Wilcoxon W	3508.000	3647.500	3412.500	3855.000
Z	-1.308	-.555	-1.841	-.745
Asymp. Sig. (2-tailed)	.191	.579	.066	.456

Test Statistics[a]

	Importance of response time - mobile banking	Importance of security - streaming video	Importance of security - streaming sound	Importance of security - social media
Mann-Whitney U	1659.000	1904.000	1806.500	1887.500
Wilcoxon W	3489.000	3734.000	3636.500	3717.500
Z	-1.408	-.083	-.587	-.182
Asymp. Sig. (2-tailed)	.159	.934	.557	.855

Test Statistics[a]

	Importance of security - video chat	Importance of security - browsing	Importance of security - real-time apps	Importance of security - playing games
Mann-Whitney U	1808.000	1828.000	1865.000	1845.500
Wilcoxon W	3638.000	3908.000	3945.000	3925.500
Z	-.599	-.496	-.286	-.383
Asymp. Sig. (2-tailed)	.549	.620	.775	.702

Test Statistics[a]

	Importance of security - mobile banking	Importance of privacy - streaming video	Importance of privacy - streaming sound	Importance of privacy - social media
Mann-Whitney U	1803.000	1831.000	1841.500	1905.000
Wilcoxon W	3883.000	3911.000	3671.500	3735.000
Z	-1.005	-.466	-.410	-.088
Asymp. Sig. (2-tailed)	.315	.641	.682	.930

Test Statistics[a]

	Importance of privacy - video chat	Importance of privacy - browsing	Importance of privacy - real-time apps	Importance of privacy - playing games
Mann-Whitney U	1672.500	1804.000	1837.500	1910.500
Wilcoxon W	3502.500	3884.000	3917.500	3990.500
Z	-1.375	-.631	-.430	-.049
Asymp. Sig. (2-tailed)	.169	.528	.667	.961

Test Statistics[a]

	Importance of privacy - mobile banking
Mann-Whitney U	1863.500
Wilcoxon W	3943.500
Z	-.425
Asymp. Sig. (2-tailed)	.671

a. Grouping Variable: Gender

NPar Tests

Kruskal-Wallis Test

Test Statistics[a,b]

	Importance of stable network - video streaming	Importance of stable network - streaming sound	Importance of stable network - social media	Importance of stable network - video chat	Importance of stable network - browsing
Kruskal-Wallis H	22.688	3.409	.302	10.663	.423
df	2	2	2	2	2
Asymp. Sig.	.000	.182	.860	.005	.809

Test Statistics[a,b]

	Importance of stable network - real-time apps	Importance of stable network - playing games	Importance of stable network - mobile banking	Importance of data consumption - video streaming	Importance of data consumption - sound streaming
Kruskal-Wallis H	.552	2.335	1.233	1.346	.245
df	2	2	2	2	2
Asymp. Sig.	.759	.311	.540	.510	.884

Test Statistics[a,b]

	Importance of data consumption - social media	Importance of data consumption - video chat	Importance of data consumption - browsing	Importance of data consumption - real-time apps	Importance of data consumption - playing games
Kruskal-Wallis H	.424	.359	1.434	1.071	.954
df	2	2	2	2	2
Asymp. Sig.	.809	.836	.488	.585	.621

Test Statistics[a,b]

	Importance of data consumption - mobile banking	Importance of response time - streaming video	Importance of response time - streaming sound	Importance of response time - social media	Importance of response time - video chat
Kruskal-Wallis H	4.588	7.633	8.495	3.003	3.173
df	2	2	2	2	2
Asymp. Sig.	.101	.022	.014	.223	.205

Test Statistics[a,b]

	Importance of response time - browsing	Importance of response time - real-time apps	Importance of response time - playing games	Importance of response time - mobile banking	Importance of security - streaming video
Kruskal-Wallis H	.078	.243	1.434	1.020	.432
df	2	2	2	2	2
Asymp. Sig.	.962	.886	.488	.600	.806

Test Statistics[a,b]

	Importance of security - streaming sound	Importance of security - social media	Importance of security - video chat	Importance of security - browsing	Importance of security - real-time apps
Kruskal-Wallis H	.444	.166	2.244	.127	3.921
df	2	2	2	2	2
Asymp. Sig.	.801	.920	.326	.938	.141

Test Statistics[a,b]

	Importance of security - playing games	Importance of security - mobile banking	Importance of privacy - streaming video	Importance of privacy - streaming sound	Importance of privacy - social media
Kruskal-Wallis H	2.772	.399	.558	.307	.003
df	2	2	2	2	2
Asymp. Sig.	.250	.819	.757	.857	.999

Test Statistics[a,b]

	Importance of privacy - video chat	Importance of privacy - browsing	Importance of privacy - real-time apps	Importance of privacy - playing games	Importance of privacy - mobile banking
Kruskal-Wallis H	.021	1.169	1.272	.219	2.249
df	2	2	2	2	2
Asymp. Sig.	.990	.557	.529	.896	.325

a. Kruskal Wallis Test

b. Grouping Variable: Age group - three groups

NPar Tests

Mann-Whitney Test

Test Statistics[a]

	Restrictions on how much data I have included in my subscription influence how I use my smartphone - comp	How much data the application consumes influences how I use it - comp	What type of network I'm connected to influences how I use my smartphone - comp	I expect applications to work just as well when traveling from one place to another as at home - comp
Mann-Whitney U	1898.000	1754.500	1845.000	1808.000
Wilcoxon W	3978.000	3834.500	3675.000	3638.000
Z	-.119	-.895	-.427	-.801
Asymp. Sig. (2-tailed)	.905	.371	.669	.423

Test Statistics[a]

	When an application crashes or is slow it's usually due to the network connection - comp	That an application works well also on a slower network connection is important for keeping me engaged - comp	Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better - comp	I stream videos regardless of which network I am connected to - comp
Mann-Whitney U	1733.500	1893.000	1530.000	1546.000
Wilcoxon W	3563.500	3723.000	3360.000	3626.000
Z	-1.010	-.171	-2.099	-2.083
Asymp. Sig. (2-tailed)	.313	.865	.036	.037

Test Statistics[a]

	I think I spend too much time on my phone - comp
Mann-Whitney U	1313.500
Wilcoxon W	3143.500
Z	-3.406
Asymp. Sig. (2-tailed)	.001

a. Grouping Variable: Gender

NPar Tests

Mann-Whitney Test

Test Statistics[a]

	Restrictions on how much data I have included in my subscription influence how I use my smartphone - comp	How much data the application consumes influences how I use it - comp	What type of network I'm connected to influences how I use my smartphone - comp	I expect applications to work just as well when traveling from one place to another as at home - comp
Mann-Whitney U	1534.500	1516.500	1182.500	1705.500
Wilcoxon W	4855.500	4837.500	4503.500	5026.500
Z	-1.180	-1.277	-3.342	-.270
Asymp. Sig. (2-tailed)	.238	.201	.001	.787

Test Statistics[a]

	When an application crashes or is slow it's usually due to the network connection - comp	That an application works well also on a slower network connection is important for keeping me engaged - comp	Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better - comp	I stream videos regardless of which network I am connected to - comp
Mann-Whitney U	1541.500	1664.500	1403.500	1595.000
Wilcoxon W	4862.500	2610.500	4724.500	2541.000
Z	-1.137	-.511	-1.910	-.857
Asymp. Sig. (2-tailed)	.256	.610	.056	.392

Test Statistics[a]

	I think I spend too much time on my phone - comp
Mann-Whitney U	1615.000
Wilcoxon W	2561.000
Z	-.746
Asymp. Sig. (2-tailed)	.456

a. Grouping Variable: Data subscription 2cat

NPar Tests

Kruskal-Wallis Test

Test Statistics[a,b]

	Restrictions on how much data I have included in my subscription influence how I use my smartphone	How much data the application consumes influences how I use it	What type of network I'm connected to influences how I use my smartphone	I expect applications to work just as well when traveling from one place to another as at home	When an application crashes or is slow it's usually due to the network connection
Kruskal-Wallis H	3.359	.761	2.971	.922	.693
df	2	2	2	2	2
Asymp. Sig.	.186	.684	.226	.631	.707

Test Statistics[a,b]

	That an application works well also on a slower network connection is important for keeping me engaged	Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	I stream videos regardless of which network I am connected to	I think I spend too much time on my phone
Kruskal-Wallis H	1.925	.122	1.488	4.317
df	2	2	2	2
Asymp. Sig.	.382	.941	.475	.116

a. Kruskal Wallis Test

b. Grouping Variable: Age group - three groups

Median Test

Frequencies

		Age group - three groups		
		<=28	29-35	>=36
Restrictions on how much data I have included in my subscription influence how I use my smartphone	> Median	23	21	16
	<= Median	17	23	24
How much data the application consumes influences how I use it	> Median	22	19	18
	<= Median	18	25	22
What type of network I'm connected to influences how I use my smartphone	> Median	4	8	7
	<= Median	36	36	33
I expect applications to work just as well when traveling from one place to another as at home	> Median	18	17	12
	<= Median	22	27	28
When an application crashes or is slow it's usually due to the network connection	> Median	20	22	17
	<= Median	20	22	23

Frequencies

		Age group - three groups		
		<=28	29-35	>=36
That an application works well also on a slower network connection is important for keeping me engaged	> Median	8	7	4
	<= Median	32	37	36
Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	> Median	12	10	6
	<= Median	28	34	34
I stream videos regardless of which network I am connected to	> Median	16	21	18
	<= Median	24	23	22
I think I spend too much time on my phone	> Median	8	11	7
	<= Median	32	33	33

Test Statistics[a]

	Restrictions on how much data I have included in my subscription influence how I use my smartphone	How much data the application consumes influences how I use it	What type of network I'm connected to influences how I use my smartphone	I expect applications to work just as well when traveling from one place to another as at home	When an application crashes or is slow it's usually due to the network connection
N	124	124	124	124	124
Median	3.00	3.00	4.00	4.00	3.00
Chi-Square	2.464[b]	1.331[c]	1.297[d]	1.927[e]	.611[c]
df	2	2	2	2	2
Asymp. Sig.	.292	.514	.523	.381	.737

Test Statistics[a]

	That an application works well also on a slower network connection is important for keeping me engaged	Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	I stream videos regardless of which network I am connected to	I think I spend too much time on my phone
N	124	124	124	124
Median	4.00	3.00	2.00	4.00
Chi-Square	1.560[d]	2.575[f]	.517[g]	.745[h]
df	2	2	2	2
Asymp. Sig.	.459	.276	.772	.689

a. Grouping Variable: Age group - three groups

b. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 19,4.

c. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 19,0.

d. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 6,1.

e. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 15,2.

f

e. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 15,2.

f. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 9,0.

g. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 17,7.

h. 0 cells (,0%) have expected frequencies less than 5. The minimum expected cell frequency is 8,4.

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - video streaming	124	4.31	1.098	1	5
Importance of data consumption - video streaming	124	3.65	1.211	1	5
Importance of response time - streaming video	124	4.19	1.039	1	5
Importance of security - streaming video	124	3.60	1.189	1	5
Importance of privacy - streaming video	124	3.89	1.084	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - video streaming	3.58
Importance of data consumption - video streaming	2.57
Importance of response time - streaming video	3.36
Importance of security - streaming video	2.53
Importance of privacy - streaming video	2.96

Test Statistics[a]

N	124
Chi-Square	68.851
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - streaming sound	124	4.06	1.117	1	5
Importance of response time - streaming sound	124	4.16	.958	1	5
Importance of data consumption - sound streaming	124	3.25	1.187	1	5
Importance of security - streaming sound	124	3.56	1.232	1	5
Importance of privacy - streaming sound	124	3.84	1.100	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - streaming sound	3.48
Importance of response time - streaming sound	3.53
Importance of data consumption - sound streaming	2.24
Importance of security - streaming sound	2.65
Importance of privacy - streaming sound	3.11

Test Statistics[a]

N	124
Chi-Square	88.537
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - social media	124	3.77	1.068	1	5
Importance of data consumption - social media	124	2.94	1.132	1	5
Importance of response time - social media	124	4.10	.999	1	5
Importance of security - social media	124	4.33	.977	1	5
Importance of privacy - social media	124	4.40	.979	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - social media	2.71
Importance of data consumption - social media	1.79
Importance of response time - social media	3.21
Importance of security - social media	3.57
Importance of privacy - social media	3.71

Test Statistics[a]

N	124
Chi-Square	177.058
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - video chat	124	4.02	1.278	1	5
Importance of data consumption - video chat	124	3.18	1.263	1	5
Importance of response time - video chat	124	4.00	1.249	1	5
Importance of security - video chat	124	4.08	1.101	1	5
Importance of privacy - video chat	124	4.27	1.029	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - video chat	3.21
Importance of data consumption - video chat	2.07
Importance of response time - video chat	3.16
Importance of security - video chat	3.13
Importance of privacy - video chat	3.43

Test Statistics[a]

N	124
Chi-Square	94.373
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - browsing	124	4.06	.881	1	5
Importance of data consumption - browsing	124	3.09	1.148	1	5
Importance of response time - browsing	124	4.23	.873	1	5
Importance of security - browsing	124	4.17	.960	1	5
Importance of privacy - browsing	124	4.25	.889	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - browsing	3.08
Importance of data consumption - browsing	1.84
Importance of response time - browsing	3.33
Importance of security - browsing	3.31
Importance of privacy - browsing	3.44

Test Statistics[a]

N	124
Chi-Square	135.023
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - real-time apps	124	4.09	.988	1	5
Importance of data consumption - real-time apps	124	2.90	1.185	1	5
Importance of response time - real-time apps	124	4.26	.891	1	5
Importance of privacy - real-time apps	124	3.83	1.095	1	5
Importance of security - real-time apps	124	3.76	1.150	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - real-time apps	3.43
Importance of data consumption - real-time apps	1.88
Importance of response time - real-time apps	3.64
Importance of privacy - real-time apps	3.13
Importance of security - real-time apps	2.93

Test Statistics[a]

N	124
Chi-Square	136.449
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - playing games	124	2.76	1.445	1	5
Importance of data consumption - playing games	124	2.79	1.245	1	5
Importance of response time - playing games	124	3.35	1.449	1	5
Importance of security - playing games	124	3.23	1.419	1	5
Importance of privacy - playing games	124	3.37	1.394	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - playing games	2.67
Importance of data consumption - playing games	2.62
Importance of response time - playing games	3.39
Importance of security - playing games	3.06
Importance of privacy - playing games	3.26

Test Statistics[a]

N	124
Chi-Square	40.036
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - mobile banking	124	3.99	1.078	1	5
Importance of data consumption - mobile banking	124	2.81	1.178	1	5
Importance of response time - mobile banking	124	4.15	1.041	1	5
Importance of security - mobile banking	124	4.74	.785	1	5
Importance of privacy - mobile banking	124	4.69	.820	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - mobile banking	2.81
Importance of data consumption - mobile banking	1.55
Importance of response time - mobile banking	2.98
Importance of security - mobile banking	3.86
Importance of privacy - mobile banking	3.79

Test Statistics[a]

N	124
Chi-Square	264.800
df	4
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of stable network - video streaming	124	4.31	1.098	1	5
Importance of stable network - streaming sound	124	4.06	1.117	1	5
Importance of stable network - social media	124	3.77	1.068	1	5
Importance of stable network - video chat	124	4.02	1.278	1	5
Importance of stable network - browsing	124	4.06	.881	1	5
Importance of stable network - real-time apps	124	4.09	.988	1	5
Importance of stable network - playing games	124	2.76	1.445	1	5
Importance of stable network - mobile banking	124	3.99	1.078	1	5

Friedman Test

Ranks

	Mean Rank
Importance of stable network - video streaming	5.50
Importance of stable network - streaming sound	4.94
Importance of stable network - social media	4.06
Importance of stable network - video chat	4.87
Importance of stable network - browsing	4.63
Importance of stable network - real-time apps	4.80
Importance of stable network - playing games	2.63
Importance of stable network - mobile banking	4.59

Test Statistics[a]

N	124
Chi-Square	179.933
df	7
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of data consumption - video streaming	124	3.65	1.211	1	5
Importance of data consumption - sound streaming	124	3.25	1.187	1	5
Importance of data consumption - social media	124	2.94	1.132	1	5
Importance of data consumption - video chat	124	3.18	1.263	1	5
Importance of data consumption - browsing	124	3.09	1.148	1	5
Importance of data consumption - real-time apps	124	2.90	1.185	1	5
Importance of data consumption - playing games	124	2.79	1.245	1	5
Importance of data consumption - mobile banking	124	2.81	1.178	1	5

Friedman Test

Ranks

	Mean Rank
Importance of data consumption - video streaming	5.65
Importance of data consumption - sound streaming	4.81
Importance of data consumption - social media	4.24
Importance of data consumption - video chat	4.72
Importance of data consumption - browsing	4.56
Importance of data consumption - real-time apps	4.11
Importance of data consumption - playing games	3.99
Importance of data consumption - mobile banking	3.92

Test Statistics[a]

N	124
Chi-Square	98.178
df	7
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of response time - streaming video	124	4.19	1.039	1	5
Importance of response time - streaming sound	124	4.16	.958	1	5
Importance of response time - social media	124	4.10	.999	1	5
Importance of response time - video chat	124	4.00	1.249	1	5
Importance of response time - browsing	124	4.23	.873	1	5
Importance of response time - real-time apps	124	4.26	.891	1	5
Importance of response time - playing games	124	3.35	1.449	1	5
Importance of response time - mobile banking	124	4.15	1.041	1	5

Friedman Test

Ranks

	Mean Rank
Importance of response time - streaming video	4.77
Importance of response time - streaming sound	4.63
Importance of response time - social media	4.54
Importance of response time - video chat	4.46
Importance of response time - browsing	4.73
Importance of response time - real-time apps	4.87
Importance of response time - playing games	3.31
Importance of response time - mobile banking	4.70

Test Statistics[a]

N	124
Chi-Square	77.830
df	7
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of security - streaming video	124	3.60	1.189	1	5
Importance of security - streaming sound	124	3.56	1.232	1	5
Importance of security - social media	124	4.33	.977	1	5
Importance of security - video chat	124	4.08	1.101	1	5
Importance of security - browsing	124	4.17	.960	1	5
Importance of security - real-time apps	124	3.76	1.150	1	5
Importance of security - playing games	124	3.23	1.419	1	5
Importance of security - mobile banking	124	4.74	.785	1	5

Friedman Test

Ranks

	Mean Rank
Importance of security - streaming video	3.70
Importance of security - streaming sound	3.61
Importance of security - social media	5.39
Importance of security - video chat	4.87
Importance of security - browsing	4.97
Importance of security - real-time apps	4.05
Importance of security - playing games	3.19
Importance of security - mobile banking	6.21

Test Statistics[a]

N	124
Chi-Square	311.527
df	7
Asymp. Sig.	.000

a. Friedman Test

NPar Tests

Descriptive Statistics

	N	Mean	Std. Deviation	Minimum	Maximum
Importance of privacy - streaming video	124	3.89	1.084	1	5
Importance of privacy - streaming sound	124	3.84	1.100	1	5
Importance of privacy - social media	124	4.40	.979	1	5
Importance of privacy - video chat	124	4.27	1.029	1	5
Importance of privacy - browsing	124	4.25	.889	1	5
Importance of privacy - real-time apps	124	3.83	1.095	1	5
Importance of privacy - playing games	124	3.37	1.394	1	5
Importance of privacy - mobile banking	124	4.69	.820	1	5

Friedman Test

Ranks

	Mean Rank
Importance of privacy - streaming video	4.00
Importance of privacy - streaming sound	3.92
Importance of privacy - social media	5.28
Importance of privacy - video chat	4.93
Importance of privacy - browsing	4.85
Importance of privacy - real-time apps	3.91
Importance of privacy - playing games	3.23
Importance of privacy - mobile banking	5.88

Test Statistics[a]

N	124
Chi-Square	251.666
df	7
Asymp. Sig.	.000

a. Friedman Test

Mann-Whitney Test

Ranks

	Age group - three groups	N	Mean Rank	Sum of Ranks
Importance of stable network - video streaming	<=28	40	49,93	1997,00
	>=36	40	31,08	1243,00
	Total	80		
Importance of stable network - streaming sound	<=28	40	42,88	1715,00
	>=36	40	38,13	1525,00
	Total	80		
Importance of stable network - social media	<=28	40	40,81	1632,50
	>=36	40	40,19	1607,50
	Total	80		
Importance of stable network - video chat	<=28	40	47,58	1903,00
	>=36	40	33,42	1337,00
	Total	80		
Importance of stable network - browsing	<=28	40	39,39	1575,50
	>=36	40	41,61	1664,50
	Total	80		
Importance of stable network - real-time apps	<=28	40	41,10	1644,00
	>=36	40	39,90	1596,00
	Total	80		
Importance of stable network - playing games	<=28	40	43,05	1722,00
	>=36	40	37,95	1518,00
	Total	80		
Importance of stable network - mobile banking	<=28	40	38,15	1526,00
	>=36	40	42,85	1714,00
	Total	80		
Importance of data consumption - video streaming	<=28	40	43,06	1722,50
	>=36	40	37,94	1517,50
	Total	80		

Ranks

	Age group - three groups	N	Mean Rank	Sum of Ranks
Importance of data consumption - sound streaming	<=28	40	39,30	1572,00
	>=36	40	41,70	1668,00
	Total	80		
Importance of data consumption - social media	<=28	40	41,68	1667,00
	>=36	40	39,33	1573,00
	Total	80		
Importance of data consumption - video chat	<=28	40	42,03	1681,00
	>=36	40	38,98	1559,00
	Total	80		
Importance of data consumption - browsing	<=28	40	42,49	1699,50
	>=36	40	38,51	1540,50
	Total	80		
Importance of data consumption - real-time apps	<=28	40	41,31	1652,50
	>=36	40	39,69	1587,50
	Total	80		
Importance of data consumption - playing games	<=28	40	43,01	1720,50
	>=36	40	37,99	1519,50
	Total	80		
Importance of data consumption - mobile banking	<=28	40	40,61	1624,50
	>=36	40	40,39	1615,50
	Total	80		
Importance of response time - streaming video	<=28	40	45,71	1828,50
	>=36	40	35,29	1411,50
	Total	80		
Importance of response time - streaming sound	<=28	40	46,45	1858,00
	>=36	40	34,55	1382,00
	Total	80		
Importance of response time - social media	<=28	40	44,34	1773,50
	>=36	40	36,66	1466,50
	Total	80		
Importance of response time - video chat	<=28	40	44,54	1781,50
	>=36	40	36,46	1458,50
	Total	80		
Importance of response time - browsing	<=28	40	41,15	1646,00
	>=36	40	39,85	1594,00
	Total	80		

Ranks

	Age group - three groups	N	Mean Rank	Sum of Ranks
Importance of response time - real-time apps	<=28	40	41,40	1656,00
	>=36	40	39,60	1584,00
	Total	80		
Importance of response time - playing games	<=28	40	43,16	1726,50
	>=36	40	37,84	1513,50
	Total	80		
Importance of response time - mobile banking	<=28	40	38,89	1555,50
	>=36	40	42,11	1684,50
	Total	80		
Importance of security - streaming video	<=28	40	41,59	1663,50
	>=36	40	39,41	1576,50
	Total	80		
Importance of security - streaming sound	<=28	40	41,69	1667,50
	>=36	40	39,31	1572,50
	Total	80		
Importance of security - social media	<=28	40	41,36	1654,50
	>=36	40	39,64	1585,50
	Total	80		
Importance of security - video chat	<=28	40	44,04	1761,50
	>=36	40	36,96	1478,50
	Total	80		
Importance of security - browsing	<=28	40	39,67	1587,00
	>=36	40	41,33	1653,00
	Total	80		
Importance of security - real-time apps	<=28	40	38,69	1547,50
	>=36	40	42,31	1692,50
	Total	80		
Importance of security - playing games	<=28	40	42,98	1719,00
	>=36	40	38,03	1521,00
	Total	80		
Importance of security - mobile banking	<=28	40	39,56	1582,50
	>=36	40	41,44	1657,50
	Total	80		
Importance of privacy - streaming video	<=28	40	38,86	1554,50
	>=36	40	42,14	1685,50
	Total	80		

Ranks

	Age group - three groups	N	Mean Rank	Sum of Ranks
Importance of privacy - streaming sound	<=28	40	39,33	1573,00
	>=36	40	41,68	1667,00
	Total	80		
Importance of privacy - social media	<=28	40	40,56	1622,50
	>=36	40	40,44	1617,50
	Total	80		
Importance of privacy - video chat	<=28	40	40,24	1609,50
	>=36	40	40,76	1630,50
	Total	80		
Importance of privacy - browsing	<=28	40	37,98	1519,00
	>=36	40	43,03	1721,00
	Total	80		
Importance of privacy - real-time apps	<=28	40	39,75	1590,00
	>=36	40	41,25	1650,00
	Total	80		
Importance of privacy - playing games	<=28	40	39,61	1584,50
	>=36	40	41,39	1655,50
	Total	80		
Importance of privacy - mobile banking	<=28	40	38,06	1522,50
	>=36	40	42,94	1717,50
	Total	80		
Restrictions on how much data I have included in my subscription influence how I use my smartphone	<=28	40	44,98	1799,00
	>=36	40	36,03	1441,00
	Total	80		
How much data the application consumes influences how I use it	<=28	40	42,58	1703,00
	>=36	40	38,42	1537,00
	Total	80		
What type of network I'm connected to influences how I use my smartphone	<=28	40	36,84	1473,50
	>=36	40	44,16	1766,50
	Total	80		
I expect applications to work just as well when traveling from one place to another as at home	<=28	40	42,35	1694,00
	>=36	40	38,65	1546,00
	Total	80		
When an application crashes or is slow it's usually due to the network connection	<=28	40	40,19	1607,50
	>=36	40	40,81	1632,50
	Total	80		

Ranks

	Age group - three groups	N	Mean Rank	Sum of Ranks
That an application works well also on a slower network connection is important for keeping me engaged	<=28	40	43,69	1747,50
	>=36	40	37,31	1492,50
	Total	80		
Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	<=28	40	40,35	1614,00
	>=36	40	40,65	1626,00
	Total	80		
I stream videos regardless of which network I am connected to	<=28	40	39,26	1570,50
	>=36	40	41,74	1669,50
	Total	80		
I think I spend too much time on my phone	<=28	40	41,21	1648,50
	>=36	40	39,79	1591,50
	Total	80		

Test Statistics[a]

	Importance of stable network - video streaming	Importance of stable network - streaming sound	Importance of stable network - social media	Importance of stable network - video chat
Mann-Whitney U	423,000	705,000	787,500	517,000
Wilcoxon W	1243,000	1525,000	1607,500	1337,000
Z	-4,005	-,965	-,126	-2,927
Asymp. Sig. (2-tailed)	,000	,334	,900	,003

Test Statistics[a]

	Importance of stable network - browsing	Importance of stable network - real-time apps	Importance of stable network - playing games	Importance of stable network - mobile banking
Mann-Whitney U	755,500	776,000	698,000	706,000
Wilcoxon W	1575,500	1596,000	1518,000	1526,000
Z	-,465	-,245	-1,020	-,962
Asymp. Sig. (2-tailed)	,642	,806	,308	,336

Test Statistics[a]

	Importance of data consumption - video streaming	Importance of data consumption - sound streaming	Importance of data consumption - social media	Importance of data consumption - video chat
Mann-Whitney U	697,500	752,000	753,000	739,000
Wilcoxon W	1517,500	1572,000	1573,000	1559,000
Z	-1,022	-,476	-,468	-,606
Asymp. Sig. (2-tailed)	,307	,634	,639	,544

Test Statistics[a]

	Importance of data consumption - browsing	Importance of data consumption - real-time apps	Importance of data consumption - playing games	Importance of data consumption - mobile banking
Mann-Whitney U	720,500	767,500	699,500	795,500
Wilcoxon W	1540,500	1587,500	1519,500	1615,500
Z	-,790	-,322	-1,005	-,045
Asymp. Sig. (2-tailed)	,430	,747	,315	,964

Test Statistics[a]

	Importance of response time - streaming video	Importance of response time - streaming sound	Importance of response time - social media	Importance of response time - video chat
Mann-Whitney U	591,500	562,000	646,500	638,500
Wilcoxon W	1411,500	1382,000	1466,500	1458,500
Z	-2,145	-2,433	-1,568	-1,670
Asymp. Sig. (2-tailed)	,032	,015	,117	,095

Test Statistics[a]

	Importance of response time - browsing	Importance of response time - real-time apps	Importance of response time - playing games	Importance of response time - mobile banking
Mann-Whitney U	774,000	764,000	693,500	735,500
Wilcoxon W	1594,000	1584,000	1513,500	1555,500
Z	-,271	-,376	-1,057	-,674
Asymp. Sig. (2-tailed)	,786	,707	,291	,500

Test Statistics[a]

	Importance of security - streaming video	Importance of security - streaming sound	Importance of security - social media	Importance of security - video chat
Mann-Whitney U	756,500	752,500	765,500	658,500
Wilcoxon W	1576,500	1572,500	1585,500	1478,500
Z	-,435	-,474	-,372	-1,453
Asymp. Sig. (2-tailed)	,664	,635	,710	,146

Test Statistics[a]

	Importance of security - browsing	Importance of security - real-time apps	Importance of security - playing games	Importance of security - mobile banking
Mann-Whitney U	767,000	727,500	701,000	762,500
Wilcoxon W	1587,000	1547,500	1521,000	1582,500
Z	-,342	-,732	-,985	-,628
Asymp. Sig. (2-tailed)	,732	,464	,325	,530

Test Statistics[a]

	Importance of privacy - streaming video	Importance of privacy - streaming sound	Importance of privacy - social media	Importance of privacy - video chat
Mann-Whitney U	734,500	753,000	797,500	789,500
Wilcoxon W	1554,500	1573,000	1617,500	1609,500
Z	-,661	-,471	-,028	-,112
Asymp. Sig. (2-tailed)	,509	,637	,978	,910

Test Statistics[a]

	Importance of privacy - browsing	Importance of privacy - real-time apps	Importance of privacy - playing games	Importance of privacy - mobile banking
Mann-Whitney U	699,000	770,000	764,500	702,500
Wilcoxon W	1519,000	1590,000	1584,500	1522,500
Z	-1,054	-,303	-,352	-1,461
Asymp. Sig. (2-tailed)	,292	,762	,725	,144

Test Statistics[a]

	Restrictions on how much data I have included in my subscription influence how I use my smartphone	How much data the application consumes influences how I use it	What type of network I'm connected to influences how I use my smartphone	I expect applications to work just as well when traveling from one place to another as at home
Mann-Whitney U	621,000	717,000	653,500	726,000
Wilcoxon W	1441,000	1537,000	1473,500	1546,000
Z	-1,797	-,831	-1,524	-,759
Asymp. Sig. (2-tailed)	,072	,406	,128	,448

Test Statistics[a]

	When an application crashes or is slow it's usually due to the network connection	That an application works well also on a slower network connection is important for keeping me engaged	Communcating with my friends on apps such as Snapchat or Messenger gives my such joy that I have a tendency to accept slower response time and crashes better	I stream videos regardless of which network I am connected to
Mann-Whitney U	787,500	672,500	794,000	750,500
Wilcoxon W	1607,500	1492,500	1614,000	1570,500
Z	-,126	-1,378	-,060	-,494
Asymp. Sig. (2-tailed)	,899	,168	,952	,621

Test Statistics[a]

	I think I spend too much time on my phone
Mann-Whitney U	771,500
Wilcoxon W	1591,500
Z	-,283
Asymp. Sig. (2-tailed)	,777

a. Grouping Variable: Age group - three groups

Mann-Whitney Test

Ranks

	Gender	N	Mean Rank	Sum of Ranks
Data subscription 2cat	Female	64	57,84	3702,00
	Male	60	67,47	4048,00
	Total	124		

Test Statistics[a]

	Data subscription 2cat
Mann-Whitney U	1622,000
Wilcoxon W	3702,000
Z	-1,807
Asymp. Sig. (2-tailed)	,071

a. Grouping Variable: Gender

Mann-Whitney Test

Ranks

	How much data included - comp	N	Mean Rank	Sum of Ranks
I think I spend too much time on my phone - comp	Less than 6GB	43	33,48	1439,50
	More than 10GB	30	42,05	1261,50
	Total	73		

Test Statistics[a]

	I think I spend too much time on my phone - comp
Mann-Whitney U	493,500
Wilcoxon W	1439,500
Z	-2,002
Asymp. Sig. (2-tailed)	,045

a. Grouping Variable: How much data included - comp

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