Aalto University
School of Electrical
Engineering

Selam A. Kebede

Effects of Quality of service on video-chat users

Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology.

Thesis supervisor: **Docent Kalevi Kilkki**
Aalto University
Thesis Instructor: **Docent Kalevi Kilkki**
Aalto University

Aalto University

School of Electrical Engineering **Abstract of Master's Thesis**

Author: Selam A. Kebede

Name of the Thesis: Effects of Quality of service on video-chat users

Date: 30.06.2013 **Language:** English **Number of pages:** 17 + 59

School: School of Electrical Engineering

Department: Department of Communications and Networking

Communications Ecosystem **Code:** ETA3003

Supervisor: Docent Kalevi Kilkki

Instructor: Docent Kalevi Kilkki

The fundamental objective of this thesis is to single out the most influential quality and usability factors on video-chat services. The main reason for pursuing this research is that discovering these specific quality factors will enable engineers and scientists to set the right priorities when they work on either improving or inventing a better quality of video-chat services. Even though, the study of human behavior is out of the scope of engineers and technologists, knowing the basic preferences of users towards the current digital communication media, such as video-chat services is significant. It is only when technologists understand the users' behavior and their interaction with technology that they could improve or invent new products / services that consider the users' overall experience. Therefore, in this thesis has conducted basic behavioral and emotional studies by using method from the social sciences in order to give conclusions on the major technical quality factors that affect users most.

Keywords: Quality of service, Quality of experience, Flow-theory, Technology acceptance, Emotions, User behavior

Acknowledgement

Writing this thesis has been an amazing journey. Every step was a lesson that thought me the skills and limitations I had. The ride was filled with a range of emotions and I cannot even think about arriving at this point without everyone that supported me. Here is where I realized how much I needed others as much as I needed myself. Therefore, I would like to thank my family to whom distance did not matter and kept encouraging me every single day, my best friends for keeping me just the right level of insane and everyone else for hearing me out in my moments of desperation and for the great words of encouragement. I honestly would not have done this without each one of you.

Finally, special thanks to Juuso Karikoski for his professional support and to my instructor, Kalevi Kilkie for giving me all the space and time I needed to figure out what I want to do and for allowing me to try my best and push my limits in every step I took.

Again, thank you very much every one!

Selam A. Kebede

30 June 2012

Espoo, Finland

Table of Contents

ABSTRACT OF MASTER'S THESIS I
ACKNOWLEDGEMENT II
TABLE OF CONTENTS III
LIST OF FIGURES IV
LIST OF TABLES IV
ABBREVIATIONS V

1 INTRODUCTION 1

2 LITERATURE REVIEW 4

2.1 Technology and User Behavior 4
2.1.1 Technology acceptance model (TAM) 5
2.1.2 Flow theory 6
2.1.3 Media richness theory (MRT) 8
2.2 Quality in use 9
2.2.1 Usability 9
2.2.2 Flexibility 10
2.2.3 Safety/Security 11
2.3 Quality of service (QoS) 11
2.4 Quality of experience (QoE) 13
2.4.1 User Experience (UX) 16
2.4.2 Emotions 19

3 METHODOLOGY 22

3.1 Data Collection 26
3.2 Survey 27

4 RESULTS 31

4.1 Background Information 31
4.2 Major Usability Factors 31
4.3 Effect of Quality of service 34

5 RESULTS ANALYSIS AND DISCUSSION 37

5.1 Finding 1: Major Usability Factors 37
5.2 Finding 2: Quality of service vs. Emotions 41
5.2.1 Anger vs. Optimism 42
5.2.2 Disappointment and frustration over video-freeze 47
5.3 Limitations 49
5.4 Practical Implications 50

6 CONCLUSION 52

APPENDIX A – BACKGROUND INFORMATION 60

APPENDIX B – USABILITY FACTORS 61

APPENDIX C – QOS VS. USER'S EMOTIONS 63

List of Figures

FIGURE 1 TECHNOLOGY ACCEPTANCE MODEL (TAM) 6
FIGURE 2 STRUCTURAL EQUATION MODEL (MODIFIED TAM WITH FLOW-EXPERIENCE) 8
FIGURE 3 THE QUALITY IN USE MODEL 9
FIGURE 4 RELATIONSHIP BETWEEN QUALITY OF SERVICE AND QUALITY OF EXPERIENCE 16
FIGURE 5 BUILDING BLOCKS OF UX 17
FIGURE 6 EMOTIONAL GUIDANCE SCALE 20
FIGURE 7 BAD IS STRONGER THAN GOOD, THE 5 TO 1 RULE 21
FIGURE 8 RESEARCH MODEL 26
FIGURE 9 IMPORTANCE OF VIDEO-CHAT SERVICE 32
FIGURE 10 RESPONSES ON USABILITY FACTORS 33
FIGURE 11 FLOW WITH IN COMPUTER MEDIATED ENVIRONMENTS, MODIFIED FROM [67] 40
FIGURE 12 ANGER VS. OPTIMISM 43
FIGURE 13 ANGER VS. OPTIMISM 43
FIGURE 14 VIDEO JITTERS / VOICE IS WORKING 44
FIGURE 15 VIDEO PLUS AUDIO JITTER 46
FIGURE 16 PERSONAL VS. BUSINESS 47
FIGURE 17 PERSONAL VS. BUSINESS: 48
FIGURE 18 EFFECT OF QOS ON FLOW EXPERIENCE 54

List of Tables

TABLE 1 FACTORS AFFECTING QUALITY OF SERVICE ON VOIP AND VTOIP COMMUNICATION NETWORKS 13
TABLE 2 QOS MEASUREMENT PARAMETERS 14
TABLE 3 QUALITY IN USEFACTORS 28
TABLE 4 PART I : BACKGROUND INFORMATION 31
TABLE 5 QOS VS. EMOTIONS 42
TABLE 6 QOS VS. EMOTIONS 42

Abbreviations

ITU	International Telecommunication Union
MNT	Media naturalness theory
MRT	Media richness theory
QoE	Quality of experience
QoS	Quality of service
TAM	Technology acceptance model
TRA	Theory of Reasoned Action
UX	User Experience
VoIP	Voice over internet protocol
VToIP	Video-Telecommunication over Internet Protocol

1 Introduction

Digital communication media has radically revolutionized our contemporary world. For many people, it has become evident that they have become heavily dependent on their smart phones. In addition, the introduction of social media has disrupted the existing way of communication in just a few years. Furthermore, we now have the luxury of seeing each other while talking, regardless of our physical location in the globe.

The concept of simple video-chat emerged at about the same time as telephony itself [1] and scientists used to refer to video-chats as 'video-telephony'. However, delivering and integrating this technology into the daily life of users took more than 100 years. In fact, several turns and paths had to be taken by scientists and researchers in order to make video-chat service available for the majority. Most of the researches in this area show that there are five major reasons for the slow adaptation of video-chat services [2]. These major factors include usability, accessibility, ubiquity, Quality of service and cost. Even though all of those factors have significant impacts on video-chat service, usability and Quality of service are considered to be the two major factors.

Usability of the service is the first major factor which affects users' behavior. Since engineers that develop the communication media are not experts in human behavioral aspects of technology usage, researchers from the social sciences have been enlisted to analyze the topic from their point of view. These social science experts have recently developed new theories and models that focus on identifying technology adaptation by users [4] [5], the nature of the media [6], and the effect of computer mediated media (CMEs) on users [7].

The second major factor is the concept of Quality of service. The term Quality of service (QoS) refers to the technical aspects' quality of the actual methods used to deliver the service. The service, in our context, video-chat, will be immensely affected by the slightest technical failures or quality issues. While quality issues

directly affect the users' perception of the service, these perceptions on the other hand determine the continuance of use by the users [3].

In recent years, the topic of 'effect of video-chat on users' behavior' has become one of the top research agendas in different schools of thought. Behavioral and social scientists are interested in discovering the reactions of users when using these communication media. These researchers [1] [2] [3] [4] are not concerned about the technical aspects of video-chat services but rather the impact on end users. In contrast, Engineers and IT specialists are striving to invent or at least improve the existing video-chat experience without fully understanding the basic impacts of the technology on the users' behavior.

In the past few years, major knowledge exchange has been occurring among these researchers from different schools [5] [6]. Theories such as the Technology acceptance model (TAM) [3], Flow theory [4], and the 'Quality in use'' framework [7] [2] developed by behavioral Scientists have significantly helped technologists to further understand human nature. In addition, after the publication of those theories and models, large number of research has emerged both from the engineering and the social science schools on the topics of quality and usability, respectively. Yet, few interdisciplinary studies exist that examine the effects of these major factors on each other and the user. Hence, the main purpose of this thesis is an attempt to fill the gap between these two schools of thought.

The thesis will implement methods that are normally used by behavioral and social sciences to identify and explain the effects of technology on users. To be more precise, this thesis has two main targets. First, it aims at identifying the main features that particularly make video-chat services useful. Second, the thesis intends to determine the effect of Quality of service on the behavior of the users of video-chat services.

The remainder of the thesis is organized as follows. Chapter 2 discusses the major literature used to construct the research model. Chapter 3 will briefly discuss the methodology. The major theories and models implemented in constructing the research framework are thoroughly explained in this chapter.

A survey method will be used to gather the main data for the thesis. Chapter 4 clearly describes the empirical findings. The outcomes between this small-scale research and the results from other major research in this topic will be illustrated in order to give broader integrity for the research. Chapter 5 briefly analyses the results and explains the reasons contributing to the conclusion. Finally, based on the research findings, Chapter 6 will present the final conclusion drawn from the research. Strength and weaknesses of the current video-chat services will be discussed while the chapter suggests possible future improvements on the major quality parameters that most affect the users' behavior.

2 Literature review

Quality is a term or rather an elusive concept used to describe the level of excellence of a product and/or a service. Quality can be subjective or purely quantitative. Therefore, whenever quality gets reviewed, having a frame of reference is required before hand. Furthermore, while the concept of quality in products is simple to comprehend, analyzing Quality of service is a matter which requires in depth analysis from a different perspective. Understanding Quality of service requires vast knowledge on the grounds that will lead to compare and give judgments.

In the course of this chapter, we will briefly go through the most fundamental theories and models applied in this thesis. These models have been selected from numerous others because they have shown direct relation to the topic at hand and are able to address the queries we are set out to answer. Note that the service in our context refers to the general service of 'video telephony over the Internet protocol' (VToIP) or in other words, it refers to simple video-chats.

2.1 Technology and User Behavior

As we set out to explore the fields that will assist in solving the research questions stated at the dawn of this paper, the following few major behavioral theories serve as a phenomenal starting point. These theories help in understanding the basic interaction of the user with technology.

Users' acceptance and usage of technology have been assumed to be mainly affected by perceived-ease-of-use and perceived-usefulness of a service/ product. However, this assumption only is not entirely relevant for all types of technologies. Although these two factors mainly affect the first steps of usage of a technology, there are still other variables that determine the user's opinion about the service/product. Therefore, in the sub-sections below we will briefly explore the major theories and models that were used in forming the outline of this research. These main topics discussed are: the most widely accepted

behavioral science theories on basic human-to-computer interactions such as: Technology acceptance model (TAM), Flow theory, Media richness theory (MRT) and Quality in use theories ,the nature of communication media, models and research methodologies, and the very basic concepts and measurement methods of Quality of service and Quality of experience.

2.1.1 Technology acceptance model (TAM)

Technology acceptance model (TAM) has been developed to explain and predict users' acceptance of new technology. This model is based on the original work of Fishbein and Ajzen [8] which is known as the Theory of reasoned action (TRA). The TRA has widely been used to predict and explain various domain of human behavior. The theory drew distinction between two constructing blocks of attitude. These blocks were: attitude towards the object and attitude towards the behavior. In general the TRA assumes that "the social behavior is motivated by the user's attitude towards carrying out that behavior, which is a function of his /her beliefs about the outcome of performing that behavior and the evaluation of each of those outcomes" [9].

Based on the above stated distinctions set forth by TRA, therefore, the Technology acceptance model (TAM) proposes to have its main focuses on attitudes towards using a system, service or technology in general. TAM suggests that the perceived usefulness and perceived ease-of-use of a system, technology and/or service are the major determinants. The original words of the Technology acceptance model (TAM) were as follows,

"User's overall attitude toward using a given system is hypothesized to be a major determinant of whether or not the user actually uses it. Attitude toward using, in turn is a function of two beliefs: perceived-usefulness and perceived-ease-of-use. Perceived-ease-of-use has a direct effect on perceived-usefulness. Meanwhile, system design features directly influence perceived-usefulness and perceived-ease-of-use. Hence, system design features have an indirect effect on attitude toward using and the actual usage behavior through their direct effect on perceived-usefulness and perceived-ease-of-use [3]*".*

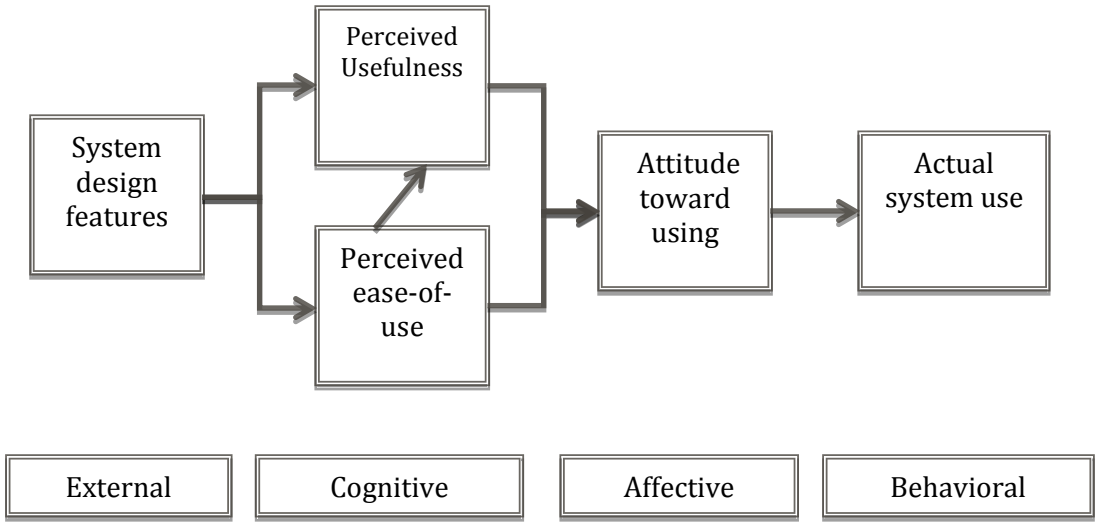

Figure 1 Technology acceptance model (TAM)

In general, TAM defines perceived usefulness as "the degree to which a person believes that using a particular system would enhance the experience" and perceived ease-of-use as "the degree to which using the technology will be free of effort" [10]. There have been quite many research results that approved the viability of TAM in the study of digital interactive media. However, this model does not fully address the actual situation of video-chat services. Therefore, Flow theory and Media richness theory (MRT) will be exploited to get better perspective when examining the research questions.

2.1.2 Flow theory

The Flow theory has its origin from the desire to understand the phenomenon of intrinsically motivated behavior apart from any extrinsic behavior that might result from the activity [4]. According to [11]

- Extrinsic motivation refers to "the desire to perform an activity because it is perceived to yield to distinct and valued outcomes."

- Intrinsic motivation refers to "the desire to engage in an activity for no other reason than the process of performing it."

- Flow is defined as the holistic sensation that people feel when they act with total involvement.

This definition suggests that when people are in the Flow state, they become absorbed in their activities and almost lose their self-conciseness. Their total awareness is focused on that particular activity and they feel like they have control over their environment [12]. When attention is completely absorbed in the challenges at hand, the person will achieve an ordered state of consciences [4].

The basic Flow model can be described as consisting of four components: control, attention, curiosity and intrinsic interest. In the quest to find a model that measures the customers experience in online environment, [13] came up with a more elaborated model of Flow. This model indicates that speed of interaction and characteristic of interactivity, corresponds to the increase in focus of attention, telepresence and time distortion, or in short, increased Flow experience. In addition, the higher the interactivity level of the media the more attractive the media will be. Therefore, the occurring chance of Flow-experience is very high. The fact that interactive media adds significant value to the Flow experience will be elaborated by the Media richness theory (MRT) in the next section.

Making use of the above references and other relevant research results, H.H. Chang [9] developed a unique model that incorporated the concept of Flow in to the Technology acceptance model (TAM). In this model, the main focus the research emphasized is that external factors such as system characteristic, individual's personalities, and cultural influence have major impacts in the building blocks of TAM. However, the basic intrinsic behavioral motivations have a stronger and more powerful impact on the users' perception of usability of a product/service. In other words, the theory of Flow has been carefully placed as the third factor that affects the usability of a service/product. The model has produced quite satisfactory outputs in researches conducted in the area of computer-mediated-communications (CMCs).

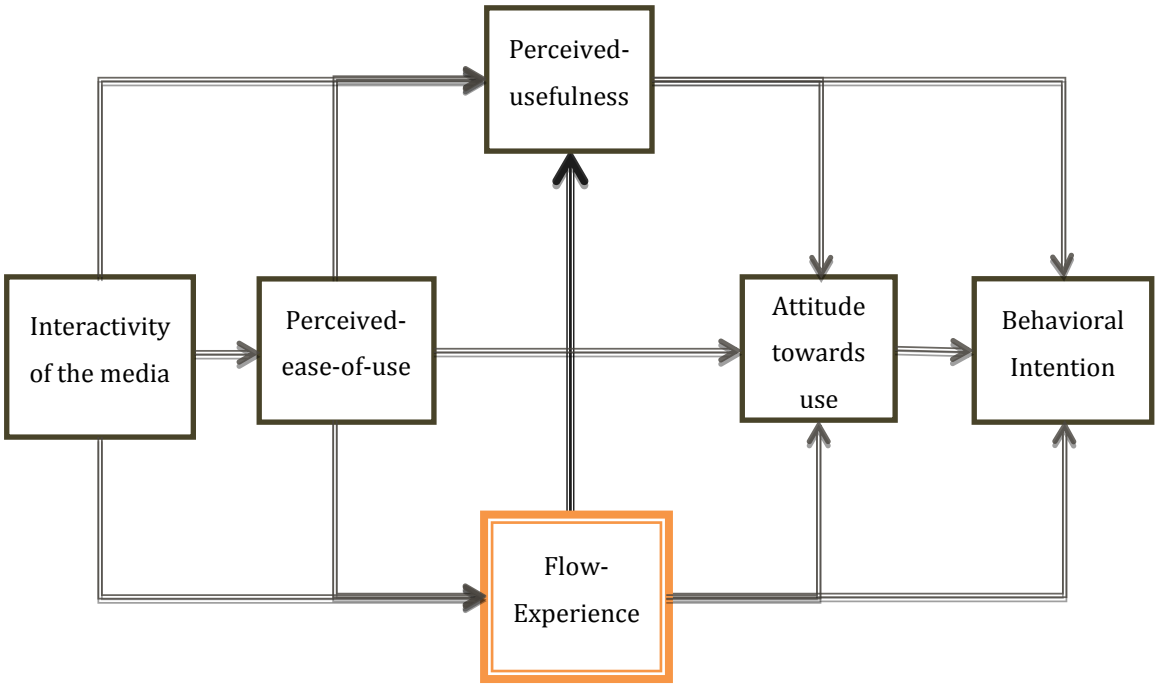

Figure 2 Structural Equation Model (Modified TAM with Flow-Experience)

2.1.3 Media richness theory (MRT)

The Media richness theory (MRT) states that "The performance of a task will be improved when task information requirements are matched with a medium's ability to convey information richness" [14]. This theory brings forward four major media capabilities that are considered to be the building blocks of a rich media. These capabilities are feedback capacity, utilized channels, language variety and personal focus. The richness of a media is measured by comparing it with Face-to-Face communication. According to MRT, a media is rich if it allows users to interact and interpret difficult and complex matter.

However, rich media does not imply 'best media' for every scenario. Sometimes even if the media is rich additional considerations such as: the 'social code' of using such media, requirements that must be fulfilled to be able to pursue smooth communication and understanding level of the person using the media must be taken in to account. There are some tasks that require specific type of media regardless of the richness level and hence, there have been research

conducted to propose a modified version of the MRV to specifically explain such discrepancies [14].

2.2 Quality in use

Despite the lack of a clear general definition to specifically define the term 'usable' or 'usability', the year 2006 has seen a major breakthrough. In this year, there has been a merger between two standardizing giants, the Consumer Interest Forum (CIF) and the International Organization for Standardization (ISO). Following this merger, some terms and concepts had to be clearly re-defined in order to give holistic and simple descriptions. Therefore, the term usability has been incorporated inside a model known as 'Quality in use'. The model of Quality in use comprises three major parts that are assumed to effectively describe and measure the overall usage of a product/ service [15].

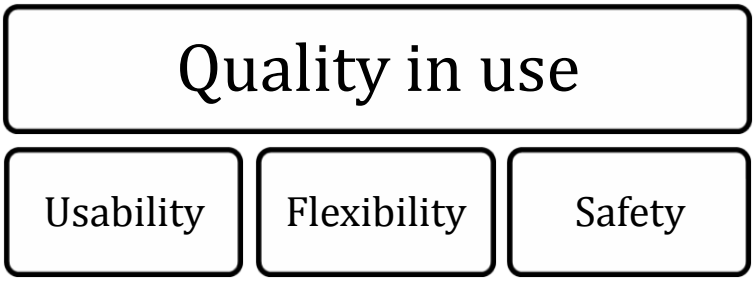

Figure 3 The Quality in use model

2.2.1 Usability

Traditionally, usability was referred to the attributes of the user interface which makes the product/service easy to use [16]. Usability has also been equally understood with the concept of operability. Furthermore, there has been certain research that specified the main traits for a product to be usable although it generates no utility. According to these researches [17], usability traits such as, the system configuration, social and practical acceptability, cost, compatibility, reliability, usefulness and utility directly affect the usability of any product or service.

In the Quality in use model above, usability is believed to be composed of effectiveness, efficiency and satisfaction. The ISO 9126-1 [7] describes usability as: “The extent to which a product can be specified to achieve specific goals with effectiveness, efficiency and satisfaction in a specified context of use”. Some literatures refer to usability as being one part of the factors that affect the Quality of experience QoE. In the model above, the usability characters, effectiveness and efficiency are defined as accuracy && completeness and resources expanded, respectively. However, the concept of satisfaction is more subjective and will be briefly elaborated in the following paragraphs.

Satisfaction is a term which includes feelings that are related to aspects such as enjoyment, fun, happiness or in general feeling positive. Unlike some might argue; satisfaction cannot be measured so long as the effectiveness and the efficiency of using a certain product or service can be measured. As has been clearly pointed out in [18], satisfaction is composed of two major parameters. These parameters are pragmatic user goals and hedonic user goals.

The pragmatic user goals refer to the ‘to do’ part of the user intention. These goals are directly related to the perceived experience related to efficiency, effectiveness and safety. On the other hand, Hedonic user goals refer to the ‘to be’ intention of the user. Hedonic quality itself is defined as “quality dimensions with no obvious or second order relation to task related goals such as originality, innovativeness and so forth” [19]. Hence, the hedonic user goal refers to the level of enjoyment or positive feeling in general after using the product or service.

The ISO/IEC CD 25010.3 [20] summarized the above mentioned parameters as: likability (cognitive satisfaction), trust (satisfaction with security), pleasure (emotional satisfaction) and comfort (physical satisfaction).

2.2.2 Flexibility

The second major division of quality of use is flexibility. This part refers to the ability of the product or the service to allow different ways of conducting the task. It also refers to the physical ability to be moved or altered in shape and

position in certain product types. In general flexibility has been defined to have three different characters [16]. The first one is context conformity which describes the extent to which "usability and safety meet requirements in all the intended contexts of use". The second characteristic is related to the extendibility of the context. This characteristic refers to the ability to extend the usability beyond the initially intended purposes. The third one is accessibility and it has been defined as "the degree of usability for users with specified disabilities" [16]. Separate consideration of flexibility of a service/ product significantly assist the identification and understanding of the factors that directly affect usability from factors that affect the quality of use in general.

2.2.3 Safety/Security

The safety measure is introduced in order to get an idea of the possible negative factors that could affect the quality of use. The first two measures explained above, the usability and flexibility, generally measure the possible benefits the user may obtain. However, assessing the potential failures or rather, shortcomings of the product/service will considerably help in understanding and improving the service/product in the future. In ISO/IEC 25010.3 [20] safety has been defined as "The degree of expected impact of harm to people, business, data, software, property or the environment in the intended context of use."

2.3 Quality of service (QoS)

Generally Quality of service (QoS) refers to the provision of the negotiated and demanded quality between user equipment and the radio access network as well as the core network [21]. Given the elusiveness of the concept of quality, trying to quantitatively measure it, poses a prominent challenge. In fact , at the moment, there are only two standards (ITU-T Rec.J247 [22] and ITU-T G.1070 [23]) set forth by the International Telecommunication Union (ITU) that are being implemented. There is also one additional measuring method which is waiting to be fully standardized. This method is called the perceptual evaluation of video quality algorithm (PEVQ) [24].

The lack of simple, chap, less complicated and parameterized measuring methods for QoS has been the main challenge in obtaining a lucid standard quality in the VToIP communications. Regardless of these phenomena; Engineers, scientist and researchers alike have been conducting studies by using other methods to identify the main factors that determine the quality of voice and video-chat systems. These methods include identifying key quality indicators, live testing and using objective methods.

Given the wide range of possible quality measures, when it comes to voice and/or video-chats, Quality of service specifically refers to the network/application layer side of the communication service. That is, the measures are conducted to analyze the quality of the data transfer over the end points, session border controllers (SBCs), gateways, calls servers, proxy servers, and packet switched and sometimes also circuit switched networks.

Research findings that studied Quality of service from the network side indicate that the major factors that affect the VoIP/VToIP services are stated in the table below [25]. In fact, these factors are the major determinants that directly affect the Quality of experience perceived by users [26].

Communication Layers	Quality Parameters
Network Layer	• Connection Failure • Latency • Jitter • Packet Loss • Burstiness of loss and jitter

Application Layer	• Resolution • Frame rate • color • Video and audio codec type • Layering strategy • Sampling rate

Table 1 Factors Affecting Quality of service on VoIP and VToIP Communication Networks

Jitter: A natural result of buffering in packet switched networks. Whenever packets are buffered, the information about their inter-packet timing is lost and this phenomenon causes the situation known us jitter. [27]

Brustiness: When the bandwidth allocated to a particular flow is less than the peak rate of that Flow, the packets at the peak of the Flow fluctuation are still buffered and smoothed. This type of buffering is determined by the burstiness in the traffic flow itself [28]

On the other hand, the perception of the user is used to measure the Quality of experience (QoE) of that service. The term Quality of experience refers to the measurement of the users' intuition about the overall Quality of service.

2.4 Quality of experience (QoE)

The Quality of experience (QoE) is a concept that originated to fully describe the impact and/or perception of QoS by the user. Quality of experience (QoE) is more concerned with the overall experiences the consumer has when accessing and using the provided service. According to the international telecommunication union recommendation ITU-T SG12 [29], QoE is described as “The overall acceptability of an application or a service, as perceived subjectively by the end user which may be influenced by the user expectations and context”. From this statement, one can understand that, although ensuring Quality of service in the

service provider environment is still a crucial matter, this alone will not guarantee the users' perception of the experience.

QoE is highly subjective and unlike the QoS quantifying its traits is much more tougher then quantifying QoS traits. It is highly recommended to understand the major factors that affect QoE's characters before attempting measuring it. According to [30] the parameters are divided in to three groups. The First parameter is the quality of the video or audio content at the source, the second parameter refers to how the content is delivered over the given network and the third parameter is the human perception. The first two parameters are what we call the Quality of service (QoS) in general and are relatively simple to measure while the third one is purely subjective.

Quality Parameters	**Measurement method**
Quality of video/audio at the source	Quantitative measurement
Quality of service delivery	Qualitative and quantitative measurement methods
Human perception	Qualitative measurement

Table 2 QoE Measurement Parameters

Various types of such subjective data collection and analysis methods exist for the purpose of quantifying QoE parameters. One such widely used measurement metric is called Mean Opinion Score (MOS) [31]. The Mean Opinion Score (MOS) is a numeric value between 1 and 5, with 1 representing the lowest quality. The minimum threshold for acceptable quality corresponds to a MOS of 3.5. The MOS was used for voice measures before the arrival of VoIP services, and its value is relative. Nevertheless, it is not unusual to find values obtained from MOS measures being put as an absolute score.

Generally there are 3 possible methodologies for measuring QoE [30]

1. Trying to predict the Quality of experience by monitoring several QoS parameters in real time. This method is also known as “Reference free Measurement” [31].

    - If the QoS parameters are precisely identified and controlled a correlation between the results of the QoS and the perceived Quality of experience can be measured by precisely identifying and controlling the QoS parameters of the simulated environment. Hence, correlation between QoE and QoS parameters could be established.

2. The Reduced-Reference model: works when there is a limited knowledge of the original stream and tries to combine real time measurements in order to predict the QoE.

3. The Full-Reference model: Assumes full access to the original service under consideration and the measurement is conducted in real time environment.

From the above models, it can be deduced that using the full-reference model will yield the most accurate measurement result. Unfortunately, this method is also the most challenging, expensive and time consuming. Specially, the issue of having control over the entire network from the point of transmission to the reception is an immense challenge which makes this model undesirable. The reference free model is the one which is easily adaptable however; it is also the one which provides with the least accurate results.

The international telecommunication union ITU, therefore, has provided additional recommendations on the practicalities that must be taken in to consideration while conducting a QoE measure [32]. The recommendation has included factors such as: the video display size, brightness, and contrast, resolution, viewing distance, peak luminance of the screen, colorfulness and

naturalness. The synchronization between video and audio and echo are also major factors that affect the perception of the user. Gender, educational background, social status, language skills, environment, relationship to the person with whom the user is having conversation with are more factors that could affect the final result of the QoE study. Therefore, in order to get the holistic view of the Quality of experience, we will briefly see the user experience theory in the next sub-chapter.

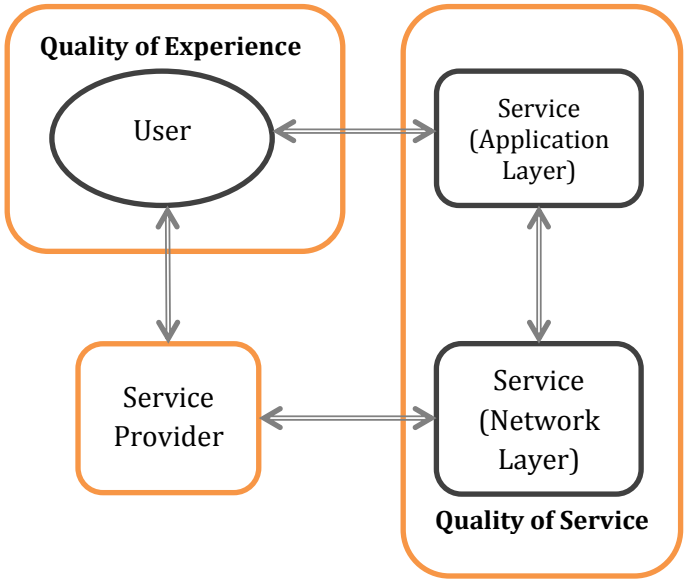

Figure 4 Relationship between Quality of service and Quality of experience

2.4.1 User Experience (UX)

Studies that revolve around 'the user experience' have become quite popular in past couple of decades as the on-line interactive media gains popularity across the globe. Research dating back to 2001 mainly concentrated on establishing a common ground or a shared view of what it means to have ‘a good user experience’ [33]. These researches have strived to define the user experience in simple terms. They have tried to find algorithms and models to measure it clearly. They argued over instrumental behavior over non-instrumental needs. They argued over pragmatic aspects of products such as behavioral goals against hedonic aspects such as interaction with relevant others. The bottom line is, all these works tried to enrich the current models of product/service quality and the user satisfaction.

The ISO 9241-210 [2] defines UX as “A person’s perceptions and responses that result from the use and/or anticipated use of a product, system or service”. This definition specifies that user experience is a concept that could be measured by using behavioral and attitudinal metrics of usability. Meanwhile, the recent studies of human-computer-interaction (HCI) [34] indicate that as technology matures, interactive products and services become not only useful, but also trendy and desirable. Thus, contemporary researchers are working on methods to measure the UX from the clear user experience point of view.

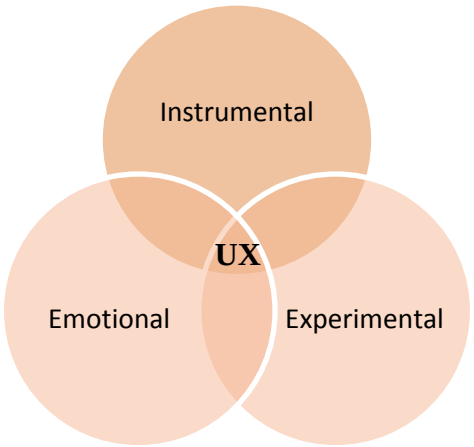

Figure 5 Building blocks of UX

According to [35] we now have two basic models to analyze the UX. The first one is called the measurement model while the second one is called structural model.

The measurement model has included four main factors that affect the user experience. This constructs are:

- The perceived hedonic quality
- The pragmatic quality (perceived usability)
- Aesthetics and
- Overall product/service quality.

The structural model, on the other hand, compares the relationship between the user experiences criteria stated above in a cause-effect manner.

Drawing our attention back to video-chat services, the UX is mainly affected by the level of engagement it provides to its users. Hence, good user experience means high level of user engagement and interactivity. User engagement on the other hand is directly affected by the quality of the service. According to [36] the main factors that directly affect the user experience of video-chat services could generally be divided to four aspects, these are

1. **Sensory:** the pleasure gained through the senses by using that product/service

2. **Emotional:** the aspect that refers to the pleasure of the ego-emotions. In other words, it means the ability to be able to feel emotions while using the particular product/service

3. **Cognitive:** describes the pleasure gained from being empowered, to be able to use one's own intelligence, knowledge or competence in order to use the system, product or service.

4. **Social:** the aspect where the user feels social-emotions, for instance, affection, happiness, identifying with others.

Generally there are two basic ways in dealing with emotions in UX. The first way is to stress on the importance of emotions as consequences of product use and the second way to concentrate on their importance as antecedents of product use and evaluative judgments [33] .Therefore, in the heart of the user experience UX, we find emotions playing a great role affecting the users' perception of the service.

Emotions are the sensors that allow us to feel our environment and react to triggers accordingly. In the next sub-chapter we will discuss the nature of emotions and briefly describe the measurement methods that will later be used in this research. The primary purpose of this research is to find out the prominent factors that affect the usability and user experience of video-chat services.

2.4.2 **Emotions**

Just like quality, defining the term “emotion” presents a notorious challenge. Although the term is being used almost by everyone on day-to-day basis; a single scientifically agreed upon definition does not yet exist. Emotions are subjective and their degree varies based on the stimulating factors. In fact many Scientists could not come up with a simple agreeable definition and hence decided to narrow it down to: “Emotions are what people say they are” [37]. Hence, in order to narrow down the concept, the following few main topics of emotions that most researchers agree on were presented by Ekman [38].

First, all researchers agree on the fact that an emotion is a physical and mental reaction in response to information processing and evaluation of provoking events. The major possible triggers that will cause an individual to react are events, appraisals, response synchronization and rapidity of change, behavioral impact, intensity and duration of the triggering factors. Second, there are expressive and physiological changes that are somewhat distinctive for each emotion. Emotions can be observed either by non-verbal reaction such as facial expression or via physiological indicators. These reactions on the other hand, can be used to infer the emotional state of a person. Third, emotion involves a subjective experience or rather a state which includes feelings, moods and /or attitudes. However, the terms do not represent the exact same phenomena [38]. Feelings, for instance, represent a single subjective experience. However, emotions refer to the total multi-modal component process. Furthermore, emotions are not to be considered as a cognitive phenomenon, rather they are reactions based on the strength of the affective stimuli and can be described according to the strength of the stimuli. For instance, the degree of affection to someone can progress from attraction to love.

Before setting out to measure emotions, the characteristics of emotions must be distinguished from other states. However, this is one of the major obstacles that pauses a challenge to the measurement of emotion in general. In a nut shell, emotions are made up of reaction components that are behavioral, expressive,

physiological and subjective [39]. Despite the fact that measuring emotions is a challenging task, there are various methods proposed by scientist and researches from all over the globe. Most of these models usually refer to two of the most astounding scientists in this area Robert Plutchik and Paul Ekman. Even though, there are others who have contributed as much, in this research the models proposed in the references [40] [41] [42] [43] [44] are used to pursue the study in measuring the effect of quality in the user's emotional experience. Plutchik [45] proposed that there are 8 basic emotions and the other emotions fall under these categories. These basic emotions are: trust, joy, fear, surprise, sadness, anger and disgust. On the other hand Paul Ekman have outlined in his paper "all emotions are basic" [46] that anger, fear, sadness, enjoyment, disgust, may be surprise, may be contempt and maybe shame/guilt to be the most basic human emotions that can readily be observed.

From the two major emotion measurement frameworks and additional similar proposed models, therefore, one can deduce a simple guideline by sensibly merging them all together. This has been done by many other researchers in accordance with the type of study they had under consideration. In this thesis, we will use the 7 emotion scale proposed by [47] and the order of the emotions by forwarded by Hicks [48] is demonstrated as follows. The proposed emotional scale puts the most positive emotions on top and puts the more negative emotions at the bottom.

Figure 6 Emotional Guidance Scale

During the analysis phase of this thesis additional theory known as “Bad is stronger than good” will be taken in to account. This theory emphasizes on the mere fact that human beings perceive bad situations, comments or bad phenomena in general to be much more stronger than the good ones. In fact, the theory states that it is the bad emotions that trigger change or make the person start asking questions than the good emotions. Bad information is processed more thoroughly [49] and hence significantly influences the user experience.

Results of research conducted under the “bad is stronger than good” topic show that a single bad comment /situation is perceived to be 5 times greater than a positive one. This implies that for every bad comment there must be 5 positive comments in order to even out the emotional effect on the person. This study has also been mentioned in many books and researches including [5] [50] [51] [52].

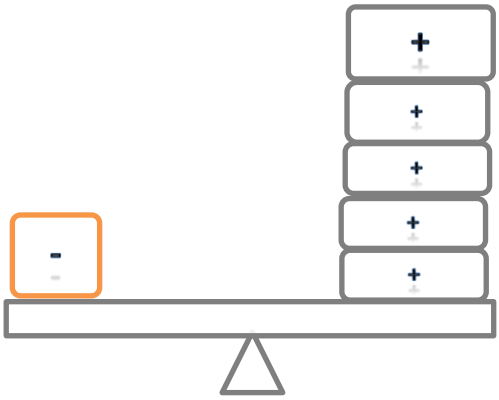

Figure 7 Bad is stronger than Good, the 5 to 1 rule

Based on the above mentioned studies, it is now possible to wrap up the chapter by giving some general comments for the research that will take place later on in this thesis. In order to measure the effect of QoS on and also to figure out the part of the video-chat service that attracts the users most, recommendations forwarded by the ITU [32] will be followed. The next chapter will give a step by step review of how the thesis was constructed, the theories are applied and the research is conducted.

3 Methodology

Based on the literature reviewed, the current chapter intends to present the research methods and models followed in order to pursue the research. There have been various important topics that are directly and indirectly related to the topic under consideration. However, having these wide range of theories and frameworks helped in strengthening the proposed framework in this thesis and the reliability of the upcoming results.

The two main inquiries this thesis intends to explain are

1. **Why do people use video-chat services? And**

2. **How does Quality of service (in this case, the quality of the video-chat) affect the user behavior?**

From the questions above, we can understand that there are two distinct issues at hand. These issues have a slight cause-effect relationship with to each. The approach followed and how the theories were synchronized is explained in detail in this chapter. Before going deep in to the details of data collection and analysis methods, the main theories were initially divided in two parts.

Part one is concerned with the very essence of starting and continuing to use technology in general. Starting with the Technology acceptance model (TAM) and later by embedding the Flow theory in to the Technology acceptance model (TAM), it will be possible to understand the core intentions of users' behavior towards technology. Using the pre-determined or rather previously conducted research results, we would be able to link the user behavior before starting to use the technology. However, our main concern is not the users' very first steps and their intentions to use the technology but rather to exactly recognize the main motives in continuance of use.

In Quality in use theory we will find several important indicators on why people generally use a particular kind of service/product. The basic measures of the

usability of any product/service are its effectiveness, efficiency and satisfaction it provides to the users. The video-chat technology/service is, therefore, ideal when it comes to effectiveness and efficiency measurement. However, the big challenge is posed when trying to measure the level of satisfaction by the users. Given the subjective nature of the idea of satisfaction, the same video-chat service can be assumed to be 'the best' or 'the worst' based on the users' expectation and values. In general we will be trying to understand the users' perspective of the video-chat usability by categorizing the data in to pragmatic and hedonic user goals. Pragmatic user goals refer to the part of the service which allows the user to do something. These goals by the user are strictly concerned with the activities they are able to carry out and hence their satisfaction is mainly based on the level of pragmatic ability of the service. Simultaneously, the hedonic goals refer to the pure quality dimension side of the service. The users who are expecting to be entertained or to enjoy using the service measure their satisfaction based on the hedonic abilities of the service. In this thesis, we will be considering both satisfaction measures when analyzing the data of video-chat usage.

The next step in part one is analyzing the flexibility of the service. We will try to see what users think about the video-chat services in general. Furthermore, to gain more incite about the service, users' opinions about video-chat and mobility will be analyzed. Considering the fact that the number of internet users over mobile devices outstripped the desktop users, understanding the mobile platform and the user perception is considered to be valuable information. Flexibility refers to the physical interface, extendibility and amount of effort required to scale up the service to other devices, time and space. In our case we will be considering video-chats over smart phones and note books.

The final step in part one will be the condition of safety. Safety issues are needed to be considered to give an overall view of the service. Safety is an important factor that solely affects the users' willingness to use the service or not. Especially when it comes to communication technologies, the topic of safety is rather sensitive. Unless the service proves to have a plausible level of security, at

least at a personal user level, it will affect the overall usability to a great extent. We will be gathering information about this particular factor and analyze the users' perception of safety when using video-chat services. This would be the last factor to consider for the first part of the thesis. After getting the information about these usability factors we will then proceed to the second part.

Part two is mainly concerned with quality and issues related to quality. The issue of quality in any service is quite important and this factor is even more important in the service of video-chat. The video-chat service is directly affected by the slightest malfunctioning at any point of the service and the effect is remarkable. Usually engineers are more concerned about numbers hence they measure the Quality of service (QoS) based on these measurements. While this measurement is quite important to understand the overall Quality of service, additional methods are required to quantify the users' experience of the same service. In other words, while "good" numbers mean good Quality of service, the same phenomena does not guarantee good Quality of experience.

In general, the Quality of service (QoS) refers to the network side of communication services. Therefore, we will need more measures to understand how the user gets affected by the quality identifying features. As mentioned in the literature review, there have been quite many studies focused at identifying the major quality factors. Therefore, these studies have put forward the major factors that affect video and audio-chat services in general. In the next step of identifying how quality affects users' behavior, we will be using these major quality identifying factors to get to know the particular effect they have on the user's specific emotion. The quality factors under consideration are the once that are found in the network layer of the communication system. These QoS factors include, connection failure, latency, jitter and resolution and color.

While setting the quality parameters is one first step in to actually conducting our research, the other side of the table is still unknown. The user behavior is as diverse as the user itself. Furthermore, there are significant amount of factors that could affect the users' perception and overall experience of using a

particular service. Therefore a deeper understanding of the human behavior, to be more precise, a deeper understanding of human emotions is profound.

Emotions are like sensors. They are the methods our body and mind react to certain internal and/or external triggers. The study of human emotions and behavior has been going-on for centuries and up-until this day, a specific and simple definition of the term emotion itself does not even exists. As stated in the literature review, for lack of a better option, Scientists have agreed to define emotions as "emotions are what people say they are" [53] The existence of different languages or different words for similar feelings in the same language has increased the discrepancy among the definitions from all over the globe. [54] In fact, it is almost impossible to know whether, for example, the one person is feeling might not be the same 'happiness' the another person is referring to [37].

Despite the above fact, by carrying out extensive researches and analyzing human and animal behavior in general, scientists have come up with some 'basic' emotions .The basic emotions are assumed to be felt by almost every human being and the triggers and the accompanying reactions to the corresponding triggers are quite similar regardless of the gender, nationality or geographical location of the person. Therefore we will be matching these 'basic' emotions with the quality factors. The quality factors stated above will be used as the trigger and we will be analyzing which of the basic emotions will be felt by the user. The emotional scale we use will be the one illustrated in the literature review, figure 6. Conducting the research this way will directly address the research question at hand by providing us exactly how the quality factors affect the users' emotions. Once the emotions are listed out, analyzing the quality of experience will be the last phase of the research to obtain the total overview.

Once the emotional impact of the Quality of service (QoS) is analyzed, the general Quality of experience (QoE) will be rather simple to draw. The Quality of experience refers to the impact of Quality of service on the user. The term Quality of experience sees the service of video-chat from three different aspects. The first aspect is the quantitative quality of the video. This refers to the physical

measurable quality. The second aspect is the way the service is being provided to the user. This part refers to the most of the topics discussed above, to be more specific, the Quality in use. The final aspect refers to the pure user perception of the service. This part refers to the emotional impacts of the service on the user. Since by this time we already have all those parameters measured, it will be the final part of the research.

The final data analysis will be conducted by taking in to account the user experience study recommendation by the ITU [31]. The user experience (UX) study takes in to account factors such as aesthetics and the whole interaction design [55]. We will be using both QoE and UX measurement tools to finalize our data analysis and the results will be presented as one.

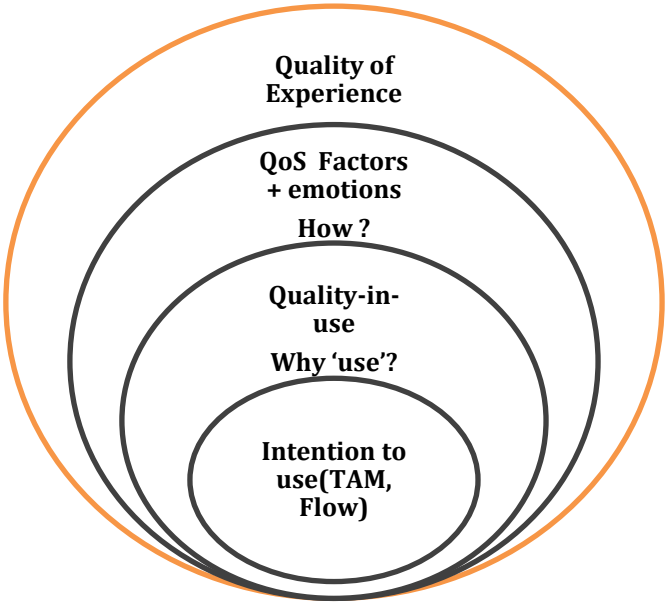

Figure 8 Research model

3.1 Data Collection

Although there are various methods of data collection and research methodologies in general, basically they are all divided in to two. Quantitative and qualitative research approaches. In addition, a newer version of research methodology with the name interpretive approach has also been widely accepted. Interpretive approach is not qualitative approach and by no means these two are not interchangeable [56].

Case study is a method that allows researchers to investigate topics that are not readily covered by other methods. Although there are other methods that disclose most of the parts concealed by case study method, case study method comes in handy when the research question is either “how” or “Why” [57]. Case study method helps in an “empirical inquiry that investigated a contemporary phenomenon with in lists real–life context, especially when the boundaries between phenomenon and context are not clearly evident” [58]. Therefore, case study is usually carried out under the normal, real life condition of the subject being studied. In addition to the reasons mentioned above, one must use case study method to illuminate or to get an in-depth understanding of similar situations.

Using the guidelines from the above mentioned and other reference materials, this thesis will use case study method in general and survey method in particular in order to gather the data from the users of video-chat service.

3.2 **Survey**

The data collection was pursued by using simple internet based survey. These surveys are preferable methods since they are much cheaper, data can be gathered faster than most of the other methods, yield higher response rates , are neutral, and can reach to respondents that are not exactly in the same place and time [59] [60]. In addition, video-chat is a service used by people who cannot exactly be at the same place, at the same time. Therefore, it was only natural to conduct the research by conducting a survey questioner online in order to reach out as many people as possible, possibly in the actual setting where video-chats are conducted.

The survey has 3 parts. The first part requests basic background information of the person. This information included gender, age, and nationality and latest educational status. These questions were included in order to give an idea of the user group. At the same time, it has been mentioned in [32] that these information is important in drawing the final data analysis. Understanding the

user group is a crucial step in data analysis and hence this is an important part of the survey. The 'nationality' question had been included to give additional information about where the data was coming from.

Part two concentrates on the general 'Quality in use' of video-chats. However, before going deep in to the Quality in use questions, basic information on whether the person has ever used video-chat and how important the video-chat the service is was requested. The Quality of service measures have been put as a control unit and a 5 choice Likert scale type questions were provided for the user to place the level of agreement with the questioner.

Quality in use measures	**Questions based on the Quality in use measures**
Usability • **Effectiveness** • **Efficiency** • **Satisfaction**	You use video-chat because it is • Cost effective • Efficient • Gives the feeling of being there
Flexibility	• Mobile devices and video-chat
Security	• Secure means of communication • Reliable

Table 3 Quality in use factors

The main question forwarded were first requesting the user if they use video-chat for given factors listed such as, cost efficiency, over all experience (Hedonic quality= fun, enjoyable), efficiency, pragmatic experience (to do = feeling of being there), security and reliability. These general usability measures were drawn

from the Quality in use theory mentioned in the literature review by simply modifying the words in to something that the users could relate to. Additionally, an option to specifically describe a situation where the user would need to use video-chat because there is no other means that will replace this functionality was given.

The last part is concentrating on the effect of Quality of service on the users' behavior. Here, we will find the questions directed to measure the effect of quality on the emotions of the users. Essentially, this part is divided in to two scenarios, which were classified based on the relationship of the users who are having the conversation. This measure was taken to clearly identify the effect of quality on the user, based on the relationship of the users. It was mentioned above that when it comes to personal interaction, emotions are mainly affected by the kind of relationship the people undergoing the interaction [61]. That is, for instance, a person will feel different when a certain quality measure affects the communication based on whether he is talking to his girlfriend or his boss.

The questions were presented as follows. First the scenario expressing the kind of relationship and the situation was stated. Then, the major quality issues described in the QoS factors in [25] were listed allowing the person to choose the specific emotions he/ she feels when the interruption happens. The quality factors used were the once that are supposed to have direct impact on the smooth flow of the communication and hence intrinsically affects both of the users. The Quality of service factors were: connection failure, video getting stuck, resolution issues, jitter and audio/video synchronization. In addition, some form of comparison was conducted between video and audio quality issues in order to understand the factor that most affects the user. More questions directed at understanding the users' expectation and hedonic and pragmatic satisfaction were set forth. An option to elaborately describe the users' opinions on the issues of multi –tasking availability and the overall Quality of service and Quality of experience on video-chat was provided.

In essence, the survey results are going to be used as the main source of data for the research at-hand. Furthermore, comparisons with other "similar" survey results will be made when analyzing the data. The survey was released online from 10th of May 2013 till 20th of May 3013. The survey can be found in the appendix section A, B and C.

4 Results

4.1 Background Information

The survey had received 120 responses within 10 days. All of the responses were complete and usable for data analysis. From all the responses, 95% of them were between age of 21-30 and only 5 % were between the ages of 30-40. Unfortunately there were no teenagers nor were there people above age 40. The gender ratio was 60% male and 40% female. The educational background of the respondents was 60% graduate, 22 % undergraduates and 18% post graduates. And finally, there have been respondents from 23 different countries in 4 continents. Interestingly enough 49% of the replies were from Africa, 32% from Europe, 12% from Asia and 7 % from both north and South America.

Age	
21-29	95%
30-39	5%
Gender	
Male	60%
Female	40%
Continents	
Africa	49%
Europe	32%
Asia	12%
America	7%
Educational Status	
Graduate	60%
Undergraduate	22%
Post graduate	18%

Table 4 part i : Background information

4.2 Major Usability Factors

In part two we find that 99% of the respondents have confirmed to use video-chat. Furthermore, for 66% of the respondents video-chat was a very important communication tool. 22 % of them described the service as fairly important. 10%

of the respondents replied by saying the service was not important for them at all.

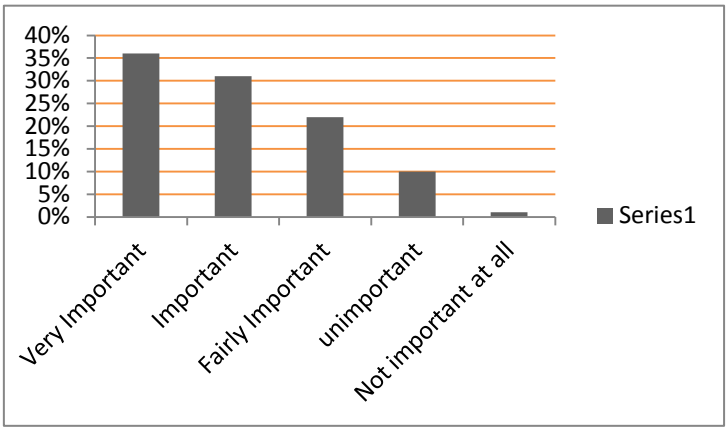

Figure 9 Importance of video-chat service

The second question was directed at the main intentions towards using video-chat. As stated above in the methodology, the questions included 6 major Quality in use factors using a Likert scale of five ranging from strongly agree to strongly disagree. The results show that the feeling of "being-there", in other words being effectively practical accounted for the highest percentage compared to all the other factors. 76% of the respondents said they agree on the fact that video-chats' main use is the very essence of the service itself. That is, providing the users with the ability to see and interact with others who are not in the exact same location. The next major reason for the use of video-chats was its cost-effectiveness. Around 70% of the respondents pointed out that they use video-chat because it is cheap. Efficiency of the communication media was backed up by 69% of the respondents while the service being fun/ enjoyable had 62% of the vote. The reliability of the service and the overall feeling of security have shown the largest amount of negative or almost negative response from the users by representing 39% and 40% of the responses respectively.

Next to the above inquiries we find the questions from the 'flexibility' quadrant of the Quality in use factors. These questions were presented to understand the users' thoughts about video-chatting on mobile devices. The size of the screen is put as one of the major determining factors that could affect video-chat/video

conferencing experience. Therefore the replies to this question are expected to provide us with quite interesting incite about the mobile video-chatting experience. 51% of the user responded they totally agree about the whole idea of 'mobile video-chatting' and 18% of them were neutral while 27% of the respondents absolutely disagree!

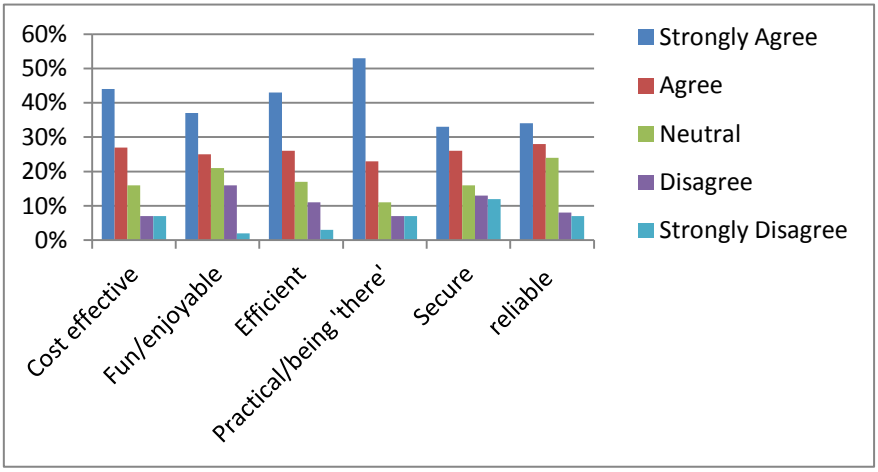

Figure 10 Responses on usability factors

The next questions were proposed to further understand the absolute main reasons on usage of video-chats. There were similar Likert scale type questions asking the respondents if the content of discussion matters for choosing video-chat over the other existing media. In addition, questions directed toward the effect of screen size on the usability of the service on mobile devices and about additional functionalities of video-chats were proposed. There was also an open ended question that allowed the users to put their reason in their own words.

For the first question, while 44% of the replies indicated that they will need to use video-chat when having major topic to discuss 27% replied that they are neutral and having "very important matter to discuss" does not mean needing to use video-chat. In fact about 30% of the replies have shown that they completely disagree on the proposed relationship between the video-chat usage and importance of the content of conversation. For the second set of questions that focused on flexibility and screen size, the results were quite as expected with 55% responses saying having smalls screen size will affect them to a great

extent. 63% of the respondents also showed that having aided services such as being able to type (text chat) and additional features such as sharing screens are of a great value to the service. The results for the open-ended type question are stated as follows. For the record, these questions were placed in the part III of the survey for diversification purpose.

Most of the users seem to have a common use for video-chat service. That is, business meeting or interviews from locations that are far to reach. In addition there have been quite many responses that emphasized on the use of video-chat for long distance relationships. The fact that the basic video-chat services are either free or very cheap seems to back up the data gathered above with more elaborate explanation for their usage. The other major usability factor proposed was the ability to conduct simple "video-conferencing", a normal video-chat with more than one person. One respondent has mentioned that video-chat is not an "ordinary phone call" and therefore the service's value is quite high. Another person responded that in near future better quality video-chat services that could allow multiple conversations and participants for basic devices should be implemented. It was apparent from most of the users that the expectations for this service are quite high and if the service fails to meet these expectations the effect would be drastic. We will see the effect of failure to meet expectations on the users' behavior in the following sub-chapters and in the analysis section of the thesis.

4.3 **Effect of Quality of service**

This last part of the survey is directed at finding out the effect of quality on the users' behavior. There were exactly similar seven questions for two different scenarios. The scenarios were drawn based on the type of relationship the user has with the other person he/she is chatting with. The first scenario was dedicated to friends, family or significant others while the second one refers to strictly-business/formal conversations using video-chat services. These conversations refer to meetings, interviews or group works where none of the participants have other personal interactions with each other.

In both scenarios, the initial call is assumed to have been established and a full conversation has begun. The quality factors therefore, are assumed to interrupt these well-established conversations. Since all the 7 major quality parameters were presented in both cases, the results presented below are the once that have shown significant difference between the personal and the business-chat scenarios. Although with varying degree, the quality issues of: connection failure, resolution/visibility, video and audio jitter and video and audio un-synchronization have shown similar results while connection failure, video-freeze and jitter returned significant differences between the two scenarios.

When the "connection fails": 36.5 % said they will feel disappointed while 26 % of the respondents answered that they will feel frustrated. On the other hand 22% replied they will feel angry for the case of "business talks" while only 7% replied the same for the case of "personal-chat".

When the "video gets stuck while the voice works just fine": 35% replied they would feel frustrated while 22.5 % said they will fell hopeful for both cases. On the contrary, 22% of the respondents said that they will feel disappointed when they are talking to their personal contacts in contrast to the 6% when having business-chat.

When the overall visual quality of the video became an issue, 33.5 % felt frustrated while 27.5 % felt disappointed. In addition about 21.5 % felt hopeful/ optimistic about the phenomena.

When the video starts to Jitter (voice is working fine in this case) quite an interesting result was obtained from the respondents. 26% of respondents show that they will feel hopeful/ optimistic if they are talking to their personal contacts in contrast to the 31% of the responses that showed anger when it is the business scenario.

Furthermore, when the video and audio start to jitter, 24% of the respondents say they will feel angry/raged when speaking to their personal relationships while only 6% registered to be angry when having a business-chat. In addition,

when the audio and video are not synchronized, 33% felt disappointed, 30% felt frustrated and 18% felt angry.

The last question of the survey was an open ended question providing the respondents with an opportunity to input their feedback about what they believe to be a "quality video-chat experience". Here are few of the most concrete replies that indicated quality issues not raised in the questioner.

In the respondent's own words, they said that "quality of video-chat experience includes many parameters including

- *Additional feature such as, being able to leave a video message (like a voice mail) will be great.*

- *Sound, sound, sound! Sound is what comes first! Even though it is a video-chat, if the voice is not working there is no reason in using the service on the first place*

- *Regardless of the resolution, no jitter please!"*

5 Results analysis and discussion

The above chapters have clearly stated that this research is mainly concerned with identifying major factors that affect the usability and users' behavior of video-chat services. The first quest was to identify the major reasons for the usage of video-chat services. And the second mission was dedicated to identifying the effect of Quality of service on the behavior video-chat users. In chapter 4 above, the reader will find the raw data obtained from the survey. Therefore, in the current chapter, we will explicitly analyze the results obtained from the research in relation to the proposed models and frameworks.

5.1 Finding 1: Major Usability Factors

The major technology acceptance and technology usability theories state that for a technology to be accepted and usable it has to fulfill certain basic requirements. The Technology acceptance model (TAM) clearly states that the perceived ease-of-use and the perceived usefulness of a technology will attract and influence the initial stages of usability [3] [12] [62]. The Flow theory on the other hand, states in addition to the perceived ease-of-use and usability of the technology, the overall 'immersion' of the user when using the technology/service/product will have a greater impact on the usability of the service.

According to the results, therefore, the video-chat service fulfills the above initial requirements. The simplicity of the service accounts for the very first steps of using the service. The service provided, being the second major cause for the usage and the attained Flow-experience, increases the major intrinsic initiations towards using the service. After ensuring the users acceptance of the service, the next steps include discovering the factors other than the once mentioned that have influenced the continued use of the video-chat service. Considering the amount of alternative digital and/ or analog communication methods, such as normal voice call, instant messaging and social media, the quest to further understand the user must be intensified. In addition, getting to know the basic reasons for the continued usage of video-chat service is fundamentally

important. The quality in use parameters and results therefore will be used to measure the usage of technology.

The international standardizing organization's (ISO) definition for the Quality in use specifically states that [63] "usability of a product/service is composed of efficiency, effectiveness, satisfaction, flexibility and safety of the service at-hand". The relationship between Quality in use and the service characteristics therefore, depends on the user's personal expectation and behavior [64]. Based on our research we have narrowed down the major usability factors of the video-chat service to these four major factors. These are: Practicality, cost-effectiveness, enjoyability and mobility.

1- Practicality

Practicality falls in line with the theories of Media richness (MRT) and Media naturalness (MNT). It is fundamental for a communication media to be as close to a face-to-face communication as possible in-order to provide the highest level of interaction between users. If it was not for this very ability provided by video-chat services, there is no other competitive factor for the service to survive in this industry. People are already used to having telephones and recently instant messaging and social media have revolutionized the communication ecosystem. Hence the main differentiating and competitive factor for video-aided-communication media is the fact that people could actually see each other when they talk. Almost obviously, therefore, this ability has gained most of the votes from the users for being the main reason to use video-chats.

This ability of "feeling like being there", however, puts significant pressure on video-chat services. When dealing with video-chats quality is the main factor that affects the users most. Although users are both intrinsically and extrinsically motivated to use the service, concerns related to Quality of experience (QoE) pose an extensive challenge towards the continuance of use. We will briefly explain how quality affects users in the next sub-chapter.

2- Cost effectiveness

The world is getting smaller by the minute and people have started travelling much more than they used to. For many of us, it has become a prominent reality to, for instance, keep a long distance relationship ,work from abroad and/or have an international team of people from all over the globe. In our contemporary world, therefore, the usages of video-chats have shifted from being a luxury to being vital means of communication.

Cost effectiveness appears to be the second major drive that that affects the initiation to use video-chat services. According to our research, most of the users responded by emphasizing that they use video-chats because the price to these services is either free or close to nothing. The fact that operators charge large amount of money for international calls was pointed out to be the foremost reason for the usage of VoIP and VToIP services for basic voice calls [65].

3- Enjoyable experience

Setting the basic importance aside, having a good experience is the other major factor that affects users' intrinsic motivation to use a product / service. Flow theory is the generally accepted theory to explain the experience felt when individuals are interacting with and through computer mediated environments (CMEs) [66]. Given this fact, Hoffman and Novak [67] proposed a modified model that included 'telepresence'. This modified model, clearly states that services that provide "the feeling of being there" such as video mediated chat services, provide greater amount of 'Flow' and therefore are quite enjoyable/fun to use.

In contrast, although video-chat services provide the user with great Flow-Experience, all the quality issues related to the service extremely affect this particular factor. The Flow-Experience is gained by the pure intrinsic motivation of the user. Therefore, regardless of the perceived-usefulness and perceived-ease-of-use the disruption of the 'Flow' accounts for the perceived poor Quality of experience by the user.

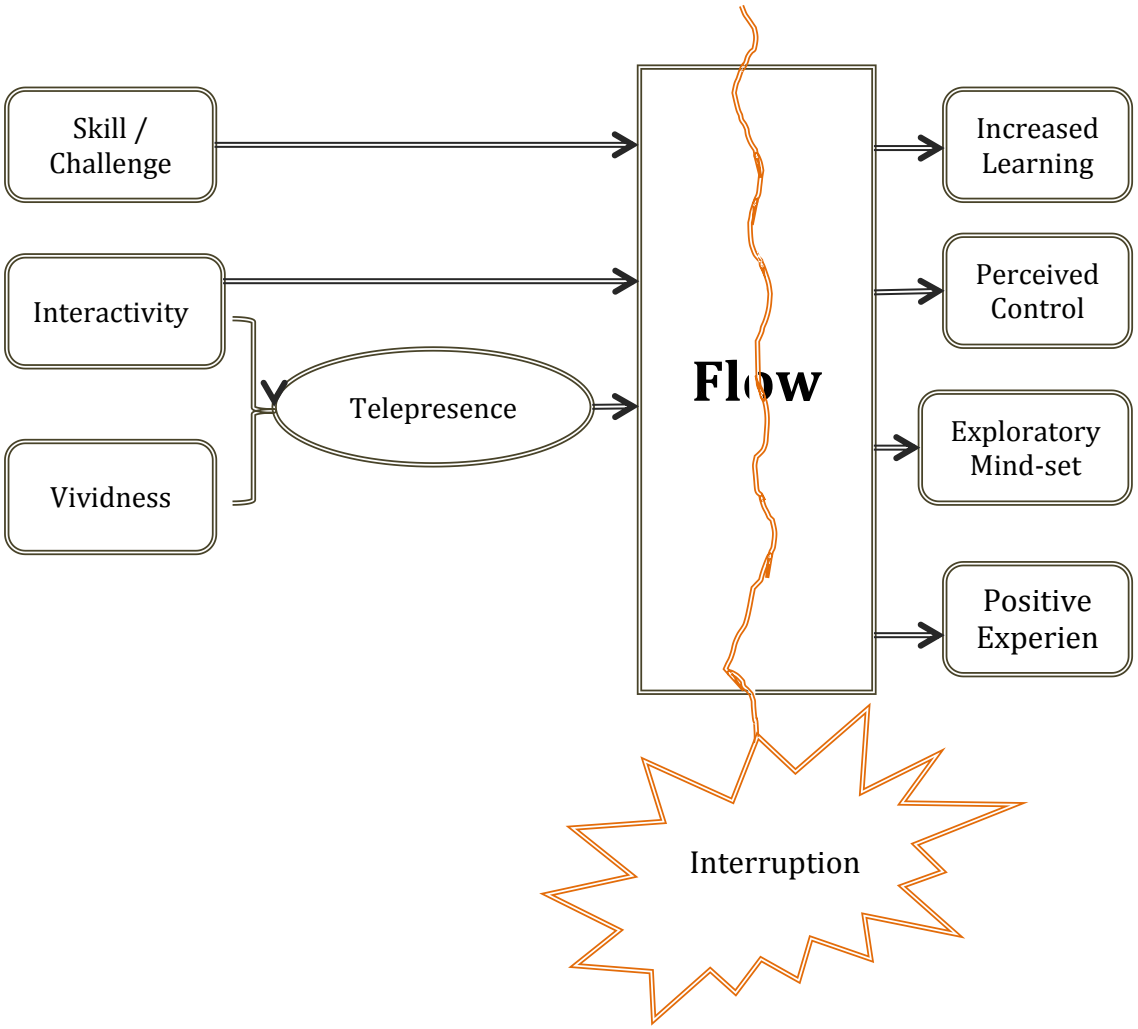

Figure 11 Flow with in computer mediated environments, modified from [67]

4- Mobility/Flexibility

Mobility/flexibility is a rather controversial factor compared to all the others. According to the results most users said they like the fact that they can use video-chat services via their mobile devices. However, they have also mentioned that they are highly affected by the screen size of their devices. The results specifically stated that smaller screen sizes will lead the users from less to almost no usage. Hence, the conclusion that could be drawn from these results is that most people use video-chat services just as a simple voice call service when they are on their mobile devices unless they necessarily need to show something for the person on the other end. Furthermore, this suggestion matches with the fact that most users being more sensitive to voice quality than video quality. Detail analysis on the quality factors is found in the next sub-topic.

Finally, the result has shown that the major Quality in use parameters of **Security** and **Reliability** to be the least driving factors on the usage of video-chats. Similar to other usability factors this phenomenon is mainly caused by the existing Quality of service issues related to video-chat services. Users appear to be very skeptical about the reliability of the service. The continued disruptions of the current free and/or cheap and personal versions of video-chat service account for these opinions about the reliability of the service. In addition, in many undemocratic countries governments have complete power of the communication media and the calls are intercepted and/or "listened" by the authorities. Most of the data came from such authoritarian countries; hence, the results found were fairly expected.

5.2 Finding 2: Quality of service vs. Emotions

In the heart of the user experience we find the emotions of the user. Emotions are the basic factors that direct the person whether he/she is feeling good or bad. It was this basic fact that initiated the approach followed by this research. Understanding the specific quality issues that directly bring about particular strong emotions is a fundamental discovery to improve those parts of the video-chat services. Obviously, the less the user feels negative the better the user experience will be. However, few interesting discoveries were made regarding this matter while we analyzed the results of our research.

The table below shows the overall data and the highlighted parts in both tables indicate the discoveries. These major 'findings' will be discussed in broad detail in the paragraphs that follow. While the table shows the full data obtained from the results, the highlighted part shows the surprising results that show difference between the personal and the business chats. Here, it is simple to notice and compare the quality factors and the corresponding emotions they triggered

	Connection Failure	*Video freeze*	*Resolution Issues*	*Video Jitter*	*Voice Jitter*	*A&V Jitter*	*A&V Unsync.*
Joy	5 %	1 %	3 %	2 %	1 %	0 %	0 %
Enthusiasm	7 %	4 %	4 %	4 %	6 %	1 %	1 %
Optimism	4 %	18 %	21 %	26 %	5 %	1 %	1 %
Frustration	34 %	48 %	37 %	37 %	35 %	30 %	30 %
Disappointment	42 %	22 %	28 %	34 %	29 %	39 %	39 %
Anger	7 %	5 %	8 %	4 %	21 %	24 %	24 %
Fear	3 %	3 %	0 %	3 %	3 %	4 %	4 %

Table 5 QoS vs. Emotions
Result = Personal-chat

	Connection Failure	*Video freeze*	*Resolution Issues*	*Video Jitter*	*Voice Jitter*	*A&V Jitter*	*A&V Unsyc.*
Joy	6 %	2 %	1 %	1 %	1 %	0 %	1 %
Enthusiasm	3 %	3 %	4 %	1 %	2 %	2 %	2 %
Optimism	8 %	27 %	22 %	4 %	3 %	23 %	3 %
Frustration	18 %	22 %	30 %	30 %	26 %	33 %	26 %
Disappointment	31 %	6 %	25 %	26 %	34 %	23 %	34 %
Anger	22 %	5 %	5 %	31 %	20 %	6 %	20 %
Fear	7 %	9 %	3 %	8 %	5 %	8 %	5 %
other	6 %		10 %		9 %	8 %	9 %

Table 6 QoS vs. Emotions
Results = Business-chat

5.2.1 Anger vs. Optimism

Most of the emotions felt by the users for both the “personal-chat” and “business-chat” scenarios were extremely similar. Meanwhile, particularly two basic emotions stood out for two specific quality factors. The two emotions are anger and optimism while the two quality factors are Voice-only jitter and Voice plus video jitter. The emotions show a complete inverse-proportionality as expected, however, the order they appear for the proposed scenarios are not the same. This phenomenon triggered the detailed analysis on the matter to further understand the connection between relationship between the people, the particular quality factor and the specific emotions felt following the interruption. The following graph briefly indicates the phenomenon.

In the graph below, 1 = connection failure, 2= video freeze, 3 = **Resolution issues, 4 = Video Jitter, 5 = Voice Jitter, 6 = A+V Jitter, 7 = A+V Synch**

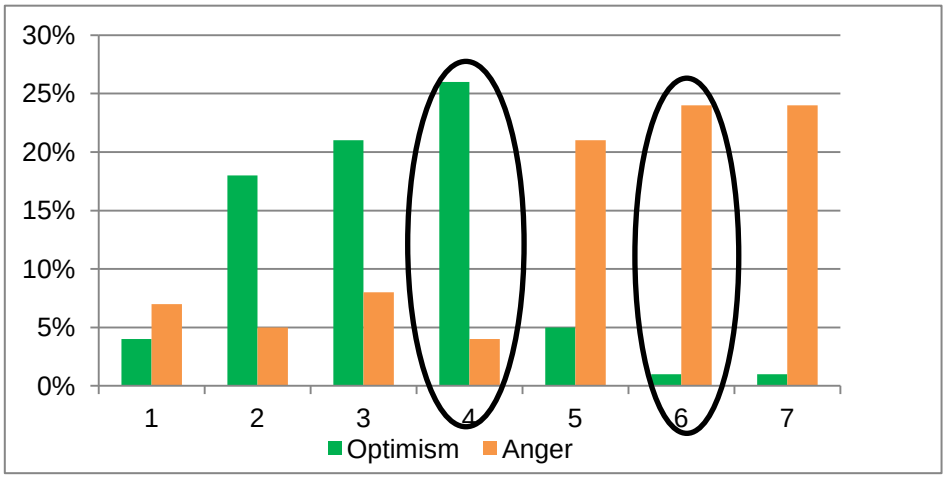

Figure 12 Anger vs. Optimism
Case: Personal-chat

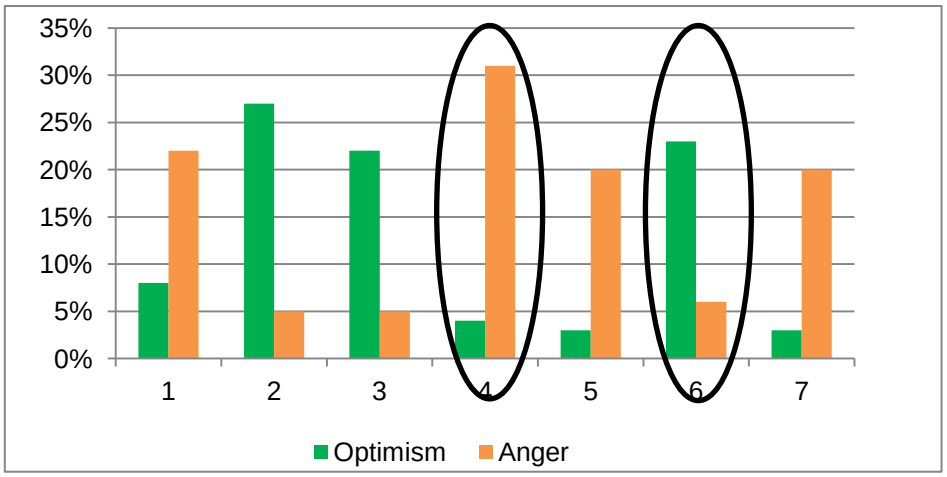

Figure 13 Anger vs. Optimism
Case: Business-chat

1- Video Jitter

The first finding discussed will be the relationship between video jitter and the emotional reactions of the two scenarios. In this finding, we can observe that users are more sensitive to video jitter when having business talks. The first scenario, that is when the talk is personal, users do not take offence at the video-jitter issue as long as their conversation is uninterrupted. In fact, according to the results of the survey, they are rather more optimistic about having a better quality. One possible explanation for this situation could be the fact that the

individuals conversing already know each other and they already know that they will see each other again. In addition they are not worried about being judged by the other party for having "bad connection" or device. Hence a strong negative emotion such as anger is not felt in this case.

In the second scenario however, the reaction was the complete opposite to the first. For the case of business video-chat, large amount of respondents emphasized that the automatic emotion felt is anger. The definition of anger states that [68] "Anger results from interaction outcomes in which expected, customary, or deserved status has been denied or withdrawn by another actor who is seen to be responsible for the reduced status".

Given that these people have no personal relationship, having video-chat with each other implies that the face-to-face conversation was highly necessary. If that was not the case, the normal voice call would have done the job. Hence, the users expect to have a tolerable quality of video when they pursue their conversation. When their expectation fails to meet the reality, therefore, anger becomes the natural reaction to the situation.

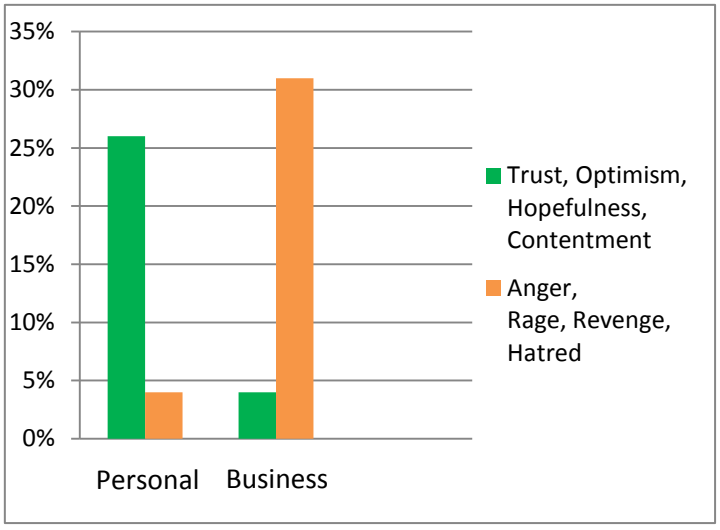

Figure 14 Video Jitters / Voice Is Working

2- Video + Audio Jitter

The second finding is a continuation from the quality issue observed on the first finding. Here, both the video and audio are presumed to suffer from jitter. As

described above, the type of relationship users have and/or the purpose of their conversation determines the emotional reaction they evoke for the interruption. Unlike the "video-only-jitter" the voice plus video jitter triggers anger in personal-chats in contrast to hopefulness brought up in the business-chat scenario.

Since the personal conversations are more focused on having deep conversations filled with emotions, the slight form of voice-interruption has significant impact on both parties. People do not use video-chat if the very basic voice-chat is not working properly. This is a very sensitive quality factor and there lies absolutely no tolerance for such incompetence. In fact, similar research has shown that people rather have a connection failure than a jitter [69] when having video-chats. Therefore, even though the users were feeling optimistic when the video-jitters while the voice was working fine, for the case of both voice and video jitter anger is somewhat the inevitable emotion. Note that, emotions arise in response to "events that are important for the individual's goals, motives or concerns"; therefore, having the voice-jitter, as mentioned above, is something not to be tolerated.

The emotions of anger are directly related to the amount of "power" the person has over the situation [70]. For instance, when connection failure occurs, the user is aware of his/her ability to re-start the conversation by calling again; hence the negative emotions felt do not go as far as Anger. However, for the case of jitter, the connection is not fully disconnected, hence the user is left to wait until the connection sort its self out. Usually, users will not automatically disconnect the chat when jitter occurs because they are still feeling somewhat hopeful for the conversation to continue again without having to re-start the call. This failure to meet their expectations, therefore, leaves the users absolutely powerless and their emotions instantly switch from optimism to frustration /disappointment and finally turn in to anger.

On the other hand, in the case of business-chats the results were astonishingly opposite to what we have seen for personal-chats. For this scenario, the users are rather optimistic about the situation instead of feeling angrier. This is one of

the most surprising results from this thesis and also the one that requires further investigation. The situation could be roughly explained by two possibilities.

The first possibility could be that users do feel optimistic thinking the worst thing that could happen is the connection failure. Restoring the connection gives more power to the user than sitting there and waiting the issues to resolve its' self. Therefore, users feel more hopeful by the prospect of having at least some kind of control over the situation if in the end the system fails to resolve the problem [70]. The other alternative explanation could be the fact that business conversations are not filled with deep emotional and personal talks has its own impact on the strength of emotions felt by the users. Hence, users may actually feel optimistic even though their conversation was disrupted. The final explanation could be that this result is an error caused by small sample size or inappropriate response. May be the respondent did not understand the scenario properly when giving their reply. It is apparent that voice is stronger quality factor than video. Therefore, the optimism felt by the users when malfunction of both qualities suffices might just be the effect of wrong data.

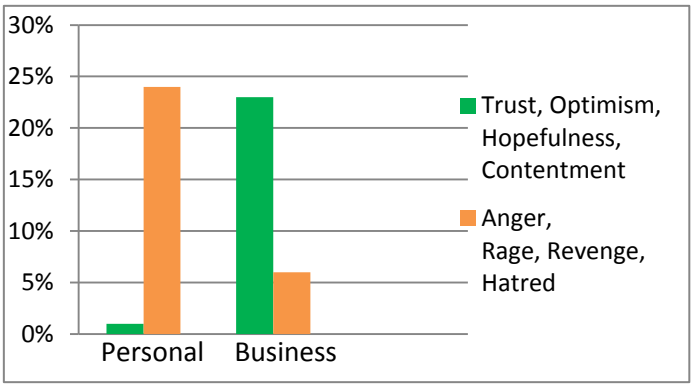

Figure 15 Video plus audio jitter

3- Video freeze and connection failure

Anger and connection failure

In addition to jitter, the second quality factor that brings about anger on the users of video-chat is connection failure. Even though, we have found in our research that connection failure is less trigger for strong emotions, the type of

relationship and the content of conversation strictly determine the reaction of the user. We can observe that the personal-chat scenario presents less anger towards connection failure in comparison to the business-chats. This case can easily be explained by the fact that the business-chats are more serious and hence need strict flow of conversation. In these cases any simple form of interruption will cause significant destruction. Close comparison to business-chats is the actual face-to-face business meetings and we all know how formal and strictly un-interrupted those meetings are. Therefore, when the user is expecting, even to a small degree, similar situation while having a video-chats, the connection failure is in fact a significant negative surprise. However, as mentioned above, the ability to re-connect almost instantly leaves some room for tolerance and keeps the users from switching to other means of communication. Unless the service is improved, therefore, it is a matter of time for a new-and-better products to take away all users.

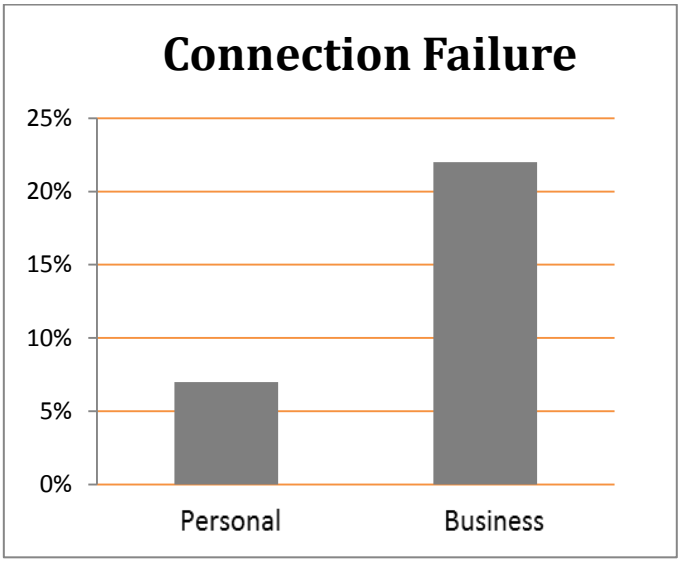

Figure 16 Personal vs. Business
Anger towards Connection Failure

5.2.2 Disappointment and frustration over video-freeze

The last finding in the Quality of service vs. emotions study is the reaction of users when the video-freezes. In general, video-freeze issue is found out to be one of the least factors to affect users. However, a distinct difference between the personal and the business-chat scenarios yet show a big gap in the users'

reaction towards the situation. Although disappointment and frustration are weaker emotions compared to anger or fear, the fact that most users highly felt frustrated and disappointed for personal-chats compared to the business-chats indicated the perception of the issue is not the same for all cases. As mentioned in the previous analysis for the other major factors, video-chats are used for sensitive conversations accompanied with facial expressions and gestures. Regardless of the type of relationship, interruption of such conversation naturally evokes negative emotions. However, in the case of personal-chats, this quality issue entails staring at a frozen screen impatiently and hence the level of frustration and disappointment rises if the situation is unresolved. On the other hand, when using video-chat for business purposes and such situation interrupts the conversation, the users will automatically start looking for a solution rather than feeling negative and powerless. Most of the respondents to the questioner have stated that when a situation like this happens, "they would re-start the video (or even may be the call itself) because the video is very important and there is no point in continuing the conversation if the video is not working". Here, the users are already prepared on what their next action is going to be if the video-freezes. This preparedness provides them with a mental control of the situation and hence do not go far and feel strong negative emotions such as frustration, disappointment or anger.

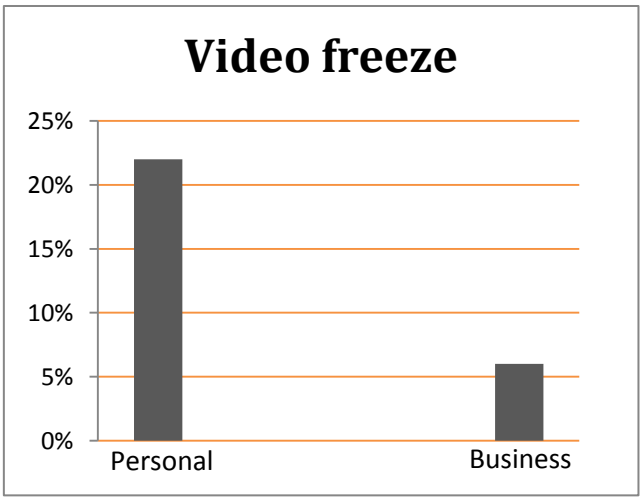

Figure 17 Personal vs. Business:
Frustration and disappointment towards Video Freeze

5.3 **Limitations**

In the course of this thesis, several challenges and limitations have been encountered. First the topic was broad and required extensive knowledge on the social and behavioral sciences. The pure technical background I have, had contributed to the considerable amount of time and energy spent in order to acquire the level of knowledge and professionalism appropriate for the research.

Second, all the data used for the research came from the single online survey. Given that most of the people who have filled this survey are students of higher institutions the survey did not include the basic general public such as people who are working full time or teenagers who are still in high school. Specially getting results from people who are working full-time would have helped in providing a more concrete result for the business-chat scenario while getting the information from teens about the usability factors would have been a great tool to predict the future of the service and the technology itself.

Third, the sample size was insufficient to apply the conclusion in a real life situation. The size was large enough to give initial indication for the research topic. However, further study with larger sample size is necessary to ensure the reliability and compatibility of the results for the larger population. After conducting these further researches, the engineers and the IT specialists could work on the improvement of quality factors that affect the users most.

Fourth, the data collection method could have been more specific and extensive including direct interviews or embedded questioners to the video-chat services that automatically pop-up whenever there is a bad quality interruption. That way, more reliable and real time data could have been gathered. However, the expense to do such research is significant and it would have taken considerable amount of time. May be this approach can be used in the future if similar kind of research is going to be conducted.

Finally, the time to conduct the research has been limited and hence only the most specific and most surprising results were considered for analysis. More

cross- sectional study could have been conducted in order to have a holistic view of the service and the interaction of the quality factors and the users' behavior.

5.4 Practical Implications

For the past few decades the Engineers who design communication services were hardly in contact with the actual users until the product is rolled out to the market. Even after the product is being used by the public, studying the user behavior was considered to be the job of behavioral and social scientists hence engineers barely stretched their hands to that area. However, recently, it has become clear to these technologists that users value not only Quality of service but also the Quality of experience.

The fundamental practical implementation of this research is to single out the most influential quality and usability factors on video-chat services. Figuring out these specific quality factors will enable engineers and scientists to set their priorities right when trying to improve the quality of video-chat services. Even though, the study of human behavior is out of the scope of the technologists, knowing some basic preferences of the users on their products is significant. It is only when technologists understand the users' behavior and their interaction with technology that they could invent products that consider the user's overall experience. Therefore, the results from this and similar research will significantly help the engineers to design a better service/product.

The second major practical implication is that such research is on its infancy and hence paves the way for more similar studies to be conducted in the future. From the social science and user behavior study point of view, more research is still required to explicate the human-to-computer interaction as digital communication strives to become more "human". Therefore, this thesis could contribute as a starting or continuing point for the researchers from the social science schools to further elaborate the topic and give more legit explanations on the users' behavior.

Lastly, users now-a-days have more power over the whole ecosystem than ever before and these users will not settle for less since they now have higher expectations and realities. The competition in the ecosystem is dramatically increasing because users have more options to choose from and have more knowledge about how far the technology could stride ahead. Therefore, device manufacturers and service providers ought to meticulously consider the users' need and should strive to live up to the users' expectations. Similar research in a wider scale needs to be conducted in the R&D teams of these companies in order to understand their users and provide them with better products and services. The methods used in this thesis, the results and the final analysis would come in handy if some researchers from the industry conduct similar studies.

6 Conclusion

The video-chat technology, or in its old term “video-telephony” , has been conceived back in the 19th century right after the invention of the telephone [71]. However, the actual expansion of the service has happened in the late 90’s and the early 2000’s following the rapid advancement of digital communication technology. Every single day engineers, technologists and scientists are striving to provide newer and better inventions that are intended to provide flawless quality of experience in the digital communication media. Furthermore, as the people all over the globe continue to grow closer, these communication media such as: the telephone, video-conferencing/simple video-chats, instant messaging and social media, have transformed from being an alternative method to serving as a compulsory communication media.

Video-chat/video conferencing is the highest level of digital communication technology for it provides users with a virtual ability of face-to-face communication. According to the Media richness theory (MRT) [1], a communication media that provides users with as much ability as the actual face-to-face communication is considered to be rich and close to the natural way of communication. However, this technology continues to be challenged by a variety of obstacles that are preventing it from becoming main stream media such as the telephone. Out of the many challenges of video-chat services the most pressing one is the issue of Quality of service (QoS). The reason for quality to be the major factor is because unlike the other existing communication media ranging from simple instant messaging to calling on the phone, video-chats are compared with the actual face-to-face communications. Users’ expectation for the service quality is always compared with the natural face-to-face communication and therefore, when the service fails to live up to their expectations; most users get affected and become reluctant to continue using the service any further.

In order to understand the effect of the technology on the users’ behavior, the typical research conducted by technologists is altering and/ or improving the

Quality of service (QoS) parameters and then merely assuming the users to have a better Quality of experience (QoE). Even though, better technical Quality of service (QoS) will bring about better quality of user experience additional methods of understanding the user are necessary to fully grasp the users' expectations off the service. Therefore, in this thesis, a rather different approach has been followed to recognize the Quality of service effects on video-chat service users.

Initially there were few selected quality of service factors and were used as a control parameter to check the users' reaction to each factor. Scenarios that clearly describe the possible situation of the user were set forth and quality factors were picked one at a time to emphasize on the specific effect each factor has on the users' emotional behavior. Therefore, despite the limitations mentioned in the previous chapter, this research has followed and successfully discovered the following remarkable results.

First it is worth noting that intrinsic behavior is exceedingly more powerful than any kind of extrinsic motivational behavior [9]. This is a crucial knowledge to emphasize since it makes understanding of the Flow theory much more comprehendible. The original Technology acceptance model (TAM) proposed that, for a technology to be useable, it has to fulfill two basic things. The first one is that it has to be perceived to be easy to use. And the second one is that it has to be perceived to be useful. Both of these factors are considered to be extrinsic and the user is assumed to use a technology/service because he/she is expecting something extrinsic in return. While both these factors are absolutely relevant and accurate there was a third and more significant factor which later got merged with the other two. This last factor is referred as "Flow".

The Flow represents the basic intrinsic intentions of the user. It is a state where people experience absolute absorption in what they are doing and lose their consciousness about time and place, a good example would be an artist painting or playing music. This factor refers to the users' intention where they use the technology simply for the sake of using it. Flow is usually linked to enjoyment and positive experience. Therefore, whenever there is an interruption caused by

a Quality of service factor (in our case when users' video-chats are interrupted because of a technical quality problem) the Flow is what gets disrupted. Disrupting the Flow of an activity on the other hand, produces rather strong emotions on the users and most of the results from our research support this statement. The model below illustrates the proposed model of how and why exactly the Quality of service parameters affect the Flow and how the interruption of the flow in turn affects the users perception about the service/ technology. It is clearly demonstrated that the users' perception of the usefulness and the ease-of-use of the service remains unchanged while their intrinsic motivation alters whenever the flow is disrupted. As already mentioned many times in this thesis, the intrinsic motivation of users is the most important drive that initiates people to do things. Therefore, whenever engineers, technologists and user experience designers are setting out to improve or invent better video-chat services, they must note that the less quality affects the flow, the better the quality of experience (QoE) will be.

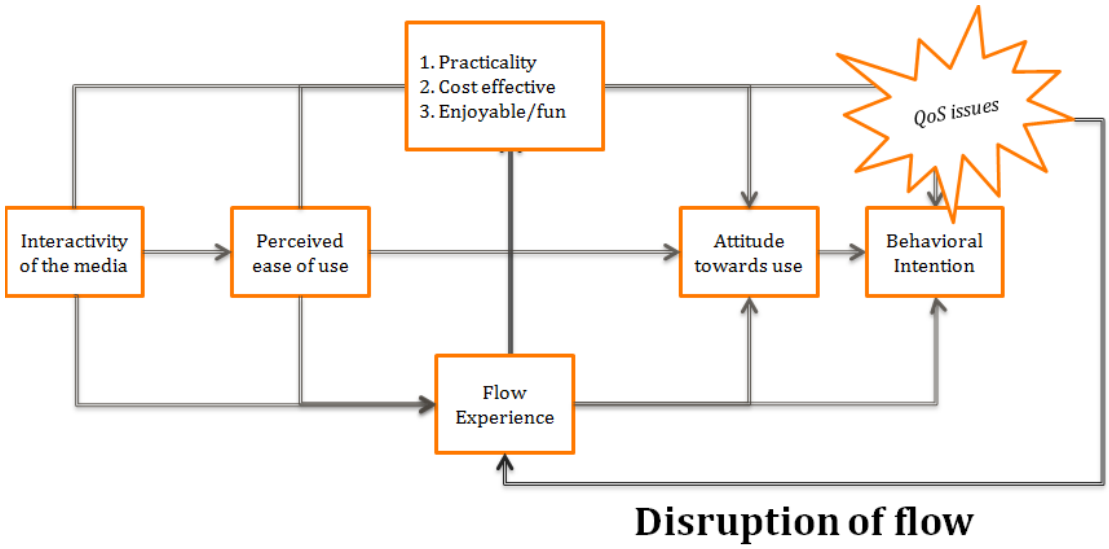

Figure 18 Effect of QoS on Flow Experience

Now, based on the results of this thesis, the major quality factors that affect the quality of experience of the users are:

1. Audio + Video Un-synchronization (delay)
2. Audio + Video Jitter
3. Connection failure
4. Video Resolution
5. Video freeze

In addition, although all bad quality factors cause negative emotions, on the users by making a good use of the theory of "bad is stronger than good", the two crucial quality factors that cause much higher degrees of bad emotions were selected. The type of relationship between the users was also another determining factor in drawing down the conclusion since it affects the degree and type of emotions felt by the users. Therefore, these two vital (QoS) parameters are

1. Jitter and,
2. Audio and Video un-synchronization

Finally, this thesis has strived to understand and give explanations about the user behavior from a different perspective. Even though the sample size of the respondents for the research was quite small the results found were still very useful. While there were some results that were fairly straightforward, there were others that have been an absolute surprise. It is obvious that this is just the beginning for the research of its kind and a more elaborate and large scale study will need to be set in the future. Meanwhile, this thesis will contribute by giving some basic understanding about the video-chat service and the users' reaction to basic quality of service factors. In addition, the results found in this thesis could be used to give directions for engineers, technologists, device manufacturers, network side service providers, social and behavior scientists and students alike.

References

[1] T. Barrow, "Media Naturaless Theory," 19 09 2009. [Online]. Available: blog.timebarrow.com. [Accessed 02 04 2013].

[2] I. 9421-210, "Ergonomics of Human-System interaction- Part 210: Human Centered design for interactive system," 2010.

[3] F. D. Davis, "User acceptance of infomation technology:system characterstics,user perceptions and behavioral impacts," *Int. J. Man-Machine Studies,* vol. 38, pp. 475-487, 1993.

[4] J. N. &. M. Csikszentmihalyi, "The Concept of Flow," in *Handbook of Positive Psychology,* New York, Oxford University Press, 1990, pp. 89-102.

[5] K. Kilkki, "Human Benefit," in *An introduction to communications ecosystems*, 2012, pp. 28-32.

[6] J. B. Walther, "Computer Mdeiated Communication : Impersonal,Interpersonal, and Hyperpersonal Interaction," *Sage Journals,* vol. 23, no. 1, pp. 3-43, 1996.

[7] I. 9126-1, "Software Engineering-Product Quality-Part 1:Quality Model.," ISO, 2001.

[8] F. M. Ajzen I, "Attitude-Behavioural Relations:A theoretical analysis and review of empirical research," *Psychological Bulletin,* vol. 84, pp. 888-918, 1977.

[9] I. C. W. Hsin Hsin Chang, "An investigation of user communication behavior in computer mediated environments," *Computers in Human Behavior,* vol. 24, pp. 2337-2354, 2008.

[10] H.-P. L. Chin-Lung Hsu, "Why do people play online games? An Extended TAM with social influences and flow experience," *Information & Managment,* vol. 41, pp. 853-868, 2004.

[11] M. Csikszentmihalyi, Beyond boredom and anxiety, San Fransisco: Jossey-Bass, 1977.

[12] T. Z. W. Yaobin Lu, "Exploring Chinese users' acceptance of instant messaging using the theory of planned behavior,the technology acceptance model,and the flow theory," *Computers in human behavior,* vol. 25, pp. 29-30, 2009.

[13] D. L. H.-F. Y. Thomas P.Novak, "Measuring the customer experience in online environments:A Structural Modeling Approach," *Marketing Science,* vol. 19, no. 1, pp. 22-42, 2000.

[14] K. S. Suh, "Impact of communication medium on task performance and satisfaction:An examination of media-richness theory," *Information & Management,* vol. 35, pp. 295-312, 1999.

[15] I. 25062, "Software Engineering-software product Quality Requirements and Evaluation (SQuaRE)-Common Industry Format (CIF) for Usability Test Reports," ISO, 2006.

[16] N. Bevan, "Extending quality in use to provide a framework for usability measurement," *Professional usability services,* pp. 1-10.

[17] J. Nielsen, "What is Usabiliity," in *Usability Engineering,* Boston, Academic Press, 1993.

[18] M. Hassenzahl, "The effect of perceived hedonic quiality on product

appealingness.," *International Journal of Human Computer Interaction,* vol. 13, pp. 479-497, 2002.

[19] M. Hassenzahl, "The effect of Perceived Hedonic Quaility on Product Appealingness," *International Journal of Human Computer Interaction,* vol. 13, no. 4, pp. 481-489, 2001.

[20] N. B. Shinjuku-ku, "ISO/IEC FCD 25010: Systems and software engineering-Software product Quality Requirements and Evaluation (SQuaRE)-Quality models for software product quality and system quality in use," ISO, 2009.

[21] A. D. P. C. Charalampos N. Pltas, "Speech and Video Telephony Quality Characterization and Prediction of Live Contemporary Mobile Communication Networks," *Springer,* pp. 1-5, 2012.

[22] I. T. Union, "ITU:Committed to connecting the world," 08 2008. [Online]. Available: www.itu.int. [Accessed 08 04 2013].

[23] I. T. Union, "ITU: committed to connecting the world," 07 2012. [Online]. Available: www.itu.int. [Accessed 08 04 2013].

[24] T. U. Stefan Paulsen, "The new,parameterised VS model for determining the Quality of Video Streams in the Video-telephony service," *Proceedings of the XXVII conference KSTiT'12,* no. 8, pp. 1-3, 2012.

[25] Empirix, "Quality of Service Testing in the VoIP Environment," *Empirix,* pp. 1-5.

[26] W. C. Hardy, QoS measurement and Evaluation of Telecommunications Quality of Service, West Sussex,England: John Wiley & Sons,Ltd, 2001.

[27] A. Chadda, "Quality of service testing methodology," Mumbai, 1999.

[28] J. C. Zheng Wang, "Analysis of Burstiness and Jitter in Real-Time Communications," *SIGCOMM'93 - Ithaca,* vol. 9, pp. 13-20, 1993.

[29] ITU-T Recommendation, "Vocabulary and effects of transmissions parameters on customer opinion of transmission quality," *International Telecommunication Union,* p. 10, 10 02 2006.

[30] R. K. D. V. B. Fernando Kuipers, "Techniques for Measuring Quality of Experience," in *Proc.of hte 8th International Conference on Wried/Wireless Internet Communications*, Lulea,Sweden, 2010.

[31] W. Paper, "Dialogic," 12 2009. [Online]. Available: www.dialogic.com. [Accessed 14 3 2013].

[32] I.-R. Recommendation, "Subjective video quality assessment methods for multimedia applications," *International Telecommunication Union,* p. 910, 1999.

[33] N. T. Marc Hassenzahl, "User Experience-A research agenda," *Behaviour and Information Technology,* vol. 25, no. 2, pp. 1-8, 2006.

[34] J. M. Carrol, "Interaction-design.org," Interaction design foundation, 2013. [Online]. Available: www.interaction-design.org. [Accessed 17 06 2013].

[35] "Modeling user experience-An agenda for research and practice," *Elsevier,* pp. 1-10, 2010.

[36] I. M. Louis Bosshart, "Media Entertainment," *Communication Research Trends,* vol. 18, no. 3, pp. 1-48, 1998.

[37] K. R. Scherer, "What are emotions? And how can they be measured?," *Trends and developments: Research and emotions,* vol. 44, no. 4, pp. 695-729, 2005.

[38] D. Ekman P., "What are emotions," *The nature of emotion,* p. 412, 1994.

[39] P. M. Desmet, "Measuring Emotions," *M.A. Blythe,A.F. Monk,K.Overbeeke,& P.C. Wright.*

[40] D. K. Paul Ekman, "Introduction: Expression of Emotion," *Handbook of Affective Sciences,* pp. 411-414, 2003.

[41] R. D. P. Ekman, "Moods, Emotions, and Traits," *The nature of emotion,* pp. 56-58, 1994.

[42] P. Ekman, "An argument for basic emotions," *Cognition and emotion,* vol. 6, pp. 169-200, 1992.

[43] P. Ekman, "Are there basic emotions?," *Psychological Review,* vol. 99, no. 3, pp. 550-553, 1992.

[44] R. Plutchik, Emotion: A psychoevolutionary synthesis, Harper & Row publishers, 1980.

[45] R. Plutchik, "The nature of emotions," *American Scientist,* vol. 89, pp. 344-350, 2001.

[46] P. Ekman, "All emotions are basic," *Oxford University Press,* pp. 15-19, 1994.

[47] G. Norwook, "Deeper Mind," in *Emotions*, 2013.

[48] J. H. Esther Hicks, "Emotional guidance scale," in *Ask and it is Given,Learning to manifest your desire,* Hay House, 2004, p. 114.

[49] E. B. F. D. V. Roy F. Baumeister, "Bad is stronger than good," *Review of general psycology*, vol. 5, no. 4, pp. 323-370, 2001.

[50] M. Pal, "Bad is stronger than good," *Business Standard,* p. 1, 02 11 2012.

[51] P. R. Hanson, "Rick Hanson, Ph.D," [Online]. Available: http://www.rickhanson.net/your-wise-brain/how-your-brain-makes-you-easily-intimidated. [Accessed 14 06 2013].

[52] T. Moon, "Are we hardwired for unhappiness?," 2009.

[53] a. Wierzbicka, "Defining emotion concepts," *Cognitive Science,* vol. 16, pp. 539-581, 1992.

[54] J. H. T. Jan E. Stets, "Why the emotional brain?," in *Handbook of the sociology of emotions*, Riverside,CA, Springer, 2006, pp. 38-60.

[55] J. J. Garrett, The elements of user experience: user-entered design for the web and beyond,second edition, Berkeley,CA, 2011.

[56] A. D. Andrade, "Interpretive research aiming at theory building: Adopting and Adapting the case study design," *The qualitative report,* vol. 14, pp. 42-60, 2009.

[57] R. K. Yin, Case study research,design and methodes, Thousand Oaks, CA: Sage Inc., 2009.

[58] R. K. Yin, "Case Study Methodes," *cosmos sorporation/ revised draft,* pp. 1-25, 2004.

[59] J. a. Krosnick, "Survey Research," *Annual reviews*, pp. 537-567, 1999.

[60] M. S. Ronald D. Fricker, "Advantages and Disadvantages of Internet Research Surveys: Evidence from the Literature," *Sage Journals*, vol. 14, pp. 347-367, 2002.

[61] T. D. A. Lillian Turner de Tormes Eby, Personal Relationships : The effect on employee attitudes,behaviour,and well-being, New York: Tayler & Francis Group, LLC, 2012.

[62] A. d. S. Liaquat Hossain, "Exploring user acceptance of technology using social networks," *Journal of High Technology Managment Research,* vol. 20, pp. 1-18, 2009.

[63] I. C. 13407, "User Centred Design process for interactive systems," *ISO,* 1996.

[64] N. Bevan, "Quality in use: Incorporating human factors into the software engieering lifecycle," *National Physical Laboratory.*

[65] "cost effective international roaming using mobile VoIP," *Audio codes,* vol. 1, pp. 1-4, 2010.

[66] P. Z. Christina M.finneran, "Flow in computer-mediated environments:Promises and challenges," *Communications of the ssociation for information systems,* vol. 15, pp. 82-101, 2005.

[67] D. T. N. Hoffman, "Marketing in hypermedia computer-mediated Environmnets : Conceptual foundation," *Journal of Marketing,* vol. 60, pp. 50-68, 1996.

[68] M. B. C. P. B. Beverley Fehr, "Anger in Close Relationships:An Interpersonal Script Analysis," *Personality and Social Psychology Bulletin,Sage journals,* vol. 25, pp. 299-310, 1999.

[69] D. Z. H. T. Eliamani Sedoyeka, "Analysis of QoS requiremnets in developing countries," *international journal of computing and ICT research,* vol. 3, no. 1, pp. 18-31, 2009.

[70] N. H. Frija, "The laws of Emotion," *American Psychologist,* vol. 43, no. 5, pp. 349-358, 1988.

[71] B. B. Warren, "The picture of the future," *Bell Laboratories Record,* vol. 47, no. 5, pp. 134-188, 1969.

Appendix A – Background Information

Gender *

Age *

Nationality *

Latest educational status *

- ○ High school
- ○ Undergraduate
- ○ Graduate
- ○ Post Graduate
- ○ Other

Have you ever used video-chat service *

- ○ Yes
- ○ No

How important is this service to you

	1	2	3	4	5	
Very important	○	○	○	○	○	Not important at all

Appendix B – Usability Factors

You use video-chat because;

It is cost effective

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

It is fun/enjoyable experience

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

Because it is efficient way of communication

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

It gives you the feeling of being 'there' with the person you are speaking with

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

You feel that it is a secure means of communication (For example, compared to texting and voice calls)

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

It is a reliable means of communication

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

You specifically use video-chat when the topic you want to discuss is of great importance. *

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

You think being able to video-chat right from your mobile devices has increased your use of the service. *

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

You think that video-chat via mobile devices will be the "norm" in the near future.

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

If not mentioned above, when do you think is the time that you NEED to use video-chat/conference

Appendix C – QoS vs. User's Emotions

Scenario 1: You are video-chatting with someone who is very close to you in person (such as your parents/close family member/your girl/boyfriend or your best friend), after establishing the conversation

1. **The connection failed. You feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

2. **The video got stuck (but the voice is working fine) you feel,**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

3. **The resolution of the video is bad or of very low quality for example the image is blurred, is in visible blocks of pixels or has bad contrast**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

4. **the video starts to jitter (Jitter = To make small quick jumpy movements), but the voice is still okay, you feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

5. **Both the video and voice start to jitter, you feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment

- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

6. The video and the audio are not synchronized, you feel

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

7. The video is working very well, but the voice jitters. You feel

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

Scenario 2: You have no personal relationship with. While you are discussing very important matter

1. **The connection failed. You feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

2. **The video got stuck (but the voice is working fine) you feel,**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

3. **The resolution of the video is bad or of very low quality for example the image is blurred, is in visible blocks of pixels or has bad contrast**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe

- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

4. **the video starts to jitter (Jitter = To make small quick jumpy movements), but the voice is still okay, you feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

5. **Both the video and voice start to jitter, you feel**

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred

- Fear, Grief, Depression, Despair, Powerlessness

6. The video and the audio are not synchronized, you feel

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

7. The video is working very well, but the voice jitters. You feel

- Joy, Power, Appreciation, Freedom, Love, Empowerment
- Enthusiasm, Eagerness, Happiness, Positive expectation, Believe
- Trust, Optimism, Hopefulness, Contentment
- Boredom, Frustration, Pessimism, Irritation, Impatience
- Disappointment, Doubt, Worry, Blame, Discouragement, Sadness
- Anger, Rage, Revenge, Hatred
- Fear, Grief, Depression, Despair, Powerlessness

Given all things working just fine, *will you be affected by the screen size of your device when you are having video calls? Larger screen, better chatting experience; smaller screens worse chatting experience?

	1	2	3	4	5	
Strongly agree						Strongly disagree

Having other functionalists such as text chatting and sharing files, screens etc... Greatly affect your video call experience?

	1	2	3	4	5	
Strongly agree	○	○	○	○	○	Strongly disagree

In your opinion, what does quality refer to when it comes to video-chat service?