COMPARISON AND EVALUATION OF MASS VIDEO NOTIFICATION METHODS USED TO ASSIST DEAF PEOPLE

by

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A thesis submitted in fulfilment of the requirements for the degree of Master of Science (Computer Science) in the Department of Computer Science

at the

University of the Western Cape

Date: August 31, 2012

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Abstract

In South Africa, Deaf people communicate with one another and the broader community by means of South African Sign Language. The majority of Deaf people who have access to a mobile phone (cell phone) use Short Message Service (SMS) to communicate and share information with hearing people, but seldom use it among themselves. It is assumed that video messaging will be more accessible to Deaf people, since their level of literacy may prevent them from making effective use of information that is disseminated via texting/SMS.

The principal objective of the research was to explore a cost-effective and efficient mass multimedia messaging system. The intention was to adapt a successful text-based mass notification system, developed by a local non-governmental organization (NGO), to accommodate efficient and affordable video mass messaging for Deaf people. The questions that underpin this research are: How should video-streaming mass-messaging methods be compared and evaluated to find the most suitable method to deliver an affordable and acceptable service to Deaf people? What transport vehicles should be considered: Multimedia Message Service (MMS), the web, electronic mail, or a cell phone resident push/pull application? Which is the most cost effective? And, finally: How does the video quality of the various transport vehicles differ in terms of the clarity of the sign language as perceived by the Deaf?

The soft-systems methodology and a mixed-methods methodology were used to address the research questions. The soft-systems methodology was followed to manage the research process and the mixed-methods

research methodology was followed to collect data. Data was collected by means of experiments and semi-structured interviews. A prototype for mobile phone usage was developed and evaluated with Deaf members the NGO Deaf Community of Cape Town. The technology and internet usage of the Deaf participants provided background information. The Statistical Package for Social Science (SPSS) was used to analyse the quantitative data, and content analysis was used to analyse the documents and interviews.

All of the Deaf participants used their mobile phones for SMS and the majority (81.25%) used English to type messages; however, all indicated that they would have preferred to use South Africa sign language on their mobile phones if it were available. And they were quite willing to pay between 75c and 80c per message for using such a video-messaging service.

Of the transport vehicles demonstrated, most Deaf people indicated that they preferred to use the SMS prototype (with a web link to the video) rather than the MMS prototype with the video attached. They were, however, very concerned about the cost of using the system, as well as the quality of the sign language videos.

Keywords: Deaf, Deaf Community of Cape Town, South African Sign Language, mobile phone, mass video notification messaging, Short Message Service, Multimedia Message Service, video streaming, cost effective, efficient delivery

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DECLARATION

I declare that "Comparison and evaluation of mass video notification methods used to assist Deaf people" is my own work, that it has not been submitted for any degree or examination at any other university, and that all the sources I have used or quoted have been indicated and acknowledged by complete references.

Full name: Ryno Hoorn

Signed: ....

Date: Friday, 31 August 2012

CERTIFICATE FROM LANGUAGE EDITOR

10 May 2012

To Whom It May Concern

This is to confirm that I am a professional copy-editor and have checked and corrected the language usage in Ryno Hoorn's master's thesis entitled "Comparison and evaluation of mass video notification methods used to assist Deaf people".

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ACKNOWLEDGEMENTS

The author wishes to thank God Almighty for giving me the strength and will to study.

I would like to thank my supervisors, Prof. IM Venter and Dr WD Tucker, as well Mr MJ Norman, for their academic wisdom.

For financial support I thank SANPAD (South Africa Netherlands Research Programme on Alternatives in Development), Telkom, Cisco, Aria technologies and THRIP (Technology and Human Resources for Industry Partnership), managed by the National Research Foundation (NRF).

Furthermore, I would like to thank all the staff members of the Computer Science Department for their assistance and advice during the years of my studies. Thanks to all my colleagues, especially the Broadband/Bridging Applications Network Group (BANG) group for motivation and advice.

For data collection purposes, I would like to thank the Deaf Community of Cape Town and their staff.

I also would like to thank the PET writing centre for their assistance: Lucinda du Plooy for guiding and helping me with my research methodology chapter and Peter Aloka Jairo for guiding me with the structure of my thesis.

Finally, I would like to thank my family, who are very special to me, for their moral support.

GLOSSARY

3GPP (3rd Generation Partnership Project): "The 3GPP is a standard body that works within the scope of the International Telecommunication Union (ITU) to develop 3rd (and future) generation wireless technologies that build upon the base provided by Global System for Mobile Communications (GSM)" (Lovetoknow Corporation, 2010; MobileBurn.com, 2009).

Antiretroviral : Antiretroviral drugs are medications for the treatment of infection by retroviruses. The American National Institutes of Health and other organisations recommend the drug as treatment to all patients with acquired immunodeficiency syndrome (AIDS).

BANG: An abbreviation for the Broadband/Bridging Applications Network Group.

CD-ROM (compact disc, read-only memory): This is a compact disc that contains accessible read-only data.

Cost-effective and efficient delivery: This refers to the "maximum benefit for a given level of payment" (CBS, 2010). In this research it refers to the cost and benefit comparison of the different video message delivery methods.

Deaf: Deaf with a capital 'D' refers to people whose first language is sign language and who are members of a specific linguistic cultural group.

E-mail: E-mail or electronic mail is a method of exchanging messages across the Internet.

FLA (Flash Audio): This Flash file "is the 'master' document file for a flash project, i.e. the source file you work with in the Flash authoring program. These files can only be opened with Flash—not the Flash Player. To create the final product which is viewed by end users; export the appropriate file (usually SWF) from the FLA file" (Media College, 2010).

FLV (Flash Video): "Supported from version 7, FLV files are the preferred format for delivering video clips via Flash" (Media College, 2010).

H.261: This is an International Telecom Union (ITU) standard that support data rates that are multiples of 64 kb/sec. It is designed for two-way communication over an Integrated Service Digital Network (ISDN) line (video conferencing). The algorithm can be implemented in hardware or software and is based on intraframe and interframe compression. H.261 supports Common Intermediate Format (CIF) and Quarter Common Intermediate Format (QCIF) resolution.

H.263: This is based on H.261 with improvements that enhance video quality over modems. H.263 supports CIF, QCIF, Sub Quarter Common Intermediate Format (SQCIF), 4CIF and 16CIF resolutions (Wave Report Inc., 2007).

HTML (Hypertext Markup Language): This is the most suitable markup language for creating web pages. A markup language consists of a set of tags. HTML uses markup tags to describe web pages.

HTTP (Hypertext Transfer Protocol): This is a networking protocol for distributed, collaborative, hypermedia information systems.

ICT (information communication technology): This refers to the implementation of technologies to increase access to information.

IP (Internet Protocol): "Internet Protocol is the principal communications protocol used for relaying data grams (packets) across an internetwork using the Internet Protocol Suite. Responsible for routing packets across network boundaries, it is the primary protocol that establishes the Internet" (Webopedia, 2010).

Mass notification: This refers to the providing of important information on a larger scale to make Deaf people aware of what is happening around them in the world. This research looks at video messaging as a notification mechanism for South African Deaf people.

MJPEG (Motion JPEG): This is not the same as (MPEG). MJPEG only provides spatial compression and MPEG provides temporal compression.

MMS (Multimedia Messaging Service): This is also referred to as Multimedia Messaging System. MMS is a communications technology developed by 3GPP (Third Generation Partnership Project) that allows users to exchange multimedia communications between capable mobile phones and other devices. It also defines a way to almost instantaneously send and receive wireless messages that include images and audio and video clips in addition to text.

Mobile phone: This is a cellular phone that provides voice communications, SMS, MMS, and Internet services such as web browsing and email (Webopedia, 2010).

MPEG-1 (Moving Picture Experts Group 1): This is a standard for the compression of moving pictures and audio known as MPEG-1 Audio Layer III (MP3). It is designed for up to 15 Mbits/sec and is the most popular standard for video transmission over the internet as .mpg files. Throughout much of Asia, it is the most popular video distribution format (Wave Report Inc., 2007).

MPEG-2 (Moving Picture Experts Group 2): This is a standard based on MPEG-1, but it designed for Digital Versatile Disc (DVD) compression and transmission of digital broadcast television. It was designed for between 1.5 Mbits/sec and 15 Mbits/sec. Its ability to efficiently compress interlaced video is the most significant enhancement from MPEG-1. MPEG-2 removes the need for an MPEG-3 and it scales well to high-definition television) resolution and bit rates (Wave Report Inc., 2007).

MPEG-4 (Moving Picture Experts Group 4): This is a standard for multimedia and web compression. It is based on object-based compression similar to the nature of virtual reality. To create an MPEG-4 file, individual objects within a scene are tracked separately and compressed together. "This results in very efficient compression that is very scalable; from low bit rates to very high. It also allows developers to control objects independently in a scene, and therefore introduce interactivity" (Wave Report Inc., 2007).

MTN (Mobile Telephone Network): MTN is a South African-based network and global communications partner (MTN, 2011).

NGO (non-governmental organization): This refers to a private not-for-profit organization that provides basic social services to the community and undertakes community development.

OMA (Open Mobile Alliance): This is a standards body that develops open standards for the mobile phone industry.

Phone-resident video push/pull application: This refers to a mobile phone application or software that streams live videos. This application or software can be installed on a mobile phone (Mashable/Video, 2010).

RTP (Real-time Transport Protocol): This is a standardized packet format for delivering audio and video over an IP network.

RTSP (Real-time Streaming Protocol): This is an application-level protocol for controlling the delivery of data with real-time properties.

SA (South Africa)

SASL (South African Sign Language): This is the primary language used by many Deaf people in South African (SA) Deaf communities. It is different from other sign languages and is only used in SA (Thibologo Sign Language Institution, 2007).

SMS (Short Message Service): This is part of the GSM specification and allows text messages to be sent or received via mobile phones.

SWF (Shockwave Flash): "The SWF file format delivers vector graphics, text, video, and sound over the Internet and is supported by Adobe Flash Player and Adobe AIR software. Flash Player already reaches over 98% of Internet-enabled desktops and more than 800 million handsets and mobile devices" (Adobe, 2009).

TCP (Transmission Control Protocol): This is one of the core protocols of the Internet protocol suite.

TV (television): This is the most widely used telecommunication medium for transmitting and receiving moving images that are either monochromatic (black and white) or in colour, usually accompanied by sound.

UDP (User Datagram Protocol): This is a communications protocol that offers a limited amount of service when messages are exchange.

USSD (Unstructured Supplementary Service Data): This is an interactive menu-driven service with custom that can be dynamically viewed by end users.

Video streaming: This refers to content sent over the Internet in compressed form that can be viewed by users in real time (SearchUnifiedCommunications, 2010).

WAP (Wireless Application Protocol): This "is an open international standard. A WAP browser is a commonly used web browser for small mobile devices such as cell phones" (Suki, Ramayah, Yi, & Amin, 2011).

CHAPTER 1

STATEMENT AND ANALYSIS OF THE PROBLEM

Introduction

In this chapter a brief overview of the study is given and the problem is stated. The motivation for the study, the research methods, and the significance of the study are explained. Finally, the thesis layout is given.

Sketching the background

There are approximately 4 million people with hearing impairment in South Africa: of these, 402,847 are profoundly deaf, 1,208,539 extremely hard of hearing and 2,417,078 hard of hearing (Glaser & Tucker, 2004). According to two other sources, the Deaf Federation of South Africa (DeafSA) and Berke, between 500,000 and 600,000 South Africans use South African Sign Language (SASL) for communication (DeafSA, 2009; Berke, 2010).

There are two categories of people who are hearing impaired, the "Deaf" and the "deaf". The Deaf with an upper case 'D' are people whose first language is sign language and who are members of a specific linguistic cultural group (the members of this group hold a set of social beliefs, values, and attitudes about themselves and their connection to the larger society) (Ladd, 2003; Tucker, 2009). On the other hand, deaf with a lower case 'd' refers to people who were born with their hearing intact, but lost their hearing later in life (e.g. because of illness, trauma, ageing, etc.). The term "deaf" is used when referring to the audio logical condition of not hearing (National Association of the Deaf, 2011; Padden & Humphries, 1988; Cavender, Ladner, & Riskin, 2006).

Statistics South Africa (Stats SA) indicated a 24% unemployment rate in South Africa (SA) in the 4th quarter of 2010 (Stats SA, 2005). In the 1st quarter of 2011 the unemployment rate in SA was reported at 25% (Trading Economics, 2011); it increased by 1% in the 2nd quarter. Unemployment rates and illiteracy rates are even higher among the South African Deaf (Berke, 2010). DeafSA indicated a 70% unemployment rate and a 75% functionally illiterate rate in Deaf communities in SA (DeafSA, 2009). The term "functionally illiterate" means that although a person may be able to read and write a few words of a spoken language like English, they do so well enough to deal with the requirements of everyday life (Kiyaga & Moores, 2003). According to DeafSA, only 14% of teachers in Deaf schools in SA can sign fluently (DeafSA, 2009), which further disadvantages Deaf children.

Statement of the problem

The aim of this research was to explore video mass messaging and its applicability to the SA Deaf community. The intension was to use a successful text-based mass notification system developed by Cell-Life, a local non-governmental organization (NGO), and adapt it to accommodate efficient and affordable video messaging for Deaf people. Cell-Life uses a system called Mobilisr "to increase access to information by means of cell phones. Mass messaging is useful in any field such as health, employment, or public safety" (Cell-Life, 2009). In the health arena, Cell-Life uses mass messaging with Mobilisr on cell phones to provide services to people infected or affected by the human immunodeficiency virus (HIV). The service is used for the dissemination of information in order to prevent HIV infection and to notify organisation members about events, the latest news, and when HIV patients need to take their medicines (Cell-Life, 2009). It should be noted that for the text messages to be useful, the receiver must be able to read and interpret the message.

Internationally, it has been found that even though Deaf people use Short Message Service (SMS) to communicate and share information with hearing people, they use it less often among themselves (Power & Power, 2004). However, their level of literacy prevents the effective interpretation of information received via SMS. Since many Deaf people cannot use the information they receive via SMS effectively, they would be better served if they could be notified by means of an SASL video message. This study therefore modified the Mobilisr software in order to support affordable and efficient video messaging for Deaf people. It was found that video mass messaging can be effected by several means: video streaming, Multimedia Messages Services (MMS), SMS with a web link to the video to be streamed by a web browser, and electronic mail (e-mail) with a web link to the video to be streamed by a web browser. Video streaming is a technique used for transferring data as a constant continuous stream over the Internet and is used worldwide to transfer multimedia files such as video, voice, and data (Javvin Technologies, 2010). MMS and other video transfer methods will be considered as modes for information dissemination to the Deaf.

This research thus focused on expanding Cell-Life's text-based mass notification system to make provision for the functionally illiterate, with specific reference to a local NGO, the Deaf Community of Cape Town (DCCT). The main problem was to address the challenges of misinterpretation of information disseminated by means of text mass notification. With the proposed system, Deaf people should be able to get full access to information disseminated via the system in their own language, SASL.

Research problem

The problem to be addressed is thus:

> How should video-streaming mass-messaging methods be compared and evaluated to find the most suitable method to deliver an affordable and acceptable service to Deaf people?

Research objectives

- The objectives of this research were to explore video mass messaging in terms of the performance, usability, and cost by using a successful text-based mass messaging system, Mobilisr, developed by Cell-life and adapt it to support efficient and affordable mass video messaging for Deaf people.

- As proof of concept, a prototype was designed and evaluated in terms of performance, usability, and cost.

Research methods

Not only was quantitative data collected but, because it was necessary to probe the experiences of the respondents, a qualitative perspective was also used. The methodological framework thus adopted for this study was a mixed-methods research approach (Plan Clark & Creswell, 2011).

The Mobilisr software was adapted to accommodate video messaging. Different mass video messaging methods were implemented on Mobilisr in order to find the most suitable method to deliver mass video messages. The most suitable method was determined by comparing and evaluating factors such as the usability of each method; the cost the user was willing to pay for using these methods; service providers charges; the quality of the sign language videos; the time taken to send and receive a video message; and the bandwidth usage when downloading the videos.

Most of the data was collected from the Deaf end users with the help of an SASL interpreter. Data such as the bandwidth required, the time it takes to deliver a message, etc. was collected in a laboratory environment. Prototypes were developed and tested in conjunction with the members of an NGO involved with the DCCT.

Data was collected during a pilot study, during the actual study, and in a laboratory environment while doing experiments with the prototype. Data concerning Internet and mobile phone usage at the DCCT was collected by the laboratory technician over a period of three years and provided valuable background information for this research.

Significance of the study

The developed system will make it possible to disseminate information to the functionally illiterate, although it can be applied in many different situations where it is necessary to disseminate information to people with reading or writing difficulties. The system was implemented and tested at the DCCT. The findings of this study indicate that messaging techniques (such as SMS, MMS, and e-mails) to render SASL are affordable and the quality of the videos is acceptable for mass messaging for Deaf people.

Overview of the thesis

In the present chapter, the background of the study is sketched. The research problem is stated and translated into research questions, and the motivation for the study and its significance are discussed. In Chapter 2 related work in terms of the research questions is discussed, as well as the key concepts of text-based and video-based messaging technologies. The literature review also includes information relating to Deaf people and video- and text-based technologies, as well as the cost of using these technologies. In Chapter 3 the research methods and the experimental design are presented. The results are presented in Chapter 4 and discussed in Chapter 5. Two articles based on this research were presented at peer-reviewed conferences and are included as an appendix.

Chapter 2

LITERATURE REVIEW

Introduction

In the previous chapter, the background of this research was discussed. To provide a succinct idea of what research has been done in this field, work related to this research and the literature that underpins this research are presented in terms of key concepts such as mobile text messaging, mobile video messaging, video streaming technologies, file formats, and cost.

Mobile messaging

Text messaging or texting is the exchange of text writing between mobile phones and fixed or portable devices over a network such as the Internet and mobile phone networks such as the South African companies MTN, Vodacom, Cell C, etc. The term "text messaging" refers to messages sent by SMS.

SMS is a text messaging service that is part of the GSM (Global System for Mobile Communications) specification and it allows text messages to be sent or received via mobile phones (cell phones), web systems, or mobile communications systems using standardised communication protocols. SMS allows users to exchanges alphanumeric messages (up to 160 characters in length) with other users of cellular networks (Peersman, Griffiths, Spear, Cvetkovic, & Smythe, 2000). SMS is the world's most used mobile data application with 3 billion active users—76% of all mobile subscribers worldwide—using SMS text messages (Ahonen & Moore, 2009).

Another mobile messaging method is MMS. This is an extension of SMS and is a standard way of sending and receiving messages that include multimedia (pictures, video, and sound) content from a mobile phone. It is most used to send pictures from camera-equipped mobile devices. MMS is also popular as a method to deliver entertainment content, including videos, text pages, pictures, ringtones, and news content. One MMS can contain a maximum file size of 300 kb; if the file exceeds this size it will be sent as two MMSs. Unlike SMSs, when a MMS is sent to a large number of subscribers delivery becomes inefficient, because MMSs differ in content and size. Fewer users use the MMS system compared to SMS: 1.3 billion users worldwide use MMS (Ahonen & Moore, 2009).

Other text messaging services are available, such as e-mail, Wireless Application Protocol (WAP) push messages, bulk messaging, etc.

Mobile text-messaging usage

Mobile text messaging is by and large used as a cheaper way of communication. It is mostly used between mobile phone users as a replacement for voice calls where a voice call is undesirable or impossible. In most cases, text messaging is much cheaper than voice calls.

Text messages are used (in most cases) by Deaf people to communicate with hearing people and they use them to share information with family and friends (Power & Power, 2004).

A Deaf communications technology study done by Wang in 2010 at the DCCT indicated that even though 90% at Deaf people in the DCCT used SMS to communicate, they were very concerned about the cost of using the technology. This study indicated that they used other text messaging communication tools to communicate as well: 40% used MXit (www.mxitlifestyle.com); 26% used e-mail, and 28% had a Facebook account (Wang, 2010). Wang further indicated that

87% of Deaf mobile phone users would be interested in using video communication systems for mobile phones and over 58% of them indicated that they would like to try using mobile video communication applications if they are free.

A study done by Pilling and Barret in 2007 indicated that, in general, Deaf people used several forms of text communication, but selected each for a specific purpose, e.g. SMS for communication with family and friends, and e-mail for communication and sending files. In the United Kingdom, e-mail and SMS were the most widely used forms of text communication among Deaf users, but SMS was mostly used by younger Deaf users. The most important reason why Deaf participants used text communications was "that they were easy or fast". Older participants were more likely to give "not knowing how to use it" as a reason for not using a particular form of communication technology and would have liked to have more information available about text communications in general (Pilling & Barret, 2007). Pilling and Barret are of the opinion that SMS can make communication easier for Deaf people.

In an Australian study, several trials of different communication methods were conducted with deaf (hard of hearing or Deaf) participants who mainly used sign language to communicate and found that SMS became the most frequently used means of communication when people were given a mobile phone that they had not used before (Pilling & Barret, 2007).

Power and Power (2004) examined the use of SMS text messaging in Australia and Europe among deaf people. They suggested that SMS technology would give deaf people access to family, friends, and business and work colleagues, both hearing and non-hearing, on an equal footing to every other mobile phone owner.

The situation was different in the United States, where deaf people use Instant Messaging (IM) more than SMS messaging (Pilling & Barret, 2007).

The literature indicates that SMS as a service is very successful. SMS has been used to update people with useful information in sectors such as health, employment, public safety, and business. In the health sector, a randomised controlled trial study was done by a University of Auckland clinical trial research unit in 2005 to determine the effectiveness of mobile text messaging in a six-week smoking cessation programme. In this study SMS was used as a service to help teenagers who owned a mobile phone and who indicated that they wanted to quit smoking. Some 1,705 smokers throughout New Zealand who wanted to quit smoking were used as participants. These people were randomised and received regular free personalised text messages providing smoking cessation advice, support, and distraction for six weeks. The results indicated that the programme was effective across different subgroups (defined by age, sex, income level, or geographic location). The study concluded that this programme offered affordable, personalised, location-independent potential as new way to help young smokers quit smoking. The researchers indicated that in a further study they want to test these findings in different settings to determine the long-term quit rate (Rodgers, Corbett, Riddel, Lin, & Jones, 2005).

A system such as that described by Rodgers et al. is helpful for people who can read and can make use of information disseminated via SMS. In South Africa, most Deaf people are functionally illiterate and they may find it difficult to make full use of information sent by SMS.

In business, the use of text messaging has grown since mid-2000. Many companies have changed to real-time messaging (e.g. SMS) and mobile phone communications to seek competitive advantage. The usage of text messaging in business includes for delivery confirmation; for advertising to customers; and for direct marketing to notify mobile phone users about new products, new services or promotions, payment due dates, financial services, etc.

Mobile mass text-messaging systems

Several mass text-messaging systems have been used in different settings, including Mobilisr, cludTexting, Vodacom Bulk SMS, MTN Bulk SMS, etc. Since Mobilisr is currently being used in the Western Cape, it was decided to adapt it for information dissemination to the Deaf. Mobilisr, an open source mobile platform, was developed by the NGO Cell-Life with the Praekelt Foundation and Upfront Systems for the Cell Phone 4 HIV Project. It was designed and created to increase access to information in sectors such as health, employment, and public safety, and to make two-way communications between citizens and service providers easier (Cell-Life, 2009).

In the Western Cape, Mobilisr is used to improve patient adherence to antiretroviral drugs and to build the capacity of organizations working with HIV/AIDS. Mobilisr supports mass messaging to prevent new infections by providing information to support treatment of those infected and to reduce the isolation of those infected or affected by HIV.

The Mobilisr system has the following functionalities: campaign management, broadcast SMS, schedule SMS, keyword SMS, pledge lines, Unstructured Supplementary Service Data (USSD), and subscribe/unsubscribe SMS (see Figure 1).

Figure 1 : Mobilisr system functions and features (Cell-Life, 2009)[1]

Campaign management can be used by the operator to manage and create campaigns. The operator can use various features, schedule the start and end of the campaign, and view the numerical targets and revenues.

Broadcast SMS can be used by the operator to send bulk SMSs to different groups of end users. Within this feature, the operator can create and have as many groups as desired. Individual contacts can be added to these groups. Keyword SMSs and subscribed/unsubscribe SMSs can be used in conjunction with this feature.

Schedule SMS is a feature that allows the operator to send a schedule broadcasting bulk SMS on a particular day at any particulate time to different groups of end users.

[1] Permission was obtained from Cell-life to use this diagram.

Keyword SMS is a feature that allows the operator to set up a keyword SMS. This keyword can be used by the end users to get the appropriate message content.

For *pledge lines*, the operators can use the keyword SMS feature to set up a keyword SMS with credits that will be pledged to the desired recipient. This pledge keyword can be used by the users to pledge donations.

USSD is an interactive menu-driven service with custom that can be dynamically viewed by end users. The content is uploaded or created by the operator. The end user can access it by dialling code *120*7675*555# to receive the content.

Subscribe/unsubscribe SMS can be used by the operator to set up a subscribe/unsubscribe keyword with an appropriate group. The end users can then use that keyword to send an SMS to a specific address and register/de-register to receive content.

The Mobilisr system is text based. To give South African Deaf people access to this type of information dissemination without the need for an interpreter, Mobilisr was adapted and modified to accommodate video messages in SASL (Hoorn & Venter, 2011).

Mobile video-messaging systems

Some free commercial software is available that allows Deaf people to communicate in either Deaf-to-Deaf mode or Deaf-to-hearing mode. These are discussed below.

Sign Forum (a discussion forum on the internet for Deaf people) allows a Deaf person to record a video message (with optional text) instead of just typing a text message. The video is recorded using client software and uploaded to the SignForum server, from where it can be accessed. SignForum runs inside a browser and, since it is video based, allows for sign language communication (Mutemwa, 2011; Omnitor, 2011).

Skype (a software application that allows voice, video, and text communication over the Internet; see Figure 2) allows free calls to other users within the Skype service, while calls to both traditional landline telephones and mobile phones can be made for a fee using a debit-based user account system. Skype has also become popular for its additional features, which include instant messaging, file transfer, and videoconferencing. Skype had 663 million registered users in 2010 (Skype, 2011).

Figure 2 : Skype application functions and features (Skype, 2011)

Camfrog (a video chat client that was created by Camshare LLC) was first launched in 2003. Camshare claims on its website that it has attracted "over 30 million downloads with millions of registered users".

Camfrog allows users to send instant messages to each other privately. Users can also interact via a private one-on-one audio/video chat. Unlike most instant message programs, users can also connect to chat rooms to view other users' text, audio, or video chats (see Figure 3).

Figure 3 : Camfrog client application (Camfrog, 2011)

Camfrog has the following features:

- *Chat:* Camfrog Client includes the ability to access Camfrog-hosted and user-hosted video chat rooms. Users have the ability to create their own rooms with different themes. User rooms have different rules from Camfrog-hosted rooms, but must follow the basic Camfrog terms of service.
- *File sharing* is possible and users may send files to each other via Camfrog with a maximum file size of 100 MB.

- *Snapshots* are images that can be sent from one user to another from their webcams.
- *Profile* pages are featured by Camfrog for users over the age of 16. Users under 16 cannot create profile photos.
- *Camfrog Mobile* is also available for Windows Mobile and the Apple iPhone. The Camfrog Windows Mobile application allows Camfrog users to IM and has one-on-one audio calls. The Camfrog iPhone application allows Camfrog users to IM, have one-on-one audio calls, and chat in chat rooms via text and on microphone.

MobileASL, developed by the University of Washington to support Deaf people with wireless cell phone communication in American Sign Language (ASL), is a mobile video system that makes use of compression and decompression methods to avoid too much bandwidth usage. It employs region-of-interest methods on the sign language videos to focus on the hand movements and facial expressions of the signer within the video (Cavender, Ladner, & Riskin, 2006).

Cavender et al. highlight some very important points that also had to be considered in this study: the sign language in the video (hand movements and the facial expressions of the signer) must be clear and understandable; the bandwidth usage to send the videos must be limited (the more bandwidth used, the more users have to pay); and cost is a key factor and must be kept down. A video codec can be used to compress a video file by removing unnecessary information such as sound for storage and transmission (Tucker & Zhenyu, 2008). After compression, the video storage size will be smaller, the transmission will be faster, and the cost will be lower.

Video-streaming technologies

Video streaming is a method/technique used for transferring data so that it can be processed as a constant and continuous stream over the Internet. This technology is used worldwide to transfer multimedia files containing video, voice, or data. With this technology, even before the entire file has been transmitted, the client browser can start displaying the files. It is based on two key technologies, i.e. video coding and scalable distribution. Bandwidth efficiency, scalability, and flexibility are key issues in video streaming. When there is a change in bandwidth, this scalable video-distributing technology can automatically adjust the amount of data transmitted. The components of a video-streaming system are a distribution server, an encoder, and a client who receives the video data (see Figure 4). Encoded video data is stored on the distribution server. The distribution server distributes this video data on the client's demand. People can watch the videos whenever their access the server on the Internet. Live distribution is carried out in real time.

For video streaming, the most important video codec standards are H.261, H.263, MJPEG, MPEG1, MPEG2, and H.264/MPEG4. Codecs designed for the Internet require greater scalability, lower computational complexity, greater resiliency to network losses, and lower encode/decode latency for video conferencing compared to video codecs for CD-ROM or TV broadcast. To achieve the highest possible frame rates and picture quality, the codecs must be tightly linked to network software.

In video streaming the transport protocols used are Transmission Control Protocol (TCP), User Datagram Protocol (UDP), Real-time Transport Protocol (RTP), and Real-time Streaming Protocol (RTSP). TCP is required for reliable document transfer by the means of the Hypertext Transfer Protocol (HTTP). RTP is designed for the transport of real-time data (audio and video included) and is the most popular transport protocol. Another open standard protocol for delivery real-time media over the internet is RTSP. The connection between the streaming media client and the server software is defined by RTSP. It also provides a standard way for client and servers from multiple vendors to stream multimedia content.

Figure 4 : Video-streaming system setup (Javvin Technologies, 2010)

Multimedia delivery methods

Streaming methods and file formats are very important when creating a video stream. Media such as video, audio, animation, etc. can be viewed on the Internet in three ways: downloading, streaming, or by means of progressive downloading.

Downloading

An entire file is saved on a computer or any other devices (usually in a download or temporary folder) when downloading a file, and it can be opened and viewed once the download is complete. This method has its own advantages and disadvantages. Quicker access to parts of the file as it downloads is an advantage of this method. Having to wait for the entire file to download is a disadvantage.

A simple hyperlink to a file is the easiest way to provide access to downloadable video files. Embedding a file in a web page using Hyper Text Markup Language (HTML) code is a slightly more advance method of providing downloadable video files. Delivering video files in this way is known as HTTP delivery or HTTP streaming. HTTP is also used to deliver web pages.

Streaming

With streaming, as soon as the file begins to download, the user can start watching it. The user can watch the file as it arrives, since the file is sent as a constant stream. Over and above the advantage that there is no waiting involved in this method, it has the additional advantage that it can be used to stream live events.

Progressive downloading

This method is a hybrid method that combines two video delivery methods. In this method, the video is downloaded as a complete file, but as soon as a portion of the file is received, the video starts to play. This method does not have all the advantages of true streaming, but it simulates true streaming.

What method to choose depends on the application and the situation. It seems as if HTTP streaming (download or progressive download) is preferred by most people (Javvin Technologies, 2010).

A streaming media/streaming video server runs on an Internet server as a specialized application. Since other methods only simulate streaming, streaming media/streaming video is referred to as true streaming. The following are the advantages of true streaming:

- the ability to handle large traffic loads;
- the ability to detect users' connection speeds and supply appropriate files automatically; and
- the ability to broadcast live events.

There are two ways to implement streaming serves:

1. by operating one's own server (by purchasing or leasing); and
2. by signing up for hosted streaming plan with an ISP (Internet service provider).

File formats

According to Media College (2010), file formats are an issue to both users and developers. Each prefers his/her own video file formats. For example, a developer will develop a video application for the Nokia E71 using .SWF video files, knowing that the Nokia E71 has the ability to play .SWF video files. On the other hand, the end user may want to use a video application on the Nokia E71, but with a different video file format. By creating video applications that can accommodate different file formats, it will be possible to reach the widest audience of users (Media College, 2010).

There are many video file formats, the most common being Windows media, real media, MPEG (in particular MPEG-4), and Adobe Flash. Each of these file formats has its own pros and cons. A comparison and evaluation of different video file formats and the pros and cons of each will be discussed in Chapter 5.

Conclusion

In this chapter, the literature was discussed in terms of the keywords defined. The various messaging methods (SMS, MMS, and e-mail), video-streaming technique file formats, and cost charged by mobile service providers were discussed. In the next chapter, the research methodology will be discussed.

Chapter 3

RESEARCH METHODOLOGY

Introduction

The literature related to this study was discussed in the previous chapter. In this chapter, the research problem is stated and the research design and methodology explained.

Research problem

To interpret information disseminated via text messages effectively, the receiver must be able to read and understand the language of the message. The assumption is that video instead of text would provide a means of disseminating information to people who find text messages challenging.

The study was guided by the following basic research question:

> How should video-streaming mass-messaging methods be compared and evaluated to find the most suitable method to deliver an affordable and acceptable service to Deaf people?

This question can be unpacked as follows into further questions:

- What transport vehicles should be considered: MMS, the web, or a SMS, with a web link to a video (web-enabled SMS)?
- What would the cost be to the end user?
- How should the cost to the end user be minimised? For example, would stripping the sound from the video footage have a significant impact on the cost of transportation?

- How does the video quality in terms of the quality of the sign language vary amongst the transport vehicles?

Overall, these research questions required a problem-solving approach to system development. Some aspects of the research questions required a quantitative study, but a qualitative perspective was needed to guage the experiences of the users. The methodological framework adopted for this study was the soft-systems methodology (SSM) (Checkland & Scholes, 1990).

Research approach

SSM was combined with a mixed-methods methodology to address the research questions.

Soft-systems methodology (SSM)

SSM is an appropriate research problems methodology for problems with no well-defined solutions (Mingers & Taylor, 1992). It forms a cycle that repeats itself until an appropriate solution to the problem is found (Checkland & Scholes, 1990). SSM was used in this research to manage the research process.

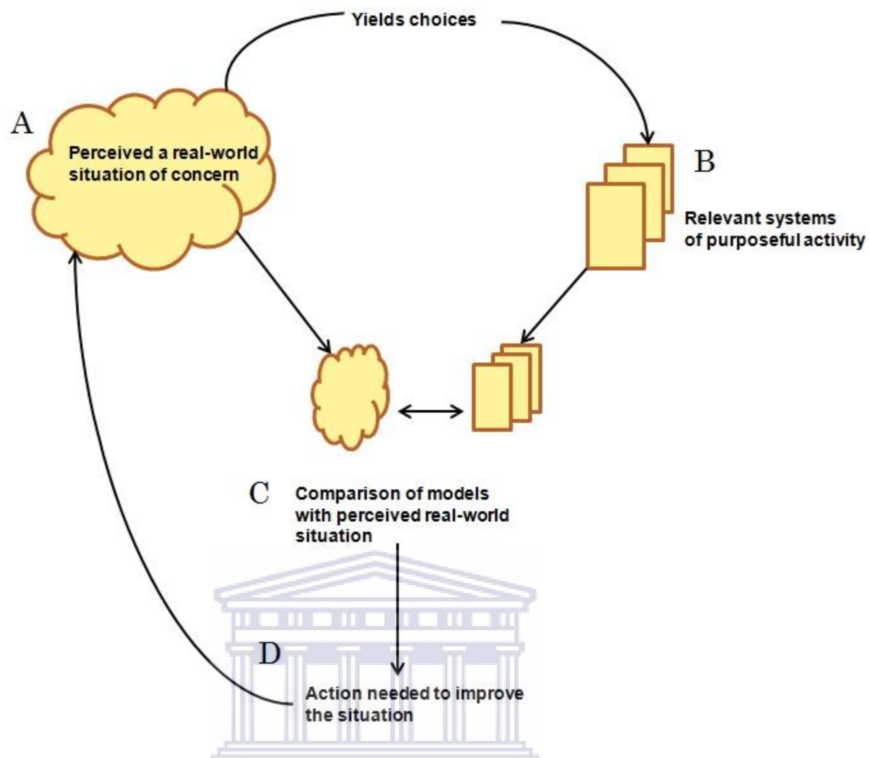

Figure 5 : The basic shape of SSM (Checkland & Scholes, 1990)

Figure 5 depicts the basic shape of SSM.

- **A** depicts the perceived real-world situation of concern. In this research, the main problem is that functionally illiterate people find it difficult to interpret information disseminated via text messages.
- **B** presents relevant systems of purposeful activity. Two prototypes were developed, namely a Symbian (Nokia)-based prototype and an Android (Vodafone)-based prototype to address the problem.
- At **C** the models are compared with the perceived real-world situation. Both prototypes were tested with Deaf users at the DCCT. The testing was done by means of the mixed-methods methodology, which involves using both qualitative and quantitative research methods. The

information retrieved from the data helped to assess whether the prototypes provides the desired solution to the problem.

- **D** presents the action needed to improve the situation. This stage involves the decision as to whether or not changes are needed to improve the prototype and whether to carry out further testing that may lead to further improvements.

Mixed-methods research methodology

The mixed-methods research methodology consists of both quantitative and qualitative methods. It is an attempt to use multiple approaches in answering research questions rather than constraining the research by using only one method. In this research method, the investigator collects and analyses data, integrates the findings, and draws inferences using both qualitative and quantitative approaches in a single study or programme of inquiry (see C in Figure 5) (Creswell & Tashakkori, 2007; Plan Clark & Creswell, 2011). It is an unlimited form of research that is creative, but also expensive. Formally, mixed-methods research is defined as "the class of research where the researcher mixes or combines quantitative and qualitative research techniques, methods, approaches, concepts or language into a single study" (Johnson & Onwuegbuzie, 2004).

Johnson and Onwuegbuzie (2004) contend that "today's research world is becoming increasingly interdisciplinary, complex, and dynamic; therefore, many researchers need to complement one method with another and all researchers need a solid understanding of multiple methods used by other scholars to facilitate communication, to promote collaboration, and to provide superior research". The goal of the mixed-methods design is not to replace the quantitative and qualitative research methods, but rather to minimize the weaknesses and use the strengths of both in a single study.

Research design

The research design is a strategy for collecting data and making effective use of it, so that desired information can be obtained and a hypothesis can be tested properly. The overall research process was managed by using SSM and the data collection process was guided by the mixed-methods research methodology. The mixed-methods research design was used to compare the potential systems (prototypes) with a real-world situation (see C in Figure 5).

Within the mixed-methods research paradigm there are two major research design types namely: the *mixed-model* research design and the *mixed-methods* research design (Johnson & Onwuegbuzie, 2004).

Mixed-model research design

The mixed-model research design mixes qualitative and quantitative approaches *within* or *across* the stages of the research process.

Within stage

> Here, "within one or more of the stages of research quantitative and qualitative approaches are mixed" (Johnson & Onwuegbuzie, 2004). An example of within-stage mixed-model would be the use of a questionnaire that includes a summated rating scale (quantitative data collection) and one or more open-ended questions (qualitative data collection) (Johnson & Onwuegbuzie, 2004).

Across stage

> Here, "across at least two of the stages of research quantitative and qualitative approaches are mixed" (Johnson & Onwuegbuzie, 2004). For example, if a researcher uses open-ended interviews for qualitative data collection, the results could be quantified by counting the number of times each type of response occurs (quantitative data analysis). The

researcher could also report the responses as percentages and examine the relationships between sets of categories or variables through the use of contingency tables. In statistics, a contingency table is a table in a matrix format that presents the frequency distribution of variables and it is used to record and analyse the relationship between two or more variables. Different mixed-model designs are shown in Figure 6 (Johnson & Onwuegbuzie, 2004).

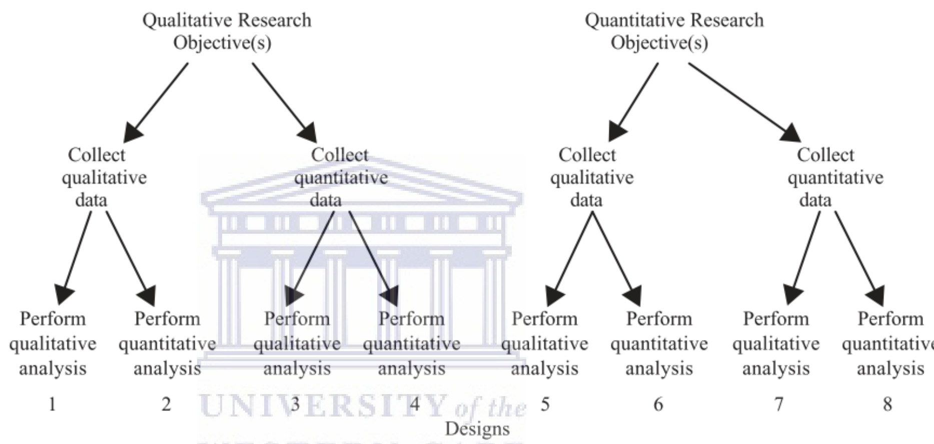

Figure 6 : Mono-method and mixed-model designs (Johnson & Onwuegbuzie, 2004)

Mixed-methods research design

The mixed-methods research design includes a *qualitative phase* and *quantitative phase* in a full research study. It is like including a qualitative mini-study and a quantitative mini-study in a full research study (see Figure 7).

Within the mixed-methods research design there are two major designs, depending on how the data is collected:

1. the concurrent triangulation research design, implying that qualitative and quantitative data are collected at the same time; and
2. the sequential triangulation research design, meaning that part of the data is collected first and the rest is collected later on.

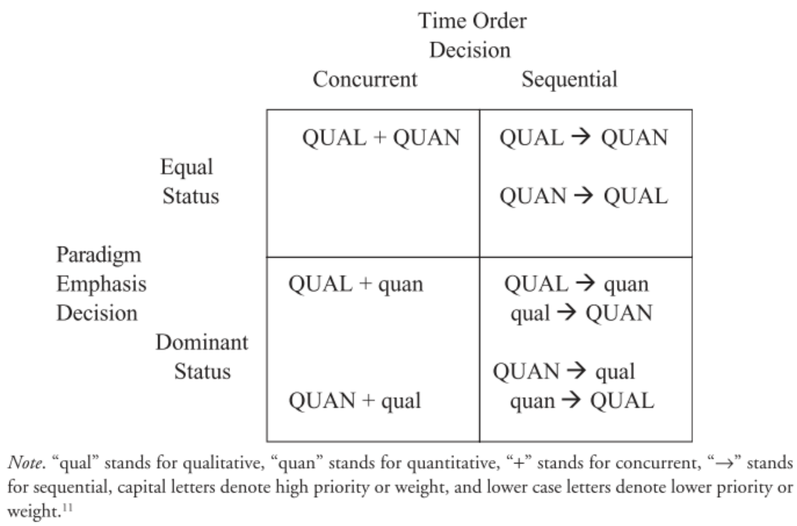

Figure 7 : Mixed-methods research design (Johnson & Onwuegbuzie, 2004)

In this study, the sequential triangulation research design was employed (see Figure 8). During the qualitative phase, interviews were conducted with the system's proposed users. During the quantitative phase, time and cost data was collected from the prototype and analysed.

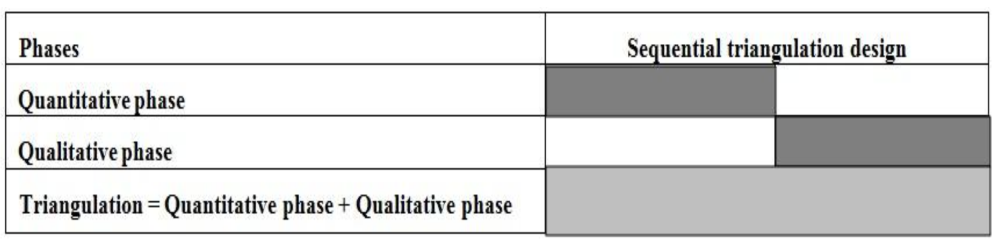

Figure 8 : Sequential triangulation research design

The sequential triangulation research design as part of the mixed-methods research design is guided by the eight-stage process model of the mixed-methods research methodology (see Figure 9).

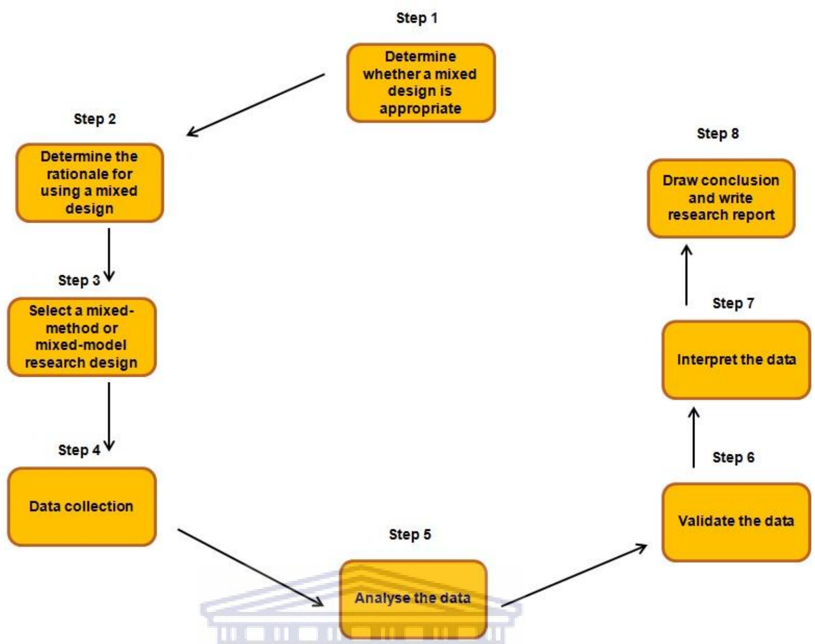

Figure 9 : Eight-step mixed research process model (Johnson & Onwuegbuzie, 2004).

1. *Determine whether a mixed design is appropriate*

   It was found that some aspects of the research question required a quantitative study, but to ascertain the experiences of the users, a qualitative perspective was also used; therefore a mixed design was appropriate for this study, because it involves both qualitative and quantitative approaches.

2. *Determine the rationale for using a mixed design*

   The five most important rationales or purposes for using mixed research are as follows: *triangulation* (seeks convergence, corroboration, and the correspondence of results from different methods); *complementarities* (seek elaboration, enhancement, illustration, and the clarification of the results from one method using the results from the others); *development* (seeks to use the results from one method to help develop or inform the other method, where development is broadly constructed to include sampling and implementation, as well as measurement decisions); *initiation* (seeks the discovery of paradox and contradiction, new perspectives of frameworks, and the recasting of questions or results from one method with questions or results from the other method); and *expansion* (seeks to extend the breadth and range of the inquiry by using different methods for different inquiry components). *Triangulation* is the reason for using mixed research because the study triangulates the correspondence of results from different methods into one method.

3. Select the mixed-methods or mixed-model research design

In this study the *mixed-methods* research design was used because the study included a qualitative phase (interviews) and a quantitative phase (time and cost data was collected as generated by the prototype).

4. Data collection

This is the process of gathering and measuring information on variables of interest in an established systematic fashion that enables one to answer stated research questions, test hypothesis, and evaluate outcomes (University, 2005).

Steps 5-8 will be dealt with later in the chapter (see page 46). Before data collection is done, sampling, research instruments, and data collection procedures need to be considered.

Sampling

Sampling is the process of selecting a suitable part of a population for the purpose to determine the characteristics of the whole population (Mugo, 2010). In the mixed-methods design there are two forms of sampling, random sampling and purposeful sampling.

Random sampling involves randomly selecting a sample size of individuals who represent a portion of a population. Each individual in the population should have an equal chance of being selected (Plan Clark & Creswell, 2011).

Purposeful sampling is when the researcher selects participants with a specific purpose, e.g. participants have experience in the key concept being explored in the study (Plan Clark & Creswell, 2011).

Both *random sampling* and *purposeful sampling* were used in this study. *Purposeful sampling* was used in the pilot and *random sampling* was used in the case studies.

In this study, data was collected during several cycles (a pilot study and two case studies). In case study 3, a prototype was only developed. (see Figure 10).

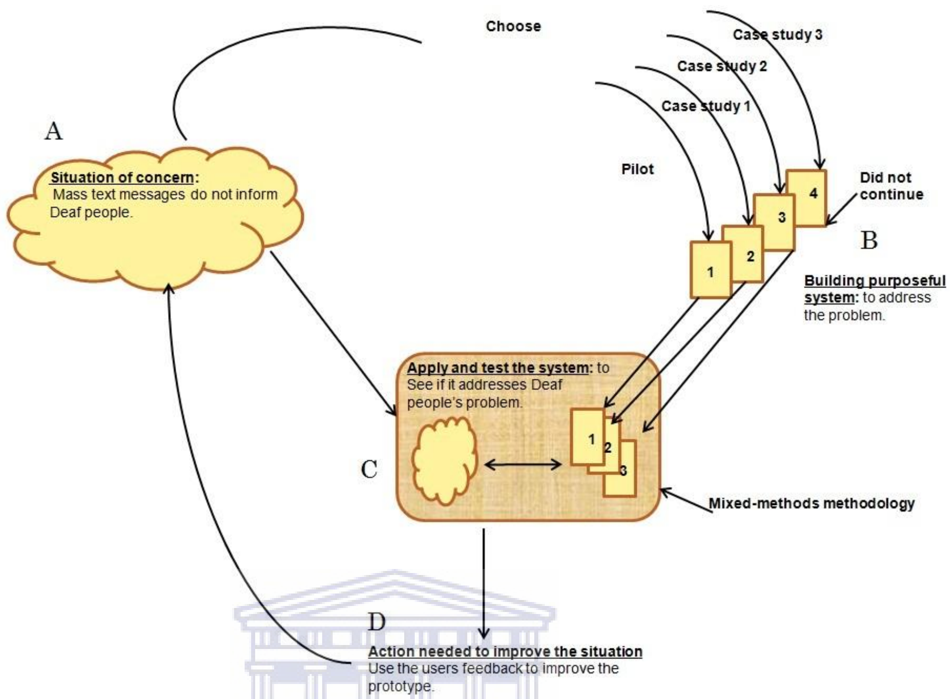

Figure 10: Detailed application of the soft-systems methodology

In the first three cycles, a prototype was developed or modified; a sample was chosen; and background, qualitative, and quantitative data was collected. The same research instruments and data collection procedures were used in each cycle.

Research instruments

Background data was collected by using information sheets (see Appendix A); quantitative data was collected by doing experiments in a laboratory environment (time, cost, and download data using different messaging methods was collected; see Appendix B); and qualitative data (see Appendix C) was collected by unstructured interviews. Observations were done during the user trials of the prototypes (see Appendix D).

Data collection procedure for the different cycles

User data was collected at the DCCT. At the beginning of each session a consent form was presented to the participants who agreed to participate in the user tests. They were informed that the data collected would be strictly confidential and that it would be used only for research purposes. They were also informed that the entire session would be video recorded.

Since all the participants involved in this study were Deaf, the interviews were done as a slide presentation. The researcher introduced himself and explained what the research entailed. To avoid confusion and miscommunication, the SASL interpreter made sure that all the participants understood what the study was about. Participants were shown how the prototype could be used and were given a chance to acquaint themselves with it.

After the demonstration and presentation, participants were interviewed as a group. Each participant was given a number to differentiate his/her responses during the analysis of the video clip and voice recording. The video recording was used to record the SASL responses of the participants and the voice recording was used to record the interpreter's interpretation of the participants' responses. After the interviews a information sheet was handed to the participants for completion with the help of the SASL interpreter and the researcher. The information sheet included their names, which phones they used, etc. The participants helped to determine the effectiveness of the various video delivery mechanisms.

Pilot study

For the pilot study, a mobile phone prototype and an interview slide presentation were prepared. The purpose of the pilot study was to refine the probes of the interviews and to improve the prototype for the case studies. An SASL interpreter was organised a week in advance to translate the presentation and the interview questions into SASL.

Prototype implementation

For the purpose of the pilot study, a Symbian prototype was developed. Mobile Python for the Series 60 (S60) was used to develop the Symbian prototype. Symbian is a mobile phone operating system for Nokia phones.

The prototype was developed based on a client server architecture (see Figure 11). The mobile client application communicates with the XAMPP (Cross platform Apache MySQL PHP Perl) HTTP server through the use of an ad hoc network.

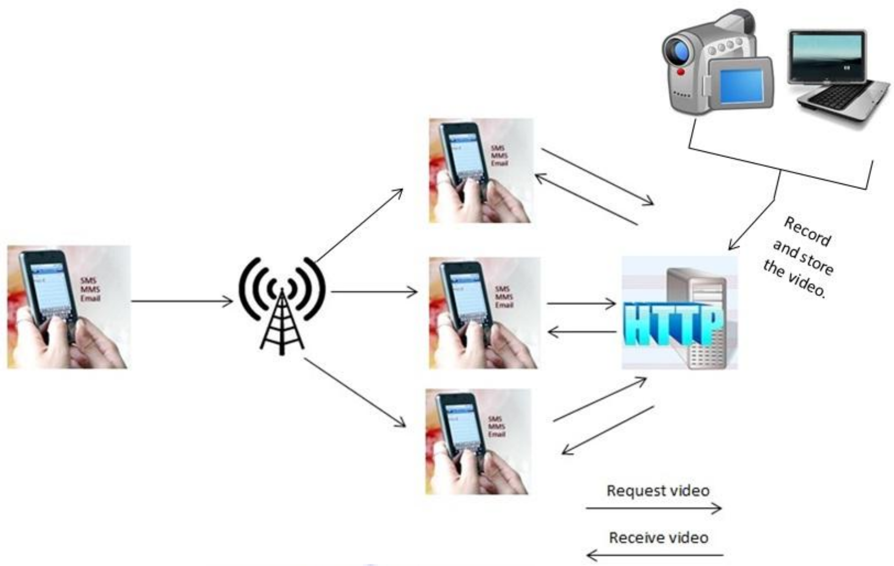

Figure 11: Mobile client and server architecture design of the prototype

Implementation tools

<u>*Software*</u>:

- Mobile Python for Series 60 (PyS60) was used as a programming language to implement the Symbian prototype. Mobile Python was used because it is very flexible for rapid prototyping on mobile phone platforms (Scheible & Tuulos, 2007).
- XAMPP (Cross-platform Apache MySQL PHP Perl) was installed as the web server application. It was used because it can be applied across all platforms and is easy to install and use.
- Linksys interface software was installed to create and manage ad hoc networks.

Hardware:

- A Nokia N82 mobile phone was used for the development of the prototype. The Nokia N82 was used because it had the necessary specifications/formats.
- Linksys router model WRT54GL was used to build an ad hoc network.
- An HP ProBook 6450b laptop served as the server.

The XAMPP server application was installed on the laptop to run as a server. The Nokia mobile phone was used to run the client application (PyS60) of the prototype.

Prototype overview

The prototype was developed based on a client server architecture (see Figure 11). Video messages can be sent using SMS with a web link, MMS with a web link, or MMS with a video attached. When a video is sent via a SMS with a web link, the receiver receives the message, and he/she then has to make a request to a server to receive the video. When a request is made, the server streams the video to the receiver's mobile phone. The same procedure applies for the MMS with a web link. When a video is sent as an attachment via MMS, the sender has to record the video using the mobile phone and then send it to the receiver. In order for the receiver to view the video, the receiver's mobile phone must be MMS enabled. The receiver must thus have some airtime, otherwise, he/she will not be able to view the attached video. (Airtime is a South African term used when referring to the customer's bill calculated by the carrier based on airtime for the actual time spent on an active mobile phone connection, including incoming and outgoing calls, messages, e-mail, etc.)

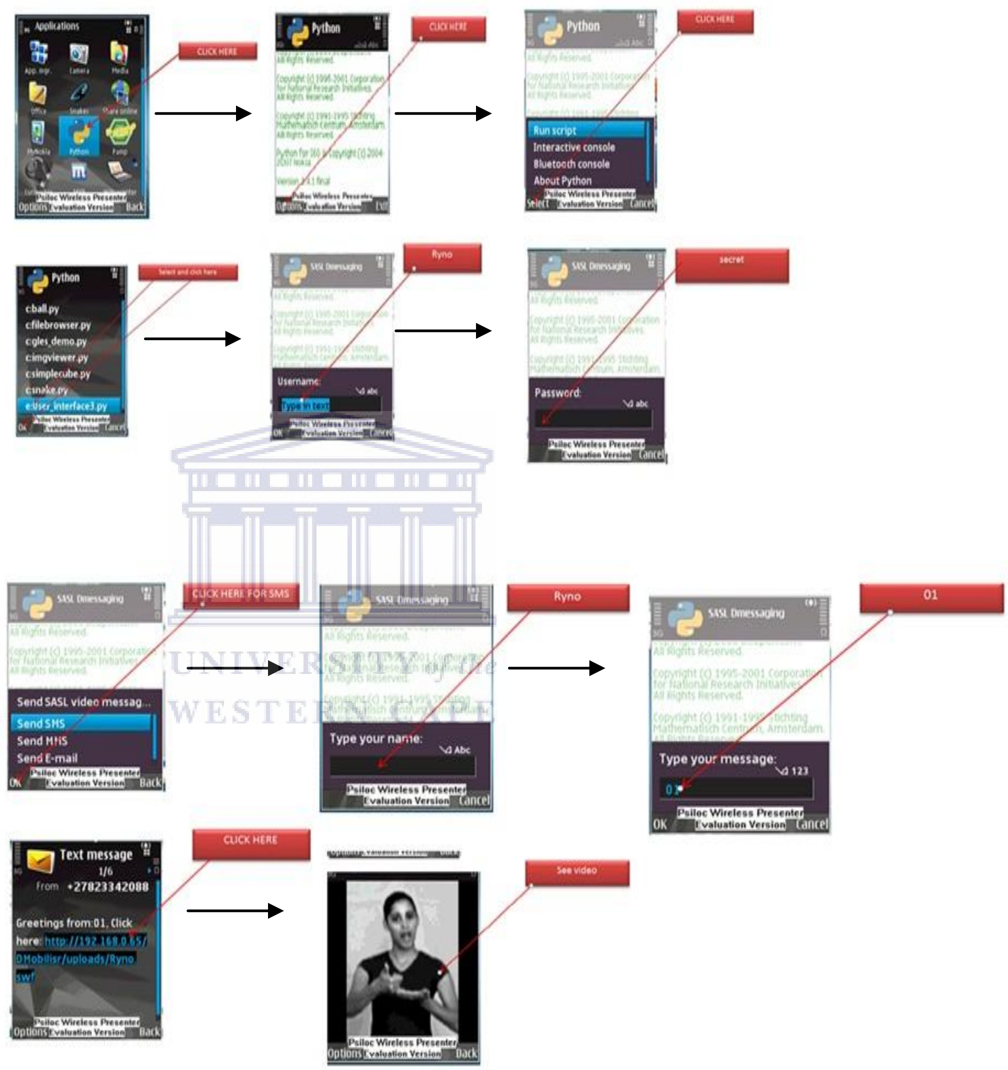

Figure 12: Symbian screens covering sending and receiving video messages

Screens and models of the mobile prototype

Figure 12 shows the screen of the Symbian mobile client of the prototype. It shows the process of sending a video message to receiving the video message using the web-enabled SMS (see Appendix E for a detailed description of the Symbian mobile client screens).

Sampling for the pilot

Purposive sampling was applied during the pilot study. Five Deaf persons were asked to participate in the pilot study with a specific purpose in mind. These participants were used in previous studies done by the University of the Western Cape's Broadband/Bridging Applications Network Group (BANG) group and thus knew what was expected of them. They are DCCT staff members and were the only people available for interviews on a Wednesday, the day that the BANG group usually visits the DCCT. This group of participants were more literate than the non-staff members.

Experiments used for collecting the quantitative data

Quantitative data (message delay period) was collected sequentially (before the qualitative data was collected), but in a laboratory. Sixty messages were sent (30 SMSs and 30 MMSs). With the prototype, the sent time was logged in a file called the sent-time log. The time the message was received was logged in a file called the received-time-log.

Other data such as the download time and airtime balances was manually collected. Download time was measured as the time it took to download a video from the server. A Samsung mobile phone stopwatch was used to determine download time. The airtime balance is the amount of credit available after a message was sent and it was collected by running a Vodacom USSD code *100# after each message was sent.

Time data refers to the time from when a video message is sent to the time the video message is received by the recipient. The purpose of the time data analysis was to determine message delivery delays.

Cost data refers to the cost of sending a message (such as an SMS and MMS). The purpose of the cost data analysis was to determine the cost of sending a message; this was done by monitoring the airtime balance each time a message was sent and comparing it with the standard prices for SMSs and MMSs (see Table 1).

Table 1 : Standard pre-paid prices of South African network operators

Network service provider	Peak time		Off-peak time	
	SMS Cost/160 characters	MMS Cost/< 300 kb	SMS Cost/160 characters	MMS Cost/< 300 kb
MTN	R0.50	R0.90	R0.35	R0.80
Vodacom	R0.80	R0.80	R0.35	R0.80
Cell C	R0.50	R1.00	R0.50	R1.00
Virgin Mobile	R0.70	-	R0.70	-
8ta	R0.50	R0.50	R0.50	R0.50
Average cost	R0.60	R0.80	R0.60	R0.80

The download time is the time it takes to download a video from a server. The purpose of monitoring the download data was to check what effect the size of the video had on the download time and speed. A stopwatch on a mobile phone was used to do the timing.

During the experiments, several third-party sound removal software packages—Audacity, Power Sound Editor, Mp3DirectCut, and WavePad Sound Editor—were used to remove sound from the videos. This was done to determine whether sound significantly contributes to the size of the video.

Performance software was used to monitor the performance of the server, i.e. the network performance and the bandwidth usage while downloading was taking place.

Interviews used for collecting the qualitative data

Unstructured interviews with open-ended questions were used to interview the participants. The unstructured interview was chosen as a method since questions can be adapted to meet the understanding of the respondents and the interview does not have to adhere to a planned sequence of questions. It is unlike the structured interview where the questions are predetermined and the order of the questions cannot change.

During the interview, the researcher read the questions and the sign language interpreter signed it to the Deaf participants. The Deaf participants then signed the answers to the sign language interpreter, who translated what was signed into English.

Case study 1

In case study 1 (cycle 2), the same mobile prototype was used and different probes for the interviews were used. The interview questions were changed to simplify the questions for the participants. Data was collected with the help on an SASL interpreter.

Prototype implementation

The same prototype that was used in the pilot was used to collect more data. No modifications or changes were made.

Sample for case study 1

Random sampling was applied: participants were randomly selected and asked if they were willing to participate. These participants were members of the DCCT who attend the third Sunday of the month function every month. Five Deaf participants were used. Their level of literacy was lower than the staff members' literacy levels.

Experiments used for collecting the quantitative data

The same procedure was followed as was followed for the pilot experiment. Thirty web-enabled SMSs and 30 MMSs were sent as part of the experiments.

The purpose of repeating the experiments of the pilot study was to determine if there is difference in the average delay in sending 30 web-enabled SMSs and MMSs.

Interviews used for collecting the qualitative data

Unstructured interviews with open-ended questions were conducted. Five Deaf participants participated. These participants were randomly selected. The interview questions were changed to make sure that the questions were not too complex for the Deaf participants. See Appendix B for the modified interview questions.

Case study 2

For case study 2, the prototype and the interview questions of case study 1 were adapted to address the problems experienced in the first study. In this study more data was collected and analysed to check if the modified prototype could address the problem more satisfactorily.

Prototype implementation (Improved Python Symbian)

In the pilot study and case study 1, the prototype was not flexible enough. The users could not search for a contact to send a video message to the contact. In the previous prototype the cell number was embedded in the software of the prototype, thus the user could not change cell numbers and could not send a message to different people. The prototype was therefore modified (see Figure 13) and a contact list functionality was implemented that allowed users to browse for contacts. The implementation tools and technologies were used to modify the prototype.

Figure 13: Contact search function

Sampling for case study 2

A random sample of six participants was used to participate in the user test and the interview session.These group of participants consisted of staff and non-staff members.

Experiments used for collecting the quantitative data

The same experiments that were done in case study 1 were repeated in case study 2. The purpose of the experiment was to collect more data in order to answer the research questions.

Interviews used for collecting the qualitative data

Unstructured interviews were conducted with the five Deaf participants (see Appendix C). The participants were interviewed after the demonstration of the prototype.

Case study 3

The purpose of case study3 was to develop a prototype on a different platform and test it with users to see how the Android prototype performs compared to the Symbian prototype. Furthermore, it was necessary to determine which format of video message would be preferred by the Deaf participants. Due to limited time, however, experiments, user tests and interviews could not be conducted with the Deaf participants.

Prototype implementation (Android prototype)

Android is a software stack for mobile devices that includes an operating system, middleware, and key applications.

The Android prototype was built on a mobile client and server architecture design (see Figure 11). It was developed using Java and eXtensible Markup Language (XML). Java was used because it incorporates many powerful features. XML was used to design the structure of the interfaces and to transport and store data.

Implementation tools

- Eclipse IDE (Integrated Development Environment) 2.6.2 Helios is a multilanguage software development environment/tool that allows the building and managing of software applications.
- JDK (Java Development Kit) 6 is an Oracle Corporation product/tool aimed at Java developers. This tool is a Java interpreter and can interpret class files generated by javac compilers.

- Android SDK (Software Development Kit) for Windows is a set of software development tools that allow developers to create applications software packages.

5. Data analysis

Quantitative data analysis

The quantitative data was analysed using the Statistical Package for the Social Sciences (SPSS) and used to generate graphs, tables, and report sheets. These graphs and tables were used to present the average cost for sending video messages using both the SMS system and the MMS system; the average delays for sending each message using both systems; and the average download time for downloading the videos. Thereafter a comparison was made between the two systems. The report sheets contain important information such as the sample size, the mean, the standard deviations, the SE of the mean, the Shapiro-Walkin W statistic, a p-value, etc. These will be used to test the normality of the quantitative data that was collected during experiments.

The Shapiro-Walk test was applied to analyse the data that was generated by SPSS. It tests if a sample is normally distributed. The test rejects the hypothesis for normality when the p-value is less than or equals to 0.05. Failing the normality test allows one to state with 95% confidence that the data does not fit the normal distribution or the data is not normally distributed. When the p-value is greater than 0.05, then the test does not reject the hypothesis for normality. Passing the normality test only allows one to state that there is no significant different from the normality found. Normality tests are for testing whether the input data is normally distributed.

Qualitative data analysis

The raw data produced from the video-recorded interviews was transcribed and read to check for any incomplete or irrelevant data (Taylor-Powell & Renner, 2003). Thematic analysis or content analysis, as outlined by Taylor-Powell and Renner (2003), was used to analyse the qualitative data; i.e. step 1, familiarization (get to know your data); step 2, focusing the analyses; step 3, categorizing information; step 4, identifying patterns and connections within and between categories; and step 5, interpretation, bringing it all together.

In this study the results were triangulated and data integration was used as an analysis process. Data integration "characterizes the final stage, whereby both quantitative and qualitative data are integrated into either a coherent whole or two separate sets (i.e., qualitative and quantitative) of coherent wholes" (Johnson & Onwuegbuzie, 2004).

Triangulation of data

The qualitative data was collected using interviews as a data collection tool. The quantitative performance data and cost data were triangulated with the qualitative feedback from the Deaf users to arrive at an optimal broadcast video messaging technique (see Figure 14).

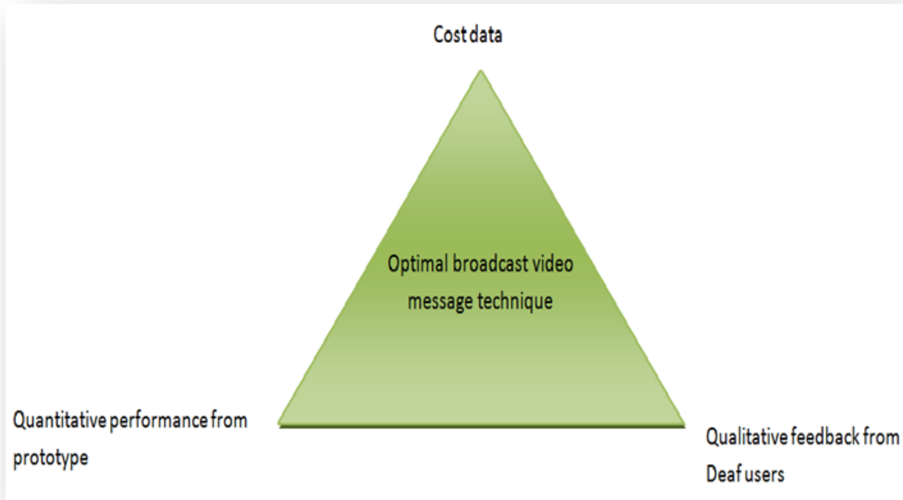

Figure 14: Optimal technique triangle

The triangle in Figure 14 represents the three forces that are dependent on one another and determine the outcome of an optional broadcast video message technique: quantitative performance from the prototype(s), qualitative feedback from the Deaf users, and cost data collected by means of experiments.

According to Dickman (2008), if any combination of two forces in the triangle has favourable outcomes, the third will "suffer". For example, if a broadcast video-messaging technique exists with good quantitative performances and good qualitative feedback, the cost will be high. Alternatively, if the cost is kept low, it may be that the broadcast video-message technique will imply poor performances or poor qualitative feedback.

6. Validate the data

Data validation is the process of determining whether data is complete and accurate, and meets specific criteria. To determine if the data was valid and complete, more than one method of data collection was used. Qualitative data was collected by means of interviews and the responses were video recorded to be observed repeatedly for validity purposes. The quantitative data was generated from the prototype and some features were added to the prototype to automatically capture the data to avoid inconsistency of data.

7. Interpret the data

Significant results were presented as graphs, tables, text, and diagrams.

8. Draw conclusions and write research report

The final step is to present the research in a report format. The report must show how the mixed research methods were applied and how the mixing of the methods took place; therefore the results should be presented in terms of triangulation of the qualitative and quantitative part of the research process.

Ethical considerations

Procedure

Approval was sought from the Science Faculty Research Ethics Committee to collect data and to present the research findings to a conference, workshop, seminar, or symposium, or to publish the findings as a journal article.

Procurement of consent and voluntary participation

The participants were invited to participate in the research by means of a consent form that explained the objectives of the research. They were given the assurance that all information provided would be treated as confidential. They were asked to indicate by raising their hands if they agreed to participate (see Appendix F). On the consent form participants were informed that they had the right to withdraw from the research at any time. Therefore, participation was totally voluntarily without any kind of coercion or deception.

Participant confidentiality agreement

To ensure privacy and confidentiality, the collected data was kept in a secure place and was destroyed after it was entered into a secure database. Each interviewee was given a respondent number and particulars of the interviewee were not made public. The results of the study will be published without revealing particulars of any of the participants.

Humanitarian considerations: risk and benefits

The data collection methods that were used in this study did not put at risk or interfere with the mental or physical integrity of the participants. The participants were informed about the objective of the research and had sufficient information to make an informed decision about their participation (Ma & Tucker, 2005). The direct or short-term benefit to the participants was that their opinions were valued and documented.

Conclusion

In this chapter, the focus was on the research design and methodological aspects of the study. The two research approaches that were employed in this study were discussed in terms of the management of the research process and the data. SSM was employed for managing the research process and the mixed-methods methodology was used to collect and analyse the data. The data analysis methods were clarified and the ethical considerations were stated. The next chapter presents the results that were obtained.

Chapter 4

RESULTS

Introduction

In the previous chapter, the research methodological approach and a brief description of the prototypes' implementation were discussed. In this chapter, the results are presented in terms of several cycles: evaluation, analysis and changes. These cycles were continued until the results were within the required boundaries.

Pilot results

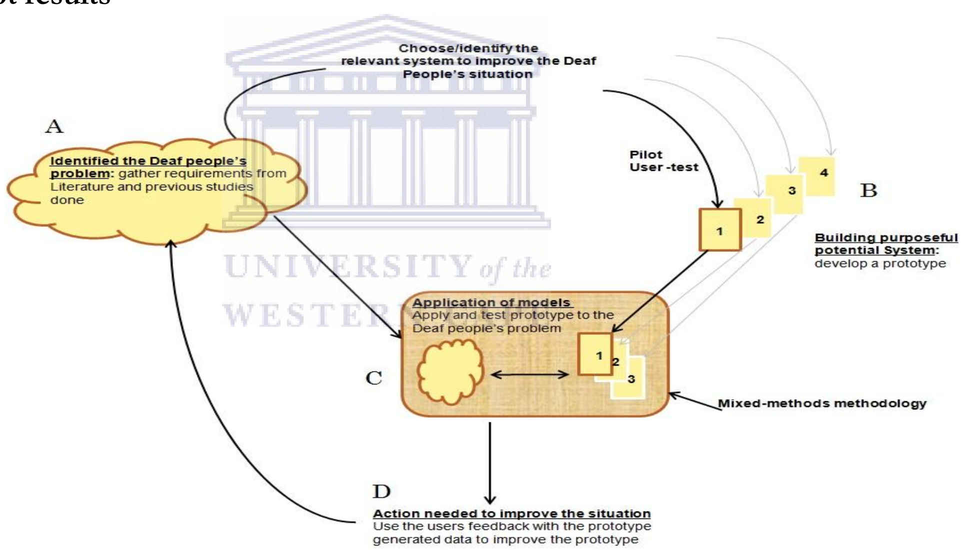

Figure 15: First cycle of the pilot study

In this chapter, the results of the pilot study (see Figure 15) and case studies will be presented in terms of:

i. the background of the study;
ii. quantitative results; and
iii. qualitative results.

Background data

To understand the Deaf participants' technology background and their Internet usage, two types of data were collected initially: on Deaf users' mobile technologies usage and their Internet usage (through a record of what Deaf users do on the Internet at the the Bastion PC lab at the DCCT – see below).

Technology background results

The technology background results are based on the five Deaf participants who participated in the pilot study (see Appendix A, nos. 1-5).

One of the participants was between the ages of 15 and 24 (20%), and the rest were older than 35 (80%) (see Figure 16).

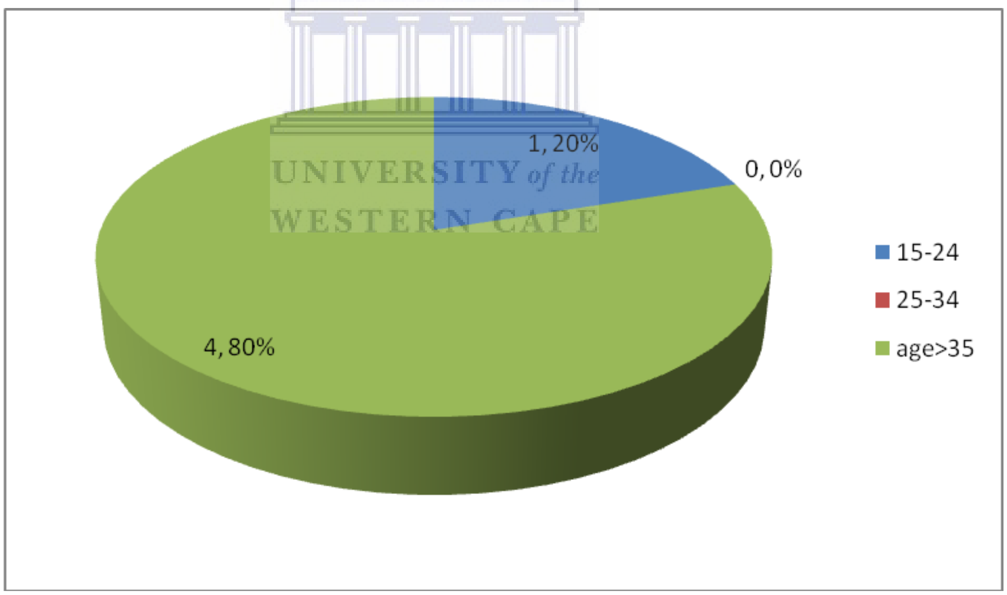

Figure 16: Age groups of participants

All five participants indicated that they used their mobile phones for SMSs and none used their mobile phones for MMSs. The researcher had a general discussion with the participants (with the help of an SASL interpreter) on why they do not use MMSs. Most of them said MMS is too expensive and their mobile phones do not have a camera to take pictures or record videos, so there is no point in using MMSs, but maybe in the future, when they have smart phones and can afford MMSs, they will consider using MMSs. Only two participants used the Internet on their mobile phones, while one participant used e-mail and another used Mxit (see Figure 17).

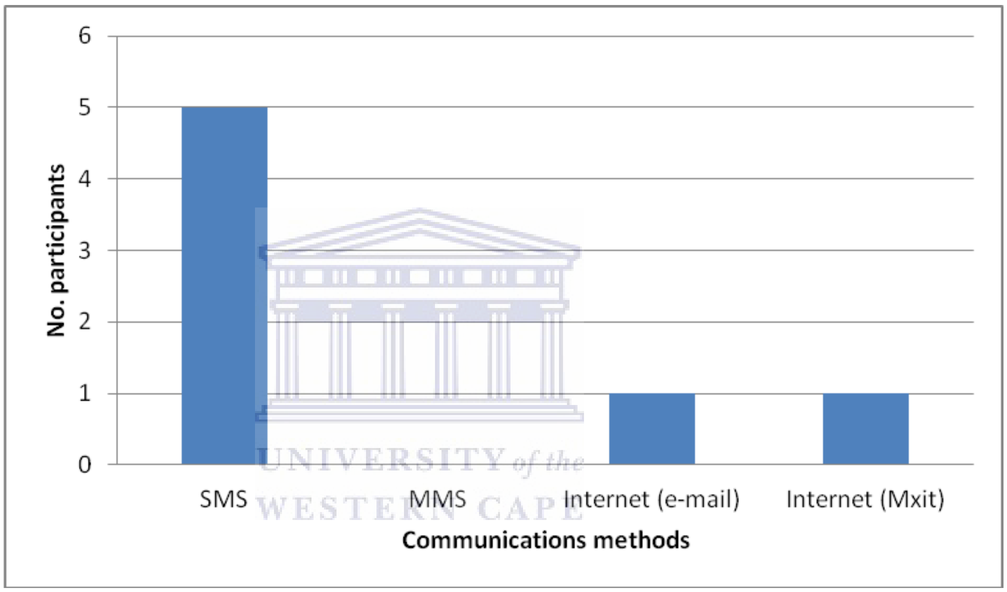

Figure 17: Participants' mobile phone usage for communication

Four of the Deaf participants sent or read text messages in English (80%) and one in Afrikaans (20%). Most of the Deaf participants used English on their mobile phones, but all of them indicated that if it were possible, the language they would prefer to use on their mobile phones would be SASL. One of participants commented: "We all will be happy if there will be an SASL language option on our mobile phones." All of the participants owned Nokia mobile phones (100%) (see Appendix A, nos. 1–5).

Internet usage results

In 2004, the UWC BANG research group opened the Bastion PC lab at the DCCT. In this lab, there are six PCs with free Internet access available for DCCT members. The DCCT laboratory manager assisted the UWC BANG research group by recording DCCT members' Internet usage. The PC lab is used by over 90 DCCT members for accessing the Internet. Figure 18 graph shows Internet usage since 2007 for the different software applications.

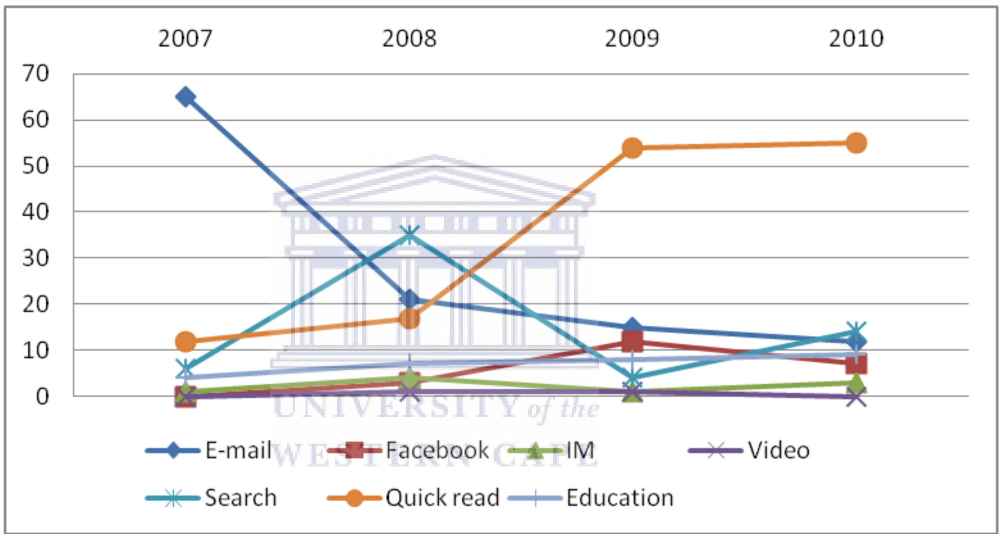

Figure 18: Internet usage at the DCCT (Bastion PC lab), 2007–2010

In Figure 18, 'e-mail' represents the number of times e-mail was used; 'Facebook' represents the number of times users visited a social network; 'IM' (Instant Messaging) represents the number of times users used IM applications such as MSN and Google Talk (gtalk); 'video' represents the number of times users used video systems such as YouTube, Skype, and Camfrog; 'education' represents how many times users used the Internet for educational purposes; 'search' represents the number of times users used the Internet for specific tasks, e.g. for job hunting, house/flat rental, etc.; and 'quick read' represents the number of times users used the Internet to get news-related information, e.g. reading news online (local news and global news).

As indicated by Figure 18, in 2007, e-mail was the most used Internet service, followed by quick read and search. In 2008, the use of e-mail decreased, while the useof other services increased. In 2009, e-mail use continued to decrease, while quick read, Facebook, and education usage increased. In 2010, quick read and search were the most popular applications used at the Bastion lab.

Experiments (quantitative data)

For a full statistical summary of the data that was generated by SPSS, see Appendix B, pilot study. The following aspects of the Symbian prototype were tested during the experiment:

Time data

Figure 19 shows the average delay (time) for sending 60 video messages using two video-streaming methods, i.e. the SMS web-link method (30 messages) and MMS video-attached method (30 messages). As shown in Figure 19, the average delay time for the web-enabled SMS mode was less than the average delay of the MMS mode, i.e. the SMS mode delivered the messages faster than the MMS mode. The web-enabled SMS mode had a delay of 4 minutes while the MMS mode had a delay of 6 minutes.

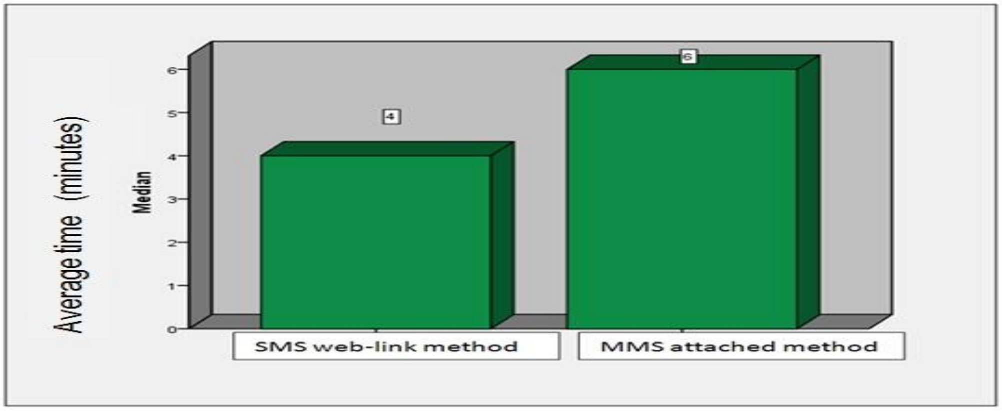

Figure 19: Average delay for sending 60 video messages (30 SMS, 30 MMS)

Cost data

The average cost per SMS for sending the 30 SMSs was 35c and the average cost per MMS for sending the 30 MMSs was 80c (see Figure 20).

The charges of South Africa's five mobile network operators during peak and off-peak time is summarised in Table 1. Two mobile service providers in SA (MTN and Vodacom) charge on average of between 50c and 80c per SMS during peak time, and between 30c and 35c per SMS during off-peak time (MTN, 2011; Vodacom, 2011). The prepaid price of an MMS of all service providers is between 50c and R1.00.

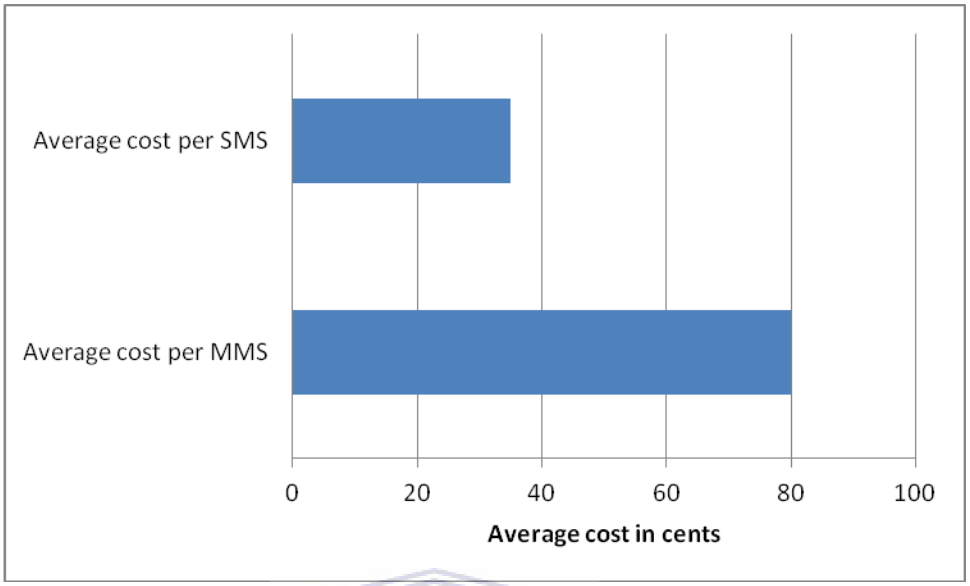

Figure 20: Average cost per message

Download time

The download specification that was used during the download part of the experiment was:

- network speed = 54 Mbps (MB per second)
- video file size = 17.9 MB
- video file format = .flv

The download time of the video sent using the web-enabled SMS mode (download time 1) was 6 seconds and the download time of the video sent using the MMS mode (download time 2) was 7 seconds (see Figure 21).

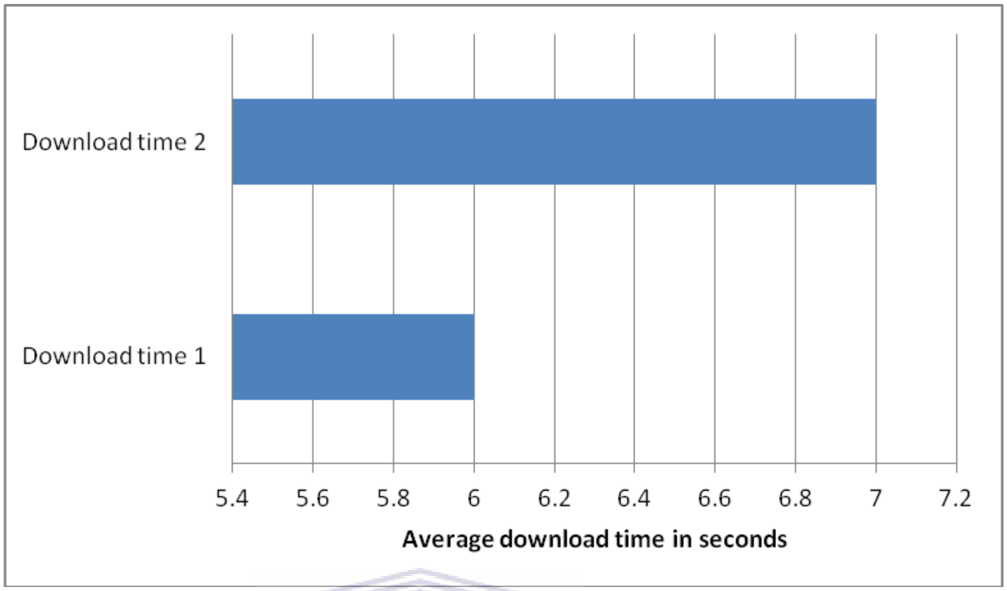

Figure 21: Average download times for web-enabled SMS and MMS

Video size

Removing the sound from the videos did not have a significant impact on the size of the video. See Figure 22 for the video file details before the sound was removed and Figure 23 for after it was removed.

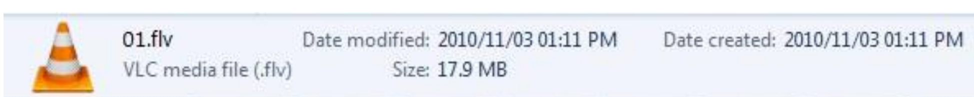

Figure 22: Video file details before removing the sound

Figure 23: Video file details after the sound was removed

Network performance

Figure 24 shows a Windows 7 Task Manager diagram. The Windows 7 Task Manager provides information about processes and programs running on a computer. It also displays the most commonly used performances and statuses of programms that are running. The task manager is mainly used to monitor the general performance of a computer. In this research the task manager was used to view the network status and how the network performed. Our focus was only on the network tab. The ad hoc network that was used during the experiment had a network speed (network performance) of 54 Mbps (see Figure 24).

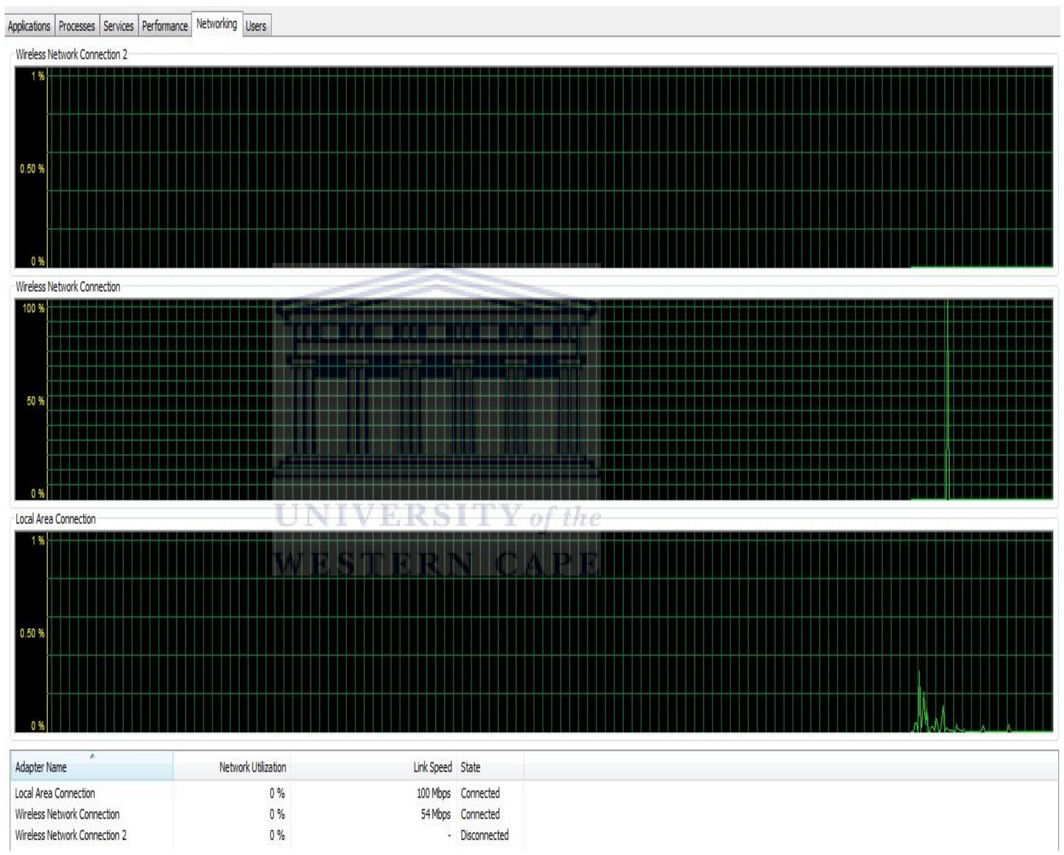

Figure 24: Network performance

Interviews (qualitative data)

The researcher used a set of unstructured probes during the interviews (see Appendix C). These probes addressed the following aspects of the prototype: the user friendliness of the web-enabled SMS (SMS with a link to the video) and MMS with the video attached; the functionalities of the mobile interfaces;

acceptability efficiency (download time); uninterrupted video streaming and effectiveness (sign language recognition in the video); and cost (what the user is willing to pay).

Most of the participants felt positive about the SMS mode of sending a video using the prototype (see Table 2). As one of the users stated: "The SMS mode was better than the MMS mode because the SMS video was clear and broad enough to see the signs" (see Appendix C).

Table 2 : Number of participants who where positive about the prototype

Prototype	**SMS mode**			**MMS Mode**		
Groups	**Staff**	**Non-staff**	**Total**	**Staff**	**Non-staff**	**Total**
Number of participants	*5*	*0*	*5*	*5*	*0*	*5*
Usability: functionality (ease of use)	3	0	3	2	0	2
User friendliness	3	0	3	1	0	1
Acceptability	5	0	5	2	0	2
Efficiency: download time	4	0	4	2	0	2
Efficiency: video play: uninterrupted video streaming	5	0	5	2	0	2
Effectiveness: level of sign language recognition in the videos	4	0	4	1	0	1

The results in Table 2 indicate that most participants found the SMS mode of the prototype easy to use. Some of the participants found the prototype difficult to use and said (through the interpreter): "It was difficult to use the SMS mode of the prototype because I tried to access the system but I couldn't. Maybe in future it will be easier to use the system"; "It was difficult, but at least with [the] help of the assistant I got access. I think we need more training on how to use the system"; "It was very difficult for me to use the SMS mode of the prototype" (see Appendix C).

The participants expressed their opinions, meanings, and interpretations of the questions that were asked. A thematic framework was used to classify and organise data according to key themes, concepts, and emergent categories (Ritchie & Lewis, 2003). The main themes around which results were organised were: acceptability (willingness to employ or use the system); usability (including functionality or ease of use, efficiency or download time, uninterrupted video streaming, and effectiveness or level of sign language recognition in the videos); and the cost to the end user for using the system.

- **The acceptability of the prototype**

The acceptability of the prototype refers to participants' willingness to employ or use the system. Questions that addressed the acceptability of the prototype were asked and a participant responded as follows: "Yes, I will definitely use this system in real life" (see Appendix C).

As seen from the responses given in Appendix C, the participants indicated that they would be willing to use the SMS mode because of the good quality of the sign language video. Many of them were not happy with the quality and size of the sign language video of the MMS mode. All of them indicated that the SMS system would be very helpful in assisting the Deaf community. Although the purpose of the system is notification, they would want to use it for communication as well.

- **The usability of the prototype**

  Usability transpired to be an important issue in terms of the ease of use of the system. Most of the participants indicated that they were happy with the SMS mode of the prototype in terms of its ease of use; as one participant said: "It was easy in terms of how the whole system is structured. To use the system was much easier than accessing the videos and opening up and clicking on the link."

  However, from some of the participants' responses to the usability questions, it was clear that these questions were not understood by all of them. Their responses also raised very import points, e.g. that the accessibility of the system was still a problem. Some of the participants did not know when the messages were received because they could not hear the sound indicating that an SMS had arrived. All participants were very concerned about the videos' size and their resultant cost. Two questions were asked that addressed usability in this pilot (see Appendix C).

- **Efficiency**

  Efficiency was another import theme as part of usability. Efficiency refers to the download time: we wanted to check whether or not participants were satisfied with the download time and what they were experiencing in terms of uninterrupted video streaming (see Appendix C).

Most of the participants were satisfed with the download time and uninterrupted streaming for the SMS mode of the prototype: two of the participants responded as follows: "When I receive the message it didn't take long for the SMS mode of the prototype"; "I think it is OK for the SMS, but I'm not sure about the MMS."

- **Effectiveness**

Another important issue that came up was effectiveness in terms of usability. Effectiveness refers to the level of sign language recognition in the videos. The participants were asked three questions during the interview to obtain information about the effectiveness of the sign language in terms of recognition (see Appendix C).

Most participants were more happy with the sign language video that was sent by the web-enabled SMS. They stated that the sign language was every clear and easy to understand. The participants were not happy with the sign language of the video that was sent by the MMS. In other words, they accepted the SMS video more than the MMS video. One participant stated: "The SMS mode was much easier and clearer, but in the MMS the size was too small."

Cost of using the system

The cost of using the system is another important issue that occurred. The following is one of the responses from the participants on the cost question: "Vodacom rates are 80c or 75c and off-peak time is less, so I will pay for the SMS, because MMS is expensive. I will pay 75c".

Most of the participants indicated their willing to pay the standard rates. The standard rates per SMS are 80c peak time and 60c off-peak time (see Table 1). All of them indicated that they would pay for a system of this kind (see Appendix C). Participants were willing to pay more than the standard price because they were aware that sending videos would be more expensive then text.

The purpose of the pilot was to refine the interview questions for the full trial. The pilot study went well and we received some very useful advice from the participants. This helped to improve the way in which we conducted the interviews for the full trails. Supervisors and colleagues who observed the entire pilot user test session also gave useful advice (see Appendix D), e.g.:

- Explain the cost better (inform people better about the cost, how much the sender pays for the sending the SMS/MMS and how much the receiver pays for receiving the SMS/MMS).
- Show the Deaf people how to use the Android 845 phone. Create a short tutorial with pictures/screen shots of the Android phone.
- Ask people to elaborate/explain more when they answer so that you get more information from the users.

For the pilot feedback and the changed set of questions, see Appendix C. All the other feedback and comments were addressed as preparation for the second cycle of user tests.

Case study 1 results

The results of case study 1 (see Figure 25) are presented in terms of:

i. the background data of the study;
ii. quantitative data; and
iii. qualitative data.

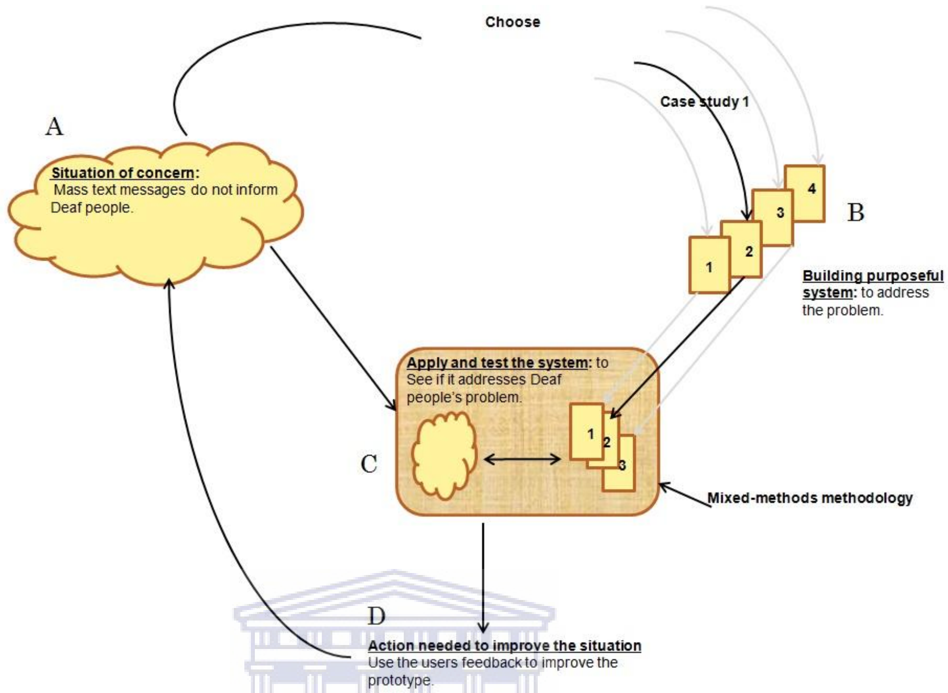

Figure 25: Case study 1: the second cycle

Background data

The same type of background as in the previous study applied in this study. A different group of Deaf participants participated. The participants' technology background data was also collected in this study. Their Internet usage was not of interest in this study, therefore no results of Internet usage at the Bastion PC lab are presented.

Technology background results

The technology background results are based on the five Deaf participants who participated in this case study (see Appendix A, nos. 6–10).

One of the participants was between the ages of 15 and 24 (14%), two were between the ages of 25 and 34 (40%) and the rest were older than 34 (see Figure 26). This group of participants was well mixed in term of age, unlike the group that participated in the pilot study.

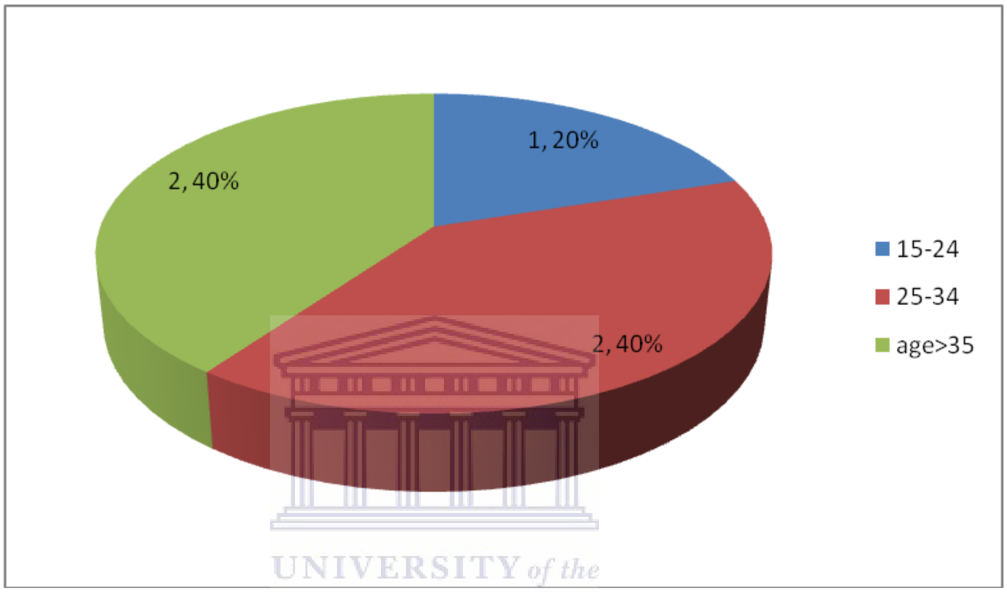

Figure 26: Age groups of the participants

The mobile phone usage for this group of participants was the same in terms of SMSs and MMS, but different in term of the Internet. All five participants used their mobile phones for SMSing and none for MMSing. Most gave the same reasons as the previous participants that participated in the pilot study: "SMSs are cheaper than MMSs. MMSs are too expensive and most of us do not use smart phones." The number for Internet usage on mobile phones increased by 1 in this case study; two of the participants used the Internet on their mobile phones for Mxit and none for e-mails (see Figure 27).

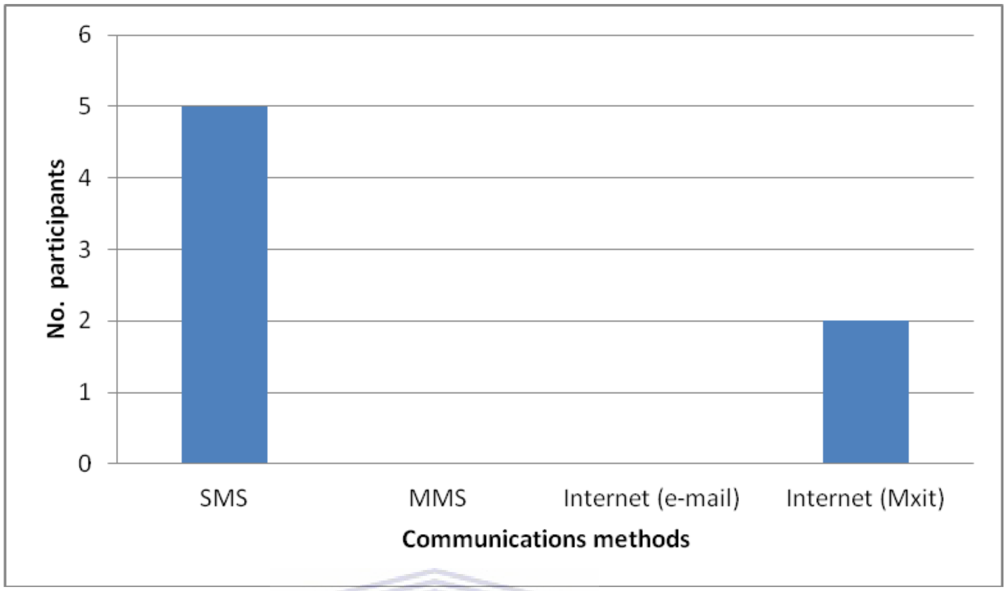

Figure 27: participants' mobile phone usage for communication

The situation in terms of sending or reading text language wise was the same as for the previous group of participants. Four of the participants sent or read text messages in English (80%) and one in Afrikaans (20%). Most of these participants used English on their mobile, but preferred SASL. This group of participants owned a variety of mobile phones: three owned Samsungs (60%); one owned a Nokia (20%) and one owned a Vodafone (20%) (see Appendix A, nos. 6–10).

Experiments (quantitative data)

The same experiment (as was done in the pilot) was done at the same time, in the same laboratory, with the same equipment. The same aspects of the prototype was tested: message delays (time data); cost per message for sending 30 web-enabled SMSs and 30 MMSs (cost data); download time for both methods; network performance; and the effect of sound removal (video size).

It was found that most of the aspects were the same (see Appendix B, case study 1). Therefore the researcher decided to double the amount of messages that were sent using both methods and then checked if this had an influence on the other aspects. The following was found:

Time data

Figure 28 shows the average delay (time) for sending 120 video messages using two video-streaming methods, i.e. the SMS web-link method (60 messages) and the MMS video-attached method (60 messages). As shown in Figure 28, the average delay time (8 minutes) for the web-enabled SMS mode was less than the average delay time of the MMS mode (12 minutes). In other words, the SMS mode delivered the messages faster than the MMS mode.

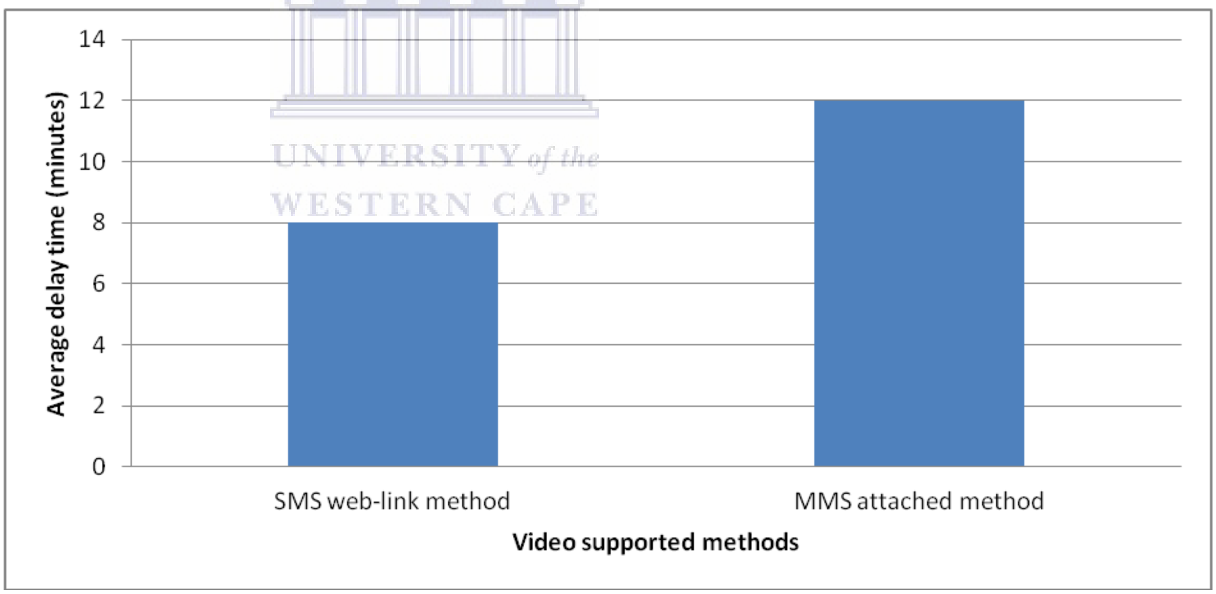

Figure 28: Average delay for sending 120 video messages (60 SMS and 60 MMS)

The results show that the increased number of messages sent has a influence on the message delays.

Cost data

Increasing the number of messages sent does not have an influence on the average cost per message. It only has an influence on the total cost for sending 60 SMSs and 60 MMSs. The average cost per SMS for sending 60 SMSs was 35c and the average cost per MMS for sending 80 MMSs was 80c (see Figure 29).

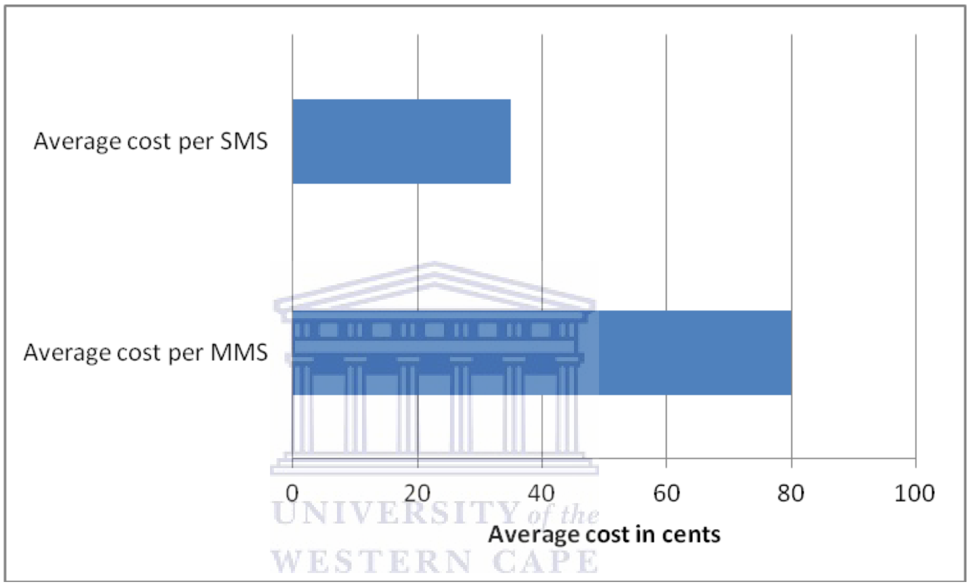

Figure 29: Average cost per message

Download time

The download specification that was used during the download part of the second experiment was:

- network speed = 54 Mbps (MB per second)
- video file size = 17.9 MB
- video file format = .flv

The download time of the video that was sent using the web-enabled SMS mode was still the same (6 seconds), as was the download time of the video that was sent using the MMS mode (7 seconds).

Network performance

Network performance did not change during the second experiment and remained 54 Mbps.

Interviews (qualitative data)

Table 3 : Number of participants who where positive about the prototype

Prototype	SMS mode			MMS Mode		
Groups	Staff	Non-staff	Total	Staff	Non-staff	Total
Number of participants	*0*	*5*	*5*	*0*	*5*	*5*
Usability: functionality (ease of use)	0	2	2	0	2	2
User friendliness	0	2	2	0	1	1
Acceptability	0	5	5	0	2	2
Efficiency: download time	0	5	5	0	2	2
Efficiency: video play: uninterrupted video streaming	0	5	5	0	2	2
Effectiveness: level of sign language recognition in the videos	0	5	5	0	3	3

The results in Table 3 show that most participants were positive about the SMS mode of the prototype. The sign language quality of the video and the ease of use of the prototype motivated most participants to be positive about the SMS mode. The majority of the participants were not positive about the MMS mode. They were willing to pay between 50c and R1 for using the system.

The results are presented as themes in terms of acceptability, usability and cost (see Appendix C, case study 1).

Acceptability

All of the participants indicated they were willing to use the web-enabled SMS in real life and two indicated that they would use MMS if they had enough airtime (see Appendix C, case study 1). One participant said: "I will consider using the SMS system in real life because the sign language in the video is clearer and better than videos in services like Skype. The SMS system will be cheaper than the MMS system therefore I will consider using the MMS system when I have enough airtime."

Usability

Most of the participants found the usability of the mobile phone difficult and this influenced the usability of the prototype. As one of the participants commented: "I don't know how to use this phone. If you can train me on how to use this mobile phone, than it would be better for me [and allow me] to give you better feedback on the prototype."

Cost

All of the participants indicated that they would be willing to pay 80c for using the system to send both SMSs and MMSs. One of the participants stated: "I'm willing to pay 80c, as charged by the mobile network operators."

As seen in the pilot study and this case study, participants were more positive about the web-enabled SMS then the MMS. Factors such as the quality of the sign language videos; the efficiency of the message in terms of time; and the cost of using the system made the participants positive about using the web-enabled SMS. After this study if was found that more interviews needed to be conducted with a mixture of staff and non-staff members, therefore case study 2 was done.

Case study 2 results

No experiments were done for this case study because in the previous study, case study 1, the outcome was found to be similar. The results of case study 2 (see Figure 30) are presented in terms of:

i. the background data of the study; and
ii. qualitative data.

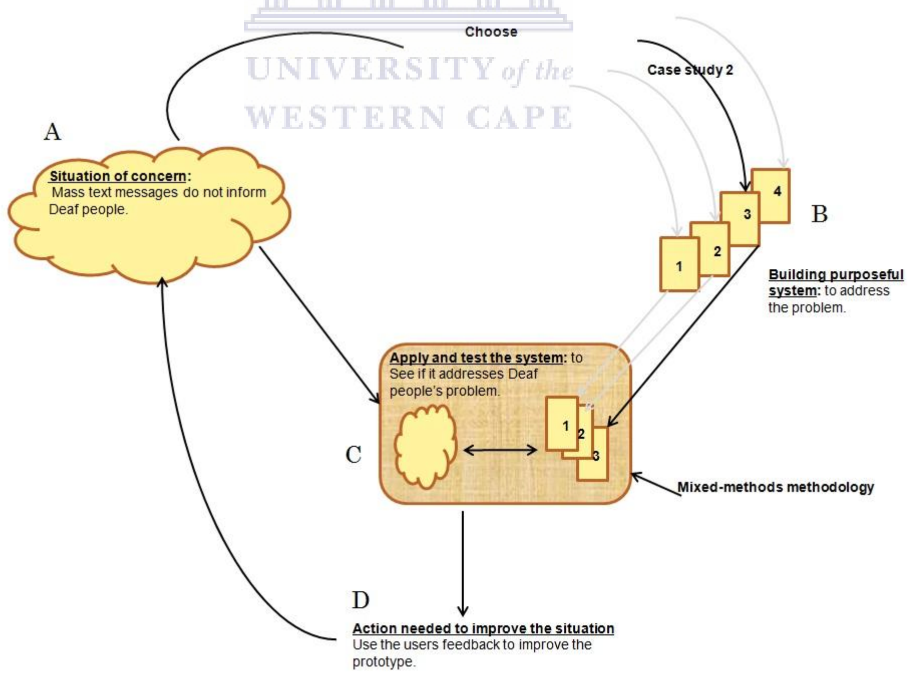

Figure 30: Case study 2: the third cycle

Background data

Background data was collected from six participants. Technology background data is presented in term of mobile phones usage (see Appendix A, no's. 10-16).

Four of the participants were between the ages of 15 and 24 (67%) and the rest were older than 25 (see Figure 31). This group of participants consisted mostly of young people.

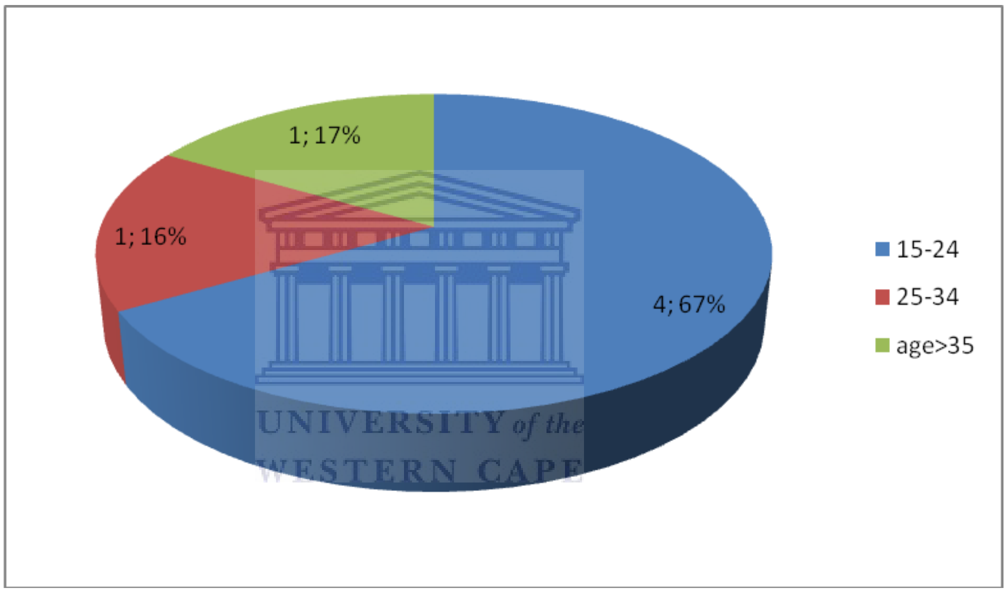

Figure 31: Age groups of the participants

All of the participants (100%) used their mobile phones for SMSs and none for MMSs (see Figure 32). Two of the participants used the Internet (20%). All of the participants (100%) used English on their mobile phone for communication and prefer to use SASL (see Appendix A, nos. 10-16). All of the participants owned or used Nokia phones.

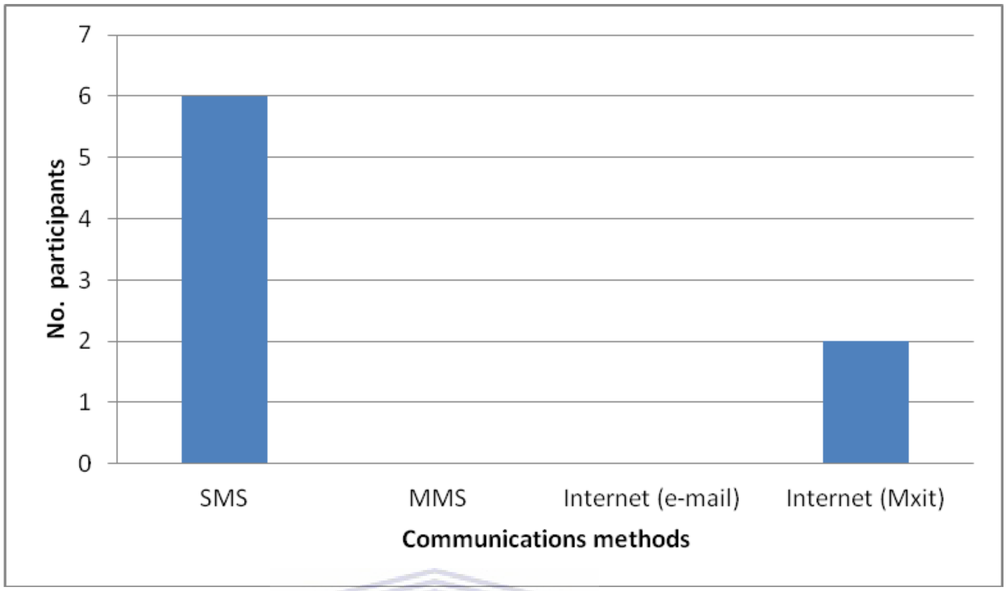

Figure 32: Mobile phone usage for communication

Interviews (qualitative data)

The interview results (see Table 4) show that once again the web-enabled SMS was more highly rated than the MMS mode of the prototype in terms of the factors of interest. Most participants were more positive about the web-enabled SMS because its video quality was better. The participants did not wait very long to receive the messages sent by SMS mode. In terms of the cost of using the system, participants indicated that they were willing to pay between 80c and R1 for using the system.

Table 4 : Number of participants that where positive about the prototype

Prototype	SMS mode			MMS Mode		
Groups	Staff	Non-staff	Total	Staff	Non-staff	Total
Number of participants	*5*	*1*	*6*	*5*	*1*	*6*
Usability: functionality (ease of use)	4	0	4	1	0	1
User friendliness	2	0	2	0	0	0
Acceptability	5	0	5	0	0	0
Efficiency: download time	3	0	3	2	0	2
Efficiency: video play: uninterrupted video streaming)	5	0	5	2	0	2
Effectiveness: level of sign language recognition in the videos	5	1	6	2	0	2

Case study 3

The purpose of case study3 was to implement a prototype on a different platform and test it with users to see how the Android prototype performs compared to the Symbian prototype. Due to limited time, however, experiments could not be done; user tests and interviews could not be conducted with the Deaf participants.

Challenges faced during data collection

Various challenges were faced during this case study regarding prototype implementation and data collection.

Prototype implementation

Two mobile phone systems were implemented and tested in a laboratory environment. The first was written in Python for Nokia phones and tested on a Nokia N82. The second was written in Java for an Android mobile phone and tested on a Vodafone 845.

Data collection

On each third Sunday of the month, most DCCT members meet and attend a church service, thus the full trial was planned to coincide with this event. The purpose of the full trial was to demonstrate the system to ten Deaf participants and gauge their opinions about such a system, but only five Deaf participants were willing to participate in the trial (see Figure 33 and Figure 34).

Figure 33: The researcher and SASL interpreter request DCCT members to participate.

Figure 34: The SASL interpreter signs to the Deaf people what the user test is all about.

Limitations

The data was collected and the prototypes were demonstrated only with DCCT participants at the Bastion PC lab. Thus the results are applicable to this particular environment only.

Several of the participants mentioned that they would have found it easier to use the the system if they had received some prior training

The majority of the participants in this study were functionally illiterate however their levels of literacy differed – with some more literate than others.

Conclusion

In this chapter, the results of the study were presented and the challenges encountered mentioned. The background study provided information about the mobile phone usage of the participants. In the next chapter, the findings will be discussed and conclusions will be drawn.

Chapter 5

DISCUSSION, FINDINGS AND CONCLUSION

Introduction

The previous chapter presented the results of the research that were obtained by means of several cycles of data collection. SSM was used to manage the research process. In this chapter, the research questions are addressed, findings are presented and a conclusion is drawn.

Discussion

The result indicate that all of the Deaf participants use their mobile phones for SMS and 81,25% of them use English as a language, but all of them prefer to use SASL as a language on their mobile phones. The qualitative analyses or user tests analysis were carried out in three parts. Each part presented a cycle of user test analyses. The results of all three cycles of user tests indicate that most of the Deaf participants preferred to use the SMS mode of the prototype with a web link to the video rather than the MMS prototype with the video attached. The preferences for the video SMS prototype were influenced by the cost (it is less than the cost of an MMS), as well as the delivery time and testing parameters. Participants indicated that a cost of between 75c and 80c for using this service is acceptable. The quantitative analyses indicated that the SMS mode of the prototype has a lower average delivery time than the MMS mode of the prototype.

When addressing the research questions the following was found (the questions are given first, followed by the findings):

How should video-streaming mass-messaging methods be compared and evaluated to find the most suitable method to deliver an affordable and acceptable service to Deaf people?

Two prototypes were developed and tested with 16 Deaf participants. The two methods, i.e. web-enabled SMS and MMS, were evaluated by gathering feedback from Deaf users with the help of an SASL interpreter and laboratory experiments.

It was found that the web-enabled SMS video-streaming method was perceived by the Deaf participants to be the most effective streaming method. The experiment results also indicate that web-enabled SMS's is more effective than MMS streaming in terms of the delay experienced.

When revisiting the research sub-questions:

What transport vehicles should be considered: MMS, the web, or a SMS, with a web link to a video (web-enabled SMS)?

the following was found:

The prototype was developed to send the video message by web-enabled SMS or MMS however, the Deaf participants preferred SMS as a transport vehicle.

What would the cost be to the end user?

All the participants indicated that they would be willing to pay between 75c and 80c for this service. The service providers charge 80c per SMS and MMS (provided the file size is less than 300 kb for the MMS) during peak time, but the SMS becomes considerably cheaper during off-peak hours (35c).

How should the cost to the end user be minimised? For example, would stripping the sound from the video footage have a significant impact on the cost of transportation?

The service could not be made more affordable because removing the sound from the videos does not have a significant impact on the size of the video and only the mobile network operators have control over the prices of the SMS, the web, and the MMS.

How does the video quality in terms of the quality of the sign language vary among the transport vehicles?

It was found that the Deaf participants felt that the quality of the sign language videos received via SMS mode is better than the quality of those received via MMS. This was expected, as the SMS videos were pre-recorded by means of video cameras, whereas the MMS videos were recorded by means of a cell phone. There is a significant difference between a cell phone recording and a video camera recording.

Findings

From the user tests results and experimental results we can see that the SMS mode of the prototype is more suitable for this population than the MMS mode. The user tests results indicate that most of the Deaf people prefer to use the SMS prototype with a web link to the video rather than the MMS prototype with the video attached. Their preference for the video SMS prototype is influenced by the cost (it is less than the cost of an MMS), as well as the delivery time and testing parameters. Participants indicated that a cost of between 75c and 80c for using this service is acceptable. The service providers charge 80c per SMS and MMS (provided the file size is less than 300 kb for the MMS) during peak time, but the SMS becomes considerably cheaper during off-peak hours 35c.

A study done by Wang in 2010 indicates that Deaf people are very concerned about the cost of using communication services. In this study, it was found that the Deaf prefer to use the video notification system, but are still very concerned about how much it will cost to use the system. Another important issue that came from Wang study was the quality of the sign language videos. Deaf people are not prepared to pay for a service if the quality of the sign language is very bad. Unemployment rates are very high in Deaf communities.

Although the purpose of this study was to adapt a successful text-based mass-messaging system to support video in a notification system, we found that Deaf people would also want to use the system for everyday communication.

Recommendations

Conducting user trials with Deaf people was a learning experience. Communication between the researcher and the Deaf participants was problematic. The researcher did an SASL course to be able to communicate with the research group; however, this was not enough to to allow him to communicate effectively or to explain the prototype clearly to the Deaf people involved in the study. It was thus necessary to employ a professional SASL interpreter to translate and explain the questions, as well as to assist with the interviews. It was found that communication between the researcher and the interpreter had to be perfect. Because the professional interpreter translated exactly what the researcher said, the researcher had to be very clear about what he intended to say.

It was found that interviews with Deaf people should not be too extended: focusing on the signing of the interpreter during the interviews can be tiring for participants. If the session became too long participants lost interest. It was found that presentations were more effective, as pictures and diagrams (in English text) could then support the explanations given. Furthermore, it was found that the user interfaces of the prototypes should be minimalist, i.e. not too many pictures and little text.

Future work

The design of both prototypes can be improved to make it simpler for participants to access the video application.

The prototype wass adapted for use on more platforms, such as Android. In case study 3 a prototype was developed for the Android platform in order to see how the Android prototype performs compared to the Symbian prototype. Furthermore, it was necessary to determine which format of video message would be preferred by the Deaf participants. Due to limited time, user tests and interviews with the Deaf participants could not be conducted with the revised prototype, however testing with this revised prototype were done in the laboratory. A further cycle of data collection will thus be necessary to test the adapted prototype with Deaf users.

In a further study, more user tests and experimental tests should be used to compare the two prototypes. These user tests should target Deaf people from other communities s well.

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APPENDIX A: INFORMATION SHEET

Table 5 : Background data on mobile phone usages collected from the Deaf participants

No.	Study	Age	What language do you use on your mobile phone?	What language would prefer to you on your mobile phone?	What brand mobile phone are you using?	For what doyou normally use your mobile phone: SMS, MMS, Internet, MXit, playing games etc?
1	Pilot	42	English	South African Sign Language	Nokia	SMS
2		19	English	SASL	Nokia	SMS, Playing games
3		47	English	SASL	Nokia	SMS
4		43	Afrikaans	SASL	Nokia	SMS, Internet (e-mail)
5		57	English	SASL	Nokia	SMS, Internet (Mxit)
6	Case 1	50	Afrikaans	SASL	Samsung	SMS
7		24	Afrikaans	SASL	Samsung	SMS, Mxit, Internet
8		35	English	SASL	Vodafone	SMS, Internet
9		34	English	SASL	Samsung	SMS, Internet
10		31	English	SASL	Nokia	SMS, Mxit
11	Case 2	23	English	SASL	Nokia	SMS, Mxit
12		20	English	SASL	Nokia	SMS, playing games
13		19	English	SASL	Nokia	SMS, playing games
14		18	English	SASL	Nokia	SMS, Internet
15		41	English	SASL	Nokia	SMS
16		34	English	SASL	Nokia	SMS, Internet

APPENDIX B: EXPERIMENT (QUAUNTITATIVE DATA)

Pilot study

The following data was collected with the prototype, captured in an Excel spreadsheet, and imported into SPSS. To obtain the statistical summary measures: Click on *Analyze* → *Descriptive Statistics* → *Explore*.

For the statistical summary of the quantitative data that was generated by SPSS, see Table 6. According to the Shapiro-Walkin test for normality, when the p-value of a variable is greater than 0.05 (p-value > 0.05), then the data is normally distributed and the mean of that variable should be used to make a comparison. When the p-value of a variable is less than 0.05 (p-value < 0.05), then the data is not normally distributed and the median of that variable should be used to make a comparison.

Table 6 : Summary of normality tests

Normality tests

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	df	Sig.	**Statistic**	**df**	**Sig.**
Message delay 1	.312	30	.000	.772	30	.000
Download time 1	.131	30	.200*	.951	30	.178
Cost per message 1	.537	30	.000	.275	30	.000
Message delay 2	.200	30	.003	.908	30	.013
Download time 2	.213	30	.001	.859	30	.001
Cost per message 2 is constant and it has been omitted						

In this study, we made a comparison between the web-enabled SMS mode of the prototype and the MMS attached mode of the prototype in terms of the following: message delays (message delay 1 and message delay 2); download times (download time 1 and download time 2); and cost per message (cost per message 1 and cost per message 2).

When looking at the message delays: the p-value for the Shapiro-Walkin test are 0.000 and 0.013, respectively, for message delay 1 and message delay 2 (see the last column under "sig." in the Shapiro-Walkin results). This implies that both datasets, message delay 1 (web-enabled SMS) and message delay 2 (MMS-attached method) are not normally distributed because both p-values are less then 0.05. As indicated in Table 6, all the other variables have a p-value of less then 0.05, except for download time 1. This implies that their datasets are not normally distributed, expect the dataset of download time 1. When doing the comparison between these variables, we used the median values, since the p-values of all the variables, except for download time 1, is less then 0.05. Message delay 1 has a median of 4 and message delay 2 has a median of 6.11 (see Table 7). Download time 1 has a median of 6.7 and download time 2 has a median of 7 (see Table 8).

Table 7 : Descriptive statistics of message delay 1 and message delay 2

		Statistic	Std. error
Message delay 1	**Mean**	3.77	.114
	Median	4	
	Variance	0.392	
	Std. deviation	0.626	
	Interquartile range	1	
Message delay 2	**Mean**	6.10	0.216
	Median	6.11	
	Variance	1.403	
	Std. deviation	1.185	
	Interquartile range	0.195	

Table 8 : Descriptive statistics of message delay 1

		Statistic	Std. error
Download time 1	**Mean**	6.457	.0263
	Median	6.7	
	Variance	1.537	
	Std. deviation	1.239	
	Interquartile range	1.3	
Download time 2	**Mean**	7.17	0.152
	Median	7	
	Variance	0.695	
	Std. deviation	0.834	
	Interquartile range	1	

Case study 1

For the statistical summary, see Table 9. The outcomes of this experiment was the same as the previous experiment that was done in the pilot study.

Table 9 : Summary of normality tests

Normality tests

	Kolmogorov-Smirnov[a]			**Shapiro-Wilk**		
	Statistic	df	Sig.	**Statistic**	**df**	**Sig.**
Message delay 1	.312	30	.000	.772	30	.000
Download time 1	.131	30	.200*	.951	30	.178
Cost per message 1	.537	30	.000	.275	30	.000
Message delay 2	.200	30	.003	.908	30	.013
Download time 2	.213	30	.001	.859	30	.001
Cost per message 2 was constant. It has been omitted						

The Shapiro-Walkin test p-values are 0.000 and 0.013, respectively, for message delay 1 and message delay 2. This implies that both datasets – message delay 1 and message delay 2 – are not normally distributed because both p-values is less then 0.05.

Message delay 1 has a median of 4 and message delay 2 has a median of 6 (see Table 10).

Table 10 : Descriptive statistics of message delay 1 and message delay 2

		Statistic	Std. error
Message delay 1	**Mean**	3.77	.114
	Median	4	
	Variance	0.392	
	Std. deviation	0.626	
	Interquartile range	1	
Message delay 2	**Mean**	6.10	0.216
	Median	6.11	
	Variance	1.403	
	Std. deviation	1.185	
	Interquartile range	0.195	

Download time 1 has a median of 6.7 and download time 2 have a median of 7 (see Table 11).

Table 11 : Descriptive statistics of download time 1 and download time 2

		Statistic	Std. error
Download time1	**Mean**	6.457	.0263
	Median	6.7	
	Variance	1.537	
	Std. deviation	1.239	
	Interquartile range	1.3	
Download time2	**Mean**	7.17	0.152
	Median	7	
	Variance	0.695	
	Std. deviation	0.834	

APPENDIX C: UNSTRUCTURED INTERVIEWS

Pilot study

The following interview questions were used during the pilot study, which was done at the DCCT with five Deaf participants.

Acceptability questions

- Would you consider using this system in real life? Please explain.

  Participant 1: "Yes, I will definitely use this system in real life."

  Participant 2: "Yes, I will use it; it's very accessible for me."

  Participant 3: "Yes, I will use it, it has everything, but unfortunately I couldn't receive MMSs on my phone. I don't know why; is my phone MMS compatible?"

  Participant 4: "I would use it in real life and it will be much easier for me to communicate with people."

  Participant 5: "Yes, I would definitely use it."

- Would you be happy using sign language of this quality on a mobile phone? Please explain.

  Participant 1: "I was happy with both and I think it will assist the Deaf community – it would be easier for us to communicate, but I prefer the SMS as opposed to MMS."

  Participant 2: "Yes, yes, the video quality is fine."

  Participant 3: "I think I would be really happy if we can have that system for the Deaf community instead of SMSs – it will be easy for us to communicate."

  Participant 4: "I think it will help in the future for the Deaf community – we need that."

Participant 5: "Yes, I'm happy with the video messaging, because sometimes English is not our first language, so it's not easy to send messages in English, so it will be in our language and much more comfortable to send messages."

Usability questions

- How easy was it to use the system? Please explain.

Participant 1: "It was not easy, because when you receive a message at least. It should have an icon, where it is easier for you just to click on it and see the message and I could not get that in this phone."

Participant 2: "I think for both messages it was not that easy to access it."

Participant 3: "It was easy [in terms of] how the whole system is structured. I would say it was easy, but just to align myself to participant 1, to use the system should be much easier [in terms of] accessing the videos and opening up and clicking on the link. It should be easy to do that and it should also show who the sender is. It was really confusing as to which one I should click on. No, the system is fine, but trying to access the messages was not that easy and even viewing the video was not that clear. For the first message, I should be able to zoom in and out in the MMS as well as in just the video. The sizes were different and I did not follow what was said in the video."

Participant 4: "It's fine, but how come the videos were not of the same size? The SMS and the MMS were different sizes. The SMS was better than the MMS, because the SMS video was clear and it was broad enough to see the signs, but in the MMS picture you should perhaps increase the size of the video and it should be easy to access or use the system. You should just have to click on the envelope and the video should play."

Participant 5: "I was OK with the SMS, but with the MMS, the size is the problem."

- How easy was it to download the video? Please explain.

  Participant 1: "It was easy to download the video."

  Participant 2: "I agree with participant 1."

  Participant 3: "I also agree with participant 1; it was easy."

  Participant 4: "It was easy."

  Participant 5: "I agree with participant 4."

Efficiency questions

- Do you think the system takes too long to download and play the video? Please explain.

  Participant 1: "When I received the message it didn't take long for the SMS mode of the prototype."

  Participant 2: "I think it is OK for the SMS, but I'm not sure about the MMS."

  Participant 3: "I don't know, because I did not know when the messages were sent to my mobile phone."

  Participant 4: "I agree with participant 3."

  Participant 5: "I didn't wait long."

Effectiveness questions

- How easy was it to understand what was said in the video? Please explain.

  Participant 1: "Yes, it was easy to see the signs, but in the second one MMS the signs were too small …. With the signing at least you just have to zoom it in a bit."

  Participant 2: "Same experience as participant 1."

  Participant 3: "The SMS mode was much easier and clearer, but in the MMS mode the size was too small."

Participant 4: “In the SMS mode the signing was clear, but a bit unclear, and you should have worked on the light as well, and in the MMS I couldn’t even see the signs, because the size was too small.”

Participant 5: “I agree with participant 4.”

- How clear were the hand gestures (hand actions) in the video? Please explain.

Participant 1: “I understood the hand movements.”

Participant 2: “The hand shapes in video that was sent by the SMS is a bit clearer then the video sent by the MMS. The MMS video is too small and unclear.”

Participant 3: “SMS was clear but not the MMS.”

Participant 4: “SMS was clean but not the MMS.”

Participant 5: “I prefer the SMS.”

- How clear were the facial expressions in the video? Please explain.

Participant 1: “I could not see the facial expressions in both videos.”

Participant 2: “I could see the hand movements but not the facial expressions.”

Participant 3: “I agree with participant 2.”

Participant 4: “I also agree with participant 2.”

Participant 5: “I could not see the structure of the sign language in the second video.”

Cost question

- How much are you willing to pay for using the system? Please explain.

Participant 1: “50c or 75c.”

Participant 2: “I think you said we’ll get a R2 discount when sending an MMS.”

Participant 3: “It will depend. If it’s a matter of emergency, I’ll use the MMS, but I prefer the SMS. I will pay 75c.”

Participant 4: “I’m willing to pay Vodacom rates, 80c or 75c peak time and off-peak time is lesser. I will pay for the SMS because MMS is expensive. I will pay 75c”

Participant 5: “I will pay 75c”

Case study 1

The following interview questions were used during the case study 1, that was done at the DCCT with five Deaf participants. The questions has been separated into parts, based on the SMS system and MMS system as recommend by the participants during the pilot study, to avoid confusion.

Acceptability questions

- Would you consider using the SMS system in real life? Please explain

  Participant 1: "Yes, I will consider using the system in real because the sign videos is better then the videos on Skype. There is no buffering in the video."

  Participant 2: "If I can be trained on how to use high end phones then I will conder using it in real life because I can't read the manuals of the phones."

  Participant 3: "I will consider using it, if I don't have to buy airtime all the time."

  Participant 4: "I agree with participant 1."

  Participant 5: "I agree with all the other participants."

- Would you be happy using sign language of this quality on a mobile phone? Please explain

  Participant 1: "Definitely yes."

  Participant 2: "Yes, it I can buy myself a smart that can play videos."

  Participant 3: "Yes, agree with participant 2."

  Participant 4: "The signlaunge was clear, so yes."

  Participant 5: "Yes."

- Would you consider using the MMS system in real life? Please explain

  Participant 1: "No, MMS is expensive."

Participant 2: "Maybe if the video quality improves."

Participant 3: "No, I can't affort MMS."

Participant 4: "Maybe."

Participant 5: "I agree participant 1."

- Would you be happy using sign language of this quality on a mobile phone? Please explain

Participant 1: "No"

Participant 2: "No"

Participant 3: "Yes but only if the video colour can be improved."

Participant 4: "No it to unclear."

Participant 5: "I don't think so."

Usability questions

- How easy was it to use the SMS system? Please explain

Participant 1: "It's a good system but it took time for you to show us how to use this thing and that made it difficult me to use the system."

Participant 2: "I'm not used to this system so it was my first time using it so I can't say much. I think with more training it will be easy for me to use the system."

Participant 3: "I was trying very best to access it. It was not easy to access it, maybe in future if I buy a smart phone it will be easier for me to use the system."

Participant 4: "It was very easy with the help of your assistant."

Participant 5: "I agree with participant 4"

- How easy was it to use the MMS system? Please explain

Participant 1: "It was very difficult but I think if I knew how to use the mobile phone, it was gone be much easier."

Participant 2: "I can't say much because I think the phone is not accessable enough for Deaf people."

Participant 3: "It was very difficult for me."

Participant 4: "Very difficult."

Participant 5: "It was OK for me."

- How easy was it to download the video when using the SMS system? Please explain

Participant 1: "Fine."

Participant 2: "It was OK."

Participant 3: "It was fine."

Participant 4: "The download process was average for me."

Participant 5: "The same as participant 4, average for me."

- How easy was it to download the video when using the MMS system? Please explain

Participant 1: "I don't know. I can't say because it took too long to receive the MMS."

Participant 2: "I had a problem with my phone. I had to use the high end phone to download that's why it was difficult for me to download"

Participant 3: "It was fine to download but I waited too long for the MMS message to appear."

Participant 4: "It was fine but the waiting for the MMS was time wasting."

Participant 5: "Took long to receive the MMS message."

Efficiency questions

- Do you think the SMS system takes too long to download and play the video? Please explain

Participant 1: "No, it was fine."

Participant 2: “Yes, it took long.”

Participant 3: “No, it didn’t take long.”

Participant 4: “No.”

Participant 5: “Fine.”

- Do you think the MMS system takes too long to download and play the video? Please explain

Participant 1: “Yes, the message took long.”

Participant 2: “Yes.”

Participant 3: “It was time wasting.”

Participant 4: “Took too long.”

Participant 5: “Fine.”

Effectiveness questions

- How easy was it to understand what was said in the video when using the SMS system? Please explain

Participant 1: “Very easy, I appreciate the quality (contrast) of the .video because every sign was clear for me.”

Participant 2: “It was very understandable.”

Participant 3: “I agree with participant 1.”

Participant 4: “I understood all the signs.”

Participant 5: “The signlanguage was easy to understand.”

- How easy it was to understand what was said in the video when using the MMS system? Please explain

Participant 1: “No, because the video is too small.”

Participant 2: “The video contrast was very bad.”

Participant 3: “Yes but not the facial expressions.”

Participant 4: “It couldn’t see the video on my phone because it didn’t receive it. When I look at participant 3 phone, the sign was unclear.”

Participant 5: "It was OK, but the facial expressions were unclear and that made me confuse."

- How clear were the hand gestures (hand actions) in the video when using the SMS system? Please explain

The same as questions 7 and 8

- How clear were the hand gestures (hand actions) in the video when using the MMS system? Please explain

The same as questions 9 and 10

- How clear were the facial expressions in the video when using the SMS system? Please explain

The same as questions 7 and 8

- How clear were the facial expressions in the video when using the MMS system? Please explain

The same as questions 9 and 10

Cost questions

- How much are you willing to pay for using the SMS system? Please explain

Participant 1: "80c, same as the network operators."

Participant 2: "Agree with participant 1."

Participant 3: "80c."

Participant 4: "R2 because the system can be very helpful for the Deaf community."

Participant 5: "I agree pay 80c."

- How much are you willing to pay for using the MMS system? Please explain

Participant 1: "80c."
Participant 2: "Nothing because it is too expensive."
Participant 3: "80c because it take to long to deliver the video message."
Participant 4: "I still think R2 will be fine."
Participant 5: "Nothing."

Case study 2

The qualitative data (interview data) was analysed directly from the video recorded during the user tests. Due to technical issues the data for thus case study could not be presented.

The following interview questions were used during the pilot study that was done at the DCCT with five Deaf participants.

- How easy was it to learn to used the SMS system? Please explain
- How easy was it to learn to used the MMS system? Please explain
- How easy was it to download the video when using the SMS system? Please explain
- How easy was it to download the video when using the MMS system? Please explain
- Do you think the SMS system takes too long to download and play the video? Please explain
- Do you think the MMS system takes too long to download and play the video? Please explain
- How easy was it to understand what was said in the video when using the SMS system? Please explain
- How easy was it to understand what was said in the video when using the MMS system? Please explain
- Would you be happy using sign language of this quality on a mobile phone? Please explain
- Would you be happy using sign language of this quality on a mobile phone? Please explain

- How clear were the hand gestures (hand actions) in the video when using the SMS system? Please explain
- How clear were the hand gestures (hand actions) in the video when using the MMS system? Please explain
- How clear were the facial expressions in the video when using the SMS system? Please explain
- How clear were the facial expressions in the video when using the MMS system? Please explain
- Would you consider using the SMS system in real life? Please explain
- Would you consider using the MMS system in real life? Please explain
- How much are you willing to pay for using the SMS system? Please explain
- How much are you willing to pay for using the MMS system? Please explain

APPENDIX D: USER TEST OBSERVATIONS/RECOMMENDATIONS

Pilot study

The following are some of the important observations and recommendations made by my supervisors and collleagues who monitored all the pilot user test sessions.

- Explain the cost factor better (inform people better about the cost, how much the sender pays for sending the SMS/MMS and how much the receiver pays for receiving the MMS and viewing the video).
- Show the Deaf people how to use the Android 845 phone. Create a short tutorial with pictures/screen shots of the Android phone.
- Make sure the phones are on vibrate (put them on vibrate before the data collection session).
- Show whatever you do on your phone on the data projector so that all the participants can see.
- Tell the participants when you made a mistake so that they can be aware and don't get confused.
- Make sure all phones have airtime and can receive MMSs.
- One phone can be made to run out of of airtime, just to show that the receiver needs to have airtime in order to view MMSs.
- Replace the current video used in the system with any recent video that was recorded.
- Use good examples when showing the video.
- Make sure the video for on-the-go recording is good enough; ask the interpreter to sign when recording a video for the MMS.

- Talk more about the slide dealing with cost; talk more about the cost of the SMS/MMS to the sender and receiver.
- Ask people to elaborate/explain more when they answer so that you get more information from the users.
- Restructure the order of the questions. Put like questions with like, e.g. put download questions together.
- Skip some of the questions that have already been answered.
- Give the participants numbers, but don't make them answer in a fixed order, e.g. one to five. Make them answer randomly so that the participants don't feel that other participants are better than they are or have some kind of advantage over the others.
- Remove the other screens and icons from the Android phone so that it only has one screen with one icon, i.e. the message icon.
- Before the next user test, test the system first with your colleagues.
- Use recorded and pre-recorded videos with both SMSs and MMSs.
- Be careful how you explain MMSs and SMSs (e.g. the use of the SMS/MMS system).

Case study 1

Participants recommended that the mobile phone application should the demonstrated to them during the project so that all participants could see at the same time how the application works.

Case study 2

The following are some of the important suggestions made by my supervisors who monitored the case study 2 user test sessions.

- Start off the presentation by telling people what the system can be used for (mass messaging), then use it. Send everyone a sign language message.
- Use the projector to show them how you send and receive a message.
- Do not have one sender and five receivers. If you can handle six at a time, have all six receive, and give volunteers a chance to send, in particular to record and send
- Use the same phone for everything (the Vodafone 845), i.e. sending, receiving, demo.
- During the demo, when sending messages to people, use real names, e.g. Meryl, Bill, etc., not Ryno1, Ryno2, ...
- Name the file something other than 01, e.g. 3rdSunday
- Have multiple 'canned' files so that each time you demo the system, you can send something different.
- Remove the voice from the video files. There's no need for it.
- Configure all the Android phones in the same way, i.e. for notifications, for display, contacts, etc. They should all be used to send/receive in the same way.
- All the phones need airtime. The demo has to work. You can explain what happens when there is no airtime. There is no need to demo it unless you really factor it in.
- Explain the difference between using standard SMS/MMS to do this and using your system's alternatives, and then also explain the cost differences, with real examples of real costs.
- I strongly recommend that you implement the system on Android.
- Use the touchscreen to simplify the interface: tap on recipients (or groups), tap on video, tap to send, etc.

APPENDIX E: SYMBIAN MOBILE APPLICATION SCREEN

Login screen

Once the user has an account on the video messaging system, the user can login (see Figure 35 and Figure 36). Each account has a username and password registered in the system database. The password is encrypted using the standard PyS60 input password encryption. Once the details are entered, they are sent to the system database to compare with the user stored in a list. When there is a match, the user logs into the home screen.

Figure 35: Authenticate username

Figure 36: Authenticate password

Home screen

Based on a successful login, a video message can be sent (see Figure 37).

Figure 37: Home screen with message options

A video message can send using SMS, MMS, or e-mail. Only SMS and MMS are active options because the Deaf end users said during a pilot study done in March

2011, “most Deaf people in DCCT are not familiar with e-mail, therefore they don’t use e-mail”.

SMS screen

Send a video message via SMS (see Figure 38 and Figure 39). The sender has to type in his/her name (see Figure 38) so that the receiver can know exactly who sent the video message.

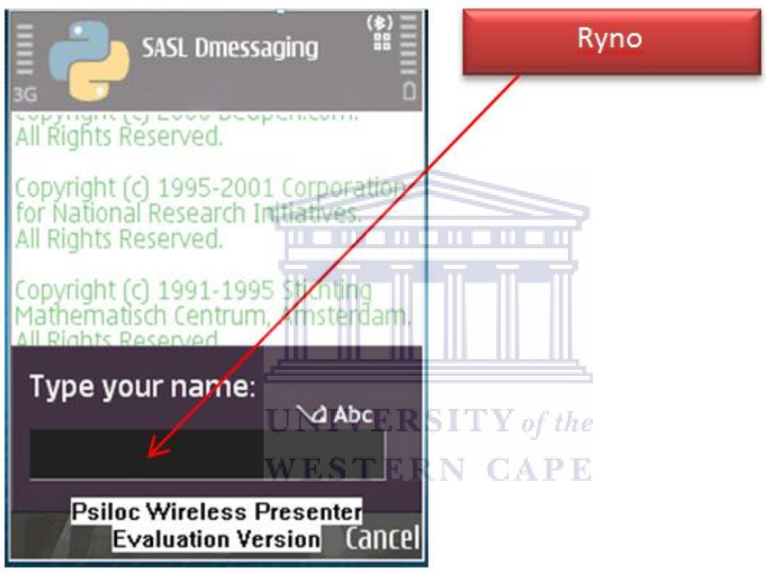

Figure 38: The sender’s name

The end user has to type in the content of the message. The content of the message will be a number and the number is referenced to a video (see Figure 39).

Figure 39: SMS message content

Receiver's screen

When the receiver receives the message, this is what the receiver sees (see Figure 40). The receiver has then to click the link to view the video.

Figure 40: Receiver message content

After the receiver clicks the links, the receiver can then view the sign language video (see Figure 41).

Figure 41: Sign language video

MMS screen

I still need to add the rest of the interfaces. The wireless presenter software expired; I will add the rest of the screen shots once the wireless presenter software is purchased.

APPENDIX F: ETHICS CONSENT FORM

The main objective of the project is to explore video mass messaging – that is to check how we can extend a text mass messaging system to support the most cost-effective and efficient delivery of video messages.

I, ________________________________, understand that my participation in this mass video notification project is solely for the collection of data to create a prototype of a system. I agree to participate and understand that all information that I will provide will be kept confidential, and that my identity will not be revealed in any publication resulting from the research (unless I choose to give permission). Moreover, all recorded interviews and their transcripts, plus data from questionnaires, will be destroyed after they have been analysed. I am also free to withdraw from the project at any time.

For further information, please do not hesitate to contact:

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Name:………………………………………………………….
Signature:…………………………………………………………
Date:……………………………………………………………

PUBLICATIONS

The following two papers based on this thesis were published in the proceedings of accredited conferences:

Hoorn, R. T. L., Venter, I. M., & Tucker, W. D. (2010). Comparison and evaluation of mass video notification methods used to assist Deaf people. South African Telecommunication Networks and Applications Conference (SATNAC), Cape Town, 5-8 September 2010,.

Hoorn, R. T. L., & Venter I. M. (2011). Using mass video notification methods to assist Deaf people. Proceedings of the 2011 Annual Conference of the South African Institute of Computer Scientists and Information Technologists, Cape Town, 3-5 October 2011. Part of the ACM ICPS Conference Series ISBN: 978-1-4503-0878-6 (pp. 275–278).

COMPARISON AND EVALUATION OF MASS VIDEO NOTIFICATION METHODS USED TO ASSIST DEAF PEOPLE

Comparison and evaluation of mass video notification methods used to assist Deaf people

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Abstract-In this work in progress paper a cost effective and efficient mass multimedia messaging system is explored. The intention is to adapt a successful text-based mass notification system, developed by a local non-governmental organization, to accommodate efficient and affordable video mass messaging for Deaf people. The questions that need to be asked are: How can we compare and evaluate various video streaming messaging methods to find the most effective streaming methods to deliver video messages? What transport vehicles should we consider: MMS, the web, electronic mail or a cell phone resident push/pull application? What is the cost to end user and service provider and how can we make such a service more affordable? How does the video quality in terms of sign language vary between each transport vehicle? Although Deaf people are accustomed to mobile text messaging, they prefer to communicate in sign language. Work related to these aims, the methods planned to achieve these goals, initial work and prototypes will be described. A project plan for this work in progress will be mapped out.

Index Terms—video streaming, mobile phone, South African sign language, cost effective and efficient delivery, mass notification

I. Introduction

Deaf with a capital 'D' refers to people whose first language is sign language and who are members of a specific linguistic culture group. Most South African Deaf people are functionally illiterate. This means that although they may be able to read and write a few words of a spoken and written language like English, they cannot read or write well enough to deal with the requirements of everyday life [1] [2]. Deaf people in South Africa communicate with each other and the broader community by means of South African Sign Language (SASL). It has been found that the majority of Deaf people all over the world use Short Message Services (SMS) to communicate and share information with hearing people and less often amongst themselves [3]. However, their level of literacy prevents effective dissemination of information via SMS and therefore Multimedia Messages Services (MMS) will be considered as a mode for information dissemination because of its ability to carry sign language content.

This paper describes a work in progress to compare and evaluate different modes/methods of video mass messaging. The questions that need to be asked are: How can we compare and evaluate various video streaming messaging methods to find the most effective streaming methods to deliver video messages? What transport vehicles should we consider: MMS, the web, electronic mail or a cell phone resident push/pull application? What is the cost to end user and service provider and how can we make such a service more affordable? How does the video quality in terms of sign language vary between each transport vehicle?

Cell-Life (www.cell-life.org) is a non-governmental organization (NGO) that currently uses mass messaging with a system called Mobilisr on cell phones to provide services to people infected or affected by the Human Immunodeficiency Virus (HIV). The service is used for the dissemination of information in order to prevent infection and also to notify organization members of events, the latest news and when they need to take their medicines. It is worth noting that for the messages to be useful, the receiver must be able to read and interpret the message. Deaf people cannot always use the information they receive via SMS effectively due to text illiteracy. Deaf people would be better served if they could be notified by means of a SASL message, i.e. a video message.

We propose to modify the Mobilisr software to allow for video messaging. Video streaming is a technique used for transferring data as a constant continuous stream over the Internet and is used worldwide to transfer multimedia files such as video, voice and data [4]. The architecture of the different video notifications solutions will be examined to discover which of the alternative video notifications delivery modes is the most effective in terms of transport, comprehension and cost.

The rest of the paper is organised as follows. Section II covers related work. Section III describes video messaging alternatives to evaluate and how to compare and evaluate them. Section IV concludes and identifies future work.

II. Related Work

In this section existing work related to this research project will be discussed. We will look two examples MobileASL a mobile video system make use of compression and decompression methods to avoid too much bandwidth usage and Mobilisr mass text messaging system. MobileASL was developed at the University of Washington for Deaf people using American Sign Language (ASL). Its purpose is to support wireless cell phone communication of ASL. MobileASL employs region-of- interest (ROI) methods on the sign language video to focus on the hand movements and the face of the signer within the video [5].

Mobilisr is an open source mobile platform that was developed by Cell-Life with Praekelt Foundation. The mobilisr application was designed to run on cell phones. It provides services to people infected or affected by HIV. This application increased access to information for HIV infected people.

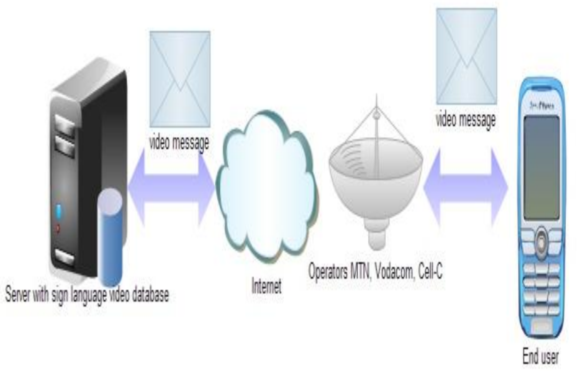

Figure 1: Mobilisr client/server architecture.

III. Video messaging alternatives and Methods

This section suggests some alternative video message delivery approaches on mobile phones and describes how we intend to compare and evaluate resulting prototypes to answer the research questions identified in Section I. The research methods will triangulate quantities performance and cost data with qualitative data collected from Deaf end-users via ethnographically-inspired methods such as user observation, interviews and surveys, all conducted with the help of a South African sign language interpreter.

Alternative video messaging approaches include SMS with a web-link to a video to be streamed by a web browser, MMS instead of SMS, e-mail with a web-link or video as attachment, and a phone-resident video push/pull application.

We will build a prototype for each alternative based on Mobilisr's client/server architecture (see Figure 1). Each prototype will be instrumented to collect performance data that can later be used to determine cost, e.g. the number of bytes transmitted for a particular type of video delivery can be used to compare costs at some number of rands per megabyte.

Prototypes will be developed and tested in conjunction with members of a Deaf NGO called the Deaf Community of Cape Town (DCCT). Deaf end-users will help determine the effectiveness of the various video delivery mechanisms because some will present sign language better than others. We will collect this data qualitatively with aforementioned ethnographically-inspired techniques. Then the quantitative performance and cost data can be triangulated with qualitative feedback from Deaf users to arrive at an optimal mass video messaging technique. This process is shown in Figure 2.

IV. Conclusion and future work

The intention of this project is to adapt a successful text-based mass notification system, developed by a local non-governmental organization to accommodate efficient affordable video messaging for Deaf people. . The research methods will triangulate quantities performance and cost data with qualitative data collected from Deaf end-users via ethnographically-inspired methods such as user observation, interviews and surveys, all conducted with the help of a South African sign language interpreter.

Alternative video messaging approaches include SMS with a web-link to a video to be streamed by a web browser, MMS instead of SMS, e-mail with a web-link or video as attachment, and a phone-resident video push/pull application.

We will build a prototype for each alternative based on Mobilisr's client/server architecture (see Figure 1). Prototypes will be developed and tested in conjunction with members of a Deaf NGO called the Deaf Community of Cape Town (DCCT).

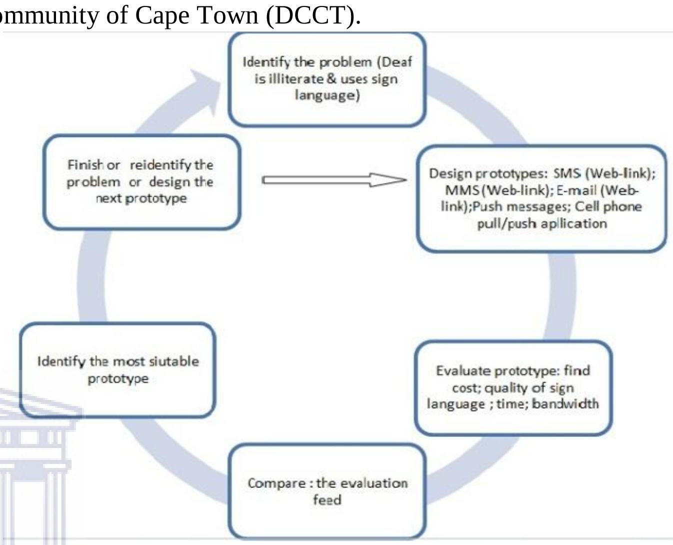

Figure 2: Prototype comparison and evaluation process.

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USING MASS VIDEO NOTIFICATION METHODS TO ASSIST DEAF PEOPLE

Using mass video notification methods to assist Deaf people

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ABSTRACT
Even though Deaf people in South Africa use texting via cell phones to communicate with hearing people they seldom use it amongst themselves. It is assumed that video messaging will be more accessible for the Deaf as their level of literacy may prevent them from making effective use of information that is disseminated via mass texting. The principal objective of the research was thus to explore a cost effective and efficient mass multimedia messaging system. The intention was to adapt a successful text-based mass notification system, developed by a local non-governmental organization, to accommodate efficient and affordable video mass messaging for Deaf people. The questions that underpin this research are: How should we compare and evaluate various video streaming messaging methods to find the most effective streaming method to deliver video messages? What transport vehicles should we consider: multimedia messaging service, the web, electronic mail or a cell phone resident push/pull application? What is the cost to the end-user and service provider and how can we make such a service more affordable? How does the video quality in terms of sign language vary between each transport vehicle? A mixed research methodology approach was followed to help answer the research questions. The preliminary results indicate that most Deaf people prefer to use the short message service prototype with a web-link to the video rather than the multimedia messaging service prototype with the video attached. Although Deaf people prefer to use the video short message service prototype they are still very concerned about the cost of using the system. They also are concerned about the quality of the sign language video.

Categories and Subject Descriptors
K.4.2 [**Computers and society**]: Social issues – *Assistive technologies for persons with disabilities*.

General Terms
Design, Performance, Human Factors

SAICSIT '11, October 3–5, 2010, Cape Town, South Africa.

Keywords
Video streaming, mobile phone, South African Sign Language, Deaf, Deaf Community of Cape Town, Short Message Service, Multimedia Message Service, cost effective and efficient delivery, mass notification

1. INTRODUCTION
Deaf people in South Africa communicate with each other and the broader community by means of South African Sign Language (SASL). It has been found that although the majority of Deaf people globally, use Short Message Services (SMS) to communicate and share information with hearing people, they less often use it amongst themselves[1][2][3]. Deaf with a capital 'D' refers to people whose first language is sign language and who are members of a specific linguistic culture group [4]. In South Africa most Deaf people are functionally illiterate. This means that even though they may be able to read or write a spoken language such as English, they often cannot read or write it well enough to deal with the requirements of everyday life[5][6]. Their level of literacy thus would prevent them from making effective use of information that is disseminated via SMS. The assumption is thus that Deaf people would be able to make better use of the information if sent via a multimedia message such as: multimedia message service (MMS), SMS with a web-link to a sign language video or an electronic mail with a web-link. The hypothesis thus is that video mass messaging will be more accessible to most Deaf people than SMS messages.

This study was motivated by the work of a non-governmental organization (Cell-Life) who currently uses mass messaging (with a system called Mobilisr on cell phones) to provide services to people infected or affected by the Human Immunodeficiency Virus (HIV). The service is used for the dissemination of information in order to prevent infection and also to notify organization members of events, the latest news and even reminds them when to take their medicines [7]. It is worth noting that for messages to be useful to the receiver, the receiver must be able to read and interpret the message. Deaf people will not necessarily be able to use the information they receive via SMS, effectively due to their limited illiteracy. It was felt that Deaf people would be better served if they could be notified by means of a SASL message, i.e. a video message [6].

This study has potential contributions to generate research in inexpensive video messaging techniques to help provide information access to illiterate people but also to send messages in sign language to Deaf people. The aim of the study thus is to find an inexpensive video messaging technique for people with a low literacy level using some well-known messaging techniques such as SMS, MMS, and e-mails.

The Mobilisr software (currently being used by Cell-life) was adapted and changed in order to allow for mass video messaging by means of video streaming. Video streaming is a technique used for transferring data as a constant continuous stream over the Internet and is used worldwide to transfer multimedia files such as video, voice, and data [8]. The architecture of the different video notifications solutions was examined to determine which of the alternative video notifications delivery modes is the most effective in terms of transport, comprehension, and cost.

A mixed research methodology approach (involving the collection of both qualitative and quantitative data) was followed to answer the research questions. Concurrent triangulation design was used to collect the data concurrently and to validate the data [9]. Data was collected from ten participants, randomly but purposefully selected from the Deaf Community of Cape Town (DCCT), by means of interviews with the help of a South African sign language interpreter. They were informed that the data collection sessions would be video recorded.

The quantitative data was analysed using the statistical package for social science (SPSS) and the qualitative data, the raw data from the video-recorded interviews, were transcribed and analysed by means of content analysis[10][11]. The rest of the paper is organized as follows: Section 2 covers the related work, Section 3 presents the prototype(s), Section 4 covers the research methodology, Section 5 presents the results and findings, in Section 6 conclusions and future work are drawn and finally in Section 7 Acknowledgments is identified.

2. RELATED WORK

Most of the South African Deaf community has little or no access to Information and Communication Technology (ICT). In most of the developed world this is not the case, and ICT access is taken for granted, even by Deaf people [12]. The University of Washington developed a system (MobileASL) to support Deaf people with wireless cell phone communication in American Sign Language (ASL). MobileASL is a mobile video system that makes use of compression and decompression methods to avoid too much bandwidth usage. It employs region-of-interest (ROI) methods on the sign language videos to focus on the hand movements and the facial expressions of the signer within the video [13].

This work highlights some very important points that also had to be considered in this study the sign language in the video (hand movements and the facial expressions of the signer) must be clear and understandable; the bandwidth usage to send the videos must be limited (the more bandwidth used, the more the users have to pay); cost is a key factor and must be kept down. A video codec can be use to compress a video file by removing unnecessary information such as sound for the storage and transmission [12]. After compressing, the video storage size will be smaller, the transmission will be faster and the cost will be lower.

Mobilisr, an open source mobile platform developed in conjunction with Praekelt Foundation and Upfront Systems [14], is used by Cell-Life to support the Cellphone 4 HIV project. The web base application was designed and created to: increase access to information in sectors such as health, employment, or public safety; and to make two-way communication between citizens and service providers easier.

In the Western Cape Mobilisr is used to improve patient adherence to Antiretroviral (ARV) drugs and to build the capacity of organizations working with HIV/AIDS. The Mobilisr technology has the following functionalities: campaign management, broadcast SMS, schedule SMS, keyword SMS, pledge lines, Unstructured Supplementary Service Data (USSD), and subscribe/unsubscribe SMS. To give South African Deaf people access to information (in SASL) Mobilisr was modified to accommodate video.

3. PROTOTYPE

A prototype was developed for each of the video messaging alternatives based on a client/server architecture (see Figure 1). The prototypes were developed in conjunction with members of a Deaf NGO namely the DCCT. Qualitative data was collected during sessions where the Deaf end-users helped to evaluate the effectiveness of the various video delivery mechanisms. Furthermore, quantitative data was collected to compare the prototypes in terms of cost. Data, e.g. the number of bytes or size transmitted for a particular type video delivery was used to compare cost (number of bits per rand).

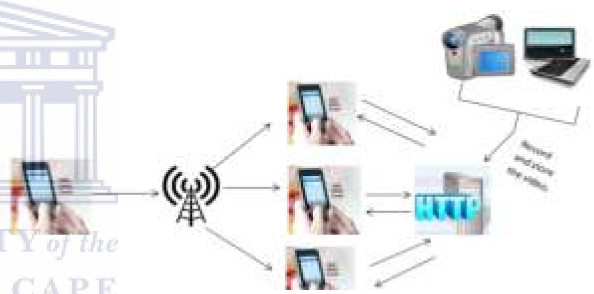

Figure 1: Client server architecture of the prototypes.

4. RESEARCH METHDOLOGY

This study followed a mixed method research approach, which uses multiple approaches to answer the research questions rather than constraining the research to one method [9]. It is a research design in which the investigator collects and analyses data, integrates findings, and draw inferences using both qualitative and quantitative approaches in a single study.

The study was guided by the following research question: How can we compare and evaluate various video streaming messaging methods to find the most suitable method to deliver affordable services to Deaf people?

The research question translates into the following sub-questions:

- Which of the various video streaming messaging methods will be the most effective streaming method to deliver video messages to the Deaf?
- What transport vehicles should be considered: MMS, the web, electronic mail or a cell phone resident push/pull application?
- What would the cost be to the end user and service provider?
- Will it be possible to make such a service more affordable, for example by stripping the sound from the video footage after recording it?

- Does the video quality, in terms of sign language, vary between each transport vehicle?

A pilot study was done to test and improve the prototype as well as the data collection tools. Five Deaf staff members of the Deaf community of DCCT were purposefully selected to participate in the pilot study. They were informed that all data collected would be strictly confidential and gave their consent that the data could be used for research purposes. An interview slide presentation as well as an information sheet was used as data collection tools. A SASL interpreter explained both instruments (group interviews and the information sheet) to the participants. The information sheet was used to collect background information about the participants such as: the mobile phone the participant is using, the participant's age etc. The participants were shown how the prototype should be used and were then given a cell phone so that they could acquaint themselves with the prototype before they were interviewed.

The pilot study revealed that the questions were unclear. One of the supervisors who monitored the entire data collection process also recommended that the sign language videos be replaced with smaller sized videos because of time constraints (demonstrating the prototype and interviewing the participants took longer than anticipated).

Since the data collection tools were refined and not changed, the data collected during the pilot study was used together with data collected in a next round of data collection. The same data collection procedure was followed with five Deaf participants (non-staff members of the DCCT) who were randomly selected.

Quantitative data was collected concurrently with the qualitative data (see Figure 2). The quantitative data was used to determine the cost of the various alternatives whilst the qualitative data informed the design and the functionality of the prototype. The two sets of data were integrated and analysed together.

Figure 2: Concurrent triangulation design.

5. RESULTS AND FINDINGS

The researcher created a set of probes which were used during the interviews. The probes addressed the following aspects of the prototypes: the user friendliness of the SMS messages with a web-link to the video, and the MMS messages with the video attached; the functionality of the mobile interfaces; what users are prepared to pay; as well as what delay in time (to stream the video) will be acceptable. Both the qualitative and quantitative results are presented in Table 1.

Most of the participants found the SMS mode prototype easy to use. Some of the participants that found the system complex said (through the interpreter): "*it was difficult to use the SMS system because I tried to access the system but I couldn't. Maybe in the future it will be easier to use the system*"“; *It was difficult but at least with the help of the assistant I got access. I think we need more training on how to use the system"*; and *"it was very difficult for me to use the SMS system"*.

It seems as if the MMS mode prototype was in general more difficult to grasp. Some commented *"I don't know how to access an MMS on a phone"; "I don't how to send an MMS"; "it was very difficult for me to use the MMS system"*. The majority did not know how to download the video once they received the MMS. It is important to note that most staff members were little impressed with the MMS prototype and also felt that the video was not clear enough *"The structure is easy but to access the messages is not easy and the videos were not clear"*. This can probably be ascribed to the size of the screen of the mobile phone that was used for demonstration purposes.

Table 1: The number of respondents that were positive about the prototype.

Prototype	SMS mode			MMS Mode		
Groups	Staff	Non-staff	Total	Staff	Non-staff	Total
Number of participants	*10*	*6*	*16*	*10*	*6*	*16*
Functionality	7	3	10	3	3	6
Download process	9	4	13	3	2	5
Video play	10	4	14	3	2	5
Recognition	9	6	15	2	4	6

The video quality of the transport vehicles could not be compared since the prototype was demonstrated in such a manner that only prerecorded videos were used for demonstrating the SMS's but the MMS's were demonstrated using both prerecorded videos and recorded mobile phone images. This may have confused the interviewees and resulted in their poor rating of MMS's. It should be re-tested in a next round of data collection.

All participants were quite willing to pay for this service as it was determined that the cost to send a video (by MMS or SMS), varied between 75c and 80c. It still needs to be determined whether the stripping of the audio from recorded videos will have any significant influence on the cost of the SMS or MMS service. From the background questions, it was found that most of the participants use low-end cell phone devices- devices that cannot play videos or access the internet.

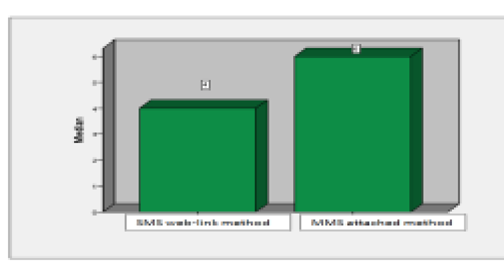

Figure 3: Average delay in minutes of video transmission.

Figure 3 represents the average delay of an 11 kb video sent via SMS (with a hyperlink) compared to the same video sent via MMS. The average delay of a web link enabled SMS is less than the average delay of an MMS.

6. CONCLUSION AND FUTURE WORK

When revisiting the research questions the following was found:

"*Which of the various video streaming messaging methods will be the most effective streaming method to deliver video messages to Deaf people*?" – It was found that the web enabled SMS video streaming method was perceived by the Deaf participants to be the most effective streaming method. The experiment results also indicate that the web enabled SMS is more effective than the MMS streaming in terms of the delay experienced.

"*What transport vehicles should be considered: MMS, the web, electronic mail or a cell phone resident push/pull application?"* – The prototype was developed to send the video message by web enabled SMS or MMS. These were found to be the most appropriate for the Deaf community. The Deaf participants preferred the SMS as transport vehicle.

"What would the cost be to the end user and service provider?" – All participants are quite willing to pay between 75c and 80c for using this service. The service providers charge 80c per SMS and MMS (provided the file size is less than 300 kb for the MMS) during peak-time but the SMS becomes considerably cheaper during off-peak hours (35c).

"*Will it be possible to make such a service more affordable, for example by stripping the sound from the video footage after recording it?"* – This was not addressed but will still be investigated.

"*Does the video quality in terms of sign language, vary between each transport vehicle?*" – It was found that the Deaf participants felt that the quality of the sign language videos received via SMS mode is better than the quality of the videos received via MMS. This was expected as the SMS videos were prerecorded by means of video cameras whereas the MMS videos were recorded by means of a cell phone.

It was difficult to find Deaf participants to participate in this study. The interaction with the sixteen Deaf participants was through a SASL interpreter whose services was time, cost dependent, and made the interaction less spontaneous. Furthermore it was very time-consuming since the prototype had to be explained very carefully with the help of the translator before the experiment could be executed. In order to determine if the stripping of the audio from a video will have a significant impact on the cost of transporting it, compression algorithms and the costing mechanism of service providers will be investigated. The prototypes used in this study were developed for a Symbian platform; it is the intention of the researchers to adapt and tests the prototypes for use on the Android platform. More experiments need to be done to determine the influence of file size on delay and the cost of streaming the videos.

7. ACKNOWLEDGMENTS

We thank William Tucker for his technical guidance. For financial support we thank Telkom, Cisco, Aria technologies and THRIP (Technology and Human Resources for Industry Partnership), managed by the National Research Foundation (NRF). Any opinion expressed in this material are those of the authors alone

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