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Faculty of Electrical Engineering,
Mathematics & Computer Science

Reducing loneliness in seniors using an automated calling system for activity invitation

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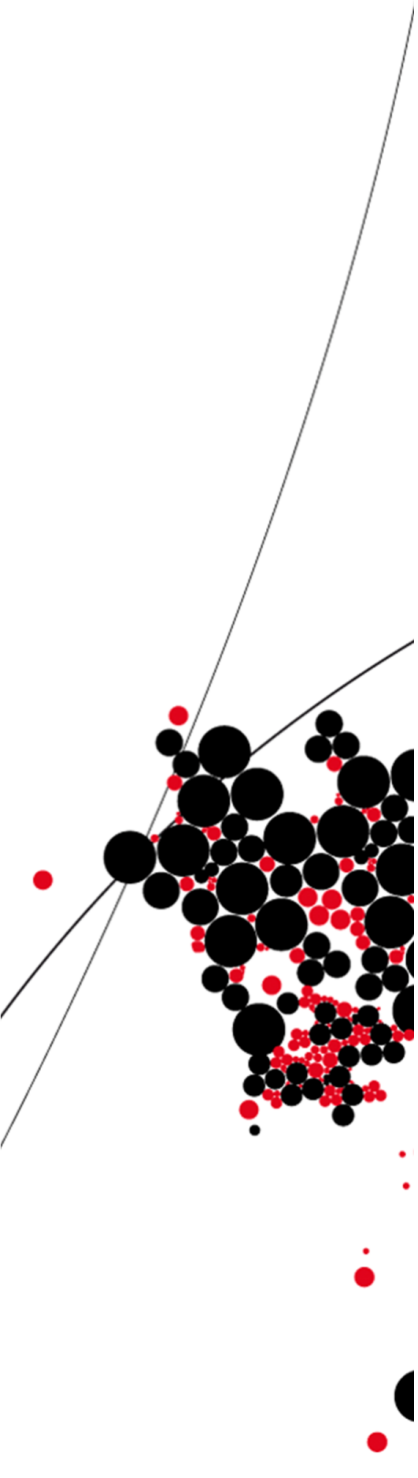

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Chapter 1

Introduction

1.1 Problem statement

Loneliness is a problem that many of us face throughout our lifetime. It is often recognised by the general feeling of sadness that accompanies it, but it has many additional negative effects. A study carried out in 2019 reports that over 25% of all adults in the Netherlands feel lonely sometimes, with 10% even feeling severely lonely[1]. The number of people that experience loneliness increases drastically with age, in the group above the age of 65 more then 40%[1] sometimes feels lonely and above the age of 75 this is more then 50%[2]. When taken into account the increasing age of the general world population[3], the number of people feeling lonely is likely to increase even more over the next years.

In addition loneliness is correlated with many physical and mental problems like depression [4][5][6], actual and perceived ill-health, excessive alcohol consumption, personality disorders, dietary inadequacies and suicide[7][8][9][10][11][12] as well as increased mortality, dementia and cognitive decline[13][14][15].

In literature there are many different definitions that aim to explain loneliness, but the concept is hard to define. There is not one definition that is generally accepted by all researchers, but many researchers agree on the elements a definition needs to have. One of the definitions that contain these elements is the one proposed by Pettigrew. He describes loneliness as: ”The subjective dissatisfaction with the discrepancy between the actual and preferred level and quality of social contact”[16]. This definition offers a understandable explanation, therefore we will follow his definition in this thesis.

When looking at the causes of loneliness it is important to make a distinction between the different types of loneliness, the three types being existential, social and emotional loneliness [17].Social and emotional loneliness come forth from a lack of social or emotional connections, existential loneliness is often related to mortality

related fears. Because social and emotional loneliness have similar causes and are the majority of loneliness cases, this thesis will focus on these types of loneliness.

Within this thesis we focus on the demographic where loneliness is the most prevalent, being people above 65 years old. We aim to create a scalable solution that helps in reducing the social and emotional loneliness that is tailored to the needs of people above 65 years old. Since this group is notorious for their limited technical knowledge, care has to be taken in developing a solution to be usable by the senior population without the need of much technical knowledge.

1.2 Scope

The population of seniors is very diverse and has many subgroups incorporated within it. Subgroups can be made on age, physically fitness, mental health, mindset, residency and many more. All these subgroups have different desires and problems, therefore a product cannot be created that offers the best solution to all these groups. To make sure that the developed product benefits at least a specific group the target audience is specified to people that:

- Are above 65 years old

  People above the age of 65 have less standard social connections due to retiring, after this age social isolation becomes more and more prevalent. This research focuses on how we can improve their situation.

- Speaking the Dutch language

  This requirement is necessary to facilitate communication with the researcher and a possible solution.

- Living in the Netherlands

  For ease the research is limited to the Netherlands.

- Has no mental impairment

  The researcher is not qualified to work with mentally impaired seniors, therefore the study will not contain people that have been diagnosed with such an impairment.

1.3 Research questions

The posed research question is a result of preliminary research and conversations with stakeholders as elaborated in chapter 1 up to and including chapter 4 of this

thesis.

The main question this thesis aims to solve is:

- **RQ1: How can we design a scalable interactive voice response (IVR) system to reduce social and emotional loneliness in seniors?**

To answer this research question the following sub-questions will be answered:

- **SQ1.1: What are the design requirements of such a system?**
- **SQ1.2: How is such a system received with the stakeholders?**
- **SQ1.3: Which challenges arise when deploying such a system?**

Chapter 2

Understanding loneliness

To create a product that aims to reduce social and emotional loneliness it is helpful to have an understanding of the concept of loneliness itself. This section aims to provide a theoretical background on this concept.

2.1 What is loneliness?

Getting a concise and all covering definition of loneliness proves a challenge, Killeen even describes loneliness as ”the difficult to define concept”[18]. Francis defined loneliness in 1976 as an unwelcome feeling of lack of companionship and a wish for interaction different from that being experienced[19]. Copel in turn defined loneliness as an emotional state in which an individual is aware of the feeling of being apart from another or others, along with the experience of a vague need for individuals[20]. Younger however defines it as loneliness is the feeling of being alone in spite of longing for others[21]. More complex definitions are also common, Stuewe defines it as the experience of isolation, disorientation, or “lostness” within a dimensional domain of meaning[22]. Keefe adds to these definitions that loneliness is not necessarily dependent on the size of ones social social network[23]. Pettigrew tried to capture the essence of loneliness by defining it as a subjective dissatisfaction with the discrepancy between the actual and preferred level and quality of social contact[24]. All these researchers tried to capture the same phenomenon but could not agree on a overarching definition, all these definitions do however give an insight into loneliness. For this thesis we will use the definition provided by Pettigrew ”the subjective dissatisfaction with the discrepancy between the actual and preferred level and quality of social contact” since it covers most important aspects of loneliness.

An important distinction should be made between the terms loneliness (feeling alone) and being alone[25]. While often used interchangeably loneliness and hav-

ing a low number of social contacts are not the same thing. Loneliness refers to the unpleasant response to the lack of social relationships, even though these con-cepts are interrelated, a low number of social relationships does not mean one is lonely[26].

So the definition of loneliness is complex and it is experienced in different manners by many individuals. It comes as no surprise that there are distinctions to be made between these subjective feelings, which all have their own causes and remedies. Hence loneliness is categorized in Social loneliness, Emotional loneliness and Existential loneliness[17].

Social loneliness

Social loneliness is the feeling that occurs when there is a lack of social connections with whom one has things in common, like friends, colleagues or neighbors. It is not about the number of social connections but about the quality of the contact[17].

Emotional loneliness

Emotional loneliness occurs when a person lacks a close, intimate connection. They often miss a social connection that they can share their personal feelings with[17].

Existential loneliness

People that experience existential loneliness often experience the following key aspects. Not connecting with others and the world outside, alienation, feelings of isolation, emptiness, and abandonment. Additionally, mortality-related fears were identified as being associated with this type of loneliness, including the fear of disappearing[27].

This study will focus on social and emotional loneliness, since these rely heavily on the amount and quality of social contact for which this study can propose a solution.

2.2 What causes loneliness?

Social and emotional loneliness is strongly correlated with the deterioration of social networks. This deterioration accelerates at a later age, which is caused by many factors. The development of physical impairments[24], the loss of friends and relatives[25][28] and the relocation of seniors to another residence are important factors that cause this acceleration. But also Physical impairments like decreased sight or mobility can be a cause for a reduced social circle, it can limit people in their ability

to visit friends or family[12][17]. This reduction of a social circle often already starts at retirement, which causes a direct decrease in daily social interactions.

2.3 How is loneliness alleviated?

Loneliness is often addressed with focused interventions[29]. The currently developed intervention strategies mainly consider the topics of contact, social participation, feeling cared for, personal development and social isolation[16][30][31][32][33][34]. The goal of these interventions is to make someone aware that they might be lonely and stress the importance of the social network to solve this problem. During the interventions, the interventionist discusses how someone could meet more people and the importance of utilizing friends and family as an emotional resource[16]. Another way to address loneliness is by interpersonal therapy, although this is a more drastic measure[35].

To combat the loss of this social circle, meeting new people through social activities is crucial. This increases the number of social interactions a senior has and with it the chances to build new valuable social connections. But research shows that seniors often visit a low number of social activities, even tho this is key to reduce loneliness. This lack of social interaction is linked to a lack of motivation, a lack of opportunities, a lack of IT skills[36] and finding relationships less compelling at a later age[37].

In the Netherlands, there are a lot of organisations that aim to alleviate and prevent loneliness for seniors. The details of how this is done is organisation-specific, but these organisations often follow a similar structure. The seniors are redirected by general practitioners, community police officers, family members or the seniors directly calls the organisation. The organisation will then visit the seniors and asses their needs, this could vary between weekly activities, a travel mate, a younger buddy that helps with everyday tasks and many more. In many cases the seniors is advised to visit activities organised to meet new people. The first three times a member of the organisation will go with them to the activities, but after this introduction period the seniors will have to go on their own. They will receive a schedule of these activities periodically, there are no followup or additional reminders.

2.4 Key takeaways for product design

When analyzing the different types of loneliness it becomes clear that a social network plays a crucial part. The main cause of the deterioration of these networks are factors such as the passing away of friends or people relocating, these are complex

problems that offer little room for concrete solutions. To combat the effects of these issues however, it is important to make sure seniors meet new people and build new emotional connections. Many of the issues that cause seniors to have a reduced amount of social participation are based on psychological thought patterns like finding relations less compelling and a lack of motivation. These problems require a lot of personalized and specialized attention to address, which leaves in turn little room for scalable technical solutions. But there is a large group of lonely seniors that have the need and wish for more social activities, but has limited opportunities to visit these types of activities; which is not helped by their limited technical knowl-edge. Many of the activities can be found online, but seniors often do not posses a computer or lack the skills to search the web. This is a target group which can benefit from a technical solution that provides them with these opportunities without the need of extensive technical skills.

Chapter 3

Related Work

To design a technology capable of reducing social and emotional loneliness for seniors it is important to understand what is currently available. This section will give an insight into the technologies and technical products currently used to address the issue of loneliness. The technologies in this field can be categorized into digital technologies, robots, Lo-fi solutions and other devices.

3.1 Digital Technologies

Digital technologies are more and more common, this is also reflected in the field of loneliness. But technological proficiency is a problem among many seniors, therefore the subset of people that can actually benefit from this technology is limited.

One of the promising opportunities lies in the use of social media[29]. This can be currently existing social media like Facebook or Instagram but also new platforms designed specifically for this purpose. One of these platforms that is currently in use is a tinder-like platform that is focused on connecting seniors. You can fill in personal information like the activities you would like to do and can see if there are other people in your neighborhood with the same preferences. It will then give you the opportunity to arrange a joint activity [38]. This platform is computer-based and therefore requires IT skills, which makes it hard to access for many seniors. One of the organisations that organizes a lot of activities for seniors in Enschede has also created a platform with a similar goal. It works like a forum, where one can post and respond to a post. When posting participants can state what you like or what you are looking for, this could be: ”A person to join me on fishing trips”. If someone likes this they can respond and you can get contact details from each other.

Another common product to reduce loneliness and increase the feeling of social participation revolves around the ability of sharing photos from family members with seniors. There are multiple variations of this technique, for example where a family

member can make a picture appear on a photo frame in the house of an senior person. Some variations give the ability to send a message back when you pick up the picture frame [39].

Tablets for seniors are also a common way to facilitate social interaction. The tablets are designed so that they are easy to use for seniors and have limited functionality. Some of the functionalities may include sending messages to others or receiving pictures from their spouse[40].

3.2 Robots

Robots are increasingly common to combat loneliness. A wide range of types and forms are available to take care of someone or to serve as a companion. These types of robot could play an important role with respect to the health and psychological well-being of seniors [41].

One of the most prevalent examples of these types of robot is the Pepper robot. Pepper is a humanoid robot which is focused on interacting with people, he can navigate through the environment and can be programmed for different use cases. Pepper can hold conversations and ask questions, it also facilitates a platform to make a humanoid robot usable for custom use-cases.

Figure 3.1: The pepper robot

There are also robots that aim specifically at being a companion for seniors, one example of this is Robot Maatje. It is a small robot that is capable of asking and answering questions, dancing, reminding people of meetings, play music and much more. Through this wide array of functions Robot Maatje can really build a

connection with someone[42].

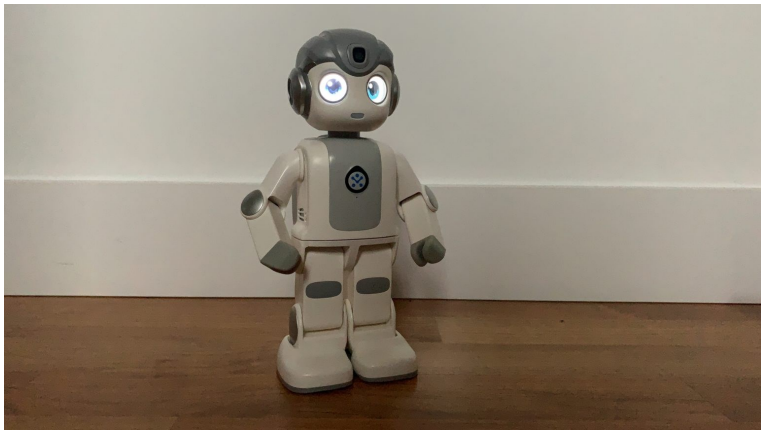

Figure 3.2: Robot Maatje [42]

Another type of social robot comes not in a humanoid form but in the form of an animal. One of these robots is the Paro “mental commit robot”, which has the form of a seal. The cute form and the interactive capabilities makes it easy for a person to form a emotional attachment to the robot, which is great for reducing the feeling of loneliness [43].

Figure 3.3: The Paro ”mental commit robot” [43]

Many other types of robots are available that provide similar functions and results, see Appendix A for a detailed overview.

3.3 Lo-Fi solutions

The two main types of solutions that do not depend on autonomous or complex technology are interventions and telephone befriending[29]. In telephone befriending, a volunteer calls a senior to make them feel heard and for the lonely person to share feelings. This interaction can occur regularly to facilitate the emotional and

social support that a senior might need. Interventions are often facilitated by family members or close friends when they suspect a senior might be lonely. The goal of the intervention is to talk the problem of loneliness and how the senior experience this. Within the intervention, suggestions can be made about ways to alleviate this feeling and agreements can be made how to proceed with this.

3.4 Other

There are some tangible products that aim to relieve loneliness by seniors. One of these products is the CRDL, which is a interactive instrument which facilitates social interactions by translating social touch to sound. When two persons both put one hand on this instrument and touch each other with the other hand it will create a sound. The sound is dependent on the way people touch each other, so knocking will cause a different sound than holding for example[42].

Figure 3.4: CRDL social technology [42]

Another technology that is used in combating loneliness is based on a button that is placed in the house of an senior. When the senior has a need for social contact, they can press the button after which a volunteer will call the seniors for a chat.

3.5 Acceptance of technology

Many technologies that are developed face problems in the deployment phase. These problems can be a resistance of personnel or end users against the technology. Making sure your developed technology gets used is an important and difficult

challenge that consists of the 3 sub parts: Implementation, Usability and Accessibility.

3.5.1 Implementation

Getting managers of nursing homes or the caretakers of seniors to actually buy, setup and use your technology is difficult. When managers were asked what the main problems were, they stated that costs, lack of ownership and issues of environment were the main problems[44]. The costs of these systems can vary widely and it is not always clear who has to pay this, this could be the insurance company, the owner of a nursing home or an seniors itself. This directly leads to the following problem, who owns the device and who is responsible for it. This also translates into who has to set it up and how is it used, these are all challenges that make implementation difficult.

3.5.2 Usability

When the device is implemented it has to be taken in use, which poses a lot of problems. Caretakers and seniors need to know how to use the device and what it benefits are and this is not always as straightforward. When caretakers where asked 51% reported problems in their daily use of technology in their work, the biggest problem being lack of stability followed by shortage of training and lack of usability. To improve these problems they recommended to improve the amount of training they received, making the devices more focused on the user and providing regular updates about the new technologies to the employees[44].

Research shows that the technology acceptance of seniors is influenced by their familiarity with technology, their enjoyment in it, the feeling of convenience and their technical knowledge [45]. Eriksen states this comes down to usability, accountability and accessibility[46]. Older adults would really like to benefit from the services of technology, but they can't understand what technology can do for them and how they can access these services [47].

3.5.3 Accessibility

Making technology easily accessible for people with low technical proficiency is of key importance. When people find the technology too difficult to use or the investment to learn the technology is too high they will often not use it. Baecker conducted a study to what influences the acceptability and came up with 11 design implications to take into account when creating technology for seniors [39]. Following are the

summed up versions of these design implications, the complete list can be found in B. These design implications will be kept in mind when developing the system.

- Design Implication 1: Avoid traditional computing aesthetics (screens, keyboards, grey, black, and office plastic) and conventions. Design appliances, not computer interfaces.
- Design Implication 2: Support expressions of personhood through alternate interaction techniques and tangible interfaces based on real-world objects and practices.
- Design Implication 3: Leverage pictures of family to engage seniors.
- Design Implication 4: Do not disrupt social ties with existing family or new friends
- Design Implication 5: Respect existing uses of devices such as smartphones and patterns of family communication, e.g., email and social media.
- Design Implication 6: Support and emphasize asynchronous but also provide opportunities for synchronous communication.
- Design Implication 7: Provide multiple possibilities for communication including video, photos, and audio, but do not require seniors to type.
- Design Implication 8: Use tactile interaction that accounts for such issues as arthritis or tremor.
- Design Implication 9: Be non-language specific. Make use of icons as much as possible.
- Design Implication 10: Design with a realistic understanding of the availability of technology infrastructure, maintenance, and assistance, which is likely to be low in nursing homes.
- Design Implication 11: Support an institutional context with sufficient administration and privacy settings.

Chapter 4

Understanding real world context

Providing a theoretical background is important in all research, but getting an insight in practical problems from users, professionals and other stakeholders is also essen-tial when developing a product. Within this research the groups that are essential are seniors themselves, organisations that deal with loneliness on a daily basis and caretakers of seniors. In this research stakeholders that have financial interests are omitted due to the exploratory nature.

This section aims to give an insight into the current situation of loneliness from a practical standpoint. It will present the information that is gathered after interviews with 7 professionals from different organisations that are actively working with seniors and results from conversations with 15 seniors.

4.1 Methods

The 7 professionals that were recruited for this preliminary study are all contacted individually via email, this e-mail is found online without any prior information. The email contained information about the topic of the study and the research phase of the researcher. In total 10 organisations were contacted of which 7 were willing to co-operate in an interview. The interviews were semi-structured and were conducted at the preferable location of the professional. The following questions were used as a guideline for the semi-structured interview:

- What are the causes for loneliness in your eyes?
- What makes the topic of loneliness complex?
- When developing technology to address loneliness, what mistakes should I avoid to make?

The important points that came up during the interview were written down by the researcher. The interviews were not recorded or filmed and no external parties were

present to limit the threshold for participation. The interview started with an introduction period in which both the interviewer and interviewee introduced themselves and the company they worked for. After this the topic loneliness was discussed as well as possible causes for it. After which all things that came up and were interesting were further discussed.

As for the interviews of the seniors, 5 of the 15 participants were recruited via direct connections of the researcher, like friends or family. The other seniors were interviewed while they were present at an activity of a neighborhood home.

The interview took place in the home of the seniors with attendance of a mutual contact of the researcher and the senior or at a suitable place in the neighborhood home.

7 of the 15 senior participants were male, the other 8 were female. There was an distribution of the ages between 65 and 87. 7 of the participants were interviewed one on one and the other participants were interviewed in groups of 2, 3 or 4, this was done to enable the researcher to get more participants. The interviews were of an unstructured nature and aimed on getting the perspective and experiences of the senior with the topic of social connections, loneliness and technology.

The main goal of these interviews is to gain an insight into the practical problems that surround loneliness. It also deepens the knowledge of the researcher to prevent possible mistakes, gain a better understanding of the loneliness landscape and to discover potential design opportunities.

4.2 Feedback from organisations

There are many organisations that provide support for seniors. These organisations can be divided in home care, activity organisation and governmental organisations. Professionals from all these fields are interviewed to asses the general needs of lonely seniors.

Home care

The organisations that are specialized in home care are responsible for helping seniors in day to day things like washing or cleaning. They will visit the seniors at set times during the week to assist in what the senior requires. When home care cannot handle all the tasks of the senior and more intensive care is needed, this is often a trigger to move to a home to offer more assistance or to have a family member take care of them.

Activity organisation

Other organisations focus on organizing activities for seniors,hey offer weekly activ-

ities like playing cards or drink a cup of coffee; this can be done in neighborhood homes or on external locations. Neighborhood homes offer a daily activity program for anyone who would like to take part. All of these organisations rely heavily on volunteers and subsidies. A sub task of these organisations are side projects, like finding volunteers that drive seniors where they need to go or taking seniors to the supermarket.

Governmental organisations

There are also many governmental organisations, some of which are responsible for going to seniors that might be lonely to find out their needs and offer a solution. Other organisations are responsible for the more general approach a region takes toward loneliness.

4.2.1 Causes of loneliness

The professionals mention multiple causes that can lead to loneliness. These can be categorized in: life-changing events, the taboo around loneliness and the development of physical or mental problems. They state that loneliness is often a combination of factors which often relate to life changing events, like the death of a close friend or family, moving to a new place or physical and mental complications. But the professionals do state that one does not necessarily become lonely after such an event, it is often about how these events are handled and which social support is available. They state that it is almost impossible to prevent these events from happening and that we have to deal with the consequences. Another contributing factor that is that the senior generation is not speaking to anyone about loneliness, it is a taboo. So often it is not known that someone is lonely until it takes a very severe form. To combat this one of the organisations offer loneliness awareness training, in which people that have jobs in which they see many people learn to spot and report possible loneliness at an early stage.

4.2.2 Signalling of loneliness

Signalling of loneliness is a big problem in the eyes of the professionals. Loneliness is often noticed in a very late stage or not at all. There are organisations where you can report when you suspect someone is lonely, this is often done by a con-cerned family member or the general practitioner. They are currently working on a system that provides general practitioners with the ability to prescribe going to social activities when they suspect that someone comes in with issues that are related to loneliness. This simplifies the current process of redirecting someone to a loneliness

organisation.

When these organisations receive a report that someone might be lonely, they evaluate the severity of the report. If the report is severe enough, they send someone to their house for an introduction. The goal of this talk is to evaluate the needs of the person, these needs can vary from person to person. Sometimes the need is to talk to someone once a week, or the need can be having someone they share a hobby with or someone that can help them with grocery shopping. But sometimes the needs are more severe and require more than sporadic social interaction by volunteers. When this is the case they will introduce them to organisations that offer activities for seniors and invite them to come along to some of these activities. If necessary there might be a volunteer that will assist the senior to the first couple of activities and introduce them. After the first times, the volunteers no longer join the seniors for the activities. The professionals mention that seniors often do not go to these activities alone and that there is only a small group that continues to go to activities at this point. But unfortunately they do not have the capacity to assist seniors for more activities. Capacity is an issue at many of these organisations, they are understaffed and often rely heavily on volunteers. After being asked about the number of people that are lonely in their neighborhood and how many they actually know of, one of the responses was “I think we only know about 10% and I don’t know what we would do if we would know about the other 90%, we already work 60 hours a week”. Other professionals mention as well that they only know about a very small proportion of people who are lonely and that they already have almost no capacity to help them as they need.

4.2.3 Complexities of loneliness

The professionals also state that loneliness is a very complex problem that is rooted deep in society. They mention that society changed in the past years and that this is heavily reflected in the current loneliness numbers. In previous generations so-cial contact was much more necessary and it was therefore much more common to visit your neighbors or close friends and family more often; it is much more com-mon these days that people do not know their neighbors. One of the professionals stated that there is a term in their region that encapsulates the social connection neighbors need to have to prevent this, its called ”noaberschap”. It means caring for your neighbors, helping them when necessary and visit them when you see anything out of the ordinary. For example when the curtains are closed for a whole day, it is customary to ring the bell to see if everything is okay, or if someone is looking a bit sad to invite them for a cup of coffee. In eyes of this professional this is lost in many neighborhoods and it is easier to just stay home the whole day and not see anyone.

He states if we really want to change this problem, this societal issue is one of the biggest we need to address. This might be the key to prevent future loneliness but it is too late for people that experience it today.

Alleviating loneliness

Solving loneliness for people that experience it today requires a lot of personal attention. The professionals state that evaluating the needs of the specific senior is very important, this is a very delicate part in which trust with the senior needs to be established. When this trust is gained people are much more likely to open up and tell them what they actually need, this trust is necessary because the topic is quite sensitive. In this part of evaluating the most important part is personalized attention, they state that since personal attention is so vital they see very limited possibility for technology in this part of the loneliness problem. After talking with the professionals they state that the only long-lasting way to relieve this social and emotional loneliness is by forming meaningful connections. Some current technical solutions aim to relieve this loneliness by the use of social robots, the professionals see this more as mitigation technique than a definite solution to the problem of loneliness.

Challenges in reaching seniors

In general it is really hard to reach seniors with information or activities. They often are not technically skilled and are therefore not reachable by means of the internet, which leaves options limited. Currently seniors are often addressed by a flyer with information, but this has some drawbacks. First of all it is expensive to print and distribute all flyers which is a main problem since many of these organisations run on subsidies. Second it is unsure how the flyer is handled once it is delivered, it might be thrown away or land at the bottom of a large stack of papers. Last is the lack of feedback the organisations receive on the flyers, they have very limited information about if the activities comply with the wishes of the seniors or what keeps them from going. The options apart from distributing flyers are limited, e-mail or whats-app is not accessible by many seniors and phoning or visiting everyone is too time intensive. Some pilots have been conducted with inviting and talking with seniors by use of a screen that is placed in the house of the senior. But seniors reported finding the technology hard and they did not like to use the system. There have been many attempts to teach seniors to use technical systems, but many of these attempts yielded no results. Seniors have a very hard time learning these systems which is not supported by a lack of motivation to do so. Professionals do state that seniors would like to benefit from the opportunities that technology offers. One might think that organizing activities from seniors for seniors might be a good solution, it increases the number of volunteers and therefore the number of people

that can be helped. But in practise the number of seniors that are willing to volunteer and organise activities is low. The professionals do not have a clear answer for this phenomenon.

4.3 Feedback from seniors

To get a understanding of the problems and issues seniors face in regards to social contact an interview is conducted with 15 seniors. From these, 10 lived with their partner, the other 5 lived alone. There seems to be a pretty big distinction between seniors in regards to their need for social contact. The seniors that took part in neighborhood home activities did not visit each other outside of the organized activities, when asked why the answers were not conclusive; going from everyone is too busy to I don't really know why. Some of the participants did however mention that they took part in weekly activities in which they see each other. Most of the participants that were interviewed at neighborhood homes had limited issues with mobility, only one or two did not manage to come to the activities by themselves. This was quite different when interviewing people recruited from other channels, in those interviews mobility was much more of an issue. People became really dependent on friends or family driving them around, some of them also had subscriptions to a taxi like service for seniors.

Technology acceptance

All of the seniors did have a phone, but and around 70% of the seniors actually had a smartphone. When asked what they used it for most of them stated that they only used it for Whatssapp. Especially people that are above 80 years old did not have a smart phone. Almost none of the participants actively engaged with personal computers. When talking about new and existing technology with the participants it was clear that they found technology quite intimidating. They mentioned that times were changing so fast and that they did not like it, many of them stated that they had given the personal computer a try but did it did not end up being something for them. This experience forms the base for many of the opinions seniors have in regards to technology. They seem to be afraid that is going to be to hard to learn it and they cannot keep up, although this is a subject that is not easily discussed. Technology that they are familiar to, like a mobile phone, a radio or a television does not seem to trigger the same resistive response.

Challenges in attending social activities

One participant stated explicitly that she had experienced severe loneliness in her past, which started when her partner passed away. She mentioned that it is very

hard to go out of the door to meet new people. She eventually worked up the courage to visit the neighborhood home in her area and started to visit their activities, this was the starting point for her to become less lonely. She mentioned that inviting seniors to activities in a nice way could be the trigger for many seniors to start forming new connections. She mentioned the example of a nice card which could be delivered, stating that they would be very welcome at a next activity. Another women who was quite lonely at the moment explained that it occurred after she moved to another city to live in a smaller home. Her physical fitness reduced and it became harder to visit friends and family. She did not know her neighbors and spend a lot of her time alone, she was very happy that the researcher called out of the blue because she had not spoken to anyone in three days. She mentioned that she would like to be invited to more social activities in her area, but that she needed transportation as well to get to these activities. She was aware that there was a neighborhood home close to her, but she had trouble getting there by foot. She also did not know when activities were and she had trouble arranging transportation. Another senior mentioned that he visited these social activities once in a while but that he always forgot to check the paper when they where. Many of the seniors lived in apartment complexes that were mainly inhabited by other seniors, which whom they had some but limited contact. The apartment complexes did often not have a common room in which activities could be organized. seniors that had day to day activities such as volunteering or working had less need for extra social activities.

4.4 Key take-aways for product design

This chapter gives an oversight of the current experiences of seniors and the professionals that work with them in their day to day operation. One of the key takeaways that professionals stated that the main solution to reducing loneliness is forming new connections with others. Since this is the only lasting solution, ideally the goal of the designed product should focus of facilitating social connections between seniors. When people are already severely lonely, directly introducing technology will not work, attention of actual people or professionals is needed to earn their trust and to evaluate their needs. This is not a good moment to introduce a technical system for the seniors, since earning their trust and getting them to open up is already difficult and introducing a technical system will be a extra burden. Creating a system that signals loneliness is not very valuable at this point, even though a very small number of lonely people is actually known. But capacity limits of the organisations prevent them from helping large groups of lonely people. Capacity limits of organisations are a big problem in alleviating loneliness. A tool to gather more volunteers is also something that would really help the organisations aimed at reducing loneliness.

Addressing complex social patterns in society by developing a product seems to be a too complex task. It is good to note that seniors are familiar with technologies such as phones and that the acts they do every day with technology do not result in such resistance. It might be a design opportunity to use technology that is already familiar with seniors for a new purpose. Another big problem within this space is the complexity of reaching seniors, many of whom do not interact with the internet at all. Currently this is done with flyers but this has many flaws, like cost and lack of feedback. If a product could be developed that can provide information to a large number of seniors in a more efficient way, this could really help organisations. A system that could organize activities autonomously could provide large number of activities for seniors, this might be a design opportunity. The interviews with the seniors show that the need for more social activities is more present in seniors that do not have a partner. But that they do not always get invited to activities or have difficulties knowing when they are. They also state that transportation to these activities is quite a challenge. Creating a product that would invite seniors for activities that takes a limited time from professionals or volunteers looks like a promising design opportunity. When discussing with organisations they mention that the activities they organize are rarely full and that they have problems getting enough seniors to activities.

To summarize:

- The main solution to reducing loneliness is forming new connections with others.
- When people are already severly lonely professional help is needed before new technology can be introduced.
- Creating a system that signals loneliness is not of very valuable at this point.
- Capacity limits are a big problem in alleviating loneliness.
- A tool to gather volunteers would be of added value.
- Using technology that is already familiar to seniors might be a design opportunity.
- A product that could provide information to seniors in a more efficient way would really help organisations.
- The need for more social interactions is more present in seniors that do not have a partner.
- The seniors that would like more social activities are not invited as much as they would like.

- Creating a product that would invite seniors for activities is a design opportunity.

Chapter 5

System design considerations

5.1 Design opportunities

When evaluating the theoretical research and the interviews with professionals and seniors, some opportunities for the development of an electronically product present themselves. One of the possibilities for a technological product is a tool to reduce the capacity shortage in this sector by recruiting volunteers. If a tool can be created that results in more volunteers this gives the organisations a chance to focus more on the needs of seniors. Since there already many platforms that aim to fulfill this task in multiple different ways and the target group is volunteers instead of seniors this research will not continue with the development of such a system.

Another design opportunity that presents itself is in the invitation of seniors for activities. This is currently done via flyers which is expensive, ineffective and also provides no feedback for the organisations. If a device or tool can be developed that invites seniors to activities in a way that is more personal, more efficient and less time consuming, this could be really helpful in organising activities. Since this is the most promising design opportunity we aim to find a solution to this problem in this research.

Design considerations

There are multiple factors that should be accounted for when creating the product. First of all the lack of capacity in organisations that deal with seniors should be considered, a product or system should be created that is not time consuming for a professional to use. Another factor is the lack of technical knowledge of the target group, the product or system should be easy to use and intuitive. It is also important to keep the technical bias of seniors in mind and aim to make a product that does not create a big restive attitude in seniors. It is also important to look at the cost of the product to make sure implementation is feasible and practical. Furthermore

special care should be taken in safety, it is very important that seniors are safe and are not pushed towards unsafe situations. Lastly it is important that privacy and invasiveness is taken into account.

5.2 Ideation within design opportunities

Within the design opportunity of a system that invites seniors for social activities multiple solutions are considered. The main goal of the product is to invite seniors with low cost and with limited time contributions of organisations. Within the research the possibilities of social robots and tablets for seniors is briefly considered although there are already many variants currently in use. Since this is a fairly well explored area, this research will not go further into this direction. It is noteworthy that creating a product comes with some challenges when considering it for scalable use, first and foremost is the cost of the solution. This is reported as one of the main factors for lack of implementation. This price often needs to be paid by either the seniors or the children of the seniors and this is something to overcome when introducing new technology. Another big point of concern is the social stigma technology has for many seniors. The practical interviews and theoretical background stated that familiarity with technology reduces the stigma. Since using a technique that seniors are familiar with reduces the social stigma, reduces the implementation burden and makes it easier for seniors to interact with it, this is the direction we will focus to find a solution.

The proposed ideas will be scored on: Time required from organisations, Technical knowledge required, Familiarity for seniors, Costs, Privacy & invasiveness and Safety. We will use a system that rates the product from 0 to 5 on these points. 0 referring to what is considered bad, ex. when scoring a 0 on invasivensess this means the system is very invasive. When scoring 5 points on a topic, this means the system does what is considered best in that scenario, for example totally not invasive.

5.2.1 Contact by television or radio

Seniors spend a lot of time in front of the television or listening to the radio, it might therefore be interesting to consider the use of this technological device when inviting seniors for activities. A device could be created that plugs into the television or radio, which switches the channel to a custom broadcast by organisations. The organisations could record a message and whenever the television or radio is turned on this message could be played such that the seniors knows about the activity and where it is. The broadcast can be in video format for the television and in audio

format for the radio. Whenever the broadcast is done, the television or radio could continue with its original task.

Evaluation and limitations

- Time required from organisations **3/4**
  The organisations have to record a video which can be time intensive, but they only have to record one video for a large group of participants. It should be noted that if personalized messages are used this time increases drastically. The time consumption is less when providing messages by radio.

- Technical knowledge required **4**
  There is limited technical knowledge required since the television and radio are familiar tools to seniors. The tool should be designed in a way that does all the work and does not require the seniors to interact with the television or radio.

- Familiarity to seniors **5**
  The television is very familiar to seniors and therefore the resistance that will be encountered when using this technique is lower.

- Costs **2**
  This proposed product requires every senior to have a device behind their television or radio which can receive and display messages. Creating a technical device that is capable of connecting to the internet and receiving and broadcasting messages will be quite costly for the seniors.

- Privacy and invasiveness **5**
  The privacy of the senior is not in harmed and the product is not invasive since it does not have any sensors that gathers information about the senior.

- Safety **4**
  If the product is designed with all required security protocols, the chances of getting into unsafe situations are very limited.

The proposed product comes with some limitations, some infrastructure is needed to make the device work. Wifi is essential to make sure the product can receive the video or audio messages. It is also important to note that people that do not watch television or listen to radio often are encouraged to do so because they might otherwise miss invitations. 5.1 gives an graphical overview of the proposed system.

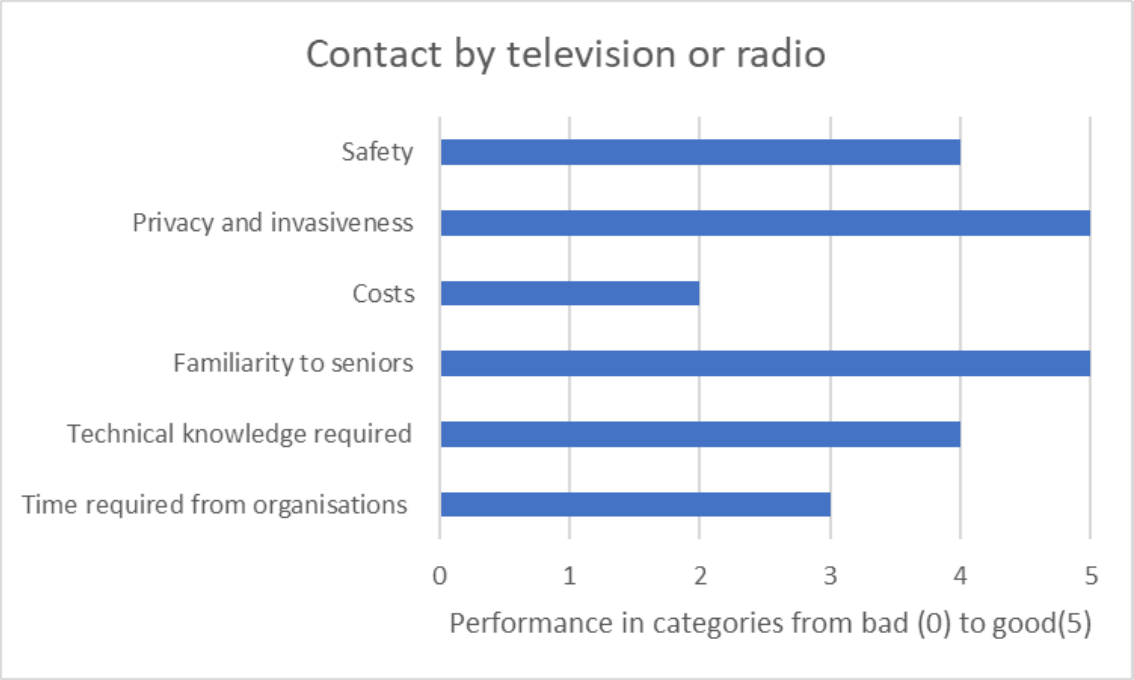

Figure 5.1: Performance contact by television or radio

5.2.2 Automatic mailbox printing

This proposed idea involves the automatic printing of flyers or information directly to the physical mailbox of the senior. A device is placed on the mailbox that can print notes removing the need for door to door delivery and automatizing the process. By using this system seniors will receive physical letters like they are used to. The device will be able to receive messages from organisations and can then print this message on paper which will directly fall through the mailbox of the senior.

Evaluation and limitations

- Time required from organisations **5**
  The organisations have to write a text to invite people for activities. But this is something they already do currently for their flyers, so this can be passed along directly to the systems.

- Technical knowledge required **2**
  For the operation of the system there is no technical knowledge required, the messages will be printed automatically. But there is a large maintenance aspect to this product, including changing paper and cartridges. This makes it so that some technical knowledge is needed.

- Familiarity to senior **5**

Letters are very common to seniors.

- Costs **1**
  This device would require additional hardware that is installed at seniors and ink and paper for printing messages, this increases costs.
- Privacy and invasiveness **5**
  The privacy of the seniors is not in harmed and the product is not invasive due to the lack of sensors.
- Safety **4**
  If the product is designed with all required security protocols, the changes of getting into unsafe situations are minimal.

Letters might be the most familiar form of communication for seniors, although providing letters is quite expensive and might therefore not be feasible to function as a scalable solution.5.2 gives an graphical overview of the proposed system.

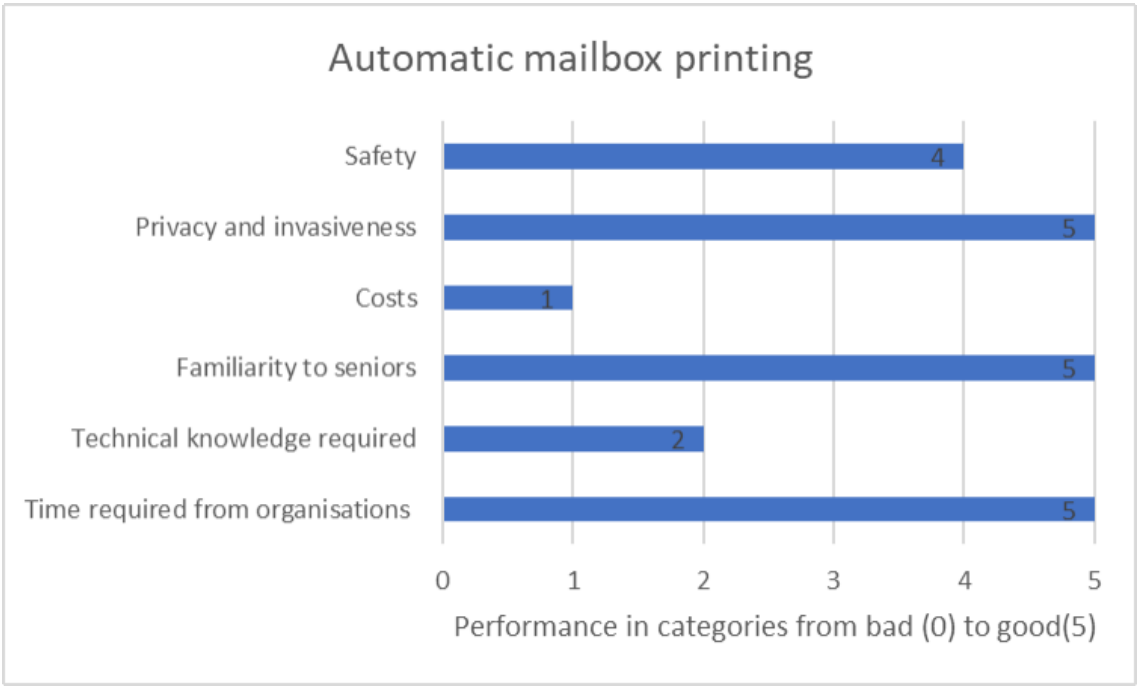

Figure 5.2: Performance automatic mailbox printing

5.2.3 Contacting seniors by phone

Contacting seniors by phone is very common and done by many friends and family, but this is almost never done via an automated system. This idea proposes a system that calls people automatically to invite them to activities, with a responsive model

in which speech recognition is embedded. This could give the possibility of direct feedback to the organiser.

Evaluation and limitations

- Time required from organisations **4**
  The organisations have to speak in a text for every activity they organize. They do only have to speak in one text that reaches all the possible participants.
- Technical knowledge required **5**
  For the operation of the system there is no technical knowledge required, seniors are very familiar with calling on a phone.
- Familiarity to seniors **5**
  Phone calls are very common to seniors.
- Costs **4**
  This device does not require additional hardware which really limits cost. The phone calls does however have some cost associated with them but due to large usage the costs for a phone call are low.
- Privacy and invasiveness **3**
  The system does record the senior to do speech recognition, therefore the system is invasive to an extent. This is something that needs to be addressed to the participant beforehand and taken into account when designing the product.
- Safety **4**
  If the product is designed with all required security protocols, the changes of getting into unsafe situations are minimal.

This system offers a cost effective way to communicate with seniors about activities. It is however very important to do the implementation in such a way that is intuitive and easy to use to reduce the burden to start using it. 5.3 gives an graphical overview of the proposed system.

5.3 Evaluation

When evaluating the scores of the ideas on all respective points we see the following results:

- Contact by television or radio **24 Points**
  The main limitations of this system are costs and the dependence on the amount someone watches television or listens to the radio.

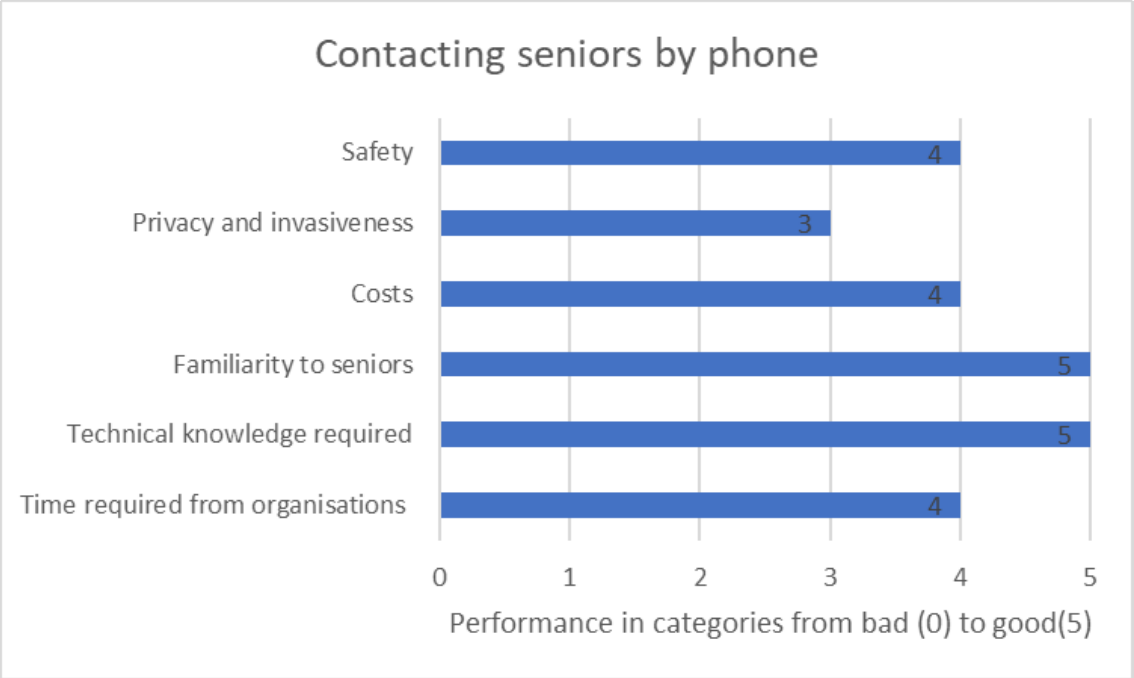

Figure 5.3: Performance contacting seniors by phone

- Automatic mailbox printing **22 Points**
  The main limitations of this system are cost and the amount of maintenance needed for the system to stay operational.

- Contacting seniors by phone **25 Points**
  The main limitations being privacy and technical design for usability.

After evaluation the system based on automatic calling of seniors for activity inviting is the most promising. It scores best on the points considered most important like cost, familiarity and time required from seniors. The main drawback is invasiveness, however this can be mitigated by implementing the proper safety protocols. For this reason the automatic phoning system is regarded as the most promising. Hence this is the system we will develop and evaluate in the remaining part of this research. Since the main limitations are privacy and design for usability we will take extra care in the design of these points.

Chapter 6

Initial System Description

To design an initial system, opinions and preferences of organisations and the target audience needs to be taken into account. For this reason additional interviews are conducted among the previously interviewed organisations and seniors to find their needs and preferences in this system. This chapter describes the design of the initial system.

6.1 Points of attention

The idea of an automated phone system is presented to 3 seniors and 3 professionals to check their initial feedback and to see if they feel that the product has potential. The conducted interviews were unstructured and focused on getting as many insights as possible into the potential of the system and the potential challenges. 2 of the 3 seniors and all of the professionals mentioned that if it was easy to use it would be of great added value. But they did mention that the implementation would be difficult due to the limited technical knowledge of the seniors. Furthermore the professionals mentioned that the system should avoid to use a robot voice if possible, this will have negative implications for seniors. Using a normal recorded voice would make the interaction more compelling and easy to interact with. The professionals also mentioned that it is important to repeat the information often, the seniors might not understand it the first time or forget it otherwise. In addition to repeating the statements, it is also important that the system is loud enough so the seniors can understand it easily. Lastly the professionals stressed the importance of testing the system on the target audience, in both early and advanced stages. This will reduce the chance of making a system that does not work or does not solve one of the needs of a senior person. The seniors stated that the system should be clear and easy to understand, they also mentioned their concern about the technological challenges that the system might have. These statements confirm the importance

of a system that is easy to use by people with low technical proficiency.

6.2 System description

The goal of the system is that one person can organize activities for a large number of seniors by automating the time consuming tasks. He/she will then prepare some audio files explaining the activity. From here the automated system will take over, it will call everyone that is registered to ask if they would like to participate in this activity at a certain date and time. If required the system can call back the senior with additional information regarding the place, time, number of participants or a cancellation. The seniors will then go to the meeting place at the specified date and time to do their activity. This procedure can be scaled such that a large group of seniors can be invited for an activity without the need of additional work by the organisation.

6.2.1 Registration

Before the system can be used a senior should be registered. The registering process will be very concise, it will require a first name, last name, address and a telephone number as well as a consent to be called by the automated system. The seniors will be given a flyer with additional information, it will also contain a num-ber that people can call to change their preferences, this is also the number people can call when they no longer want to be called by the system. The main reason for this registration is to get consent from the seniors person to be called and that their message is recorded to improve the system.

6.2.2 Proposed systems

This thesis will propose 2 such systems that will have the same functionality but will gather the attendance in a different way. These 2 systems are introduced to evaluate the preferences of the seniors. The first proposed system will be based on voice recognition, the called person can talk into the phone and the system will perform speech recognition to provide the best possible response, which will be provided in the form of a pre-recorded message. Such a system is in literature defined as a interactive voice response system (IVR).

The second system is based on a dial menu, this system will require the called person to press 1, 2 or 3 on the dial pad on their phone. These dialed numbers will be used to gather the response of the senior, on which the system will provide

pre-recorded messages as a response. Such a system is defined in literature as a system based on Dial tone multi frequency (DTMF)

IVR based system

The IVR based system works by calling a senior via phone, after which an initial pre-recorded message is played. This might be ”Hello, this is the activity system”, after which a message is played detailing the activity. The message will end with a question like ”do you want to join the activity?” on which the senior person can respond by speaking to the phone in the way they would normally do. The system will then perform speech recognition and intent classification to evaluate if the user would like to join the activity. The details of the scripts are specified in the iteration sections since these change per iteration. The speech recognition of this system works by using the google speech API[48]. The speech is send in real-time to this API which transcribes the results and sends it back, this transcription is used as input for the intent classifier. The intent classification is based on a simple self-created library with words or sentence structures of which the intent is manually classified. This library contains words such as Yes, No but also I would like that or i cannot make it and is separated in a list for Yes and a list for No. This library will grow by manually reviewing footage of the actual use of the system. The intent classifier will match the transcribed result to the words or sentence structures in the library to find the correct intent. When no intent could be classified the system will ask the question again. Details about the specific implementation will be given in each iteration.

DTMF based system

The DTMF based activity system is very similar to the voice based activity system with a few changes. Instead of requiring people to speak to the phone it requires people to input a number on the phone. The questions will be asked with addition of a statement requiring the person to dial a number. This system does therefore not use voice recognition and is more robust by design, details about the specific implementation will be given in each iteration.

Chapter 7

First iteration

The goal of this initial test is to see whether both systems are usable at all and if there are any big problems that make the system non-functional. The target audience for this test is a convenience sample of all ages.

7.1 System description

The first iteration of tests aims to provide insights into the initial usability of the bare bone system. The system will call the mobile phone of the researcher and will provide the initial text, the participant will than be able to respond to the message after which an end message is provided. This system will consist of 2 different methods of providing answers, the first system will be IVR based; this means that the participant can talk back to the phone. There is voice recognition software implemented which can detect what the participant said, which is then analyzed with the intent classifier. The second system is DTMF based and requires the participant to press a dial on the phone to answer the question. The system shall then provide an end message that is consistent with the given answer or ask for clarification when the answer is unclear.

7.1 shows the flow of the system. The messages will be dependent on the type of system implemented.

7.1.1 Script

This section described what exactly is said by the system for each method. Note that the script is in dutch since this research is executed with dutch participants.

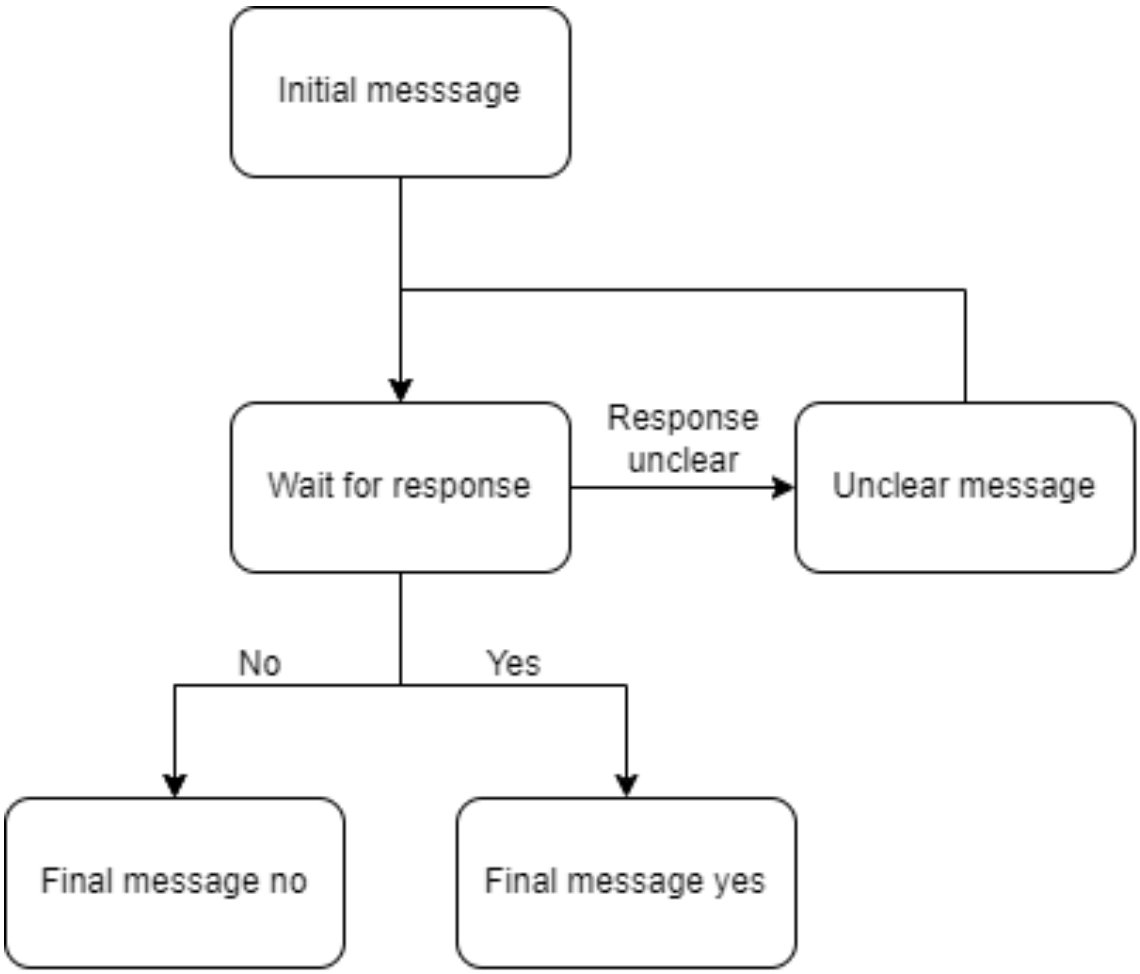

Figure 7.1: Iteration1 system description

IVR

- **Initial message**
  Dutch: Zou je vanavond mee willen doen aan de activiteit?

  English translation: Would you like to join the activity?

- **Unclear message:**
  Dutch: Zou je ja of nee kunnen zeggen?

  English translation: Could you please say yes or no?

- **Final message no:**
  Dutch: Ik heb je afgemeld, nog een fijne dag gewenst.

  English translation: I noted that you will not attend the activity, have a pleasant day.

- **Final message yes:**
  Dutch: Ik heb je aangemeld, tot straks

  English: I noted that you will attend the activity, see you tonight.

DTMF

- **Initial message:**
  Dutch: Zou je vanavond mee willen doen aan de activiteit? Toets 1 als je wel mee wilt doen, toets 2 als je niet mee wilt doen.

  English translation: Would you like to join the activity tonight? Dial 1 if you would like to join, dial 2 if you would not like to join.

- **Unclear message:**
  Dutch: Ik begrijp je niet zo goed. Toets 1 als je wel mee wilt doen, toets 2 als je niet mee wilt doen.

  English translation: I don't understand you, could you press 1 if you would like to join the activity, dial 2 if you would not like to join.

- **Final message no:**
  Dutch: Ik heb je afgemeld, nog een fijne dag gewenst.

  English translation: I noted that you will not attend the activity, have a pleasant day.

- **Final message yes:**
  Dutch: Ik heb je aangemeld, tot straks.

  English: I noted that you will attend the activity, see you tonight.

7.2 Method

The initial iteration is tested by conducting a practical test after which a semi-structured interview is conducted. The goal of the test is to evaluate whether a very basic form of the system has any potential or if it is very complex to work with the system, for this reason the usability is evaluated after a practical test. The 7 participants

are recruited from friends and family of the researcher. From the 7 participants, 2 were over the age of 70, 2 were in the age range between 50 to 70 and 3 were in their 20's. The researcher visited all of the participants in their home setting. The researcher explained that the goal of the system was to invite more seniors to activities. The session then continued with testing the prototype. This section started with the researcher explaining that the system works based on voice recognition so that they can talk to the phone. The researcher then started the system, after which the system called the phone of the researcher, this phone is then given to the participant after which no further instructions are given. The participant then listens to the audio message en can respond as they like. After the participant is done with the call the semi-structured interview begins. This interview is based on the following questions:

- What did you think of the system?
- How did you experience the usability of the system?
- What could be improved?

The researcher takes notes on interesting points. When the system is evaluated, the same procedure then followed for the DTMF based system. When the evaluation is done, the participant is thanked for their time after which the test is finished.

7.3 Result

After conducting the tests with the participants the results were positive, all 7 participants reported the system as easy to work with. It did however become clear that the time it takes the system to answer after a person is done with talking is very important. All 7 of the participants mentioned that this time was too long in the system, this caused the participants to repeat their answer. Two of the participants mentioned that when this time is shorter it would be more intuitive. All of the participants had a preference to a voice based system, even the participants of age 70+. Every participant that was under the age of 70 reported that they preferred the voice based system but that they thought seniors would prefer the dial based system. Another point that was common among participants was the need of repeatability, 5 out of 7 participants mentioned that it would be valuable if the system would repeat the answer that was given so that it could be confirmed. Another valuable feedback point is to use the formal ”U” instead of the informal ”je” in the recorded messages.

It is also valuable to note that the system was perceived as clear and easy to understand. It was not perceived as robot like, which was positively experienced the participants.

7.4 Improvements made

The improvements made at this stage can be summarized by:

- Fine tuned the time between when someone is done talking and when the next message is played.
- Changed all references that contain ”je” to ”U”.
- Added the functionality to repeat what the system has classified and ask if it is correct.

The choice between a voice based and dial based system is not yet made since their are not enough participants of the target group in this iteration.

7.5 Next steps

The initial test provided good feedback and promising results. The participants were able to work with the system and provide their answer, after some tweaking the system was reported clear and easy to work with. To extend on these results and create a practically usable system it is important to specify the setting in which the system will be used. The system is usable with minimal work and highly scalable, since only one audio file has to be rerecorded. When we introduce this system into the daily work processes of current organisations we will inherit the limitations that come with this structure. There is limited space in the places they organise activities and limited time and people to register new seniors to the system. It would be more interesting to create a system that could organize activities autonomously for a large group of seniors in the Netherlands, so that the current limitations in staff and space do not apply. When looking to semi-autonomously organize activities for a large group of the senior demographic it is important to have a location that is not dependant on the weather or long travel times. Since a large percentage of seniors live in apartment complexes this is a prime location to organize autonomous activities. The goal of the system will be to organize autonomous activities for all senior apartment complexes in the Netherlands. It should be noted that many apartment complexes do not have a common room, therefore the activities shall take place in the homes of the seniors in small groups. The system will automatically register who would like to attend the activity and will tell them where and at what time the activity will begin. The activity will not be guided and the seniors are responsible to organize the basic things necessary for the activity. When adapting this approach the activities that the seniors will be invited to should not depend on large rooms or many additional tools.

Activities like playing a game or drinking a cup of coffee are perfect for this structure. The next chapter will gave the details about how this system is implemented.

Chapter 8

Second iteration

8.1 Improved system description

The goal of the system is that one person can organize activities for a large number of apartment complexes by automating the time consuming tasks. The person can come up with an activity that can be done in all these apartment complexes (ie. a specific card game, walking, lunching, drinking a cup of coffee), he/she will then prepare some audio files explaining the activity. From here the automated system will take over, it will call everyone that is registered in a specific apartment complex to ask if they would like to participate with this activity at a certain date and time. The system then has a detailed list of people that would like to participate, if required the system will then call back with detailed information regarding the place, time, number of participants or cancellation if this is required. The seniors will then go to the meeting place at the specified date and time to do their activity. This activity will not be guided by anyone and it will therefore be the responsibility of the seniors themselves to conduct this activity. This procedure can be scaled over multiple apartment complexes to organize this same activity without any additional effort from the person organizing the activities.

8.1.1 Recruiting and registration

To recruit and register people in a specific apartment complex a flyer with a number they can call to register themselves can be an option. A more time consuming method will be to provide a flyer in every mailbox with an explanation of the system and a time when someone will come by the apartment complex to elaborate on the flyer. When enough people from an apartment complex are registered the system can be turned on for this apartment complex. The flyer will also contain a number that people can call to change their preferences, this is the number people can call

when they no longer want to be called by the system.

Before the system can be put to use at least 4 seniors need to be registered and all the audio fragments need to be pre-recorded. Also a list has to be made of all the elderly with their corresponding phone numbers.

8.2 Proposed systems

As described this thesis will propose 2 such systems that will have the same functionality but will gather the attendance in a different way as described in the previous system description.

8.2.1 IVR based activity collection system

The voice recognition based activity collection system has two parts. The first part of the system calls the seniors to see if they would like to join the activity. The second part of the system calls the seniors back to provide details on the activity (i.e. where to meet, what to bring, who is joining). These subsystems will be further elaborated in the following sections.

functional diagram initial activity registration system

The initial activity registration system is responsible for calling every person in an apartment complex and ask if they would like to join a certain activity. This system starts by calling a person and greeting them, it will then proceed with explaining an activity and ask if the person would like to attend. The speech recognition software is then started and transcribes the response of the called person. An intent classifier is then used on the transcribed response to determine if the person would like to join or not, for certainty sake it will then ask the person to confirm the classification. If the person says yes they will be thanked and a message is played to tell them they will be called back with the details. If the person says no, the system will change its answer and try again. See appendix D.1 for a detailed flow chart of the system. The actual text fragments that are used are detailed in 8.1, since the system is dutch in nature the text is also described in dutch and the English translation is given.

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. We gaan vanavond bridgen, heeft u zin om mee te doen?

  English translation: Hello, you are speaking with NAME of the activity organisation. We are going to play a card game tonight, would you like to join?

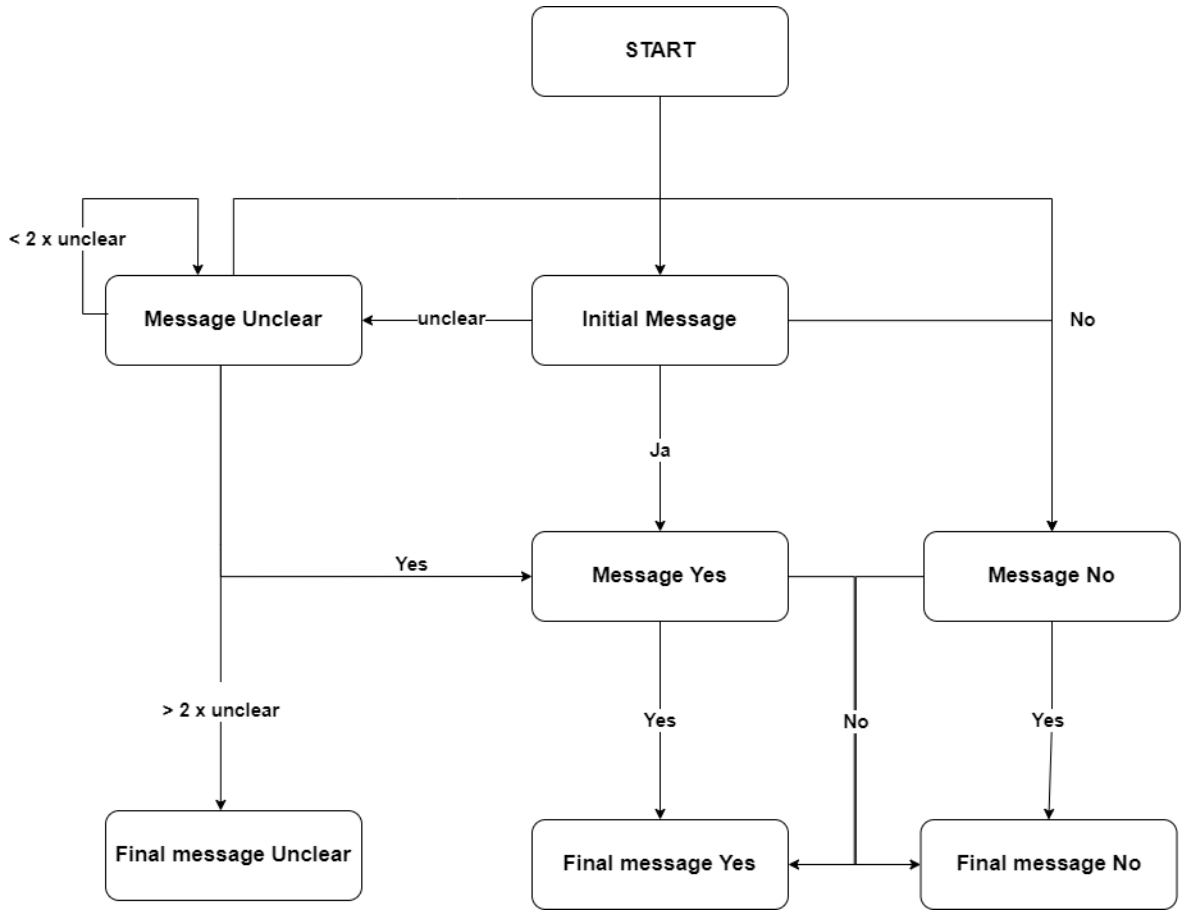

Figure 8.1: The used text for the IVR based system

- **Message Unclear:**
  Dutch: Ik begrijp u niet helemaal, zou je ja of nee kunnen zeggen?

  English translation: I don't completly understand you, could you please say yes or no?

- **Message Yes:**
  Dutch: Dank u wel, Ik heb begrepen dat u vanavond graag mee zou willen doen. Klopt dit?

  English translation: I noted that you will attend the activity tonight, is this correct?

- **Message No:**
  Dutch: Dank u wel, Ik heb begrepen dat u vanavond niet mee wilt doen. Klopt dit?

  English: I noted that you will not attend the activity tonight, is this correct?

- **Final message Unclear:**
  Dutch: Dank u wel, Ik begrijp u niet helemaal. Ik bel later terug om het nogmaals te proberen.

  English translation: I don't fully understand you, I will call back later to try again.

- **Final message Yes:**
  Dutch: Dank u wel, Ik heb u aangemeld. U wordt later terug gebeld met de details, tot straks!

  English: Thank you, I have signed you in for the activity. U will be called back later with the details, speak to you soon.

- **Final message No:**
  Dutch: Dank u wel, Ik heb u afgemeld. Nog een fijne dag gewenst.

  English translation: Thank you. I noted that you will not attend the activity, have a pleasant day.

functional diagram callback system

This part of the system is responsible for calling people back for details when they mentioned that they would like to visit the activity. It works similar as the initial system as it greets the person and then plays the message explaining the details of the activity. An example of such a message can be: You are playing cards tonight with gerda, hans and truus. You are expected at 7 o clock in apartment number 139b. This system will also ask if the person understood this and if they would like to hear it again. Figure D.2 Shows a detailed description of this system. 8.2 Gives an overview of the actual speech fragments used in the system.

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. U gaat vanavond bridgen met NAAM, NAAM en NAAM in appartement APPARTEMENT NUMMER. U word om 7 uur verwacht, heeft u dit begrepen?

  English translation: Hello, you are speaking with NAME of the activity organisation. You are going to play cards tonight with NAME, NAME and NAME in apartment APARTMENT NUMBER. U are expected at 7 o clock, is this clear?

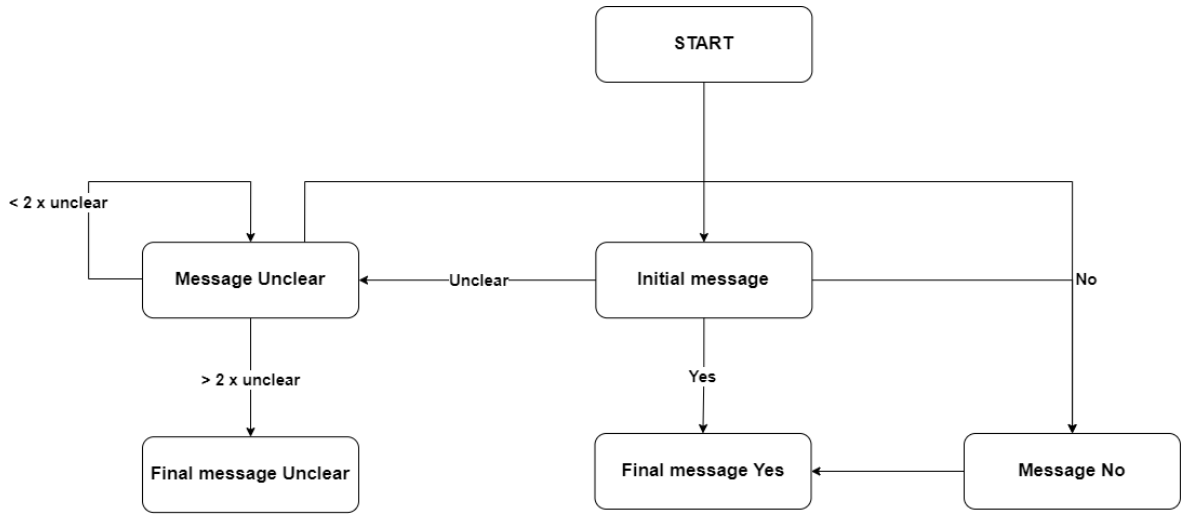

Figure 8.2: The used text for the IVR based callback system

- **Message Unclear:**
  Dutch: Ik begrijp u niet helemaal, zou je ja of nee kunnen zeggen?

  English translation: I don't completly understand you, could you please say yes or no?

- **Final message unclear:**
  Dutch: Dank u wel, Ik begrijp u niet helemaal. Ik bel later terug om het nogmaals te proberen.

  English translation: I don't fully understand you, I will call back later to try again.

- **Final message Yes:**
  Dutch: Dank u wel, veel plezier vanavond.

  English: Thank you, have fun tonight.

- **Message No:**
  Dutch: U word om 7 uur verwacht in apartment APPARTEMENT NUMMER.

  English translation: You are expected at 7 o clock in apartment APARTMENT NUMBER.

8.2.2 DTMF based activity collection system

The Dial based activity system is very similar to the voice based activity system with a few changes. Instead of requiring people to speak to the phone it requires people to input a number on the phone. The questions will be asked with addition of a statement requiring the person to dial a number. This system does therefore not use voice recognition and is therefore simpler by design. D.3 gives a detailed overview of the initial calling system based on dial input, D.4 gives a functional overview of the dial callback system. A description of the text used for the voice based system is detailed in 8.3 and 8.4.

IVR based callback system

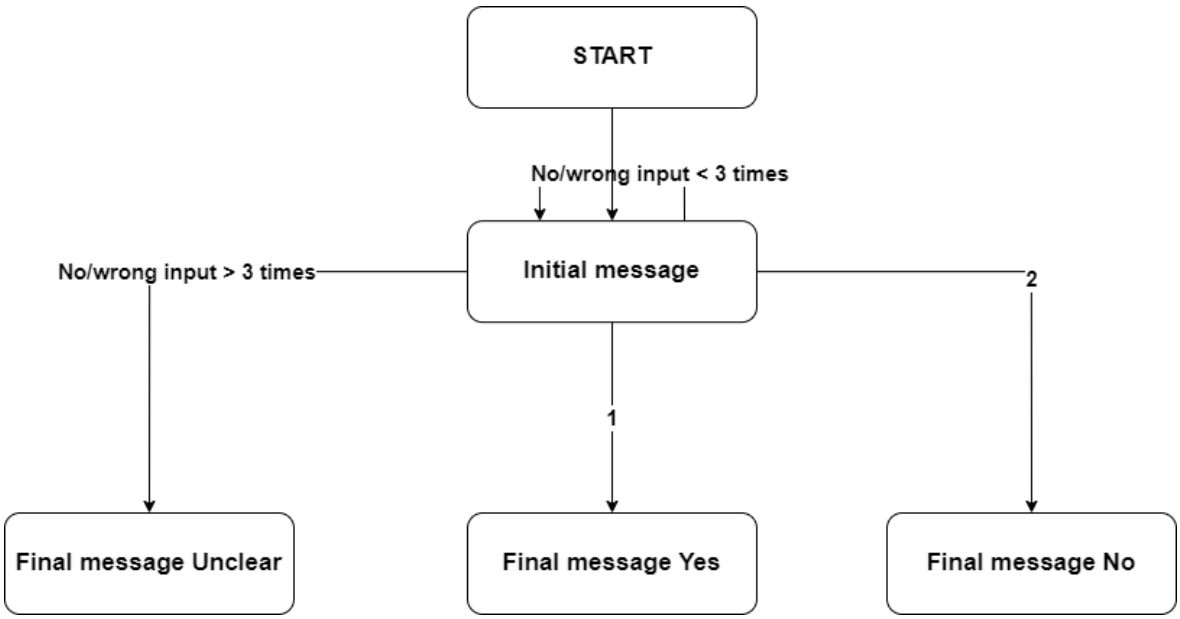

Figure 8.3: The used text for the DTMF based system

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. We gaan vanavond bridgen, toets 1 als u graag mee doet, toets 2 als u niet mee wilt doen.

  English translation: Hello, you are speaking with NAME of the activity organisation. We are going to play cards tonight press 1 if you would like to join, press 2 if you would not like to join.

- **Final message Unclear:**
  Dutch: Dank u wel, Ik begrijp u niet helemaal. Ik bel later terug om het nog-

maals te proberen.

English translation: I don't fully understand you, I will call back later to try again.

- **Final message Yes:**
  Dutch: Dank u wel, Ik heb u aangemeld. U wordt later terug gebeld met de details, tot straks!

  English: Thank you, I have signed you in for the activity. U will be called back later with the details, speak to you soon.

- **Final message No:**
  Dutch: Dank u wel, Ik heb u afgemeld. Nog een fijne dag gewenst.

  English translation: Thank you. I noted that you will not attend the activity, have a pleasant day.

DTMF based callback system

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. U gaat vanavond bridgen met NAAM, NAAM en NAAM in appartement APPARTEMENT NUMMER. U word om 7 uur verwacht, toets 1 als u dit begrepen heeft, toets 2 als we het nogmaals moeten herhalen.

  English translation: Hello, you are speaking with NAME of the activity organisation. You are going to play cards tonight with NAME, NAME and NAME in apartment APARTMENT NUMBER. U are expected at 7 o clock, press 1 if this is clear, press 2 if you would like to hear it again.

- **Final message:**
  Dutch: Dank u wel, veel plezier vanavond.

  English: Thank you, have fun tonight.

- **Message No:**
  Dutch: U word om 7 uur verwacht in appartement APARTEMENT NUMMER

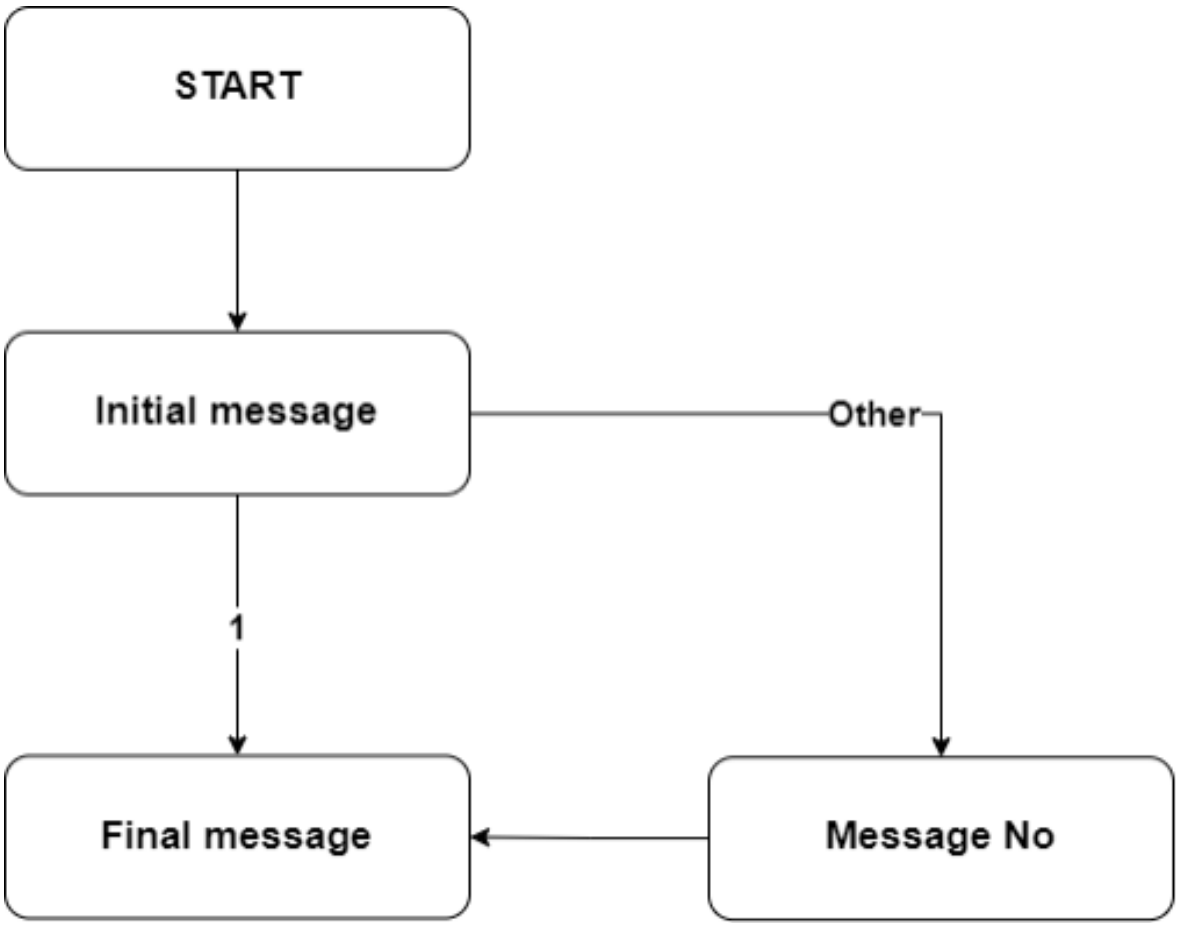

Figure 8.4: The used text for the DTMF based callback system (in dutch)

English translation: You are expected at 7 o clock in apartment APARTMENT NUMBER.

8.2.3 Future functionality

The current proposed system has some short comings that can be addressed in future versions that are not included in this work. The registration process can be more elaborate by asking about mobility issues and preferences for activities. It might also be a good idea to give a telephone number the senior can call when something goes wrong with passing their availability. This telephone number can also for seniors to pass preferences to the system (i.e. People they do not want to be paired up with).

8.2.4 Limitations

The activities however do have some requirements for the system to be scalable and efficient. The activities should not depend on a common room, since not all

apartment complexes will have one. It is also important that the activities do not require additional materials that are not commonly owned since no one will be able to provide these. Examples of activities that can be organized with this system are: A walk, Playing the card game bridge, watching a television program, drinking a cup of coffee, lunching together, going to the supermarket together, helping each other with chores that might be difficult, going to the park, organizing a picnic.

8.3 Methods

The main goal of this test is: to evaluate the usability of the system in it current form, to see the challenges that arise when trying to implement this system within the defined target group and to determine if seniors in apartment complexes actually would like to use such a system.

This system is tested by first conducting a semi-structured interview to determine the needs of the senior after which the prototype is tested and evaluated by another semi-structured interview. This session was conducted with a total of 5 seniors above the age of 70 that were living in different apartment complexes. The sessions took place at the home of the participant and are conducted in a 1 on 1 scenario. The session started with an introduction and some small talk, after which a semi-structured interview took place to determine the needs of the senior. This semi-structured interview was based on the following questions:

- How often do you have social activities in a week?
- Would you like more social activities?

The answers to these questions were followed through to get as much information as possible. After this the IVR and DTMF based system were both tested and evaluated in the same manner as the previous test, with the use of the same questions. For this test there are in total 5 participants which are all above the age of 70, 3 of which participated in an earlier test of this research. The other 2 participants are recruited via the previously contacted organisations.

To find out if unknown seniors from apartment complexes would be interested in automatic organisation of activities, the researcher tried to recruit multiple people from an unknown apartment complex by the use of flyers. In total 10 flyers were put in the mailboxes which stated a time and date on which the researcher would come by. See appendix E for the used flyer. This approach did not yield any participants, gathered insights in this will be elaborated in the results section.

8.4 Results

After conducting the tests some interesting points were found. The most noticeable point was that it was very challenging to explain the system to the participants. The technical system together with the somewhat complex structure of organizing activities without guidance was often not perceived clearly. After explaining the system the participants were noticeably confused, after some more explanation the system became more clear. 5 of the 5 participants stated that they would not use the system or that it would not work in their situation. 2 of the participants mentioned that people in their apartment complex were very busy and that they would not like to make time for such an activity. The other three people stated that the system could help someone but that it was not for them without any clear motivation. The participants did however state that the interaction with the phone system was clear and intuitive.

The other method of recruiting revolved around flyering in an apartment complex and visiting at a specified date and time that was stated on the flyer. Of the 10 persons that received the flyer 4 people opened their door after ringing, of these people none was interested in joining an activity in their apartment complex. The main reason was that ”they were too old for activities”, often due to physical impairments. An interesting point to note is that 3 of the 4 seniors did not read the flyer and that they already said no before the technological aspect even came up.

All the seniors in this test stated that they had a preference for the voice based system, together with the results of the previous test we have gathered enough results to determine the preference of the voice based system. Hence we will continue with the use of the voice based system over the dial based system.

Some of the seniors mentioned that the text of the callback system was quite short and that they would prefer longer messages.

Expert analysis

Since the results of this test showed that none of the seniors was interested in using the system themselves, an expert on loneliness in seniors is contacted to discuss the and try to explain these results. The main goal being to find out why this system did not work and find a use case in which the system would be of more value.

The expert stated that this result is expected, he mentioned that loneliness is a complex topic. When people are alone for a long period of time just inviting them to activities is not enough anymore, the step to start going to activities has become too big. This can be due to the gradual loss of physical capabilities or the trust in their body, but also due to not being used to going to these social events. It can be quite nerve wracking to go to a new event where you don’t know anyone. He mentioned that this is something often seen in practise and that extensive human

contact with a professional or volunteer is necessary to make sure that these people join social activities again. He stated that this part of loneliness alleviation can not be automated and that the added value of this system might be more in the stage when people are already going to social activities. The system can be used to invite people for activities from organisations such that people attend more activities and feel more included in the organisations.

8.5 Next steps

After talking with this expert multiple organisations are contacted to discuss if this would be something that could benefit seniors in their region. From the four contacted organisations all of them replied positively and interviews were conducted to determine the specific use cases. Two of the contacted organisations were overarching organisations focused on the suppression of loneliness, they stated that the most promising area to start would be organisations that focus directly on organisation activities for seniors like neighborhood homes. 2 Neighborhood homes were contacted to verify these statements, they mentioned that they had no way to actively invite the seniors to activities since they were not reachable by technological means and going door to door was too time intensive. They stated that they would see great benefit in a system that could invite seniors for activities by phone and that they would be interested in trying this system. The system will be adapted to fit the use case of inviting seniors to activities to neighborhood homes to see if the system can be of added value in this use case. Since some seniors mentioned that they would prefer longer messages this will be included in the next iteration of the system. It is interesting to note that the organisations also saw additional benefit in using the system to remind people of social events for which they had signed up. In practise it often happens that seniors forget the social event they signed up for, they mentioned this system could call them before the activity begins to remind them of it. Since this solution does not revolve around reducing loneliness, this will not be tested.

Chapter 9

Third iteration

9.1 Improved system description

The current system focuses on inviting seniors to activities in neighborhood homes. The current method of inviting seniors is by using flyers, these provide a fixed agenda of activities for the next 3 to 6 months. The downside of this method is a lack of flexibility, a lack of feedback of the seniors and a lack of interaction with the seniors.

The system will be put to use whenever the neighborhood home feels that it is time for another invitation, they will then record audio messages with the details of the activity. After which they system can be put to use to automatically call all seniors on a list. For this test the functionality to call all seniors is not yet implemented and it works one call at a time. The system will be exclusively voice based since this was the preference of a majority of the seniors in previous tests. Instead of two separate phone calls like in the previous system, this will be a single phone call since there will be no need for a callback system because no additional information has to be provided. The actual flow and text of the system is detailed in 8.1.

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. We gaan vanavond kaarten in het buurtcentrum Rozewijde, we zullen zorgen voor een koekje en een kopje koffie of thee. Om 7 uur zullen we beginnen en om 9 uur zal het afgelopen zijn. Het lijkt ons leuk als u er ook bent, heeft u zin om mee te doen?

  English translation: Hello, you are speaking with NAME of the activity organisation. We are going to play a card game tonight in neighborhood home Rozewijde, we shall provide a cookie and a cup of coffee or thee. It shall start at 7 o clock and shall end at 9 o clock. We would really like to see you there tonight,

would you like to join?

- **Message Unclear:**
  Dutch: Ik begrijp u niet helemaal, zou je ja of nee kunnen zeggen?

  English translation: I don't completly understand you, could you please say yes or no?

- **Message Yes:**
  Dutch: Dank u wel, Ik heb begrepen dat u vanavond graag mee zou willen doen. Klopt dit?

  English translation: I noted that you will attend the activity tonight, is this correct?

- **Message No:**
  Dutch: Dank u wel, Ik heb begrepen dat u vanavond niet mee wilt doen. Klopt dit?

  English: I noted that you will not attend the activity tonight, is this correct?

- **Final message Unclear:**
  Dutch: Dank u wel, Ik begrijp u niet helemaal. Ik bel later terug om het nogmaals te proberen

  English translation: I don't fully understand you, I will call back later to try again.

- **Final message Yes:**
  Dutch: Dank u wel, Ik heb u aangemeld. We zien u graag om 7 uur bij buurtcentrum Rozewijde, tot straks!

  English: Thank you, I have signed you in for the activity. We will see you at 7 o clock at neighborhood home Rozewijde, see you then.

- **Final message No:**
  Dutch: Dank u wel, Ik heb u afgemeld. Nog een fijne dag gewenst.

  English translation: Thank you. I noted that you will not attend the activity, have a pleasant day.

9.2 Methods

This iteration is tested by conducting an interview along with a practical test of the system, similar to the previous tests. The test is conducted on 2 seniors that frequent neighborhood homes, the professionals of the neighborhood home and a professional of an over aching organisations against loneliness. The goal of this test is to catch final problems or inaccuracies before the final test. The seniors are recruited via the use of the contacted neighborhood homes, the professional of the over-arching organisation has already participated at an earlier test.

9.3 Results

The professionals of the neighborhood homes were really positive about the system, they mentioned they saw a lot of potential and they would like to test it further. The professional from the other organisation mentioned that the initial text was way too long. This was supported by the experiences of the seniors, they had trouble following the initial message. Some seniors stated that the speed of speaking should be slower or the message should be shorter and more concise. Apart from this one senior stated that she would be interested in using the system, the other stated that she would not be interested in using the system. From this we cannot draw any additional conclusions. The seniors and professional stated stat it would be beneficial to show how the system works by a practical example. In this way they know what they can expect and can get used to the interaction with the system.

9.4 Next steps

For the next part of the system the initial text is shortened to make sure it is easy to understand for seniors, no other adjustments are made to the system. After the processing of the previous feedback the system is ready for its final evaluation which will be described in the next chapter.

Chapter 10

Final Iteration

10.1 System description

The system used for this final iteration is very similar to the system used in the previous iteration. It focuses on inviting seniors to activities in neighborhood homes by the use of automatic calling. The professional at the neighborhood home will record a message to give details about the activity that they are organizing, after which the system can be put to use. It will call all seniors that are registered to ask if they would like to join the activity, if the senior would like to participate they are signed up for the activity. The system works based on speech recognition and intent classification to determine if the response of the senior states that they would like to participate or not. 8.1 gives a complete overview of the flow of the system, as well as all messages that are played and the text that is used for these messages.

- **Initial message:**
  Dutch: Hallo, u spreekt met NAAM van de activiteitenorganisatie. Er is vanavond om 7 uur een kaartavond in buurthuis maasplein, lijkt het u leuk om mee te doen?

  English translation: Hello, you are speaking with NAME of the activity organisation. We are going to play a card game tonight in neighborhood home Maasplein at 7 o clock. Would you like to join?

- **Message Unclear:**
  Dutch: Ik begrijp u niet helemaal, zou je ja of nee kunnen zeggen?

  English translation: I don't completly understand you, could you please say yes or no?

- **Message Yes:**

Dutch: Dank u wel, Ik heb begrepen dat u vanavond graag mee zou willen doen. Klopt dit?

English translation: I noted that you will attend the activity tonight, is this correct?

- **Message No:**
  Dutch: Dank u wel, Ik heb begrepen dat u vanavond niet mee wilt doen. Klopt dit?

  English: I noted that you will not attend the activity tonight, is this correct?

- **Final message Unclear:**
  Dutch: Dank u wel, Ik begrijp u niet helemaal. Ik bel later terug om het nogmaals te proberen.

  English translation: I don't fully understand you, I will call back later to try again.

- **Final message Yes:**
  Dutch: Dank u wel, Ik heb u aangemeld. We zien u graag om 7 uur bij buurtcentrum Maasplein, tot straks!

  English: Thank you, I have signed you in for the activity. We will see you at 7 o clock at neighborhood home Maasplein, see you then.

- **Final message No:**
  Dutch: Dank u wel, Ik heb u afgemeld. Nog een fijne dag gewenst.

  English translation: Thank you. I noted that you will not attend the activity, have a pleasant day.

10.2 Method

The goal of the final test is to evaluate the currently developed system on usability and to determine if participants are interested in using this system.

For this final test all participants are recruited directly from neighborhood homes. The researcher made arrangements with the management of two neighborhood homes so the participants could be recruited there. The researcher visited multi-ple days at each of these neighborhood homes, on these days multiple activities

took place for which seniors came to the neighborhood home. Before and after these activities the researcher asked some seniors to help them with a research for the university. After which some explanation was given and they were asked if they would like to participate in the research, after which they were asked to sign an informed consent form. After this a semi structured interview was conducted about the current social needs of the senior. The questions of the interview are specified in the next sub chapter .The research proceeded by explaining what system was developed and what the goal of the system was. The researcher then demonstrated the system such that the seniors knew what to expect and how to interact with the system. After the demonstration the seniors themselves tried the system, after which the interviewer conducted a free form interview to gather all possible information of the usability and experience of the system.

The test had a total of 6 participants, all of these were above the age of 70 and frequented the neighborhood home. There was an even distribution between males and females in this test. The tests took place in a common room of the neighborhood with some distraction noises from time to time, all participants are interviewed separately.

10.2.1 Interview questions

This section will describe the interview questions that are asked before and after testing the system. The main goal of these interview questions is to get an insight in the living situation of a senior and about additional factors that might have an effect on their interest in the system.

Initial Interview

These questions are asked at the start of the research, the questions are translated to English but the test was conducted in dutch.

- What is your age?
- With how many people do you live and what is your relation
- to these people?
- In what type of living accommodation do you reside?
- Do you have issues with limited mobility?
- Would you like more social activities?
- Would you like to be invited to more social activities?

- Would you like to keep using this system to be invited to more activities?
- Do you have any additional remarks?

Interview after testing

After testing the system a conversation took place to discuss the usability and experience with the system. This conversation had a free form to get all the information that a senior would like to share about the system. The conversation ended with the question ”Would you like to keep using this system to be invited to more activities?”.

10.3 Results

This chapter gives the results of the final test, the results are summarized in 10.1. The respondents were all above the age of 70 and living alone in a house or apartment. Two of the participants had issues with mobility, while the other four did not experience any difficulties. There was a equal differentiation between seniors that would like more social activities and seniors that would not like more social activities. All participants found the system easy to use and clear in the communication and were successful in passing their preference to the system. The system classified the responses of the seniors correctly in all instances.

from the three participants who would like more social activities all of them mentioned that they would be interested to use the system in their daily life. Two of the participants had mobility issues and both of these mentioned that they would like to use the system but that they would be in need of transportation. They mentioned that this could be an additional question to add to the system. The professionals of the neighborhood homes mentioned that it might be possible to pick up these elderly with a car.

Another factor to keep into account is that a bias is created by the method of recruitment. Not all seniors that were asked to cooperate were interested in participating in the study. This was especially prevalent in people that visited with their partner, from the 8 people that came in with their spouse none participated in the study, often mentioning that they often did social activities together and that they had no interest in going to more social activities.

The two neighborhood homes reported that they would like to keep working with the system. The first organisation mentioned that a personal aspect is important in systems and that they believe this solution can offer such a personal aspect. The second neighborhood home mentioned that they are very enthusiastic about the product. They mention that seniors are hard to reach and that this product is a good way to invite them for activities. Furthermore they mention that the system is very

promising for people that have issues with remembering activities and that it could be very useful to help this target group.

	Participant numbers					
	1	2	3	4	5	6
What is your age?	89	84	92	75	83	78
With how many people do you live?	Alone	Alone	Alone	Alone	Alone	Alone
In what type of living accommodation do you reside?	Apartment	Apartment	Apartment	Apartment	House	Apartment
Do you have issues with limited mobility?	No	No	Yes	No	Yes	No
Would you like more social activities?	No	No	Yes	No	Yes	Yes
Would you like to be invited to more social activities?	No	No	Yes	No	Yes	Yes
Would you like to keep using this system?	No	No	Yes	Yes	Yes	Yes
Would you like transportation to be included?	No	No	Yes	No	Yes	No

Table 10.1: Results for all participants of the final test

Chapter 11

Discussion

This chapter aims to discus the gathered results and conducted research.

First of all it should be explicitly stated that the research is of an exploratory nature. The thesis found design opportunities and discussed and developed a possible solution to invite seniors to more activities. The research did however not provide any conclusive results of the performance of the system when actually implemented. It conducted tests with a very small sample size and therefor the conclusions drawn from these tests cannot be assumed to be representative of the target demographic. The final test was conducted with only 6 participants in a very controlled setting, no proof is given for the usability of this system when seniors are called unexpectedly when they are home. Furthermore there is a large selection bias in test subjects, this bias is created by the method of recruiting. The research had a lack of people that are actually really lonely at the moment and are not yet ready to visit social activities, this is due to the lack of expertise of the researcher with this target demographic and the difficulties faced when recruiting seniors. This thesis only proceeded with the path of familiar technologies to find a solution for the posed problems, while there might be many other approaches and solutions to tackle this problem.

It should be noted that all of the professionals that were consulted in this research found the proposed problem very interesting and stated that they saw great potential. Even professionals that had a sceptical attitude found the system interesting and many of the organisations are still very interested in the further development of the system. One of the main factors of importance for this system is the low cost of setup and operation, this is a crucial factor in this sector which is confirmed by the consulted professionals.

11.1 Challenges in conducting tests with seniors

During this test a lot of challenges with conducting tests with seniors were encountered, for this reason the number participation in this final test is small. The first challenge when conducting research with seniors is reaching them. Seniors are not active on the internet and spend a lot of time indoors, which is a similar problem that neighborhood homes face. When you just show up unannounced you have the risk of triggering a fear response in a senior, since they are not used to people coming by unannounced. Therefore the best way to come into contact with seniors is by the use of organisations. But getting into contact with these organisations and convincing them to cooperate with your research is time consuming.

When you convinced organisations to participate with the research, the next task is to find participants. Due to the protective nature of these organisations this can be really challenging and extremely time consuming, you are also very dependent on the current situation in these organisations, what activities they are organizing and how well your system fits their current needs. Therefore taking things into your own hands by spending extended amounts of time at activities and talking to seniors is the most effective approach.

When you have access to the target audience the other issue arises which is rooted deep in their demographic. Many seniors in this demographic are effected by fear and caution because this group is a target for scammers and burglars. When you visit this group you hear many stories about burglaries and scams and how people were effected by it. This is something you also see when asking people to join a research, they ask a lot of questions before eventually making the choice on whether to cooperate. This especially becomes an issue when the seniors are asked to sign an informed consent form. Multiple seniors refused to sign these because they were afraid of signing something, no matter the content. Even asking their name often resulted in a restive attitude, with often seniors deciding not to give a name. This is something that makes the research significantly harder to conduct with large groups, especially without creating a bias.

11.2 Recommendations

This research provides a design opportunity and suggests a system which fits within this design opportunity. The initial results of the system show great potential to reduce the complexities in inviting seniors as well as a response from multiple seniors that would actually like to use the system in practise.

The presented system offers opportunities for additional research. The system needs to be tested over a longer period of time with multiple seniors to invite them

to multiple activities. In this way more insight can be gathered in the actual practical usability for the seniors and to evaluate if the system is actually used over longer periods of time.

When further developing the system the focus should be on reducing the cost per phone call, as it is quite high in the current system. This can be done by creating specialized hardware that can interact directly via a sim card with a large amount of phone calls available, or creating a version that can be used on the phone and utilize a sim card that is present in the phone. Another important factor for developing the system to be scalable is the setup of the server side, this has to be very secure and scalable. A scalable database infrastructure based on dedicated servers can be used for this, or another option is to create the system in such a manner that it can be run locally at neighborhood homes. This might result in some problems with the network, since a lot of voice data is send so this should be accounted for. Research into a scalable recruitment method for seniors can also be extremely valuable.

The system can also be improved and reevaluated by adding the preferences of seniors into the system, like mobility and their preference of activities.

Chapter 12

Conclusion

Within this thesis we conducted research to create a scalable IVR system to reduce social and emotional loneliness in seniors. For this purpose more then 10 professionals and over 20 seniors are interviewed to find their needs and to evaluate the proposed solutions.

RQ1: How can we design a scalable interactive voice response (IVR) system to reduce social and emotional loneliness in seniors?

This thesis presents the design of a scalable IVR system to reduce social and emotional loneliness. This is achieved through evaluating current challenges in alleviating loneliness with professionals and seniors and using this information to find design opportunities for this field. After which a design phase is conducted to propose solutions that contribute to the current challenges faced by the professionals and seniors. Within this thesis the lack of interactive invitations for seniors is chosen as the focus area. After developing an idea based on automatic calling by phone, the target audience is involved intensively during the development of this solution. Each iteration is tested with seniors and if necessary professionals were included. The end result is an automatic system for inviting seniors for activities that shows potential to contribute to the problem of loneliness in seniors.

The results of this thesis should be considered as exploratory only, the limited number of people that partook in the final test and the lack of actual implementation in a home setting means we cannot state if this system is as scalable as proposed and if it significantly reduces social and emotional loneliness. We can however con-clude that the results gathered from this thesis provide a system that shows potential and which can be the focus of additional research.

The answer to this question comes forth from answering the sub-questions stated in this thesis.

SQ1.1: What are the design requirements of such a system?

As stated in 4.4 an IVR based system is the most beneficial in assisting current organisations with the loneliness alleviation process. The system would provide no benefit to someone that has severe loneliness and is not yet ready to act upon this by visiting more social interactions. The system is beneficial for seniors that would like more social activities and is ready to go to these activities independently. When this is not yet the case, professionals are needed to create this awareness and help them be involved in social activities. Furthermore the system should take into account the limitations that developing a system for seniors brings along. The first limitation is the under staffing in the organisations that aim to help lonely seniors. The organisations are dependent on subsidies and are not able to hire enough people to help all seniors, the second limitation is the lack of technical knowledge from the seniors. Products that require more then very basic interfacing or technical knowledge are not usable by a large group of seniors. Note that when creating a product that is too complex it triggers a bias from many seniors which result in a resistive response. The third limitation is cost, there is limited money available from the government to fund solutions. Therefore the costs have to be as low as possible to facilitate easy implementation and large scaliblity. Furthermore focus should be placed on privacy, intrusiveness and safety.

SQ1.2: How is such a system received with the stakeholders?

The system is presented to over 10 professionals and over 20 seniors over the course of the thesis in various stages of the research. All of the professionals that are interviewed viewed the system as having potential. The professionals in the early stage stress the importance of making the system easily usable by seniors and to confirm this by extensive testing. In initial tests they mentioned that it would be very hard to make the system intuitive and easy to work with. At the end of the thesis the majority of the professionals feel that the system could provide a lot of value to seniors and organisations. Some of the organisations mentioned that the system would also be really help full to put to use to remind seniors of activities the day before the activity, especially for seniors that might develop some dementia. The organisations that saw potential in the system include over-arching loneliness prevention organisations, organisations that organise activities in a region, neighborhood homes and professionals in provide daycare to seniors.

To evaluate and design the system over 20 seniors are consulted during the course of this thesis. In initial stages some of the seniors stressed the importance of being invited to activities and how the right approach could make a difference. There was a distinction between seniors that did not have a need for more social activities

and the seniors that did have this need. The second group saw more potential in the system then the first group. This distinction persisted through the development of the product, hence the system is better suited to the needs of seniors with a desire to have more social interaction. The developed system is experienced as clear and easy to interact with and all seniors with a wish for more social contact mentioned to be willing to use the system in daily life. Although a majority of seniors mentioned that the system should only invite them to activities that they find interesting, so it should be able to save their preference. The seniors that had reduced mobility mentioned that the system should include a question that provides transport to the activity.

All the neighborhood homes consulted in this thesis are positive about the product and would like be included in the development process.

SQ1.3: Which challenges arise when deploying such a system?

Deploying a technical system based on reduction of loneliness comes with implementation challenges, the first challenge being reaching seniors. When aiming to reach seniors in the currently utilized way of providing flyers, the responses are very limited. This might be due to this being the target demographic for scams, hence they are very suspicious to initiatives that they do not know. Another problem with deploying such a system is that addressing loneliness requires personal attention from a professional, therefore such a system can only be used in later stages of loneliness alleviation. The understaffing is also a problem when aiming to deploy a technical system, as one is dependant on organisations to reach seniors but these organisations are often overworked. Therefore they do not always have the time to introduce the system to new seniors. Since the goal is to create a system for seniors, special care has to be taken in providing a solution that fits the need of that senior. This would include inviting them only to activities they might enjoy, keeping mobility in mind or not inviting people to activities that they cannot participate in due to mental and physical impairments. Apart from this concerns about privacy and security might be a problem when deploying such a system.

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Appendix A

description of social robots

Robot name	Main Focus	Type	Material	Target	Emotions?	Responds to:	Connectivity	Behaviour
Aibo [8]	E	Aml (dog)	P	A	☺	T, So, Si, Sp	W, B	Sp, So, Mo
CareBot	H	Rbt	P	All	☻	Si, Sp	W	L, Sp, Mo
CompanionAble [13]	C	Rbt	P	E	☺	T, Sp, Si	I	L, Mo, Sp
FurReal Cat	E	Aml (cat)	F	C	☺	T	/	So, Mo
Hasbro I-Cat	E	Dvt (cat)	P	A	☺	T, So	/	L, Mo, So
Heart Robot	C	Hmd	C	All	☺	T	/	L, Mo
Homie [14]	C	Aml (dog)	F	E	☺	Sp, T	B, S	L, Sp, So
Hopis [13]	H	Aml (dog)	C	All	☻	/	W	Sp
Huggable [15]	C	Aml (bear)	F	C	☺	T, So, Si	I	Sp
iCat [8]	C	Aml (cat)	P	All	☺	T, Sp	U	L, Sp, Mo
KASPAR [16]	H	Hmd	R	D, C	☺	T, So, Si Mo, Sp	U	Mo
Keepon	H	Dvt (snowman)	R	C	☺	So, Si	/	Mo
Mood Lamp	E	Dvt (mushroom)	P	C	☺	To, So	B	L, So
Nabaztag	T	Dvt (rabbit)	P	A	☺	Sp	I, R	L, Sp, Mo, So
NeCoRo [17]	C	Aml (cat)	F	All	☺	T, So, Si	/	So, L
Nursebot [13]	H	Rbt	P	E	☺	To, Sp, Si	I	L, Mo, Sp
Paro [18, 19]	C	Aml (seal)	F	All	☺	T, So, Si, Sp	/	So, Mo
PC Mascot	T	Dvt (parrot)	P	A	☻	/	U	L, Sp, Mo
Pleo	C	Aml (dinosaur)	R	All	☺	T, So, Si		So, Mo
Probo [20]	C	Aml (elephant)	C	C	☺	T, So, Si, Sp	/	L, Mo, Sp
Robosapien	E	Hmd	P	C	☻	T	Ir	Sp
Teddy Phone	T	Dvt (bear)	F	A	☻	So	T	So, Mo
USB Robot Owl	E	Dvt (owl)	P	A	☻	/	U	Mo
Wakamaru-bot [13]	C	Hmd	P	E, D	☺	Si, Sp	I	Sp
Yorisoi Ifbot	C	Hmd	P	E	☺	Sp	I	L, Sp, Mo

Figure A.1: List of social robots [49]

KEY	
Main Focus	H: healthcare, C: companion, E: entertainment, T: communication
Type	Aml: animal, Hmd: humanoid, Rbt: robot, Dvt: device-type
Material	C: cloth, P: plastic, F: fur, R: rubber
Target	All: all ages, E: elderly, D: disabled, A: adults, C: children
Expresses emotion?	☺: yes, ☻: no
Responds to / Behaviour	Sp: speech, T: touch, L: light, Si: sight, So: sound, Mo: movement
Connectivity	W: WiFi, I: Internet, R: RFID, B: Bluetooth, Ir: Infrared, U: USB, T: phone line, S: SMS

URL: CareBot (www.geckosystems.com), CompanionAble (www.companionable.net), Hasbro FurReal Cat, Hasbro Mood Lamp, and Hasbro I-Cat (www.hasbro.com), Heart Robot (www.heartrobot.org.uk), Huggable (robotic.media.mit.edu/index.html), KASPAR (kaspar.feis.herts.ac.uk), Keepon (beatbots.net), Nabaztag (www.nabaztag.com), PC Mascot (www.parrotchronicles.com/reviews/pcmascot/pcmascot.htm), Pleo (www.pleoworld.com), Robosapien (www.wowwee.com), Teddy Phone (no longer available), USB robot owl (www.thinkgeek.com), Yorisoi Ifbot (www.techdigest.tv/2009/01/ces_2009_yoriso.html)

Figure A.2: Legend of list of social robots [49]

Appendix B

Elaborate Design Implications

Design Implication 1: Avoid traditional computing aesthetics (screens, keyboards, grey, black, and office plastic) and conventions. Design appliances, not computer interfaces. Support compelling concepts and metaphors from real life, such as a "wave."

Design Implication 2: Support expressions of personhood through alternate interaction techniques and tangible interfaces based on real-world objects and practices. Specifically, natural objects may be a good source of design inspiration, given that seniors relate well to animals and plants, and use tangible objects on their persons as emotional supports — letters, pictures, cards, small stuffed animals.

Design Implication 3: Leverage pictures of family to engage seniors. We have seen this idea in many of the studies and locations summarized above. For the resigned group in particular, light forms of short social engagement, akin to a wave or a smile across the street, may be beneficial as a first step to relieving a sense of resignation and a possible state of social isolation. For all groups, the family and caregivers play an important role in the adoption of technology. Additionally, it is important to respect existing patterns of communication, e.g., telephones, cell phones, and social media. These insights support the next two design implications: Design Implication 4: Do not disrupt social ties with existing family or new friends; leverage emergent social activity in place e.g. sharing stories between seniors as well as remote connections with family and friends. Design Implication 5: Respect existing uses of devices such as smartphones and patterns of family communication, e.g., email and social media. Our studies support the appropriateness of asynchronous communication in particular to allow seniors and families to manage interaction patterns, to deal with seniors' concerns, and to respect the unpredictability of availability for conversation. Yet, we respect work such as Cao (9), which asserts that families trying to bridge time zone differences value synchronous communication the most, and manage to achieve this by adopting routines for ensuring availability.

Design Implication 6: Support and emphasize asynchronous but also provide

opportunities for synchronous communication. Our various studies also suggest other attributes of ideal communication appliances.

Design Implication 7: Provide multiple possibilities for communication including video, photos, and audio, but do not require seniors to type.

Design Implication 8: Use tactile interaction that accounts for such issues as arthritis or tremor. Perhaps because our studies were done in Toronto, but we suspect more generally applicable, we encountered many language challenges due to a diverse urban population.30

Design Implication 9: Be non-language specific. Make use of icons as much as possible. Finally, we saw in several settings the need to design systems and infrastructure as well as appliances, and to realize that appliances in seniors' residences and care centers may need to be shared

Design Implication 10: Design with a realistic understanding of the availability of technology infrastructure, maintenance, and assistance, which is likely to be low in nursing homes. Design Implication 11: Support an institutional context with sufficient administration and privacy settings. Especially where rooms are shared or use of a device/appliance needs to be facilitated by the staff. [39]

Appendix C

Additional background information on technology for elderly

C.1 Non-social technology

Activity monitoring

One of the most prominent research fields for elderly is activity monitoring. The goal is to use sensors to detect specific activities that an elderly person is doing with the main goal of detecting when someone might need help. These systems come in many forms, almost all of these systems use a sensor network in the house of the elderly and try to classify their activity using a machine learning model [50] [51] [52]. Some systems also focus on providing the collected data to caregivers or family members in a use full format like fall alarms or alarms or mentioning when someone has not eaten for a while[53]. When using these systems an elderly can live longer safely at home, it also helps combatting the worries that family members might have of the risks that living alone at an old age bring along[51].

Some systems only use a more basic approach like sending a message with a video of a person when that person leaves a zone in their house[38]. Or the usage of pressure panels on the floor to just detect where someone is in their house to see if they spend an unusualy long amount of time in this place[38].

C.1.1 Health monitoring

Another common category of technologies for elderly revolve around health monitoring. These technologies make sure that the elderly person is not in distress and monitors or prevent health issues. Fall detectors are commonly used to notify relatives or staff when a person has fallen down, this is done by sensors in a watch that an elderly person wears. Another type of watch that is commonly used has

a big SOS button that the elderly person can press when they need help. Other technologies include hip protectors, automatic dawn/dusk lights, electronic calendars, speaking clocks, fire/smoke alarms, automatic medicine dispensers[54] and plinth lights for guiding someone to the toilet at night[38]. There also is some smart incontinence material with moist sensors.[42]

Happybot Felix is a small robot in the form of a light. Felix is a happiness measurer where you can manually set your mood by spinning it. The light inside Felix will then turn to the color that matches this mood and sends this data to an online diary in which you and your caretaker can see how you felt the past time. [42]

Figure C.1: Happybot Felix [42]

C.1.2 Entertainment

Entertainment devices for elderly are widely populair and are in continuous development. Some of these inventions use virtual reality to bring someone to an new or recognisable environment[38]. The Qwiek.up projects images on the wall or ceiling accopanied with sound with the goal to entertain [38]. iQare focusses more on entertainment by tablet, giving the elderly a tablet with which they can read newspapers, listen to music, do games or search for information about their disease.

Actiz made a place where people experience the forest by hearing whistling birds and moving paintings[38]. They also made an experiencechamber that shows the favorite music, colors and pictures of someone when they walk in. It also shows pictures of their children and changes the color of the lights.

C.1.3 GPS

GPS technology is used in 59% of the nursing homes in the Netherlands [44]. This technology is used to locate people within a builidng or on the street. People with dementia have the tendency to start wandering around and when they go outside

they often get lost. GPS gives a caretaker the possibility to go and pick them up without heaving to search for a long time.

GPS is also often used within a nursing home to make sure that people cannot acces areas they are not allowed to. This is done by connecting the GPS device with the doors in the building which close when someone without acces comes close. This is an important way of reducing the possibility that people who wander go outside.[38]

Appendix D

System description Iteration 2

See figure D.1 for a detailed description.

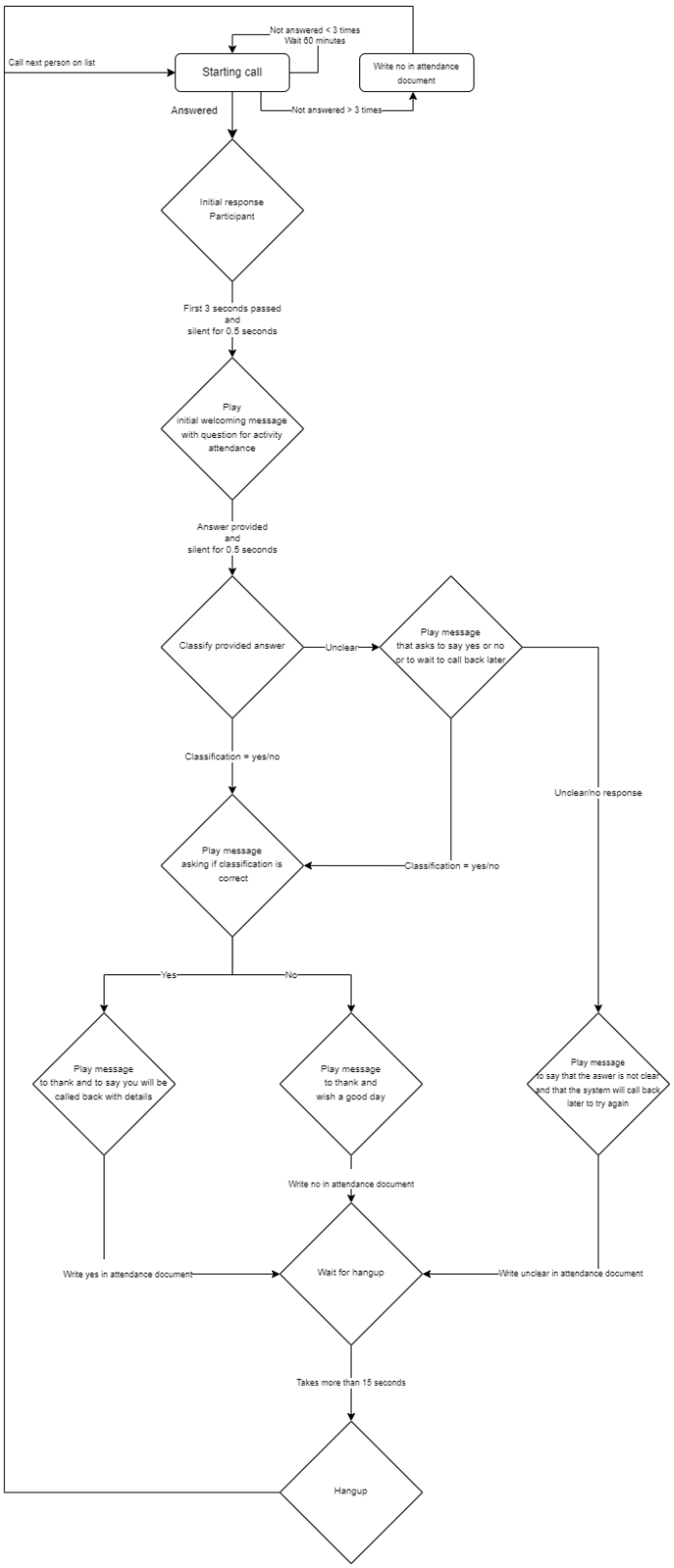

Figure D.1: functional diagram initial voice based activity registration system

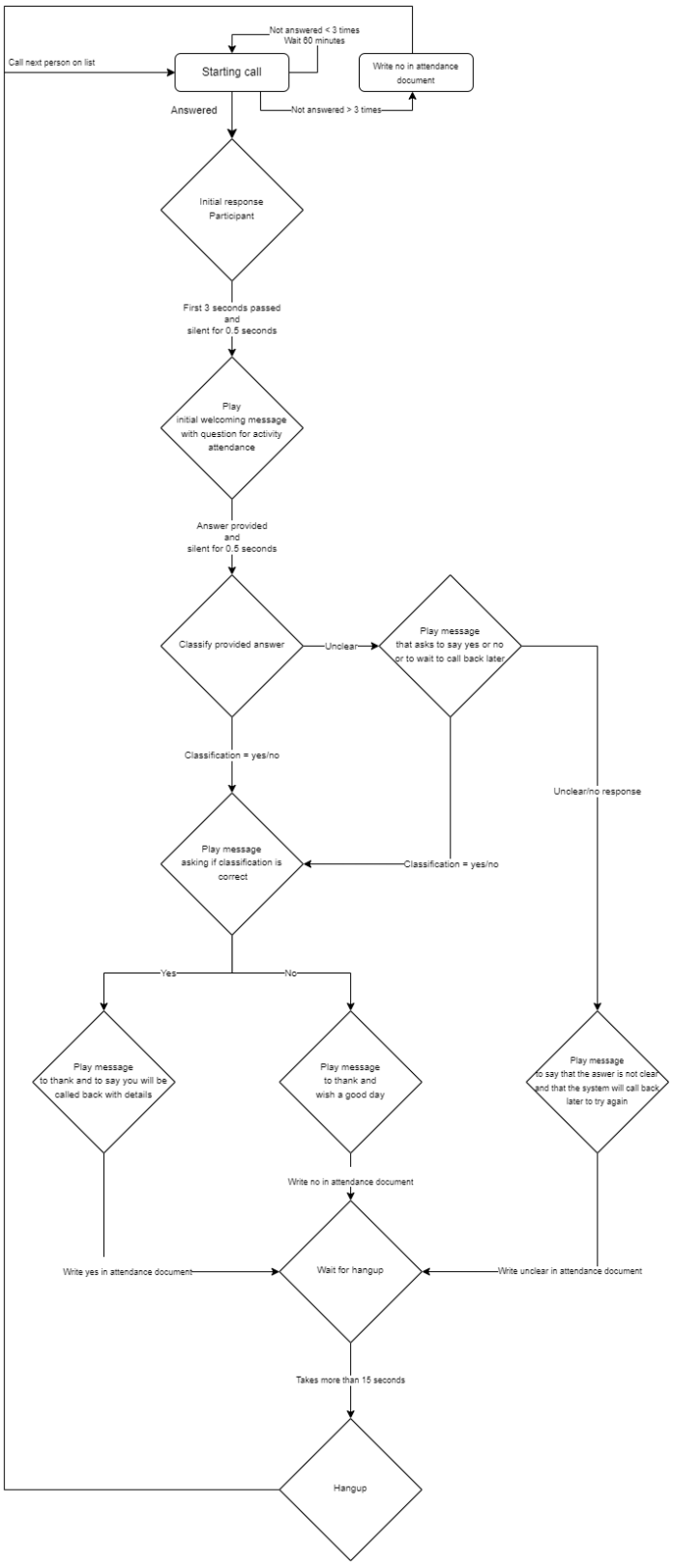

Figure D.2: functional diagram voice based callback system

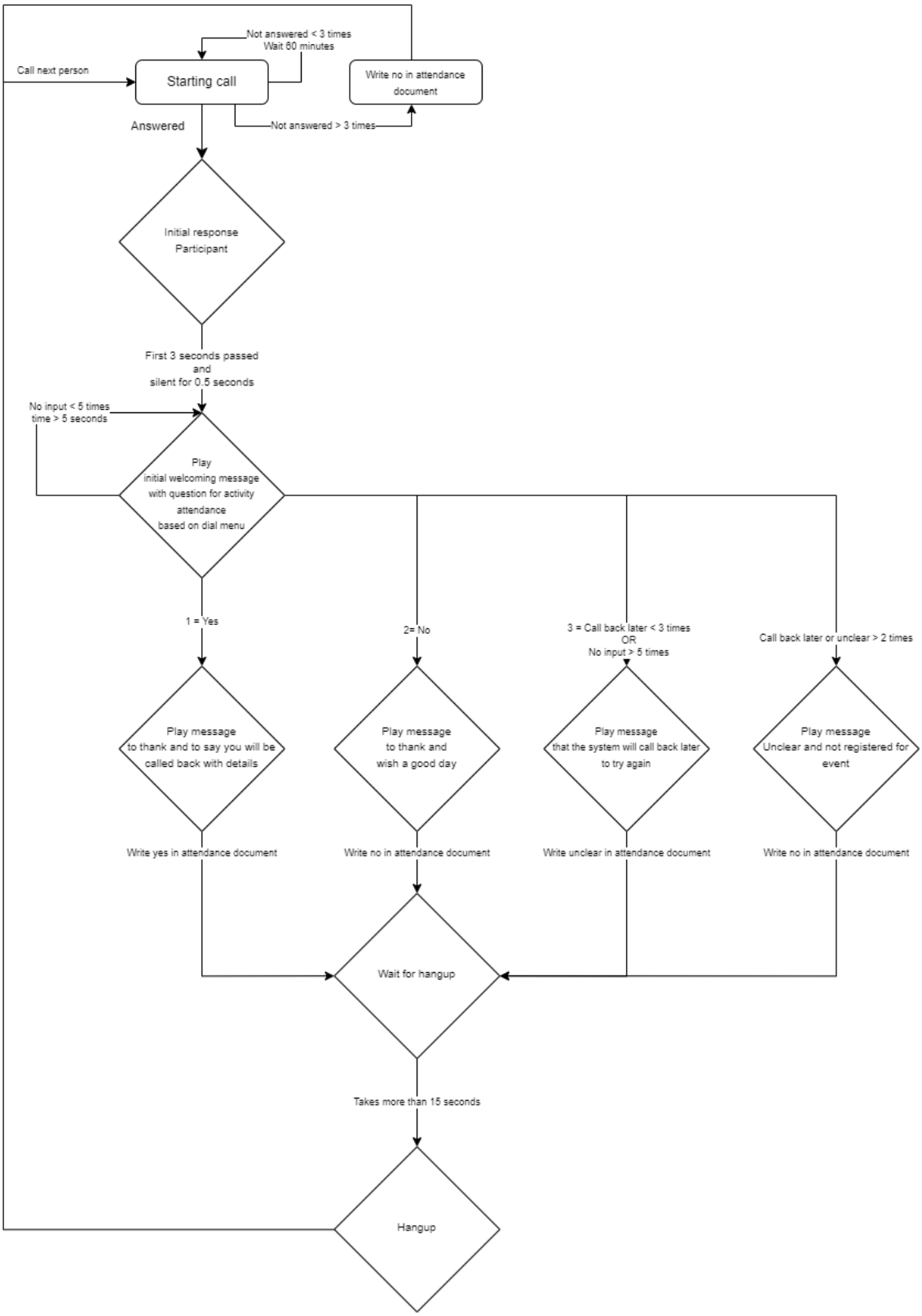

Figure D.3: functional diagram initial dial based activity registration system

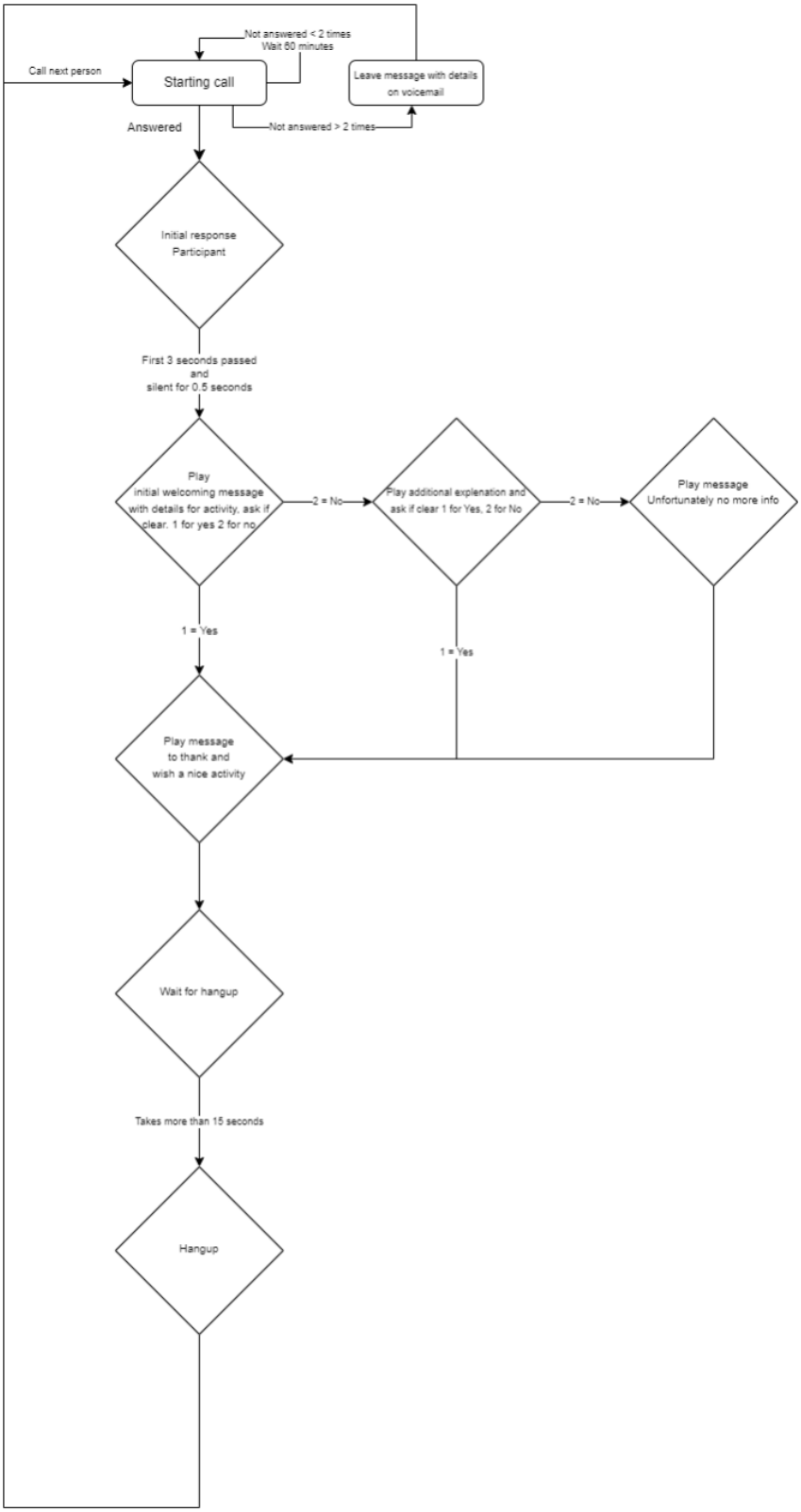

Figure D.4: functional diagram dail based callback system

Appendix E

Flyer iteration 2

WILT U MEER ACTIVITEITEN ONDERNEMEN MET UW BUREN DAN IS DEZE FLYER VOOR U.

Ik organiseer kosteloos wekelijkse activiteiten
voor appartementen-complexen in heel Nederland,
zodat u meer meer tijd met uw buren kan doorbrengen.

Mijn naam is Jop Koning en ik ben onderzoeker bij de universiteit van Twente. Mijn focus is het organiseren van meer actviteiten voor mensen in appartementen-complexen.

Om voor iedereen activiteiten te kunnen realiseren, maak ik gebruik van automatsch bellen om de informatie over de activiteit door te geven.

KIJK OP DE ACHTERKANT VOOR MEER INFORMATIE

Hoe werkt het?

Een keer per week wordt er een activiteit georganiseerd.

Op de dag van de activiteit wordt u gebeld
om de activiteit van de avond uit te leggen
en te vragen of u hier aan mee zou willen doen. U kunt
dan aangeven of u wel of niet mee wilt doen voor die activiteit.

Welke activiteiten worden er georganiseerd?

Elke week wordt er een leuke activiteit verzonnen.
Dit kan variëren van een wandeling maken,
een kop koffie drinken met uw buren of het spelen van een spelletje.
De activiteiten zullen altijd plaatsvinden in een appartement van
een bewoner of buiten rondom het appartementen-complex.

Wat gebeurt er als ik niet opneem?

Als u niet opneemt is er niks aan de hand.
U wordt tot 3 keer terug gebeld,
neemt u dan nog niet op wordt u automatisch afgemeld.

Zijn hier kosten aan verbonden?

Nee, meedoen is helemaal gratis.

Bent u geïnteresseerd?

Ik kom op 21-2-2023 langs bij uw appartementen-complex.
Ik zal dan aanbellen om te vragen of u intresse heeft en een uitleg te geven.
Mocht u hier geen intresse in hebben
voelt u zich dan vrij om de deur niet open te doen.

Vragen of al aanmelden?

U kunt mij altijd bereiken op 06-83949299

Appendix F

Flyer final iteration

WILT U MEER ACTIVITEITEN ONDERNEMEN? DAN IS DEZE FLYER VOOR U.

Kosteloos uitgenodigd voor verschillende wekelijkse activiteiten voor senioren.

Mijn naam is Jop Koning en ik ben onderzoeker bij de universiteit van Twente. Mijn focus is het betrekken van meer senioren bij georganiseerde actviteiten.

Om voor iedereen activiteiten te kunnen realiseren, ontwikkel ik een belsysteem dat helpt bij het organiseren.

KIJK OP DE ACHTERKANT VOOR MEER INFORMATIE

Hoe werkt het?

Twee keer per week wordt u gebeld voor een activiteit.

Op de dag van de activiteit wordt u gebeld
om de activiteit van de avond uit te leggen
en te vragen of u hier aan mee zou willen doen. U kunt
dan aangeven of u wel of niet mee wilt doen voor die activiteit.

Welke activiteiten worden er georganiseerd?

Elke week wordt er een leuke activiteit georganiseerd.
Dit kan variëren van bingo, een knutselmiddag of een avond klaverjassen.
De activiteiten zullen plaats vinden bij u in het buurtcentrum.

Wat gebeurt er als ik niet opneem?

Als u niet opneemt is er niks aan de hand.
U wordt tot 3 keer terug gebeld,
neemt u dan nog niet op wordt u automatisch afgemeld.

Zijn hier kosten aan verbonden?

Nee, meedoen is helemaal gratis.

Vragen of al aanmelden?

U kunt mij altijd bereiken op 06-83949299